Pearson Edexcel

International GCSE

Physics (9–1) (Modular)

Sample Assessment Materials

Pearson Edexcel International GCSE in Physics (Modular) (4XPH1)

First teaching September 2024
First examination June 2025
First certification August 2025

Issue 1

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Contents

Introduction

The Pearson Edexcel International GCSE (9-1) in Physics (Modular) (4XPH1) is designed for use in schools and colleges. It is part of a suite of International GCSE modular qualifications offered by Pearson.

These sample assessment materials have been developed to support this qualification and will be used as the benchmark to develop the assessment students will take.

The sample assessment materials in this document are derived from the existing Edexcel International GCSE (9-1) in Physics qualification, which is linear in design.

Both linear and modular routes are designed to provide the same level of demand overall while offering candidates a choice of assessment options. In the modular qualification, candidates are able to sit and resit individual units in different series.

Note: Within International GCSE (9-1) in Physics (Modular), assessments are referred to as units. This is to support the modular nature of the qualification as each individual assessment is entered for as a separate unit.

General marking guidance

- All candidates must receive the same treatment. Examiners must mark the last candidate in exactly the same way as they mark the first.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than be penalised for omissions.
- Examiners should mark according to the mark scheme – not according to their perception of where the grade boundaries may lie.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification/indicative content will not be exhaustive. However, different examples of responses will be provided at standardisation.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, a senior examiner must be consulted before a mark is given.
- Crossed-out work should be marked **unless** the candidate has replaced it with an alternative response.

Subject specific marking guidance

Symbols and terms used in the mark scheme:

- Round brackets ( ): words inside round brackets are to aid understanding of the marking point but are not required to award the point
- Curly brackets { }: indicate the beginning and end of a list of alternatives (separated by obliques) where necessary, to avoid confusion
- Oblique /: words or phrases separated by an oblique are alternatives to each other and either answer should receive full credit
- ecf: indicates error carried forward which means that a wrong answer given in an early part of a question is used correctly in a later part of a question.

You will not see 'owtte' (or words to that effect). Alternative correct wording should be credited in every answer unless the mark scheme has specified otherwise.

The Additional Guidance column is used for extra guidance to clarify any points in the mark scheme. It may be used to indicate:

- what will not be accepted for that marking point, in which case the phrase 'do not accept' will appear alongside the relevant marking point
- it might have examples of possible acceptable answers which will be adjacent to that marking point.

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE (9–1)

Sample assessment material for first teaching 2024

Time 1 hour 40 minutes

Paper reference **4WPH1/1P**

Physics (Modular)
UNIT 1

You must have:
Ruler, calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate 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 unit is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

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.

Turn over ▶

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S 8 1 5 4 7 A 0 1 2 4

Pearson

FORMULAE

You may find the following formulae useful.

energy transferred = current × voltage × time $E = I \times V \times t$

$$\text{power} = \frac{\text{work done}}{\text{time taken}} \qquad P = \frac{W}{t}$$

$$\text{power} = \frac{\text{energy transferred}}{\text{time taken}} \qquad P = \frac{W}{t}$$

(final speed)^2 = (initial speed)^2 + (2 × acceleration × distance moved)

$v^2 = u^2 + (2 \times a \times s)$

pressure × volume = constant $p_1 \times V_1 = p_2 \times V_2$

$$\text{force} = \frac{\text{change in momentum}}{\text{time taken}} \qquad F = \frac{(mv - mu)}{t}$$

change in thermal energy = mass × specific heat capacity × change in temperature

$\Delta Q = m \times c \times \Delta T$

Where necessary, assume the acceleration of free fall, $g = 10\ \text{m/s}^2$.

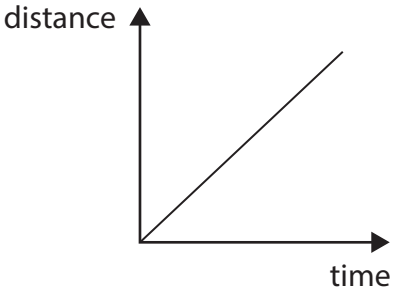
Answer ALL questions.

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 ☒.

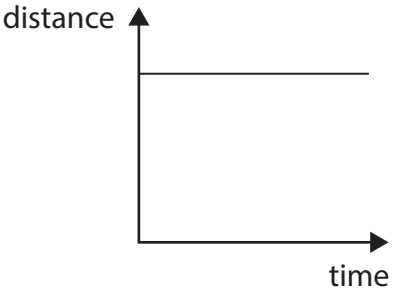
1 The motion of an object can be represented using graphs.

(a) The graphs, P, Q, R and S, show different types of motion.

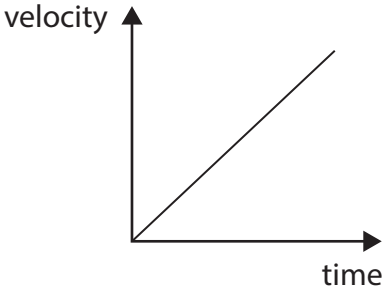
P



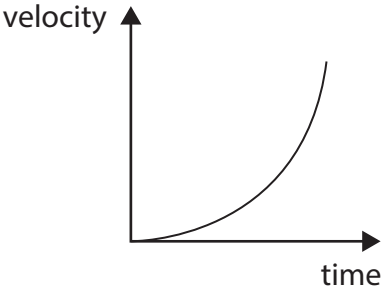
Q



R



S



The table lists some types of motion.

Place one tick (✓) in each row of the table to show which graph represents which type of motion.

(4)

	Graph			
Types of motion	**P**	**Q**	**R**	**S**
constant acceleration				
increasing acceleration				
moving at constant velocity				
stationary				

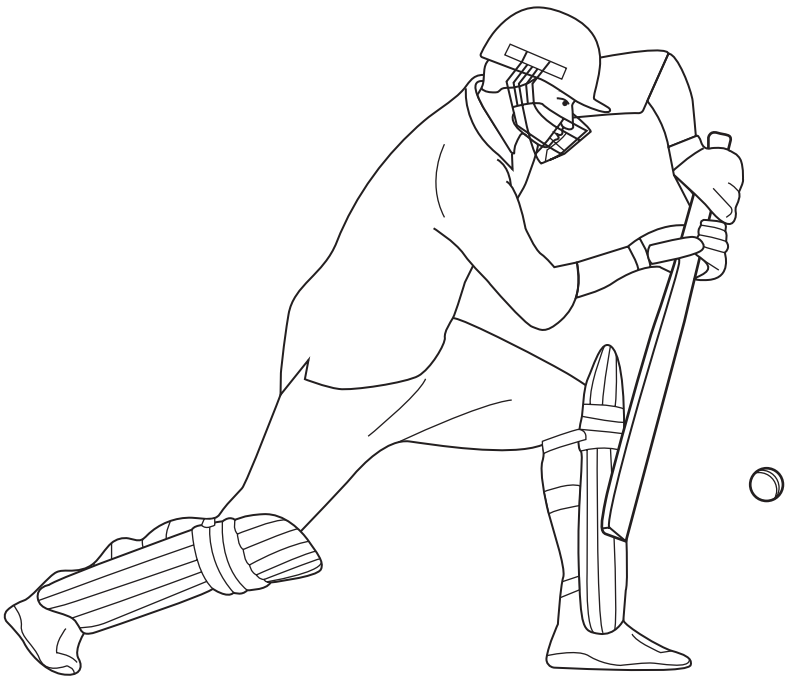
(b) State the feature of a velocity-time graph that can be used to determine the distance travelled by an object.

(1)

.....

(Total for Question 1 = 5 marks)

2 Cricket is a sport played with bats and balls.



(a) (i) A cricket player hits a ball with a bat. Before the ball is hit, it is moving to the **left** with a momentum of 4.2 kg m/s.

The bat is contact with the ball for 0.012 s.

After the ball is hit, it moves to the **right** with a momentum of 6.7 kg m/s.

Calculate the mean force the bat exerts on the ball and state the direction of the force.

(3)

mean force = ... N

direction .....

(ii) State the magnitude and direction of the mean force the **ball** exerts on the **bat**.

(1)

magnitude of mean force = ... N

direction of force .....

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(b) The cricket player wears padded protective equipment.

This protective equipment reduces the risk of injury to the player if they are struck by the cricket ball.

Explain how this protective equipment reduces the risk of injury to the player.

Use ideas about momentum in your answer.

(3)

(Total for Question 2 = 7 marks)

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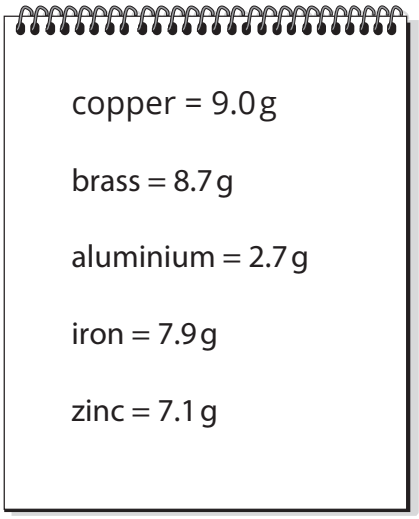
3 A student is given five metal cubes, each with a volume of 1.0 cm^3.

Each cube is made from a different metal.

The student measures the mass of each cube to determine the density of each metal.

These are the student's results for the mass of each cube.



