



National
Qualifications
2017

X757/75/02

Physics
Section 1 — Questions

WEDNESDAY, 17 MAY

INSTRUCTIONS TO CANDIDATES

Candidates should enter their surname, forename(s), date of birth, Scottish candidate number and the name and Level of the subject at the top of their first answer sheet.

Record your answers by writing the letter at the end of each question.

Reference may be made to the Data Sheet and to the Relationship Sheet.

Questions marked with an asterisk differ in some respects from those in the printed paper.

An OW in the margin indicates a new question.

DATA SHEET

Speed of light in materials

Material	Speed in m s^{-1}
Air	3.0×10^8
Glass	2.0×10^8
Water	2.3×10^8

Speed of sound in materials

Material	Speed in m s^{-1}
Air	340
Water	1500

Gravitational field strengths

	Gravitational field strength on the surface in N kg^{-1}
Earth	9.8
Mars	3.7
Mercury	3.7
Moon	1.6

Specific heat capacity of materials

Material	Specific heat capacity in $\text{J kg}^{-1} \text{ }^\circ\text{C}^{-1}$
Alcohol	2350
Ice	2100
Water	4180

Specific latent heat of fusion of materials

Material	Specific latent heat of fusion in J kg^{-1}
Alcohol	0.99×10^5
Water	3.34×10^5

Radiation weighting factors

Type of radiation	Radiation weighting factor
alpha	20
beta	1
fast neutrons	10
gamma	1
slow neutrons	3

Specific latent heat of vaporisation of materials

Material	Specific latent heat of vaporisation in J kg^{-1}
Alcohol	11.2×10^5
Water	22.6×10^5

SECTION 1

Attempt ALL questions

- * 1. Refer to the diagram for Question 1. A cyclist is travelling along a straight road. The graph shows how the velocity of the cyclist varies with time.

The kinetic energy of the cyclist is greatest at

- A P
- B Q
- C R
- D S
- E T.

- * 2. Refer to the diagram for Question 2. A circuit is set up as shown.

The reading on ammeter A_1 is 5.0 A. The reading on ammeter A_2 is 2.0 A.

The charge passing through the lamp in 30 seconds is

- A 0.1 C
- B 10 C
- C 60 C
- D 90 C
- E 150 C.

- * 3. Refer to the diagram for Question 3. A lamp is connected to a constant voltage power supply. The power supply is switched on. The graph shows how the current in the lamp varies with time. Which row in the table shows what happens to the current and resistance of the lamp between 0.05 s and 0.45 s?

	<i>Current</i>	<i>Resistance</i>
A	decreases	increases
B	decreases	stays the same
C	stays the same	decreases
D	increases	decreases
E	increases	increases

- * 4. Refer to the diagram for Question 4. A circuit is set up as shown on the diagram.
The purpose of the transistor is to
- A supply energy to the circuit
 - B decrease the voltage across R_1
 - C change electrical energy to kinetic energy
 - D supply energy to the motor
 - E switch on the motor.
- * 5. Refer to the diagram for Question 5. Five students each carry out an experiment to determine the specific heat capacity of copper. The setup used by each student is shown.
The student with the setup that would allow the most accurate value for the specific heat capacity of copper to be determined is
- A student 1
 - B student 2
 - C student 3
 - D student 4
 - E student 5.
6. The mass of a spacecraft is 1200 kg.
The spacecraft lands on the surface of a planet.
The gravitational field strength on the surface of the planet is 5.0 N kg^{-1} .
The spacecraft rests on three pads. The total area of the three pads is 1.5 m^2 .
The pressure exerted by these pads on the surface of the planet is
- A $1.2 \times 10^4 \text{ Pa}$
 - B $9.0 \times 10^3 \text{ Pa}$
 - C $7.8 \times 10^3 \text{ Pa}$
 - D $4.0 \times 10^3 \text{ Pa}$
 - E $8.0 \times 10^2 \text{ Pa}$.
7. A solid is heated from -15°C to 60°C . The temperature change of the solid is
- A 45 K
 - B 75 K
 - C 258 K
 - D 318 K
 - E 348 K.

8. A student makes the following three statements about waves.

- I In a transverse wave, the particles vibrate parallel to the direction of travel of the wave.
- II Light waves and water waves are both transverse waves.
- III Sound waves are longitudinal waves.

Which of these statements is/are correct?

- A I only
- B II only
- C III only
- D I and II only
- E II and III only

* 9. Refer to the diagram for Question 9. The diagram represents a wave travelling from X to Y. The wave travels from X to Y in a time of 0.5 s. Which row in the table shows the amplitude, wavelength and frequency of this wave?

	<i>Amplitude (m)</i>	<i>Wavelength (m)</i>	<i>Frequency (Hz)</i>
A	1.3	1.5	2.0
B	2.6	1.5	24
C	1.3	3.0	8.0
D	2.6	3.0	8.0
E	1.3	3.0	24

10. A microwave signal is transmitted by a radar station.

The signal is reflected from an aeroplane.

The aeroplane is at a height of 30 km directly above the radar station.

The time between the signal being transmitted and the reflected signal being received back at the radar station is

- A $5 \times 10^{-5} \text{ s}$
- B $1 \times 10^{-4} \text{ s}$
- C $2 \times 10^{-4} \text{ s}$
- D $5 \times 10^3 \text{ s}$
- E $1 \times 10^4 \text{ s}$.

11. A member of the electromagnetic spectrum has a shorter wavelength than visible light and a lower frequency than X-rays. This type of radiation is
- A gamma
 - B ultraviolet
 - C infrared
 - D microwaves
 - E radio waves.

- *12. Refer to the diagram for Question 12. The diagram shows the path of a ray of red light as it passes from air into a glass block. Which row in the table shows the angle of incidence and the angle of refraction?

	<i>Angle of incidence</i>	<i>Angle of refraction</i>
A	Q	S
B	S	Q
C	P	R
D	R	P
E	Q	R

13. A sample of tissue is exposed to 15 μGy of alpha radiation and 20 μGy of gamma radiation. The total equivalent dose received by the tissue is
- A 35 μSv
 - B 320 μSv
 - C 415 μSv
 - D 700 μSv
 - E 735 μSv .

- *14. Refer to the diagram for Question 14. Two forces act on an object as shown. The resultant force acting on the object is
- A 50 N at a bearing of 053
 - B 50 N at a bearing of 143
 - C 50 N at a bearing of 217
 - D 50 N at a bearing of 233
 - E 50 N at a bearing of 323.

- *15. Refer to the diagram for Question 15. The graph shows how the velocity v of an object varies with time t .

The graph could represent the motion of

- A a ball falling freely downwards
- B a rocket accelerating upwards
- C a ball thrown into the air then falling back to Earth
- D a ball falling to Earth from rest then rebounding upwards again
- E a car slowing to a halt then accelerating in the same direction.

- *16. Refer to the diagram for Question 16. In the diagram a trolley is on a slope. It is released from rest at point X and moves with constant acceleration on a slope as shown.

A computer displays the acceleration and average velocity of the trolley between light gates, P and Q.

The trolley is now released from rest at point Y.

Which row in the table shows how the acceleration and average velocity compare with the previous results obtained?

	<i>Acceleration</i>	<i>Average velocity</i>
A	less	same
B	same	same
C	greater	greater
D	less	less
E	same	less

17. A rocket accelerates vertically upwards from the surface of the Earth.

An identical rocket accelerates vertically upwards from the surface of Mars.

The engine thrust from each rocket is the same.

Which row in the table shows how the weight of the rocket and the unbalanced force acting on the rocket compares on Mars and Earth?

	<i>Weight on Mars compared to weight on Earth</i>	<i>Unbalanced force on Mars compared to unbalanced force on Earth</i>
A	greater	greater
B	same	same
C	same	less
D	less	greater
E	less	less

***18.** A satellite is in a circular orbit around a planet.

A group of students make the following three statements about the satellite.

- I The greater the altitude of a satellite the shorter its orbital period.
- II The satellite has a constant vertical acceleration.
- III As the satellite orbits the planet, its vertical velocity increases.

Which of these statements is/are correct?

- A I only
- B II only
- C III only
- D I and II only
- E II and III only

19. A heater transfers energy to boiling water at the rate of 1130 joules every second.

The maximum mass of water converted to steam in 2 minutes is

- A 1.0×10^{-3} kg
- B 6.0×10^{-2} kg
- C 0.41 kg
- D 17 kg
- E 32 kg.

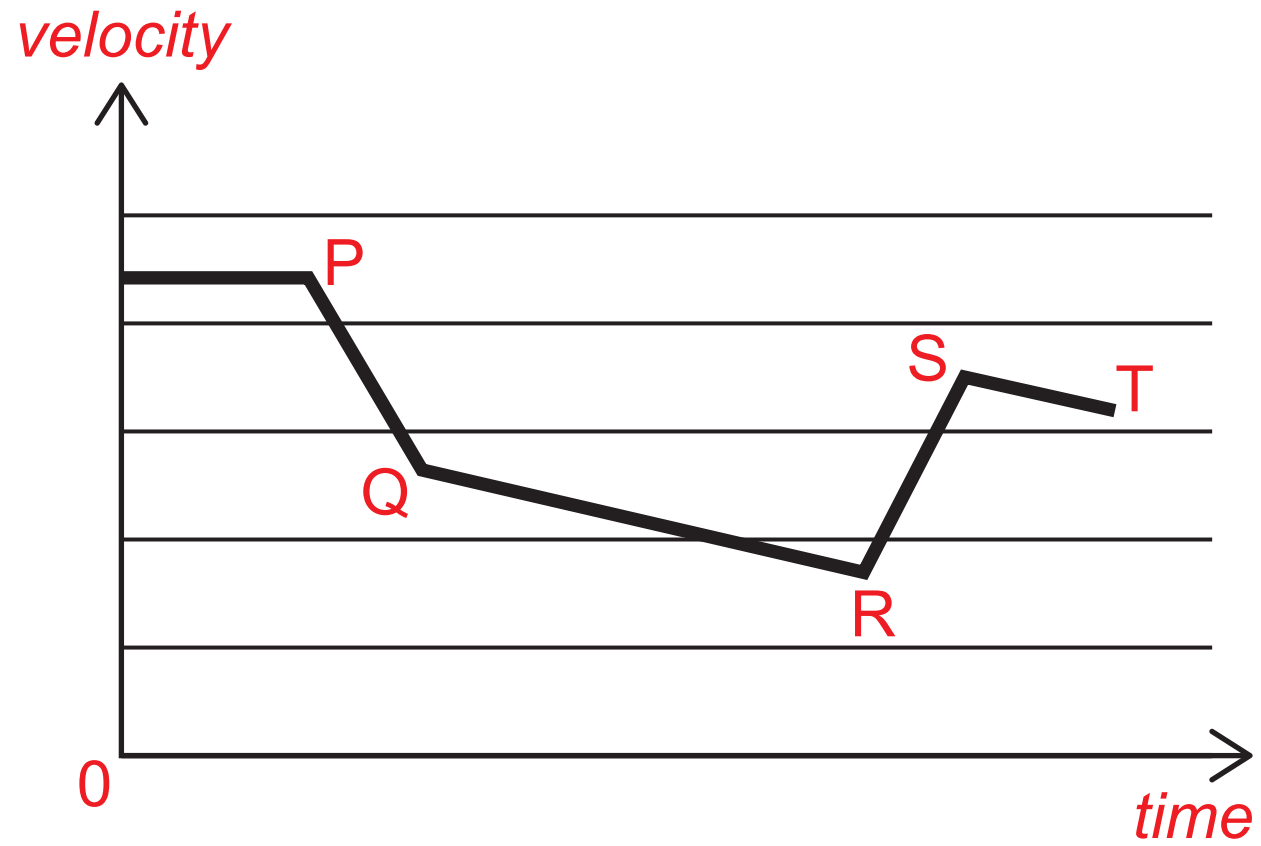
***20.** Refer to the diagram for Question 20. Light from stars can be split into line spectra of different colours. The line spectra from three stars, X, Y and Z, are shown, along with the line spectra of the elements helium and hydrogen.

