

Pearson BTEC Level 3 Nationals

Write your name here

Surname

Forename

Learner Registration Number

Centre Number

Level

 3

Applied Science

Unit 1: Principles and Applications of Science I

Certificate/Extended Certificate/Foundation Diploma/Diploma/Extended Diploma

Sample assessment material for first teaching September 2016

Time: 1 hour 30 minutes

Total



marks

You must have:

Calculator

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and learner registration number.
- Answer **all** questions.
- Answer the questions in the spaces provided
– *there may be more space than you need.*

Information

- The total mark for this paper is 90.
- The paper is comprised of three sections worth 30 marks each
 - Section A: Periodicity and Properties of Elements
 - Section B: Structures and Functions of Cells and Tissues
 - Section C: Waves in Communication.
- The marks for **each** question are shown in grey boxes
– *use this as a guide as to how much time to spend on each question.*
- The periodic table of elements and formulae sheet can be found at the back of this paper.

Advice

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

Paper reference
31617H
S52536A

©2016 Pearson Education Ltd.
1/1/1/1/1/1



Turn over ►

PEARSON

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

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Section A – Periodicity and Properties of Elements

- 1 Chemists use the periodic table to predict the chemical properties of elements based on their location in the table.
Part of the periodic table is shown.

	1	2																		3	4	5	6	7	0	
1																										
2																										
3	A																					C				
4																										D
5																										
6																										

The letters, A, B, C and D, represent four different elements.

- (a) (i) Which element, A, B, C or D, is in the d-block of the periodic table?

1 mark

- A
- B
- C
- D

- (ii) Which element, A, B, C or D, has the most stable electronic structure?

1 mark

- A
- B
- C
- D



(iii) Which element, A, B, C or D, reacts violently with water?

1 mark

- A
- B
- C
- D

(b) An element has the electronic configuration $1s^2 2s^1$

Identify which period the element is in.

1 mark

(c) Complete the electronic configuration for an atom of sodium.

1 mark

$1s^2 2s^2$

Total for Question 1 = 5 marks

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



2

Magnesium chloride, MgCl_2 , is an important industrial chemical.

It can be made by reacting magnesium with dilute hydrochloric acid.

(a) Give **one** use of magnesium chloride.

1 mark

(b) Calculate the relative molecular mass for magnesium chloride.

