



Rewarding Learning

General Certificate of Secondary Education
2021–2022

Centre Number

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Candidate Number

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Single Award Science: Physics

Unit 3

Higher Tier



[GSA32]

GSA32

WEDNESDAY 24 NOVEMBER, MORNING

TIME

1 hour.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.

You must answer the questions in the spaces provided.

Do not write outside the boxed area on each page or on blank pages.

Complete in black ink only. **Do not write with a gel pen.**

Answer **all eleven** questions.

INFORMATION FOR CANDIDATES

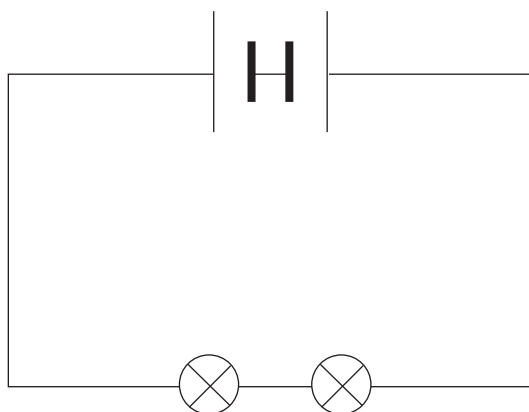
The total mark for this paper is 60.

Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.

Quality of written communication will be assessed in Question 4.



- 1 The diagram below shows a circuit which has been incorrectly set up.

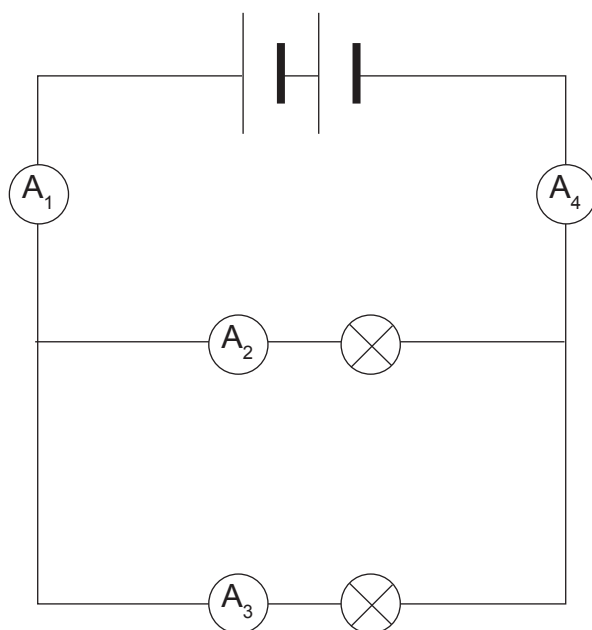


- (a) Each cell has a voltage of 1.5 V. What is the total voltage in this circuit?

_____ V [1]



- (b) A student set up the circuit shown below containing two identical bulbs and four ammeters.



- (i) What term is used to describe how the bulbs are connected in this circuit?

_____ [1]

The ammeter A_1 has a reading of 0.4 A.

- (ii) What is the reading on:

ammeter A_3 ? _____ A

ammeter A_4 ? _____ A [2]

- (iii) Give **two** advantages of connecting bulbs as shown in this circuit.

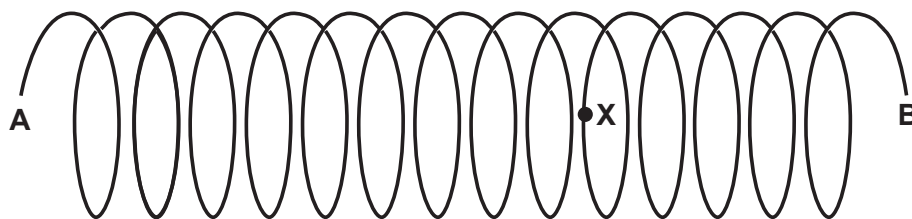
1. _____

2. _____ [2]

[Turn over



- 2 (a) A student uses a slinky spring to show a longitudinal wave.



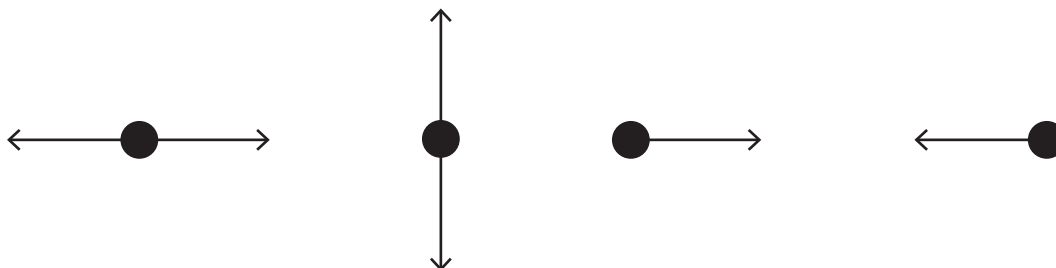
Source: Principal Examiner

- (i) In the box above, draw an arrow to show the direction the student would move the slinky spring to produce a longitudinal wave. [1]

- (ii) What do longitudinal waves carry from one place to another? [1]
- _____

- (iii) How will the particle, labelled X on the diagram above, move when the longitudinal wave travels along the slinky spring from A to B?

