CAMBRIDGE Professional English

Cambridge English for Scientists

TEACHER'S NOTES

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Scientists
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UNIT 1 Getting started in research

- Planning a career in science
- Applying for research funding
- Writing up a résumé or CV
- Preparing for an interview

Go to page 12 for essential background information on the topic and useful web links.

Don't forget to use the Additional activity worksheet in the Resources section of the Cambridge English for Scientists website.

Science-specific terms can be found in the Glossary on Student's Book pages 117–125

Refers to the Audioscript on Student's Book pages 91–102

Planning a career in science

Before you begin …

If this is the beginning of a course with a new group of students and your students don't know each other, you could ask them to give a three-minute presentation on themselves: their name, their work or studies, experience, ambitions and areas of expertise and interest within science and research (both in the public and private industries if they are professionals).

You could also brainstorm with the class the various scientific fields and write their ideas on the board. Afterwards, compare their ideas with a list from a dictionary (e.g. several scientific fields and their definitions can be found here: http://www.wordiq.com/definition/List_of_academic_disciplines#Natural_sciences http://dictionary.cambridge.org/search/british/?q=science&x=0&y=0).

Print some English-language adverts for jobs in science, for example from http://www.nature.com/naturejobs **or a website in your country. The jobs should be suitable for your students, according to their area of science. For example, *Nature Jobs* has a function where you can search by job title, discipline, area of the world or a selection of employers. If your students are still in higher education, they may be interested in reading adverts for internships or fellowships. Doing a search for 'internship' here:** http://www.science.gov/internships **yields a wide range of internship adverts. Give each pair one or two different adverts. Students read the job adverts and discuss in pairs whether (a) the job sounds interesting and (b) they would have the necessary qualifications, skills and experience to apply. They then pass theirs to the next group and discuss the next adverts. At the end, elicit from the class which jobs look the most attractive and suitable for members of the group. They could also underline useful vocabulary from the adverts, which you could put up on the board.**

1 a **Students discuss the questions in pairs and then feed back to the class.**

b **Make sure students read and understand the terms in the table as they will be useful in the 'Writing up a résumé or CV' and the 'Preparing for an interview' sections of the unit. Allow time for students to make a similar table from their countries. Students discuss the questions in pairs and then feed back to the class.**

Note

Students may ask about the 'post-doctorate', which relates to advanced academic work and research, or the 'habilitation', which is the highest academic qualification a person can achieve in certain European and Asian countries. Students may ask how to explain what the habilitation is in English, therefore a good definition is: the habilitation requires the candidate to write a professorial thesis based on scholarly accomplishments and/or publications, reviewed by and defended before an academic committee in a process similar to that of the doctoral dissertation. In the sciences, between 10 and 30 (or more) research articles have to be published during a period of about 4 to 10 years. While the PhD is sufficient for a faculty position at a university in the United States, in other countries only the habilitation qualifies the candidate to independently supervise doctoral students and/or receive an academic promotion.

2 a **Students listen to the recording and tick the options which interest Eriko and put a cross next to the options which don't. You could ask the students for definitions of the vocabulary, listed below, which is heard in the conversation. After they have listened, you could ask students to look at the Audioscript and try to guess their meanings from the context and/or use a dictionary.**

1 junior researcher
2 fieldwork
3 benchwork
4 post-doc (an abbreviation of *post-doctorate*)
5 higher education

▶1.1 page 91

Answers

✔ teaching (undergraduate) students
✔ doing post-doctoral research
✘ supervising a research team
✔ finding a permanent position at a university
✔ discussing theory
✘ doing practical fieldwork
✘ staying in London
✘ finding a well-paid job

Extension activity: private or public industry

You could write the following question on the board: 'What are the advantages and disadvantages of working in academia or industry?' and ask the students to brainstorm in pairs and then feed back to the class.

b **Students listen to the eight sentences and write the number of the sentence in the corresponding column.**
▶1.2 page 91

Answers

likes or dislikes: sentences 3 and 5
past experiences: sentences 2 and 7
future (more certain): sentences 1 and 6
future (possible): sentences 4 and 8

c **Students write the underlined phrases from the Audioscript in the correct column in the second row of the table.**

Answers

Talking about …			
likes or dislikes	**past experiences**	**future (more certain)**	**future (possible)**
3 But I'm not so interested in doing that.	2 But I did my Master's here, part-time, while I was working as a research assistant in the lab.	1 And then I'm meeting a couple of people from the University of Glasgow at the conference next month.	4 But in industry you could supervise more junior researchers.
5 I find it really interesting to explain quite complex topics.	7 So, basically I've done everything here.	6 I'm going to leave here, though.	8 You would also be out in the field more.

Language note

As a follow up lesson, mention that the *present perfect* is commonly used when listing professional experience. Write examples on the board such as:
I have published three articles.
I have taught introductory calculus and I have supervised interns.

The *past simple* is also useful for actions in the past, such as:
I went to Massachusetts Institute of Technology (MIT).
I completed my PhD in 2002 and in 2003 I moved to Budapest.

Extension activity: *present perfect*

Using the *present perfect* and the *past simple*, students write a list of their scientific, educational and/or professional experience. Ask them to include some dates. Students then work in pairs and read their lists to each other. Mention this list will be useful in Exercises 3b and 15 later on in the unit.

3 a **Allow time for students to think about and make notes on the questions.**

b **Students take turns to interview each other in pairs.**

Applying for research funding

Before you begin …
Ask students if anyone has ever applied for a scholarship or fellowship. Ask students what it involved and the time it took them to apply. Doing a search for 'fellowship' here: http://www.science.gov/internships yields a wide range of fellowship adverts. You could print off two or three examples for the students and ask them to identify the characteristics the adverts have in common such as qualifications, the time frame, the benefits and the required documents (e.g. cover letter, recommendation letters, a CV, etc.).

4 a **Make sure students read and understand the website extract. Students discuss the questions in pairs and then feed back to the class. You could ask students to elaborate on their reasons for answering 'yes' or 'no' in question 2. To follow up on question 4, you could ask students to elaborate on the importance of government investments in the sciences by asking the following question:**

How is providing money to scientists at the beginning of their career seen as an 'investment'?

Answers

1 No – the scholarship is for the individual, not for an organisation.
2 Student's own answers
3 Personal details – name, address, education/qualifications, research experience
Project proposal – what you want to work on, where and with whom; how much funding you will need; why it is useful research
4 These potential leaders will be able to guide future research and train and mentor future researchers. The investment in one leader now will therefore be amplified in the future.

Extension activity: investigating a fellowship

Elicit questions from the students that they could ask to obtain more information about the fellowship in Exercise 4a. Ask students to write an email to the fellowship committee asking their questions.

Suggested answers

1 Can two applicants share the fellowship?
2 What would be the salary?
3 Is there a particular area of research that is given priority?
4 Can candidates apply over consecutive years?
5 Would it be possible to get in touch with last year's fellowship winners?
6 Will the fellowship committee help in obtaining a visa?

b **Students work in pairs or individually to complete the matching activity.**

Answers

1 j 2 e 3 i 4 c 5 h 6 g 7 b 8 a 9 d 10 f

5 a **Ask students to individually brainstorm a project summary in their area of research. Make sure they understand instructions 1–6. Let students know they can download this document to help them:** http://www.latrobe.edu.au/learning/assets/downloads/research-report-writing.pdf

Language note

It is not uncommon for project summaries to be written in the first person plural (we) when the applicant is representing an institution or working with a co-author.

b **Allow time for students to read Eriko's complete project summary. You could remind students that the Glossary in the Student's Book can help them with some of the vocabulary. Ask them to brainstorm, in pairs, what the commercial applications of the research might be.**

Answers

Possible applications for the robot technology could include many of the functions sniffer dogs are used for today, for example:
- in rescue operations following disasters (earthquakes, avalanches etc.) to detect bodies
- to detect chemical/gas leaks (e.g. in mining)
- at customs to detect plant matter, drugs and other materials
- to locate mines or unexploded bombs
- to find truffles

Extension activity: odour-detecting robots

Depending on your students' interests, ask them to do an Internet search for odour detection robots to see if they can find up-to-date examples of institutes, companies and parts of the world where this technology is being researched and put to use. Ask them to try to find out who the leading experts in this field are. Students then feed back to the class. Additional reading on this subject can be found on the following websites:

- **What Can Sharks Tell Us About Designing Robots**
  http://www.popularmechanics.com/technology/engineering/robots/shark-smell-and-robot-design
- **Robots that Smell**
  http://itotd.com/articles/240/robots-that-smell

c **Students work in pairs to complete the matching activity.**

Answers

A 2 B 6 C 3 D 1 E 5 F 4

d **Students work independently to underline words they could use in their own summaries.**

Suggested answers

B The proposed research will concentrate on …
C This technology will …
D This research aims to …
E This will then (be tested experimentally)
F This should produce …

6 a **Make sure students understand the words in the box and then ask them to fill the gaps in the project summary.**

Answers

1 However
2 The proposed research
3 will indicate
4 aims to
5 The study
6 The initial phase

Additional activity Unit 1: a project summary

If students need more help writing project summaries, you can use this Additional activity worksheet for Unit 1 in the Resources section to help them expand their vocabulary.

b **Allow time for students to write a project summary using the phrases from Exercises 5d and 6a and, if desired, the Additional activity worksheet.**

Writing up a résumé or CV

Before you begin …

Ask students if anyone has already written a résumé, CV or cover letter in English. If they have, ask if it is up-to-date and whether they would like to bring it to class to help their classmates. You could ask students to go to this website (which provides useful input on résumés/CVs for the sciences):

http://artsandsciences.virginia.edu/gradschoolcareer/academiccareers/applicationmaterials/cvs.html

You could ask the students what they think is considered an attractive résumé/CV (e.g. a professional layout, organisation, easy to read, plenty of experience, education, references, etc.). Remind the students that recruiters often spend seconds, not minutes, reading CVs.

You could give them an example of a poorly written résumé/CV and ask them how long it takes them to read it. Then compare it with a résumé/CV that's easy to read.

Speed reading exercise: have students read a résumé/CV and time them to answer the important questions: education, experience, who the candidate knew, where they worked, who they worked for, etc.

7 a **Students discuss the questions in pairs and then feed back to the class.**

b **Students refer back to the SARF application in Exercise 4a and discuss the questions in pairs.**

Suggested answers

Computer skills: what programs, applications, programming languages you are familiar with and how proficient you are at using them
Dissertations: the title, a short description of the work and your conclusions, the name(s) of your supervisor(s) and the date it will be finished if in progress
Education: begin with your most recent or expected degree. List degrees, majors, institutions, and dates of completion (or expected date) in reverse chronological order. You could also list key units.
Grants and awards: details of any grants or awards you have received – who they were from and for how much money
Personal information: name, address, telephone number and email address
Presentations: list items in standard bibliographic format
Publications: as presentations, list in standard bibliographic format. Those in press or submitted manuscripts can be included.
Research experience: job title, the name of the employer or institution, dates, your responsibilities and accomplishments
Study abroad: where and when you studied, who your supervisors were, what you investigated, what courses you took
Teaching experience: what courses you taught (and in what capacity, e.g. lecturer/tutor), the name of the employer or institution, dates, your responsibilities and accomplishments
Technical skills: include any additional technical skills you have which will not be immediately obvious from the dissertations / work experience you listed
Travel: where you have been and why (to work as a volunteer, for pleasure, on business)

8 a **Students listen to the conversation between Eriko and Susana and complete the headings Eriko will use.**
▶1.3 page 91

Answers

1 Education
2 Teaching Experience
3 Grants
4 Awards

b **Students compare their list of headings from Exercise 7b with the list in Audioscript 1.3 and discuss what is different.**

You could also ask students whether the kind of information under the headings in Audioscript 1.3 is similar to their ideas in Exercise 7b, question 3.

c **Students listen to the conversation again and answer the question.**
▶1.3 page 91

Answers

1 Use a lot of different headings
2 Write the most recent thing first

9 a **Students look at the CV extract on page 86 in the back of the Student's Book and discuss whether Carlos needs to make any changes to what he has written.**

Students may ask about translating the education establishments into English. You may want to remind them that this is unnecessary given that potential employers may want to find the institutions on the Internet.

Students may also suggest Carlos provides a working title for his PhD thesis.

Answers

Yes – he should write his most recent educational experiences first.

b **Make sure students understand the term 'bullet points', then ask them to answer the questions.**

Answers

1 A verb in the past simple. Regular verbs add *-(e)d* to the root of the word (e.g. produce > produced).
2 It is better first to state what you did and then say why you did it.

Extension activity: word formation

You may wish to give the students more practice with word formation and changing existing vocabulary into various word forms. For example: analysis (n); analyst (n); analyse (v) (also perhaps mentioning that many don't change their form). Ask students to guess the verb and noun forms of the following verbs, which also appear in Exercise 9c: focus; research; generate; create; develop; determine; involve; structure; adapt. Ask the students to write sentences using the different forms of the verbs then feed back to the class. For example: 'I was involved in many projects', 'My involvement in this project goes back five years'.

Suggested answers

verb	noun
focus	focus
research	research
generate	generation
create	creation
develop	development
determine	determination
involve	involvement
structure	structure
adapt	adaptation

c **Ask students to re-write the sentences like the examples they studied in Exercise 9b.**

Suggested answers

1 used pure cloned enzymes to generate specific carbohydrate oligomers
2 created a new CD4 positive HeLa cell clone
3 developed sensitive methods to determine the fine structure of pectins in maize
4 investigated the way the myocardium adapts at the sub-cellular level following exercise

10 a **In pairs, students answer the questions. Remind them that using the correct citation forms of publications will be useful for their résumés/CVs, as well as any articles they may write in English (e.g. for the References Cited section at the end of journal articles). You may also want to ask students what 'Working Title' means: a title of the thesis or paper, which has not been officially decided upon.**

Answers

1 1 author's name 2 year 3 title of article 4 journal name 5 journal volume and/or issue number 6 page numbers
2 In press
3 Submitted manuscript

b **Ask students to put the different elements of the publications in the correct citation order.**

Answers

1 Hernandez Sanchez, R. and Alvarez, C.M. (2011) 'Salinity and intra-annual variability of perilagoonal vegetation' *Submitted manuscript.*
2 Hernandez Sanchez, R., Gomez Herrera, S.A. and Alvarez, C.M. (2011) 'Declining peri-dunal variability in Doñana' Environmental Management Review. *In press.*
3 Hernandez Sanchez, R. and Alvarez, C.M. (2010) 'Hydroperiod effects on peri-dunal vegetation' Spanish Hydrology Journal Vol 2. pp167–184

11 **Ask students to think of a job or scholarship they could apply for. They could do a search at** http://www.nature.com/naturejobs **or a company of their choice. If your students need to apply for internships, you might encourage them to apply for companies that have partnerships with their institutions. Students then work independently to write a first draft of the Personal Information and Education sections of their résumés/CVs. You could provide corrections yourself, or involve the class in a peer-correction session (thus preparing them for future editing and article review practice, which is addressed later in the book).**

Preparing for an interview

Before you begin …

Ask students if anyone has conducted an interview in English. Has anyone been both an interviewee and an interviewer? On the board, brainstorm with the students key characteristics (in personality, work ethic and background) that interviewers may look for in a fellowship or job applicant. Ask them what they think interviewers are most interested in knowing about them. Is it their education? Their job experience? Or even money they've obtained through grants?

12 Ask students to read the extract and answer the questions.

Answers

1 By conference call
2 Confirm her availability for the date and time, upload a video of her presenting her research proposal
3 **Suggested answer**
She cannot see the interviewers, there might be a time delay between the UK/Australia, it might be difficult to hear what is said

13 a In pairs, students list the advantages and disadvantages of the three bulleted points. You may want to mention that preparing a pre-written script is acceptable provided they learn how to pronounce jargon correctly.

b Students listen to the conversation and answer the questions. Question 1 can be answered in several different ways, though students should recognise that Eriko is feeling nervous, self-conscious etc.
▶1.4 page 91

Answers

2 He says she speaks too quickly.

c Students predict what advice Carlos might give Eriko on her second attempt to make the presentation even better.

d Students listen to Carlos's feedback and answer the questions. See if the students made the right predictions.
▶1.5 pages 91–92

Answers

1 clearly
2 louder
3 stronger
4 pause
5 problem
6 English
7 speaker

e Students listen and answer the questions.
▶1.6 page 92

Answers

1 Yes
2 Yes

f Students listen to the extracts and mark the stressed words.
▶1.7 page 92

Answers

2 research (NB: Eriko uses the American English pronunciation. British English would stress this word as 'research')
3 useful
4 example
5 However, number, problems

g Students complete the phrases in Exercise 13f with information that is related to their work. Ask them to practise the phrases, paying close attention to the stress and intonation.

h Ask students to plan a short presentation text (about 70 words), then memorise it, or choose the text from Eriko's presentation in Audioscript 1.6 (page 92 of the Student's Book). You may wish to ask students to underline key words and syllables to improve their pronunciation and intonation. This activity can be given as homework, or memorised during class as study practice. Students can work in pairs to help each other memorise their texts.

14 a Students complete the interview advice using the words in the box.

Answers

1	see	6	tone of voice
2	phone number	7	shuffle
3	application form	8	comfortable position
4	questions	9	facing
5	late	10	thank

Extension activity: interview advice

You could also ask students to add to the advice in the book. Some possibilities include:

- Check the local time for the interviewers. Students can do so, by going to this website: http://www.timeanddate.com/worldclock/
- Smile when speaking on the phone to sound more confident.

You may then want to ask students to write an email to an interviewer confirming the local time for each person, the technology used (e.g. telephone, Skype, video conference) and ask if the candidate can prepare anything in advance for the interview.

b Students decide which pieces of advice in Exercise 14a are the best. You may wish to include the advice they suggested in the Extension activity above.

15 In pairs, ask students to make a list of possible interview questions. They can use the ideas they came up with at the beginning of this section in the Student's Book (see previous: *Before you begin ...*). They can also use the website mentioned in the 'Background information and useful web links' section of this unit.

Extension activities: interview practice

- You may wish to ask students to practice interviewing with their backs to each other. Or one student can sit in front of the class with his or her back to the group and the rest of the class can ask questions (jury style). Turning their backs could help recreate the 'teleconference' aspect of interviewing. Encourage students to smile while answering questions – remind them it's not to show happiness, but to improve the sound of confidence and pronunciation.
- In a small class or one-to-one class, you may want to record the students and play back the recording. Ask the student/s to describe the quality of their voice. Is it monotone? Nasal? Does it need more 'smile' in the intonation?
- You can also ask students to answer the questions using the *past simple* and *present perfect* to review work done in Exercise 2c.
- Students could run a long-term group project: pooling together all the questions students at their institution have been asked during interviews in English. Put these questions in a file and publish it on an internal school website, or in a newsletter, to help future students prepare for their interviews.

Background information and useful web links

Getting started in research

Research can be defined as the thorough study of a subject, especially in order to discover (new) information or reach a (new) understanding. Applied research is discovering, interpreting, and the development of methods and systems on a wide variety of scientific matters of our world and the universe. 'Publish or perish' is the scientist's maxim. Career advancement hinges on publications. But data generation requires time and money.

Useful web links

Research definition
http://en.wikipedia.org/wiki/Research

Planning a career in science

Useful web links

English-language adverts for jobs in science

http://www.nature.com/naturejobs

Funding Your Future: Publish Or Perish

http://sciencecareers.sciencemag.org/career_magazine/previous_issues/articles/2009_09_11/science.opms.r0900077

Applying for research funding

Writing proposals has become an important feature of modern scientific research. The person, or organisation, responsible for providing funding will base their decision on the quality of the written project proposal via a 'peer review'. Winning a grant or fellowship is one of the most important steps for scientists to obtain the resources needed to carry out their research.

Useful web links

A wide range of fellowship adverts

http://www.science.gov/internships

Research proposal definition

http://en.wikipedia.org/wiki/Research_proposal

Writing up a résumé or CV

CVs are typically requested for fellowship and internship applications. A résumé/CV should be well-organized and easy to follow, should highlight an applicant's strongest qualifications, and should be tailored to each application submitted. Maintaining a résumé/CV is a process that requires frequent updating (say, annually or semi-annually), which will grow in length as the student progresses in his or her career.

Useful web links

CVs

http://artsandsciences.virginia.edu/gradschoolcareer/academiccareers/applicationmaterials/cvs.html

The Basics of Science C.V.'s.

http://chronicle.com/article/The-Basics-of-Science-CVs/46275/

Preparing for an interview

Candidates may, of course, be asked a wide variety of questions. However, the list on this website is fairly typical of interviews for positions in the geosciences:

Useful web links

Some Typical Academic Interview Questions

http://serc.carleton.edu/NAGTWorkshops/careerprep/jobsearch/interviewquestions.html

You've Worked Hard to Get This Far

http://sciencecareers.sciencemag.org/career_development/previous_issues/articles/2030/you_ve_worked_hard_to_get_this_far/

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TEACHER'S NOTES

Unit 2 The scientific community

- Communicating with scientific communities
- Writing a critical review
- Completing a Material Transfer Agreement

Go to page 24 for essential background information on the topic and useful web links.

Don't forget to use the Additional activity worksheet in the Resources section of the Cambridge English for Scientists website.

Science-specific terms can be found in the Glossary on Student's Book pages 117–125

Refers to the Audioscript on Student's Book pages 91–102

Communicating with scientific communities

Before you begin …
You could ask the class to discuss the following questions:

1 Who did you last communicate with about your scientific work?
2 Did you have any difficulties in the communication? If so, how did you solve them?
3 How might communicating with a member of the general public about your work be different to communicating with another scientist?

1 a Students match the methods of communication to the pictures.

Answers
1 f 2 a 3 b 4 e 5 d 6 c

b Students look at the pictures and discuss in pairs which methods of communication they usually use. You could also ask students to work in pairs to give specific examples of a journal, conference, blog etc. that they know for their field. Students could also be asked to say why they consider these methods of communication to be useful or important (e.g. *I always try to attend the annual Lunar and Planetary Science Conference because …. I like reading New Scientist because …*).

c Students discuss the questions in small groups and then feed back to the class.

Suggested answers
a because developments in one specialism within the field can contribute to research in other areas; to network; to ensure they have a more rounded picture of the field; for general interest
b to share protocols/materials/results; to compare findings; to network; to 'bounce' ideas off one another; to avoid replication of experiments; to collaborate on particular areas of research
c for general interest; because the boundaries between fields are often blurred; because developments in one field can have a knock-on effect on other fields

Note: field and specialism

Field refers to the general area of interest e.g. genetics. Specialism refers to the particular part of the field in which you mainly focus your research and in which you are an expert e.g. fungal genetics or clinical genetics.

d **Students work in pairs to choose an appropriate form of communication for each speaker.**

Suggested answers

1 A popular science magazine or book. Maybe a newspaper.
2 A conference; An online forum
3 An online forum; An academic journal; A conference

Note

The Hadron Collider (see statement 1 in Exercise 1d on page 14 of the Student's Book) is a gigantic particle accelerator used by physicists to study the smallest known particles. Two beams of subatomic particles called 'hadrons' travel in opposite directions inside the accelerator, gaining energy with every lap. Physicists collide the beams head-on at very high energy to recreate the conditions just after the Big Bang.
More information can be found at: http://public.web.cern.ch/public/en/lhc/lhc-en.html

2 a **Students read the extracts and match them to a form of communication from Exercise 1a. Make sure students know that more than one correct answer may be possible and that there is not a direct match between the forms of communication from Exercise 1a and the extracts A–E.**

Answers

A 6 (a popular science magazine) or 2 (an online forum or science blog)
B 3 or 6 (a newspaper or a popular science magazine)
C 4 (an academic journal) or possibly 6 (a popular science magazine)
D 2 (an online forum or science blog)
E 4 (an academic journal)
Not included 1 (a conference), 5 (a popular science book)

b **Students discuss the questions in pairs and then feed back to the class.**

Language note: noticing style in writing

Noticing the style (or genre) of a text can be challenging for students at intermediate levels. However, the ability to recognise that different kinds of writing (e.g. forum post, research paper) use different kinds of language will be necessary for students to progress to a more advanced level.

Some features you could draw students' attention to for each extract are given below.

A includes:

- less formal phrases (*more people were … there are some points to consider when putting …*), which suggest a newspaper
- an in-text reference (*the study by Lipton et al. (2010)*), which suggests an academic paper

This extract probably comes from a popular science magazine or a science blog (the actual source is NHS Options, an online journal for employees of the UK's National Health Service).

B includes:
- multi-word verbs (*be down to … look at …*) and verb-noun collocations (*have a lower risk of … has the greatest effect*) suggest that this is a newspaper
- descriptions which give the general idea but no specific details (*Tea and coffee drinkers …a large body of evidence … may not be …*)
- reference to researchers but no mention of the name or date (…, *say researchers*)

This extract probably comes from a newspaper (the actual source is the BBC news website).

C includes:
- a passive verb (*can be … generated*)
- very specific descriptions (*lentivrius-mediated transgenesis … current gene silencing techniques in mammalian systems*)
- abbreviations which the writer assumes the reader knows (*RNAi*)

This extract probably comes from an academic journal or a high-quality science magazine aimed at professionals (the actual source is an abstract for a scientific research paper in an academic journal).

D includes:
- Informal phrases (*Hi! … Thanks!*) and an 'emoticon' (a symbol which represents the writer's feeling about something) (*:-( )*, which suggest a personal email
- An address to more than one reader (*Has anyone …?*), which suggests a forum post
- very specific descriptions (*nanoparticles sticking to glassware … silylation protocol*), which suggest a more formal academic use

This extract probably comes from a forum post (the actual source is in fact a science forum).

E includes:
- use of Latin phrases in italics (*in vitro*)
- very specific descriptions (*inhibit breast cancer metastasis … risk of death from breast cancer … a prospective observational study*)
- use of 'hedging' language – phrases which make a claim more cautious (*studies suggest that … aspirin may inhibit … Animal and in vitro studies suggest that aspirin may …*)

This extract probably comes from an academic journal or a high-quality science magazine aimed at professionals (the actual source is an abstract for a scientific research paper in an academic journal).

