

- C** Read Chuyu's summary of his procedure below. Then read the first paragraph again and say what labels A–F in the diagram represent.

(1) Multi-anvil high pressure apparatus was used to generate the high pressure and temperature for the specimen. (2) The powdered mineral sample was placed into a tube of rolled rhenium. (3) The rhenium tube was loaded into a ceramic octahedron. (4) Two tungsten-rhenium thermocouple leads were attached to the octahedron. (5) The octahedron was surrounded by a set of eight tungsten carbide cubes. (6) The cubes were placed into the space formed by six secondary anvils in the press.

(7) The press was pumped up to the correct pressure. (8) The anvils transform the directed force of the hydraulic press to hydrostatic pressure on the sample. (9) Heating of the tube was carried out using an electrical current conducted through the anvils. (10) Temperature was controlled with a programmable temperature controller. (11) Energy diffraction patterns were collected using a germanium solid state detector. (12) The patterns were analysed to work out the material's strength.

- 3 a** Underline the main verb in each sentence of the summary in Exercise 2c (the first one has been done for you). Then answer the following questions.

- 1 Which main verb form is used in almost all the sentences?
- 2 How is this structure formed?
- 3 Why is this structure often used in describing a process?
- 4 Which main verb is different? Why?

- b** When you are reading the scientific literature, it is useful to record any VERB + PREPOSITION combinations you find. Read the summary again and find at least five VERB + PREPOSITION combinations.

- C** Complete the sentences by choosing the correct preposition (a, b or c).

- 1 First, leucine **was separated** _____ other amino acids in the protein hydrolysate.
a for b from c with
- 2 Many bacteria, such as *Bacillus* spp., **can be isolated** _____ insects.
a from b to c with
- 3 Subsequently, the specimens **were embedded** _____ methylmethacrylate.
a at b in c to
- 4 The sections **were stained** _____ uranylacetate and lead citrate solutions.
a with b to c under
- 5 MIP-1 β was added to wells which **had been coated** _____ BSA.
a by b from c with
- 6 pH **is maintained** _____ 6.5, using Waterlife Buffer and Sera pH Minus.
a at b in c to

- 4 a** Chuyu has asked a colleague, Thabo, to check his work. Look at the summary in Exercise 2c again. Has it been written in an appropriate style? Would you change anything?

b ▶ 5.1 Listen to Chuyu and Thabo's conversation. What two changes does Thabo recommend?

c ▶ 5.2 Listen to the end of the conversation again and follow Thabo's instructions to combine the two sentences below.

The powdered mineral sample was placed into a tube of rolled rhenium. The rhenium tube was loaded into a ceramic octahedron.

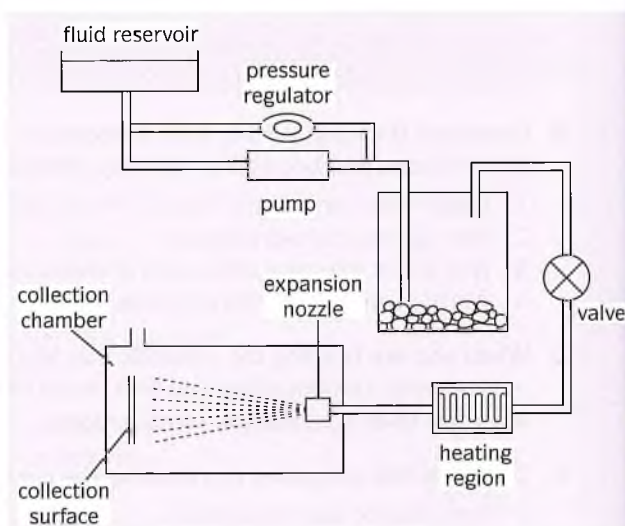
d Which word (or words) does Thabo suggest replacing in the second sentence? What word replaces it (them)?

e Combine sentences 4 and 5, and then 6 and 7 in Chuyu's summary using *which* and *then*. Then compare your answers with the key on page 109.

5 a Look at the diagram from a review of supercritical fluid technology. Complete the description of the process using the words in the box.

at first then was which [x2]

The diagram provides a schematic view of the rapid expansion of supercritical solutions (RESS) process. (1) _____, the supercritical fluid (SF) (2) _____ pumped into the vessel (3) _____ contained the solid solute. The SF dissolved and became saturated with the solute. The resultant solution was (4) _____ introduced into a precipitation chamber by expansion through a laser-drilled nozzle. The precipitation unit was maintained (5) _____ conditions where the solute had low solubility in the SF. As the SF expanded, its solubility decreased, (6) _____ resulted in a high degree of solute supersaturation and subsequent precipitation.



b Think of a process you know well. Draw a sketch and write a short description.

Evaluating the results of an experiment

6 a Think about an experiment you have done recently. Then in pairs, discuss 1–5.