Circle your answer.



[1]



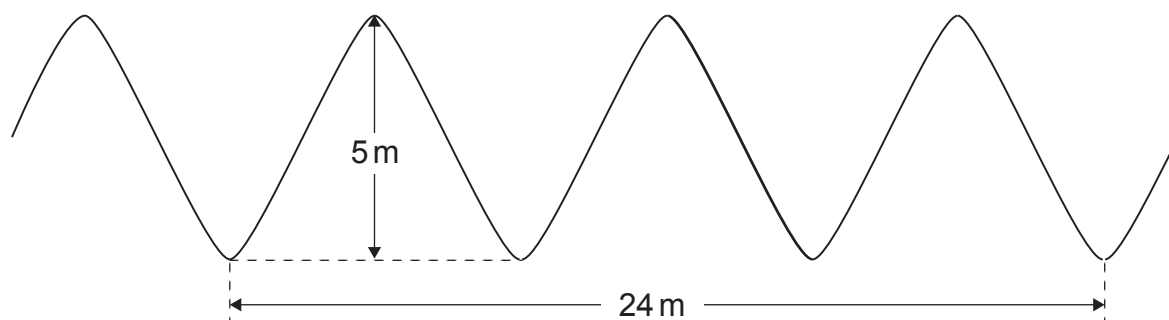
The table below shows the range of frequencies some animals can hear.

Animal	Lowest frequency/Hz	Highest frequency/Hz
dog	67	45 000
cow	23	35 000
ferret	16	44 000
rat	200	76 000

- (b) How many animals, named in the table, can hear frequencies lower than a human?

_____ [1]

- (c) The diagram below shows a transverse wave.



Source: Principal Examiner

- (i) What is the amplitude of this wave?

_____ m [1]

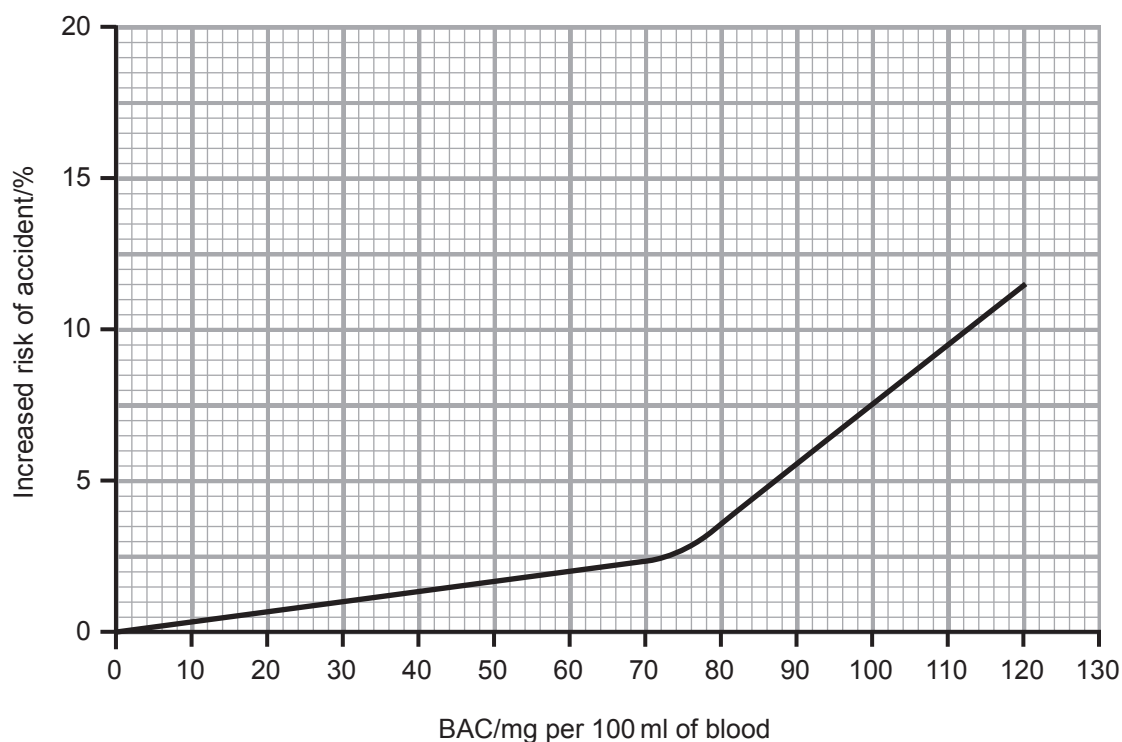
- (ii) What is the wavelength of this wave?

_____ m [1]

[Turn over



- 3 The graph below shows how blood alcohol concentration (**BAC**) affects the risk of a driver causing an accident.



- (a) Use the graph to estimate the percentage increased risk of causing an accident with a **BAC** of 130 mg per 100 ml of blood.

_____ [1]

- (b) The legal limit for driving in Northern Ireland is 80 mg of alcohol in 100 ml of blood.
Using information from the graph explain why some people think this limit is too high.

_____ [1]



The table below shows how the percentage blood alcohol content in males and females is affected by the number of units of alcohol consumed and body mass.