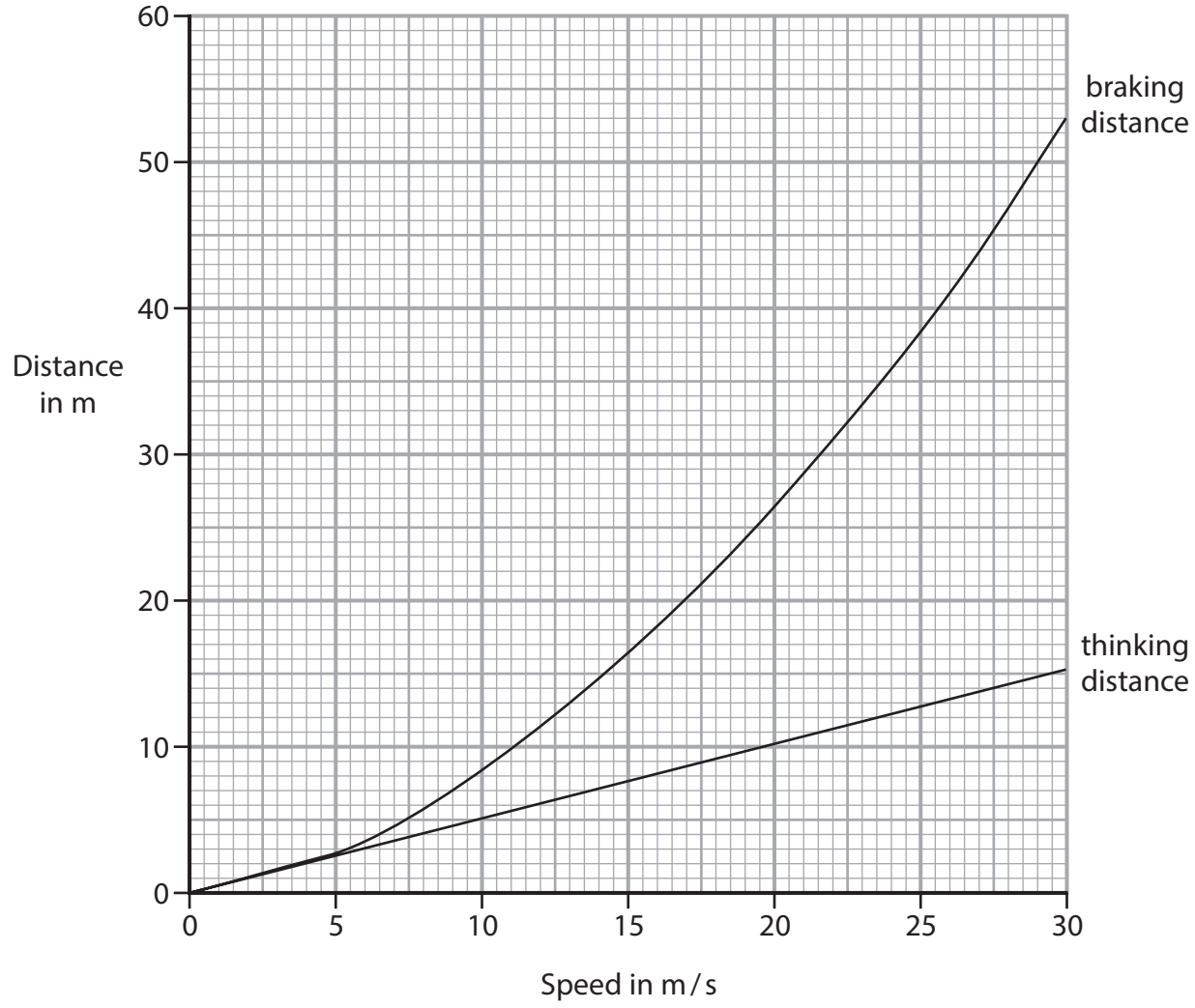
Draw a results table of the student's results.

Include a column to show the density of each metal in g / cm^3.

(4)

(Total for Question 3 = 4 marks)

4 The graph shows how the thinking distance and the braking distance vary with the speed of a car.



(a) Which of these does **not** affect thinking distance?

(1)

- ☒ **A** alcohol consumed by the driver
- ☒ **B** condition of the road
- ☒ **C** speed of the car
- ☒ **D** tiredness of the driver

(b) Which of these would increase the braking distance of the car?

(1)

- ☒ **A** faster reaction time of the driver
- ☒ **B** ice on the road
- ☒ **C** more powerful brakes
- ☒ **D** tyres with more grip

(c) Determine the stopping distance of the car when the speed of the car is 20 m/s.

(3)

stopping distance = ... m

(d) (i) State the formula linking average speed, distance moved and time taken.

(1)

(ii) Determine the reaction time of the driver of the car.

(3)

reaction time = ... s

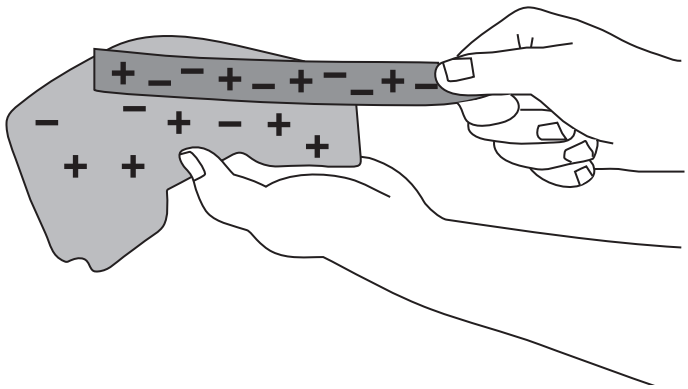
(e) Calculate the mean braking acceleration of the car as it brakes to a stop from an initial speed of 30 m/s.

(4)

acceleration = ... m/s^2

(Total for Question 4 = 13 marks)

5 A student charges a plastic rod by rubbing it with a cloth.



The rod becomes negatively charged.

(a) (i) Which statement explains how the rod becomes negatively charged?

(1)

- ☒ **A** the rod gains positively charged electrons
- ☒ **B** the rod loses positively charged electrons
- ☒ **C** the rod gains negatively charged electrons
- ☒ **D** the rod loses negatively charged electrons

(ii) Describe how the student could demonstrate that the rod is charged.

(2)

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(b) The student has several other rods made from different kinds of plastic.

Some rods can be charged positively and some can be charged negatively.

Describe an experiment to show that different rods can have different types of charge.

You may draw a diagram to help your answer.

(3)

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(Total for Question 5 = 6 marks)

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6 The photograph shows a solar power farm.

(Source: © Alessandro Pierpaoli/Shutterstock)

(a) Discuss the advantages and disadvantages of using solar power rather than fossil fuels to generate electricity.

(4)

(b) Solar panels produce direct current (d.c.).

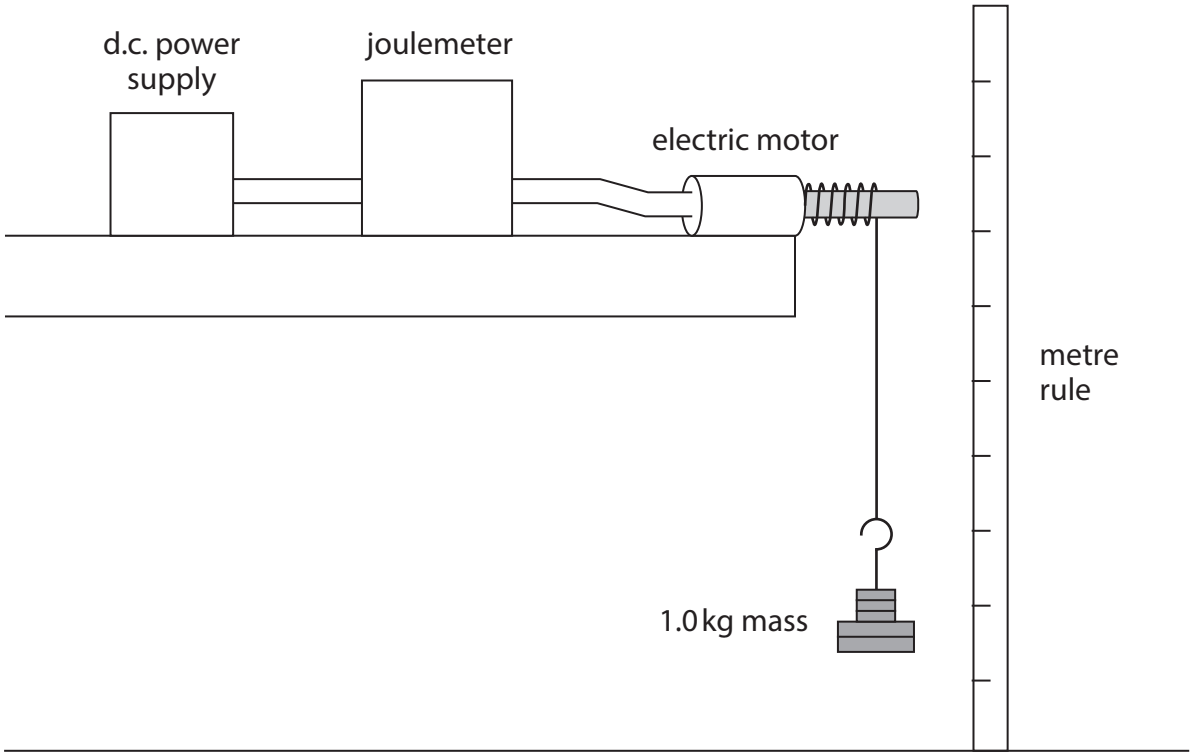
The National Grid in many countries operates on alternating current (a.c.).

Describe the difference between direct current (d.c.) and alternating current (a.c.).

(2)

(Total for Question 6 = 6 marks)

7 A student uses this apparatus to investigate how the efficiency of an electric motor varies with its input voltage.



This is the student's method.

- connect the electric motor to a d.c. power supply and a joulemeter
- attach a 1.0 kg mass to the electric motor using a length of string
- set the voltage of the power supply to 10 V and switch on the power supply
- switch off the power supply when the mass has been lifted through a distance of 50 cm
- record the input energy to the motor from the joulemeter
- calculate the energy transferred to the gravitational store of the mass
- calculate the efficiency of the motor

The student repeats this process, setting the power supply to a different voltage each time.

(a) Give **two** control variables for the investigation.

(2)

1 .....

2 .....

(b) Show that the gravitational store of the 1.0 kg mass increases by 5.0 J when it is lifted through a distance of 50 cm.

(2)

(c) The table shows the student's results.

Power supply voltage in V	Joulemeter reading in J	Motor efficiency (%)
3.0	99.4	5.0
3.5	25.5	19.6
4.0	16.5	30.3
5.0	13.5	37.0
6.0	12.6	39.7
8.0	12.8	39.1
10.0	12.7	