- 1 Briefly describe the experimental process.
- 2 Explain what you predicted would happen.
- 3 Describe what actually happened.
- 4 Explain what you learned from the experiment.
- 5 Explain what you did as a follow-up to the experiment.



b Chuyu has carried out the procedure he described in Exercise 2c using the minerals olivine, ringwoodite and wadsleyite (all $(\text{Mg,Fe})_2\text{SiO}_4$), and perovskite (CaTiO_3) as samples. Look at the predictions he made before running his experiment. Use the glossary (pages 117–125) to check the meaning of the underlined words.

c ▶ 5.3 Chuyu is discussing the results with Lucia, a colleague. Listen to the first part of their conversation and mark each of Chuyu's predictions with a tick if it was right or a cross if it was wrong.

d ▶ 5.4 Listen to the next part of the conversation and answer the following questions.

- 1 What two things does Chuyu say he needs to do in the next experimental run to verify his results?
- 2 What other explanation does Chuyu give for the results?

7 a ▶ 5.3 Chuyu and Lucia talk about their expectations of the results compared with what actually happened. Complete the extracts below using one word in each gap. Then listen to the first part of the conversation again and check your answers.

- 1 Right, well, firstly I thought _____ the differential stress in all of the samples _____ go up as the pressure increased, and it _____ for olivine and for perovskite.
- 2 Right. And, _____ I expected, the perovskite was the strongest. It yielded later than olivine.
- 3 OK, well, I expected _____ increasing the temperature _____ reduce yield strength.
- 4 Right. And that's what _____ happen with the olivine.
- 5 Really? I _____ the minerals _____ all be affected by temperature.

b Complete the following table using the expressions in bold in Exercise 7a. Then answer the questions below.

Expectations	Outcomes

- 1 Look at the phrases in the first column. Why do the speakers use 'would' in these expressions?
- 2 Why do you think Chuyu says 'That's what did happen' (not 'That's what happened')?

- 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

8 a Read the summary of Chuyu's most recent results. Match the highlighted parts of the summary to an underlined expression with a similar meaning in Audioscript 5.3 on page 96. (The tenses in the Audioscript may not be the same as in the summary.)

b Why do you think Chuyu uses different words in the written summary from those he used in the conversation with Lucia?

c In 1–4 below, each (a) sentence is from an informal conversation and each (b) sentence is from a formal research paper. Complete each (b) sentence using part or all of the highlighted phrases in Exercise 8a, and any other necessary words.

- 1 a And then I've started looking at the petrography, too.
b _____, petrography studies have been _____.
- 2 a As I expected, sodic glasses had lots of cations with low average field strength and non-sodic glasses didn't have many at all.
b Sodic glasses contained _____ number of cations with low average field strength and non-sodic glasses the lowest.
- 3 a I thought the Al_2O_3 in the samples would decrease as SiO_2 increased, and it did.
b In all five tephra samples, Al_2O_3 decreased _____ the increase in SiO_2 .
- 4 a So far, I've looked at the morphology and mineralogy of tephra samples from La Malinche.
b _____, the morphology and mineralogy of tephra samples from La Malinche _____ examined.

9 Think about the experiment you discussed in Exercise 6a. Then write a short summary in a formal style using the text in Exercise 8a as a model.

To date, strengths at high temperature and pressure of the upper mantle mineral olivine and the lower mantle mineral perovskite have been investigated. In addition, some research has been carried out on wadsleyite from the transition zone. In all three mineral samples, at ambient temperature, differential stress increased with pressure until yielding occurred. Of the minerals studied, perovskite has the highest strength and olivine the lowest. Olivine and wadsleyite have similar characteristics of yield strength in response to temperature; strength decreases significantly as temperature increases. Perovskite, on the other hand, shows no change in yield strength in response to temperature up to 873 K when temperature is increased at a pressure of 20 GPa.

Describing problems with an experiment

10 Think about an experiment you did where you had a problem. Tell your partner:

- what the problem was
- what the possible causes of the problem were
- how you discovered what was causing the problem
- how you solved the problem

- 11 a ► 5.5 Chuyu has been continuing his experiments using wadsleyite and has moved on to look at the fourth mineral, ringwoodite. He is talking to Lucia about some problems he has had. Listen and complete the second column of the table with the two possible causes of the problem.

Problem	Possible cause	Likelihood	Action to be taken
Expects ringwoodite to act like wadsleyite, but it doesn't.	1	likely/possible/unlikely	Send sample for analysis
	2	likely/possible/unlikely	Be more careful between runs

- b ► 5.5 Listen again. How likely do they think each possible cause is? Circle the correct option in the third column of the table.

- 12 a Look at the phrases (1–5) below from the conversation. Which phrase is used to describe

- a a problem?
- b a possible cause?
- c the likelihood of something being correct?

- 1 ... so far the results are **all over the place**.
- 2 **It looks like** you're using olivine again.
- 3 Yeah, it's **possible**. But **I really think it's unlikely**.
- 4 **I guess** if my measurements aren't coming from the same base point then **there could be** problems.
- 5 ... a calibration issue is a **possibility**.

- b In pairs, think about a problem you are having with your current research. Use the expressions in Exercise 12a to describe some possible causes for the problem. Then explain how likely you think each one is.

