SECOND EDITION

REVISE BTEC NATIONAL Applied Science

REVISION WORKBOOK

Pearson

REVISE BTEC NATIONAL
Applied Science

REVISION WORKBOOK

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A note from the publisher

While the publishers have made every attempt to ensure that advice on the qualification and its assessment is accurate, the official specification and associated assessment guidance materials are the only authoritative source of information and should always be referred to for definitive guidance.

This qualification is reviewed on a regular basis and may be updated in the future. Any such updates that affect the content of this Revision Workbook will be outlined at **www.pearsonfe.co.uk/BTECchanges**.

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Introduction

This Workbook has been designed to help you revise the skills you may need for the externally assessed units of your course. Remember that you won't necessarily be studying all the units included here – it will depend on the qualification you are taking.

BTEC National Qualification	Externally assessed units
Certificate	Unit 1: Principles and Applications of Science I
For both: Extended Certificate Foundation Diploma	Unit 1: Principles and Applications of Science I Unit 3: Science Investigation Skills
Diploma	Unit 1: Principles and Applications of Science I Unit 3: Science Investigation Skills Unit 5: Principles and Applications of Science II
Extended Diploma	Unit 1: Principles and Applications of Science I Unit 3: Science Investigation Skills Unit 5: Principles and Applications of Science II Unit 7: Contemporary Issues in Science

Your Workbook

Each unit in this Workbook contains either one or two sets of revision questions or revision tasks to help you **revise the skills** you may need in your assessment. The selected content, outcomes, questions and answers used in each unit are provided to help you to revise content and ways of applying your skills. Ask your tutor or check the Pearson website for the most up-to-date **Sample Assessment Material** and **Mark Schemes** to get an indication of the structure of your actual assessment and what this requires of you. The detail of the actual assessment may change, so always make sure you are up to date.

This Workbook will often include one or more useful features that explain or break down longer questions or tasks. Remember that these features won't appear in your actual assessment.

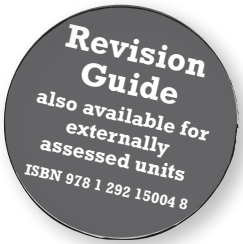
Grey boxes like this contain **hints and tips** about ways that you might complete a task, interpret a brief, understand a concept or structure your responses.

Guided This icon will appear next to **an example partial answer** to a revision question or task. You should read the partial answer carefully, then complete it in your own words.

This is a **revision activity**. It will help you understand some of the skills needed to complete the revision task or question.

These boxes will tell you where you can find more help in Pearson's BTEC National Revision Guide. Visit www.pearsonschools.co.uk/revise for more information.

There is often space on the pages for you to write in. However, if you are carrying out research and making ongoing notes, you may want to use separate paper. Similarly, some units will be assessed through submission of digital files, or on screen, rather than on paper. Ask your tutor or check the Pearson website for the most up-to-date details.



Contents

Unit 1: Principles and Applications of Applied Science I

Unit 3: Science Investigation Skills

Unit 5: Principles and Applications of Applied Science II

Unit 7: Contemporary Issues in Science

A small bit of small print

Pearson publishes Sample Assessment Material and the Specification on its website. This is the official content and this book should be used in conjunction with it. The questions and revision tasks in this book have been written to help you practise the knowledge and skills you will require for your assessment. Remember: the real assessment may not look like this.

Unit 1: Principles and Applications of Applied Science I

Your exam

Unit 1 will be assessed through an exam, which will be set by Pearson. You will need to use your understanding of core science concepts to respond to questions that require short and long answers.

Your Revision Workbook

This Workbook is designed to **revise skills** that might be needed in your exam. The details of the actual exam may change so always make sure you are up to date. Ask your tutor or check the **Pearson website** for the most up-to-date **Sample Assessment Material** to get an indication of the structure of your exam and what this requires of you.

To support your revision, this Workbook contains revision questions to help you revise the skills that might be needed in your exam. The revision questions are divided into three sections:

- Section A: Biology (Structures and functions of cells and tissues)
- Section B: Chemistry (Periodicity and properties of elements)
- Section C: Physics (Waves in communication).

The periodic table of elements is on page 162 and the formulae sheet can be found on page 163.

Each of the sections will contain a range of different question types, including multiple choice, short answer, calculations, drawing questions and open response. You should make sure you understand what each different command word is asking you to do in the question.