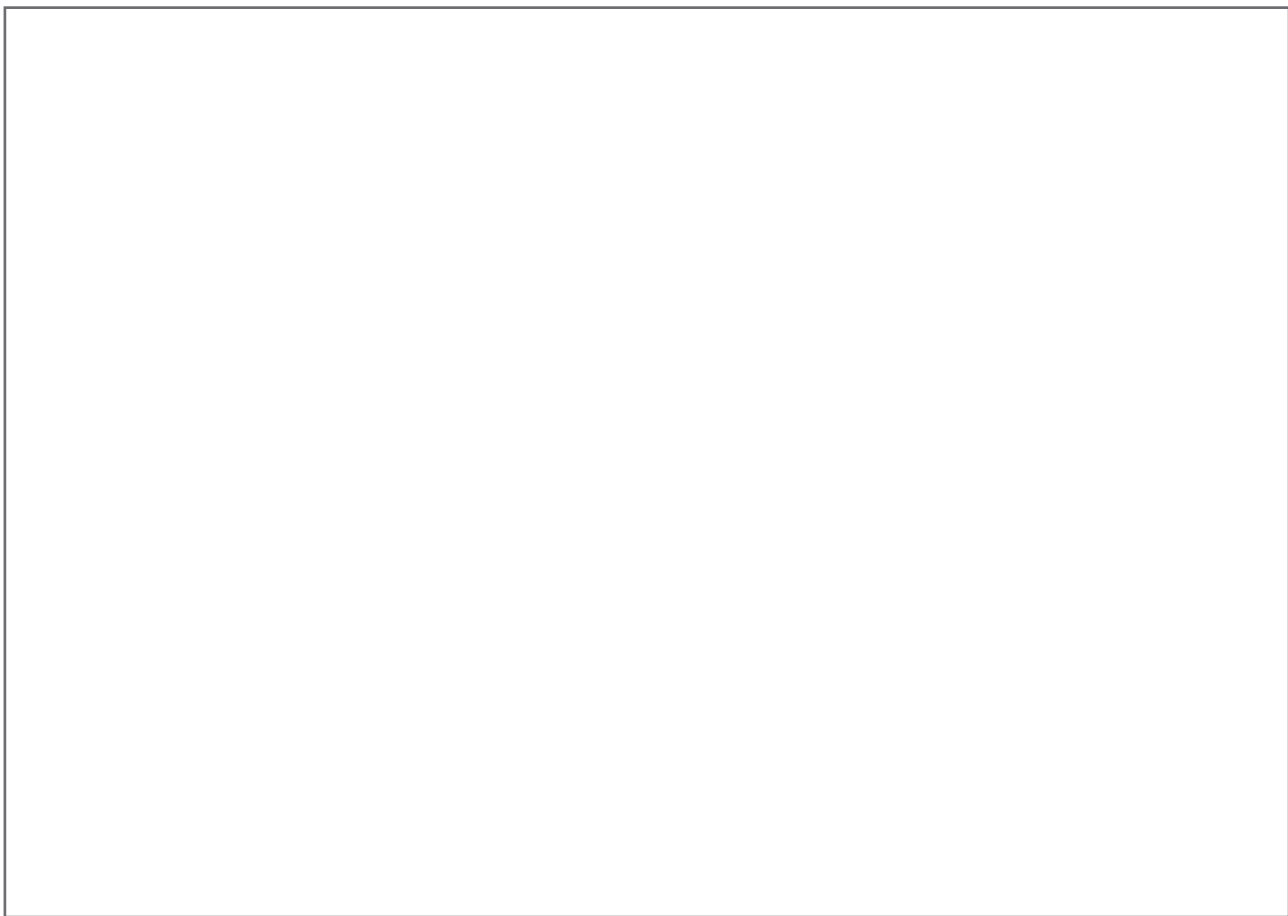
2 marks

Show your working.



(c) Draw dot and cross diagrams to show the arrangement of the **outer** electrons in the magnesium ion and the two chloride ions in magnesium chloride, MgCl_2 .

3 marks



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



(d) Calculate the number of moles of hydrochloric acid in 50 cm³ of 0.2M hydrochloric acid.

3 marks

Show your working.

..... moles

Total for Question 2 = 9 marks



3

Copper wire is used in electric cables because it is ductile and a conductor of electricity.

The properties of copper are related to its structure.

(a) Explain why copper is ductile.

3 marks

Handwriting practice area for question (a) with 10 horizontal dotted lines.

(b) Explain why copper is a conductor of electricity.

3 marks

Handwriting practice area for question (b) with 10 horizontal dotted lines.

Total for Question 3 = 6 marks



4

Industrial chemists have to understand the chemistry of oxides.

For example, silicon dioxide is used in glass making and carbon monoxide is used in the extraction of iron from iron ore.

- (a) (i) Explain how burning carbon in air can lead to the formation of carbon monoxide.

2 marks

.....

.....

.....

.....

- (ii) Write the balanced equation for the reaction between silicon and oxygen.

2 marks

.....

Period 3 elements bond with oxygen to form oxides.

The type of bonding in these oxides depends on the electronegativity of each element in the oxide.

The table shows the electronegativity of some period 3 elements, as well as for oxygen.

element	electronegativity of element
magnesium	1.31
silicon	1.90
sulfur	2.58
oxygen	3.44



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(b) Explain how bonding in the oxides of elements in period 3 changes across the period.

6 marks

Large rectangular area with horizontal dotted lines for writing the answer.