3 a Check that students understand the idea of reader and purpose. Students read extracts A–E in Exercise 2a again carefully and complete the second column of the table.

Answers

1 does anyone know …?
2 be down to
3 :–(, Thanks!
4 say researchers in *Archives of Internal Medicine*
5 Lipton *et al.* (2010)
6 This was a prospective observational study
7 will need to be verified
8 *in vitro*

b Students discuss the questions in pairs and then feed back to the class.

Answers

Features 5,6,7 and 8 are appropriate for formal scientific research papers
Features 1,2, 3 and 4 are appropriate for personal communication

4 a Students discuss the questions in pairs and then feed back to the class.

b Allow time for students to read the posts and to think about the answers to the questions. Students then feed back to the class.

Extension activity: online research

Ask students to research the answers to these 3 questions online. Answers posted in response to the forum posts at the time said the following:

A: Virologists don't know

B: Barium sulphate, lead, very deep water

C: No. Writing clearly helps because it makes it easier for a busy editor to understand the message but a paper wouldn't be declined just because it was not well-written.

c Students read the posts again and match each sentence to its function.

Answers

Post A: a 1, b 2, c 3
Post B: a 2, b 1, c 3
Post C: a 3, b 1, 2

d Ask students to look at the Subject fields and then elicit how the questions differ from normal questions.

Answers

There are no question words, no articles (*a*, *an*, *the*) and no main verbs (can't in B belongs to the relative clause *which can't …*; *considered* in C is a past participle)

Extension activity: noun phrases* as questions

Write the following questions on the board and ask students to make each one into an appropriate subject line for an online post:

- Can anyone tell me what V5 antibody I should use for IP?
- What's the best protocol for extracting bacterial RNA from cells in agar?

Suggested answers

V5 antibody for IP?
Best protocol for extracting bacterial RNA from cells in agar?
* *Noun phrases* are widely used in all forms of academic writing, including scientific research papers. A noun phrase consists of a noun (e.g. *drugs* or *survival*), called the headword, whose meaning is specified by the addition of words before and/or after the noun (e.g. *nonsteroidal anti-inflammatory drugs* or *survival among women with breast cancer*). For more information on noun phrases see *Cambridge Grammar of English* pages 318–373.

Additional activity Unit 2: indirect questions

One way to make questions more polite is to make them less direct. For practice with indirect questions, you can use this Additional activity worksheet for Unit 2 in the Resources section of the *Cambridge English for Scientists* website.

e Allow time for students to think of a question and to write their forum post.

Extension activity: getting answers to forum posts

If your class have related specialisms, they could try to answer their peers' posts. You could also encourage the students to post their questions on a real internet forum such as http://network.nature.com/forums and www.scienceforums.net, which both have free registration.

5 **Students discuss the questions in pairs and then feed back to the class.**

Suggested answers

2 If you use an inappropriate style, your work will not be respected and it may not even be understood. Even good research may not be published if written in an inappropriate style.

3 Every time you look at a text in English, keep a record of where you read it (a book, a text message, a research paper), why it was written (to entertain, to arrange a meeting, to report new research), who it was written for (the public, a friend, the scientific community), then underline useful words and phrases that you only/mostly find used in those texts.

Writing a critical review

Before you begin …

Find a selection of news headlines reporting recent developments in your class's areas of interest. http://www.sciencedaily.com/ is a good source as it can be browsed or searched by subject area. Elicit what the story behind the headline might be. Students then read the articles and report back on the actual news story.

6 a **Students read the headlines and beginnings of the articles and then work in pairs to answer the questions.**

Suggested answers

2 The science reported in the media is often exaggerated so, for example, something that was found to reduce stress may be portrayed as curing it, something which causes a small change may be suggested to cause a large change. In addition, the context of the research is often removed or the findings are extrapolated, so a finding in mice, for example, is presented as applying to humans, a finding in certain people presented as applying to the population as a whole. The difference occurs because bold statements are much more eye-catching and the public is often not (believed to be) interested in details.

3 You could look at the report of the same research in a science magazine or, even better, look at the original journal article.

b **Allow students time to complete the sentences individually. Students then discuss their ideas in pairs and feed back to the class.**

Suggested answers

a If you read research *critically*, it means that you think about what you are reading, considering what is good and what is not good about the research done (particularly the method used and the conclusions drawn from the results).

b You should always read research critically because it allows you to judge how reliable the results obtained are and how credible the conclusions drawn are.

Note: *critical review* and *criticism*

A *critical review* of a piece of research is not the same as a *criticism*. A critical review should consider both the positive and negative points of the research. A criticism focuses only on the negative aspects.

7 a **Students discuss the questions in pairs. They then listen to the recording and make notes on Martina's answers to the questions.**
▶2.1 page 92

Answers

1 Two (*a couple of*) paragraphs: a brief summary and then Ryuchi's opinion
2 No, Ryuchi needs to read the whole paper in order to write a critical review of it.
3 Read the abstract first, make a table and note the key points from each section of the paper.
4 Yes
5 Ryuchi should make his own notes (it will help him write the review in his own words).

b **Students match the questions to the correct section of the research paper and then feed back to the class.**

Note: *dependant variables, independent variables* and *controlled variables*

Variables are the features which can change in an experiment. In any experiment, there will be one *dependent variable*, which is the feature being measured, one or more *independent variables*, the features which are changed and one or more *controlled variables*, which are kept constant.

Answers

Introduction: 4, 7
Method: 1, 5, 6
Results: 3
Discussion: 2

c **Allow students time to check the meanings of the words in the box.**

d **Students read the summary column of the table and answer as many of the questions in Exercise 7b as they can.**

You could ask the students to say what they think the answers to questions 4 and 7 might be.

Answers

The questions which can be answered are:
Method
1 *What variables were investigated?* Changes in cortisol and catecholamines in urine, and changes in energy metabolism and in gut microbial activities before eating dark chocolate and after 8 and 15 days of eating 40 g chocolate/day in high and low anxiety participants
5 *Who/What was studied?* 30 young healthy adults
6 *What procedure was used?* Questionnaire to divide group into high vs low anxiety; Blood and urine samples taken; 40 g chocolate/day given for 14 days; Blood and urine samples taken again at 8 days and 15 days
Results
3 *What were the main findings?* All participants had lower levels of stress hormones in the blood; the high and low anxiety groups had more similar energy metabolism and gut microbial activity after eating the chocolate than before.
Discussion
2 *How did the authors interpret the results?* 40 g chocolate a day for 2 weeks can change metabolism. This could affect health in the long term.

Suggested answers

The research is relevant because stress-related diseases are believed to be increasing in society. Finding something which reduces stress could be of therapeutic benefit.
The hypothesis could have been that chocolate could reduce stress. People often claim this anecdotally.

e **Before they look at the opinion column and listen to Ryuchi and Martina discussing the research, you could elicit from students their opinion of the research.**

Allow students time to look at the opinion column before you play the recording. Students listen to the recording to complete the notes. You could also check the meanings of:

- *sample size:* the number of subjects (in this case people) assigned to a treatment condition in an experiment or study.
- *placebo**
- *blind trial**

*These two items are in the Glossary on Student's Book pages 117–125

▶2.2 page 92

Answers

1	short	6	chocolate
2	reduces	7	same
3	stress	8	placebo
4	anxiety	9	metabolic
5	control	10	blind

f **Students discuss the questions in pairs and then feed back to the class.**

Note: *credible, original, reliable, significant* and *valid*

If research is *credible* we can believe the results. If it is *original*, the research has not been done before. If it is *reliable*, the research could be repeated and the same results would be found. *Significant* research produces findings which are important. If research is *valid*, it tests what it claims to test. A good piece of research should be all of these things.

8 a **Students read the extracts from Ryuchi's critical review and answer the questions.**

Answers

1 No, they don't include all the main points from the notes. Not mentioned are:
From the summary column:
– The researcher's interpretations of the results as presented in the discussion section of the table
From the opinion column:
– The short trial period
– The fact that they did not look at stress levels / reported anxiety after eating the chocolate
– The suggestions for improving the study (i.e. need more people with the same anxiety levels / give chocolate or placebo / look at long-term changes / use a blind trial)
2 a Extract A summarises part of the research
b Extract B gives an evaluation

b **Students read the extracts and replace the underlined phrases with an underlined expression from Exercise 8a.**

Note

The *brachial artery* referred to in extract b is the main artery in the upper arm.

Answers

a One problem with this research is; In addition / Furthermore
b Furthermore / In addition
c changes in [blood flow] were analysed
d The research found
e The results cannot be applied to; making it impossible to
f Blood samples were taken

c **Students order the extracts in Exercise 8b to make two paragraphs.**

Answers

A paragraph which summarises the research: f, b, c, d
A paragraph which gives an evaluation: a,e

9 **Students find a piece of published research in their field to review. Many of the articles at http://www.sciencedaily.com/ have links to the original research or if students have access to a database such as Science Direct www.sciencedirect.com, they could use this to find an article.**

Students make a table and take notes on the key points in the article, along with their opinion. Encourage the students to use only their notes when writing their critical review rather than looking back at original text. This will help them to write using their own words and will stop them being tempted to 'copy' from the source text.

Extension activity: comparing science in the media with actual scientific research

The news articles introduced by the headlines in Exercise 6a can be found at the following links:

http://www.sciencedaily.com/releases/2009/11/091111123612.htm

http://www.medicalnewstoday.com/articles/176940.php

Students read these articles and compare how the science presented in the news article differs from the actual science as described by Ryuchi. Alternatively, they could compare a news report of the research they chose in Exercise 9 with the actual science.

Completing a Material Transfer Agreement

Before you begin…

Ask students to make a list of the most common materials they use in their research and where they get these materials from. Students compare their lists in pairs and then feed back to the class. You might want to ask students if any of the materials on their list require approval and why. You could introduce the terms BioSafety and Ethics Committee Approval. These committees are explained in a note under Exercise 11a, below.

Note

An *MTA* is sometimes referred to as a *Material Transfer Agreement* and sometimes *Materials Transfer Agreement*. Both versions are acceptable and commonly used.

10 a **Students read the email, discuss the questions in pairs and then feed back to the class.**

Answers

1 To remind members of staff that protecting their work and using their work commercially are important

b **Students read the next part of the email and match the headings to the extracts.**

Answers

1 D 2 C 3 B 4 E 5 A

c **Students discuss the questions in pairs and then feed back to the class. Write the students' answers to question 3 on the board to be referred to after Exercise 11a.**

Suggested answers

2 MTAs may be needed for things like:
- substances (e.g. chemical, pharmaceutical, nucleic acid)
- biological organisms (e.g.virus, bacteria, cells, animals, plants)
- genetically modified organisms (e.g. animal, plant, micro-organism)
- biological materials (e.g. tissues, blood, urine or other body products)
- software
- nuclear materials

Any material that is commercially available will not require an MTA.

3 Details of who the individuals/organisations involved are; what the material is and what it is to be used for; where the material will be used/stored; whether approval has been given for its use (e.g. biosafety approval / ethics approval); whether it will be used for commercial gain

11 a **Allow time for students to read the MTA. Students then feed back on the information which is the same as or different to that mentioned in Exercise 10c, question 3.**

Note

A *Biosafety Committee* reviews applications regarding research projects involving the use of Genetically Modified Organisms and biohazardous materials. It ensures that laboratory activities are planned and carried out in ways that protect the health and safety of employees, the public, lab animals etc., and prevent damage to property.
An *Ethics Committee* reviews applications for research involving the use of animals and human subjects.
IP (*Intellectual Property*) refers to creations of the mind including discoveries and inventions for which property rights are recognized.

b **Students listen to the recording and complete the MTA.**
▶2.3 pages 92–93

Answers

1 No 2 No 3 Yes 4 Yes 5 No 6 Yes 7 Joint 8 Yes

c **Students discuss the questions in pairs and then feed back to the class.**

Suggested answers

1 A lay summary is a summary written for the general public, not for an expert in the field. Anyone should be able to understand it.
2 He should avoid very technical language or jargon although some amount of detail will be needed. He should keep the writing impersonal, for example by avoiding personal pronouns and by using passive forms. He should avoid exclamation marks, emoticons, etc.
3 The reader may be an administrator rather than a scientist. If they are a scientist, they will not necessarily work in Binh's field.
4 A lay summary is required so that whoever reads it can understand it – no specific knowledge is necessary.

d **Students complete the summary using the phrases in the box.**

Answers

1 material is samples of
2 different types of
3 will be stained to show
4 The aim of the research is to investigate

Extension activity: completing an MTA

Students complete the blank version of the MTA form below for some material they use in their research.

MATERIAL TRANSFER FORM

SECTION A

(to be completed when **sending** or **receiving** material):

Recipient Researcher: _____

Recipient Institution & Address: _____

_____

Provider Researcher: _____

Material Name: _____

Is this work involved with existing commercial arrangements?	**Yes / No**
Does the work involving the material have commercial potential?	**Yes / No**
Is this material hazardous?	**Yes / No**
Is BioSafety Committee Approval required?	**Yes / No**
Is Ethics Committee Approval required?	**Yes / No**
If required, has Ethics and/or BioSafety Approval been received?	**Yes / No**
Who will own the IP in any modifications to, or data collected on the material?	**University / Other / Joint**
Will any University of the South students be involved in using the material?	**Yes / No**

SECTION B

(to be completed when **receiving** material):

Brief lay summary of what the material is and what it will be used for:

12 Allow time for the students to think of some material and to write their lay summary. If you used the extension activity in Exercise 10b, you could ask the students to add their summary to section B of the MTA. If the students are from different fields, they could read each other's summaries to check that they are understandable to a lay person.

Extension activity: comparing MTAs

Ask the students to find MTAs from different institutions online (or their own institution if they have an MTA in English). Students compare the MTAs to find similarities and differences and then feed back to the class.

Additional activity Unit 2: Ethics Committee Approval

For more on Ethics Committee Approval, use this Additional activity worksheet for Unit 2 in the Resources section.

Background information and useful web links

Critical Review

A critical review summarizes and evaluates the strengths and weaknesses of a book, chapter, journal article etc. A critical review does not mean criticising the text in a negative manner.

Useful web links

Writing a Critical Review

http://www.lc.unsw.edu.au/onlib/critrev.html

Using a Scientific Journal Article to write a Critical Review

http://www.lib.uoguelph.ca/assistance/writing_services/components/documents/scientific_review.pdf

Technology Transfer and Material Transfer Agreements

Technology transfer is the process of sharing of skills, knowledge, technologies, etc. between institutions to ensure that scientific developments are accessible to a wider range of users.

A **Material Transfer Agreement** (MTA) is a contract that governs the transfer of tangible research materials between two organizations, when the recipient intends to use it for his or her own research purposes. The MTA defines the rights of the provider and the recipient with respect to the materials and any derivatives.

Useful web links

Technology Transfer

http://en.wikipedia.org/wiki/Technology_transfer

Material Transfer Agreement

http://en.wikipedia.org/wiki/Material_transfer_agreement

Quick Guide to Material Transfer Agreements at UC Berkeley

http://www.spo.berkeley.edu/guide/mtaquick.html

Chocolate and stress

Chocolate can affect the brain by causing the release of various neurotransmitters, molecules which transmit signals between neurons. The neurotransmitters affected by chocolate include endorphins, which are known to reduce pain and stress; serotonin, a known anti-depressant; phenylethylamine, which affects blood pressure and blood-sugar levels and increases alertness, improves mood and reduces depression; anandamine, which stimulates dopamine production leading to positive feelings; and theobromine, which causes physical and mental relaxation and increases alertness.

Useful web links

Brain cannabinoids in chocolate

http://kkloukin.home.cern.ch/kkloukin/chocolate.htm

The sweet lure of chocolate

http://www.exploratorium.edu/exploring/exploring_chocolate/index.html

Ethics Committee

An **Ethics Committee** is an independent body consisting of science professionals and non-specialist members, whose responsibility it is to protect the rights, safety and well-being of human and animal subjects involved in research.

Useful web links

Human Research Ethics

http://research.curtin.edu.au/guides/human.cfm

Animal Research Ethics

http://research.curtin.edu.au/guides/animal.cfm

Cambridge English for
Scientists
TEACHER'S NOTES

Unit 3 Finding a direction for your research

- Doing a literature review
- Using evidence in arguing a point
- Taking part in a meeting

Go to pages 35–36 for essential background information on the topic and useful web links.

Don't forget to use the Additional activity worksheet in the Resources section of the Cambridge English for Scientists website.

Science-specific terms can be found in the Glossary on Student's Book pages 117–125

Refers to the Audioscript on Student's Book pages 91–102

Doing a literature review

Before you begin …

Write the following questions on the board (or alternatively, dictate the five questions to students). Students then work in small groups to discuss their answers.

1 What was the last text you read related to your subject area?
2 Why did you read the text?
3 Did you read the whole text or just part of it?
4 Did you read it quickly or slowly?
5 Did you take notes, highlight sections or not write at all?

You could extend this to a discussion of matching reading purpose with reading strategy. For example, a scientist who needs to check the quantity of a particular reagent for an experiment might scan the methodology section of a paper for the information, whereas the same scientist could read the discussion section intensively in order to fully understand the implications of the research.

1 a **Make sure students understand what biomimetics is (see the background information and useful web links on pages 35–35 for useful sources of information). Students match the natural phenomena to the inventions they inspired.**

Answers

1 termite mound	4 mosquito
2 snail shell	5 beetle
3 boxfish	6 plant leaves

b **Students discuss the questions in pairs and then feed back to the class.**

Answers

1 **Suggested answers**
- bacterial control inspired by red algae
- vaccines without refrigeration inspired by resurrection plant
- fibre manufacture inspired by golden orb weaver spiders
- water purification inspired by the marsh ecosystem
- pacemaker replacement inspired by humpback whales
- fire retardant inspired by animal cells
- self-assembling glass inspired by sea sponges
- wound healing inspired by flies
- optical brighteners inspired by *Cyphochilus* beetle

2 More or less any science discipline can be included in a biomimetics group depending on what they are trying to mimic.

Extension activity: biomimetics research

Give each student a biomimetic invention to investigate (see examples at http://webecoist.com/2010/12/31/inspired-by-insects-10-creepy-crawly-biomimetic-designs/#**). Ask them to give a short (5-minute) presentation including the following information (information in brackets can be used as an example for students):**

1 **what the invention is (A cost-efficient and ecologically-sound air-conditioned building)**
2 **what natural phenomenon inspired it (Termite mounds)**
3 **how this phenomenon functions in nature (The mound has a series of openings which the termites open and close throughout the day to allow cool air to enter the bottom of the mound, pushing warm air up and out of the top.)**
4 **how the phenomenon has been copied by scientists (The building is made from material with a high heat capacity so the walls absorb heat through the day, but the heat does not get inside. In the evening, when the temperature drops outside, vents are opened so warm air inside, which has been produced by people/machines, moves out (because heat rises) assisted by fans. At night, the cold air flows through gaps in the floor, to cool the building.)**
5 **who the major researchers in the area are (The Eastgate Centre, Harare, Zimbabwe is designed in this way. It was designed by architect Mick Pearce.)**

2 a Allow time for students to read about Pia and to look at the diagram. Students then use a dictionary to check the meaning of the words.

Note

The surface properties of an implant determine the way the body responds to it and so current research is investigating ways to alter the surface of the implant but not its mechanical properties. Calcium phosphate-coated implants have been shown to have a better success rate than non-coated ones.
One way to apply the *coating* is by the plasma-spray process, which involves *spraying* the melted substance onto a *surface*. A powder of the coating material is injected into a very hot flame, where it is rapidly *heated* and accelerated. As the hot material hits *the implant surface*, it rapidly cools and forms the *coating*.

b Students discuss the questions in pairs and then feed back to the class. Note that the students may not know the correct answer to question 2, but they should try to make a guess.

Answers

1 Only the parts of the surface which face the spray can be covered.
2 By dipping the implant in a saturated solution and encouraging the coating to 'grow'.

Note

Small crystals form when solute molecules in a solution come into contact with each other. Attractive forces allow them to stick together for a short time but if they stay together long enough to encounter other solute molecules, which also stick, eventually the attractive forces are too strong to be broken and a crystal forms. If a solid surface is provided (such as an implant), solute molecules will tend to gather on the surface and this is where the crystal will form.

3 a Students discuss the questions in pairs and then feed back to the class.

Answers

1 To find out where the 'gap' is; to check what you are thinking of doing has not been done before; to get ideas about possible methodologies
2 By searching a database for key terms; by asking others in your area for ideas of what to read; by reading a review and then looking at the sources cited
3 Plan her research; write a review

b Students read the extracts and match them to functions 1–3. Tell them to ignore the underlining at this stage. You could also elicit why Pia has made a note of the author and date for each extract (Answer: It is important to cite sources in a literature review. If you don't do this and submit or publish a paper which includes other people's work but without citations, you could be accused of plagiarism. It is therefore good practice to note down the reference while reading and note taking.).

Answers

1 D 2 B, E 3 A, C

c Students match the definitions to the underlined words and phrases. Point out that although the verb definitions are in the infinitive, different verb forms are used in texts A–E.

Answers

1 follow-up study (Extract E)
2 application(s) (Extract D)
3 irregular (Extract C)
4 induce(d) (Extract A)
5 modify(ing) (Extract D)
6 maintain(ing) (Extract D)
7 decompose(d) (Extract A)
8 enhance (Extract E)

d Students work in pairs to explain points 1–3. Encourage them not to just read from the book. Paraphrasing (saying the same thing in different words) is an important skill in writing a literature review.

e Allow time for students to read the review and answer the questions.

Answers

1 Yes
2 No. She has changed words (paraphrased)
3 By citing the sources (author + date)
4 'And others'. Used when there are more than two authors

Extension activity: paraphrasing

If your students need help with paraphrasing, direct them to the information at http://eberly.wvu.edu/current_students/advising_resources/avoiding_plagiarism/unit_4__paraphrasing and the exercises at http://annex.ncwc.edu/writing_lab/nc/handouts/setv/prints/SETV8P.html

The latter is formatted as a handout and so may not appear so attractive as a web page. Note also that these sites do not have an explicit science focus; however, the exercises are useful for paraphrasing techniques and examples of poor paraphrase. Please check whether the material is appropriate for your group of students.

f **Students look at the review again and answer the questions.**

Answers

a However
b In addition

g **Ask students which of the words in the box have the same meaning as *however* (*in contrast* / *on the other hand*) and which the same meaning as *in addition* (*moreover*). Elicit the function of *as a result* and *therefore* (to give a result). Students then complete the sentences with the correct word.**

Answers

1 In contrast 2 Moreover 3 On the other hand 4 Therefore
5 As a result

h **Make sure that the students understand the difference in the use of *and*/*but* and the words in Exercises 3f and 3g. Point out the change in punctuation. Students combine the sentences using the conjunctions. You could also elicit the conjunction which would replace *as a result* / *therefore* (*so*).**

Answers

- Studies have found better survival rates for coated implants (Havelin et al., 2000), but the usual plasma-spray technique cannot coat all surfaces evenly (Pilliar, 2005).
- However, the usual plasma-spray technique cannot coat all surfaces evenly (Pilliar, 2005) and the plasma-spraying process causes CaP input powders to break down into other compounds such as tetra calcium phosphate (Radin and Ducheyne, 1992).

Language note

Some style guides include a comma before the conjunction e.g. *Studies have shown better survival rates for coated implants, but the usual plasma-spray technique cannot coat all surfaces evenly.* This is more common in British than American English.

i **Students work in pairs to complete the task.**

Suggested answer

All four ways are possible, but version (b) is probably the best.
In version (a) the sentences may be too short.
Version (b) is in an appropriate style and presents the information in a logical order by combining the two facts about the spraying process in one sentence and information about the survival rate in another.
Version (c) is in an appropriate style and emphasises the important contrast between (Sentence 2) and (Sentence 3). However, the sentences in (b) are in a more logical grouping.
Version (d) may be too long for a single sentence.

j **Students complete the extract using the linking words. Make sure they know there is one extra word.**

Answers

1 First 2 so 3 However 4 and 5 In addition

Using evidence in arguing a point

Before you begin…
Ask the students to think of an amazing piece of 'natural design'. If they need ideas you could mention:

- In dolphins, only half the brain sleeps at a time so they can continue to breathe.
- A male horned dung beetle can lift 1141 times its own body weight – the equivalent of a 70 kilogram person being able to lift the weight of six double-decker buses.
- The Resurrection Fern can survive for 100 years without water.

Students work in pairs to explain what they chose and why it is amazing. Ask one or two pairs to report back to the class.

4 a **Allow time for students to read the information and to discuss in pairs ways to capture water from fog. You may wish to pre-teach some of the vocabulary before students read (or alternatively, check comprehension post-reading). For example: ground, droplet, vapour, condense and dust. µm stands for micrometre (1×10^{-6}m). Then students feed back to the class.**

Note

Students may know about fog-catching nets, which are in use in some places in Peru. These are large (4m x 8m), plastic nets stretched between two poles. As the wind blows the fog through the net, water droplets stick to mesh. Because water droplets are hydrophilic, they stick together to form drops. Eventually the drops get large and heavy and roll down into a gutter. From there, the water flows through tubes into a tank.