Hydrogen and helium are both present in

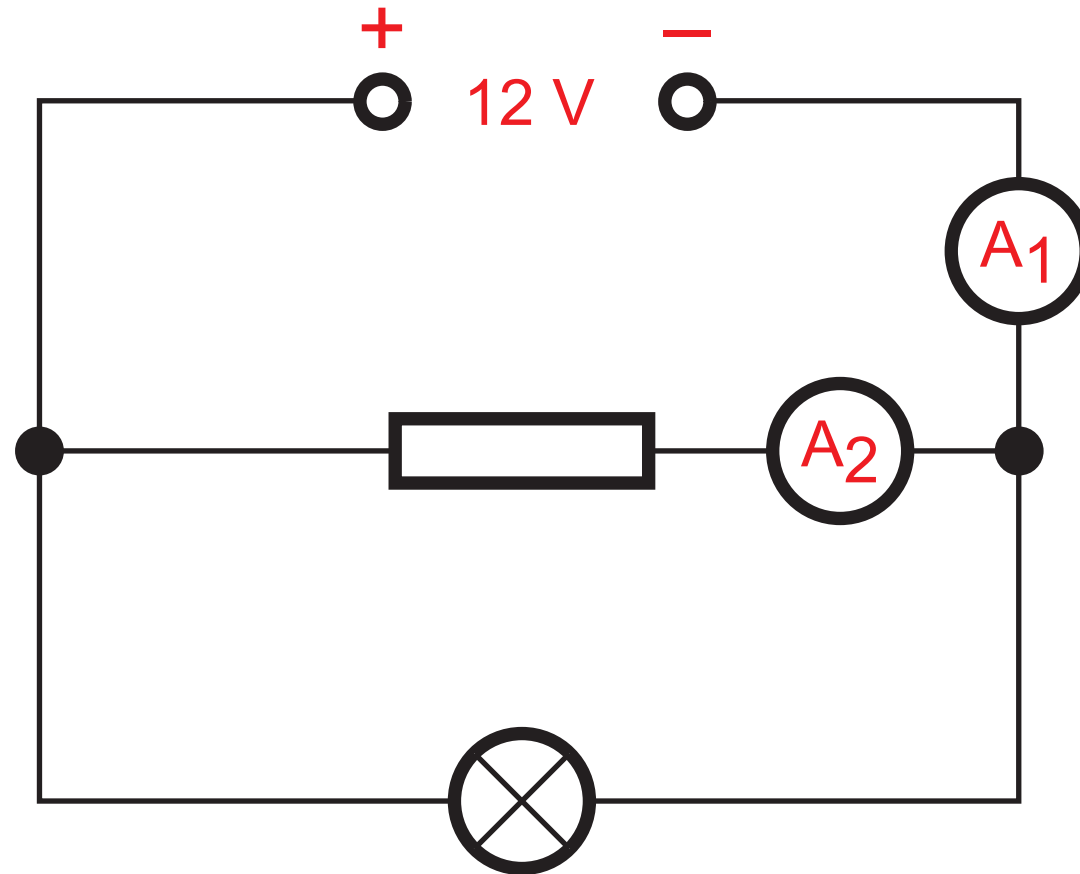
- A star X only
- B star Y only
- C stars X and Y only
- D stars X and Z only
- E stars X, Y and Z.

[END OF SECTION 1. NOW ATTEMPT THE QUESTIONS IN SECTION 2]