Total for Question 4 = 10 marks

END OF SECTION **TOTAL FOR SECTION A = 30 MARKS**



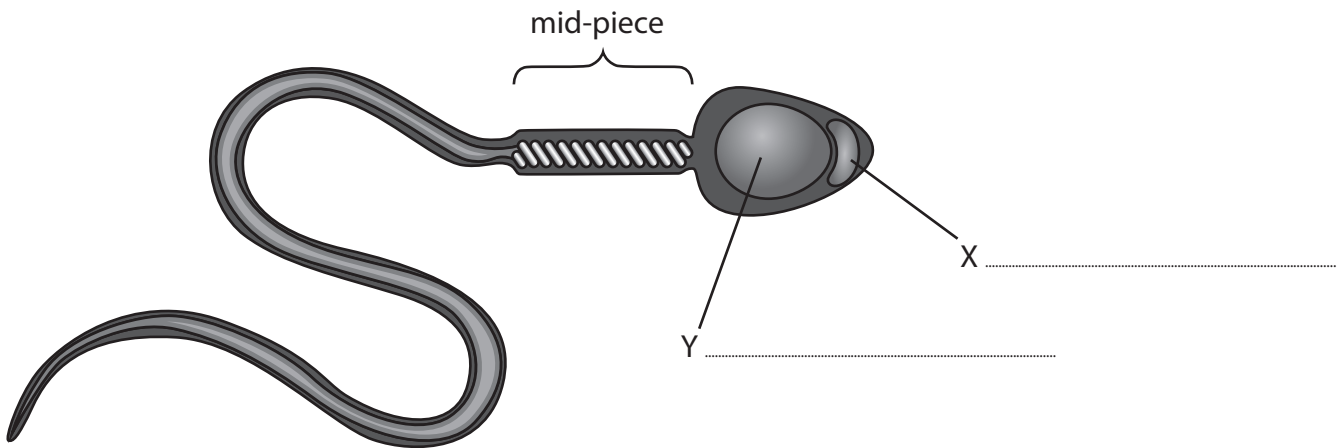
Section B – Structure and Functions of Cells and Tissues

5 Scientists researching fertilisation in humans need to understand how sperm cells are adapted for their specific function.

The diagram shows a human sperm cell.

(a) Complete the missing labels, X and Y, on the diagram.

2 marks



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(b) Explain how the mid-piece of a human sperm cell is specialised to support the function of its tail.

3 marks

Handwriting area with 10 horizontal dotted lines for the answer.

Total for Question 5 = 5 marks



6

A microbiologist studies microscopic lifeforms such as bacteria in order to learn more about their structure and function.

(a) Name the type of ribosome found in bacteria.

1 mark

.....

(b) Explain how the ultrastructure of a bacterium capsule prevents dehydration.

2 marks

.....
.....
.....
.....



A microbiologist measures an electron micrograph image of a bacterium to be 4.5 cm in length.

The magnification used to view the bacterium was 22 500x.

(c) Calculate the actual size of the bacterium.

3 marks

Show your working.

..... μm

Total for Question 6 = 6 marks

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

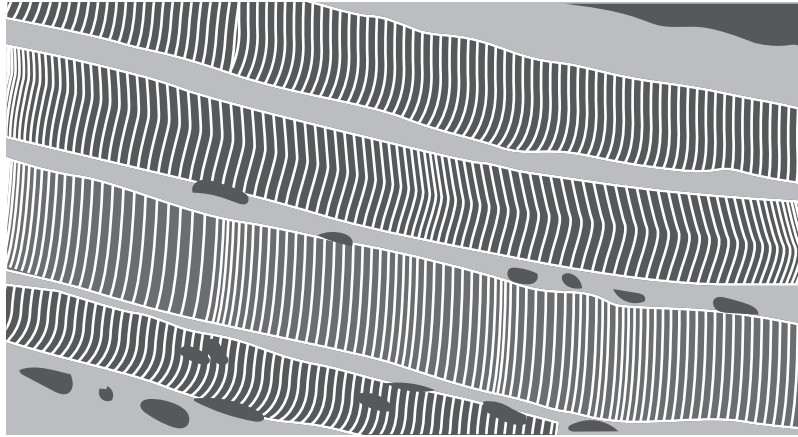
DO NOT WRITE IN THIS AREA



7

Sports scientists study the structure of skeletal muscle.

The diagram shows a section of skeletal muscle.



- (a) Name the **two** myofilaments found in a skeletal muscle fibre that give it its striated appearance.

2 marks

.....

.....

- (b) Explain the function of the sarcoplasmic reticulum in skeletal muscle tissue.

3 marks

.....

.....

.....

.....

.....

.....

Total for Question 7 = 5 marks



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

BLANK PAGE

QUESTION 8 BEGINS ON THE NEXT PAGE.