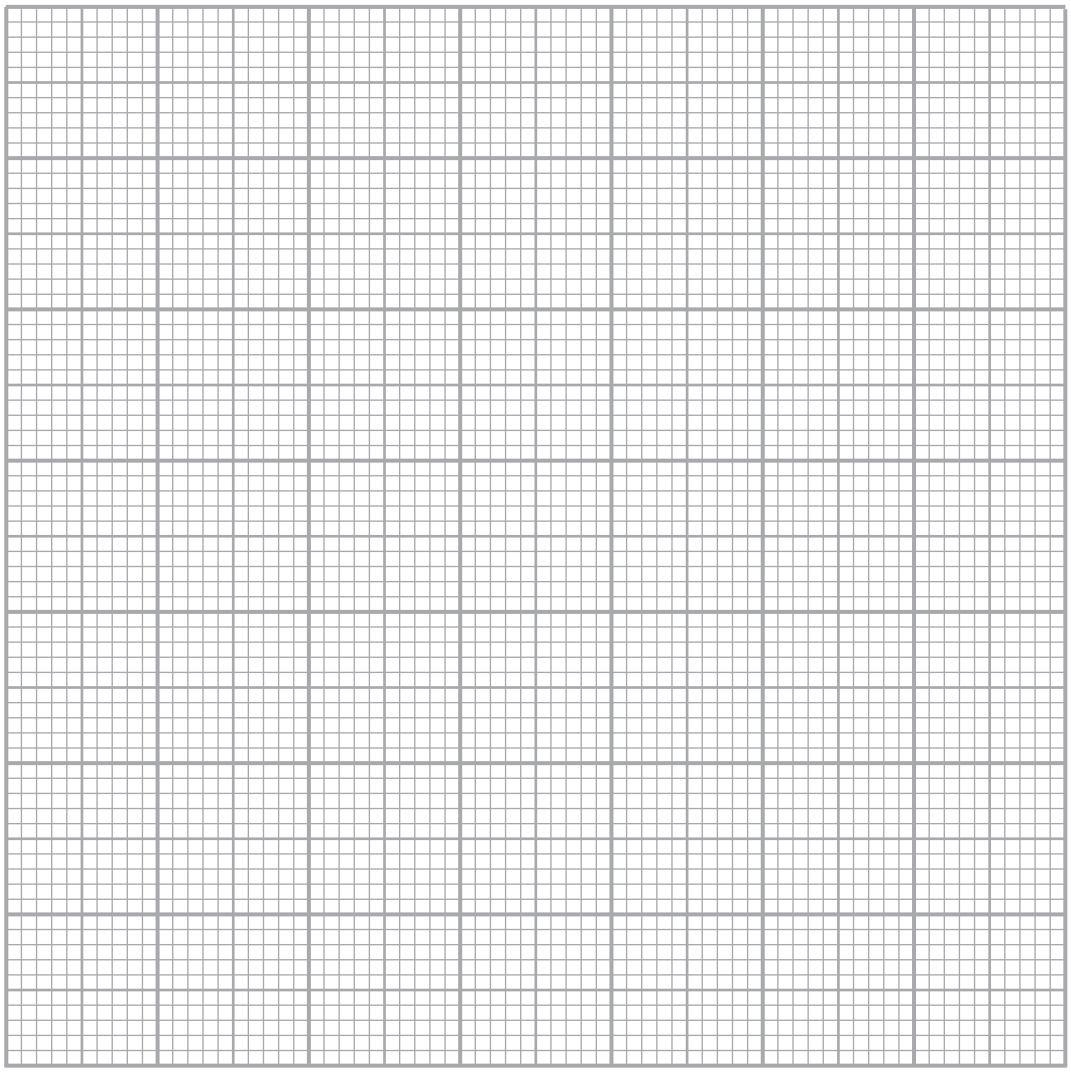
(i) Calculate the motor efficiency when the power supply is set to a voltage of 10 V.

(3)

efficiency = ... %

(ii) Plot a graph of the motor efficiency on the y-axis against the power supply voltage on the x-axis.

(3)



(iii) Draw a curve of best fit.

(2)

(iv) Using the graph, determine the minimum power supply voltage that will allow the electric motor to operate at maximum efficiency.

(1)

power supply voltage = ... V

(Total for Question 7 = 13 marks)

8 A student investigates the change of state by heating a sample of a substance.

The student starts heating the substance when it is a solid.

As they heat the substance it melts, turning into a liquid, which is then heated further.

On the axes, draw a graph that shows how the temperature of the substance changes during this heating process.

The specific heat capacity of the substance when it is a solid is greater than when the substance is a liquid.

(3)

(Total for Question 8 = 3 marks)

9 A student uses the circuit shown in diagram 1 to investigate how the current changes with voltage for a filament lamp.

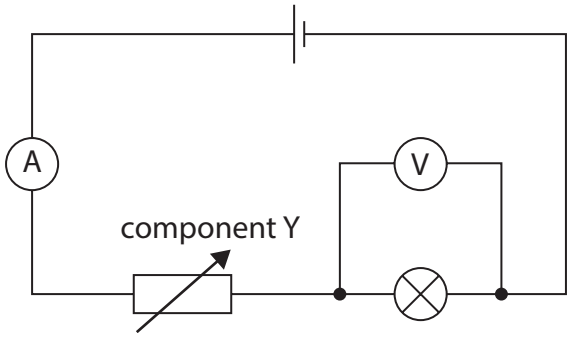


Diagram 1

(a) (i) Give the name of component Y.

(1)

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(ii) Give a reason why component Y is included in the circuit.

(1)

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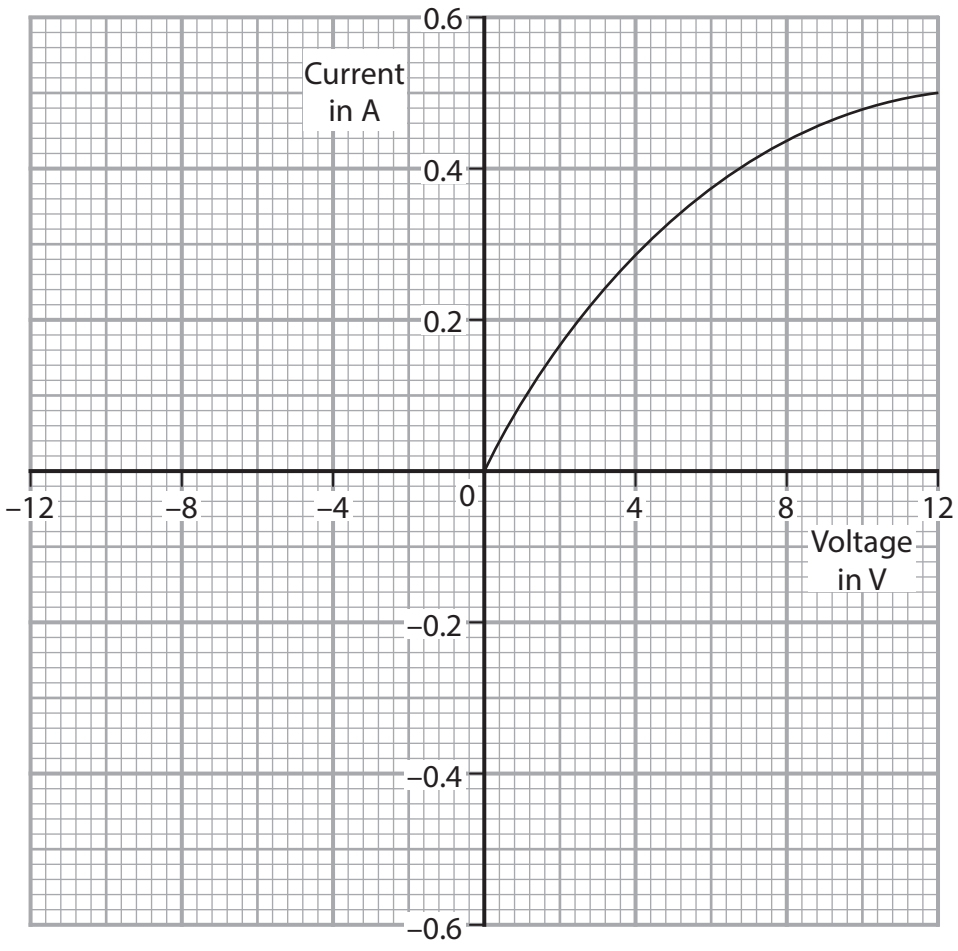
.....

(b) The graph shows some of the student's results.



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(i) State the formula linking charge, current and time.

(1)

(ii) Determine the current in the lamp when the voltage across the lamp is 10 V.

(1)

current = ... A

(iii) Calculate the charge transferred through the lamp in 30 s when the voltage across the lamp is 10 V.

Give the unit.

(3)

charge = ... unit .....

(iv) Calculate the time for the lamp to transfer 250 J of energy when the voltage across the lamp is 10 V.

(3)

time = ... s

(v) The student disconnects the cell and reconnects it with its terminals reversed.

Complete the graph to show how the current in the lamp varies with voltage across the lamp when the cell is connected with its terminals reversed.

(2)

(c) The student replaces the filament lamp with a light emitting diode (LED) and replaces the cell with an alternating current (a.c.) power supply, as shown in diagram 2.

The student also removes the ammeter and voltmeter from the circuit.

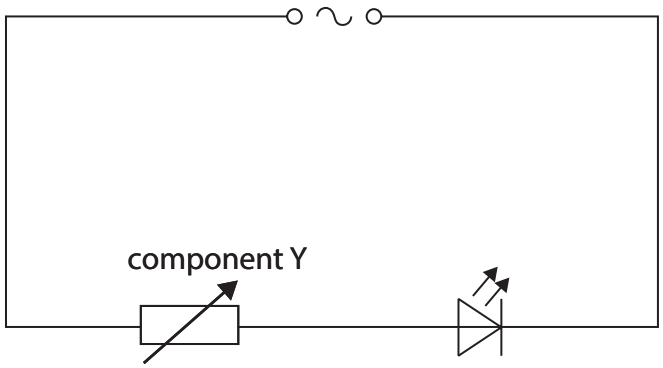

Diagram 2

Explain why the LED flashes on and off in this circuit.

(2)

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(Total for Question 9 = 14 marks)

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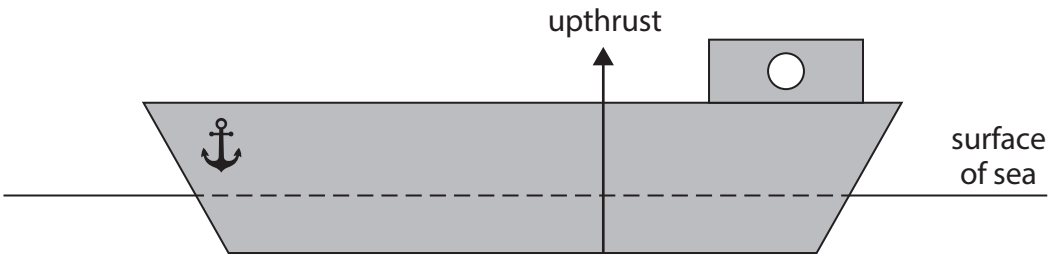
10 A ship floats on the sea.



(a) The ship floats because of the forces acting on it.

The upward force acting on the ship is called upthrust.

This force is shown on the diagram.

Draw another labelled arrow on the diagram to show the other vertical force acting on the ship.

(2)

(b) The upthrust force acting on the ship is proportional to the pressure difference between the bottom of the ship and the surface of the sea.

The pressure acting on the ship at the surface of the sea is 100 kPa.

(i) State the formula linking pressure difference, height, density and gravitational field strength (*g*).

(1)

(ii) The bottom of the ship is 15.8 m below the surface of the sea.

Show that the pressure acting on the bottom of the ship is approximately 260 kPa.

[density of seawater = 1030 kg/m^3]

(3)

(iii) Explain why the bottom of the ship is deeper below the surface of the sea when the ship is fully loaded with cargo.