Units of alcohol	Blood alcohol content/%					
	Male body mass			Female body mass		
	60 kg	80 kg	100 kg	60 kg	80 kg	100 kg
1	0.03	0.02	0.01	0.04	0.03	0.02
2	0.06	0.05	0.04	0.08	0.06	0.05
3	0.09	0.07	0.06	0.11	0.09	0.07
4	0.12	0.09	0.08	0.15	0.11	0.09
5	0.16	0.12	0.09	0.19	0.14	0.10

(c) Give **two** conclusions that can be made from this data.

1. _____

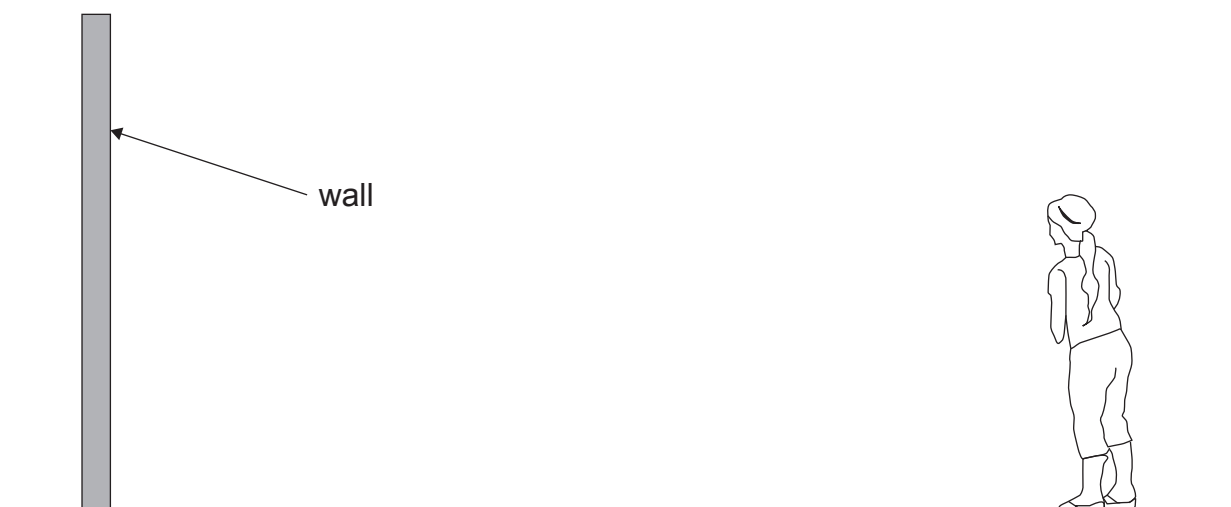
2. _____

[2]

[Turn over



- 4 The speed of sound can be found by making careful measurements and using a formula to calculate the answer.



Source: © Getty Images

Describe how a student could use a wall to find an accurate and reliable value for the speed of sound using the **echo method**.

Your answer should include:

- the measurements needed;
- the equipment used and
- how the speed of sound is calculated from the measurements.

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.





[6]

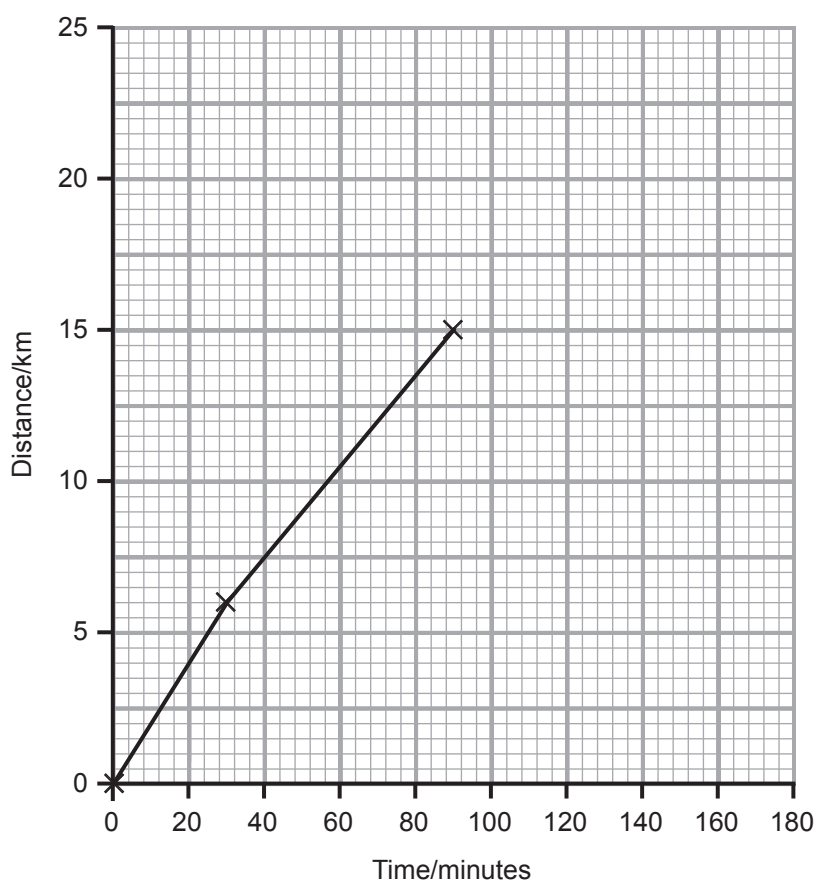
[Turn over



- 5 The table below shows the distance a cyclist travels over a period of 180 minutes.