To help you revise skills that might be needed in your Unit 1 exam this Workbook contains two sets of revision questions starting on pages 2 and 20. The first set contains lots of help with hints and guided answers, while the second set is less guided to give you more practise at answering questions. See the introduction on page iii for more information on features included to help you revise.

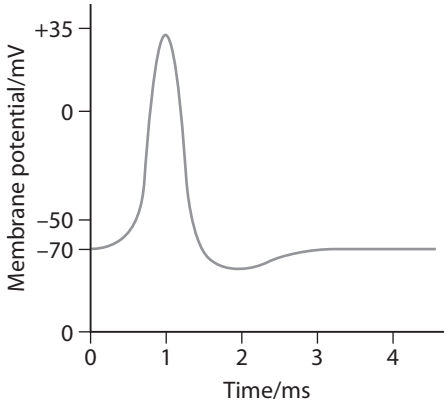
- Read each question carefully before you start to answer it.
- Check your answers if you have time at the end.

Revision test 1

Section A: Structures and functions of cells and tissues

Answer ALL questions. Write your answers in the spaces provided.

1 The graph shows a recording of an action potential.



(a) What state is the membrane potential at 1 ms on the graph? 1 mark

- ☐ **A** depolarised
- ☐ **B** hyperpolarised
- ☐ **C** polarised
- ☐ **D** repolarised.

(b) Sodium channels open to allow an increased flow of sodium ions into the neuron.

Use the graph to estimate the time when this happens. 1 mark

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Look for the time when the membrane potential starts to increase for depolarisation. Also you are looking for a precise time not a range.

(c) State the time when hyperpolarisation is at its greatest. 1 mark

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In action potentials remember depolarised is when membrane potential is positive and polarised is when the membrane potential is negative. 'Hyper' means over or above, so this will be the membrane potential when it is at the **most** negative membrane potential.

(d) At what time do the potassium channels open? 1 mark

- ☐ **A** 1 ms
- ☐ **B** 2 ms
- ☐ **C** 3 ms
- ☐ **D** 0.5 ms

Potassium ions diffuse out of the cell and take positive charge with them, making the cell potential more negative. When do the cells start becoming more negative?

Guided

(e) Explain how the normal balance of sodium and potassium ions is regained. 2 marks

The Na^+/K^+ ATP pumps use energy to rapidly transport .....

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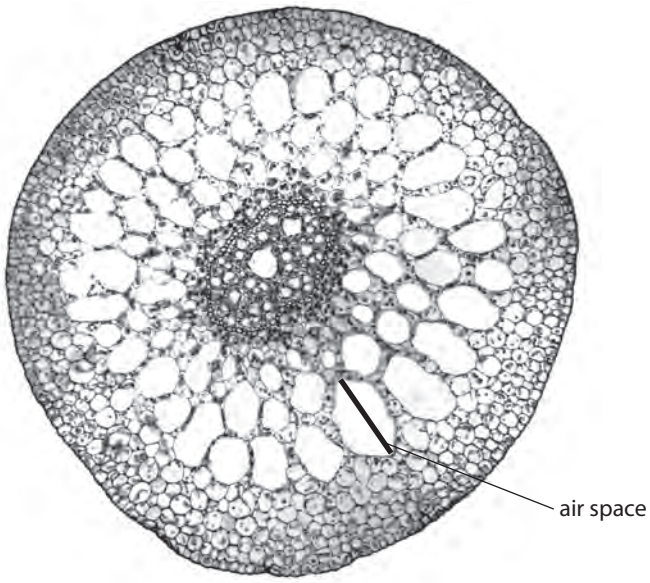
Links You can revise action potential on page 11 of the Revision Guide.

Total for Question 1 = 6 marks

2 The photograph shows a transverse section of a pondweed stem through a light microscope.



(a) The total magnification of the image is ×50. The eyepiece lens has a magnification of ×10.

Calculate the magnification of the objective lens. **2 marks**

total magnification = eyepiece lens × the objective lens

Magnification = ...

Guided

(b) Calculate the actual length of the air space marked on the photograph. **2 marks**

$$\text{magnification} = \frac{\text{size of image}}{\text{size of real object}}$$

$$\text{size of real object} = \frac{\text{size of image}}{\text{magnification}}$$

You need to measure the actual length of the air space first. Be careful of the units.

$$\text{length of air space} = \frac{\qquad}{500} = \text{.....}\ \mu\text{m}$$

(c) All aquatic plants have a similar stem structure, with a cortex of parenchyma cells with large air spaces. Suggest an explanation of why the stems have a structure like this. **3 marks**

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Consider what an aquatic plant needs to do in order to survive.