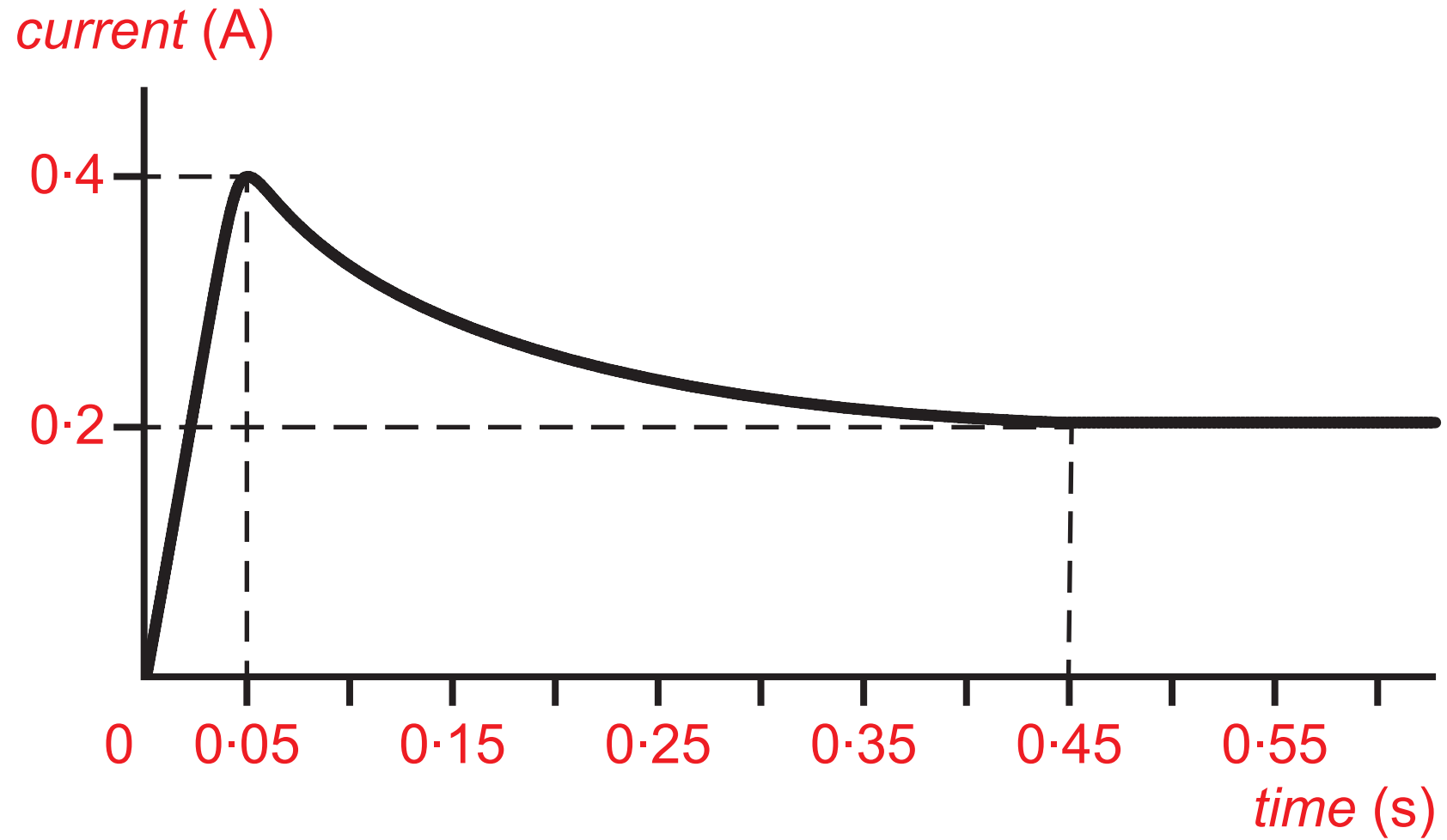
Question 1



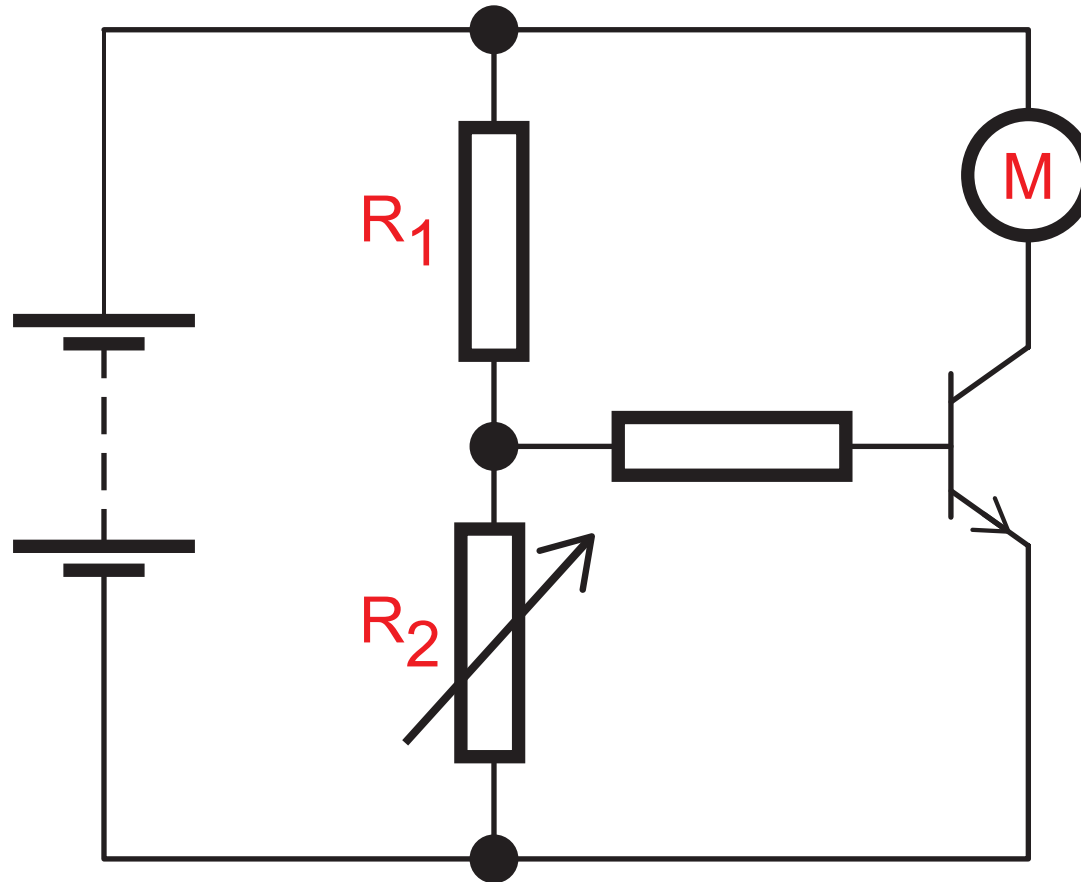
Question 2



Question 3



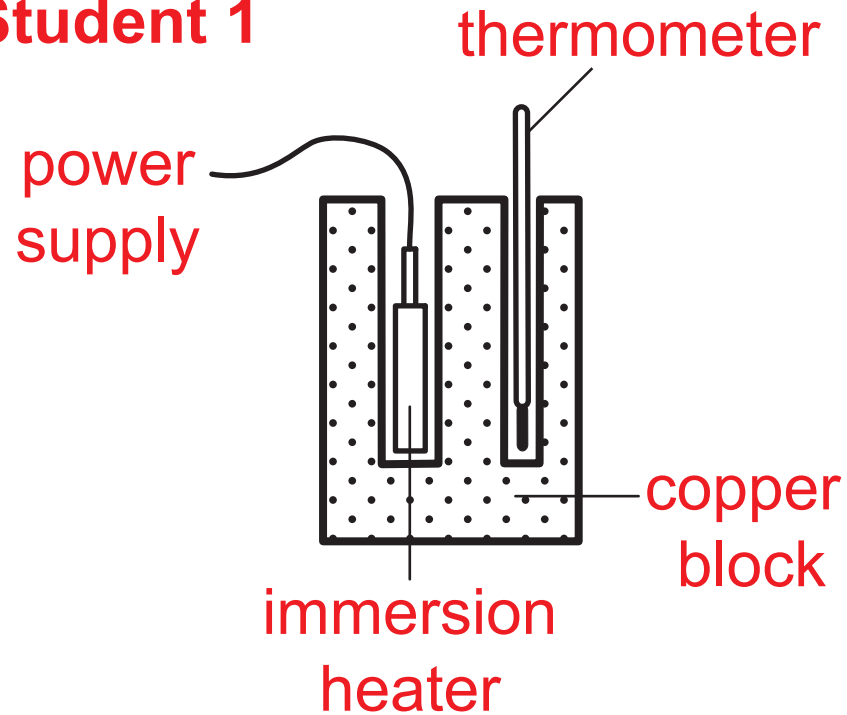
Question 4



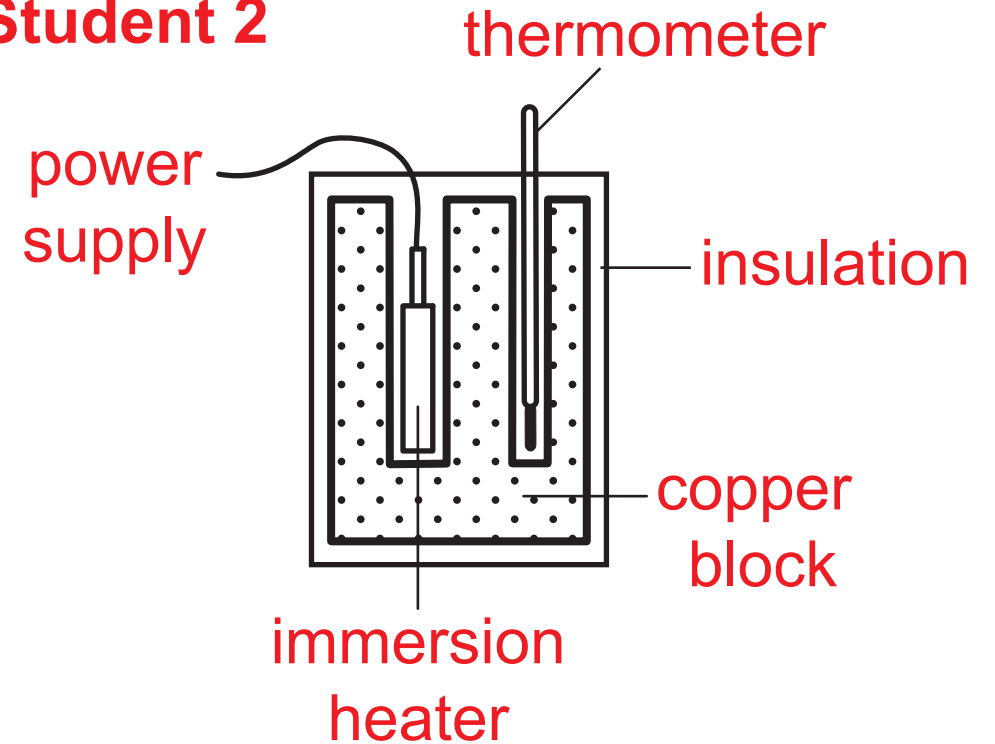
Question 5

Diagram 1 of 3

Student 1

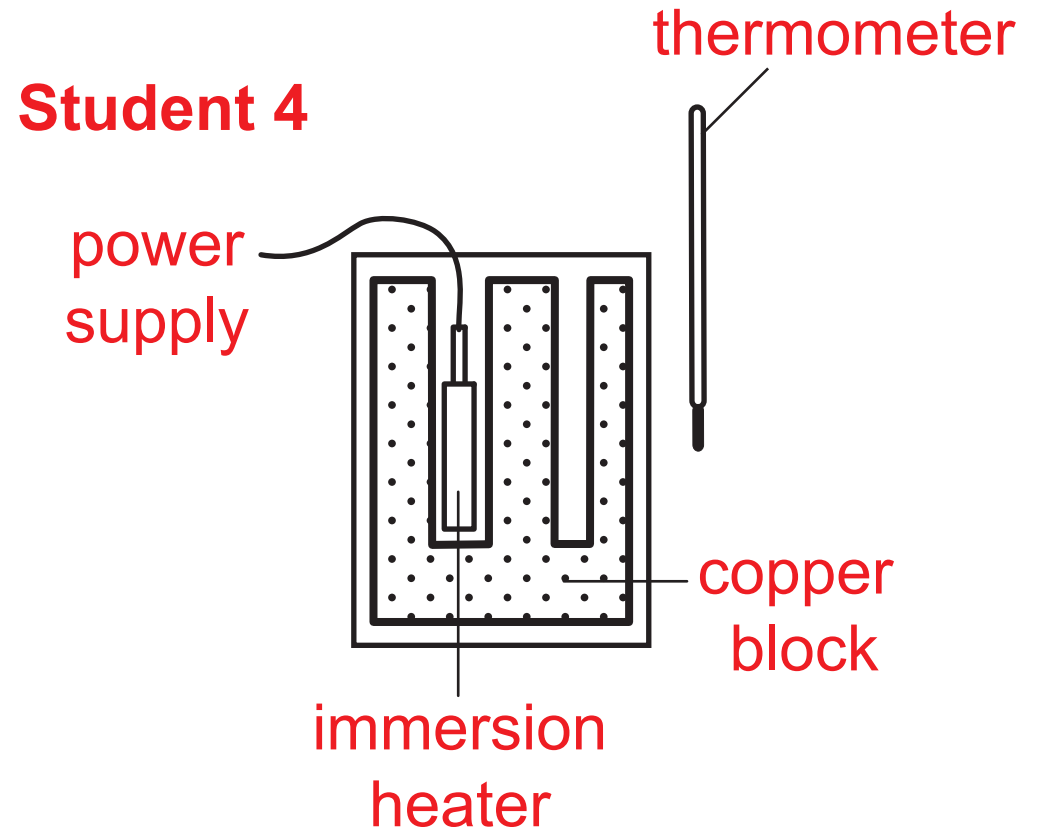
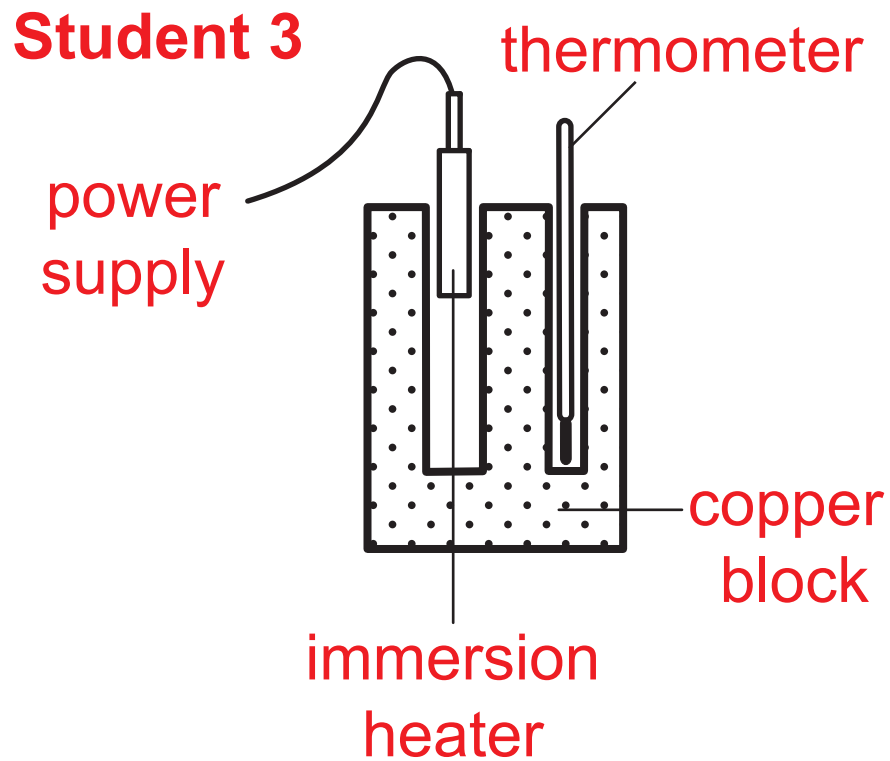