Time/minutes	Distance/km
0	0
30	6
90	15
160	15
180	24

- (a) On the grid below plot a distance-time graph to show this information. The first three points have been completed for you.



[1]



(b) Between which times is the cyclist travelling the fastest?

_____ minutes and _____ minutes [1]

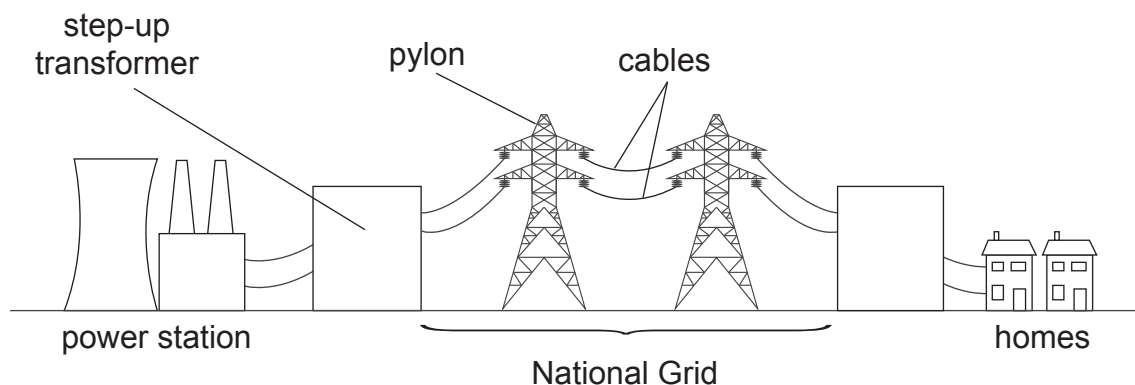
(c) Describe the motion of the cyclist between 90 and 160 minutes.

_____ [1]

[Turn over



- 6 The diagram below shows a power station and the National Grid which transmits electricity to homes around the country.



Source: Principal Examiner

- (a) A power station produces $3 \times 10^9 \text{ W}$ of power at 25 000 V. The step-up transformer increases the voltage to 400 000 V before transmission through the cables.

Use the equation:

$$\text{current} = \frac{\text{power}}{\text{voltage}}$$

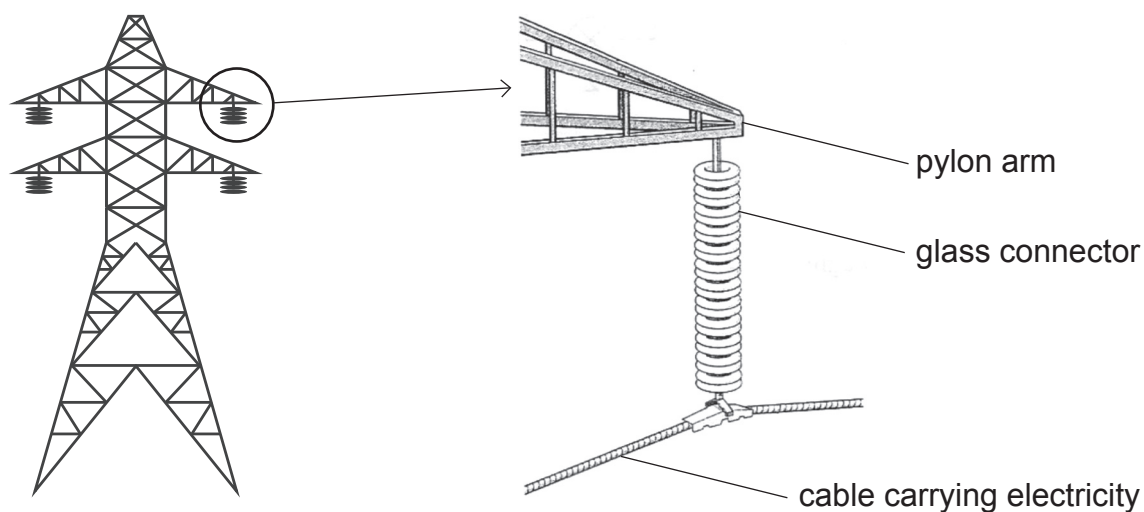
to calculate the current that will flow through the cables of the National Grid.

(Show your working out.)

_____ A [2]



The diagram below shows part of a pylon.



Source: Principal Examiner

- (b) Suggest **one** reason why glass is used to make the connector shown in the diagram.

[1]

- (c) Explain fully why a step-up transformer is used to increase the voltage before transmission through the National Grid.

[2]

[Turn over



The table below shows the percentage of energy wasted by four different transformers.