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Total for Question 2 = 7 marks

3 Plants are complex multi-cellular organisms and have many different specialised cell types.

(a) Give a definition for specialised cells. 2 marks

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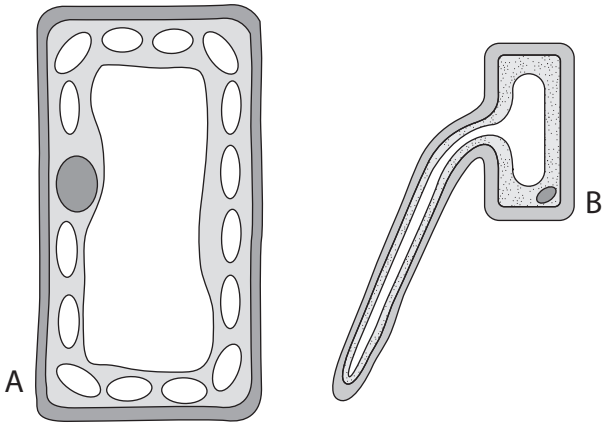
Guided

(b) Below are diagrams of two specialised plant cells A and B.



(i) State the names and functions of cell A and cell B. 2 marks

Cell A is a ..... it carries out .....

Cell B is a ..... it takes up .....

(ii) Compare cells A and B.

In your answer explain the differences between the two cells. 4 marks

You should use the number of marks as a guide for how many points to write. If you are asked to compare two things, one of those points must be a similarity or a difference.

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Links You can revise specialised plant cells on page 5 of the Revision Guide.

Total for Question 3 = 8 marks

4 Myoglobin is a protein found in muscle cells, which binds on to oxygen.
There are two different types of muscle cells. They can be fast twitch or slow twitch.

Fast twitch muscle cells rely mainly on anaerobic respiration for energy. Anaerobic means without oxygen.

(a) Choose the statement below, which is **true**. 1 mark

- ☐ **A** Slow twitch muscle cells have less myoglobin than fast twitch muscle cells.
- ☐ **B** Slow twitch muscle cells have more myoglobin than fast twitch muscle cells.
- ☐ **C** Slow twitch muscle cells have no myoglobin.
- ☐ **D** Slow twitch muscle cells have the same quantity of myoglobin as fast twitch muscle cells.

(b) Skeletal muscles have a bundle-within-bundles structure. They are covered in a tough layer of connective tissue, within this are many bundles, each of which contains 10 to 100 or more muscle fibres or cells.

Muscle cells also have a bundle-within-bundle structure. Describe the structure of a muscle cell, in terms of the muscle's main function of contraction. 2 marks

It's important to read the question and note down what the question tells you. For this question, your answer should focus on features specific to a muscle cell, not general features of any cell such as a nucleus or cell membrane.

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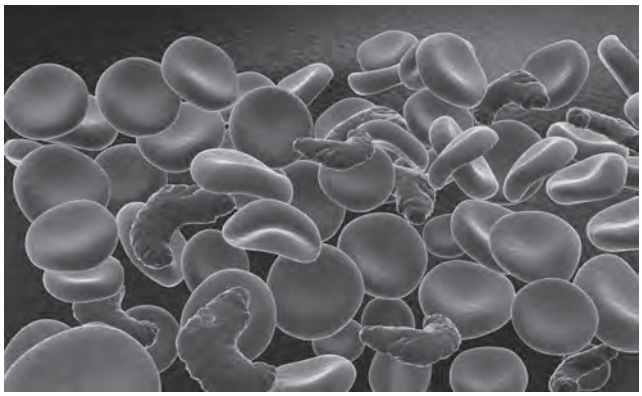
Total for Question 4 = 3 marks

5 Sickle-cell disease is an inherited condition, where the haemoglobin is abnormal.
This causes the red blood cells to be inelastic.
They only last for about 10–20 days compared to 3–4 months normally.
Below is an image showing sickle cells next to some normal red blood cells.



Deduce the problems these abnormal red blood cells could cause people who suffer from sickle-cell disease.