Student 2



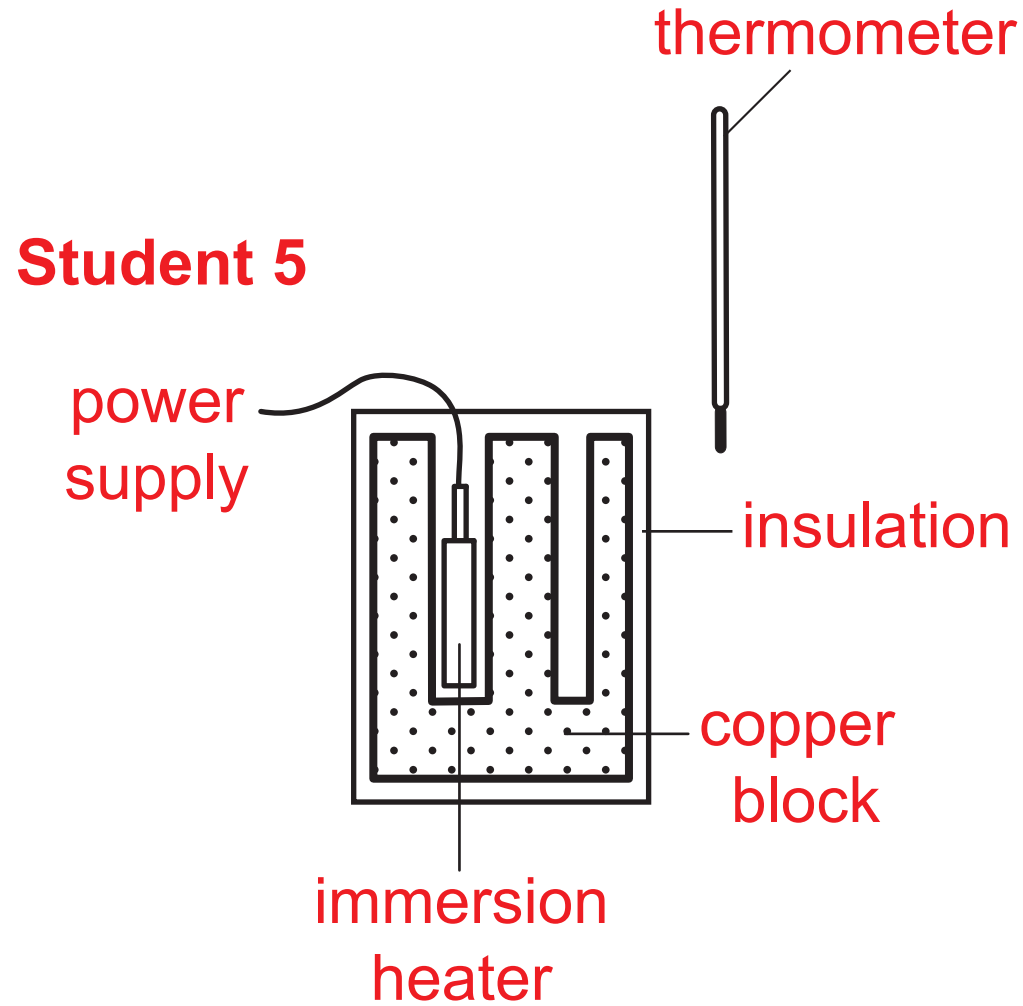
Question 5

Diagram 2 of 3

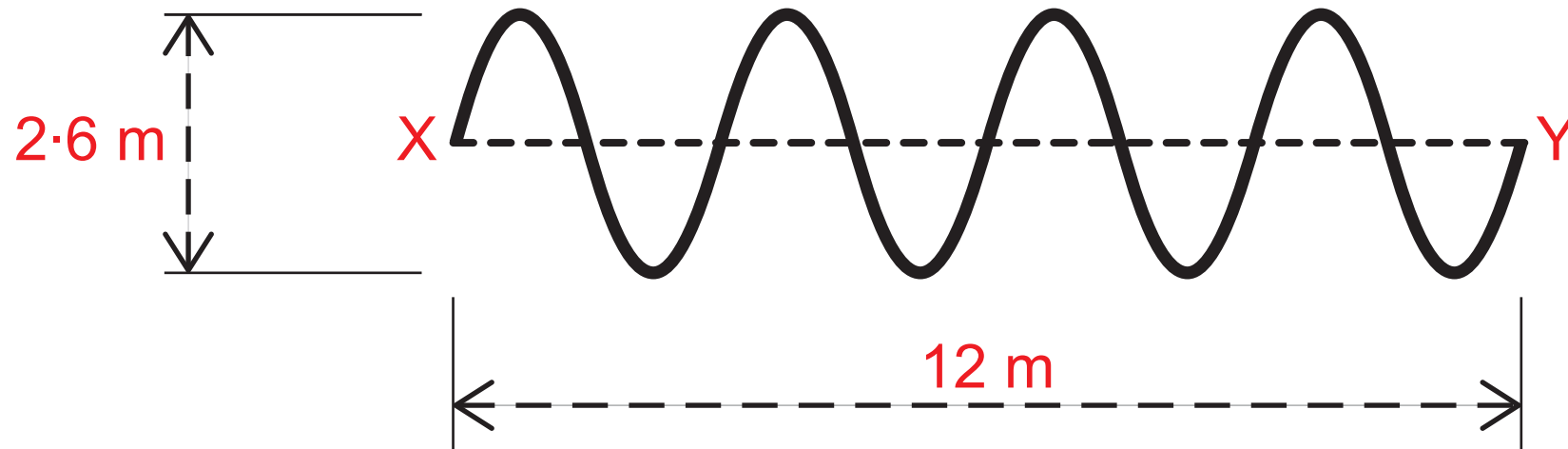


Question 5

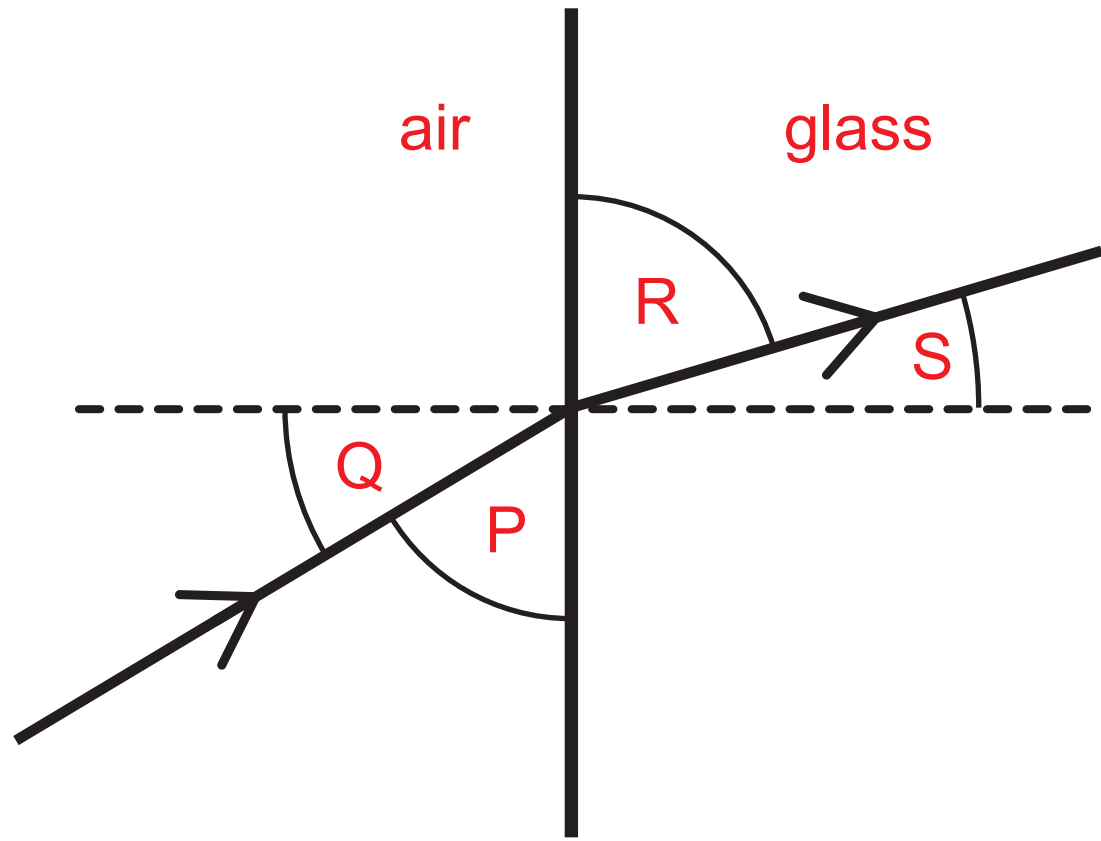
Diagram 3 of 3



Question 9

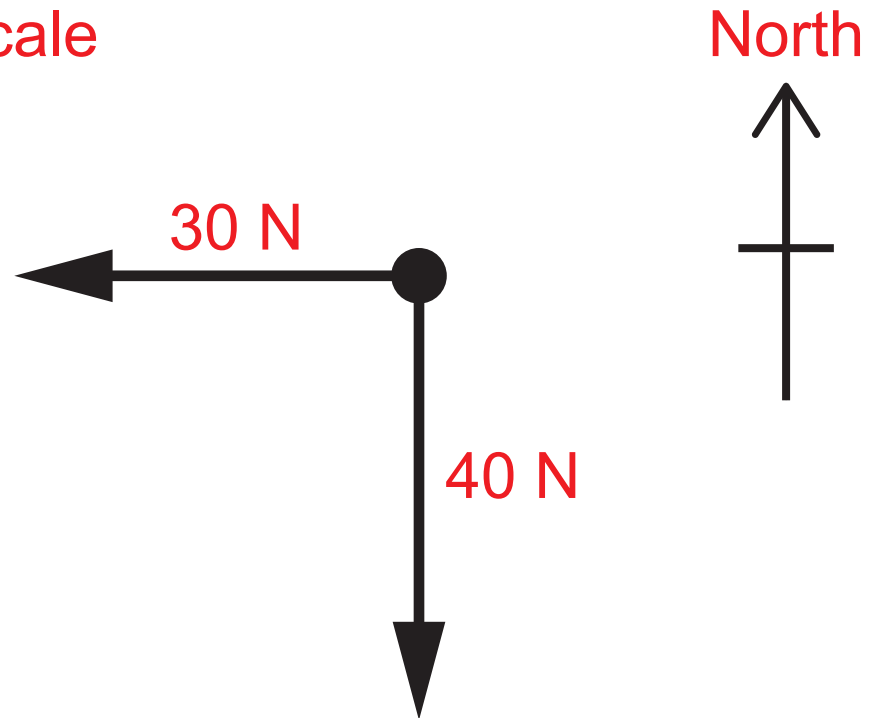


Question 12

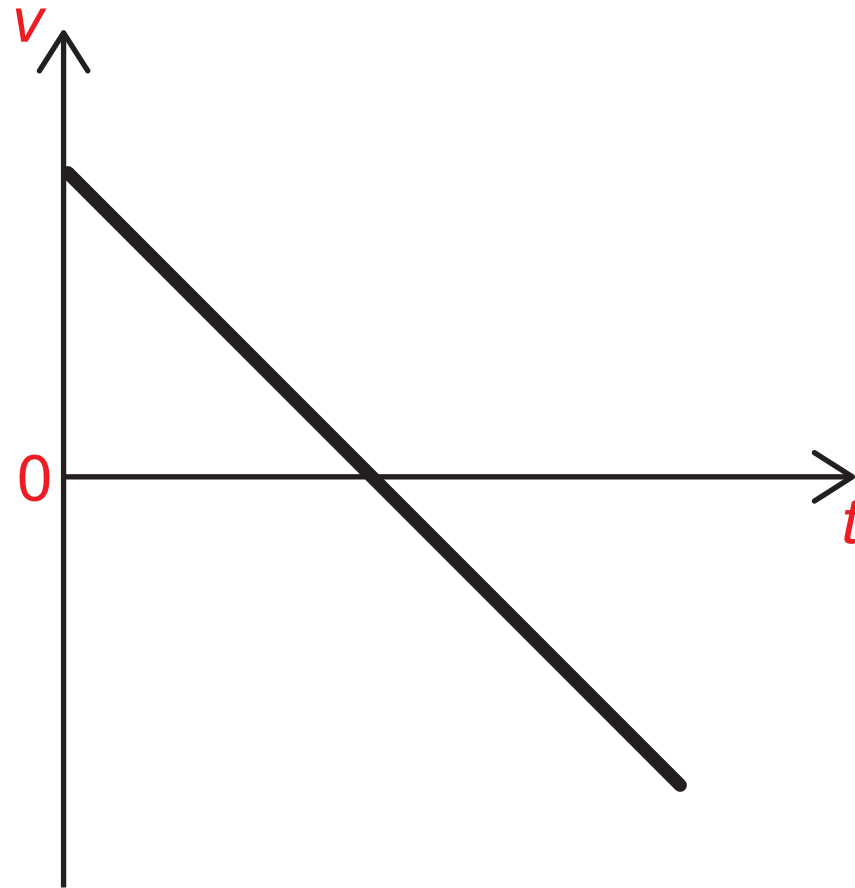


Question 14

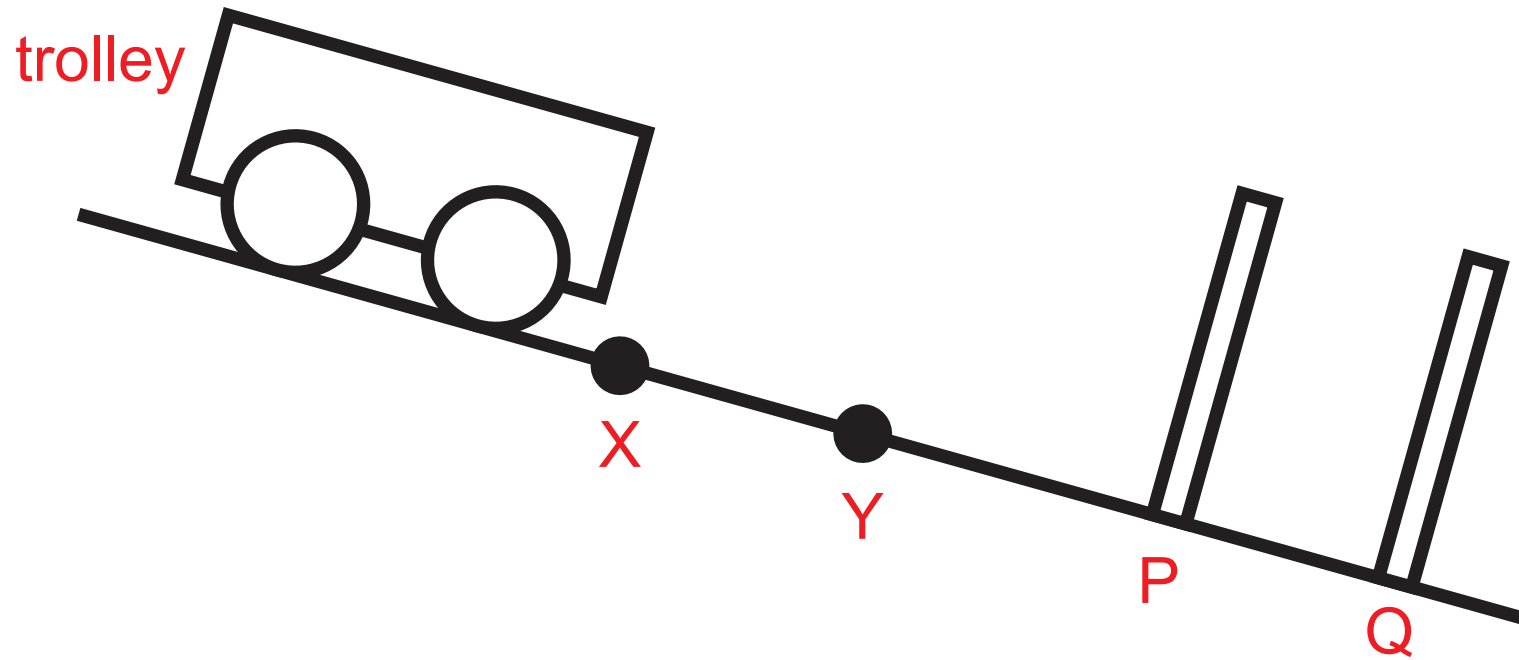
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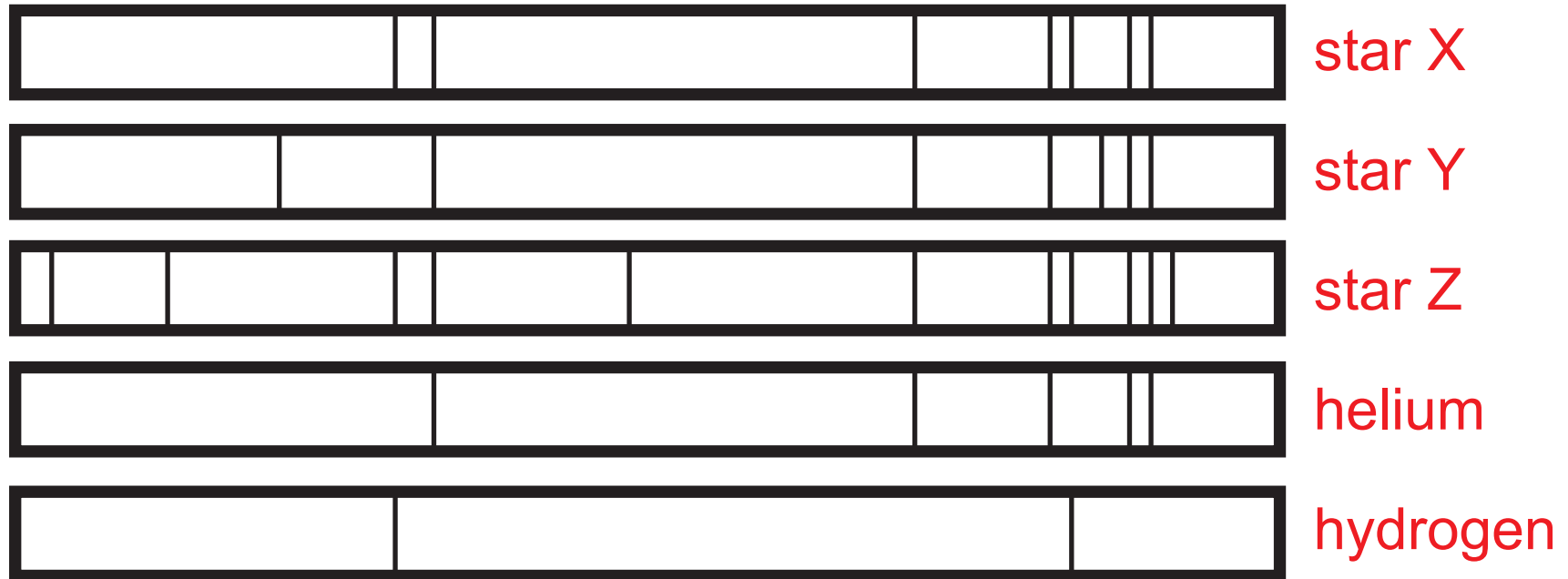
Question 15



Question 16



Question 20





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Physics
Section 1 — Answer Grid
And Section 2

WEDNESDAY, 17 MAY

INSTRUCTIONS TO CANDIDATES

Candidates should enter their surname, forename(s), date of birth, Scottish candidate number and the name and Level of the subject at the top of their first answer sheet.

Total marks — 110

SECTION 1 — 20 marks

Attempt ALL questions.

SECTION 2 — 90 marks

Attempt ALL questions.

Reference may be made to the Data Sheet and to the Relationship Sheet.

Marks are shown in square brackets at the end of each question or part question.

Questions marked with an asterisk differ in some respects from those in the printed paper.

An OW in the margin indicates a new question.

SECTION 1 — 20 marks

The questions for Section 1 are contained in the question paper X757/75/02.

1. The answer to each question is **either** A, B, C, D or E. Decide what your answer is, then write the letter at the end of each question.
2. There is **only one correct** answer to each question.

Sample Question

The energy unit measured by the electricity meter in your home is the:

- A ampere
- B kilowatt-hour
- C watt
- D coulomb
- E volt.

The correct answer is **B** — kilowatt-hour. You write: Question 7. B.

Changing an answer

If you decide to change your answer, cancel your first answer by brailleing it out and write the answer you want.

SECTION 2 — 90 marks

Attempt ALL questions

- * 1. Refer to the diagram for Question 1. The rating plate on a food blender is shown.