(2)

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(Total for Question 10 = 8 marks)

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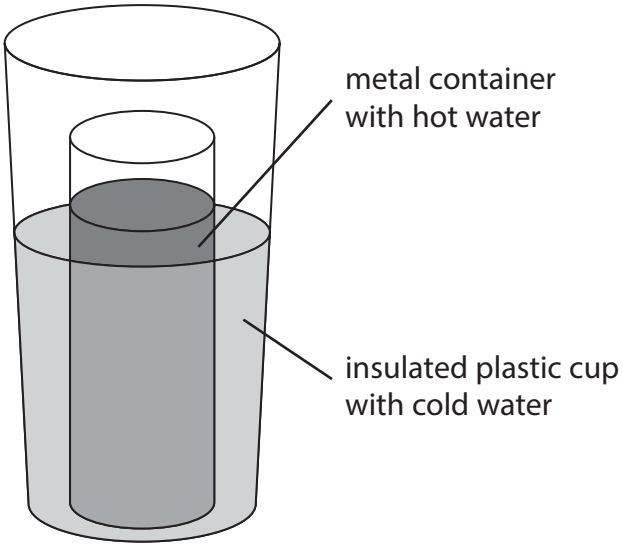
11 A student pours a known volume of hot water into a metal container. They place the metal container into an insulated plastic cup containing an equal volume of cold water.

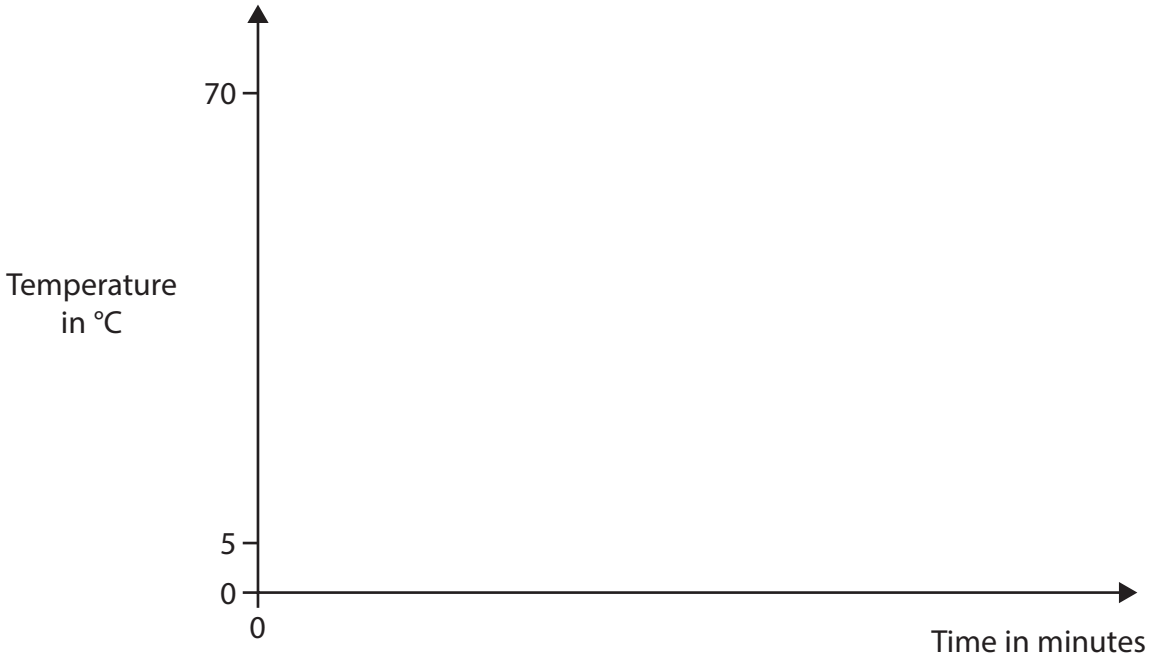


The student uses temperature probes to measure the temperatures of both the water in the metal container and the water in the plastic cup.

The hot water has an initial temperature of 70 °C and the cold water has an initial temperature of 5 °C.

(a) On the axes, sketch how the temperature of the hot water and the temperature of the cold water vary with time.

(4)



(b) Explain why the temperatures of the hot water and the cold water change.

You should refer to different types of thermal energy transfer in your answer.

(4)

(c) Explain how placing a lid on the plastic cup would affect the results.

(3)

(Total for Question 11 = 11 marks)

TOTAL FOR UNIT = 90 MARKS

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Physics Unit 1 (Modular)
Mark Scheme

Question Number	Answer	Mark
1(a)	One mark for each correct row. Reject mark for row if more than one tick seen.	**4**

Type of motion	Graph			
	P	Q	R	S
constant acceleration			✓	
increasing acceleration				✓
moving at constant velocity	✓			
stationary		✓		

Question Number	Answer	Mark
1(b)	area (under the line) / eq;	**1**

Question Number	Answer	Notes	Mark
2(a)(i)	substitution into F = (mv – mu/t; evaluation; correct direction; e.g. (F =) (6.7 - -4.2) / 0.012 (F =) 910 (N) (direction =) right	-1 if POT error independent mark 208.3… scores 2 marks max. If given with correct direction Allow 908.3… (N) allow forwards ignore compass directions 0.9083… Scores 1 mark	**3**

Question Number	Answer	Notes	Mark
2(a)(ii)	same forces as in (a)(i) AND <u>opposite</u> direction; e.g. (F =) 910 (N) AND (direction =) left	allow ECF from (a)(i) for both points allow ECF for compass direction only if opposite to direction given in (i)	**1**

Question Number	Answer	Notes	Mark
2(b)	any three from: MP1. Idea that there is a change of momentum (when ball hits player); MP2. (equipment) increases (impact) time; MP3. Decreases rate of change of momentum (of ball); MP4. Decreases force (on player); MP5. Decreases pressure (on player);	allow spreads force over larger area	**3**

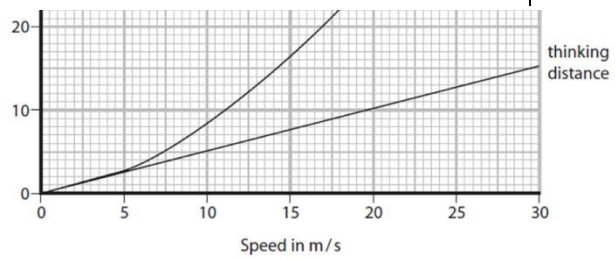
Question Number	Answer	Mark
3	column listing metals; column listing masses with mass and unit heading; column listing densities; correct unit for density in heading;	**4**

Question Number	Answer	Mark
4(a)	The only correct answer is **B** (condition of the road); 1 *A is incorrect because consumption of alcohol increases reaction time* *C is incorrect because thinking distance is determined by speed* *D is incorrect because tiredness increases reaction time*	**1**

Question Number	Answer	Mark
4(b)	The only correct answer is **B** (ice on the road); *A is incorrect because reaction time does not affect braking distance* *C is incorrect because more powerful brakes would decrease the braking distance* *D is incorrect because tyres with more grip would decrease the braking distance*	**1**

Question Number	Answer	Notes	Mark
4(c)	idea that stopping distance = thinking distance + braking distance; correct reading of either distance; correct evaluation; e.g. stopping distance = thinking distance + braking distance thinking distance = 10.0 m / braking distance = 26.5 m stopping distance = (10.0 + 26.5) = 36.5 (m)	stated or implied allow 26.0-27.0 (m) for braking distance allow 10.0-10.5 (m) for thinking distance allow 36.0-37.5 (m)	**3**

Question Number	Answer	Notes	Mark
4(d)(i)	(average) speed = distance (moved) / time (taken);	allow standard symbols and rearrangements e.g. t=s/v allow s or d for distance	**1**

Question Number	Answer	Notes	Mark
4(d)(ii)	suitable pair of readings taken from graph; rearrangement of formula; evaluation; e.g. thinking distance = 15 m when speed = 30 m/s time = distance / speed (time = 15 / 30 =) 0.50 (s)	allow v or s for speed i.e. (30,15), (20,10), 3(10,5) etc. allow any answer in range 0.40-0.60 (s)	**3**
			

Question Number	Answer	Notes	Mark
4(e)	correct braking distance reading from graph; substitution into $v^2 = u^2 + 2 \times a \times s$; rearrangement; evaluation; e.g. braking distance = 53 m $0^2 = 30^2 + [2 \times a \times 53]$ a = (-)900 / 106 (a =) (-)8.5 (m/s^2)	allow 53 seen anywhere 4 in working final answer of 6.6 (m/s^2) (using stopping distance instead of braking distance) scores 3 marks final answer of 30 (m/s^2) (using thinking distance instead of braking distance) scores 3 marks allow 52-53 m allow 8.49-8.65	**4**

Question Number	Answer	Mark
5(a)(i)	The only correct answer is **C** the rod gains negatively charged electrons; *A is incorrect because electrons are not positively charged* *B is incorrect because electrons are not positively charged* *D is incorrect because this would make the rod positively charged*	**1**

Question Number	Answer	Mark
5(a)(ii)	a named demonstration; a relevant observation; e.g. put charged rod near hair hair moves towards/is attracted to rod put charged rod near (small) pieces of paper pieces of paper move towards to the rod put charged rod near steam of water water bends towards the rod put rod next to another charged rod rod will move towards/away from other rod use a gold lead electroscope (GLE) gold leaf deflects	**2**

Question Number	Answer	Notes	Mark
5(b)	MP1. Method to allow (rods) to swing freely; MP2. Idea that rods are brough close together; MP3. Observation of attraction AND repulsion;	marking points may be shown on a labelled diagram e.g. suspend/balance on watch glass allow if another **charged** insulator used e.g. a balloon allow if rod brought near another **charged** insulator reject if method would not give attraction and repulsion e.g. holding rod near stream of water	**3**

Question Number	Answer	Notes	Mark
6(a)	any FOUR from: advantages: MP1 no carbon (dioxide) emissions; MP2 no contribution to { global warming/ greenhouse effect/acid rain }; MP3 is renewable; MP4 low maintenance/no moving parts; disadvantages: MP5 needs a favourable climate; MP6 needs long days/doesn't work at night; MP7 needs a lot of space; MP8 cannot respond to rapid charges in demand;	 ignore unnamed 'greenhouse gases'	**4**

Question Number	Answer	Mark
6(b)	d.c travels in one direction only; a.c changes direction **frequently/continuously;**	**2**

Question Number	Answer	Notes	Mark
7(a)	any two from: MP1. Mass (being lifted); MP2. Height (lifted)/distance; MP3. Power supply/circuit being used; MP4. Temperature (of motor);	Ignore 'some motor' condone weight	**2**

Question Number	Answer	Notes	Mark
7(b)	conversion of cm to m; substitution into GPE = mass x g x height; e.g. 50cm = 0.5m GPE = 1 x 10 x 0.5 (= 5 J)	 allow 0.5 seen anywhere allow use of g = 9.8(1) (m/s^2)	**2**