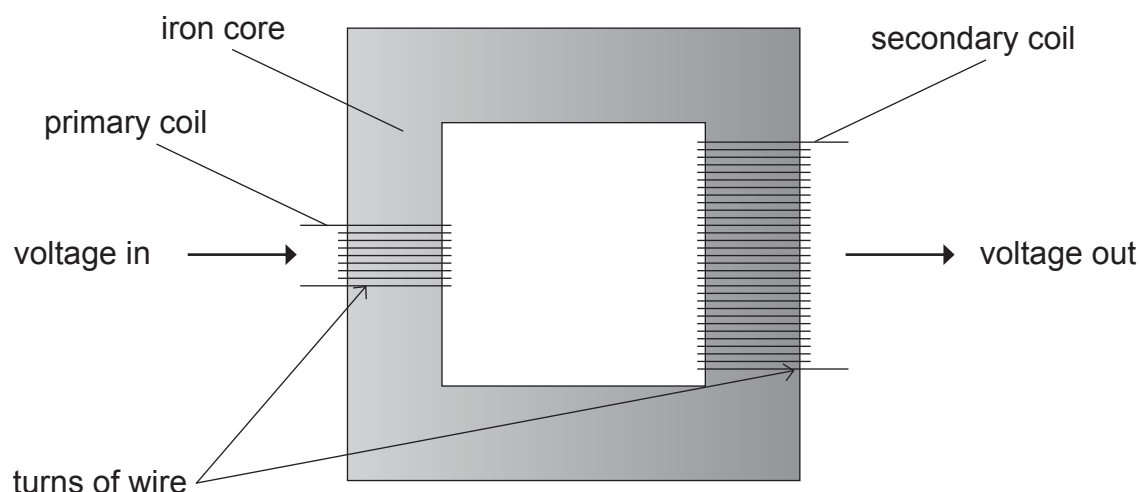
Transformer	Percentage of energy wasted as sound/%	Percentage of energy wasted as heat/%
A	1.1	7.2
B	1.1	5.2
C	1.3	4.8
D	1.5	6.9

(d) Which transformer **A**, **B**, **C** or **D** is the most efficient?

_____ [1]



The diagram below shows a transformer.



Source: Principal Examiner

A student investigated how changing the number of turns of wire in the primary and secondary coils of a transformer affected the output voltage.

The results are shown below.

Voltage in/ V	Number of turns of wire on the primary coil	Number of turns of wire on the secondary coil	Voltage out/ V
16	50	100	32
16	80	20	4
100	5	20	400
400	160	100	250

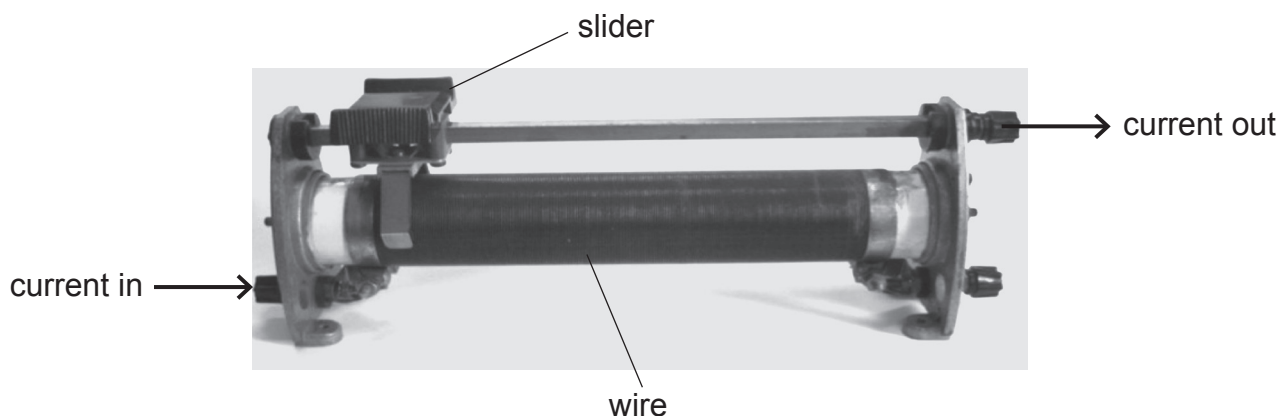
(e) Give **one** conclusion that can be made from these results.

[1]

[Turn over



(f) The photograph below shows a variable resistor (rheostat).



Source: Principal Examiner

(i) In the box below draw the electrical symbol for a variable resistor.



[1]

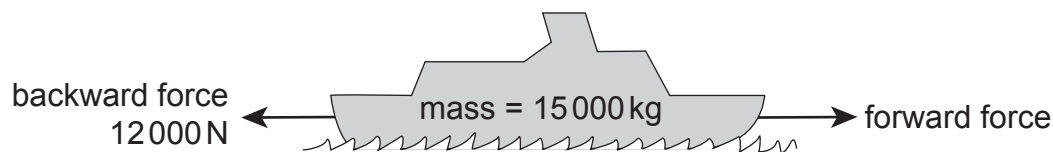
Moving the slider to the right on this variable resistor increases the length of wire in the circuit.

(ii) State how this affects the current flowing. Explain your answer.

[2]



- 7 The diagram below shows two of the forces acting on a boat as it moves through the water.



Source: Principal Examiner

The two forces produce a resultant force, to the right, of 30 000 N.

- (a) Calculate the size of the forward force.