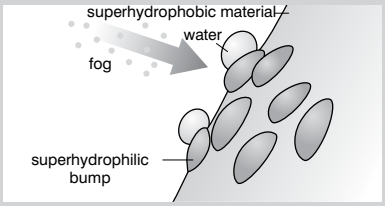
b **Students read the extract from the email and answer the questions.**

Answers

1 A (super-)hydrophilic material is one which attracts water; a (super-) hydrophobic material is one which repels water
2 A water-harvesting material
3 The Namib desert beetle's wings
4 She plans to develop a superhydrophobic material which has a surface covered in superhydrophilic bumps

c **Students draw a diagram of the design for the material and then look at the key on page 106.**

Answers



d **Students listen to the recording to answer the questions.**
▶3.1 page 93

Answers

Yes, he is (at the end of the conversation after Rayna describes the commercial application of her design).

e **Students listen to the recording again and answer the questions.**
▶3.1 page 93

Answers

1 Because it *seems to double the work*. Rayna's idea needs two surfaces (hydrophilic and hydrophobic), whereas the lotus design needs only one (a hydrophobic surface)
2 Because Rayna's material could *collect water just from fog, not raindrops, so you wouldn't need actual rainfall*
3 Rayna thinks that *nets must be less efficient because of the holes in them.* A solid material would stop more fog.
4 To collect water for drinking etc. in refugee camps; to collect and recycle water in cooling towers in factories
5 The use in cooling towers as it *sounds like a profitable use*

Extension activity: science and ethics

Bryn's increased interest in the research when a profitable purpose is mentioned could be the starting point for a debate on ethics in research. You could have the students debate the statement:

The main aim of scientific research should be to help humanity not to increase company profits.

5 a **Point out that throughout the discussion Rayna uses evidence to support her point of view. Use the example sentences to go through the differences in the use of *because*, *because of* and *so* (see Language note below). Explain that with *because* the dependent clause can also start the sentence e.g. *Because they have holes in them, I think the nets must be less efficient* / *I think that the nets must be less efficient because they have holes in them*. Students complete the sentences with the correct word.**

Answers

1 Because of 2 Because 3 because 4 so 5 because of

Language note

Because starts a dependent clause and joins it to an independent clause to form a complex sentence. *Because of* joins a noun phrase to an independent clause. *So* joins two independent clauses to form a compound sentence.

b **Students listen to the extract and circle the correct phrases. They then check their answers with the audioscript.**
▶3.2 page 93

c **Students work in pairs to decide which version of the conversation is more polite and why.**

Answers

The version from audioscript 3.2 is more polite because it uses phrases that are less certain and less direct (*I think … could be … might be …*). This shows that the speaker is more modest.

Language note

Language such as *I think we could* and *I don't believe it would be…*, which Rayna and Bryn use in Exercise 5b, is sometimes known as 'hedging'. We often use 'hedging language' to politely disagree with someone as it softens our disagreement. Common structures for hedging include modal verbs particularly *could* and *might*, verbs such as *I think*, *guess*, *believe*, *feel* …, as well as *it seems/appears* …, and phrases like *as far as I'm aware*, or *as far as I can tell*. For more information on hedging see *Cambridge Grammar of English* pages 279–283 and the Language note on page 97 of the Teacher's Notes.

Extension activity: disagreeing politely

Explain that not only is the language used when disagreeing important, the way you say it is also vital. Have students listen to the extract again and answer the following questions:

- **When Rayna disagrees with Bryn, does she speak quickly and confidently or softly and with pauses? (softly and with pauses)**
- **Are any words stressed in the polite phrases? (the verbs are often stressed – think, might etc.)**

You could have students practise copying the way Rayna says the sentences to soften the disagreement.

d **Students rewrite the sentences. You may want to make it clear that these sentences would be used in a discussion, but they would not be suitable in a scientific paper. You could have them practise saying the sentences politely.**

Suggested answer

1 I think that biomimetic solar panels which move with the sun **could** be created by using alternative materials and designs.
2 They **would** be useful in developing areas, where motor-based sun-tracking panels are not affordable.
3 Also, **it seems to me that** solar cells that track the sun **would** probably **be** more efficient at generating power than those in a fixed position.

6 **Allow time for students to think of an issue to argue about. If they come from different fields, they may need to choose a more generic topic such as whether companies should be able to patent gene sequences or whether space exploration is a waste of money. Provide feedback on the use of evidence and on whether they sound polite.**

Taking part in a meeting

7 a **Students discuss the questions in pairs and then feed back to the class.**

b **Students listen to the recording and make notes on the speakers' problems.**
▶3.3 page 93

Answers

1 Sahal: hard to listen to many people; topic changed quickly so he became confused
2 Hitomi: everyone talked at the same time; she couldn't find a way to join in
3 Sam: couldn't concentrate for such a long time; he missed important questions; he was asked a question but couldn't answer
4 Radek: didn't know how to interrupt, ask questions, etc., politely

c Students discuss the question in small groups.

8 a Allow time for students to read the text and to answer the questions in pairs.

Answers

1 The structure of many ridges, covered by millions of setae ending in hundreds of spatulae, increases the surface area which can come into contact, and so form attractive forces, with the surface.
2 By aligning the setae so the spatulae are flat against the surface and then sliding the foot to create shear force, the gecko can stick.
3 By changing the shape of the setae to increase the angle with the surface, the forces are reduced and the foot can peel away.
4 So few spatulae stick to the piece of dirt that the forces between the dirt and the surface are larger than those between the foot and the dirt, hence the dirt is 'pulled off' the foot.

Note

Shear force is force applied parallel to a surface, while *adhesive force* is the force applied perpendicular to the surface. *Adhesive force* thus stops you pulling something off a surface, while *shear force* stops you sliding the item along the surface. For example, if you drop a piece of wet glass on a bench, it is hard to lift it because the *adhesive force* is strong. However, you can slide it to the edge of the bench showing that the *shear force* is not so strong.

Extension activity: gecko feet

If you are teaching on a longer course, you could ask students to watch the series of three short videos at http://www.youtube.com/watch?v=6ULF_uvRAHI&feature=BF&list=SP1BE0A9EDEB892FAF&index=1

The video is likely to be quite challenging as the presenter's voice does not have much range, there is music over some of the speech and idiomatic language is also used. Please note also that the videos may begin with an advertisement. The total time for all three videos is 8'53". They are best watched in the order Brief History of the Gecko (4'03") – *Sticky Gecko Feet* (2'25") – *Curling Toes and Technological Advances* (2'28"). Have students make notes on the following:

- **two early hypotheses about how geckos stick**
- **an explanation for why sticky feet evolved**
- **the factors that are important in geckos sticking to surfaces**
- **the factors that allow the gecko to become 'unstuck'**
- **potential uses of gecko adhesives**

Suggested answers

- Bumps on the surface rub against the gecko's sole producing friction (like the grips on shoes).
  A sticky fluid is secreted from the feet, which forms a bond.
- Early geckos lived on the ground so no claws / sticking power was needed. They developed claws to help catch prey on rocks. To climb smooth, waxy plants, sticky pads developed.
- The foot is covered in hairs which end in many flat ends. Forces from the gecko and the surface become charged and attract each other.
  The way the gecko places its foot is also important.
- Curling the toes back to a 30° angle reduces the forces.
- For sticking very small things together e.g. in microsurgery or computer chips.

b **Elicit who is the most senior and most junior of the scientists (Sarah is the most senior, Ali the most junior). Students listen to the recording and answer the questions.**
▶3.4 page 93

Answers

1 He's been using a curved setal model rather than the usual straight ones.
2 He asks why Deepak has been focusing on forces in one single seta.

c **Students discuss the question in pairs and then feed back to the class. Do not confirm answers yet.**

d **Students listen to the recording and answer the questions.**
▶3.5 page 94

Answers

No, he isn't. He seems to be trying to clarify his question. He says things like 'No, I've got that', and 'No, I know what they are ...' to show that Deepak isn't answering his question.

e **Students listen to the recording and answer the questions.**
▶3.6 page 94

Answers

1 It was relevant.
2 Yes, he thinks it was relevant and acknowledges the 'gap' in the research and the need for another collaborator.

9 a **Students discuss the questions in small groups and then feed back to the class. Point out that in English-speaking culture such criticism is acceptable provided it is done politely.**

Answers

In some countries and cultures, it is not appropriate for a junior scientist to interrupt and/or be critical of a senior colleague's ideas. However, it is often more acceptable in an English-speaking scientific culture (if done politely and constructively).

b **Go through the ways to make an interruption polite. Then, students look at the audioscripts to find the phrases used to interrupt. Ask them why Ali interrupts in each case. It is usually to ask for clarification or further explanation.**
▶3.4–3.6 pages 93–94

Answers

Sorry, Sarah. Could I just ask what kind of forces?
Erm, sorry. Can I just check I understood?
Sorry, could you quickly explain that? I'm not quite sure what you mean.
Erm, could I jump in and ask a question?

Additional activity Unit 3: asking for more information

To provide students with more practice in asking for clarification/explanation, you can use the Additional activity for Unit 3 in the Resources section.

10 a **Students listen to the recording and complete the sentences.**
▶3.7 page 94

Answers

1 Well
2 So
3 Right
4 Anyway
5 Erm

b **Students work in pairs to work out the function of the words and phrases and to find other examples.**

Answers

They all signal the start of a turn. That is, they show that someone in the conversation would like to say something.

11 **Students work in groups of three to role play a departmental meeting. Allow students time to think about what they will say about their research and to make some brief notes. Provide feedback on the use of interrupting phrases and phrases to signal the beginning of a turn. If you used the Additional activity, also provide feedback on the use of phrases to ask for clarification.**

Background information and useful web links

Biomimetics

Biomimicry, *biomimetics* and *bionics* are all terms for the process of examining nature and using its designs to inspire solutions to human problems. The words *biomimicry* and *biomimetics* are derived from the Greek root *mimesis* (to imitate) with the prefix *bio-* meaning life.

Useful web links

Biomimetics: Borrowing from Biology

http://www.thenakedscientists.com/HTML/articles/article/biomimeticsborrowingfrombiology/

Biomimicry/Bimimetics: General Principles And Practical Examples

http://www.scq.ubc.ca/biomimicrybimimetics-general-principles-and-practical-examples/

The Buzz about Insect Robots

http://www.science.org.au/nova/084/084key.htm

Coating metallic bone implants

Joint replacement surgery is becoming increasingly common. However, how well implants are accepted by the body depends on the implant surface. Plasma-spraying has been used to coat the implants with bioactive calcium phosphate but this technique has limitations. Alternative coating methods are thus being investigated.

Useful web links

Implant Coating Could Create New Six Million Dollar Man

(The Six Million Dollar Man is a reference to a popular American TV series from the 1970s about a man who receives bionic implants following a horrific plane crash.)

http://www.nano.org.uk/news/jun2009/latest1892.htm

Namib Desert beetle

The Namib Desert beetle lives in one of the driest areas on earth. Only about 40 mm of rain fall each year. The beetle obtains water by catching water contained in fog on bumps on its back.

Useful web links

Beetle spawns new material

http://web.mit.edu/newsoffice/2006/beetles-0614.html

Beetle's wings inspire water-moving materials

(You may need to be a subscriber to access the full text version of this article.)

http://www.newscientist.com/article/dn9129-beetles-wings-inspire-watermoving-materials.html

African beetles beat the heat in the Sahara desert

The following video shows Namib beetles 'catching water' (between 0'56" and 1'38").

http://www.youtube.com/watch?v = XsMJNNshPOs

Fog nets

In villages just outside Lima, Peru, where there is little rainfall, fog nets are used to harvest water. The alternative is expensive, low-quality water which is delivered by truck.

Useful web links

Fog Catchers Bring Water to Parched Villages

http://news.nationalgeographic.com/news/2009/07/090709-fog-catchers-peru-water-missions.html

Gecko feet adhesives

Gecko feet have a number of interesting features; they allow the gecko to stick to almost any surface, they become unstuck rapidly and with no difficulty, and they are self-cleaning. Researchers hope to create biomimetic adhesives based on these features.

Useful web links

Gecko's amazing sticky feet

http://news.bbc.co.uk/2/hi/781611.stm

Gecko's gravity-defying trick explained

(You may need to be a subscriber to access the full text version of this article.)

http://www.newscientist.com/article/dn12054-geckos-gravitydefying-trick-explained.html

Mimicking Gecko Feet: Dry Adhesive Based On Carbon Nanotubes Gets Stronger
http://www.sciencedaily.com/releases/2008/10/081009143704.htm

Literature review

A literature review is important in the early stages of planning research as it gives the scientist a thorough understanding of the work which has been done in the area and where the gaps in the research are. The review does not simply summarize the research; it relates various pieces of research to each other and evaluates the significance of each.

Useful web links

The literature review

http://www.monash.edu.au/lls/llonline/writing/science/lit-review/index.xml

Literature review – online tutorial

http://library.usm.maine.edu/tutorials/esp/index.htm

Paraphrasing and summarising

http://www.monash.edu.au/lls/llonline/writing/information-technology/sources/2.5.3.xml

Cambridge English for
Scientists
TEACHER'S NOTES

Unit 4 Designing an experiment

- Describing approaches to data collection
- Designing an experimental set-up
- Describing material phenomena and forces
- Making predictions of experimental results

Go to page 50 for essential background information on the topic and useful web links.

Don't forget to use the Additional activity worksheet in the Resources section of the Cambridge English for Scientists website.

Science-specific terms can be found in the Glossary on Student's Book pages 117–125

Refers to the Audioscript on Student's Book pages 91–102

Describing approaches to data collection

Before you begin …

Ask students to think about the last experiment they did and to discuss the following questions in pairs:

1 What were you investigating?
2 What materials and equipment did you use?
3 What was the experimental procedure?

1 a Elicit what is meant by 'the scientific method' and go through the definition. Ask students what is meant by 'collocation'.

Answers

- analyse data
- collect data
- conduct (or run) an experiment
- define the question
- design an experiment
- draw conclusions
- form a hypothesis
- interpret data

Language note: collocations

A collocation describes two or more words which sound natural in English. For example, English speakers would say *I ran an experiment* not *I made an experiment*. So the verb *run* collocates with the noun *experiment* but the verb *make* does not. You could explain that the meaning of *I made an experiment* will probably be clear but *I ran an experiment* is more natural. You may also want to mention that a word (e.g. *experiment*) can collocate with more than one verb (e.g. *run, conduct*). When this is true, we often find that one collocation (e.g. *run + experiment*) is more informal (and so more often used in conversation) while another (e.g. *conduct + experiment*) is more formal (and so more often used in writing). Students match the words/phrases in the box to the verbs.

b Students number the stages in Exercise 1a in the order they would usually be done. Do not check the answers as students will do this in Exercise 1c.

c **Students read the extract and check their answer to Exercise 1b.**

Answers

1 define the question
2 form a hypothesis
3 design an experiment
4 conduct (or run) an experiment
5 collect data
6 analyse data
7 interpret data
8 draw conclusions

d **Students read the extract again and find the noun forms of the verbs in the box.**

Answers

analyse – analysis
collect – collection
design – design (*this word uses the same form for the verb and the noun*)
explain – explanation
form – formation
observe – observation
relate – relationship
run – run (*this word uses the same form for the verb and the noun*)
vary – variable

Extension activity: word stress

Ask the students to mark the stressed syllable in the nouns and verbs in Exercise 1d.

Answers

NB: Syllables are divided by (.) and stressed syllables are marked by (•)

an.a.lyse – a.na.ly.sis
col.lect – col.lec.tion
ex.plain – ex.pla.na.tion
form – for.ma.tion
ob.serve – ob.ser.va.tion
re.late – re.la.tion.ship
run – run
va.ry – va.ri.a.tion

Language note

The stress falls on the penultimate syllable in nouns ending with the suffix *-tion/ -sion*. For more information on common stress patterns with suffixes see the Language note for Exercise 10e on page 47 below.

2 **a** **Allow students time to read the summaries and choose the word which correctly completes each heading.**

Answers

1 Theoretical 2 Field 3 Internal 4 Descriptive 5 Quantitative

b **Students work in pairs to think of an example of an experiment which exemplifies the alternative heading. Use the suggested answers to make sure students are clear on the difference between the pairs of terms.**

Suggested answers

1 Practical research: A linear accelerator was used to accelerate electrons up to 20 GeV. Due to the high energy and momentum of the electron it is able to probe inside the proton. As the energy of the electron increased, there was far more scattering at larger angles than expected. This suggests the proton is not an elementary (fundamental) particle but is made of smaller, point-like particles which could deflect the electron by a large amount.
2 Laboratory experiment: To examine precipitation and temperature effects on populations of *Aedes albopictus*, caged populations of the mosquito were maintained at 22, 26, and 30 °C. All cages were assigned to one of three simulated precipitation treatment regimes.
3 External validity: To investigate the link between economic status and likelihood of smoking in 18–25 year-old males, survey questionnaires were sent out to students picked at random from the university's database.
4 Experimental study: The effects of eating soy on breast cancer incidence were investigated. Half of the subjects ate at least one soy-based product a day, while the second group, the control group, ate an essentially soy-free diet. During the 30 years of the study, the women's incidence of breast cancer was recorded.
5 Qualitative research: To investigate the effect of eating dark chocolate on stress levels, subjects completed a questionnaire rating their stress levels. After eating the chocolate, the questionnaire was filled in again.

Note

- *theoretical research*: a conclusion is drawn from what is already known. It is not tested by observation or experiment.
- *experimental research*: experiments are conducted and the results used to draw conclusions.
- *field experiment*: research is conducted on animals/plants etc. in their natural habitat.
- *laboratory experiment*: research is conducted on animals/plants etc. in an artificial environment.
- *external validity*: research is conducted on a representative sample of the population to allow the results to be generalized to the population as a whole.
- *internal validity*: groups within the experiment are matched for all features except that being investigated to ensure that no other factor affects the results.
- *descriptive study*: the research examines differences between populations over time to identify patterns or trends.
- *experimental study*: samples of a population are treated differently to examine the effect the treatment has on the population.
- *qualitative research*: the research is more subjective, collecting non-numerical data or explanations. It is often used to determine what exactly should be investigated further.
- *quantitative research*: collects objective, often numerical, data to investigate an item's effect.

Extension activity: video lecture – Hydrogen Highway

Note: This extension task is similar to the one suggested for Exercise 3a, below. You may therefore wish to review that suggestion first before deciding which activity is best for your class.

Students watch the 9-minute video Hydrogen HWY at http://www.abc.net.au/catalyst/stories/s2050132.htm **and make notes on the following:**

- **why we need an alternative fuel**
- **how fuel cells are used to produce electricity**
- **three problems of using hydrogen as a fuel**
- **three solutions (one per problem) under investigation to solve the problems**

The website also includes a transcript. However, it should be noted that there is some minor variation in places between what is heard on the video and what is written in the transcript.

Suggested answers

- We are running out of oil and so need a new, preferably clean, fuel for the future.
- Solar powered cells produce energy to split water into H_2 and O_2. The hydrogen is stored and can then be recombined with oxygen to produce electricity with only water as a by-product.
- 1 Fuel cells are expensive because they use platinum as a catalyst. The process that applies the platinum is wasteful, so more platinum is used than is really necessary.
  2 The power to make hydrogen currently comes from oil refineries, which does not solve the problem that we are running out of oil and need cleaner energy.
  3 Storage is an issue because hydrogen doesn't compress easily and can pass through most substances due to its small size.
- 1 Plasmas* can be used to apply thinner platinum layers.
  2 Hydrogen could be made without electricity, for example by using algae, which split water to form H_2 when they photosynthesise.
  3 Hydrogen could be stored inside other substances. Under pressure it would move into the spaces inside the other substance and then as the pressure was released, it would move out again.

* A plasma is a state of matter, different to solid, liquid or gas, which contains a significant number of electrically charged particles, unlike a normal gas which is electrically neutral.

3 a Students discuss the questions in pairs and then feed back to the class.

Answers

1 Hydrogen is environmentally friendly, renewable and easily produced from water.
2 Hydrogen can be used in any application in which fossil fuels (i.e. coal, petroleum and natural gas) are being used today, with the exception of cases in which carbon is specifically needed. Hydrogen can be used as a fuel in furnaces, internal combustion engines, turbines and jet engines and is more efficient than fossil fuels. Cars, buses, trains, ships, submarines, aeroplanes and rockets can run on hydrogen. Hydrogen can also be converted directly to electricity by fuel cells, with a variety of applications in transportation and stationary power generation.

Extension activity: producing hydrogen for use as a fuel

Students look at the animated slide show 'Fuelling Fuel Cells – The Hydrogen Economy' at http://www.doitpoms.ac.uk/tlplib/fuel-cells/case.php **Before the task, you might want to go through the meaning of the following words and phrases, all of which appear in the text of the slides: conventional, derive, do something on an industrial scale, landfill site, revival, stringent legislation*, tidal power, to be in sth's infancy. Then ask students to write a short summary about where we obtain energy from and how it is used to make hydrogen.**

Students could also do some online research to investigate other methods of producing hydrogen. http://www.hydrogencarsnow.com/blog2/index.php/hydrogen-fuel-production/alternative-methods-for-producing-hydrogen/ **has a list of methods currently being researched. Each student could be given one method and asked to research it and report back.**

***Please note that at the time of writing, these student-produced slides include a number of spelling and typographic errors (*a n (an), *comercial (commercial), *imediate (immediate), *legeslation (legislation), *the (The … at beginning of a sentence).**

Suggested answers

The energy to produce H_2 is obtained primarily from fossil fuels, with some contribution from biofuels, nuclear power and other renewable sources. Fossil fuels can be reacted with steam at high temperatures in a reformer to produce H_2 directly. They can also be used, along with the other energy sources, to generate electricity. The electricity is then used to power electrolysers, which use an electrical current to split water into its hydrogen and oxygen components. Another possible way to produce H_2 is by using bacteria to break down fossil fuels or biofuels to produce H_2 gas, although this method is not well developed yet.

b **Check that the students understand the words *condensed*, *adsorbed* and *porous*. Allow students time to discuss the advantages and disadvantages of the three methods of hydrogen storage. Feed back to the class.** http://www.doitpoms.ac.uk/tlplib/fuel-cells/case.php **contains more about the advantages and disadvantages of various methods of storing hydrogen.**

Suggested answers

a **Advantages:** it would be easier to fill a car, etc. with gas than with liquid hydrogen
Disadvantages: needs a large tank and high pressures to store; high pressure difficult to contain safely; tank would need to be very heavy in order to counteract the lift generated by the hydrogen

b **Advantages:** tank lighter than for gas storage
Disadvantages: large amount of energy needed to cool hydrogen enough to liquefy it; tanks must be well insulated to keep cold; liquid hydrogen has a low energy density by volume

c **Advantages:** carbon is a possible porous material – high availability and low cost; takes little space to store; safe
Disadvantages: high pressures and/or low temperatures needed for hydrogen adsorption; material may not release the hydrogen easily

Language note: *adsorb* and *absorb*

Point out the difference between adsorb and absorb. *Adsorb* (v) means to collect a gas or liquid on the surface. *Absorb* (v) means to take something in. Also point out the spelling of the noun forms *adsorption* and *absorption*.

c **Allow students time to read the questions. Students listen to the recording to answer the questions.**
▶4.1 page 94

Answers

1 adsorbed onto a porous material
2 porosity (of the carbon fibres)
3 They discuss five different variables: carbonisation temperature; type of hydroxide (potassium or sodium); ratio of hydroxide to carbon fibres; heating rate; nitrogen flow rate
4 look at the papers mentioned, see what they found to be the optimal conditions, and start by replicating those

Language note

Point out the spelling of *porosity* (without a *u*). Elicit examples of other words which have this spelling change from adjective to noun (e.g. *generous – generosity*; *luminous – luminosity*).

Note

Activated carbon is produced in a two stage process. First, the material is carbonized by slowly heating it to extremely high temperatures. The carbonized material is then activated either by exposing it to CO_2, O_2 or steam at around 600–1200 °C, or through chemical activation with an acid (e.g. H_3PO_4), base (e.g. NaOH) or salt ($ZnCl_2$) at 450–900 °C. Activation makes the material extremely porous and so it has a large surface area for adsorption.

d **Students listen to the recording again and tick the variables Silvana will investigate.**
▶4.1 page 94

Answers

✔ carbonisation temperature
✔ type of hydroxide (potassium or sodium)
✔ ratio of KOH or NaOH to carbon fibres

e **Students discuss the questions in pairs. Refer them to the Audioscript if they cannot remember Dominique's reasons.**

Answers

The results will become too difficult to analyse. It might be difficult to reproduce (*replicate*) the data.

f **Students complete the summary with the words from the box.**

Answers

1 affects 2 collecting 3 data 4 dependent 5 independent 6 controlled

Extension activity: variables

Students work in pairs to describe what the controlled, independent and dependent variables were in the last experiment they did (for more information on variables see Unit 2 of the Teacher's Notes page 18).

g **Students discuss the questions in pairs and then feed back to the class.**

Answers

1 **Controlled:** nitrogen flow rate; heating rate; carbonisation temperature; ratio of hydroxide to carbon fibres
Independent: type of hydroxide
2 **Dependent variable**: hydrogen adsorption

4 a **Students look at the sentences and answer the questions.**

Answers

1 the future
2 suggestions
3 adverbs (*maybe/perhaps*) and modal verbs (*could/should/might/will*)
4 an infinitive verb (without *to*)

Extension activity: position of adverbs

Point out that a very common position for the adverbs *maybe* and *perhaps* is at the beginning of the sentence. You could ask students where else in the sentences a, b, d and f they could be placed (between the modal verb and the main verb: a *You could maybe look*; b *I should perhaps look*; d *I could perhaps start*; f *I'll maybe have*).

b **Students work in pairs. Assign the role of researcher and supervisor to one member of each pair. Allow time for students to read Exercise 2a and think about a suitable experiment. Then ask them to look back at Exercises 2a and 4a for useful language. You could encourage them to make a note of key language they plan to use. Students then role play the conversation in pairs. After the role play, you could elicit a suitable experiment from the class.**

Suggested discussion points

Use a laboratory experiment to do practical research. Ensure internal validity by changing only one variable – everything else must be the same between groups. The study should be experimental and quantitative.
Caged populations of the mosquito should be used. The cage size and number of mosquitoes in each cage should be identical. To measure the effects of temperature, cages are maintained at different temperatures (e.g. 22, 26, and 30 °C) for an identical length of time. To measure the effect of rainfall, different rainfall regimes should be simulated. The study should be done in such a way that each different rainfall regime is examined at each different temperature. The number of mosquitoes at the end of the treatment period is then counted.

You could also ask students why scientists might be interested in researching the effects of temperature and rainfall on mosquito populations.

Suggested answers

If changing temperatures and patterns of rainfall alter the mosquito population, then one of the effects of climate change could be a change in the distribution of mosquitoes and so mosquito-borne diseases. The mosquito *Aedes Albopictus* is a vector for West Nile virus and Dengue Fever.