Your answer should explain the effects of the inelastic red blood cells and their short life span.

6 marks

Remember that normal red blood cells squeeze through capillaries and that they carry oxygen to cells for respiration.

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Links You can revise red blood cells on page 6 of the Revision Guide.

Total for Question 5 = 6 marks

END OF SECTION

TOTAL FOR SECTION A = 30 MARKS

Section B: Periodicity and properties of elements

Answer ALL questions. Write your answers in the spaces provided.

1 Bromine is a fuming red–brown liquid at room temperature. It is a mixture of two isotopes, ^{79}Br and ^{81}Br.

(a) Which of the following is the number of neutrons in the isotope ^{79}Br? 1 mark

- ☐ **A** 42
- ☐ **B** 44
- ☐ **C** 46
- ☐ **D** 48

(b) Identify **two** correct statements about the isotopes. 2 marks

- ☐ **A** ^{79}Br and ^{81}Br have the same number of atoms.
- ☐ **B** ^{79}Br and ^{81}Br have the same number of electrons.
- ☐ **C** ^{79}Br and ^{81}Br have the same number of ions.
- ☐ **D** ^{79}Br and ^{81}Br have the same number of neutrons.
- ☐ **E** ^{79}Br and ^{81}Br have the same number of protons.

Isotopes are atoms with the same atomic number but different mass numbers.

Guided

(c) The electronic configuration of a bromine atom can be written in terms of sub-shells.

(i) Complete the electronic configuration of a bromine atom. 1 mark

Remember that bromine is in group 7 of the periodic table.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ .....

(ii) State why bromine is classified as a p-block element. 1 mark

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Bromine fluoride is a polar molecule.

(d) Describe the charge distribution in a polar molecule. 1 mark

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Bromine forms three compounds with phosphorus.
The compounds have the molecular formulae PBr_3, PBr_5 and P_2Br_4

(e) (i) Give the meaning of molecular formula. 2 marks

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PBr_3 can be prepared by heating phosphorus (P_4) in bromine vapour.

Guided

(ii) Write a chemical equation for this reaction. State symbols are not required. 1 mark

P_4 + …… . Br_2 → …… . PBr_3

(iii) One of the three phosphorus bromides has the following percentage composition by mass:

P = 16.2% Br = 83.8%

Calculate the empirical formula of this bromide. 2 marks

The percentages are the same as the mass, in grams, in 100 g of the compound. The calculation should be carried out in three stages:

1. Calculate the amount, in moles, of each element in 100 g (divide the mass by the relative atomic mass, Ar).
2. Calculate the ratio of moles, by dividing both by the smaller value.
3. Calculate, if necessary, the simplest whole number ratio of moles of each element.

Now write the empirical formula using this ratio.

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empirical formula …… .

(iv) Determine the identity of the bromide. 1 mark

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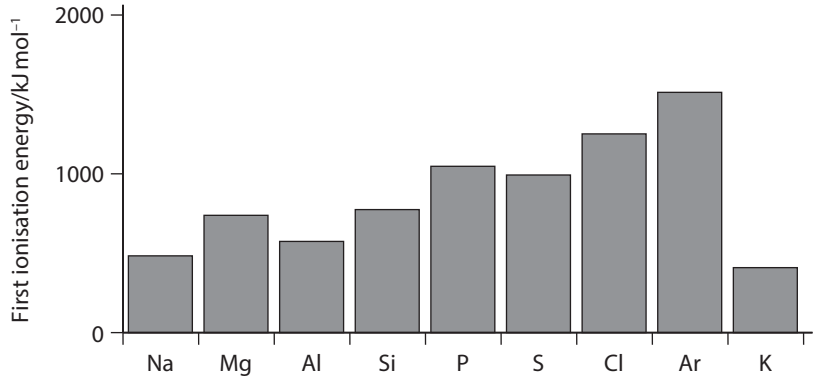
Links You can revise moles on page 22 of the Revision Guide.

Total for Question 1 = 12 marks

2 The bar chart shows the first ionisation energies of the elements sodium to potassium.



Guided

(a) State what is meant by the term first ionisation energy. **3 marks**

The energy required to remove one electron from .....

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(b) Explain why the first ionisation energy shows a general increase from Na to Ar. **3 marks**

Think about how the following affect the attraction between the nucleus and the outer electrons:
- The change in the charge of the nucleus from Na to Ar.
- The change in the shielding of the outer electrons from Na to Ar.

