

PHYSICS



EXAM QUESTION PACK

TOPIC 10: ELECTRICITY AND CIRCUITS (PACK 1)

SCORE

/132

PERCENTAGE

%

STEMUP

These questions belong to Pearson Edexcel, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by Pearson Edexcel. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with Pearson Edexcel and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. Pearson Edexcel has not endorsed, approved or been involved in the production of it. Pearson Edexcel and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

Pearson Edexcel publishes its past papers, mark schemes and examiner reports. Always check the current specification at [qualifications.pearson.com](https://www.pearson.com/qualifications) before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

* Explain, with the aid of a circuit diagram, the method a student could use to investigate how the resistance of a single lamp changes with the potential difference across the lamp.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

Q2.

A student investigates resistors connected in parallel using a number of resistors. Each resistor has the same resistance.

Figure 10 shows a circuit diagram with one resistor, R.

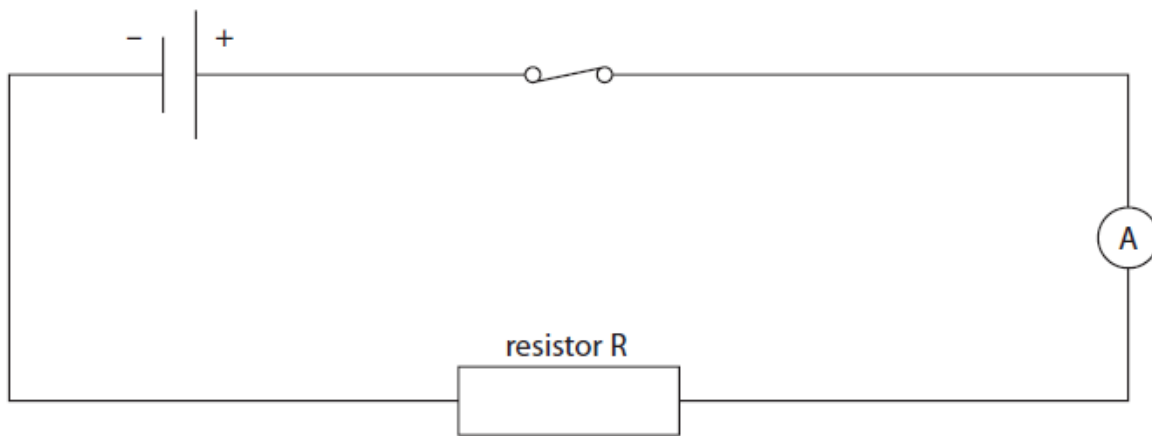


Figure 10

(i) Add to Figure 10:

- a voltmeter to find the potential difference across resistor R
- another resistor in parallel with resistor R.

(2)

(ii) State the measurements that the student must take to find the overall resistance of the resistors in parallel.

(2)

.....

.....

.....

.....

(iii) The student investigates how the overall resistance of the circuit changes when additional resistors are added in parallel to R.

Each resistor has the same resistance.

Figure 11 shows the results of the student's investigation.

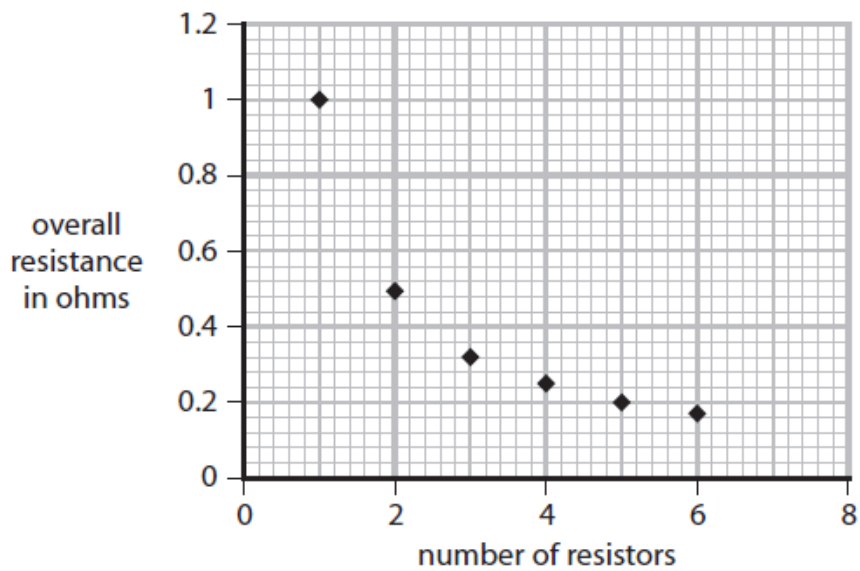


Figure 11

State the resistance of a single resistor.