Question Number	Answer	Notes	Mark
7(c)(i)	Efficiency formula seen; substitution; evaluation; e.g. efficiency = useful energy output/total energy input efficiency = 5/12.7 (x100%) efficiency = 39.4 (%)	 ignore s.f. allow 39,39.37… reject unsupported incorrect answer	**3**

Question Number	Answer	Notes	Mark
7(c)(ii)	suitable linear scale chosen (>50% of grid used); axes labelled with quantities and unit; all plotting correct to nearest half square;	ignore orientation ignore plotting at 10v	**3**

Question Number	Answer	Notes	Mark
7(c)(iii)	Acceptable curve of best fit drawn up to a voltage of 6V; straight horizontal line of best fit drawn from 6V onwards;	i.e. curved line with even distribution of points either side by eye	**2**

Question Number	Answer	Notes	Mark
7(c)(iv)	correctly read voltage from graph consistent with candidates curve of best fit;	allow ranges 5.4V – 6.6V allow ecf from (iii)	**1**

Question Number	Answer	Mark
8	line starting from y-axis with positive gradient and line after melting with positive gradient; gradient of liquid line greater than solid line; horizontal line showing melting;	**3**

Question Number	Answer	Notes	Mark
9(a)(i)	variable resistor;	allow rheostat	**1**

Question Number	Answer	Notes	Mark
9(a)(ii)	idea that it allows the current / voltage (across lamp) to be varied;	ignore references to changing resistance	**1**

Question Number	Answer	Notes	Mark
9(b)(i)	charge = current × time;	allow standard symbols 1 and rearrangements e.g. Q=I×t reject C, c for current and charge	**1**

Question Number	Answer	Mark
9(b)(ii)	0.48 (A);	**1**

Question Number	Answer	Notes	Mark
9(b)(iii)	substitution; evaluation; unit; e.g. charge = 0.48 × 30 (charge =) 14 coulombs / C	allow ecf from (ii) mark independently allow 14.4 ignore As	**3**

Question Number	Answer	Notes	Mark
9(b)(iv)	substitution into E = V × I × t; rearrangement; evaluation; e.g. 250 = 10 × 0.48 × time time = 250 / 4.8 (time =) 52 (s)	allow ecf from (ii) allow alternative method involving calculating charge transferred, then using Q=It allow 52.08…(s)	**3**

Question Number	Answer	Notes	Mark
9(b)(v)	curve drawn of similar shape to existing but through 180° rotation into negative quadrant of graph; curve starts at (0,0) and finishes at (-12,0.5); coulombs / C	DOP	**2**

Question Number	Answer	Notes	Mark
9(c)	any two from: MP1. idea that current changes direction; MP2. LED only allows current in one direction; MP3. LED will not light up when current in reverse direction;	Allow descriptions of electrons movement for current allow RA	**2**

Question Number	Answer	Notes	Mark
10(a)	Downward arrow labelled weight; downward arrow is equal in length to upthrust arrow;	Ignore starting point of arrow allow 'gravitational force', 'force due to gravity' reject 'gravity' judge by eye	**2**

Question Number	Answer	Mark
10(b)(i)	Pressure (difference) = height x density x g;	**1**

Question Number	Answer	Mark
10(b)(ii)	substitution; evaluation of pressure difference in Pa OR kPa to at least 3s.f.; addition of surface pressure (100kPa) to give answer; e.g. p = 15.8 x 1030 x 10 p = 162740 Pa OR 162.74 kPa p = 162.74 + 100 (=260 kPa)	**3**

Question Number	Answer	Mark
10(b)(iii)	any two from: MP1. idea that {weight of ship/downwards force} is greater; MP2. larger pressure difference (when deeper in water); MP3 larger upthrust force (needed to keep forces balanced);	**2**

Question Number	Answer	Notes	Mark
11(a)	line decreases from 70; other line increases from 5; both are correctly curved; lines become asymptotic at an intermediate temperature;	 DOP reject if intermediate temperature closer to 70 than 5	**4**

Question Number	Answer	Notes	Mark
11(b)	any 4 from: MP1. hot water loses energy/cold water gains energy; MP2. (thermal) energy is transferred from hot to cold water; MP3. By conduction (through the metal); MP4. idea that energy transfer stops when thermal equilibrium is reached; MP5. some (thermal) energy lost (to surroundings) by convection/evaporation/radiation; MP6. little/no (thermal) energy is transferred out through the insulated plastic cup;	 allow colder water gains heat from hot water allow equivalent statements for thermal equilibrium e.g. same temperature	**4**

Question Number	Answer	Notes	Mark
11(c)	(energy transfer by) convection/radiation decreases; idea that equilibrium temperature will be higher; idea that time taken to cool (to room temperature) will be longer;	Allow reference to evaporation condone no change to intermediate temperatures	**3**

Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International GCSE (9–1)

Sample assessment material for first teaching 2024

Time 1 hour 40 minutes

Paper reference **4WPH2/1P**

Physics (Modular)
UNIT 2

You must have:
Ruler, calculator

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate 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 unit is 90.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*

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.

Turn over ▶

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S 8 1 5 4 8 A 0 1 2 4

Pearson

FORMULAE

You may find the following formulae useful.

$$\text{frequency} = \frac{1}{\text{time period}} \qquad f = \frac{1}{T}$$

$$\text{orbital speed} = \frac{2\pi \times \text{orbital radius}}{\text{time period}} \qquad v = \frac{2 \times \pi \times r}{T}$$

$$\text{pressure} \times \text{volume} = \text{constant} \qquad p_1 \times V_1 = p_2 \times V_2$$

$$\frac{\text{pressure}}{\text{temperature}} = \text{constant} \qquad \frac{p_1}{T_1} = \frac{p_2}{T_2}$$

$$\frac{\text{change of wavelength}}{\text{wavelength}} = \frac{\text{velocity of a galaxy}}{\text{speed of light}} \qquad \frac{\lambda - \lambda_0}{\lambda_0} = \frac{\Delta\lambda}{\lambda_0} = \frac{v}{c}$$

Where necessary, assume the acceleration of free fall, $g = 10\,\text{m/s}^2$.

Answer ALL questions.

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 ☒.

1 Diagram 1 shows the magnetic field between the poles of two strong bar magnets.

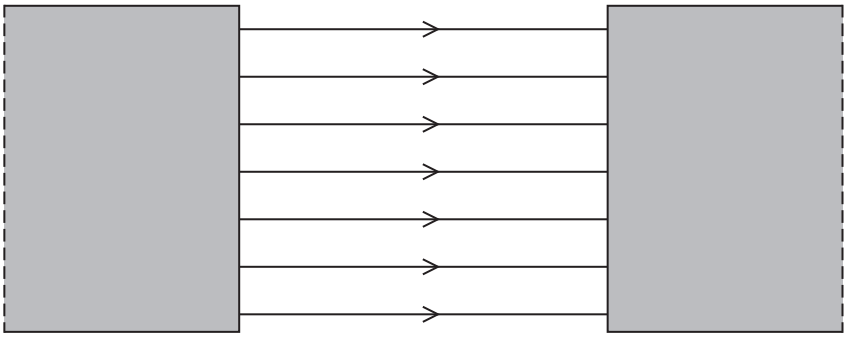

Diagram 1

(a) Add labels to diagram 1 to show the poles of the bar magnets.

(1)

(b) The bar magnets are made from steel.

Give **one** reason why steel is a good material for making bar magnets.

(1)

.....

.....

(c) Explain how diagram 1 shows a uniform magnetic field.

(2)

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(d) Diagram 2 shows a metal wire being moved downwards through the uniform field between the poles of the same bar magnets. The orientation of the magnets has not been changed.

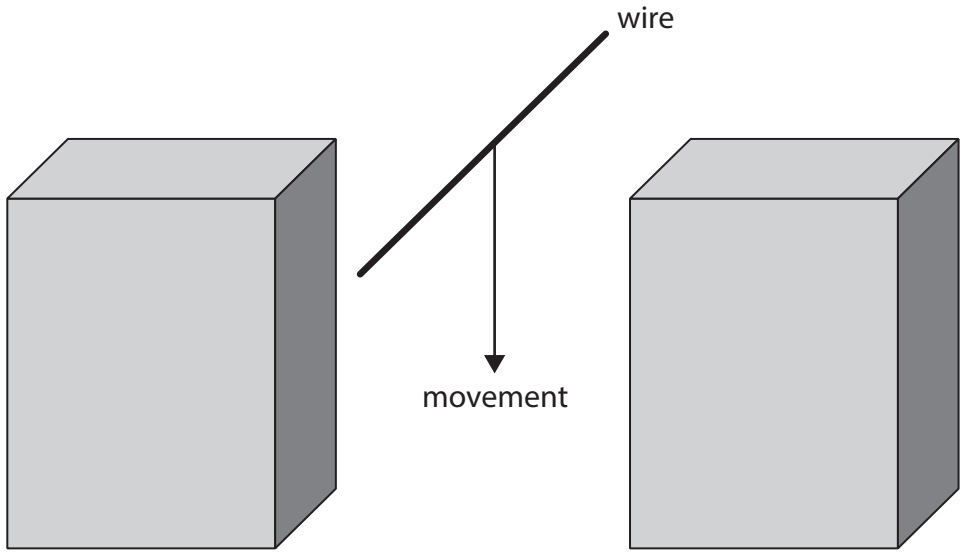

Diagram 2

(i) Give a reason why a voltage is induced between the ends of a metal wire as it moves between the poles of the bar magnets.

(1)

.....

.....

(ii) State **two** changes that could be made to this arrangement that would increase the magnitude of the induced voltage.

(2)

1 .....

2 .....

(Total for Question 1 = 7 marks)

2 (a) Technetium-99m has a half-life of 6 hours and can be used as a medical tracer.

It is injected into a patient's blood and moves around the patient's body.

Technetium-99m emits gamma radiation, which is used to locate the position of the tracer in the patient's body.

(i) Technetium-99m does not exist naturally.

Suggest why technetium-99m is usually made at the hospital where it is used.

(1)

(ii) Explain why technetium-99m is an effective isotope to use as a medical tracer.

(2)

(b) The gamma radiation emitted by technetium-99m is potentially harmful to humans.

Discuss the risks of using technetium-99m to doctors and to patients.

(3)

(Total for Question 2 = 6 marks)

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3 Lead-210 is a radioactive isotope of lead and is represented using this symbol.

$$^{210}_{82}Pb$$

(a) State what is meant by the term **isotope**.

(2)

.....

.....

.....

.....

(b) How many protons are in the nucleus of lead-210?