Designing an experimental set-up

5 a **Students match the instruments to the pictures.**

Answers

1 b 2 e 3 f 4 c 5 h 6 d 7 g 8 a

b **Students discuss the meaning of the suffixes in pairs.**

Answers

-graph shows that the instrument writes, draws or records
-meter shows that the instrument measures a unit of something
-scope shows that the instrument is used to see something

c **Students match the instruments and what they measure. Then, students listen to the recording to check their answers.**
▶4.2 pages 94–95

Answers

pH – litmus paper
radiation – geiger counter
changes in voltage over time – oscilloscope
light intensity – spectrometer
distance – calipers
torque – dynamometer
motion – seismograph
wavelengths of light – interferometer

Extension activity: describing uses

Students look at Audioscript 4.2 on pages 94–95 of the Student's Book and highlight the language used to describe the use of the different instruments.

Suggested answers

… you can simply use litmus paper to check that it is in fact pH neutral.
… I was going to use the geiger counter to check for radiation.
You need to use the scintillation counter for that.
… the geiger counter is OK for measuring beta radiation, right?
… by using an oscilloscope we can create a trace of how the voltage changes …
… this will measure the intensity of the blue-green light that passes through …
… we're using these calipers to do that …
… that measures force or torque, right?
They're both used to measure movement – motion – though.
… you use the interferometer for that? Right, for measuring the wavelengths and their interference when they encounter one another.

Additional activity Unit 4: 'use'

You can use the Additional activity worksheet for Unit 4 in the Resources section to practise using forms of 'use'.

d **Students discuss the questions in pairs.**

6 a **Allow time for students to look at the diagram and to discuss in pairs which words might complete the gaps.**

b **Students listen to the recording to complete the notes.**
▶4.3 page 95

Answers

a	activation	e	furnace
b	weight	f	temperature
c	ceramic/steel	g	cooling
d	steel/ceramic	h	nitrogen

7 a **Students match the beginnings and the endings of the sentences. They then check their answers with Audioscript 4.3 on page 95.**

Answers

1 e 2 b 3 g 4 a 5 f 6 c 7 d

b **Students discuss the questions in pairs and then feed back to the class.**

Answers

1 More confident: I'm going to, I'm planning to, I'll try
More tentative: I was thinking of, I think I'll try, I thought I should, I was planning on
2 INFINITIVE: I'm going to, I thought I should, I'm planning to
VERB-*ing*: I was thinking of, I think I'll try, I'll try, I was planning on

Language note

Students may ask about the difference between *try to* + INFINITIVE and *try* + VERB-*ing*. *Try to* + INFINITIVE is used to talk about attempting to do something which is difficult to do, e.g. *I tried to find out what material to use for the sample tray but the papers didn't mention it*. In contrast, *try* + VERB-*ing* means to do something and see what happens as a result, e.g. *I don't know the best ratio of hydroxide to carbon fibres, so I'll try using 4:1 and 10:1 and see what results I get*.

8 a **Students listen to the recording to answer the questions.**
▶4.4 page 95

Answers

1 steel 2 quartz 3 1.5 / 6–7.5 4 75

b **Students complete the sentences with a verb from the box and decide what their function is.**

Answers

1 were 2 don't 3 would 4 think
The sentences are used to make suggestions.

9 a **Allow time for students to think of an experimental set-up and to draw and label their sketch.**

b **In pairs, students take turns to explain their plans for the experiment. Provide feedback on the use of the phrases covered in this unit.**

Describing material phenomena and forces

Before you begin …
Print copies of the Periodic Table of Elements. Both black and white and colour versions can be found at http://www.chemistryguide.org/periodic-table-of-elements.html **Elicit the properties of the different groups or of individual elements. Information about the common characteristics of the groups can be found at** http://library.thinkquest.org/C0110203/char.htm **An interactive periodic table can be found at** www.ptable.com

10 a **Students read the extract and complete the table. You could also check the meaning of *compressed* (to make sth smaller so that it takes up less space).**

Answers

noun	verb	adjective
compression	compress	compressed
adsorption/adsorbent	adsorb	adsorbent
activation	activate	activated
porosity		porous

b **Students discuss the questions in pairs and then feed back to the class. Check that the words they think of with the different suffixes are the correct part of speech.**

Answers

1 *-sion/-tion* e.g. concentration, equation, diffraction
-ent e.g. referent, detergent, solvent
-ity e.g. electricity, activity, flexibility
2 *-ed* e.g. dissolved, used, electrified
-ent e.g. different, luminescent, fluent
-ous e.g. bulbous, contagious, fibrous
3 As part of guessing the meaning of new words from the context; to help select the right part of speech when writing

c **Students complete the words using the correct vowels. You could also have students work in pairs to test each other on the properties and their definitions.**

Answers

1 brittleness
2 capacitance
3 concentration
4 conductivity
5 density
6 flammability
7 luminance
8 mass
9 permeability
10 porosity
11 pressure
12 reactivity
13 solubility
14 velocity
15 viscosity
16 volume

d **Students answer the questions in pairs.**

Answers

1 aluminium 2 glass 3 neon 4 oxygen 5 ethanol 6 blood

e **Students divide the suffixes into two groups: noun endings and adjective endings.**

Answers

noun suffixes: -ance; -bility; -ity; -ness; -osity; -tion
adjective suffixes: -able; -ent (more common as an adjective than as a noun); -ive; -ous

Extension activity: word formation (physical and chemical properties)

You could ask students to use the suffixes to predict the adjective forms of other nouns in the table in Exercise 10c e.g. reactivity – reactive so conductivity – conductive. You could also elicit the word stress in the words and point out changes in the position of the stress e.g.: re.ac.tive – re.ac.ti.vi.ty
You could also have students work in pairs to write questions similar to those in Exercise 10d to then ask another pair.

Language note: word formation and stress

Different words which use the same suffix often stress the same syllables (see also the Language note on Exercise 1d on page 38). The following are two common patterns which are usually true:

- Stress the syllable immediately before these suffixes: *-tious*/*-cious, -eous, -orous, -osity*/*-ity, -sion*/*-tion,*
- Do not move the stress when forming words with the following suffixes: *-able, -al, -ful, -ness, -ous*

More detailed information about stress patterns with suffixes can be found in *English Pronunciation in Use Intermediate* (ISBN 9780521001854) and *English Pronunciation in Use Advanced* (ISBN 9780521619561).

f **Students work in pairs to complete the task.**

Answers

1 F – To concentrate a solution, add more solute. To dilute it, add more solvent.
2 T
3 T
4 T

g **Students match the verbs to the correct noun forms.**

Answers

concentrate – concentration
conduct – conductivity
dissolve – solubility
permeate – permeability

h **Encourage students to use their knowledge of suffixes and word formation to complete the task before checking the meanings of the words in bold where necessary.**

Answers

1 extract 2 absorb 3 malleability 4 reflectivity 5 detectable

11 **Allow time for students to think of three different materials they use in their research. They may also need to use a dictionary if the materials' most important properties have not been covered in this section. If that is the case, encourage them to explore the various forms of the word. Students then explain the materials and their uses in pairs.**

Making predictions of experimental results

Before you begin …

Check the meaning of the following words with students: *boil*, *deflate*, *inflate*, *neck* (of a bottle), *weigh*. Then read (or dictate) the following set of procedures to students and ask them to make predictions of what will happen at each stage.

a Put the opening of a deflated balloon over the neck of a bottle. Make sure no air can escape. Weigh the bottle and balloon. Put the bottom half of the bottle in boiling water for 1 to 2 minutes.
b Remove the bottle from the boiling water. Put it in ice water for 1 to 2 minutes.
c Remove the bottle from the ice water. Let it return to room temperature and dry it. Weigh the bottle and balloon again.

Answers

a The balloon inflates
b The balloon deflates
c The weight doesn't change

12 a **Make sure students remember the key points of Silvana's experiment. Students listen to the recording to answer the question.**
▶4.5 page 95–96

Answers

the type of hydroxide

b **Students complete the predictions with words from the box and then listen to the recording again to check their answers.**
▶4.5 page 95–96

Answers

1 If	4 expect	7 My prediction is that
2 will probably	5 any	8 lead to
3 more	6 between	9 allow

13 a **Students look at the sentence and answer the questions.**

Answers

1 If the fibres are more porous
2 they adsorb more hydrogen
3 Fibres adsorb more hydrogen if they are more porous.

b **Students look at the 4 sentences and answer the questions.**

Answers

1 a Sentence (a) expresses something you know to be true – the result is not in doubt; sentence (b) expresses what you are fairly sure the result will be.
b Sentence (b) expresses what you are fairly sure the result will be; sentence (c) expresses what you think the result will be, although you are less sure than in (b).
c Sentence (b) expresses what you are fairly sure the result will be; sentence (d) expresses a less likely result, although still possible.
2 No, the tense in the *if*-clause remains the same.

Language note: the zero and first conditional

The sentences in Exercises 13a and b are often referred to as conditional sentences in grammar books. In Exercise 13a, and sentence a in Exercise 13b, the sentence is a 'zero conditional'. It has the structure *If + present tense, present tense*. It expresses a possible situation in the present, with the likely outcome of the situation. There is little doubt as to the outcome. Sentences b–d in Exercise 13b are 'first conditional' sentences and have the structure *if + present tense, will/might + infinitive*. They also express a possible situation in the present; however, the outcome here is less certain. In sentence b, you are fairly sure what the result will be, though less so than in sentence a. In c and d you are less confident of the outcome. A fuller explanation of conditionals with exercises for students can be found in Unit 24 of *Developing Grammar in Context*: *intermediate* (Nettle & Hopkins, 2003).

14 **Allow time for students to read the stages in the experiment and to write down their predictions. Students then feed back to the class.**

Answers

What should happen is:
1 There is no change to the time for the pendulum swing.
2 There is no change to the time for the pendulum swing.
3 The time gets shorter as the string gets shorter.

15 **Students make notes on their predictions of the outcome of the experiment they sketched in Exercise 9a. Students explain their predictions in pairs.**

Background information and useful web links

The Scientific method

The Scientific method is a method of investigation which collects observable and measurable data to test a hypothesis.

Useful web links

Steps of the scientific method

http://www.sciencebuddies.org/science-fair-projects/project_scientific_method.shtml

Producing hydrogen

At present fossil fuel reforming is the main way hydrogen is produced. However, there are a number of other methods being used or under investigation. Developing cheap, efficient and clean methods of producing hydrogen is essential if it is to be used as a fuel.

Useful web links

The quest to make hydrogen the fuel of the future

http://www.science.org.au/nova/111/111key.htm

Hydrogen fuel cells

A hydrogen fuel cell generates electricity through a reaction between hydrogen and oxygen, in the presence of a catalyst. The only by-product is water making it clean and safe.

Useful web links

Fuelling the 21st Century

http://www.science.org.au/nova/023/023key.htm

Fuel Cells

http://www.doitpoms.ac.uk/tlplib/fuel-cells/index.php

Cambridge English for
Scientists
TEACHER'S NOTES

Unit 5 Describing an experiment

- Describing a process
- Evaluating the results of an experiment
- Describing problems with an experiment
- Keeping a lab notebook

Go to pages 61–62 for essential background information on the topic and useful web links.

Don't forget to use the Additional activity worksheet in the Resources section of the Cambridge English for Scientists website.

Science-specific terms can be found in the Glossary on Student's Book pages 117–125

Refers to the Audioscript on Student's Book pages 91–102

Describing a process

Before you begin …

In pairs, ask the students to discuss any experiments they have conducted. Ask if the results were what they expected? Were there any surprises? Why? What are the basic steps when conducting an experiment? The students can refer back to the 'scientific method' text in Exercise 1c on page 30 of the Student's Book. Students feed back to the class and the answers can be written on the board. Tell the students that they will be asked to elaborate on their experiments later in the unit.

1 **Students discuss the questions in pairs and then feed back to the class.**

Suggested answer

3 If you are describing an experimental process in a paper or poster, you need to include sufficient detail that another scientist could replicate your method. This means you need to include details like what you did, under what conditions, using what equipment or reagents, for what timings.

2 a **Allow time for students to answer the questions in pairs and then feed back to the class.**

Answers

1 The Earth has four major layers: the *inner core*, *outer core*, *mantle* and *crust*. The crust and the top of the mantle make up a thin layer on the surface of the Earth, but rather than being continuous, this layer is made up of a number of pieces, called tectonic plates, which fit together like a jigsaw puzzle. These pieces are always moving around, sliding past one another and bumping into each other. Since the edges of the plates are rough, they sometimes get stuck against each other. While the edges of faults are stuck together, the rest of the block is moving. The energy that would normally cause the blocks to slide past one another is being stored up. Eventually the force of the moving blocks builds up so that the friction of the rough edges of the fault is no longer enough to stop the plates from moving. The blocks suddenly move, releasing all the stored-up energy. This is an earthquake.

2 As the plates rub against each other, pressure and temperature build up. If the minerals in the mantle stay strong at high temperatures and pressures, it will take longer for the temperature and pressure to build up enough for an earthquake to occur. However, if they lose strength at lower temperatures and pressures, earthquakes will occur more easily.

Extension activity: researching earthquakes on the Internet

As a pre-lesson research discussion, ask students if they use the Internet for research. How do they use it? Can they always trust the information they get from the Internet? What can they do to make sure that the information on websites is reliable? Have they experienced any difficulties with using translation tools on search engines?

Next, ask students to go online and find where the most recent earthquake took place. One website that offers this information is: http://earthquake.usgs.gov/earthquakes/recenteqsww/

***To follow up, ask the students if anyone has ever experienced an earthquake and ask them to describe to the class what it felt like, how long it lasted, what it was similar to. Small ones sound like thunder or a truck passing, while bigger earthquakes can cause us to lose our balance. (*You may want to be careful asking this question as students may be sensitive about such questions and may be uncomfortable talking about their earthquake experience.)**

Ask the students if they can describe the process of an earthquake or the reasons they occur.

They can use this collection of articles on earthquakes as a part of their internet search: http://science.howstuffworks.com/nature/natural-disasters/earthquake.htm

b **Allow time for students to study the diagram and come up with their own descriptions. Before the task, you might want to go through the meaning of the following words and phrases: *anvil* (a heavy block of iron or steel on which hot metals are shaped by hammering), *cubes, detector, high pressure, octahedron, press, tubes***

c **Allow time for students to read Chuyu's summary and label the diagram in Exercise 2b.**

Answers

A powdered mineral sample
B tube of rolled rhenium
C ceramic octahedron
D two tungsten-rhenium thermocouple leads
E tungsten carbide cubes
F six secondary anvils in the press

3 a **Ask students to work alone to underline the main verbs in the summary. Then ask them to compare what they have underlined. Allow time for students to answer the questions and feed back to the class. You may need to clarify the difference between main verb (e.g. *done* in *I have done that*) and auxiliary verb (e.g. *have* in *I have done that*).**

Answers

Multi-anvil high pressure apparatus **was used** to generate the high pressure and temperature for the specimen. The powdered mineral sample **was placed** into a tube of rolled rhenium. The rhenium tube **was loaded** into a ceramic octahedron. Two tungsten-rhenium thermocouple leads **were attached** to the octahedron. The octahedron **was surrounded** by a set of eight tungsten carbide cubes. The cubes **were placed** into the space formed by six secondary anvils in the press.
The press **was pumped up** to the correct pressure. The anvils **transform** the directed force of the hydraulic press to hydrostatic pressure on the sample. Heating of the tube **was carried out** using an electrical current conducted through the anvils. Temperature **was controlled** with a programmable temperature controller. Energy diffraction patterns **were collected** using a germanium solid state detector. The patterns **were analysed** to work out the material's strength.

1 past simple passive
2 *was/were* + past participle
3 The passive is used to suggest that anyone who follows the same scientific procedure will get the same results. The passive is used when the person who did the action is less important than the process the verb describes.
4 *transform*. The anvil is an important part of the procedure. In this case, it is important what does the action so we use it as the subject.

Language note

General English EFL grammars most commonly address: the passive + by + agent (e.g. *The policy was written by a committee.*). However in the descriptions of scientific processes, it is much more common to have the passive without an agent if the agent is human (e.g. *The press was pumped up…*) and generally only include the agent in the sentence if it is non-human (e.g. *The enzyme is used by cancer cells to …*).

b **Ask students to identify the multiword verb combinations in the text.**

Answers

place into, load into, attach to, surround by, form by, pump up to, carry out, conduct through, control with, work out

c **Ask students to complete the multiple-choice question task.**

Answers

1 b 2 a 3 b 4 a 5 c 6 a

Extension activity: multiword verbs

Students test each other by reading the first part of a verb in bold in Exercise 3c to elicit from their partner the preposition without looking at his or her book. For additional practice with multiword verbs in science, ask students to complete the quiz on this website: http://www.ihbristol.com/learn-online/exercise-general/advanced/vocabulary/phrasal-verbs-science/213/

4 a Allow time for students to study the writing style of the summary in Exercise 2c and ask if the summary is appropriate for a scientific journal. Students feed back to the group. Do not confirm answers yet as these will be addressed in Exercise 4b.

b Students listen to the conversation and answer the question.
▶5.1 page 96

Answers
- use linking words, to make the stages clear (but not too many)
- combine sentences

c Students listen to the end of the conversation and follow Thabo's instructions.
▶5.2 page 96

Answers
First, the powdered mineral sample was placed into a tube of rolled rhenium, **which** was **then** loaded into a ceramic octahedron.

d Students answer the questions.

Answers
The rhenium tube in the second sentence is replaced with *which.*

e Ask students to combine the sentences then compare their answers with the key.

Answers
- Two tungsten-rhenium thermocouple leads were attached to the octahedron, which was then surrounded by a set of eight tungsten carbide cubes.
- The cubes were placed into the space formed by six secondary anvils in the press, which was then pumped up to the correct pressure.

5 a Allow students time to read the text and complete the gap fill.

Answers
1 First 2 was 3 which 4 then 5 at 6 which

Extension activity: linking words

You may want to check the students' understanding on the importance of using linking words in their summaries. Some examples include: *for instance*; *in addition*; *furthermore; due to*. Can the students think of any linking words? Write their answers on the board.

A very useful website which divides up linking words into categories (e.g. giving examples, adding information, summarising, sequencing ideas, giving a reason, giving a result, and contrasting ideas) and also provides a practical activity can be found here: http://library.bcu.ac.uk/learner/writingguides/1.33.htm More linking words are in Exercise 13a of the Student's Book.

b Allow students time to draw their sketches and write their descriptions. You may wish to assign this as homework. Encourage them to use the linking words they studied in Exercise 5a. Remind them of Thabo's advice in Audioscripts 5.1 and 5.2, in which he suggests combining sentences where possible and using linking words to make the stages clearer. If some students need help with ideas for this activity, refer them to the description of earthquakes mentioned at the beginning of the unit in these Teacher's Notes.

Evaluating the results of an experiment

Before you begin …

Write these quotations on the board or use it as a dictation exercise.

- 'Try Again. Fail again. Fail better'. Samuel Beckett (Irish Writer)
- 'Try not to become a man of success, but rather try to become a man of value'. Albert Einstein
- 'I haven't failed, I've found 10,000 ways that don't work'. Thomas Alva Edison (American inventor)
- 'I never failed once. It just happened to be a 2000-step process'. Thomas Alva Edison
- 'The great question is not whether you have failed, but whether you are content with failure'. (Chinese Proverb, also used by Abraham Lincoln, who lost several elections before he became President of the United States)
- 'There is no such thing as a failed experiment, only experiments with unexpected outcomes'. Richard Buckminster Fuller (American engineer and architect)

Ask students to work in pairs and choose one or more quotations they like and how it relates / they relate to their own personal and/or professional experience, including expectations, outcomes, disappointments, etc.

6 a **Students think about an experiment they have done recently. Then, in pairs, they discuss 1–5 and feed back to the class.**

b **You may want to first see if the students can infer the meaning of the underlined words using context. Students then check their answers in the Glossary.**

Answers

differential stress the difference between the greatest and the least compressive stress experienced by an object.
stress a measurement of the average force on a surface
yield to change shape because of the force on an object
yield strength the amount of stress which can be put on an object before it deforms (changes shape)

c **Students listen to the first part of the conversation and answer the question.**
▶5.3 page 96

Answers

- differential stress in the olivine and perovskite samples will go up with pressure ✔
- perovskite will be stronger than olivine, i.e. it will yield later ✔
- for olivine, increasing the temperature will reduce yield strength ✔
- for perovskite, increasing the temperature will reduce yield strength ✘

d **Students listen to the second part of the conversation and answer the questions.**
▶5.4 page 96

Answers

1 increase temperature; increase pressure
2 that the results are accurate

7 a **Allow students time to fill in the gaps then check their answers using the listening.**
▶5.3 page 96

Answers

1 that; would; did
2 as
3 that; would
4 did
5 thought; would

b **Make sure students understand the expressions in bold in Exercise 7a before completing the table and answering questions 1 and 2.**

Answers

Expectations: I thought that the differential stress in all of the samples would go up; I expected that increasing the temperature would reduce; I thought the minerals would all be affected
Outcomes: it did; as I expected; that's what did happen
1 To show that these are past expectations. We often use *will* for present expectations (e.g. *I **think** that the differential stress in the sample **will** go up*), so to talk about past expectations *will* changes to *would*.
2 *did* emphasises the fact that his prediction was correct.

Extension activity: using *do/did* for emphasis

Write on the board the following notes (NB: this is taken from the text in Exercises 6b and 8a):

olivine and perovskite: Yield lower pressure? Temperature increase?

olivine: Yes!

perovskite: No!

Then dictate the following sentence, and accentuate *did: I thought olivine would yield at a lower pressure and that's what did happen, but the perovskite didn't.*

Then ask the students to identify which parts of this statement are:

- **the expectation (answer: *I thought olivine would yield at a lower pressure*)**
- **the confirmation (answer: *that's what did happen*)**
- **the unexpected revelation (answer: *but the perovskite didn't*)**

To practice using 'did' for emphasis, you could ask students to write five sentences describing the results of a recent experiment that also include the distinct three parts above. Then, ask students to say their sentences to their partner, but also to accentuate 'did' for emphasis, as you did in the example above.

8 a **Allow students time to read and understand the summary. Using Audioscript 5.3, students answer the questions.**

Answers

- To date → so far
- have been investigated → I've looked at
- In addition, some research has been carried out → I've also done a couple of runs
- increased with pressure → go up as the pressure increased, and it did.
- has the highest strength → was the strongest
- decreases significantly → went right down
- increases → went up

b **Ask students to answer the question.**

Answers

There is a difference in the level of formality between the spoken and written forms. The spoken version is less formal.

Language note: register

It is not uncommon for students of a foreign language to see that language (and its associated cultures) as broadly homogenous. However, proficient users recognise that different social activities and situations require different uses of the language. For example, the words *child*, *descendant*, *kid*, *offspring* and *progeny* can all be used to refer to the 'same' thing but cannot be used appropriately in the same situations. This aspect of foreign language learning can be referred to as register, which the *Common European Framework of Reference for Languages* defines as the 'systematic differences between varieties of language used in different contexts' (Council of Europe: 120).

c **Ask students to complete the gaps 1–4 using the highlighted phrases in Exercise 8a.**

Answers

1 **In addition**, petrography studies have been **carried out**.
2 Sodic glasses contained **the highest** number of cations with low average field strength and non-sodic glasses the lowest.
3 In all five tephra samples, Al_2O_3 decreased **with** the increase in SiO_2.
4 **To date**, the morphology and mineralogy of tephra samples from La Malinche **have been** examined.

Additional activity Unit 5: writing in an appropriate style

You can use the Additional activity for Unit 5 in the Resources section to help students to think about writing in an appropriate style (or register) for a scientific research paper.

9 **Ask students to refer back to an experiment they discussed in Exercise 6a and write a short summary in a formal style. You may want to assign this for homework and encourage the students to peer-correct their drafts.**

Describing problems with an experiment

***Before you begin* …**
Print out a short list of failed scientific experiments or inventions. Three can be found here: http://www.ehow.com/list_7317980_famous-failed-inventions.html **Ask the students why these inventions failed. Some students might also be interested in reading about some various failed predictions:** http://listphobia.com/2009/12/20/10-most-famous-failed-predictions-of-all-time **You could list these predictions on the board and ask students to brainstorm reasons for why they turned out to be invalid.**

10 **Students work in pairs and take turns describing an experiment where they had a problem.**

11 a **You may want to review Chuyu's mineral experiment earlier in the unit before conducting the next listening task. Students listen to the conversation to find the two causes.**
▶5.5 pages 96–97

Answers

1 The samples might not be ringwoodite at all.
2 The machine might need to be recalibrated.

b Students listen again and answer the question.
▶5.5 pages 96–97

Answers
1 The samples might not be ringwoodite at all. (unlikely)
2 The machine might need to be recalibrated. (possible)

12 a Students look at the phrases 1–5 to answer the questions.

Answers
1 a 2 b 3 c 4 c 5 b

b Students work in pairs to discuss problems they are having in their current research and then feed back to the class. Encourage them to use the expressions in Exercise 12a.

13 a Allow students time to read the summary and fill in the gaps with the words in the box.

Answers
1 surprising
2 similar
3 appears
4 possible
5 possibly
6 unlikely
7 possibility
8 likely

b Students choose the correct linking word (a–f).

Answers
a Because of
b As a result,
c However,
d Firstly,
e Although
f Therefore,

14 Allow students time to write a short summary describing and reporting on problems they've had with an experiment. Or students can search the web for a problematic experiment of their choice and report back on their findings. You could assign this as homework and/or online research work.

Extension activity: reporting problems

After the students have completed their summaries, you may want to ask them to present their findings in a mini 5-minute presentation using slides. They can work as individuals or in pairs. This will give them presentation practice for future tasks later in the book.

Keeping a lab notebook

15 a In pairs, allow students time to discuss the meaning of the symbols and feed back to the class.

b Ask students to match the abbreviations 1–12 with the meanings a–l.