- (a) The plugs on all modern electrical appliances in the UK are fitted with fuses rated at either 3 A or 13 A.
- (i) Describe the circuit symbol for a fuse. **[1 mark]**
 - (ii) State the purpose of the fuse fitted in the plug of an appliance. **[1 mark]**
 - (iii) Determine the rating of the fuse fitted in the plug of the blender. Justify your answer by calculation. **[4 marks]**
- (b) The blender is connected to an alternating current (a.c.) supply. Explain in terms of electron flow what is meant by *alternating current*. **[1 mark]**
-
- * 2. Refer to the diagram for Question 2. A student sets up the circuit as shown.
- (a) The student closes switch S1.
- (i) Calculate the voltage across the motor. **[4 marks]**
 - (ii) Calculate the power dissipated in the motor. **[3 marks]**
- (b) The student now also closes switch S2.
- (i) Calculate the combined resistance of the two resistors. **[3 marks]**
 - (ii) State the effect that closing switch S2 has on the power dissipated in the motor. Justify your answer. **[3 marks]**

- * 3. Refer to the diagram for Question 3. A bicycle pump with a sealed outlet contains $4.0 \times 10^{-4} \text{ m}^3$ of air.

The air inside the pump is at an initial pressure of $1.0 \times 10^5 \text{ Pa}$.

The piston of the pump is now pushed slowly inwards until the volume of air in the pump is $1.6 \times 10^{-4} \text{ m}^3$ as shown.

During this time the temperature of the air in the pump remains constant.

(a) Calculate the final pressure of the air inside the pump. **[3 marks]**

(b) Using the kinetic model, explain what happens to the pressure of the air inside the pump as its volume decreases. **[3 marks]**

- * (c) Refer to the diagram for Question 3 (c). The piston is now released, allowing it to move outwards towards its original position. During this time the temperature of the air in the pump remains constant.

Describe the shape of the line that should be added to the graph to show how the pressure of the air in the pump varies as its volume increases. **[2 marks]**

- * 4. A student observes water waves entering a harbour.