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(c) Explain why the first ionisation energy of Al is lower than that of Mg. **2 marks**

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Consider the orbital that the outer electron occupies in the atom of each element.

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(d) Explain why the first ionisation energy of K is much lower than that of Ar, even though it has a higher nuclear charge.

4 marks

Include the following in your answer:
- In which quantum shell each outer electron can be found.
- How much shielding the outer electron experiences in each atom.

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Total for Question 2 = 12 marks

Guided

3 Chlorine, bromine and iodine are known as halogens.

Discuss how van der Waals forces are responsible for the trend in boiling temperature of these halogens.

6 marks

To 'discuss', you need to show a clear understanding of the topic, consider all aspects of the topic, make connections between different aspects and discuss the extent or importance of features.

Consider the following points:

- How an instantaneous dipole is created in a molecule.
- How this instantaneous dipole affects a neighbouring molecule.
- How the number of electrons in a molecule affects the size of the instantaneous dipole and hence the size of the attraction between molecules.
- How the number of electrons in the molecule changes from chlorine to bromine to iodine.
- How the size of the attraction between the molecules affects the amount of energy required to separate the molecules to form a gas.
- How the amount of energy required to separate the molecules affects the boiling temperature.

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You can revise intermolecular forces on page 20 of the Revision Guide.

Total for Question 3 = 6 marks

END OF SECTION

TOTAL FOR SECTION B = 30 MARKS

Section C: Waves in communication

Answer ALL questions. Write your answers in the spaces provided.

1 Wi-Fi and Bluetooth® are used to transmit data between instruments and computers, e.g. in a hospital ward or operating theatre. By using different protocols they can successfully share the same frequency range.

(a) In which of these regions of the electromagnetic spectrum do Wi-Fi and Bluetooth® data communications operate? 1 mark

- ☐ **A** 1 MHz
- ☐ **B** 2.5 GHz
- ☐ **C** 30 GHz
- ☐ **D** 1 THz

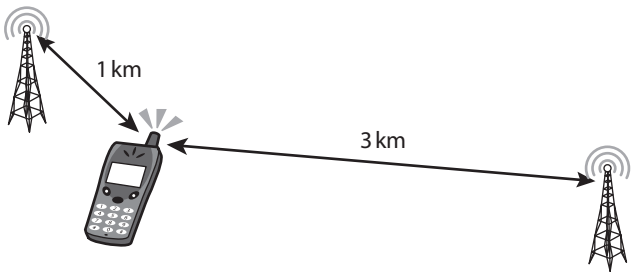
(b) A TV remote control operates on a wavelength of 940 nm. Select the region of the electromagnetic spectrum in which this wavelength falls. 1 mark

- ☐ **A** microwave
- ☐ **B** visible light
- ☐ **C** infrared
- ☐ **D** ultraviolet

Links See page 40 of the Revision Guide for reminders of the regions and the frequency bands of the electromagnetic spectrum.

Guided

A mobile phone handset is 1 km from the nearest cellular mast and 3 km from the mast in an adjacent cell.



(c) Explain how different frequency bands are used by mobile phone networks to achieve interference-free communications. 3 marks

Each mobile phone operator is allocated a separate set of frequency bands by the .....

.....

For three marks you need to make three separate points.

The upload signal from a mobile handset is broadcast on a slightly different frequency from the

.....

The cell masts in adjacent cells .....

.....

Guided

(d) The upload signal broadcast from the phone handset is detected at both the masts shown in the diagram.

Calculate how many times stronger the detected signal will be at the nearest mast, compared with that at the mast in the next-door cell.

2 marks

The broadcast is in all directions, so its intensity obeys the inverse square law: $I = k/r^2$

So $I_1 / I_2 = (r_2 / r_1)^2 = (\ldots\ldots\ldots\ldots\ldots\ldots$ km / 1 km$)^2$

$= \ldots\ldots\ldots\ldots\ldots\ldots$ times stronger.

Quote the law or formula you are using, and show your calculation working. There is a mark for each.

Total for Question 1 = 7 marks

2 A clarinet has a mouthpiece with a single reed. That end of the clarinet behaves like a closed-ended pipe. The other end of the instrument is open to the air.

When air is blown over the reed in the clarinet mouthpiece, a stationary wave is set up in the instrument and a sound is produced.