Answers
1 d 2 i 3 h 4 k 5 b 6 c 7 j 8 g 9 f 10 e
11 l 12 a

c In pairs, ask students to brainstorm abbreviations for 1–10 then feed back to the class.

Suggested answers

1	↓	6	v/v
2	°C	7	w/o
3	K (NB: the ° is not used with K)	8	2:1
4	≥	9	h
5	+	10	conc.

d **Ask students to brainstorm other abbreviations for their lab notebooks and write them on the board. Their answers may vary greatly depending on their field. This site might help:** http://www.abbreviations.com/

Suggested answer

- RBC – red blood cell
- mg/l – milligrams per litre
- ant. – anterior
- ppm – parts per million
- cf – compared with
- Ab – antibody
- LM – light microscope/microscopy
- soln – solution
- bact – bacteria
- min – minutes

e **Allow students time to study the notes from the lab notebook before they listen to the conversation and complete the gaps using abbreviations addressed in Exercises 15a and 15c.**
▶5.6 page 97

Answers

1	RT	5	↓
2	378 K	6	7
3	Δ	7	conc.
4	K		

16 a **In pairs, students discuss the questions and feed back to the class. You could ask if the students are aware of the role the notebook plays in protecting intellectual property. Has anyone contributed to an Open lab notebook? (see Note and Extension activity below)**

Note

Open-source is an adjective that refers to, but is not limited to, software, research, etc. that is freely available and offered by online communities. Open-source science is a way for scientists to post their raw data and discuss their findings and results with a wider community of researchers online.

Extension activity: open-source science discussion/debate

You could ask the students to discuss in pairs the pros and cons of open-source science. You could assign this article as reading homework before they feed back to the class: http://pubs.acs.org/cen/science/84/8430sci1.html **You could also ask the students if they agree or disagree with the following quote from the article: 'Open-source is going to become an important way to do science.' Alternatively, you could divide the class into two groups, or have the students work in pairs to debate this quote. One group can speak in favour of open-source science and the other group can be the critics.**

b Make sure students understand the fragments of the conversation before completing the listening task.
▶5.7 page 97

Answers

1 share
2 notes
3 search
4 changes
5 group's
6 safer

c In pairs, students discuss using e-notebooks and feed back to the class.

17 a Make sure students understand the descriptions (a–e) before listening to the extracts 1–5.
▶5.8 page 97

Answers

a 3 b 5 c 1 d 4 e 2

b Ask students to turn to Audioscript 5.8 in order to complete the table.

Answers

	Past	Present
Ability/Possibility	*could do*	**can share**
Advice	*should have done*	**should try**
Lack of obligation	*didn't have to do* *didn't need to do*	**don't need to worry**
Obligation	**had to use**	*must do*
Prohibition	**were never allowed to take**	*are not allowed to do* *can't do* *mustn't do*

18 In pairs, allow students time to discuss their lab book protocol. You could ask students to feed back to the class.

Background information and useful web links

Describing a process

Process descriptions are used widely in science to explain phenomena and natural processes. These descriptions show how a change takes place through a series of stages. It can also be used to examine the steps of one event over time or to describe something that occurs cyclically (e.g. the phases of the Moon). A well-organized description allows the reader to both understand and visualize the process or event.

Useful web links

Problem Solving and Science Process Skills (although this site is aimed at secondary (high school) students, the issues discussed are very useful)

http://www.suite101.com/content/problem-solving-and-science-process-skills-a65807

A good introduction to describing and evaluating scientific research

http://www.experiment-resources.com/index.html

Definition of earthquakes and the various forms

http://science.howstuffworks.com/nature/natural-disasters/earthquake.htm

Website on earthquake occurrence and frequency around the world

http://earthquake.usgs.gov/research/parkfield/safod_pbo.php

Passive voice use in science

http://www.biomedicaleditor.com/passive-voice.html

Practice with phrasal verbs in science

http://www.ihbristol.com/learn-online/exercise-general/advanced/vocabulary/phrasal-verbs-science/213/

Evaluating the results of an experiment

When scientists evaluate the results of their experiments, there are a number of factors they need to consider. Was the experiment valid and carried out in a controlled environment? How well was the experiment carried out? How could the experiment have been improved? Did the experiment answer one's hypothesis or only yield more questions? Could certain variables be changed in order to test for something else?

Useful web links

Some experiments the students could evaluate in class or as homework (although this site is aimed at secondary (high school) students, the information is very useful)

http://www.practicalphysics.org/go/HswCollection_7.html

Useful language for measuring accuracy

http://www.practicalphysics.org/go/Guidance_120.html

Describing problems with an experiment

Not all scientific experiments go according to plan. Therefore, it is important for scientists to explain the reasons behind any breakdown in the procedure or the reasons behind why they didn't obtain the results they had hoped. Some anomalies may occur on a random basis and be difficult to reproduce experimentally or explain. Some may be a result of human or equipment error. Whatever the outcome, scientists need to be very thorough when discussing the accuracy, errors and reliability of their experiments.

Useful web links

Things we learn from failed scientific experiments

http://io9.com/5053093/the-most-spectacular-failed-scientific-experiments

Some failed experiments can be important ones

http://www.scidev.net/en/health/infectious-diseases/editorials/even-failed-experiments-can-be-important-ones.html

Keeping a lab notebook

Scientists use a lab notebook as the primary record of their research. It's used to document hypotheses, experiments and initial analysis or interpretation of these experiments. It's an organisational tool, a memory aid, and can also have a role in protecting any intellectual property that comes from the research.

Useful web links

Overview of a lab

http://www.rod.beavon.clara.net/lab_book.htm

Comprehensive advice on keeping a lab notebook

http://www.swarthmore.edu/NatSci/cpurrin1/notebookadvice.htm

Images of a lab book (although this site is aimed at secondary (high school) students, the information is useful)

http://www.upscale.utoronto.ca/PVB/Harrison/AzumaBook/Azuma.html

Sample guidelines students could use to create their own internal notebook policy document

http://www.ruf.rice.edu/~bioslabs/tools/notebook/notebook.html

Cambridge English for
Scientists
TEACHER'S NOTES

Unit 6 Writing up research 1: materials and methods

- Describing states and processes
- Describing data: numbers / numerical values
- Writing up from lab notes

Go to page 74 for essential background information on the topic and useful web links.

Don't forget to use the Additional activity worksheet in the Resources section of the Cambridge English for Scientists website.

Science-specific terms can be found in the Glossary on Student's Book pages 117–125

Refers to the Audioscript on Student's Book pages 91–102

Describing states and processes

Before you begin …

Before the class, photocopy and cut up enough of the vocabulary cards (below) for each student to have one card. The cards list four science-related words formed using common prefixes. In class, students work in groups of four people. Give each student in the group a different vocabulary card. Students explain the meaning of each word to the others in the group, who should guess what the word is. After the activity, you could go through the prefix meanings with the group:

di-	two
herbi-	plant
homo- /homeo-	same (opposite = hetero-)
trans-	across
anti-	against
astro-	star
chloro-	green
aero-	air
micro-	very small (or specifically 10^{-6})
poly-	many
thermo-	heat
a-	without
con-	with; together
iso-	like; same
photo-	light

1	2
diatomic (adj) /ˌdaɪəˈtɒm.ɪk/ describes a molecule that consists of two atoms of the same kind (e.g. H_2) **herbicide** (n) /ˈhɜː.bɪ.saɪd/ a chemical which is used to destroy plants, especially weeds **homogeneous** (adj) /ˌhɒm.əˈdʒiː.ni.əs/ consisting of parts which are all of the same type (e.g. pure table salt is all NaCl) **transgenic** (adj) /trænsˈdʒen.ɪk/ describes an animal or plant that contains one or more genes that have been added from another type of plant or animal	**antibiotic** (n) /ˌæn.ti.baɪˈɒt.ɪk/ a chemical that can destroy harmful bacteria in the body **astrophysics** (n) /ˌæs.trəʊˈfɪz.ɪks/ the scientific study of the chemical structure of the stars and the forces that influence them **chlorophyll** (n) /ˈklɒr.ə.fɪl/ the green-coloured substance in plants **homeostasis** (n) /ˌhəʊ.mi.əʊˈsteɪ.sɪs/ the ability of a cell to keep the conditions inside it the same despite changes in the conditions around it
3	**4**
aerobic (adj) /eəˈrəʊ.bɪk/ describes a chemical process which uses oxygen **microbe** (n) /ˈmaɪ.krəʊb/ a very small living thing which is too small to see without a microscope **polychromatic** (adj) /ˌpɒl.ɪ.krəˈmæt.ɪk/ having many different colours (e.g. to describe light with more than one colour) **thermodynamics** (n) /ˌθɜː.məʊ .daɪˈnæm.ɪks/ the area of physics connected with the action of heat and other types of energy, and the relationship between them	**amorphous** (adj) /eɪˈmɔː.fəs/ having no fixed form or shape **convection** (n) /kənˈvek.ʃən/ the flow of heat through a gas or a liquid **isotopes** (n) /ˈaɪ.sə.təʊps/ forms of an atom which have different atomic weights but the same chemical structure e.g. Carbon-12 and Carbon-14 **phototropism** (n) /fəʊˈtɒt.rə.pɪ.zəm/ the growth or movement of a plant towards light

1 a **Students match the beginnings and endings of the sentences.**

Answers

1 d 2 h 3 a 4 g 5 i 6 f 7 c 8 e 9 b

b **Students underline the part of the ending which summarises the meaning of each prefix. You could also elicit (or introduce) the following additional prefixes during feedback: *exo-* (moving out – opposite of *endo-*); *under-* (not enough – opposite of *over-*); *intra-* (within – contrasted with *inter-*).**

Answers

2 nano = 10^{-9}
3 re = again
4 endo = (move) inside
5 over = too much
6 multi = many
7 inter = between
8 en = inside
9 in = in(to)

c **Ask students to discuss the questions in pairs. Then have students either feed back to the class or watch the video mentioned in the extension activity below, which answers these questions.**

Extension activity: nanotechnology video

Students watch the video short 'Nanotechnology Report' at http://www.youtube.com/watch?v=e80bfIcoNUA **and make notes on:**

1 **how small a nanometre is**
2 **what nanotechnology is**
3 **current and potential applications of nanotechnology**

Answers

1 Nanotechnology is the area of science which deals with developing and producing nano- (very small) devices, tools and machines.
2 **Suggested answers**
medicine (diagnosis, tissue engineering, drug delivery)
chemistry (catalysts, filters)
energy (increasing efficiency and reducing consumption)
information/communication (memory storage, semiconductors)
engineering (aerospace, construction)

1 A nanometre is one millionth of a millimetre
2 Nanotechnology is tiny technology – working at the nanometre level
3 Current – cosmetics, sports equipment; future – targeted drug delivery e.g. for anti-cancer drugs to remove side effects

Note: nanotechnology

Nanotechnology deals with structures with a size of 1 to 100 *nanometres* in at least one dimension. A nanometre (nm) is $1x10^{-9}$m. To get an idea of how small that is, a human hair has a diameter of about 60,000 nm and a sheet of paper is about 100,000 nm thick. Nanotechnology aims to create new materials and devices to be used in a range of applications. However, nanotechnology raises concerns about the potential impact of nanomaterials. Current news articles on the topic can be found at http://www.sciencedaily.com/news/matter_energy/nanotechnology/

2 a **Make sure students understand the terms:**

pharmaceutical research research related to producing drugs

targeted drug delivery drugs going to the exact place in the body where they are needed (it was mentioned in the nanotechnology video)

Students work in pairs to discuss what they think is happening in each stage and then feed back to the class.

Answers

a The nanotube surface is functionalised with a chemical receptor and the drug molecules are encapsulated.
b The open end of the tube is capped.
c After the nanocapsule is ingested, it locates to target site due to the functionalised surface.
d The cell internalises the capsule, for example by receptor-mediated endocytosis.
e The cap is removed or biodegrades inside the cell.
f The drug molecules are released.

Note: targeted drug delivery

Targeted drug delivery is a method of delivering medication so that it is concentrated in the affected area, avoiding the remaining tissues. This improves *efficacy* while reducing *side effects*. Targeted drug delivery can be used to treat many diseases, but its most important application is to treat *cancerous tumours*.

b **Students listen to the recording and mark the statements true or false.**
▶6.1 page 97

Answers

1 F – He asks her to explain what is happening in the diagram.
2 T
3 F – It is sometimes called a 'magic bullet' because it sends the drug to where it is needed.
4 F – Her main interest is in how to encapsulate the drug in a nanotube.
5 T – It can be swallowed, injected or inhaled.
6 T – She uses biodegradable caps.

3 a **Allow time for students to complete the extracts with words from the box. Students listen to the recording to check their answers. Point out that to be able to use these verbs accurately in their writing, students need to know which prepositions commonly collocate with them e.g. attach to. Encourage students to make a note of such collocations through the rest of this unit (and in their learning).**
▶6.2 page 98

b **Students match the verbs in the sentences to their definitions.**

Answers

1 c 2 a 3 e 4 b 5 d

c **Allow time for students to look up the words in the Glossary or a dictionary and to complete the sentences. Make sure they know that the verb form may need to be changed.**

Answers

1 diluted
2 ground into
3 purify
4 rinsed with
5 fuse together

Language note: *with* and *by*

Sentence 4 in Exercise 3c includes the verb phrase *was rinsed with distilled water*. Point out the difference between *with* + NOUN and *by* + NOUN. With is used to introduce the object used to perform the action e.g. *The product was rinsed <u>with</u> distilled water*. By is used to introduce the agent – the person or thing that does the action e.g. *The product was rinsed <u>by</u> the scientist*.

4 a **Students read the extracts and decide whether they are used to ask for help or to offer help.**

Answers

1 O 2 A 3 A 4 O 5 O

b **Allow time for students to draw a sketch of a process related to their work and to look up any vocabulary items they need to explain the process. Students work in pairs to role play the conversation. Provide feedback on the use of the phrases from Exercise 4a or any other similar phrases used.**

5 a **Allow students time to read the extract and to discuss in pairs how the text could be improved. You could tell them that Tom suggests five main changes. Students then listen to the recording and make notes of these changes. When eliciting feedback for this exercise, make a brief note of the five changes on the board. Students can refer to these when completing the next exercise rather than looking at the Answer key since the improved text is on the same page.**
▶6.3 page 98

Answers

- There are too many sequencing words; it's better to just write in order and only use words like 'then' when you really need to.
- Don't use 'I' or 'We'; use passives.
- Change 'for target …' to 'to target …' to say why something is done.
- Use present tense (not past) to describe a process in general; use the past tense for specific experiments.
- Take out the sentence with examples of ways to ingest the tubes; never include information the reader doesn't need to understand your work.

b **Students use the notes from Exercise 5a to improve the paragraph. They then compare their answer with the paragraph on page 110 of the Student's Book.**

6 a **Go through the information about using the passive. Ask students why the person or thing performing an action is not the main point of interest in a description of a scientific process (see Language note below). Elicit the structure of the passive (see Language note below). Students rewrite the sentences using the passive voice.**

Answers

1 The tissue surface was rinsed with ice-cold isotonic saline solution.
2 After incubation at 37 °C for 60 minutes, the suspension was diluted to 100 ml with water.
3 Particles as small as 10 μm are filtered out using a mesh.
4 The audiometric thresholds are measured at six frequencies from 250 Hz to 8 kHz. / The audiometric thresholds at six frequencies from 250 Hz to 8 kHz are measured.
5 Densitometry was used to analyse the autoradiograph.

Language note: a grammar summary of the passive voice

The passive voice is formed by using the correct form of the verb *be* followed by the past participle e.g. *The surface of the nanotube is functionalized*. It is commonly used in academic writing to move the focus away from the agent and onto the action itself. Processes and experimental procedures are often described using the passive voice because it should be possible for anyone to replicate them and get the same results.
In sentences with non-human agents, the choice of whether to use the active or passive voice depends on the focus of the text. In a text such as Kimiko's, the focus is on nanotubes and so the active structure *The nanotube locates to the target site* is appropriate. In a text about drug targets, however, *The target site is located by the nanotube* would be more suitable. For more information on the passive see *Cambridge Grammar of English* pages 793–802. For exercises on the passive for the students, see Unit 26 of *Developing Grammar in Context: intermediate*.

b **Students answer the questions.**

Answers

Sentences 3 and 4 describe a process in general; Sentences 1, 2 and 5 report a particular procedure.
The present tense is used when describing a process in general. The past tense is used to report a particular procedure which was carried out in one particular experiment or set of experiments.

C **Students work in pairs to answer the questions.**

Answers

The following sentences have verbs in the passive:
Exercise 3a – 4 (*is encapsulated*), 5 (*is internalised*)
Exercise 3b – 1 (*was used*), 2 (*is caught*), 5 (*was extracted*)
Exercise 3c – 1 (*were diluted*), 2 (*was ground*), 3 (*could be used*), 4 (*was rinsed*), 5 (*is liberated*)
The following sentences could be made more formal by using the passive:
Exercise 3a – 1 (*the surface of the tube is coated*), 2 (*folate receptors are attached*), 3 (*the drug is encapsulated*), 4 (*a cap is used*), 6 (*biodegradable caps are used*)
The following verbs do not need to be changed because they have non-human subjects:
Exercise 3a – 6 (*The cap dissolves*)
Exercise 3b – 2 (*the gas cools*, *the water vapour condenses*), 3 (*Devices … would filter out*), 4 (*Haemotoxylin-Eosin stains*)
Exercise 3c – 5 (*two deuterons fuse together*)

7 **Allow time for students to write a paragraph describing the process they sketched and discussed in Exercise 4b.**

Extension activity: peer-editing

If you have a confident group of students, you could have the students peer-edit each other's paragraphs. Write the following questions on the board to guide them:

1. **Are passives used appropriately and 'I' or 'we' omitted?**
2. **Is *to* + INFINITIVE used to say why something was done?**
3. **Is the present used if it is a general process and the past if it is about one specific experiment?**

Extension activity: debate over nanotechnology

Students do some online research to find out more about the arguments for and against nanotechnology, particularly in relation to its application to targeted drug delivery. An excellent starting point is the Big picture on nanotechnology link in the Background Information and Weblinks section on page 74. Students could report back to the class, or you could have them work in groups of four to role play an ethics panel review. In this case, two of the students should play the scientists, explaining to the panel the benefits of the technology. The other two students play the panel members, presenting arguments against the technology.

Describing data: numbers / numerical values

Before you begin …
You could ask students to look at a table of data (such as this one http://lsda.jsc.nasa.gov/books/apollo/Resize-jpg/ts3c3-6.jpg). Ask students to look at the table and decide what they think was being investigated. Students then work in pairs to discuss what they think the key findings are.

Suggested answers

The research is investigating what happens to red blood cell mass when astronauts go into space
Key findings:

1 Overall decrease in red cell mass in all studies (e.g. from –2.0% to –27.0%)
2 Some increase in red cell mass (in Tektite I, Apollo 8, BAFB chamber and Sealab 111)
3 Gemini missions
   - atmosphere 100% oxygen
   - red cell mass loss 13–21%
4 Apollo 7 & 8
   - atmosphere never pure oxygen
   - red cell mass loss 2–3%
5 BAFB chamber and BAFB chamber (1970)
   - 91% oxygen lead to a 3% decrease in red cell mass
   - 100% oxygen lead to a 12.7% decrease in red cell mass
6 Length of the mission – no effect

Note

The table shows changes in red blood cell mass in human subjects in a number of different space missions, as well as in simulation chambers on the ground, and in undersea laboratories. Tektite 1 and Sealab 111 are the underwater programs, those labelled 'chamber' research conducted on the ground and the Gemini and Apollo data from space missions.
Changes in red cell mass are of interest to scientists monitoring the health of astronauts. A reduction in red cell mass, anaemia, leads to less oxygen being delivered to the cells in the body. Because the cells depend on oxygen for survival, anaemia can have a range of clinical consequences. Problems can also arise as the body tries to compensate for the loss of red cells. The heart rate can increase to try to deliver more oxygen, or blood flow may be reduced to less vital areas of the body.
Normal air is composed of around 21% oxygen with the O_2 having a partial pressure of 3.07 psia*. Far lower percentages can be breathed at higher pressures, provided the remaining gases in the mixture are non-toxic (such as helium).
*psia stands for 'pound-force per square inch absolute' and is a measure of atmospheric pressure, equivalent to 6.0 x 10^3 N/m^2 (newton per metre squared). At sea level, the atmospheric pressure is 14.7 psia

8 a Students use the Glossary to check the meaning of the underlined words. You may also want to check the meanings of *assay* (question 2) and *mole* (question 6):

assay a procedure in molecular biology for measuring the activity of a drug/ biochemical
mole a unit of measurement for the amount of a substance – see Exercise 9a

Students listen to the recording and choose the correct number.
▶6.4 page 98

Answers

1 a 2 c 3 a 4 b 5 b 6 c 7 b 8 b

b Students listen to the recording to complete the values.
▶6.5 page 98

Answers

a	¼	d	2,905,740	g	10^6	j	$17^5/_8$
b	15%	e	5 x 10^9	h	10,893	k	0.003
c	1.356	f	–35	i	–57	l	5,090,019

C **Students work in pairs to answer the questions. If you have a weaker group, allow them to refer to the way the values and symbols were said in Audioscript 6.5 on page 98 for help with this task. Students then listen to the recording to check their answers.**
▶6.6 page 98

Answers

1 a three quarters b five eighths
c four ninths d ten to the power of seven / ten to the seven
e ten to the power of minus nine / ten to the minus nine
2 a per cent b times c minus
3 A **decimal point (.)** describes parts of a whole number; a **comma (,)** separates hundreds from thousands (1,100), hundreds of thousands (110,000), millions (1,100,000), etc.
1.356 = one point three five six; 1,356 = one thousand, three hundred and fifty-six

Language note: describing numbers

Numbers and other numerical values sometimes have more than one pronunciation. Some common alternatives to be aware of are:

- 10^7 can be said *ten to the power of seven* or *ten to the seven*.
- 0 can be said *oh*, *nought* or *zero*. *zero* is the most widely-used alternative in scientific and engineering contexts, though *nought* is a common alternative in British English and *oh* may replace *zero* after a decimal point (e.g. *zero-point-zero-two* or *zero-point-oh-two* for 0.02).
- In decimals, we say the numbers individually e.g. 0.19 is *nought-point-one-nine*, not *nought point nineteen*.

When talking about a data range from negative to positive, *plus* (+) is used before the positive number for clarity. In British English, *and* is used between the hundreds and the tens in a number e.g. *eight hundred and ninety*. In American English, it is not used e.g. *eight hundred ninety*.

9 a **Students read the introduction to the International System of Units. Before they do the exercise, you could ask if they know what the seven base units are. If they do not know, do not tell them the answer yet (Answer: *metre*, *kilogram*, *second*, *ampere*, *kelvin*, *candela*, *mole*). Students match the unit to its abbreviation and the quantity it measures. If they did not know the seven base units, ask them which of the eleven in Exercise 9a they are (see above – the others are SI-derived units).**

Answers

1	metre	m	length
2	kilogram	kg	mass
3	second	s	time
4	ampere	A	electric current
5	kelvin	K	thermodynamic temperature
6	candela	cd	luminous intensity
7	mole	mol	amount of substance
8	hertz	Hz	frequency
9	joule	J	energy
10	ohm	Ω	resistance
11	degree Celsius	°C	temperature

Language note

Names of units start with a lower-case letter, even when the symbol for the unit begins with a capital letter (e.g. *kelvin* and *K*). This also applies to *degrees Celsius* because *degree* is the unit (*Celsius* is a modifier used to distinguish *degrees Celsius* from *degrees Fahrenheit*). When writing numbers and units, there should be one space between the number and unit.

b **Students discuss the questions in pairs and then feed back to the class.**

c **Students complete the table using the prefixes.**

Answers

1 kilo-
2 mega-
3 giga-
4 tera-
5 centi-
6 milli-
7 micro-
8 nano-
9 pico-

Language note: kilogram

Kilogram is the only SI unit with a prefix as part of its name and symbol. To avoid multiple prefixes, the unit name *gram* and symbol *g* are used with the other prefix names and symbols.
In Exercise 9d, questions 4 and 8, there is a hyphen between the number and the unit because the value is an adjective modifying a noun i.e. *50-nanosecond laser pulses*.

d **Students listen to the recording again and complete the units of measurement.** ▶6.4 page 98

Answers

1 mg
2 pmol
3 Ω
4 A
5 K
6 kJ
7 kHz
8 ns

10 **Students find some data they are familiar with. Allow time for them to think about how to say the key values. Students work in pairs to discuss the key findings of the data.**

Writing up from lab notes

11 a **Ask students to look back at the diagram on page 46 and elicit the stages in the targeted drug delivery process. Ask students if they can remember which part of the process Kimiko is most interested in (Answer: encapsulating molecules in CNTs). Students look at the extract from Kimiko's notebook and match the words (a–h) to the definitions (1–8).**

Answers

1 b 2 f 3 g 4 e 5 c 6 a 7 d 8 h

b **Students work in pairs to look at the notes and answer the questions.**

Answers

1 To check the size of the CNTs and the wall thickness, and that they are consistent
2 She suspends the tubes in a solution and puts a drop onto the slide. When the solution evaporates, the CNTs remain on the slide.
3 By capillary action

12 a **Students look at the extracts from the notebooks and work in pairs to decide what the symbols and abbreviations mean. You may want to check the meanings of *deionised water*, *fluorescent*, *residue* and *solvent* first (see below). Make sure the students know that the abbreviation *sol*^{n} means solution. Point out that they could use the ^{n} abbreviation in nouns ending *-tion/-sion*.**

deionised water purified water which has been processed to remove mineral salts
fluorescent bright and easy to see, even in the dark
residue a substance that remains on a surface and cannot be removed easily
solvent a chemical used to dissolve or suspend another substance (**NB:** the *solute* is the substance being dissolved)

Answers

@	at	EM	electron microscope
~	approximately	L	length
→	leads to	w/	with
D	diameter	w/v	weight per volume
diam.	diameter		

Extension activity: notes into sentences

Students orally describe Kimiko's 29th October procedure from the notes. This will give oral practice of transforming notes into sentences prior to doing the same into written form for the 18th November experiment in Exercise 13a.

b **Students work in pairs to identify the differences between Kimiko's two experiments. They then suggest ways to complete the spaces and feed back to the class. Write up on the board the kind of information which is likely to fill each space i.e. Is it a number or a word? How do you know? How large a number? What kind of word?**

c **Students listen to the recording and complete the notes.**
▶6.7 pages 98–99

Answers

1	50	4	2-propanol
2	700	5	3
3	15	6	glass

13 a **Explain that Kimiko has used her 18th November lab notes to write up part of her materials and methods section. Elicit how the write-up might be different from the lab notes (e.g. full sentences; no abbreviations; more academic vocabulary; verbs in the passive voice).**

Students complete the two extracts using words from the boxes. Make sure they refer to the lab notes while doing the task.