(a) To determine the frequency of the waves, the student measures the time taken for a wave to pass a point at the harbour entrance. The student measures this time to be 2.5 s

(i) Calculate the frequency of the waves. **[3 marks]**

(ii) Suggest how the accuracy of the frequency determined by the student could be improved. **[1 mark]**

(b) The distance between one wave crest and the next crest is 8.0 m. Calculate the velocity of the waves. **[3 marks]**

- * (c) Refer to the diagram for Question 4 (c). Waves travel towards the entrance of the harbour as shown. Describe the pattern of wave crests inside the harbour. **[2 marks]**

(d) As the waves pass into the harbour the student observes that the amplitude of the waves decreases. Explain this observation. **[1 mark]**

5. Alpha, beta and gamma are types of nuclear radiation, which have a range of properties and effects. **Using your knowledge of physics**, comment on the similarities and/or differences between these types of nuclear radiation. **[3 marks]**

- * 6. Refer to the graph for Question 6. Gamma radiation passing through a lead absorber is detected by a Geiger-Müller tube. The count rate is displayed on a ratemeter.
- The count rates for a range of different thicknesses of lead absorber are recorded.
- Using these results the technician produces a graph of corrected count rate against thickness of lead absorber as shown.
- (a) State what additional measurement the technician must have made in order to determine the corrected count rate. **[1 mark]**
- (b) The half-value thickness of a material is the thickness of material required to reduce the corrected count rate from a source by half.
- (i) Using the graph, determine the half-value thickness of lead for this source of gamma radiation. **[1 mark]**
- (ii) Determine the thickness of lead required to reduce the corrected count rate to one eighth of its initial value. **[2 marks]**
- (iii) The technician suggests repeating the experiment with aluminium absorbers instead of lead absorbers. Predict how the half-value thickness of aluminium would compare to the half-value thickness of lead for this source. **[1 mark]**
- (c) When working with the radioactive source the technician is exposed to an equivalent dose rate of $2.5 \times 10^{-6} \text{ Sv h}^{-1}$. The annual equivalent dose limit for the technician is 20 mSv. Calculate the maximum number of hours the technician may work with this source without exceeding this limit. **[3 marks]**
- * 7. Nuclear reactions are used to generate electrical energy in a nuclear power station.
- (a) The fuel for the power station is in the form of pellets, containing uranium-235. A fuel pellet has an activity of 80 kBq. State what is meant by an *activity of 80 kBq*. **[1 mark]**
- (b) In a nuclear reaction a uranium-235 nucleus is split by a neutron to produce two smaller nuclei, three neutrons, and energy.
- (i) Explain how a single reaction can lead to the continuous generation of energy. **[2 marks]**
- (ii) One nuclear reaction releases $3.2 \times 10^{-11} \text{ J}$. In the reactor, 3.0×10^{21} reactions occur each minute. Determine the maximum power output of the reactor. **[4 marks]**
- (c) The nuclear reactor produces waste that emits nuclear radiation. State a use of nuclear radiation. **[1 mark]**

- * 8. In speedway, motorbikes are raced anticlockwise round an oval track. A race consists of four laps of a 380 m track.
- (a) State the displacement of a motorbike from the start line to the finish line for a complete race. **[1 mark]**
- * (b) Refer to the graph for Question 8 (b). The speed-time graph of a motorbike for the first 8.0 s of a race is shown.
- (i) Calculate the distance travelled by the motorbike in the first 4.0 s of the race. **[3 marks]**
- (ii) Determine the **greatest** acceleration of the motorbike during the first 8.0 s of the race. **[3 marks]**
- (c) The winner of the race completes all four laps in a time of 79 s. Calculate the average speed of the winner. **[3 marks]**
- * 9. A weightlifter applies an upwards force of 1176 N to a barbell to hold it in a stationary position.
- (a) Describe how the upward force exerted by the weightlifter on the barbell compares to the weight of the barbell. **[1 mark]**
- (b) Calculate the mass of the barbell. **[3 marks]**
- (c) The weightlifter increases the upward force on the barbell to 1344 N in order to lift the barbell above their head. Calculate the initial acceleration of the barbell. **[4 marks]**
- *10. Refer to the diagram for Question 10. An articulated lorry has six pairs of wheels. There are three on the lorry and three on the trailer. One pair of wheels, the middle pair on the lorry, can be raised off the ground.
- Using your knowledge of physics, comment on situations in which the wheels may be raised or lowered. **[3 marks]**

- *11.** A tennis player serves a tennis ball horizontally at a velocity of 42 ms^{-1} . The effects of air resistance are negligible.
- * (a)** Refer to the diagram for Question 11 (a). State which of the following graphs P, Q or R shows the vertical velocity of the ball after it leaves the player's racquet. **[1 mark]**
- (b)** In a second serve the player hits the ball horizontally with a smaller velocity from the same height. State whether the time taken for the ball to reach the ground is less than, equal to, or greater than the time taken in the first serve. Justify your answer. **[2 marks]**
- (c)** The tennis court has a retractable roof to allow play to continue in all weather conditions. It requires 5.5 kJ of energy to move one section of the roof a distance of 25 m . Calculate the average force acting on this section of the roof while it is being moved. **[3 marks]**
- *12.** The star Wolf 359 is at a distance of 7.8 light-years from Earth. A radio signal from Wolf 359 is detected by a radio telescope on Earth.
- (a)** (i) State the speed of the radio waves. **[1 mark]**
(ii) Calculate the distance, in metres, from Wolf 359 to Earth. **[3 marks]**
- (b)** Another telescope is used to observe the same star in the visible part of the spectrum.
- (i) State a suitable detector of visible light that may be used in this telescope. **[1 mark]**
- (ii) State whether the time taken for the visible light from the star to reach Earth is less than, equal to, or greater than the time taken for the radio waves from the star to reach Earth. **[1 mark]**

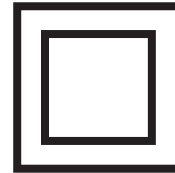
[END OF QUESTION PAPER]

Question 1

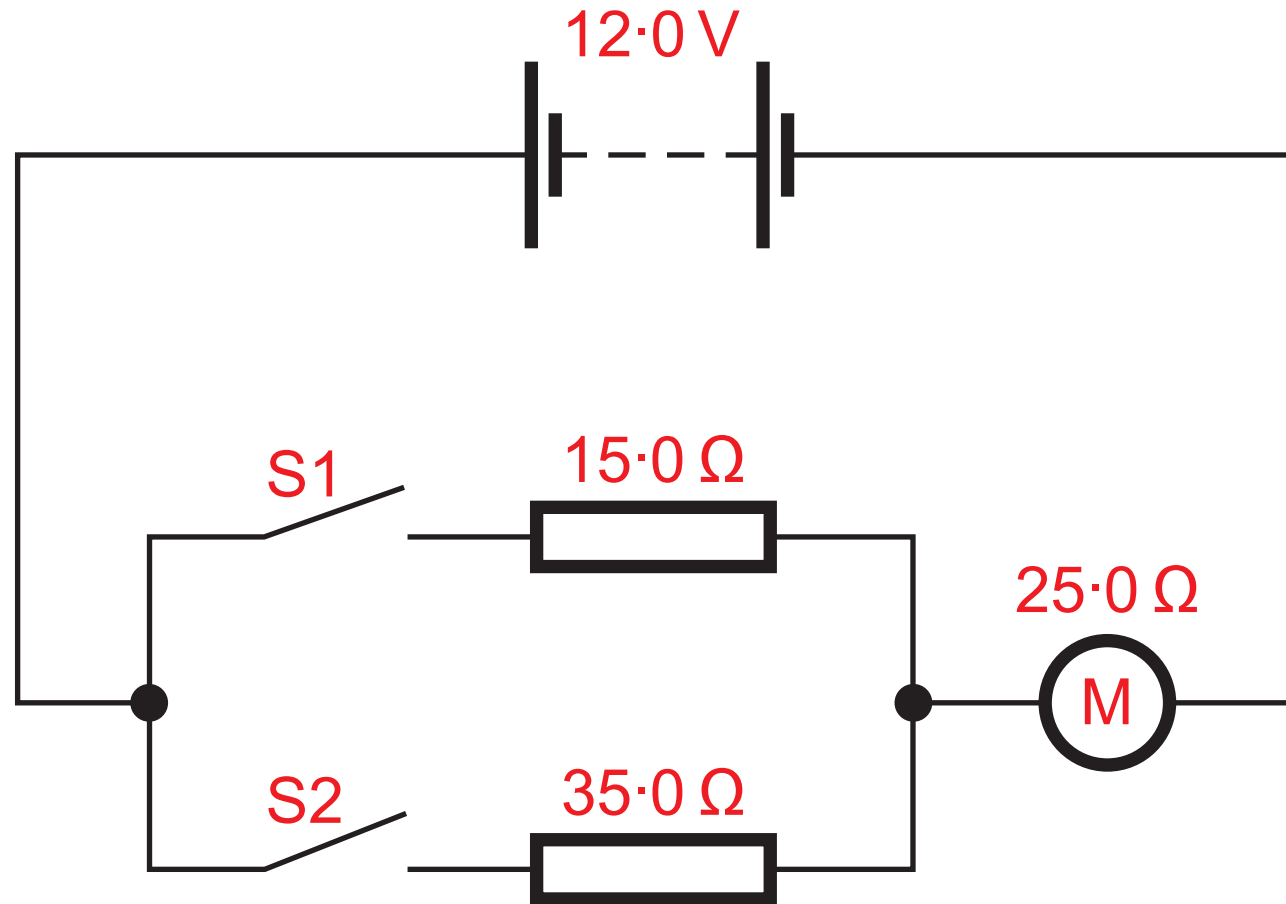
230 V a.c.