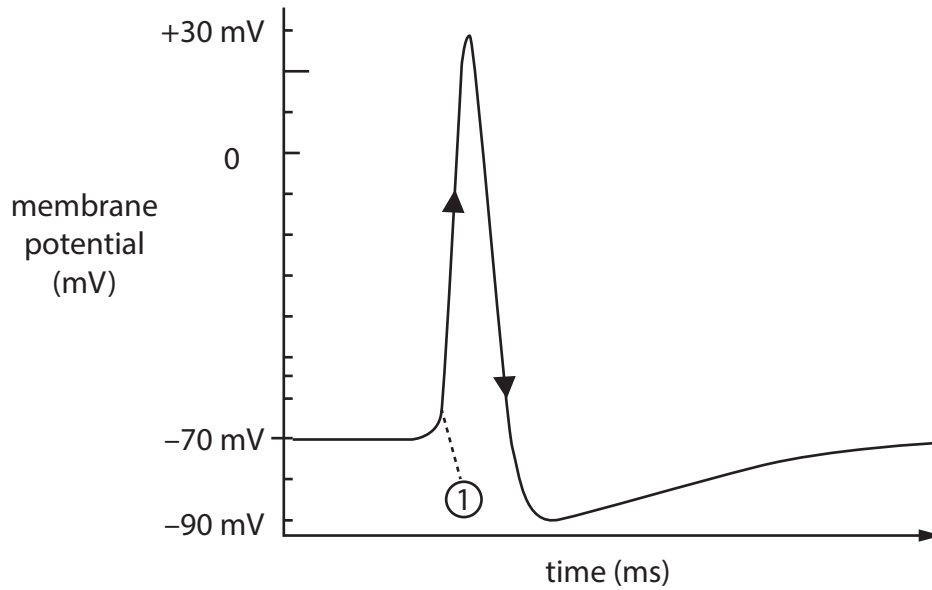


8

Neurologists study the response of the nervous system to stimuli.

A stimulus triggers a sequence of events known as an action potential in a neuron.

The graph shows the potential difference across the membrane of an axon during an action potential.



(a) Describe the changes in membrane permeability at point 1 on the graph.

4 marks

.....

.....

.....

.....

.....

.....

.....

.....

.....



(b) Explain how hyperpolarisation occurs in an axon cell.

4 marks

Area for writing the answer, consisting of a large rectangle with horizontal dotted lines for guidance.

Total for Question 8 = 8 marks

DO NOT WRITE IN THIS AREA

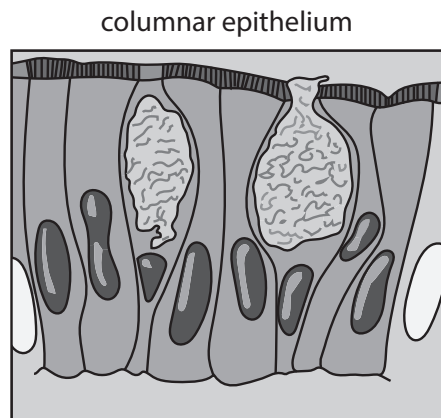
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



9

The diagrams show two types of epithelial tissue found in the lungs; squamous and columnar.



Explain how the structure of the squamous and columnar epithelial tissue supports their function in the lungs.

6 marks

A large rectangular area containing horizontal dotted lines for writing the answer.

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

Large rectangular area with horizontal dotted lines for writing.

Total for Question 9 = 6 marks

END OF SECTION

TOTAL FOR SECTION B = 30 MARKS



S 5 2 5 3 6 A 0 1 9 3 1

Section C – Waves in Communication

10 A flute is a musical instrument. It is used to play a note into a microphone connected to a cathode ray oscilloscope (CRO). The CRO displays the output of the note played. This is shown in diagram A.

A tuning fork is also used to produce the same note. The CRO display of this note is shown in diagram B.

The CRO display settings are the same for both.