Answers

1	ranged	6	estimated	11	placed	16	consisted
2	length	7	and	12	aid	17	ratio
3	to	8	actual	13	evaporated	18	laden
4	average	9	due	14	blending	19	covered
5	approximately	10	suspended	15	with	20	filled

b **Students read the extracts again and find which verbs are used in the passive voice and which in the active.**

Answers

a passive: estimate, place, prepare, suspend
b active: consist, cover, evaporate, fill, investigate, range

Additional activity Unit 6: writing up from notes

If your students need more practice in using the passive, you can use this Additional activity for Unit 6 in the Resources section.

c **Students look at the notes and put the remaining words in the correct order to complete the three sentences. Make sure students know that the underlined noun phrase (see Language note page 81) begins the sentence in each case.**

Answers

1 The change in red blood cells ranged from approximately plus 8% to minus 7.4%.
2 The cells were suspended in an incubation medium and then placed in a flask.
3 The stream sediment samples were soaked in HCl at a 1-to-1 volume ratio.

Additional activity Unit 6: nouns and articles

If your students need more practice in using articles, you can use this Additional activity for Unit 6 in the Resources section.

14 **Allow time for students to think about an experiment they would like to write up. Students work individually to write the methods and materials section.**

Background information and useful web links

Nanotechnology

Nanotechnology can be defined as small scale engineering. It has applications in many fields. While nanotechnology has many potential benefits, it also has potential risks.

Useful web links

Nanoscience – working small, thinking big

http://www.science.org.au/nova/077/077key.htm

Big Picture on Nanoscience

Aimed at high school science students, this is an excellent 16-page magazine all about nanoscience, its current and potential applications, benefits and drawbacks.

http://www.wellcome.ac.uk/stellent/groups/corporatesite/@msh_publishing_group/documents/web_document/wtd015798.pdf

Nanotechnology – taking it to the people

http://www.science.org.au/nova/089/089key.htm

Nanotechnology Challenges, Risks and Ethics

http://science.howstuffworks.com/nanotechnology5.htm

Nanosafety and the environment

http://www.ecosmagazine.com/?paper = EC153p20

Carbon nanotubes (CNTs)

Carbon nanotubes are hexagonal arrangements of carbon atoms that have been rolled into tubes. They have interesting electronic properties and so have attracted a great deal of scientific interest.

Useful web links

Carbon nanotube science and technology

http://www.personal.reading.ac.uk/ ~ scsharip/tubes.htm

What are carbon nanotubes?

http://www.nano2hybrids.net/view_post.php?postid = 244 – a series of short videos explaining what CNTs are, how they are made and what they are used for.

Targeted Drug Delivery

Targeted drug delivery is a method of delivering medication to a patient in a manner that increases the concentration of the medication in some parts of the body relative to others, thus preventing damage to healthy tissue.

Useful web links

Magic bullet for targeted drug delivery

http://www.mydigitalfc.com/leisure-writing/magic-bullet-targeted-drug-delivery-526

Targeted Drug Delivery and Drug Release Systems Using Nanotechnology For Improved Healthcare

http://www.azonano.com/Details.asp?ArticleID = 1702

Cambridge English for
Scientists

TEACHER'S NOTES

Unit 7 Writing up research 2: presenting data

- Analysing data (statistical analysis)
- Summarising data in visual form
- Writing captions for figures
- Describing visual data

Go to page 84 for essential background information on the topic and useful web links.

Don't forget to use the Additional activity worksheet in the Resources section of the Cambridge English for Scientists website.

Science-specific terms can be found in the Glossary on Student's Book pages 117–125

Refers to the Audioscript on Student's Book pages 91–102

Analysing data (statistical analysis)

Before you begin …

Ask students to look at the photos and guess what they show. Ask where these organisms might live. Elicit from the class environments on our planet or in the universe that contain extreme conditions. Ask students what characteristics make these environments extreme? (extremes of concentration (of oxygen, for example), temperature, pressure, etc.) Write students' answers on the board.

Suggested answers

Main picture: Hot springs – many microorganisms can live here despite high temperatures and very high concentrations of some elements, e.g. sulphur.
Top picture: Pompeii Worm habitat on or near Black Smokers, hydrothermal vents on the sea floor, which give the worm its volcanic name.
Centre picture: Deep-sea tube worms found around a methane seep off New Zealand's east coast
Bottom picture: Diatoms – found in a wide variety of extreme environments, including ancient Antarctic ice, alkaline environments and hypersaline lakes.

1 a Allow time for students to match the extremophiles with the conditions then feed back to the class.

Answers

1 e 2 f 3 g 4 b 5 a 6 d 7 c

b Students discuss the questions in pairs and then feed back to the class. You could also ask students to come up with any other reasons research on extremophiles might be useful then feed back to the class.

Answers

1 a It could help show us how/why some organisms become genetically isolated from other, similar organisms (evolution)
b It could help us to understand the possible structures and adaptations of early organisms
c It could give us ideas how and where we might search for life on other planets

Suggested answer

2 Enzymes that can be used in industrial processes under extreme physical or chemical conditions. For example, for the removal of hydrogen peroxide in the industrial bleaching (cleaning) in the production of paper and textiles.

c **Ask students to identify the prefixes in 1a (1–7) and find a word or phrase in (a–g) that has a similar meaning.**

Answers

2 alkali- + pH 9 or above
3 cryo- + temperatures of 15 °C or lower
4 metalo- + metals
5 osmo- + high osmotic pressures
6 radio- + radiation
7 thermo- + temperatures between 60 and 80 °C

d **Students answer the questions and feed back to the class.**

Answers

a -tolerant b -resistant c -phile

Extension activity: the *-phile* suffix

For higher levels:

Write the suffix *-phile* on the board and draw a circle around it. Draw six lines attached to the circle to make a spidergram. Then read out individual definitions listed below and ask students to guess the prefix that corresponds to the definition. For example, read out attracted to humans and students try to guess *anthrophile*. Then write the prefix *anthro-* on one of the lines of the spidergram.

For lower levels:

Draw a spidergram with *-phile* in the middle and the prefixes on the lines connected to it. Read out the definitions and have students guess which word is being described to them.

anthro	phile	attracted to humans (e.g. parasites).
geo	phile	attached to soil
halo	phile	attracted to salt or salt-water
helio	phile	attracted to sunlight
hyperthermo	phile	attracted to extremely hot environments
microaero	phile	attracted to environments with low levels of oxygen.

e **Students match the affixes with their meanings.**

Answers

1 e 2 f 3 g 4 d 5 c 6 a 7 b

Language note: affixes

Affixes are fixed groups of syllables which attach to a word stem to form a new word. English has two types of affix: *prefixes* (appearing at the beginning of the word, such as *anti-*) and *suffixes* (appearing at the end of the word, such as *-less*).

f **Allow time for students to read the definitions and identify the extremophile.**

Answers

1 a hyperthermophile
2 a halophobe
3 a neutrophile
4 a polyextremophile

2 a **Based on their work with affixes, ask students what they think *hydrothermal (hydro + thermal) vents* are (a definition is given in the Glossary on page 120 of the Student's Book). Students listen to the recording to answer the questions. You could ask the students what *raw data* means (it is data that has not been processed for meaningful use). Students can read the end of the listening text to help them with the definition. You could ask students why statistics are important to science (for example, we need statistics to summarise complex data in an analysable form. Statistics allow scientists to make meaningful comparisons and observations when there are multiple sources of data).**
▶7.1 page 99

Answers

1 high temperatures and high metal concentrations
2 to go up; to show high levels
3 as the control group; to compare them with the vent species of shrimp
4 (4 types of) (antioxidant) enzymes

b **Allow time for students to match the terms with their definitions.**

Answers

1 h 2 j 3 a 4 d 5 e 6 g 7 b 8 c 9 f 10 i

Extension activity: statistics syllable stress

Check the students' pronunciation of the terms in Exercise 2b by asking them to underline the stressed syllable.

Answers

NB: Syllables are divided by (.) and stressed syllables are marked by (●)

A.nal.y.sis of Va.ri.ance (A.NO.VA or A.NO.VA)
co.e.ffic.ient
co.rre.la.tion
re.gre.ssion a.nal.y.sis
sam.ples
stan.dard de.vi.a.tion
va.ri.a.bles

c **Allow time for students to fill in the gaps. The abbreviation, MT (line 2) level, stands for *metallothionein*. Metallothioneins (or MTs) belong to a family of cysteine-rich low molecular weight metal-binding proteins. Tiago used this word in Audioscript 7.1.**

Answers

1 samples	5 p-value
2 mean	6 standard deviation
3 ANOVA	7 correlation
4 t-tests	8 regression analysis

3 a **Check students understand the purpose of the table: Tiago is comparing the results of hydrothermal vent species and his control, the coastal (lagoon) species. Students discuss in pairs then feed back to the class. (If you wish to be prepared for their possible feedback, sentences in Exercise 3b and the suggested answers to Exercise 3c offer useful information.)**

b **Allow time for students to complete the sentences using the table in Exercise 3a. You could review the passive voice (from Units 5 and 6) and ask students to identify examples of the passive in Exercise 3b and discuss why the passive or active voices are used here. You could also ask students to discuss the meaning of *significant* in statistics (when a statistic is *significant*, it means that the result is probably caused by something other than chance. See Student's Book Glossary page 122).**

Answers

1 approximately sixfold higher than in	4 No significant differences
2 not significantly different from	5 threefold higher in
3 the lowest	6 A significantly higher

Language note

You could check students' understanding of *sixfold* ('multiplied by six'. *–fold* is a suffix used to make adjectives meaning *times*) and *threefold*.

c **Allow time for students to write four more sentences using the data in Exercise 3a to compare the hydrothermal vent species with Tiago's control, the coastal (lagoon) species.**

Suggested answers

1 *M. fortunata* exhibited a far higher cytosolic SOD activity than any other species.
2 MT levels in *P. elegans* were slightly less than three times higher than those in *P. varians*.
3 No significant difference was seen in the cytosolic CAT levels in the two coastal shrimp species, or in the two vent species. However, the vent species exhibited higher levels than the coastal species.
4 Levels of GPx in *P. varians* were not significantly different from those in *P. elegans* or in *R. exoculata*. However, levels in *P. elegans* and *R. exoculata* were significantly different from each other.

d **Allow time for students to think of an experiment and to discuss the various statistical analysis in pairs.**

Summarising data in visual form

Before you begin ...
As a warm up activity to making graphs and charts, you could first ask students to interpret them. You could print the 10 graph interpretation questions off this website or ask students to answer them in a computer lab (although this site is aimed at secondary (high school) students, the information is still very useful):
http://staff.tuhsd.k12.az.us/gfoster/standard/bgraph2.htm

4 a **Students work in pairs to discuss the questions then feed back to the class. You could mention that Cleveland, W. S. in his 1984 article 'Graphs in Scientific**

Publications' in *The American Statistician* (http://www.jstor.org/pss/2683400), stated that in some journals, as much as 30% of the space is taken up by graphs. Ask students if they think, or have found, this to be true.

Answers

1 Visuals are used in papers to:
- present a large amount of information in a small space
- present complicated findings in a clear and simple way
- draw attention to the key findings

b Ask students to complete the sentence pairs.

Answers

1 f 2 d 3 e 4 b 5 c 6 g 7 a

c Ask students to read the advice on presenting data in Exercise 4b, elicit answers to the questions, then students feed back to the class.

5 a Ask students to complete the exercise on visuals.

Answers

1	row	5	scatter plot	9	y-axis	13	label
2	column	6	x-axis	10	histogram	14	scale
3	line graph	7	line of best fit	11	stacked bar chart	15	caption
4	point	8	bar chart	12	key	16	pie chart

b Ask students to complete the exercise using the words in the box.

Answers

a	bar chart / table	d	pie chart / stacked bar chart
b	scatter plot	e	diagram
c	map	f	histogram / line graph

6 a Ask students to refer to the bar chart in Exercise 5a (the bar chart labelled 8 and 9 on page 58 of the Student's Book) as they listen to the recording to complete the notes 1–4. You could ask students what they think Océane means when she says, 'the shading is good [and it] will reproduce well in print' (Audioscript 7.2). Then add that to any advice students came up with in Exercise 4c. You could remind students that many scientific journals make strict specifications on how to present data visually.
▶7.2 page 99

Answers

1 axes
2 included
3 show what the colours mean
4 show standard deviation

Note

Figures which are inaccurate or poorly presented can have serious consequences. A famous example is reported by Tufte (1997) in *Visual Explanations: Images and Quantities, Evidence and Narrative*. Tufte showed that the poor quality of presentation on engineering drawings (including the use of too much ink, unhelpful shading and coding) led to a misunderstanding over the safety of launch conditions for the US space shuttle *Challenger* on 28 January 1986. The *Challenger* exploded shortly after launch killing all the crew on board.

b Students work in pairs to complete the role play.

Extension activity: editing visual data

Students can bring to class data that they are currently working on or use charts and graphs from other parts of the book and discuss in pairs ways the data could be better presented.

Additional activity Unit 7: preparing visual data

You can use the Additional activity worksheet for Unit 7 in the Resources section to help students discuss visual data in English.

Writing captions for figures

Before you begin …
Ask students to bring to class captions that they have written in previous research. You can also find several examples on this website: http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWtablefigs.html

You can discuss with the students whether they think the captions are clear, well written, too long or too short. Ask if they would make any changes to the captions. You can also use these to help students answer the questions in Exercise 7a.

7 a Students discuss the questions in pairs and feed back to the class.

Answers

1 The normal convention is that captions for tables appear above the table, while captions for figures appear below the figure, unless a particular journal specifies otherwise.
2 An explanation of what is being shown; the object of study; the sample size; the location of the study; the treatment applied, and a summary of the statistics; other information such as an explanation of codes used in the figure (a key)
3 The main problem is often being concise and using appropriate noun phrases rather than full sentences.

b Allow students time to read the four captions and answer the questions.

Answers

1 In brackets as *n = 51* (where *n* means the number and *51* is the value)
2 There is no main verb in caption A or the underlined part of caption D. They are noun phrases.
3 No; the original authors and the year they published the work are given in brackets (or parentheses)
4 *compared with* The purpose of the table is to make a comparison between a number of different variables (temperature, pH and various chemical concentrations) in three different environments, one of which is seen as 'standard' (average seawater) and two others which are seen as 'special' (lagoon system and vent field).
5 *under investigation*
6 In brackets and in italics. In brackets because it is additional information, not the main point. In italics because it is the Latin, not the English-language name.
7 a It tells the reader what the visual shows or describes.
b They give the reader information about the experimental process he/she needs in order to understand the information in the visual.
8 *The data represent*
9 *not statistically different*
10 There is no main verb in the underlined part of the caption. It is a noun phrase. The other parts of the caption have main verbs (*represent* and *are*), so are sentences.

Language note: noun phrases

A *noun phrase* is a phrase whose headword is a noun or a pronoun. They are very commonly used in captions. In the examples below, the headword is in bold and the modification in italics.
people *who use computers*
treatments *that are based on antibodies*
data *that has been released recently*

computer **users**
antibody-based **treatments**

newly released **data**

Caption C also has a noun phrase in which the headword is in the middle: *Thermal **tolerances** for the three symbiotic species…* Further noun phrase practice can be found in Unit 8 (Exercise 9a–b on page 67 of the Student's Book and in the Additional activity for Unit 8 in the Resources section).

8 a Make sure students can identify the noun phrases in captions A to D then ask them to complete the exercise.

Answers

1 Length-frequency of four samples of mussels collected at three different sites of the Lucky Strike area.
2 Copper concentration in the soft and exoskeleton tissues of four shrimp species.
3 Comparison of the physical and chemical characteristics of the hydrothermal fluids at Menez Gwen, Lucky Strike and Rainbow (adapted from Douville *et al.*, 2002).

b Ask students to complete the caption using the words in the box.

Answers

1 Fig. 1
2 *B. azoricus*
3 expressed
4 Values
5 represent
6 ($p < 0.05$)

c **Ask students to add brackets to the text.**

Answers

Add brackets to: (cytosolic and mitochondrial), (0.4 μM), and (n=10)

d **Ask students to use figures from their own research or sketch a graph.**

You can also print graphs from these two websites:

http://abacus.bates.edu/~ganderso/biology/resources/writing/HTWtablefigs.html

http://www.visionlearning.com/library/module_viewer.php?mid=156&l=

Remove the captions and ask students to write their own using a graph or figure of their choice. See how close the students come to the captions on these websites.

Describing visual data

Before you begin …

Read these statements to the students and ask them to discuss them in pairs then feed back to the class.

- Summaries of the statistical analyses may appear both in the text and in the relevant Tables or Figures' captions.
- Important negative results should be shown, too.
- The passive voice will likely dominate here.

9 **Students discuss 1–8 in pairs then listen to the recording to answer the questions. You could remind students of the definition of *p value* as seen in Exercise 2b (*the measure of significance, which shows if it is likely that the variation in results is just chance*).**

▶ *7.3* **page 99**

Answers

1 The text highlights the key results. A chart might show a few different things; the text points out which are the most important.
2 Definitely – they're an important part of finding the answer to your questions.
3 No – just highlight the main trends of key differences. Any interpretation comes in the discussion section.
4 No, only the ones which show something interesting.
5 Yes.
6 Things that are similar or different. Values that are very high or low. Interesting correlations.
7 Absolutely not – make notes on the key results only.
8 Put the test name and the p value in parentheses after the result.

10 a **Allow time for students to study the graphs and read the extracts then ask them to answer the question.**

You could ask the students how they came up with their answers, e.g. identify the lexical clues they used in the two extracts.

Suggested answers

Extract A describes visual 1
-significant inhibition of SOD (cytosolic and mitochondrial), CAT and total glutathione peroxidase activity
Extract B describes visual 3
As temperature increased, H2S uptake in Alviniconcha sp. decreased
For I. nautilei, H2S consumption also decreased as temperature increased.

b **Make sure students understand the terms 1–15 and the underlined phrases in A and B before they do the matching exercise.**

Answers

1 changed
2 are shown
3 shown as a percentage of
4 decreased
5 had the fastest consumption of H_2S
6 compared with
7 caused
8 resulted in
9 inhibition of
10 stayed high
11 increased
12 showed a linear pattern of
13 as high as
14 was seen
15 while no significant change

Extension activity: syllable stress

Check the students' pronunciation of the phrases (1–15) in Exercise 10b and selected underlined phrases in Exercise 10a by asking them to underline the stressed syllable.

Answers

NB: Syllables are divided by (.) and stressed syllables are marked by (•)

Words from Exercise 10a:	Words from Exercise 10b:	
per.cen.tage	a.ffec.ted	re.duc.tion
in.hi.bit.ion	pre.sen.ted	re.mained
in.creased	ex.pressed	lin.e.ar
de.creased	pro.por.tion	re.la.tion.ship
con.sum.ption	grea.test	ob.served
patt.ern	com.par.i.son	sig.nif.i.cant
re.sul.ted	pro.duced	diff.e.rence

11 **Remind students they can use the graphs and captions they wrote in Exercise 8d to write their descriptions. Or they can use the graphs and captions from other units or websites such as this one (scroll down to see the graph samples on the right-hand side of this site):** http://staff.tuhsd.k12.az.us/gfoster/standard/bgraph2.htm

Background information and useful web links

Analysing data (statistical analysis)

Statistics are used to provide a measure of the probability of observing a certain result. Statistical analysis is used in designing scientific studies to increase consistency and measure uncertainty.

Useful web links

Extremophiles: A recent discovery of an organism able to thrive and reproduce using the toxic chemical arsenic

http://www.uapsg.com/2010/12/nasa-breakthrough-extremophile-here-on.html

http://www.sciencedaily.com/releases/2010/12/101202140622.htm

This site gives a comprehensive background on statistics and discusses the limitations and misuses of statistics

http://www.visionlearning.com/library/module_viewer.php?mid = 155

The students could also take the 'Statistics Quiz' this site provides

http://www.visionlearning.com/library/quiz_taker.php?qid = 216&mid = 155&mcid =

Summarising data in visual form

Visual representations of data are essential for both data analysis and interpretation.

These can highlight trends in numeric datasets that might not otherwise be apparent. Understanding and interpreting visual forms of data is a critical skill for scientists and students of science.

Useful web links

designing visuals

This website provides useful advice on designing visuals and contains plenty of graph and chart examples

http://www.visionlearning.com/library/module_viewer.php?mid = 156

This is an example of a style guide when designing visuals for an authentic scientific journal

http://www.sciencemag.org/site/feature/contribinfo/prep/prep_subfigs.xhtml

Writing captions for figures

Writing figure captions is an important skill; as much as possible, the captions should stand alone in explaining the visual data. Many scientists may read only the abstract, figures, figure captions, tables, table captions, and conclusions of a paper. Therefore, scientists need to be sure their figures, tables and captions are well labelled and well documented.

Useful web links

captions

This website provides several examples of captions (also called: legends) and advice on how to write them. Click on 'Legends' on the list at the top of this page

http://abacus.bates.edu/ ~ ganderso/biology/resources/writing/HTWtablefigs.html

Describing visual data

Putting data into a visual format can facilitate additional descriptions. Analysis involves working to uncover patterns which are then explained in the scientist's paper.

Useful web links

This website offers a comprehensive description of data analysis and its purpose
http://www.visionlearning.com/library/module_viewer.php?mid = 154

Cambridge English for
Scientists
TEACHER'S NOTES

Unit 8 Writing up research 3: results and discussion

- Organising the results and discussion sections
- Preparing and writing the results section
- Preparing and writing the discussion section

Go to page 95 for essential background information on the topic and useful web links.

Don't forget to use the Additional activity worksheet in the Resources section of the Cambridge English for Scientists website.

Science-specific terms can be found in the Glossary on Student's Book pages 117–125

Refers to the Audioscript on Student's Book pages 91–102

Organising the results and discussion sections

Before you begin …
Students look at the image on page 62 and guess what it shows. It is the structure of graphene, a one-atom-thick sheet of carbon. Ask students what other carbon structures they know. Diamond and graphite are both common carbon forms; they may also remember Carbon Nanotubes (CNTs) from Unit 6. Introduce the word 'allotrope'. Allotropes are different structural forms of an element, which have different physical and chemical properties. Students could look online to find out about the different carbon allotropes, their structures, properties and uses (see Background information and useful weblinks on page 95).

1 a **Students discuss the questions in pairs and then feed back to the class.**

Answers

1 The information in the results section highlights the key findings of the research and also any secondary findings. The discussion section explains what the results mean and how they move research in the area forward. The discussion section often also relates the current research to earlier research by the author team and/or other researchers.
2 The results section is more objective and presents the facts of what is found. The discussion is more subjective as it requires a personal interpretation of what the results mean. The two are often separated to make it clear what is fact and what is opinion.
3 The results and discussion sections may be presented together if (a) there is only one key finding in the research; (b) the research produced a large number of results. When there is only one finding, the researcher writes the sections together because separate results and discussion sections would be very short. When there are many results, the researcher may choose to use sections with headings and subheadings to separate different parts of the research.
4 The discussion focuses on interpreting the results. A conclusion is a short summary of the whole paper.

b **Students read the extracts and decide which section of the paper each one comes from. In feedback, have the students justify their answers.**

Answers

A Results (the results data are presented)
B Discussion (includes interpretation of the results)
C Materials and methods (it describes process, method, equipment)

Note

The science here on activated carbons being used for gas storage is based on the same principle as that in Unit 4. See background information and weblinks for Unit 4 on page 50.

c **Students read the extracts again and answer the questions.**

Answers

a Carbonisation and activation
b were performed, were contained
c The highest ...
d ranging between ... and ...
e Therefore
f will be
g examined
h attained

2 a **Allow time for students to read the information about Max and to match the words to their meanings. Students then work in pairs to guess what Max has been investigating. Do not confirm the answer to this yet.**

Answers

1 ultra-thin
2 sheet
3 Fermi level
4 property of sth
5 impurity
6 layer
7 Dirac point
8 dope/dopant

Note

Graphene is an *ultrathin* carbon *layer* which can be used in nano-electronic devices, such as transistors for use in computers. In pure graphene *sheets*, the *Fermi level** lies above the *Dirac point**, which indicates the presence of free electrons. This gives graphene some interesting electronic properties. For example, because the electrons can travel large distances without being scattered, graphene is a promising material for very fast electronic components. Free electrons also give graphene an overall negative charge and this charge must be reliably controlled and manipulated if graphene-based electronics are to be developed. To do this, graphene needs to be *doped* by adding *impurities* to the sheet. Many different *dopants* have been investigated including nitrogen dioxide (NO_2), bismuth and gold.

* Fermi level and Dirac point are defined in Exercise 2a on page 63 of the Student's Book

b **Students listen to the recording to answer the questions. Ask students if their predictions for Exercise 2a were correct (Max is investigating ways of doping graphene).**

▶8.1 page 100

Answers

1 carbon 2 lays the dopant onto 3 F4-TCNQ 4 negative 5 air

Additional activity Unit 8: Nobel Prize in physics 2010

You can use this Additional activity for Unit 8 in the Resources section as a note-taking exercise on a video about the science behind the 2010 Nobel prize in physics and for practice using *wh*-cleft sentences for adding emphasis.