_____ N [1]

- (b) Use the equation:

$$\text{resultant force} = \text{mass} \times \text{acceleration}$$

to calculate the acceleration of the boat.

(Show your working out.)

_____ m/s² [2]

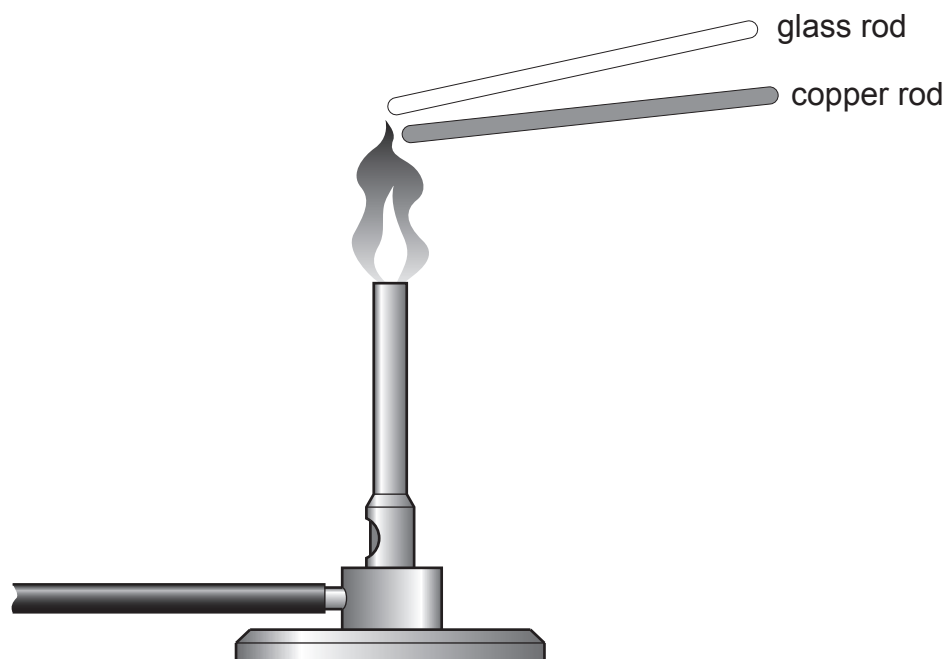
- (c) What name is given to the force that opposes the motion of the boat?

_____ [1]

[Turn over



- 8 The diagram below shows a copper and glass rod being heated in a flame.



Source: Principal Examiner

The heat will travel through the copper rod faster than the glass rod.

- (a) Describe how heat travels through **glass**.

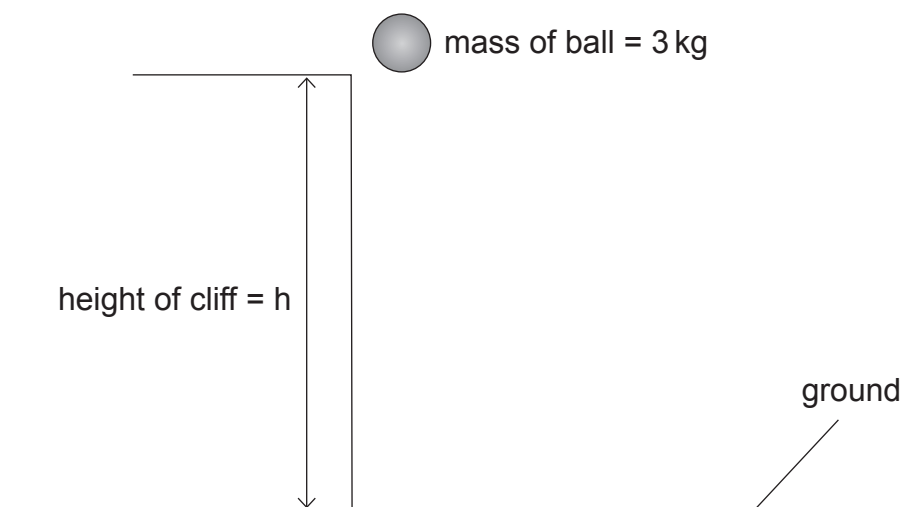
[2]

- (b) Name the particle that allows heat to travel faster through the copper rod.

[1]



- 9 A ball with a mass of 3 kg has 640 J of potential energy before it is dropped off a cliff.



The ball loses 60 J of energy as it falls.

- (a) Calculate the kinetic energy of the ball just before it hits the ground.

_____ J [1]

- (b) Use the equation:

$$E_p \text{ (potential energy)} = m \text{ (mass)} \times g \text{ (gravity)} \times h \text{ (height)}$$

to calculate the height of the cliff. Give your answer to 1 decimal place.
Take gravity as 10 m/s^2 .