(1)

- ☒ **A** 82
- ☒ **B** 128
- ☒ **C** 210
- ☒ **D** 292

(c) (i) A sample of lead-210 has an initial activity of 240 Bq.

After 66 years, the activity of the sample is 30 Bq.

Calculate the half-life of lead-210.

(2)

half-life = ... years

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(ii) Lead-210 decays into lead-206 through a number of stages.

This involves one alpha decay and a number of beta decays.

This incomplete equation summarises these stages.

$$^{210}_{82}Pb \rightarrow {}^{206}_{82}Pb + \ldots\ldots\ldots\ldots \alpha + \ldots\ldots\ldots\ldots {}^{0}_{-1}\beta$$

Complete the equation by giving the missing numbers.

Write your answers in the spaces provided.

(2)

(Total for Question 3 = 7 marks)

4 This question is about astrophysics.

(a) The table lists some statements about the universe.

Place ticks (✓) in the table to show which statements support the Big Bang theory.

(2)

Statement	Supports the Big Bang theory
black holes are formed from extremely massive stars	
cosmic microwave background radiation is detected in all directions	
cosmic rays from space are detected at the Earth's surface in all directions	
each galaxy contains billions of stars	
most galaxies show a red-shift in the light detected from them	

(b) The sun will become a red giant star when it leaves the main sequence.

Which row correctly describes how the surface temperature and brightness of the Sun will change when it becomes a red giant?

(1)

		Surface temperature	Brightness
☒	**A**	decreases	decreases
☒	**B**	decreases	increases
☒	**C**	increases	decreases
☒	**D**	increases	increases

(c) Astronomical objects can be classified by their absolute magnitude.

State what is meant by the term **absolute magnitude**.

(2)

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(Total for Question 4 = 5 marks)

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5 (a) (i) State the formula linking input power and output power for a transformer.

(1)

(ii) The step-down transformer has an input voltage of 275 kV and an output voltage of 230 V.

The transformer has an output current of 95 A.

Calculate the input current to the transformer.

Assume the transformer is 100% efficient.

(3)

input current = ... A

(b) Explain how transformers are useful in the large-scale transmission of electricity.

You may draw a diagram to support your answer.

(5)

(Total for Question 5 = 9 marks)

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6 (a) (i) Which of these coloured stars has the highest temperature?

(1)

- ☒ **A** orange
- ☒ **B** red
- ☒ **C** white
- ☒ **D** yellow

(ii) Which of these is the stage nearest the end of the life cycle of a star with a mass much greater than the Sun?

(1)

- ☒ **A** main sequence
- ☒ **B** protostar
- ☒ **C** supernova
- ☒ **D** white dwarf

(b) The Sun is a main sequence star.

(i) In the Sun, hydrogen nuclei are changed into helium nuclei, releasing energy.

Name the process that changes hydrogen into helium.

(1)

.....

(ii) Describe the evolution of the Sun when it leaves the main sequence.

(2)

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(c) The Sun's core has a mass of approximately 7×10^{29} kg.

Approximately 75% of the mass of the core is hydrogen.

(i) Calculate the approximate mass of hydrogen in the Sun's core.

(1)

mass of hydrogen = ... kg

(ii) When most of the hydrogen nuclei in the Sun's core have been changed into helium nuclei the Sun will leave the main sequence.

The Sun's core loses approximately 9×10^{19} kg of hydrogen each year.

Estimate the time until the Sun leaves the main sequence.

Give your answer to one significant figure.

(2)

time = ... years

(d) Diagram 3 shows the orbit of a comet around a star.

Draw a labelled arrow on diagram 3 to show the force acting on the comet due to the star.

(2)

not to scale

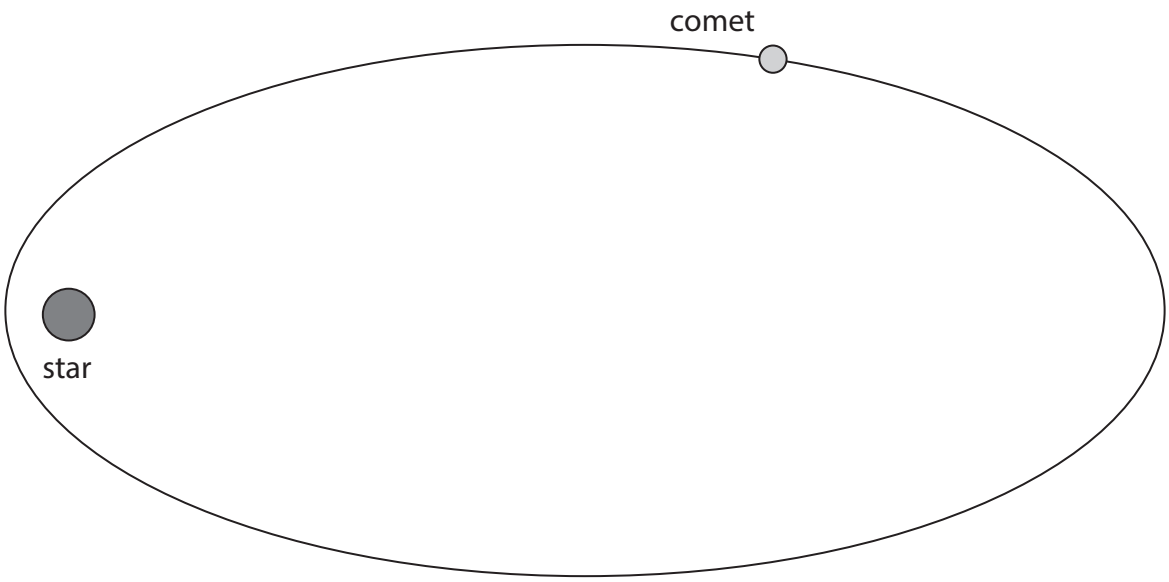

Diagram 3

(Total for Question 6 = 10 marks)

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7 Diagram 4 shows a coil wire, WXYZ, positioned between the opposite poles of a magnet.

The arrows show the direction of the current in the coil.

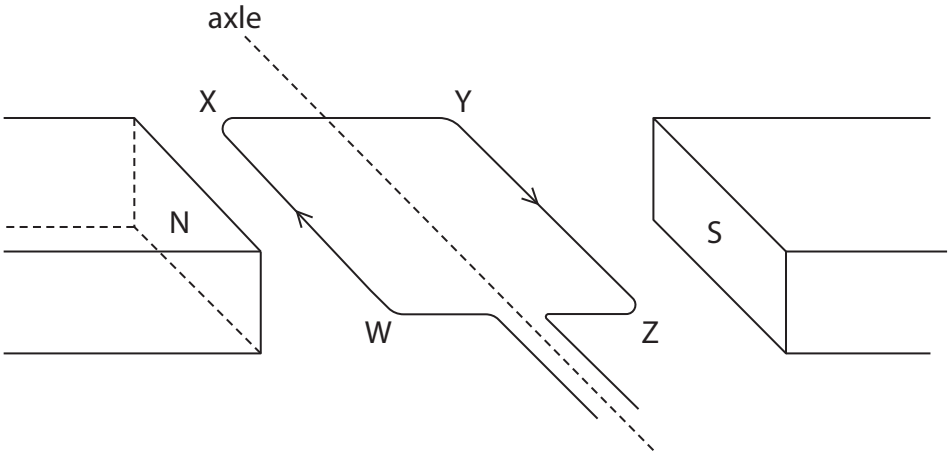

Diagram 4

(a) Draw arrows on diagram 4 to show the direction of the forces that act on the coil due to the magnet.

(2)

(b) Explain the motion of the coil of wire.

Refer to magnetic fields in your answer.

(4)

(c) Explain how the motion of the coil will change if the current is increased.

(2)

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(Total for Question 7 = 8 marks)

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8 (a) Describe an experiment to determine the refractive index of a glass block.

In your answer you should include:

- a labelled diagram
- the apparatus needed
- the method used

(6)

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(b) Give **two** uses of total internal reflection.

(2)

1 .....

.....

2 .....

.....

(Total for Question 8 = 8 marks)

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9 This question is about waves.

(a) Diagram 5 represents a wave.

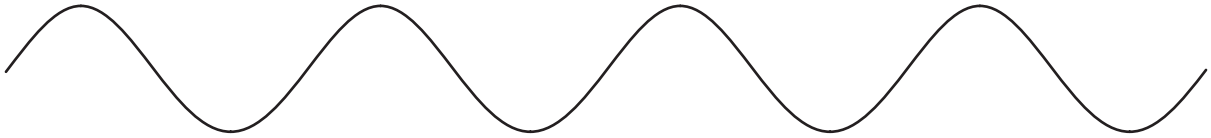

Diagram 5

(i) Determine the amplitude of the wave by measuring it with a ruler.

(1)

amplitude = ... cm

(ii) Determine the wavelength of the wave by measuring it with a ruler.

(1)

wavelength = ... cm

(b) Microwaves are part of the electromagnetic spectrum.

(i) Name the part of the electromagnetic spectrum that has a lower frequency than microwaves.

(1)

.....

(ii) Microwaves travel at a speed of 3.0×10^8 m/s in the air.

A microwave has the wavelength of 2.7 cm.

Calculate the frequency of this microwave.

[wave speed = frequency × wavelength]

(3)

frequency = ... Hz

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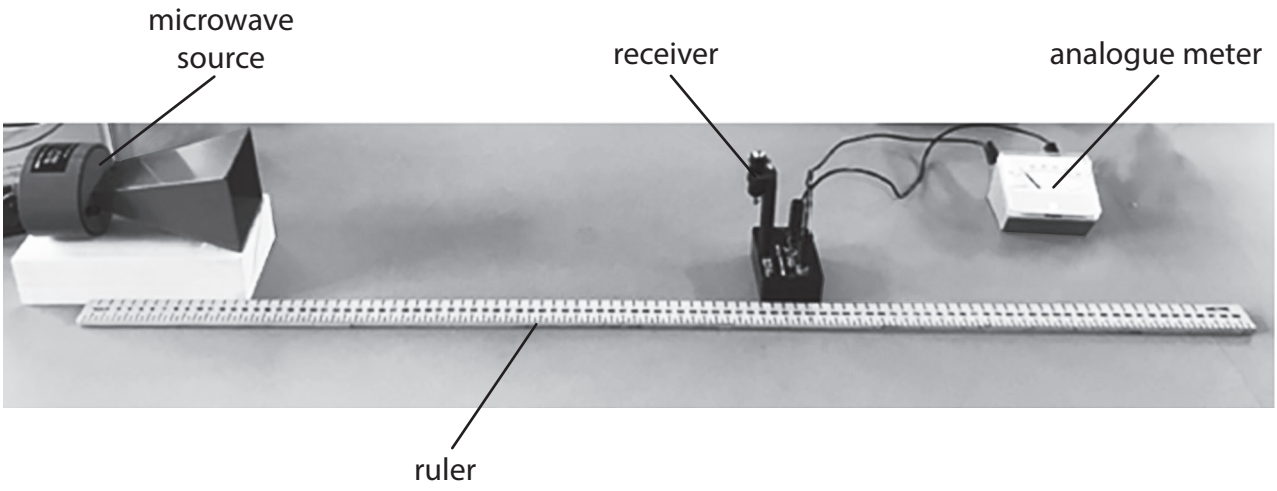
(c) A student uses a microwave source and a receiver to investigate microwaves.