50 Hz

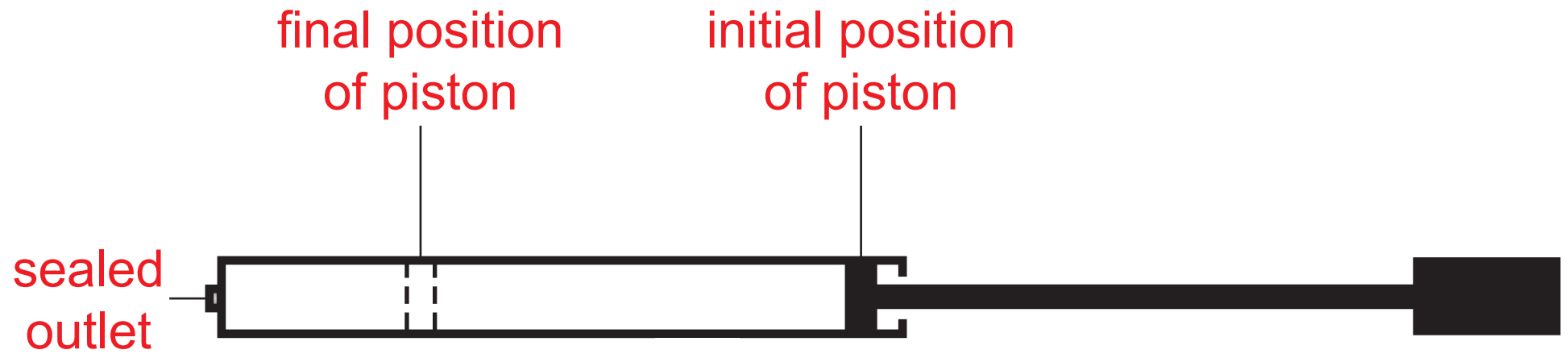
290 W



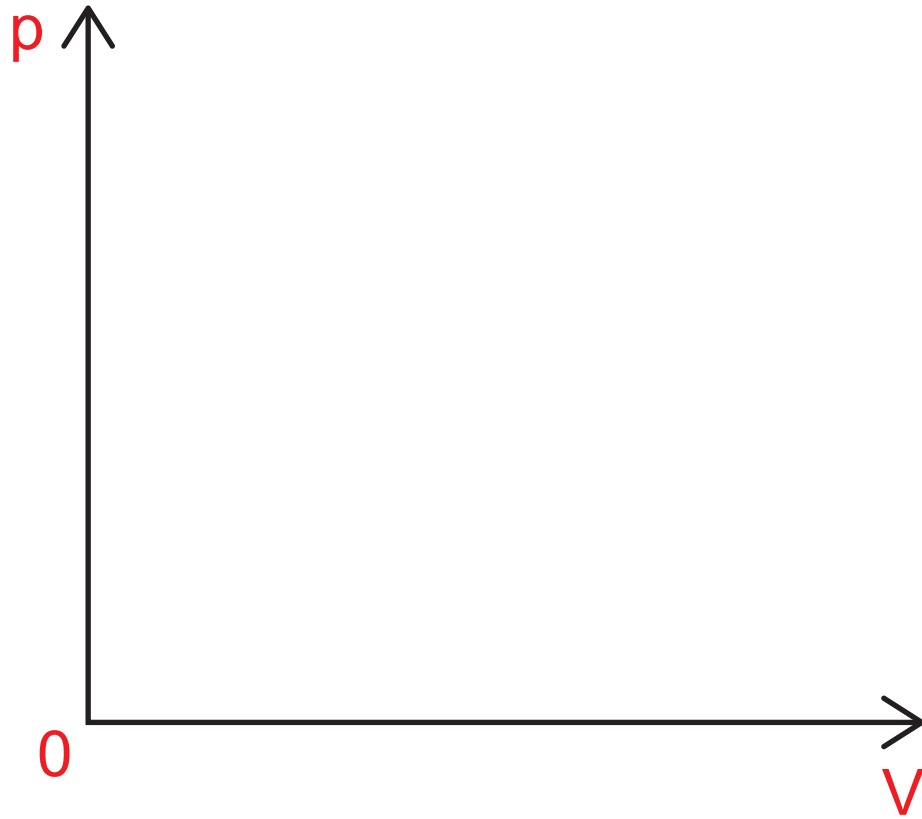
Question 2



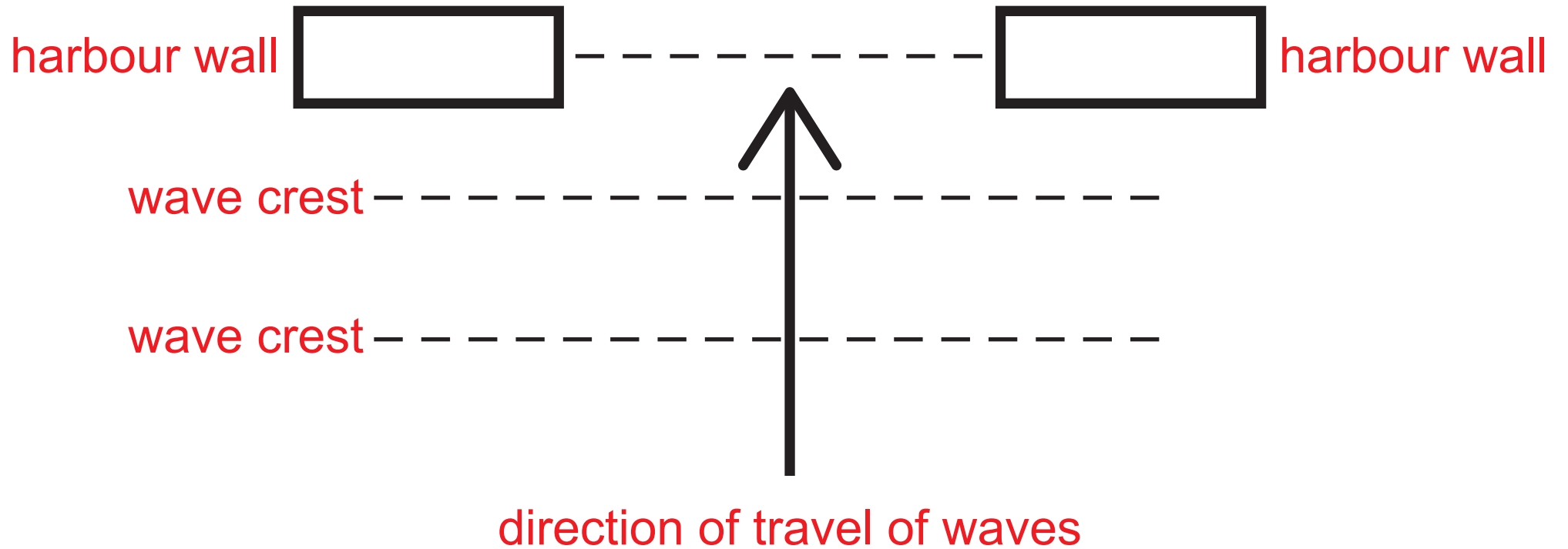
Question 3



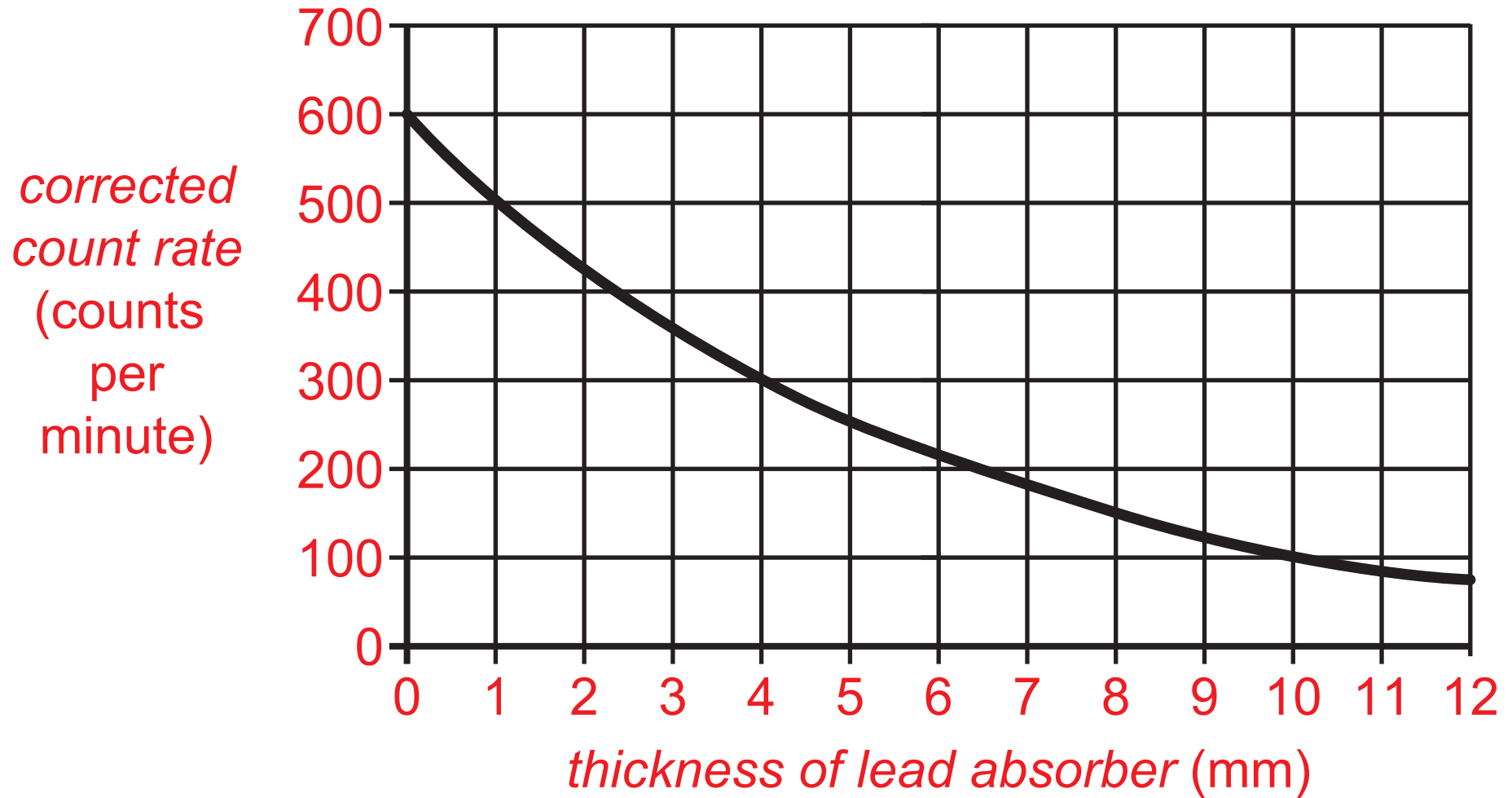
Question 3c



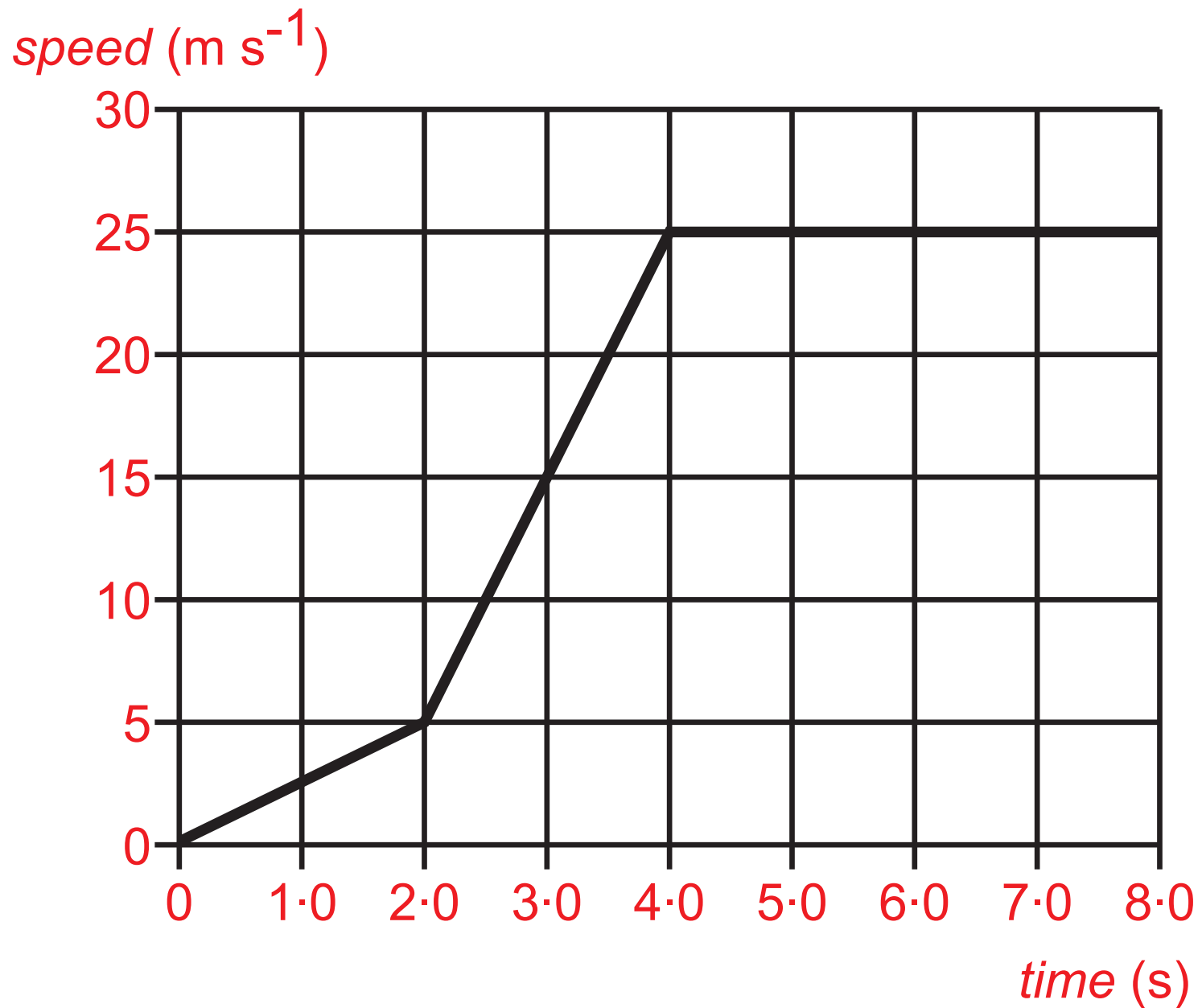
Question 4c



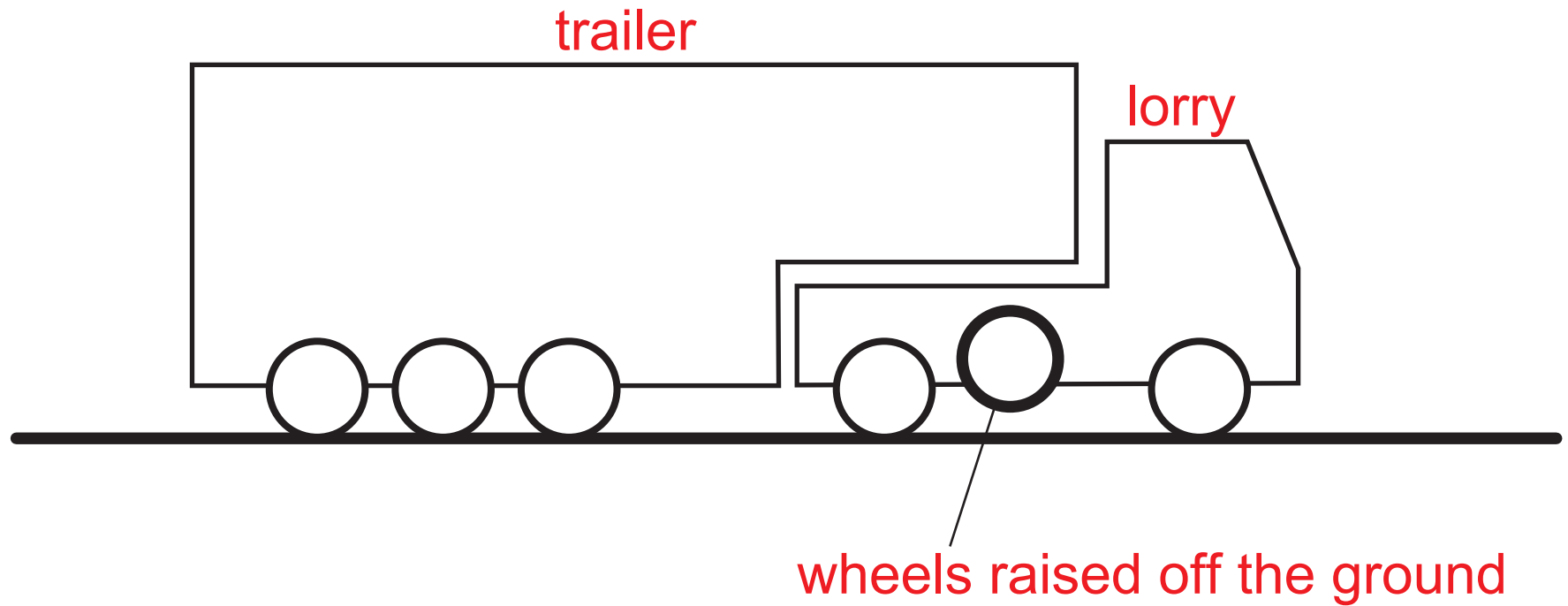
Question 6



Question 8b

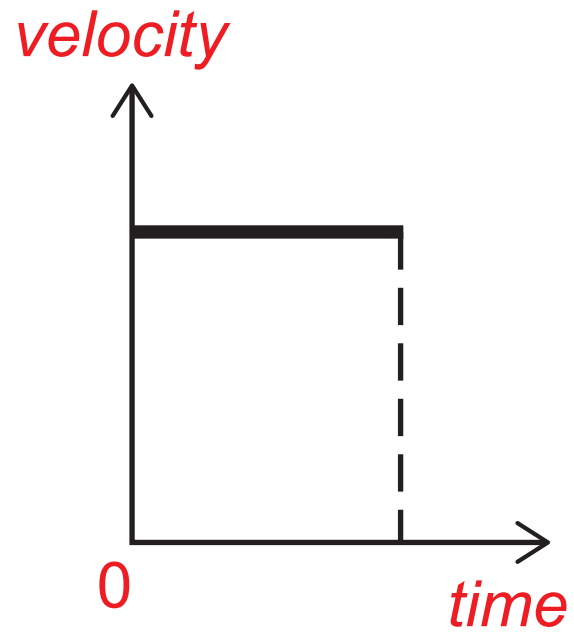


Question 10

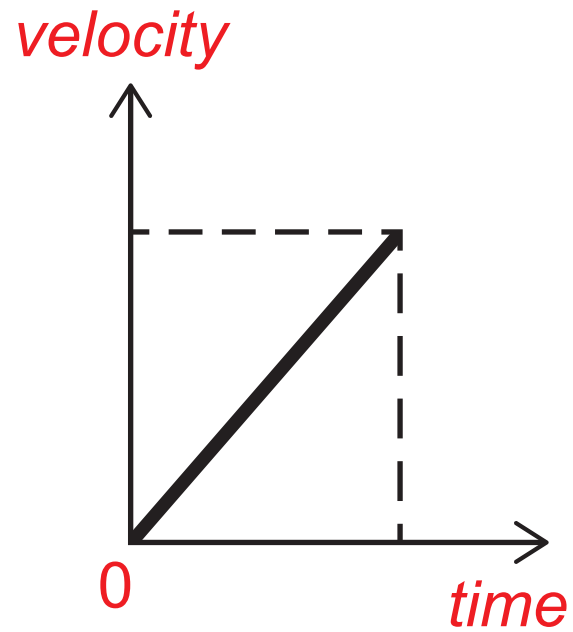


Question 11a

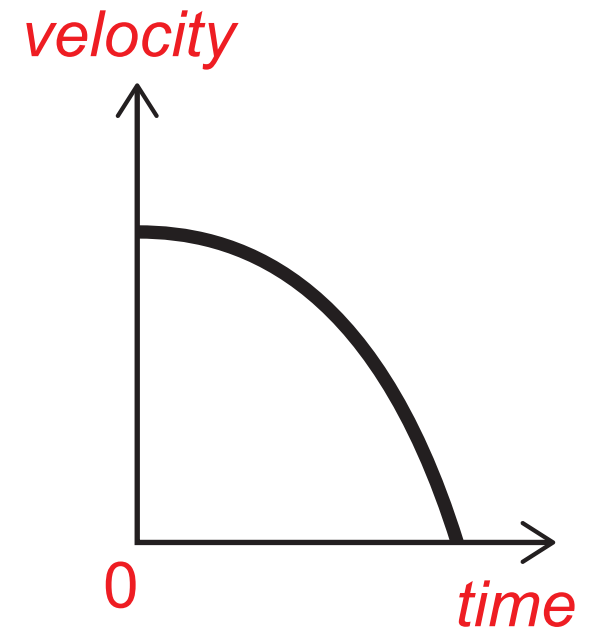
Graph P



Graph Q



Graph R





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X757/75/11

**Physics
Relationships Sheet**

WEDNESDAY, 17 MAY

$$E_p = mgh$$

$$E_k = \frac{1}{2}mv^2$$

$$Q = It$$

$$V = IR$$

$$R_T = R_1 + R_2 + \dots$$

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \dots$$

$$V_2 = \left(\frac{R_2}{R_1 + R_2} \right) V_S$$

$$\frac{V_1}{V_2} = \frac{R_1}{R_2}$$