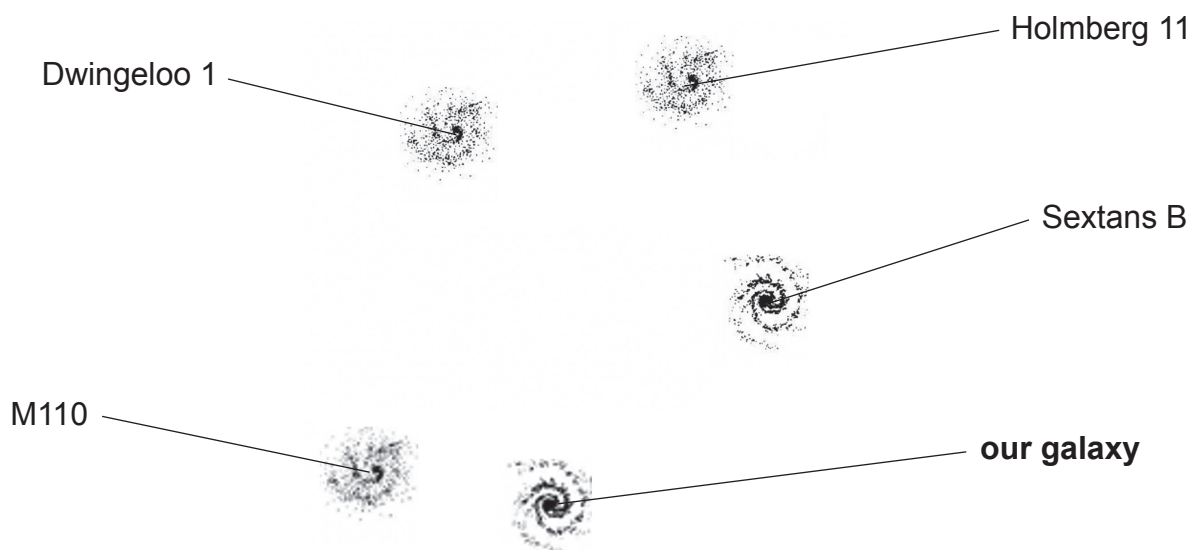
(Show your working out.)

_____ m [3]

[Turn over



10 (a) The diagram below shows our galaxy and some of its neighbouring galaxies.



Source: Principal Examiner

(i) What name is given to our galaxy?

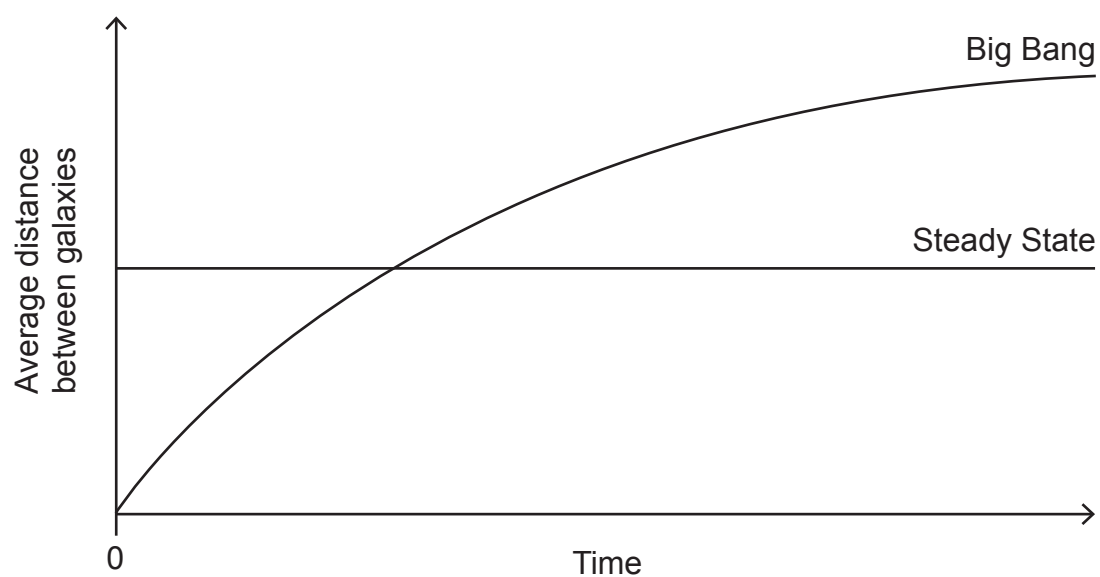
_____ [1]

(ii) Name the galaxy that is moving at the greatest speed away from our galaxy.
Explain your answer.

_____ [1]



The graph below represents two possible theories for the formation of the Universe.



(b) Use the graph to give **two** main differences between the Big Bang theory and the Steady State theory.