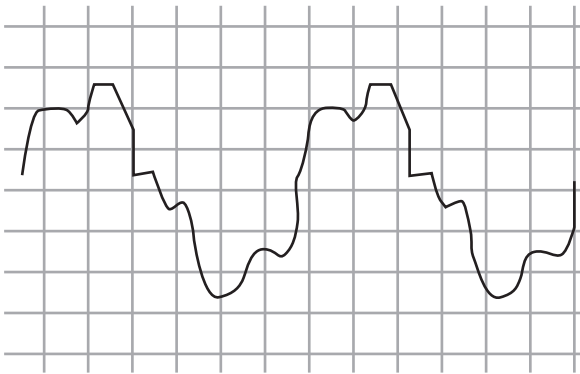


diagram A

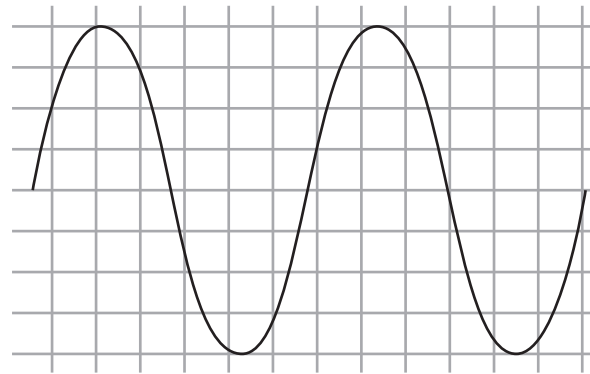


diagram B

(a) Identify **two** differences between the note displayed in diagram A and the note displayed in diagram B.

2 marks

.....

.....

.....

.....



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(b) Name the type of waveform that transfers the sound from the flute to the microphone.

1 mark

.....

(c) Describe how the vibrating air inside the flute produces a stationary wave.

3 marks

.....
.....
.....
.....
.....
.....

Total for Question 10 = 6 marks

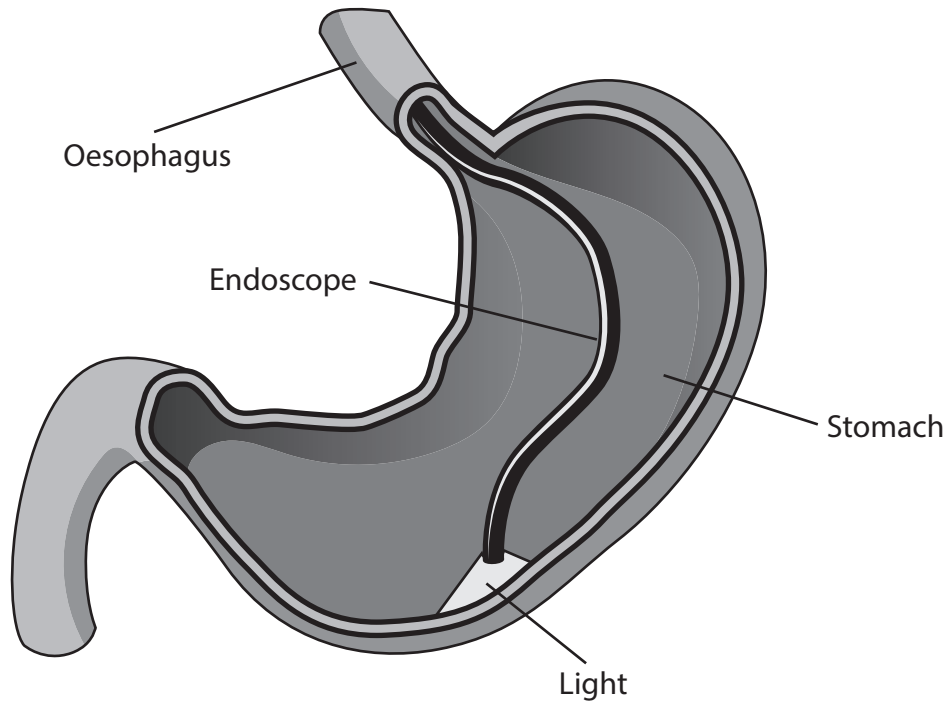


11

An endoscope is a device that doctors use to look at organs inside the body.

An endoscope contains bundles of optical fibres that can also be used to illuminate the organ being investigated.

A diagram of an endoscope that uses some optical fibres for illumination is shown.