3 a **Students read the extract and choose the best main idea. Students work in pairs to discuss why the other options are not suitable as main ideas.**

Answers

b Effect of F4-TCNQ on monolayer graphene
(a) and (c) are both specific pieces of information: (a) is just one of Max's findings and (c) is a statement of one general truth.

b **Allow time for students to read the extract again and answer the questions.**

Answers

1 The second sentence (*The doping level of the graphene layers was precisely monitored with ARPES measurements*) describes method, so it belongs in the materials and methods section. The fifth sentence (*Evidently, deposition of F4-TCNQ activated electron transfer from graphene toward the molecule thus neutralising the excess negative charge*) is an interpretation, so it belongs in the discussion section.
2 *has an effect on* in the first sentence, *is deposited* in the sixth sentence and *is observed* in the final sentence should be in the past tense (*had an effect on*, *was deposited* and *was observed*). These are reporting the results of one specific experiment (or set of experiments) conducted in the past. In sentence 3, 'the Fermi level *is located* about 0.42 eV above the Dirac point', the verb can stay in the present simple as it is talking about a general truth, rather than one particular past finding.

Language note

In sentence 3, the verb *is located* stays in the *present simple* as it reports a general truth, rather than the result of a specific past experiment.

c **Students discuss the questions in pairs and then feed back to the class.**

Answers

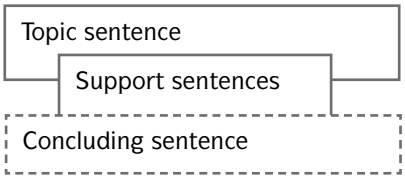
1 b
2 The other sentences give evidence for the key result.

d **Students read the extracts and decide which sentences describe key results.**

Answers

Sentences a and e describe a key result.

e **Go through the information in italics to make sure students understand the difference between topic and supporting sentences. You could draw a visual representation of the paragraph structure on the board. You could add a space for a concluding sentence at the end (see language note below).**



Point out that the sentences they selected in Exercise 3d are the topic sentences for two different paragraphs from Max's paper. You could write these into the 'topic sentence' box in the diagram. Students then find and order the supporting sentences which go with each topic sentence. Have students check their answers with the key on page 113. You could add these to the diagram.

Answers

(a) A comparison with the nonfluorinated version of the F4-TCNQ molecule, TCNQ, shows that the charge transfer increases significantly when the F4 is present. (c) Charge transfer occurs with TCNQ, but the Fermi energy always remains at least 0.25 eV above the Dirac point (Fig. 4a). (f) The maximum shift of the band structure is obtained for a TCNQ deposition of 0.4 nm (Fig. 4d), but no additional shift is observed for higher amounts of deposited molecules.
(e) The F4-TCNQ layer is sensitive to temperature. (b) As the temperature increased above 75 °C, the difference between the Dirac energy and the Fermi energy also increased. (d) The difference returned to the level of a graphene layer at 230 °C.

Language note

The paragraphs here do not contain concluding sentences. This is usual in paragraphs which form part of a longer piece of work. However, in stand-alone paragraphs, a concluding sentence is usually required. This typically rephrases the topic sentence or summarises the information in the support sentences. Further exercises on paragraph structure can be found at http://www.monash.edu.au/lls/llonline/writing/science/paragraphs/index.xml

Extension activity: paragraph structure

Students look back at the two paragraphs from Nour's paper in Exercise 10a (A and B) on page 61 and identify the topic sentence and support sentences in each one.

Answers

In each paragraph, the first sentence is the topic sentence and the remaining sentences are the support.

4 **Allow time for students to think of an experiment and to make notes on the key findings. They then use these to write topic sentences about the main results.**

Make sure they know not to write the support sentences yet. If students are reluctant to share their 'real' results, they could use the NASA data referred to in Unit 6 of these Teacher's Notes (page 67), or the data they found for Exercise 10 in Unit 6.

Preparing and writing the results section

5 a **Students listen to the recording and complete the notes.**
▶8.2 page 100

Answers

1 secondary
2 visuals/data
3 research questions
4 references
5 too many words
6 headings/subheadings

b **Students work in pairs to discuss the questions. You could also ask them if there is any other advice they would give Max.**

c **Point out that Florence mentions referring to the visuals in the results write up (*So what I'd do is prepare the visuals, to summarise the data … and then basically think about the most logical order to present that data*). Elicit any phrases the students know for doing this. Students then complete the task.**

Answers

1 As shown in Fig. 1a
2 As Fig. 1d shows
3 It can be observed in Fig. 3d that *or* In Fig. 3d, it can be observed that
4 Fig. 3d shows that

Extension activity: paragraph headings

Florence also mentions that Max can use subheadings in the results section. This is very common in science papers which report on multiple experiments. Headings can be used in the method and discussion sections, as well as in the results.

Write this heading on the board: F4-TCNQ doping of graphene. Tell the students it is a suitable heading for the paragraph in Exercise 3a.

Ask the students:

- **Does the heading present a result or state what the experiment was investigating?**
- **Is the heading a full sentence or a noun phrase?**

Ask students to look at the 2 paragraphs in Exercise 3e and to choose a heading from the list below for each paragraph.

- **Doping graphene with TCNQ**
- **F4-TCNQ dopes graphene better than TCNQ**
- **F4-TCNQ is sensitive to temperature**
- **Temperature response of F4-TCNQ**

You could also ask students to look at the topic sentences they wrote in Exercise 4 on page 65 and to write down the sub-headings they would use in the results section of a paper presenting those results.

Answers

- It states what was being investigated. The paragraph's topic sentence will present the result.
- It is a noun phrase.

Doping graphene with TCNQ and *Temperature response of F4-TCNQ* are the two best headings.

6 a Students read the paragraph and underline the phrases used to describe comparison or contrast.

Answers

Comparison: far less effective, compared to
Contrast: In contrast to, While, half that of

Extension activity: titles for paragraph headings

You could have students decide on a suitable sub-heading for the paragraph.

Suggested answer

Doping graphene with TCNQ.
A subheading which mentions a comparison between doping with F4-TCNQ and with TCNQ is also possible. However, the real focus is on the result of experiments with TCNQ.

b **Draw the students' attention to the first sentence of the text in Exercise 6a. Ask if the sentence still makes sense if the word *far* is removed (yes, it does). Elicit the function of *far* in the sentence (to show degree) and a possible synonym for *far* here (*much*). Students then complete the matching exercise.**

Answers

1 g 2 d 3 a 4 c 5 e 6 b 7 h 8 f

c **Students look at the phrases in bold in the sentences in Exercise 6b and find the adjectives and adverbs used to express degree.**

Answers

a noticeable, extremely, significantly, highly, considerably
b slight, minor, marginal

Language note

Adjectives can be used to modify nouns e.g. *TAGH had only a minor effect*.
Adverbs can modify verbs e.g. *The anxiety-related differences were significantly reduced*, or adjectives e.g. *The robot was highly successful*.

d **Students complete the paragraph with words from the box. You could also have them think of a sub-heading for the paragraph.**

Answers

1 as can be seen in 2 contrast to 3 considerably 4 resulted in a longer
5 noticeably thicker 6 while

7 **Allow time for students to write at least one paragraph about their results. If they write more than one paragraph, you could also have them write sub-headings for each one.**

Preparing and writing the discussion section

Before you begin ...
Before the lesson, photocopy and then cut out enough of the cards below (A and B) so that there are enough for one between two or three students in the group.

In class, divide the students into A and B and then ask them to work in a pair with a partner from the same group. Explain to the students that they are going to look at the results of some very simple experiments in order to use language for explaining reasons for results and drawing conclusions. Then hand out one of the cards below to each pair, according to their group. Give students 5–10 minutes to discuss what conclusions can be drawn from the results.

After the discussion, ask every A student to find a B student to work with. Students then report to each other what the experimental results were and what conclusions they drew. Then students feed back to the class.

A

1 If you hold your nose while eating a piece of food, you cannot identify the food from its taste.
2 A 6kg bowling ball floats in water.
3 If you fill a glass with water, put cardboard over the mouth of the glass and turn it upside down, the cardboard stays.
4 If you put a raisin into a bottle of soda, it sinks to the bottom, then floats up, then sinks again etc.

B

1 If you fill half a glass with very salty water and then top it up with tap water and drop an egg into the glass, the egg floats half way down the glass.
2 If you drop iodine on a slice of potato, it turns black; if you drop it on a slice of apple, there is no change.
3 If you completely fill a glass with water, right to the rim, you can generally add about 10–12 small coins before the water overflows.
4 When a straw is placed in a glass of water, from the top, it looks like it bends.

Suggested answers

The conclusions that can be drawn are:

A

1 Sense of smell is a vital part of taste discrimination.
2 The bowling ball is less dense than water.
3 The air pressure from outside is greater than the pressure of the water inside the glass.
4 The initial sinking shows that raisins are denser than the liquid. The rising shows that they have become buoyant; this is because CO_2 bubbles from the soda stick to the raisin. When the raisin gets to the surface, the bubbles burst releasing the CO_2 so the raisin sinks again.

B

1 The egg is more dense than tap water but less dense than salt water.
2 A potato contains starch but an apple does not.
3 The surface tension of water is strong.
4 Light refracts (bends) when it passes from water to air.

8 a Students work in pairs to try to answer the questions. Do not check answers yet.

b Students listen to the recording and make notes on the answers to the questions. ▶8.3 page 100

Answers

1 Yes – comment on all the results mentioned, in the same order, and say what they mean.
2 No – if the result is important, it should be in the results section.
3 You don't need to mention the results in detail, but you probably need to refer to them. Use a noun phrase to summarise the result, then interpret the finding.
4 Yes – tie your results in to what others have done, or to other work you've done.
5 Be concise.

9 a Students use the words and phrases in the box to complete the sentence.

Answers

1 movement of 2 towards 3 deposition of 4 electron transfer
5 from

Extension activity: nominalisation

Students look at the paragraph from the early draft and underline all the verbs. They then look at the completed later draft and find the verbs. Ask them:

- **what has happened to the other verbs from the first draft?**
- **how are other nouns (e.g. *Fermi level*) included in the sentence?**

Explain that this process allows a lot of information to be expressed in only a few clauses.

Answers

Verbs in first draft: moves, happens (used to avoid repetition of 'the Fermi level moves toward the Dirac point'), indicates, has been deposited (x2), are activated (x2), are transferred
Verbs in the later draft: indicates, activates
Other verbs (except happens) change to the noun form (movement, deposition, transfer).
Other nouns are included in prepositional phrases (of the Fermi level, towards the Dirac point etc) which post-modify the head nouns (forming noun phrases). See the Additional activity on noun phrase structure in the Resources section for more information.

Language note: nominalisation

Noun phrases are common in academic writing. They are used as an alternative to long clauses and allow the writer to include the same information in much less space. The nouns typically give either verb-type meanings (e.g. *move – movement*) or adjective-type meanings (e.g. *able – ability*). The process of changing from a verb or adjective to a noun is known as nominalisation. The resulting noun phrases can act as subjects or objects, just as nouns can. For more information on nominalisation see *Cambridge Grammar of English* pages 271–272 and page 333.

b **Students complete the sentences with either a noun form or a preposition.**

Answers

1 The **ability of** a gecko **to** walk **on** walls demonstrates that **activation of** the adhesive system improves the gecko's movement over smooth surfaces.
2 The **formation of** a CaP layer **on** the surface allowed further crystal growth.
3 Although the species *M. fortunata* has a lower **exposure** to vent fluids it seems to have a higher **accumulation of** metals in its tissues.

Additional activity Unit 8: noun phrases

For more on noun phrase structure, you can use this Additional activity for Unit 8 in the Resources section.

c **Ask students to read the extract and to find the word which is repeated in sentences 2 and 3 (*increase*(*s*)). Explain that to reduce repetition, a relative clause or VERB-ing form could be used here. Students then combine the sentences to remove this repetition. Make sure they know they should write two sentences; one using a relative pronoun, one using the VERB-ing form.**

Answers

a ... the energy difference increases, which indicates ...
b ... the energy difference increases, indicating ...
NB: A comma **(,)** replaces the full stop **(.)** before *which* or *indicating*.

d **Students rewrite the sentences using a relative pronoun or VERB-ing.**

Answers

1 The adhesive apparatus is only activated on sloped surfaces, not on flat surfaces even when slippage occurs**, which results** / **resulting** in greatly reduced sprinting velocity on smooth, flat surfaces.
2 Consumption of dark chocolate resulted in the decrease in the stress hormone cortisol in the urine**, which suggests** / **suggesting** potential benefits of dark chocolate consumption.
3 On exposure to metals, *B. azoricus* demonstrates considerable antioxidant enzymatic activity**, which reflects** / **reflecting** a physiological adaptation to continuous metal exposure.

Language note: relative clauses

Relative clauses can be used to combine information from two sentences:
I did an experiment last week. It was unsuccessful.
The experiment which I did last week was unsuccessful
In this example, *which* refers to *The experiment*. In this case, *which* refers to a noun but *which* can also be used to refer to a previous clause or sentence:
The adhesive apparatus is only activated on sloped surfaces, not on flat surfaces even when slippage occurs, which results in greatly reduced sprinting velocity on smooth, flat surfaces.
In this kind of relative clause, we use *which* preceded by a comma. For more information on relative clauses see *Cambridge Grammar of English* pages 566–574. For exercises on relative clauses for the students, see Units 21 and 22 of *Developing Grammar in Context: intermediate.*
Instead of *which*, we can also use VERB-*ing* to combine information from two sentences (called a *participle clause*). We can only do this when the VERB-*ing* replaces the subject:
Consumption of dark chocolate resulted in a decrease in the stress hormone cortisol in the urine. This suggests potential benefits of dark chocolate consumption.
Consumption of dark chocolate resulted in a decrease in the stress hormone cortisol in the urine, suggesting potential benefits of dark chocolate consumption.
For more information on non-finite relative clauses (participle clauses) see *Cambridge Grammar of English* pages 574–576.

10 **Allow time for students to write a discussion paragraph related to the results paragraph they wrote in Exercise 7. You could ask students to peer-edit one another's paragraphs, focusing particularly on the use of noun phrases and relative clauses to make the writing more concise.**

11 a **Students read the statements and mark them as limitations or ideas for future research.**

Answers

1 L 2 L 3 F 4 F 5 L 6 F 7 F

b **Students listen to the recording and tick the points discussed.**
▶8.4 page 100

Answers

Points mentioned: 2, 3, 5, 7

You could also ask students why their paper should mention limitations and future research.

Suggested answers

- Places research findings in context. Show just what conclusions can be drawn from the work.
- Increases the work's validity and credibility.
- Shows you understand how limitations affect the results.
- Lets you explain how limitations could or why they couldn't affect the conclusions reached.
- Better than having reviewers/readers think you are unaware of limitations.
- Lets you show you know how your research could be improved and what questions are still unanswered.
- Allows you to clarify how your work has moved the area on and what new questions have arisen as a result.

12 a **Students read the paragraph and answer the questions.**

Answers

Limitations: The results of the present study might have been different if; Another limitation of the study is
Suggest future research: further studies are needed; it would be beneficial to investigate this further; Future research should also be encouraged to examine

b **Students decide which phrases express limitations and which suggestions for further research.**

Answers

Limitations: 1, 2, 4
Suggest future research: 3, 5

c **Students complete the paragraph using the words and phrases in the box.**

Answers

1 indicates 2 hoped 3 serve as 4 scope 5 permit 6 Given
7 clear 8 raises

13 a **Students read the paragraph and answer the questions.**

Answers

a 1 b 2, 3, 4 c 5, 6

b **Students look at the paragraph again and underline phrases used to refer to other researchers' work. Point out how the author's name and the year the research was published are included. More on referring to other researchers' work is covered in Unit 9, Exercises 4a and 4b (page 72 of the Student's Book).**

Answers

As presented in several other studies, …
in a previous paper, it was shown that …
Recent work has suggested theoretically that …

14 **Allow time for students to write their concluding paragraph. As they need to refer to the work of other researchers, you may need to set this as homework.**

Background information and useful web links

Carbon Allotropes

Allotropes are different forms of one element. They differ structurally and so have different properties. There is some debate over how many carbon allotropes exist. Most people agree that there are at least three (diamond, graphite, and the fullerenes), but some argue there are eight or more.

Useful web links

Introduction to carbon allotropes

http://www.chm.bris.ac.uk/webprojects2003/shanley/carbonallotropes/index.htm

Carbon allotropes – The Same & Not The Same

Although aimed at those teaching high school students, this is a useful resource on the topic.

http://www.nsec.northwestern.edu/Curriculum%20Projects/Carbon%20Allotropes.pdf

Graphene and the carbon revolution

The first 4½ minutes of this video focus on the different carbon allotropes. The second part focuses on graphene and is the same as the *What is graphene?* video mentioned below.

http://www.youtube.com/watch?v = wfD8tHhNe6U

This is a video by the Vega Science Trust (www.vega.org.uk), a charitable, not-for-profit organisation established to promote science through television and the Internet by giving scientists a way of communicating with the general public. Their site contains a large number of videos, some aimed at the general public as a whole, others targeted specifically at (school age) science students.

Graphene

Graphene is a monolayer form of carbon. It has a number of interesting properties and so many potential applications. The Nobel Prize in Physics for 2010 was awarded to Andre Geim and Konstantin Novoselov 'for groundbreaking experiments regarding the two-dimensional material graphene'.

Useful web links

Graphene – the perfect atomic lattice

http://nobelprize.org/nobel_prizes/physics/laureates/2010/press.html

More information for the public from the Nobel Prize Site

http://static.nobelprize.org/nobel_prizes/physics/laureates/2010/info_publ_phy_10_en.pdf

What is graphene?

http://www.youtube.com/watch?v = EX8ClPVkD1g

The Nobel Prize video is from the Sixty Symbols site, www.sixtysymbols.com, a collection of videos about physics and astronomy presented by experts from The University of Nottingham. They also have a site with chemistry-related videos www.periodicvideos.com and a more general site where you can go behind the scenes with scientists www.test-tube.org.uk

Cambridge English for
Scientists

TEACHER'S NOTES

Unit 9 Writing up research 4: introduction and abstract

- Writing the introduction
- Writing the abstract
- Giving a title to your paper
- Contacting journals

Go to page 104 for essential background information on the topic and useful web links.

Don't forget to use the Additional activity worksheet in the Resources section of the Cambridge English for Scientists website.

Science-specific terms can be found in the Glossary on Student's Book pages 117–125

Refers to the Audioscript on Student's Book pages 91–102

Writing the introduction

Before you begin …

On the board, brainstorm a list of all the things students would expect to find in the introduction to a research paper. Leave the students' answers on the board to compare them to Exercise 1b later on.

1 a **See if students can guess the meaning of the word panspermia, by analysing its parts (*pan-* everywhere and *spermia* seeds). You could remind them of the extremophile definition (organisms that have adapted to live in very extreme conditions) at the beginning of Unit 7. You could also assign questions 1–3 as homework before students begin work on Unit 9. Ask students to answer questions 1–3 in pairs then feed back to the class. Encourage them to use the words in the box.**

Answers

1 Panspermia is the hypothesis that the **seeds of life** exist all over the universe and that early life forms could have begun on other planets and travelled to Earth on **meteorites**.

3 Supporters of the hypothesis claim that a number of facts make it credible. Firstly, they believe that the fossil record shows that life forms appeared too soon after the Earth was formed for them to have begun here. Secondly, research suggests that other planets or moons contain possible habitats for life, and meteorites from Mars have been found on Earth, showing that the **vehicle** for this transport exists. Some of these meteorites have also been shown to contain molecules which are important for life. Thirdly, many **extremophile** species have been shown to survive in **harsh conditions** and so it is possible that an organism could survive in **deep space**. In fact, some bacteria, **lichens** and even a kind of animal called a tardigrade have been able to survive in such conditions, using the surface of the planet or meteorite as a **protective layer** against **UV radiation**. Finally, some researchers claim to have discovered extraterrestrial bacteria in meteorites and living cells in air from 40 km above the Earth.

Language note: hedging

Using grammar structures such as verbs in the second conditional, modal verbs such as *may*, *might*, *could* and phrases such as *it is possible that* … , … *believe that* …, *experts claim that* …, etc. are examples of what is sometimes called *hedging* (or *vague language*). Hedging is important in scientific and other academic forms of writing because the writer(s) wish to show that the validity of their claims is dependent upon the quality of the evidence which is used to support them. As such, scientific writing tries to avoid describing results, conclusions etc. in language which would suggest that their claims are beyond dispute or are unfalsifiable (i.e. they cannot be proved wrong). In other words, hedging is an evasive wording technique. For more information on hedging, see Unit 3 page 31 of the Teacher's Notes.

Extension activity: language of the hypothesis

Even though panspermia is widely accepted among the scientific community, it is still a hypothesis. You could ask students to look at the answers to questions 1 and 3 in the Student's Book Answer key page 114 and tell them to underline the words and phrases that present/describe a hypothesis.

Answers

1: could have
3: claim; believe that; suggests that; have been shown; it is possible that

b **Ask students to match the beginnings of the questions to their endings.**

Answers

1 What was I investigating?
2 Why was it important?
3 What was already known about the subject of my research?
4 What did I expect to know after doing the research?
5 How did I approach the problem?

c **Allow time for students to read the extracts in order to label each one according to the questions in Exercise 1b. You may first want to check students' understanding of the following words in the text before they complete the exercise.**

- *microbial ecology*: the relationship of microorganisms with one another and with their environment
- *presence*: current existence
- *surface composition*: the physical properties of the outer layer of an object or planet
- *terrestrial*: of or relating to, or inhabiting, the land
- *spore*: a reproductive structure that is adapted for dispersal and surviving for extended periods of time in unfavourable conditions. Spores form part of the life cycles of many bacteria, plants, algae, fungi and some protozoans.

Answers

1 What was I investigating?
2 What was already known about the subject of my research?
3 What did I expect to know after doing the research?
4 Why was it important?
5 How did I approach the problem?

2 a **Ask students to determine the best order of the extracts in Exercise 1c.**

Answers

4, 2, 1, 3, 5

b **Ask students to answer the questions. For question 2, some students may also call the grammatical form in (a) the conditional. For example, extract 3 uses the second conditional, which is useful when describing hypotheses.**

Answers

1 a Could (protect); would increase
b report
c have investigated; have speculated
d reported; were able to; found; decreased
2 a *would* and *could*
b present simple
c present perfect simple
d past simple

3 a **Allow time for students to read the extract and answer the question while looking back to Exercise 1b.**

Answers

Q4 *Why was it important?* If sufficiently protected by meteorite-like material, microorganisms may also survive the journey through space.
Q2 *What was already known about the subject of my research?* Brandstätter *et al.* (2008) reported that microorganisms embedded in 2 cm-thick rocks on the outer surface of a re-entry capsule, simulating the entry of a meteorite, did not survive.
Q1 *What was I investigating?* The resistance of rock-colonising microbial communities and lichens to outer space conditions
Q3 *What did I expect to know after doing the research?* Further information about the resistance.
Q5 *How did I approach the problem?* In a real, in-space, experiment – during the Biopan-6 flight of ESA on board a Russian Foton satellite

b **Ask students to complete the gaps. You could also ask students to identify the three words or phrases that are used when describing hypotheses: *the possibility of*; *it is believed that*; *may***

Answers

1 have provided 2 have been 3 reported 4 did not survive 5 is

4 a **In pairs, students discuss the main differences between the two sentences then feed back to the class.**

Answers

Both sentences are citations (they tell us the author(s) of a research paper and what they discovered). The main difference is that in (a), the author comes first, in (b) the information comes first. Sentence (a) is *author prominent* and is written author–(date)–information. Sentence (b) is *information prominent* and is written information–(author, date).

b **Ask students to complete sentences (1 and 2) with the phrases (a–d).**

Answers

1 a; c 2 b; d

c Ask students to complete the definitions using the verbs in the box.

Answers

1 demonstrate/prove 2 prove/demonstrate 3 observe 4 hypothesise
5 suggest 6 conclude 7 discover

Extension activity: citation practice

To prepare for Exercises 5a and 5b, you could ask students to write three of their own examples of author-prominent and information-prominent citations using their own research or previous citations they've seen in the Student's Book.

5 a Before starting this exercise, you may want to use the Extension activity (citation practice) above. Allow time for students to discuss a research topic they are working on or another topic of their choice, and in pairs answer the questions in Exercise 1b while taking notes.

b Using their notes and (if available) the citations they wrote in the Extension activity above (citation practice), ask students to write introductions to a research area of their choice. Students can find additional information on citations from this website: http://tim.thorpeallen.net/Courses/Reference/

Writing the abstract

6 a Students discuss the questions in pairs then feed back to the class.

Answers

1 To get the reader's attention and encourage them to read further; to provide a concise summary of the key points of the research
2 The abstract should give the researcher enough information to know if the paper is relevant to his/her own research.
3 A sentence or two of the key points from the introduction, method, results and discussion
4 When you search for papers via a database, often all you can see initially is the abstract. In the past, a visual or heading might attract attention and encourage you to read further, but now you can't see those unless you choose to look at the whole article. The abstract therefore needs to encourage people to look at the whole paper.

b Allow time for students to read the extracts and match them to sections 1–4.

Answers

1 D 2 A 3 C 4 B

c Students work in pairs to decide the best order of extracts A–D and feed back to the class.

Answers

D, A, C, B
The information in the abstract should be presented in the same order that the sections appear in the paper.

The answers to Exercises 6b and 6c are in the same order intentionally to demonstrate to the students that the organisation of the abstract should mirror that of the paper overall.

7 a Students listen to the conversation and use the extract in Exercise 6b to answer the question.
▶9.1 page 101

Answers

B

b Students listen again and answer the questions. Before students check their answers in Exercise 7b, you could ask students to give reasons for the advice they labelled 'false'. Then students check their answers in the Answer key on page 115.