$$P = \frac{E}{t}$$

$$P = IV$$

$$P = I^2R$$

$$P = \frac{V^2}{R}$$

$$E_h = cm\Delta T$$

$$p = \frac{F}{A}$$

$$\frac{pV}{T} = \text{constant}$$

$$p_1V_1 = p_2V_2$$

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$d = vt$$

$$v = f\lambda$$

$$T = \frac{1}{f}$$

$$A = \frac{N}{t}$$

$$D = \frac{E}{m}$$

$$H = DW_R$$

$$\dot{H} = \frac{H}{t}$$

$$s = vt$$

$$d = \bar{v}t$$

$$s = \bar{v}t$$

$$a = \frac{v-u}{t}$$

$$W = mg$$

$$F = ma$$

$$E_w = Fd$$

$$E_h = ml$$

Additional Relationships

Circle

$$\text{circumference} = 2\pi r$$

$$\text{area} = \pi r^2$$

Sphere

$$\text{area} = 4\pi r^2$$

$$\text{volume} = \frac{4}{3}\pi r^3$$

Trigonometry

$$\sin \theta = \frac{\text{opposite}}{\text{hypotenuse}}$$

$$\cos \theta = \frac{\text{adjacent}}{\text{hypotenuse}}$$

$$\tan \theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\sin^2 \theta + \cos^2 \theta = 1$$