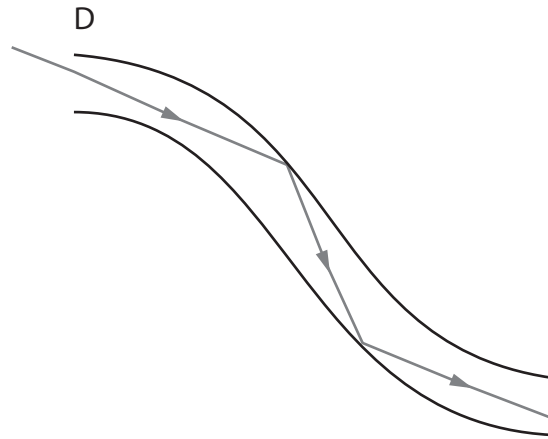
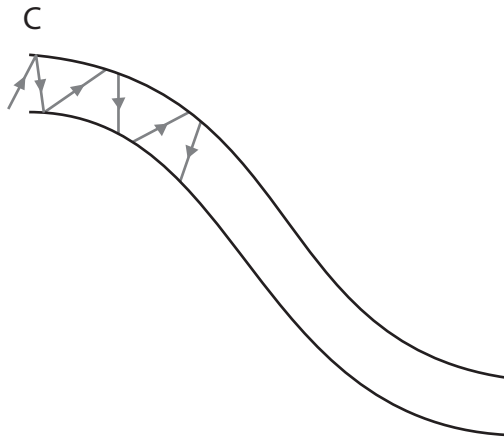
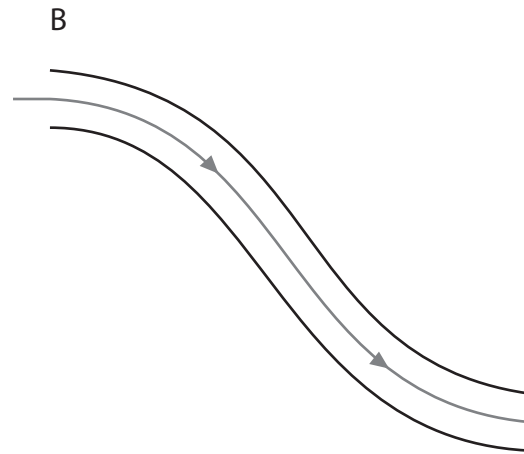
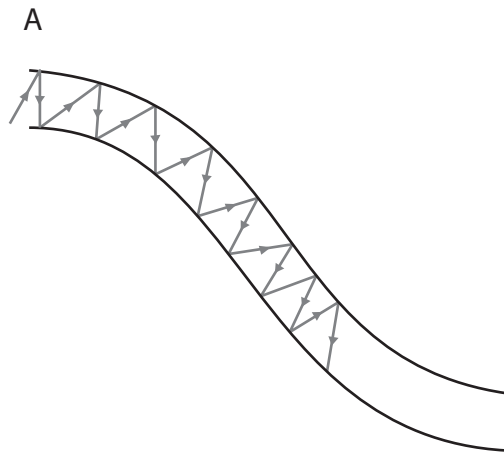
DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



(a) Identify the diagram, A, B, C or D, that shows the path of a light ray in an optical fibre that would illuminate the organ.



1 mark

- A
- B
- C
- D



The refractive index of the optical fibre is 1.48

The speed of light in air is approximately 3×10^8 m/s

(b) Calculate the speed of light in the optical fibre.

3 marks

Show your working.

Speed of light = m/s



A technician who is using the endoscope accidentally bends the optical fibres to a very sharp angle. The optical fibres do not crack or break.

He notices that the brightness of the light leaving the optical fibres is reduced.

(c) Explain why the brightness of the light is reduced.

2 marks

.....

.....

.....

.....

.....

.....

.....

Optical fibres use digital signals for communication.

Digital signals are clear and of high quality. They can carry a lot of data.

(d) Explain **one other** advantage of using digital signals in long distance communication.

2 marks

.....

.....

.....

.....

.....

.....

.....

Total for Question 11 = 8 marks

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



12

Light from a sodium-vapour lamp passes through the slits in a diffraction grating and creates a pattern on a screen.

This pattern is called an emission spectrum.