Answers

1 F – Svenja points out that you should not reference other people's work in an abstract. These references are mainly found in the introduction and discussion sections of the paper.
2 T
3 F – Mya needs less methodological information in the abstract. If someone wants to know about the details of the method, they can read that section of the paper.
4 F – There should not be references to figures in the abstract.
5 T

c Allow time for students to read the advice in the Audioscript and re-write sections A, C and D. You could assign this as homework. You could ask if Svenja's advice might help change any abstracts they themselves have written in the past.

Answers

Current surface conditions on Mars are extremely challenging for life. The question is whether there are any features on Mars that could provide protection against the surface conditions. One possibility is that the surface material plays a protective role.
With the aim of evaluating this possibility two microorganisms, *Acidithiobacillus ferrooxidans*, an acidophile, and *Deinococcus radiodurans*, a radiation-resistant microorganism, were exposed to simulated Mars conditions. Exposure was for different times under the protection of 2 and 5 mm layers of oxidised iron minerals. Survival was evaluated by growing the organisms on fresh media. Here we report that both the 2 and 5 mm thick layers provided enough protection against radiation and Mars environmental conditions for the bacteria to survive.

8 a Looking back at all four abstracts in Exercise 6b, students identify the phrases that correspond to 1–4.

Answers

1 The question is whether ...
2 One possibility is that ...
3 With the aim of evaluating this possibility ...
4 Here we report that ...

b Ask students to match the phrases a–l to their functions in Exercise 8a.

Answers

1 state the research question: a, d, f, j
2 present the hypothesis: b, i
3 introduce the method: k
4 introduce key results: c, e, g, h, l

Extension activity: further practice with abstracts

A large number of extracts written by Life sciences students from Purdue University can be found on pages 68–139 of the pdf file at the following link: https://www.science.purdue.edu/images/current_students/research_day/2008Abstract.pdf You could print some out and distribute two or three to each student. Ask students to come up with the key words for these abstracts.

c **Ask students to replace the underlined words with *that* or *those*.**

Answers

1 Those 2 that 3 that 4 those 5 that

Extension activity: further practice editing abstracts

You could use this website to provide students further practice editing abstracts. It contains further advice on writing abstracts but also an example of a bad abstract and advice on how to improve it. You could print out the bad abstract and ask the students to re-write it and compare their answers to that of the website.

http://writing2.richmond.edu/training/project/biology/abslit.html

9 a **Allow time for students to brainstorm ideas for the bullet points and write the answers. If they choose not to use their own research, they could be asked to use other research that has been discussed in the Student's Book (for example the project summary in Unit 1 Exercise 5b or Unit 2 Exercise 7d).**

b **Allow time for students to construct a draft of an abstract. Once they have finished, they could work in pairs and carry out peer-correction.**

Giving a title to your paper

Before you begin …
Ask the students where the titles of papers can most often be found (examples could include: the bibliography or references of published papers and articles, the Internet, conference programmes, CVs (if they get an opportunity to review any), Table of Contents for a conference proceeding).

Ask students where they would look if they wanted to find articles on their area of science and if they were to look on the Internet, how they could refine their search to find titles that interest them (e.g. put complete ideas in inverted commas such as in 'Extremophiles in astrobiology' or do a refined internet search for articles in .pdf format such as in 'Extremophiles in astrobiology' filetype:pdf)

10 a **In pairs, students read the titles and discuss which ones are the most helpful for the reader. You might want to check that students understand the terms listed below.**

- *Staphylococcus aureus*: also known as *Staph Aureus* or *S. Aureus*, means the 'golden cluster seed' or 'the seed gold'. It is also known as golden staph and is the most common cause of staph infections.
- *host cell*: a living cell in which a virus reproduces

- *invasion*: (pathology) the spread of pathogenic microorganisms or malignant cells to new sites in the body
- *spontaneous*: self generated; happening without any apparent external cause
- *mutant*: an organism that has characteristics resulting from chromosomal alteration
- *colonial*: in biology, having spread into new areas
- *mammalian*: of, or pertaining to, mammals (warm-blooded vertebrate with skin that is usually covered with hair)
- *longevity*: the length or duration of life

You could ask the students which image on the right in the Student's Book refers to which three of the titles 1–6.

Answers

Image of the cat: 5
Image of the elderly man: 6
Image of the apple: 2

b **Ask students to answer the questions and feed back to the class. You could ask students to explain why the advice is good and bad.**

Answers

Good advice: e, f, g
Bad advice: a, b ,c, d

c **You could ask students to refer back to Mya's research on panspermia (his paper's introduction in Exercise 1c and his abstract in Exercise 6b). Re-reading these texts could help them decide in pairs which title is best. Note that the students' choices may vary depending on their point of view.**

d **Students listen to the conversation and answer the questions.**
▶9.2 page 101

Answers

1 Title 4: Protection for *Acidithiobacillus ferrooxidans* and *Deinococcus radiodurans* exposed to simulated Mars environmental conditions by surface material
2 It's too long.
3 It includes the key finding.

e **Students refer back to the titles in Exercise 10c and listen to the conversation again and answer the questions.**
▶9.2 page 101

Answers

Title 1: Jokes are unclear (vague); the readers may not understand the joke; the joke probably won't include important keywords for an internet search
Title 2: It is not clear (vague); a question in the title does not say what the key results were
Title 3: The title is too general (imprecise); it does not say what kind of organism; it does not say what kind of protection; the title says what the researcher did, but not what the key result was.
Advice: Include keywords for internet searches; say what the key result of the research was; include details about what was studied or where the research happened; avoid using phrases like 'A study of …'.

f **Students refer back to Exercise 10a, discuss the questions and feed back to the class.**

11 a **Using title 4 in Exercise 10c and the sentence provided, students answer the questions.**

Answers

a The data suggest that
b 'from' is used in *are protected from* to describe the thing that causes the damage; 'for' is used in *protection for* to describe that thing which receives the protection from any possible damage.
c *exposed*. Title 4 is a noun phrase and 'exposed' is a short form for *which are exposed*.

b **Ask students to fill the gaps. You could tell the students that the noun for each gap will come from a word that appears in the key results above each title.**

Answers

1 Modification
2 variation
3 Activation
4 detection

12 **Ask students to refer back to the key results they wrote in Exercise 9a to help them write a title.**

Contacting journals

Before you begin …
Refer students to the first part of Unit 2 (Exercises 1a–d and 2a–b) where they discussed the various methods of communication in the scientific community. Ask students to brainstorm, in pairs, which scientific journals they usually read. They could do an internet search and find more. Ask the students to find the titles of journals and magazines that are:

- for scientists in the same area of study
- for scientists in all fields
- for the general public
- for teachers of science

13 a **Students discuss the questions in pairs then feed back to the class.**

b **Allow time for students to match the headings to the extracts.**

Answers

A 2 B 4 C 3 D 1 E 7 F 6 G 8 H 5

14 a **Before the students turn to page 88, you could refer them back to the lesson on appropriate writing styles on page 15 of the Student's Book (Unit 2 Exercises 3a–b).**

Students read the letter on page 88 then answer the questions.

Answers

The style of the underlined words and phrases in the letter is not appropriate.

15 **Students write their own cover letters. They could compare their drafts in pairs and carry out peer-correction.**

Additional activity Unit 9: submitting your manuscript

Use the Additional activity for Unit 9 in the Resources section to practise reading for specific information with the guidelines for submitting a manuscript to a journal.

Background information and useful web links

Writing the introduction

Introductions can be the most difficult part of papers to write. It is important to provide an introduction that helps readers understand the issues in the paper and offers evidence to prove the thesis. Ideally, an introduction will make the readers want to read the paper.

Useful web links

These websites offer strategies for writing effective introductions and provide examples of introductions to be avoided.

http://www.unc.edu/depts/wcweb/handouts/introductions.html

http://classweb.gmu.edu/biologyresources/writingguide/Introduction.htm

Writing the abstract

An abstract is a self-contained, short statement that describes a larger work. It contains the scope, purpose, results, contents of the work and key terms. It does not evaluate or review the work mentioned.

Useful web links

These websites offer strategies for writing effective abstracts and provides examples of abstracts to be avoided.

http://www.unc.edu/depts/wcweb/handouts/abstracts.html#types

http://classweb.gmu.edu/biologyresources/writingguide/Abstract.htm

Giving a title to your paper

Scientific paper titles must be self-explanatory. The title should tell readers what the key finding is. The title, 'A Biology Lab Report' is too general. A good example is: 'The Effects of Light and Temperature on the Growth of Populations of the Bacterium, Escherichia coli'. It is often best to write the title only after the research has been completed and written up to be sure that the title accurately reflects the content.

Useful web links

This link offers helpful advice on writing a paper title as well as other parts of the work.

http://www.colby.edu/biology/BI17x/writing_papers.html

Contacting journals

Not every article is appropriate for every journal. When contacting scientific journals, it is recommended that students first read articles in the journal they want to submit a paper to and make sure that the article exactly fits the journal editor's requests (e.g. follows the style guidelines).

Useful web links

This website offers some useful advice when submitting papers.

http://www.scidev.net/en/practical-guides/how-do-i-submit-a-paper-to-a-scientific-journal-.html

This website offers more advice on submitting papers including writing cover letters.

http://www.experiment-resources.com/journal-article-submission.html

Cambridge English for
Scientists
TEACHER'S NOTES

Unit 10 Presenting research at a conference

- Giving a paper at a conference
- Socialising at a conference
- Presenting a poster

Go to page 114 for essential background information on the topic and useful web links.

Don't forget to use the Additional activity worksheet in the Resources section of the Cambridge English for Scientists website.

Science-specific terms can be found in the Glossary on Student's Book pages 117–125

Refers to the Audioscript on Student's Book pages 91–102

Giving a paper at a conference

Before you begin …

Ask the students to brainstorm the following questions then feed back to the class:

- What are the names of well known conferences in their field?
- Why do they go / why are they sent to conferences?
- Why are conferences necessary in science?
- Do you think, with today's technology (and in some cases, financial limitations), online conferences will replace those that take place face to face?
- What would be the advantages and disadvantages of attending a conference online?

Suggested answers

1 ICAST (International Conference on Adaptive Science & Technology); IFIP (International Federation for Information Processing).
2 To learn about new research; to present research; to add talks to your CV; to follow up on research grants; to stay up to date in your field; you can find research partners.
3 They facilitate communication and the spread of knowledge to a large audience; they allow for scientists to present their work and sometimes critique the work of others.
4 Online conferences are still a relatively new concept, but they are growing in popularity because they are inexpensive to organise. Online platforms allow for many international delegates to attend and watch the live feed of a speaker, all the while posting their questions publicly or privately to other delegates.
5 Advantages: Online conferences cost less than a face-to-face conference. Some can be attended free of charge. They facilitate the discussions between delegates even when a talk is taking place. Delegates can come and go as they please without disturbing the speaker. Online conferences also help in keeping a video log of the talks and discussions for later use.
Disadvantages: Some institutions may not accept online conferences as a valid format for attending or presenting one's research. Also, modern technology still has some catching up to do to allow for high-quality presentations or talks going on at the same time. And many delegates may still prefer that face-to-face time with their peers.

1 a **Ask students to discuss the questions in pairs or small groups and feed back to the class. During feedback, you could expand on the discussion with some supplementary questions. For question 1, you could ask students whether they prefer to read directly from their paper or use bullet point prompts on slides or note cards.**

NB: In some English-speaking countries (such as the United States), audiences may prefer talks that aren't read. You may wish to refer the students back to the presentation techniques they studied in Unit 3 (Exercises 13a–h).

For question 2, you could ask the students what their definition of a 'large' audience is (20 people? 100? The number in the photo in the Student's Book?). Finally, you could ask if they have ever presented research in pairs or shared a talk with other presenters, such as in a symposium.

b **Students read the poster to answer the questions. You could also ask students to discuss the reasons why there are three different prices for academia, students and industry.**

Answers

1 Anyone who works in malaria research; pharmaceutical companies
2 No – if a researcher wants to submit an abstract, he/she must apply before 4 April.
3 Go to the website www.eimr.org/con7

c **Students complete the phrases with the words in the box. You could ask the students if they know the definitions of the following conference terms:**

- *Keynote speaker*: one or more specialized speakers who present a talk at a general session. Often these are notable individuals who draw attention and participants to the meeting.
- *Plenary speaker*: a talk during a conference or similar meeting that is scheduled at a time when everyone can attend.
- *Symposium*: a meeting of a selection of experts in a particular field during which papers are presented on specific subjects. Symposiums can take place during bigger conferences.
- *Panel discussion*: a conversation about a specific topic conducted by a group of experts, usually either in the presence of an audience or in a broadcast (or both).

Answers

1 application **deadline**
2 on a **strictly** first-come, first-served **basis**
3 **keynote** speakers
4 online **registration** only
5 poster **presentation**
6 **preliminary** programme
7 **registration** fees
8 to **submit** an abstract
9 in due **course**
10 check back for **updates**

d **Students match the phrases to the definitions.**

Answers

a 5 b 6 c 10 d 7 e 9 f 4 g 1 h 3 i 2 j 8

2 a The diagram in this exercise matches the text (a–f) in Exercise 2b on the next page. Allow time for students to study the diagram and discuss their ideas. The activity should only take 5–7 minutes as the aim is to prepare them for the reading task which follows in Exercise 2b (on page 80). Students should not be expected to understand the immune response in detail, but to gain a general understanding of what the process shows. You could help students by asking (or writing on the board) the following questions:

Picture 1: What does this picture show?
Picture 2: What is the relationship between: the virus and the cell? the antigen and the T cells? What do you think an antigen does?
Picture 3: What effect does the killer T cell have on the Antigen presenting cell?
Picture 4: What other ways can a T cell develop? What do you think 'Effector' and 'Memory' might mean?
Picture 5: What do the following words mean: antibody, cytokine, macrophage? How might the cytokines affect: B-cells? Macrophages? Killer cells?
Picture 6: What is in the thought cloud over the memory Th cell? What might this represent?

These questions can be answered by reading texts a–f in Exercise 2b.

b Allow time for the students to match the descriptions to the diagram in Exercise 2a.

Answers

a 1 b 4 c 5 d 6 e 3 f 2

c Students discuss the question in pairs then feed back to the class.

Suggested answer

In his talk, Milan mentions that counting IFN-γ secreting T cells using the *ex vivo* IFN-γ ELISPOT is the method that has been used. His research investigates an alternative, the use of flow cytometry and RT-PCR to detect the secretion of MIG (CXCL9), a cytokine secreted by T cells.

3 a Allow time for students to read the extracts before they listen to the presentation. Before listening, you could write the following phrases on the board and then ask students to work in pairs to suggest how each phrase could be completed.

I'd like to start …
I'll begin …
I'll conclude …

You could then tell students that these phrases continue with VERB-ing … . Verbs likely to follow these phrases are *start* / *begin by* … *showing*/*demonstrating*/*explaining*/*discussing*/*introducing* and *conclude by* … *summarising*/*proving*.
▶10.1 page 101

Answers

1 Good afternoon, everybody.
2 I'd like to start by thanking you
3 My name is Milan Poborski and
4 I'm going to talk today
5 To start with, I'll explain
6 After that, I'll
7 Finally, I will discuss
8 I plan to talk for about 40 minutes, leaving plenty of time for

b Students refer to the phrases in Exercise 3a to match them to the functions.

Answers

a 8 b 1 c 4 d 3 e 5, 6, 7 f 2

c Students refer to Audioscript 10.1 to answer the question. To help students answer this question, you could refer them back to work they did in Unit 9 (Exercise 6b) on writing abstracts. Using Audioscript 10.1, you could direct the students' attention to the use of *'ll/will* + INFINITIVE after signposting phrases such as: *to start with, I'll explain …* / *After that, I'll describe …* / *Finally, I will discuss …* . This use of *will* corresponds to its function in making promises.
▶10.1 page 101

Answers

His presentation is organised in the same order as a research paper: he is going to give an introduction to the problems with other methods, describe the method he used and the results he got, and finally he will discuss his key results.

d Students refer to previous research to help them plan the introduction and use phrases from Exercise 3a. You could tell students that a good way to write an introduction is to refer to their abstract or the introduction of their paper. If you have lower level students, you could suggest they write out the entire introduction. Higher-level students could simply make notes.

4 a Students match 1–5 to a–e before listening to the presentation.
▶10.2 page 101

Answers

1 c 2 a 3 b 4 d 5 e

b Students match the underlined phrases in Exercise 4a to the advice.

Answers

a Let's begin by looking at
b That's all I have to say about … so now I'd like to move on to
c As I have already said
d I will be returning to those shortly.
e As you can see from this image

c Students listen to the extracts and match them to the functions in Exercise 4b.
▶10.3 page 102

Answers

1 c 2 d 3 b 4 e 5 a

d Students find and underline the phrases in Audioscript 10.3
▶10.3 page 102

Answers

1 As I mentioned earlier
2 I'll deal with this point later.
3 We've looked at … so now let's turn to
4 the charts here indicate
5 Next we'll look at

5 Refer students back to their introductions in Exercise 3d and ask them to plan the body of their presentations.

Extension activity: presentation slides practice

Refer students to Milan's presentation in Audioscripts 10.2 and 10.3. Using the lexical clues in these extracts, ask them to design a presentation slide for each one (10 in all) and show them to the class. For example, for 4 in Audioscript 10.2 ('Let's begin by looking at the size of the malaria problem. Malaria kills over one million people every year in 109 countries'.), students could design a slide that has a map of the world with the countries in which Malaria is present. Or they could project an image of the Brazilian city: Sao Luis (population 1,000,000) to demonstrate that the equivalent of the entire population of Sao Luis dies every year due to Malaria.

6 a **Students work in pairs to determine the order of the conclusion and then listen to the presentation to check their answers.**
▶10.4 page 102

Answers
d, c, a, e, b

b **Students listen to the presentation again and complete the gaps.**
▶10.4 page 102

Answers
1 **So let me** recap what I've said.
2 I therefore **believe** that ...
3 That **brings me** to the end of my talk today.
4 I would like to thank you for **being such an** attentive audience
5 I would be happy to **answer any questions** you may have.

7 **Refer students back to Unit 1, Exercise 13 to help them with their presentations. You could also refer them to Carlos's advice on vocal variety in Audioscript 1.5. Allow time for students to finalise and practice their presentations. You could give them the choice to practise a joint presentation and/or practise them in small groups of 4 to 5 students each to work up to presenting to larger audiences.**

Socialising at a conference

Before you begin ...
While the main purpose of conferences is for professional reasons and expanding research horizons, you could ask the students to brainstorm non-work related activities they would expect to do at a conference. Possible activities the students may mention are:

- going out for drinks
- going out for dinner
- Karaoke
- dancing
- sightseeing or going on a tour of the city arranged by the organisers

8 a **Students discuss the questions in pairs then feed back to the class.**

b **Students answer questions 1 and 2 and then brainstorm a list of possible phrases for each situation (a–h) for question 3 before feeding back to the class.**

c **Students refer to a–h in Exercise 8b while listening to the extracts.**
▶10.5 page 102

Answers

Conversation 1: b, c
Conversation 2: g, h
Conversation 3: d, h
Conversation 4: e, g, h
Conversation 5: a
Conversation 6: f
Conversation 7: b
Conversation 8: d, h

9 a **Students complete the sentences then listen to the conversation again.**
▶10.5 page 102

Answers

1	How	4	based	7	about	10	sessions
2	honest	5	looking	8	go	11	face
3	this	6	giving	9	turnout	12	forward

b **Students role play the activities a–h in Exercise 8b. They can also choose to use the phrases addressed in Exercise 9a. You could mention that they will have further conference role play practice later on in Exercise 11.**

10 a **Students listen to the extracts and answer the questions.**
▶10.6 page 102

Answers

1 1, 4, 6, 8
2 2, 3, 5, 7

b **Students listen again to answer the questions.**
▶10.6 page 102

Answers

4 and 5 are unsuitable in English-speaking cultures because they are too direct. 8 might be unsuitable in some situations, especially if the phrase is used without an introduction or greeting such as 'Hello' or 'Hi'.

Language note

Opinions on directness in Exercise 10b may vary depending on the students' nationalities. For example, some students may not find 'I'm Jose-Luis. What's your name?' as too direct. Therefore, you could mention that directness may not be determined by a sentence's words alone but by the way it is said. You could ask the students to practice the phrases in Audioscript 10.6 in pairs using different emotions (e.g. annoyed, bored, tired, happy, nervous etc.) and discuss the impressions they make on the listener.

11 **Students practise socialising in pairs or small groups using the role cards.**

Extension activity: further practice socialising at conferences

You could ask students to brainstorm other conference situations and role play those as well.

Suggested answers

Student A is having problems hooking up his/her computer to the projector. Student B and C are the technical helpers at the conference and try to help Student A. Include problems such as equipment compatibility, the default language on the computer, operating system issues, etc.

Student A wants to take the organized tour of the city and invites Student B and C who haven't decided yet if they want to go to some talks instead.

Student A paid and registered in advance but Student B can't find the registration or the badge. Student C is the conference organiser and tries to find a solution.

Student A is the conference organiser and Student B is only moderately satisfied with the conference. Student B gives feedback about the quality of the speakers, the food, the venue and the overall organisation. Student A responds to this negative feedback but remains polite and cordial.

Presenting a poster

Before you begin …
Ask students to brainstorm, in pairs, vocabulary for poster design then feed back to the class. This gives you an opportunity to elicit or pre-teach useful vocabulary for describing poster design.

Suggested answers

Frame, background, border, font (type, serif, sans serif), symbols, header, footer, size, dimensions, heading, colour, shading, layout, panels, columns, materials (cardboard, paperboard, tape, glue, drawing pins (UK) / thumbtacks (US)), transport container (tube, seams for folding).

12 a **Students discuss the questions in pairs then feed back to the class. You could ask the students if they should include poster presentations on their CV or résumé (yes, they should).**

b **Students complete the gaps with the words in the box.**

Answers

1	title	4	contact	7	heading	10	sentences
2	simple	5	columns	8	Number	11	font
3	abstract	6	text	9	white space	12	colours

c **In pairs, students look at the two posters on pages 89 and 90, discuss the questions and feed back to the class. Students discuss which poster they think was more successful.**

Answers

1 Both posters are well organised.
2 There is space around the sections in both posters.
3 Title and section headings are clear.

13 **Students plan their own posters using the advice in Exercises 12b and 12c. You could assign this as homework.**

14 a **Students listen to the poster summary and answer the questions.**
▶10.7 page 102

Answers

1 F – Mosi refers to 'most studies so far' which suggests more than a few have been done.
2 T
3 F – Mosi used human volunteers who had not had malaria.
4 T
5 T

b **Students use the Audioscript to answer the questions.**
▶10.7 page 102

Answers

1 It seems then that
2 My research though focuses on
3 most studies so far have
4 As you can see in this chart, / The second graph shows
5 In this study,

15 a **Students listen to the three extracts to answer the questions. You could also refer students to the 'indirect questions' Additional activity for Unit 2 in the Resources section.**
▶10.8 page 102

Answers

- Could you just clarify … Answer C
- Can you tell me … Answer B
- I can't remember … Answer A

b **Students put the phrases in the correct order.**

Answers

1 **Is that what you wanted to know about** them?
2 **If you want to know more about** the specifics of the protocol or the reagents I used, **just send me an email**. The address is here, on this handout and on my card.
3 **Does that answer your** question?

16 a **Students prepare to present their research in two-minute presentations using the work they did in Exercise 13. You could assign this as homework.**

Additional activity Unit 10: question and answer sessions

Use the Additional activity for Unit 10 in the Resources section to practise useful phrases for question-and-answer sessions.

b **Students present their posters while the others ask questions.**

Extension activity: further practice with conference preparation

Tell students they will be asked to speak at a scientific conference of their choice. Ask students to research the conference and write a short report on what audience type can be expected. Include information on age, private, public, sponsors, registration price, location and photos of past conferences, questions that they expect to be asked, even cultural considerations. To find a conference they can use this website: http://www.scicentral.com/Y-confer.html

Suggested answer

The ICAST (International Conference on Adaptive Science & Technology) Conference is held annually either in Europe, North America or Asia and promotes the technical interchange among researchers in the fields of active materials, structures, and devices. About 100 delegates come from both private and public industries and include students and experienced researchers. The registration price (depending on the location) ranges between 300 and 450EUR per person. The sponsors are national research institutions depending on the host country.

Background information and useful web links

Giving a paper at a conference

Conferences are used for researchers to present and discuss their work. Together with academic or scientific journals, conferences provide an important channel for the exchange of information between researchers.

Useful web links

This site features a selection of directories of scientific conferences

http://www.scicentral.com/Y-confer.html

Designing Effective Oral Presentations

http://riceowl.rice.edu/guidance.cfm?doc_id=11775

How to Get the Most Out of Scientific Conferences

http://chronicle.com/article/How-to-Get-the-Most-Out-of-/46399/

Socialising at a conference

One of the main reasons that people cite for attending a conference is the networking opportunities.

Useful web links

This site provides some advice into networking at conferences

http://entrepreneurs.about.com/b/2009/03/13/top-10-conference-networking-tips.htm

This site is helpful for those who are a little shy

http://ask.metafilter.com/72886/Advice-for-a-first-time-conference-goer

This site contains advice for dealing with small talk

http://www.careerbuilder.com/Article/CB-482-Getting-Ahead-12-Tips-for-Making-Small-Talk/

Presenting a poster

A scientific poster is a large document that communicates one's research at a conference and contains a short title, an introduction, and an overview of the experimental approach, the results, some discussion and a bibliography. If all the text is kept to a minimum, a person could fully read a poster in about 10 minutes.

Useful web links

Advice on how to make a poster

http://www.swarthmore.edu/NatSci/cpurrin1/posteradvice.htm

Creating Effective Poster Presentations

http://www.ncsu.edu/project/posters/NewSite/index.html

Examples of Posters

http://www.ncsu.edu/project/posters/NewSite/ExamplePosters.html

Advice on handling questions

http://www.consultpivotal.com/questions.htm

http://blog.waltritscher.com/index.php/2005/02/17/speaker-tips-handling-questions-from-the-audience/

http://www.presentationdynamics.net/tag/handling-questions/

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