- 13 a Chuyu has summarised his recent problems in a report for his supervisor. Complete the summary using the words in the box.

appears likely possibility possible possibly similar surprising unlikely

(a) *Because / Because of* the results obtained with wadsleyite, those from studies of ringwoodite are rather (1) _____. Ringwoodite, like wadsleyite, is a transition zone mineral. (b) *So / As a result*, these minerals would be expected to act in a (2) _____ way. (c) *However, / But* in the current data, ringwoodite (3) _____ to behave more like olivine. There are a number of possible causes of these findings. (d) *At the beginning, / Firstly*, it is (4) _____ that the sample tested is not in fact ringwoodite, but actually some other mineral, one (5) _____ from the olivine group. (e) *However, / Although* this is (6) _____, a composition analysis is being carried out to verify the identity of the sample material. A second (7) _____ is that the multi-anvil needs to be recalibrated. This seems the most (8) _____ cause of the problem. (f) *So / Therefore*, it will be checked immediately.

- b Now complete the summary by choosing the correct linking word (a–f).

Write a short summary describing and reporting problems you have been having with an experiment. Use the experiment you talked about in Exercises 6a and 9, or another experiment you know well. Your summary should say:

- what the problem is
- what the possible causes of the problem are

Keeping a lab notebook

- 15 a** The abbreviations and symbols below could all be used in a scientist's lab notebook. In pairs, discuss what you think each one means.

1 Δ	_____	5 @	_____	9 $\uparrow$	_____
2 RT	_____	6 $\therefore$	_____	10 E	_____
3 $\pm$	_____	7 $\therefore$	_____	11 w/	_____
4 w/v	_____	8 $\rightarrow$	_____	12 $\sim$	_____

- b** Now match the abbreviations or symbols (1–12) to the correct meanings (a–l) below.

- | | |
|------------------------|---|
| a about; approximately | h more or less (to show the deviation from the number stated) |
| b at | i room temperature |
| c because | j therefore |
| d change | k weight per volume |
| e energy | l with |
| f increases | |
| g leads to | |

- c** In pairs, decide how you might represent each of the following in a lab notebook.

- | | |
|----------------------------|---------------------|
| 1 decreases | 6 volume per volume |
| 2 degrees Celsius | 7 without |
| 3 kelvin | 8 two to one ratio |
| 4 greater than or equal to | 9 hours |
| 5 positive | 10 concentration |

- d** What other abbreviations do you often use in your lab notebook?

- e** ▶ 5.6 Listen to two scientists talking about two different experimental set-ups. Complete the notes from the lab notebook with a number and/or abbreviation or symbol from Exercises 15a and 15c.

- 16 a** In pairs, discuss the following questions.

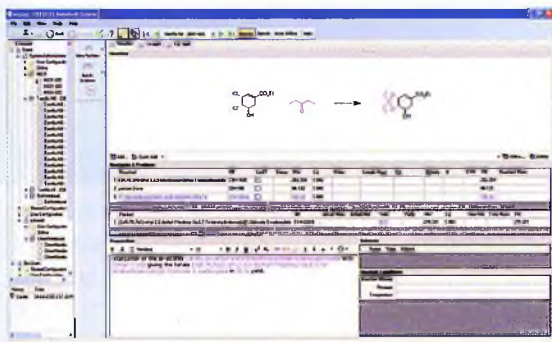
- 1 How do you keep a record of your experiments?
- 2 Have you ever used a lab notebook software package?
- 3 How does the lab notebook protocol in your current lab compare to other labs you have worked in?

5 mg char into TGA pan.
Heat (1) _____ - (2) _____
- hold 30 min
= (3) _____ from last time
Heat 20 (4) _____ /min to
873 K
then (5) _____ rate -
(6) _____ K/min to 1473 K
Gas = high purity CO_2
(7) _____ 25% + N_2

- b** ▶ 5.7 Chuyu is asking another scientist, Mayumi, about her experiences using an electronic lab notebook. Listen and complete Chuyu's notes. Write one word in each gap.

- * It's easy for people to (1) _____ information.
 * You don't have to try to understand someone else's (2) _____
 * You can (3) _____ your own lab book.
 * All the (4) _____ you make are automatically highlighted.
 * The packages can be adapted to fit your (5) _____ requirements.
 * It's much (6) _____ than a paper lab book.

- c** In pairs, discuss the advantages and disadvantages of using an e-notebook.



An example of a screen from an e-notebook

- 17 a** ▶ 5.8 Listen to five extracts from the conversation. For each extract you hear (1–5), choose the correct description of the situation (a–e).

- a describing something that people are able to do _____
 b describing something that was prohibited _____
 c describing something she was obliged to do _____
 d explaining that it is not necessary to do something _____
 e making a suggestion _____

- b** Look at Audioscript 5.8 on page 97 and complete the table below with the underlined phrases in the script.

	Past	Present
Ability/Possibility	could do	
Advice	should have done	
Lack of obligation	didn't have to do didn't need to do	
Obligation		must do
Prohibition		are not allowed to do can't do mustn't do

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Work in pairs. Explain to your partner the lab book protocol you are expected to use now. Tell your partner anything that was different in a place you used to work, or the way you used a lab notebook in your past studies.