(a) Which property of light produces the pattern on the screen?

1 mark

- A absorption
- B interference
- C reflection
- D refraction

For a clear diffraction pattern to be produced on the screen, the light passing through the diffraction grating has to have coherence.

(b) Describe what is meant by coherence.

2 marks

.....

.....

.....

.....

.....

.....



DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

(c) Explain how the diffraction grating produces an emission spectrum.

You can use a labelled diagram to help your explanation

4 marks

A large rectangular box for writing an answer, containing several horizontal dotted lines for guidance.

Total for Question 12 = 7 marks



13

Various parts of the electromagnetic spectrum are used for communication.

An electromagnetic wave has a frequency of 4.5×10^9 Hz.

The speed of light is 3×10^8 m/s

(a) Show that the wavelength of the electromagnetic wave is approximately 7.0 cm.

3 marks

Show your working.

..... cm



The Periodic Table of Elements

	1	2	Key										3	4	5	6	7	0 (8)																								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)																								
	relative atomic mass		atomic symbol		name		atomic (proton) number																																			
6.9	Li lithium 3	9.0	Be beryllium 4	45.0	Sc scandium 21	47.9	Ti titanium 22	47.9	47.9	50.9	V vanadium 23	52.0	Cr chromium 24	54.9	Mn manganese 25	55.8	Fe iron 26	55.8	55.8	58.9	Co cobalt 27	58.9	58.9	58.7	Ni nickel 28	63.5	Cu copper 29	65.4	Zn zinc 30	69.7	Ga gallium 31	72.6	Ge germanium 32	74.9	As arsenic 33	79.0	Se selenium 34	79.9	Br bromine 35	83.8	Kr krypton 36	
23.0	Na sodium 11	24.3	Mg magnesium 12	88.9	Y yttrium 39	87.6	Sr strontium 38	91.2	Zr zirconium 40	92.9	Nb niobium 41	95.9	Mo molybdenum 42	[98]	Tc technetium 43	101.1	Ru ruthenium 44	101.1	101.1	102.9	Rh rhodium 45	102.9	102.9	106.4	Pd palladium 46	107.9	Ag silver 47	112.4	Cd cadmium 48	114.8	In indium 49	118.7	Sn tin 50	121.8	Sb antimony 51	127.6	Te tellurium 52	126.9	I iodine 53	131.3	Xe xenon 54	
132.9	Cs caesium 55	137.3	Ba barium 56	178.5	Hf hafnium 72	178.5	Hf hafnium 72	186.2	Re rhenium 75	186.2	Re rhenium 75	183.8	W tungsten 74	186.2	Os osmium 76	190.2	Os osmium 76	190.2	192.2	Ir iridium 77	192.2	192.2	195.1	Pt platinum 78	197.0	Au gold 79	200.6	Hg mercury 80	204.4	Tl thallium 81	207.2	Pb lead 82	209.0	Bi bismuth 83	[209]	Po polonium 84	[210]	At astatine 85	[222]	Rn radon 86		
[223]	Fr francium 87	[226]	Ra radium 88	[227]	La* lanthanum 57	[261]	Rf rutherfordium 104	[262]	Db dubnium 105	[262]	Db dubnium 105	[266]	Sg seaborgium 106	[264]	Bh bohrium 107	[277]	Hs hassium 108	[277]	108	[268]	Mt meitnerium 109	[268]	[271]	Ds darmstadtium 110	[272]	Rg roentgenium 111	[272]	Rg roentgenium 111	[272]	[272]	[272]	[272]	[272]	[272]	[272]	[272]	[272]	[272]	[272]	[272]	[272]	[272]

Elements with atomic numbers 112-116 have been reported but not fully authenticated

* Lanthanide series
* Actinide series

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA



Formulae Sheet

Wave speed

$$v = f\lambda$$

Speed of a transverse wave on a string

$$v = \sqrt{\frac{T}{\mu}}$$

Refractive index

$$n = \frac{c}{v} = \frac{\sin i}{\sin r}$$

Critical angle

$$\sin c = \frac{1}{n}$$

Inverse square law in relation to the intensity of a wave

$$I = \frac{k}{r^2}$$

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

DO NOT WRITE IN THIS AREA