Photograph 1 shows how the student sets up their apparatus.



Photograph 1

The meter shows the strength of the microwaves detected by the receiver.

The strength of the microwaves is measured in arbitrary units.

The student varies the distance between the microwave source and the receiver, and records the meter readings.

(i) Photograph 2 shows the analogue meter for one of the readings.

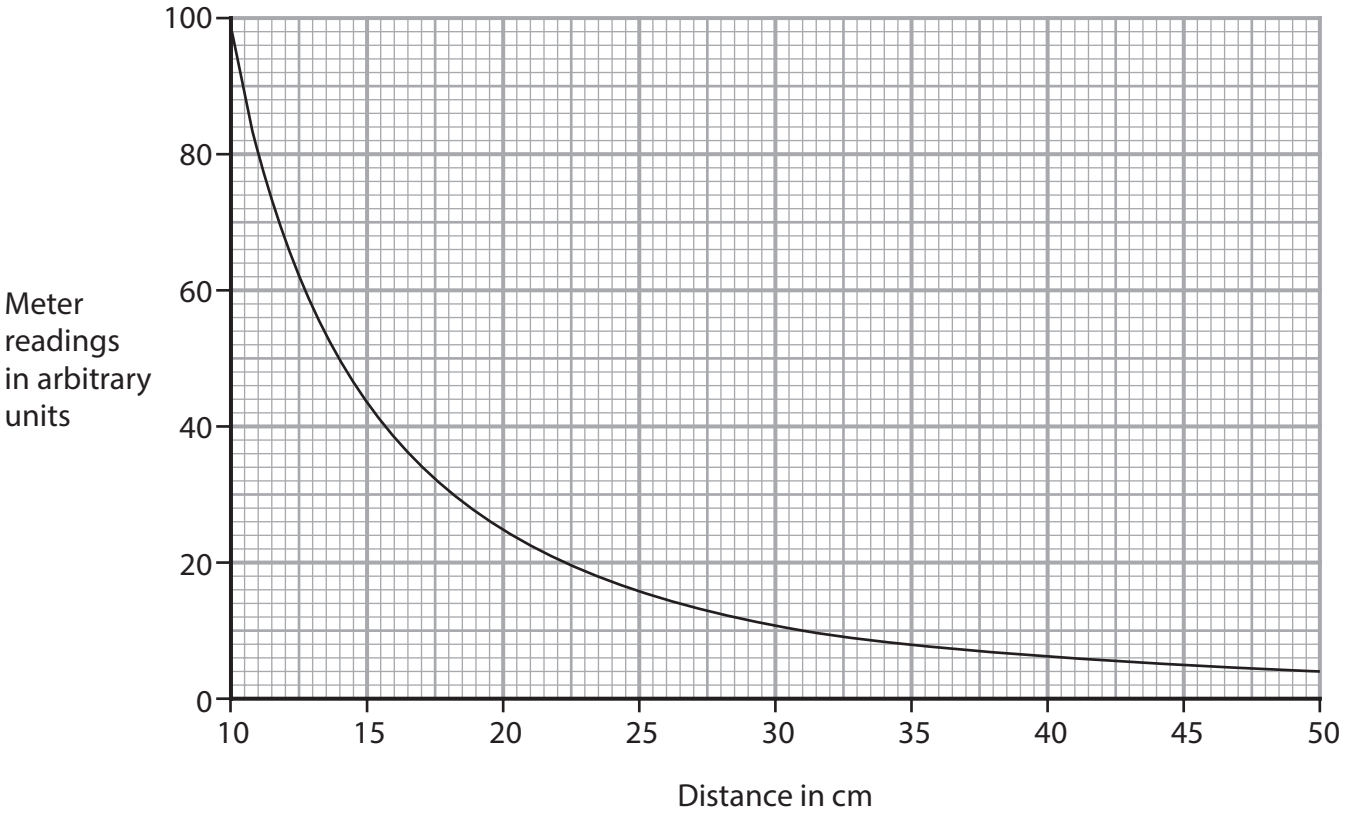
Photograph 2

Give the reading on the analogue meter.

(1)

reading = ... arbitrary units

(ii) The graph shows the results of the student's investigation.



The student concludes that the meter reading is inversely proportional to the distance between the microwave source and the receiver.

To be inversely proportional

meter reading × distance = constant

Comment on the student's conclusion.

You should use data from the graph in your answer.

(4)

(Total for Question 9 = 11 marks)

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10 (a) Describe an investigation to determine the speed of sound.

You may draw a diagram to help your answer.

(5)

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(b) A microphone is connected to an oscilloscope.

A sound is detected by the microphone.

Diagram 6 shows the oscilloscope trace.

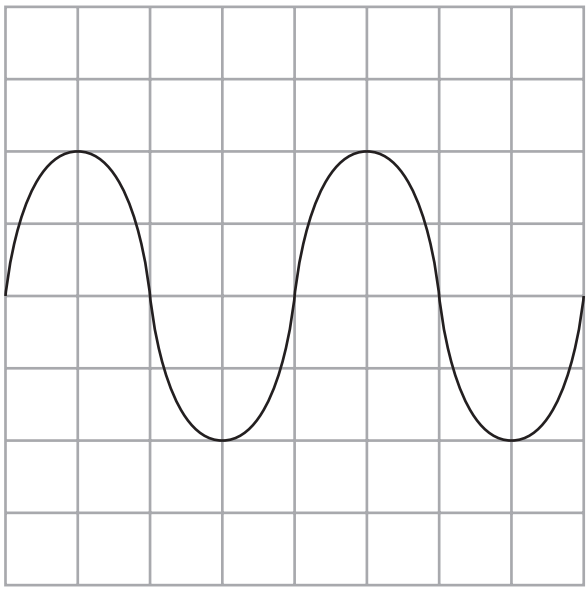

Diagram 6

Oscilloscope settings

y direction: 1 square = 0.1 V

x direction: 1 square = 5.0 ms

(i) Determine the period of the sound wave.

(3)

period = ... s

(ii) Calculate the frequency of the sound wave.

(2)

frequency = ... Hz.

(Total for Question 10 = 10 marks)

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11 (a) Scientific balloons are tested in a laboratory before they are used.

In the first test the pressure of the air inside the balloon is 120 kPa.

The balloon is sealed and has a volume of 92 m^3.

(i) The pressure of the air inside the balloon is reduced to 64 kPa by reducing the external air pressure.

Calculate the new volume of the balloon.

(2)

volume = ... m^3

(ii) Give an assumption that is made in the calculation.

(1)

.....

(b) The pressure of the air in the balloon is returned to 120 kPa.

The temperature of the air inside the balloon is 290 K.

The balloon is tested again, changing the temperature of the air and keeping the volume of the balloon constant.

(i) Explain why the pressure of the air in the balloon decreases when the temperature of the air decreases.

(3)

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(ii) Calculate the temperature of the air when the pressure of the air in the balloon is 64 kPa.

Give your answer in kelvin.

(3)

temperature = ... K

(Total for Question 11 = 9 marks)

TOTAL FOR UNIT = 90 MARKS

Question Number	Answer	Notes	Mark
1(a)	N on left pole and S on right pole;	allow north for N and south for S ignore attempt at labelling poles on far sides of magnets	**1**

Question Number	Answer	Notes	Mark
1(b)	idea that steel is a hard **magnetic** material;	allow steel keeps its magnetism/magnetic field allow steel is hard to demagnetise	**1**

Question Number	Answer	Notes	Mark
1(c)	any two from: MP1. (field) lines are straight; MP2. (field) lines are evenly spaced; MP3. (field) lines are parallel;	allow equivalent statements	**2**

Question Number	Answer	Notes	Mark
1(d)(i)	idea that wire cuts magnetic field lines;	allow wire passes through field lines ignore wire interacting with field lines	**1**

Question Number	Answer	Notes	Mark
1(d)(ii)	any two from: MP1. move wire faster; MP2. move magnets closer together; MP3. use stronger magnets; MP4. turn wire into a coil;	 ignore “bigger” magnets ignore more turns on the coil	**2**

Question Number	Answer	Notes	Mark
2(a)(i)	idea that it decays very quickly / activity will be zero by the time it is injected / there will be no technetium-99m left;	ignore ‘it has a short half-life’	**1**

Question Number	Answer	Notes	Mark
2(a)(ii)	any one from: • idea that gamma can penetrate out of the body; • idea that gamma can be detected outside the body; any one from: • idea that half-life is long enough to complete the procedure; • idea that activity will fall to safe level in a day / quickly;	marks must be from separate lists allow idea that technetium will not be in body for very long	**2**

Question Number	Answer	Notes	Mark
2(b)	harmful effect of gamma radiation given; idea that patient will have procedure very rarely / only when necessary (so risk is low); idea that doctor will administer procedure regularly (so risk is higher) / doctor limits time exposure to patient (to reduce risk);	e.g. • cancer • cell damage • cell mutation allow suggestion that risk to patients is higher as they receive greater dose allow idea that doctor increases distance from patient (to reduce risk)	**3**

Question Number	Answer	Notes	Mark
3(a)	(nuclei with) the same number of protons; (but) different number of neutrons;	allow same atomic number / same element allow different nucleon / mass number /atomic mass	**2**

Question Number	Answer	Mark
3(b)	The only correct answer is **A** (82); *B is incorrect because this is the number of neutrons* *C is incorrect because this is the number of nucleons* *D is incorrect because this is double the proton number + nucleon number*	**1**

Question Number	Answer	Notes	Mark
3(c)(i)	evidence of 3 half-lives; correct evaluation; e.g. 240 ÷ 23 = 30 66 ÷ 3 = 22 (years)	seen anywhere in working	**2**

Question Number	Answer	Notes	Mark
3(c)(ii)	correct atomic and mass numbers used for alpha particle; correct evaluation of number of beta particles; e.g. atomic number of alpha = 2, mass number = 4 (therefore) 2 beta decays (to get back to 82) $^{210}_{82}Pb \rightarrow {}^{206}_{82}Pb + {}^{4}_{2}\alpha + 2\,{}^{0}_{-1}\beta$	seen anywhere in working	**2**