1. _____

2. _____

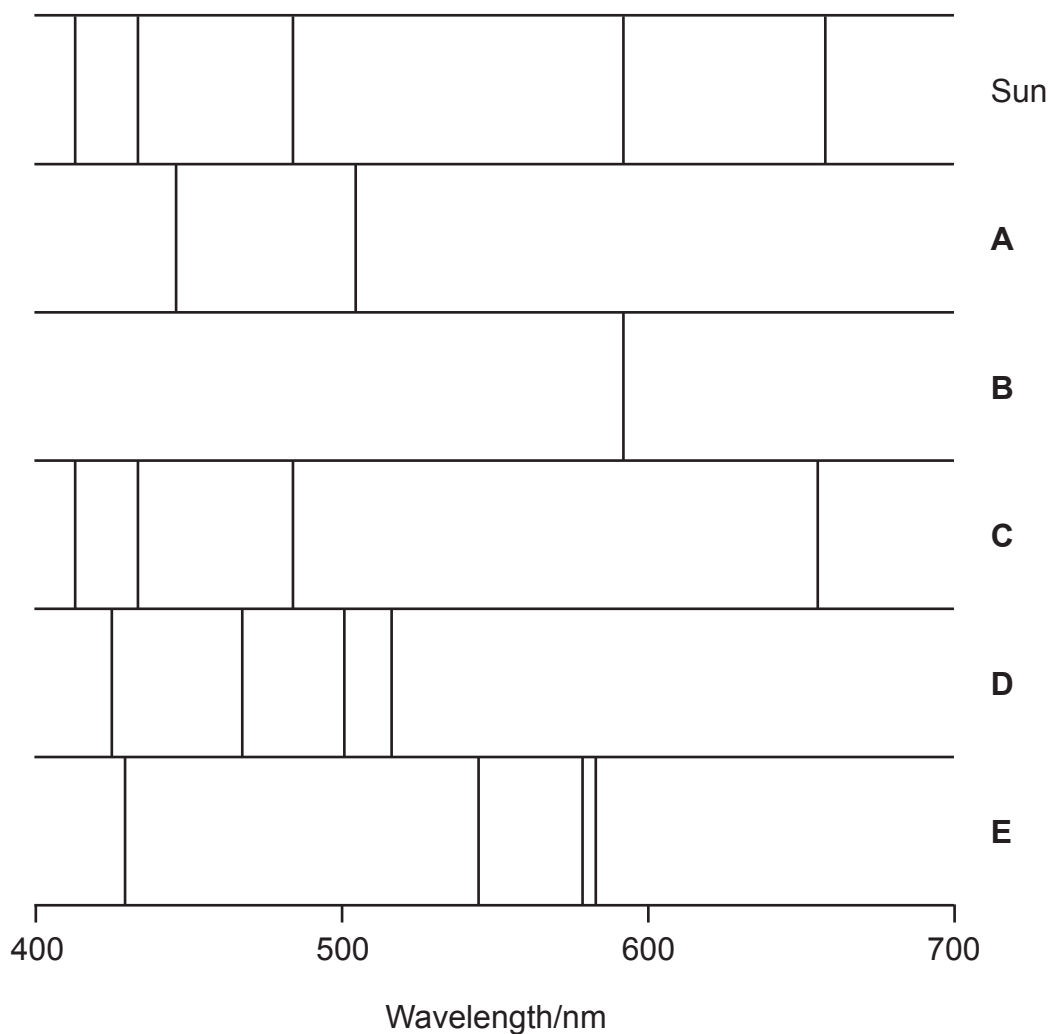
[2]

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When scientists look at the spectrum of light from the Sun, they see a series of lines. The lines are there because light at that wavelength has been absorbed by elements in the Sun's atmosphere. Every element absorbs light at unique wavelengths and shows a pattern.

The pattern for the Sun and five elements **A**, **B**, **C**, **D** and **E** are shown below.



(c) Use this information to identify which element(s) (**A**, **B**, **C**, **D**, **E**) are present in the Sun.

_____ [2]





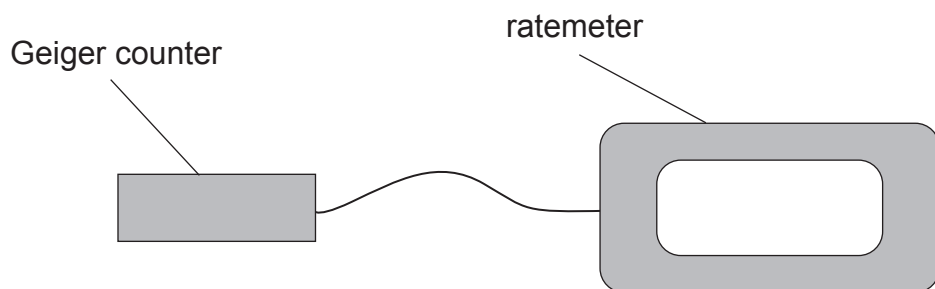
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(Questions continue overleaf)



- 11 (a) A scientist wanted to find the half-life of technetium-99m using the apparatus shown below.



Source: Principal Examiner

He first found the background radiation and then measured the activity of the technetium-99m over a 12 hour period.

The table below shows his results.

Time/ hours	Activity/cpm	
	Including background radiation	Corrected for background radiation
0	110	100
2	89	79
4	73	63
6	60	50
8	49	39
10	41	31
12	35	25

- (i) Use information in the table to calculate a value for background radiation.

_____ cpm [1]



(ii) Describe the trend shown by the information in the table.

[1]

(iii) Use the information in the table to find the half-life of technetium-99m.

_____ hours [1]

(iv) Suggest what the reading on the ratemeter will be after 18 hours.

_____ cpm [1]

(b) Technetium-99m emits radiation that causes ionisation.

(i) What is meant by the term **ionisation**?

[1]

(ii) State **one** health risk associated with ionising radiation and describe one way to reduce this risk.

[2]

(c) Technetium-99m is used as a medical tracer, it is put inside the body and detected from the outside. Suggest what type of radiation technetium-99m emits.

_____ [1]

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For Examiner's
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Examiner Number

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