(a) A sound wave is produced by compressions and rarefactions of the material through which it travels. Name this type of wave.

1 mark

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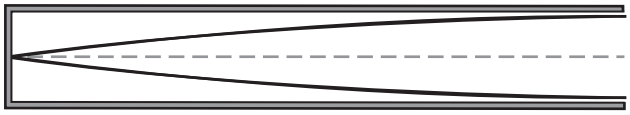
The diagram shows how the amplitude of air vibrations varies down the length of such a pipe



(b) Label **one** node and **one** antinode on the diagram.

2 marks

Node means a point of no vibration.

Guided

(c) The pipe is 0.75 m long. Calculate the wavelength for the next higher harmonic above the fundamental mode.

2 marks

The next harmonic has two nodes and still has an antinode at the open end.

So it fits ¾ of a wavelength into the pipe. So, ¾ λ = ...

Therefore λ = ...

Links You can revise musical instruments on page 36 of the Revision Guide.

Total for Question 2 = 5 marks

3 All four strings on a violin are the same length, but they have different mass per unit length values and can be separately tensioned to tune them. In the head of a violin, each string is wound round a peg, which can be turned to adjust the tension in that string.

Guided

(a) (i) Calculate how many times larger the tension force must be to double the frequency of the note.

2 marks

Look on the formula sheet (page 163) to find equations: 'wave speed' and 'speed of a transverse wave on a string'.

$f = v/\lambda$

$v = (T/\mu)^{1/2}$

It is the same string throughout, so μ has a constant value,

Therefore, $v \propto T^{1/2}$

So, if f_1 is the original frequency, and f_2 is the frequency of the note one octave higher:

$f_2/f_1 = 2 = v_2/v_1 = (T_2/T_1)^{1/2}$

Because the length of the string does not change, λ is constant, so can be disregarded in this equation.

So, $(T_2/T_1) = 2^2 =$ ..... times larger.

(ii) Give **two** differences between the types of wave produced in the string when the violin bow is drawn across it and the sound waves that radiate out from it through the air.

2 marks

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Waves can be progressive or stationary. They can also be either transverse or longitudinal.

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(iii) Interference patterns occur when waves are coherent. State what is meant when two waves are coherent.

1 mark

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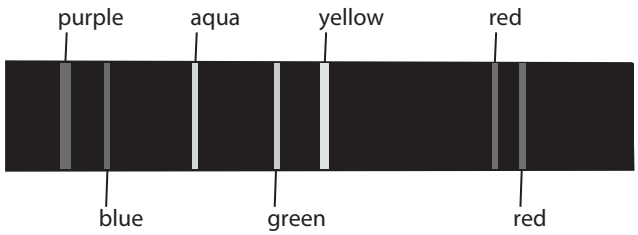
The diagram shows a spectrum made when light, produced by passing an electric discharge through a mercury vapour sample, is passed through a diffraction grating. This spectrum is a series of separate lines of specific colours.



Guided

(b) Describe how emission spectra such as the one shown above can be used to identify elements in samples of unknown composition.

2 marks

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Links You can revise interference and diffraction gratings on pages 33–34 of the Revision Guide.

Total for Question 3 = 7 marks

Guided **4** A table decoration can be created using optical fibres made from Perspex®. A light source in the base of the decoration feeds light into the cut ends of a bunch of fibres. The fibres are allowed to spread out at their other cut ends, where bright dots of light appear. The fibres appear to be unlit along their length apart from those bright spots.

(a) Perspex® has a refractive index of 1.48.

Calculate the critical angle for Perspex®. 2 marks

Refractive index, $n = 1/\sin C$. So $\sin C = 1/n =$ ..... .

Therefore the critical angle, $C = \sin^{-1}$ ..... .

= ..... .

Find the formula connecting critical angle with refractive index on the formula sheet and rearrange it.

(b) Perspex® is a transparent material, but light emerges only from the ends of the fibres.

Draw the path taken by one of the light rays passing through a fibre on the diagram. 2 marks

(c) Explain why no light is seen coming out from the sides of the fibres. 1 mark

Most of the light that enters the fibre will strike the outside surface at an angle

..... than the critical angle and so will undergo

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Optical fibres make important contributions to improved healthcare.

One use of them is in endoscopy. This technique, widely used in hospitals, allows many types of medical investigation and operation to be performed with only minimal cutting of body tissue.