Question Number	Answer	Mark
4(a)	<table><tr><th>Observation</th><th>Supports the Big Bang theory</th></tr><tr><td>Black holes are formed from extremely massive stars</td><td></td></tr><tr><td>Cosmic microwave background radiation is seen in all directions</td><td>✓</td></tr><tr><td>Cosmic rays from space are detected at the Earth's surface</td><td></td></tr><tr><td>Each galaxy contains billions of stars</td><td></td></tr><tr><td>Most galaxies show a red-shift in the light detected from them</td><td>✓</td></tr></table> 1 mark for each correct tick; -1 for each additional tick if more than two ticks seen 5 ticks scores zero	**2**

Question Number	Answer	Mark
4(b)	The only correct answer is **B** (decreases, increases); 1 *A is incorrect because a red giant is more powerful than a main sequence star* *C is incorrect because a red giant is cooler and more powerful than a main sequence star* *D is incorrect because a red giant is cooler than a main sequence star*	**1**

Question Number	Answer	Notes	Mark
4(c)	the brightness/luminosity (of an object); 2 idea of a standard distance;	allow 10 parsecs/32(.6) light years condone incorrect distance	**2**

Question Number	Answer	Notes	Mark
5(a)(i)	input power = output power; OR primary voltage × primary current = secondary voltage × secondary current;	allow • formula in words or symbols • standard abbreviations: i.e. s, p, in, out, 1, 2	**1**

Question Number	Answer	Notes	Mark
5(a)(ii)	substitution; rearrangement; evaluation; e.g. 275 000 × I_p = 230 × 95 (I_p =) 230 × 95 / 275 000 (I_p =) 0.079 (A)	 -1 for POT error 79.45…(A) scores 2 marks allow 0.07945…	**3**

Question Number	Answer	Notes	Mark
5(b)	any five from: MP1. step-up transformer used before transmission; MP2. voltage is increased before transmission; MP3. current is reduced before transmission; MP4. less heating in transmission cables; MP5. less energy wasted in transmission cables; MP6. step-down transformer used after transmission; MP7. voltage is decreased after transmission for safety;	allow any mark if clear from diagram	**5**

Question Number	Answer	Mark
6(a)(i)	The only correct answer is **C** (white); *A is incorrect because its temperature is the second lowest* *B is incorrect because its temperature is the lowest* *D is incorrect because its temperature is the second highest*	**1**

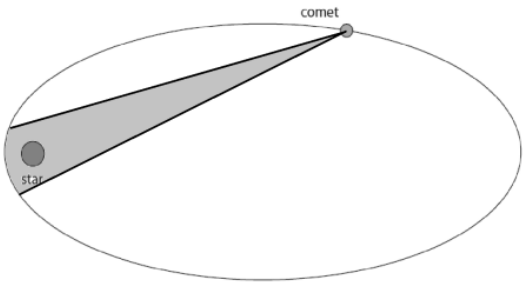
Question Number	Answer	Mark
6(a)(ii)	The only correct answer is **C** (supernova); *A is incorrect because the main sequence is not at the end of the stars life* *B is incorrect because a protostar is not at the end of the stars life* *D is incorrect because the star is too massive enough to form a white dwarf*	**1**

Question Number	Answer	Mark
6(b)(i)	(nuclear) fusion;	**1**

Question Number	Answer	Notes	Mark
6(b)(ii)	Sun becomes a red giant; (then) a white dwarf;	 allow planetary nebula reject mention of supernova, neutron star or black hole for this mark	**2**

Question Number	Answer	Notes	Mark
6(c)(i)	(mass =) 5 x 10^{29} (kg);	Allow 5.3 x 10^{29}, 5.2 x 10^{29}, 5.25 x 10^{29} (kg)	**1**

Question Number	Answer	Notes	Mark
6(c)(ii)	evaluation of time; answer to 1 significant figure; e.g. (time = 5.25 x 10^{29} / 9 x 10^{19} =) 5.8 x 10^{9} (years) (time =) 6 x 10^{9} (years)	allow ecf from (c)(i) allow 5.56 x 10^{9} (years) allow 6 000 000 000, 6 billion years	**2**

Question Number	Answer	Notes	Mark
6(d)	arrow pointing from the comet to the star; force labelled ‘gravitational’;  	accept any arrow pointing from comet to star within shaded area ignore starting position of arrow allow ‘gravity’ or ‘weight’	**2**

Question Number	Answer	Mark
7(a)	arrows drawn on sides WX and YZ one up, one down; 2 arrow on WX down, arrow on YZ up;	**2**

Question Number	Answer	Notes	Mark
7(b)	any four from: MP1. magnetic field around the wire; MP2. interaction between this field and the field from the magnet; MP3. (produces) a force on wire / coil; MP4. forces on opposite sides of the coil are in opposite directions; MP5. coil starts to rotate;	 allow magnetic field overlap also scores MP3 allow coil rotates / turns / spins	**4**

Question Number	Answer	Notes	Mark
7(c)	force (on wire/coil) increases; (therefore) rotation speed is greater;	allow strong magnetic field around wire/coil allow coil spins faster	**2**

Question Number	Answer	Notes	Mark
8(a)	any five from MP1-MP7: apparatus: MP1. method of creating thin beam of light; MP2. protractor; method: MP3. draw round the block; MP4. shine light into the block at an angle to the normal; MP5. mark incident and refracted rays; MP6. measure angles from the normal; MP7. repeat for different angles of incidence; PLUS MP8. graph of sin(i) and sin(r) with n found from gradient	allow marking points from diagram e.g. laser, ray box etc. ignore torch however expressed allow simple use of n=sin(i)/sin(r)	**6**

Question Number	Answer	Mark
8(b)	optical fibres; named prismatic use e.g. cats eye reflector, binoculars, periscope etc;	**2**

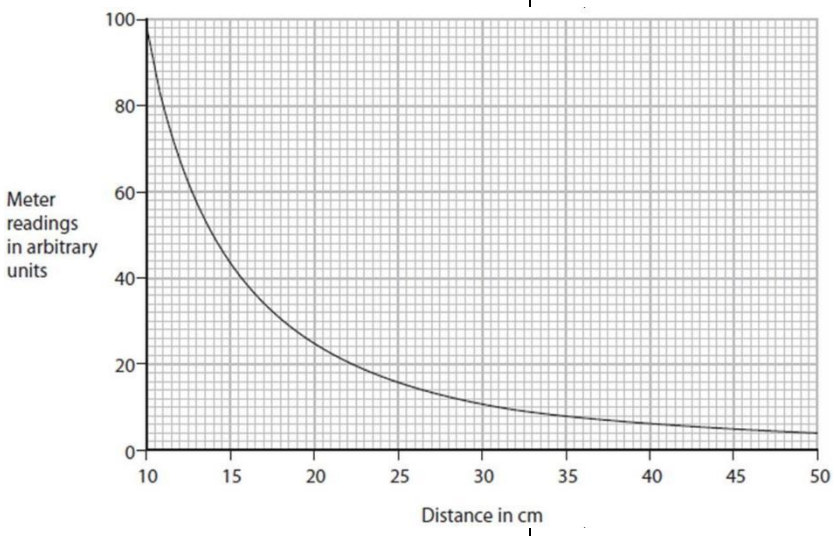
Question Number	Answer	Mark
9(a)(i)	amplitude in the range of 0.8 – 0.9 (cm);	**1**

Question Number	Answer	Mark
9(a)(ii)	wavelength in the range 3.9 – 4.0 (cm);	**1**

Question Number	Answer	Notes	Mark
9(b)(i)	radio (waves);	allow radio frequency reject radioactive (waves), radiation (waves)	**1**

Question Number	Answer	Notes	Mark
9(b)(ii)	substitution; rearrangement; evaluation; e.g. 3.0×10^8 = frequency x 0.027 (frequency =) $3.0 \times 10^8 / 0.027$ (frequency =) 1.1×10^{10} (Hz)	allow wavelength substitution in cm or m -1 if POT error allow $1.11\ldots \times 10^{10}$ (Hz)	**3**

Question Number	Answer	Mark
9(c)(i)	68;	**1**

Question Number	Answer	Notes	Mark
9(c)(ii)	relationship is not inversely proportional; correct calculation of constant for one pair of readings correct calculation of constant for second pair of readings; statement to show meter reading × distance is not constant;  	allow conclusion is incorrect	**4**

Question Number	Answer	Notes	Mark
10(a)	any five from: MP1. outlines a viable method; MP2. realistic values suggested for experiment to work; MP3. suitable measuring instrument named; MP4. further detail of setup; MP5. idea of repeats AND average; MP6. Correct formula for described method;	a fully labelled diagram can score all the marks e.g. • measuring time for a known distance • measuring wavelength for a known frequency e.g. • at least 1m for microphones/sound sensors and oscilloscope/data logger method • at least 100m for seeing and hearing a clap method • at least 50m for wall and echo method wavelength measured at least 10cm e.g. stop clock, stopwatch, ruler, tape measure, oscilloscope, trundle wheel, timer e.g. • start timing when see a clap and stop when hear it • clap by wall and time how long for clap to come back • moving a microphone until waveforms line up on oscilloscope • for echo method, idea time and distance is "there and back" allow repeats AND identifying anomalies e.g. • speed = distance / time • speed = frequency × wavelength	**5**

Question Number	Answer	Notes	Mark
10(b)(i)	period represented by 4 squares; correct use of x-scale; correct evaluation; e.g. period = 4 squares period = 4 × 5.0 ($\times 10^{-3}$) period = 20 ms = 2.0 × 10^{-2} (s)	allow ECF from wrong number of squares if clear in working -1 POT error answer of 0.01, 0.04 (s) scores 2 marks allow 0.02(s)	**3**

Question Number	Answer	Notes	Mark
10(b)(ii)	substitution into given formula; correct evaluation; e.g. frequency = 1 / 0.02 frequency = 50 (Hz)	allow ECF from (i)	**2**

Question Number	Answer	Notes	Mark
11(a)(i)	rearrangement OR substitution into given formula; evaluation; e.g. $V_2 = p_1 \times V_1 / p_2$ OR 120 × 92 = 64 × V_2 (volume =) 170 (m^3)	 allow 172, 173, 172.5	**2**

Question Number	Answer	Notes	Mark
11(a)(ii)	constant temperature / amount of air / mass of air;	however expressed e.g. number of particles constant	**1**

Question Number	Answer	Notes	Mark
11(b)(i)	any three from: MP1. (reduction in temperature) reduces speed/KE of particles; MP2. idea of fewer collisions with walls per unit time; MP3. idea of each collision with wall being less 'hard'; MP4. force (per unit area) on the container decreases;	 allow particles collide with walls less often	**3**

Question Number	Answer	Notes	Mark
11(b)(ii)	substitution into given formula; rearrangement; evaluation; e.g. 120 / 290 = 64 / T_2 T_2 = (64 × 290) / 120 (temperature =) 150 (K)	 allow 155, 154.6… (K)	**3**

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