To transmit and receive patient data, hospitals, GPs and other health professionals also increasingly rely on broadband internet connections that use fibre optics.

(d) Compare the uses made of optical fibres in endoscopy and in broadband internet connections.

In your answer you should refer to frequencies, analogue and digital data types, the types of fibre used and the quality of the data communicated.

6 marks

In a medical endoscope, the optical fibres can carry light with a full range of visible frequencies.

One bundle of fibres carries .....

Another bundle of fibres .....

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By contrast, fibres in a broadband network .....

That means .....

To demonstrate your understanding of the topic, it helps to explain the term 'digital' by describing how numbers are encoded by flashes of light.

Each separate frequency band of IR radiation can carry another separate set of digital information. The fibres used in an endoscope do not need to carry the signal more than about a metre and just need to deliver a lot of light efficiently. But in broadband optical fibre cables .....

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You can revise fibre optics and types of signal on pages 37–39 of the Revision Guide.

Total for Question 4 = 11 marks

END OF PAPER

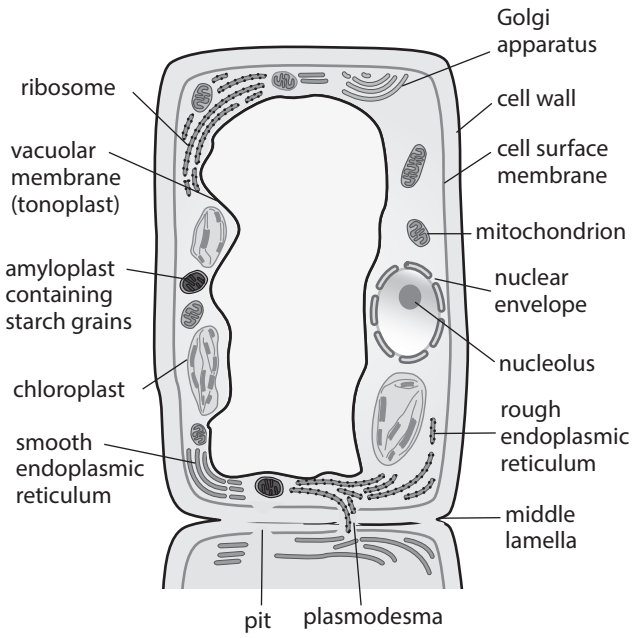
TOTAL FOR SECTION C = 30 MARKS
TOTAL FOR PAPER = 90 MARKS

Revision test 2

Section A: Structures and functions of cells and tissues

Answer ALL questions. Write your answers in the spaces provided.

1 Below is a diagram of a plant cell.



(a) Plant cells have some different features to animal cells.

Compare a plant cell with an animal cell. 3 marks

Compare means you need to state any similarities or differences between a plant cell and an animal cell. You should use the number of marks as a guide for how many points to write.

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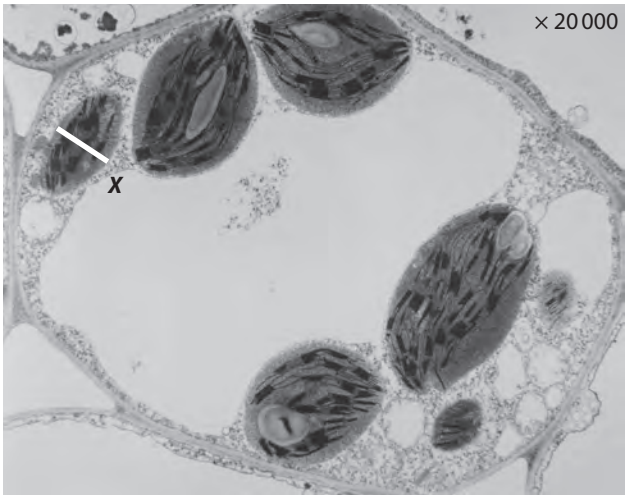
Links You can revise plant and animal cells on pages 4–6 of the Revision Guide.

(b) The image below shows an electron micrograph of a plant cell.

Calculate the diameter *X*, marked on a chloroplast in micrometres.

3 marks



magnification = size of image/size of real object

There are 1000 micrometres in a millimetre.

Diameter *X* of chloroplast = ... µm

Links You can revise epithelial cells on page 7 of the Revision Guide.

Total for Question 1 = 6 marks