(1)

resistance = ... Ω

(iv) Comment on the relationship between the overall resistance of the circuit and the number of resistors in parallel.

Use information from Figure 11 to support your answer.

(3)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 8 marks)

Q3.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The technician connects four devices to the car battery.

Each device is connected to its own switch and its own fuse.

Figure 9 shows how the four devices, fuses and switches are connected.

The current in each device is shown next to the device.

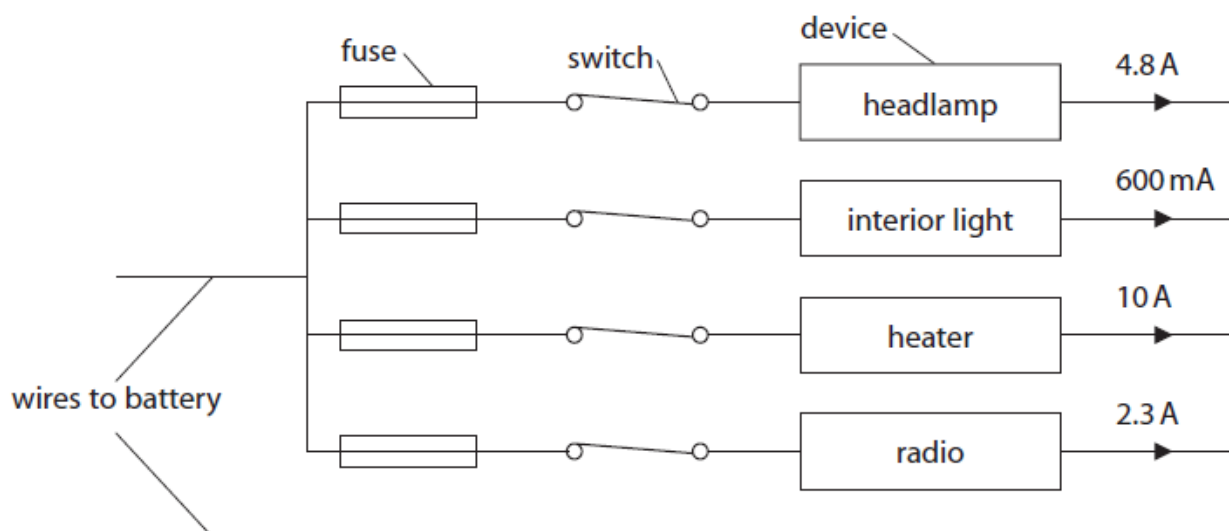


Figure 9

(i) Calculate the current in the wires to the battery when all the devices are switched on.

(1)

current = ... A

(ii) State how the overall resistance of the circuit changes when any one of the devices is switched off.

(1)

.....
.....

(iii) There is a current of 2.3 A in the radio when the radio is working correctly.

Which of these should the technician choose to protect the radio circuit?

(1)

☒ **A** 2 A fuse

☒ **B** 5 A fuse

☐ C 10 A fuse

☐ D 13 A fuse

(iv) Explain why the wires to the battery in a car are thicker than the wires that connect each device to its switch and its fuse.

(2)

.....

.....

.....

.....

(Total for question = 5 marks)

Q4.

A student investigates moments of forces.

Figure 14 shows the apparatus used.

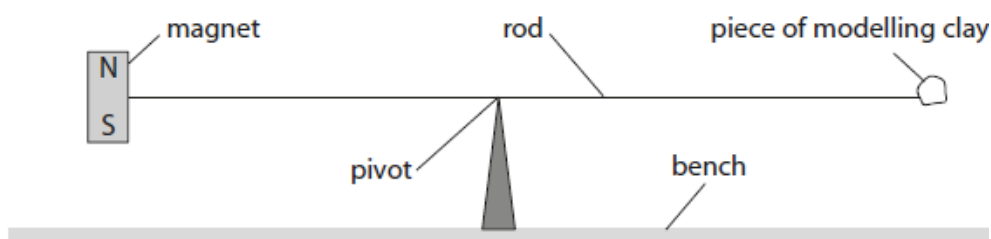


Figure 14

The pivot is under the centre of the rod.

A magnet is fixed to one end of the rod.

A piece of modelling clay is fixed to the other end of the rod.

The system is in equilibrium.

(a) The student fixes a coil to the bench under the magnet as shown in Figure 15.

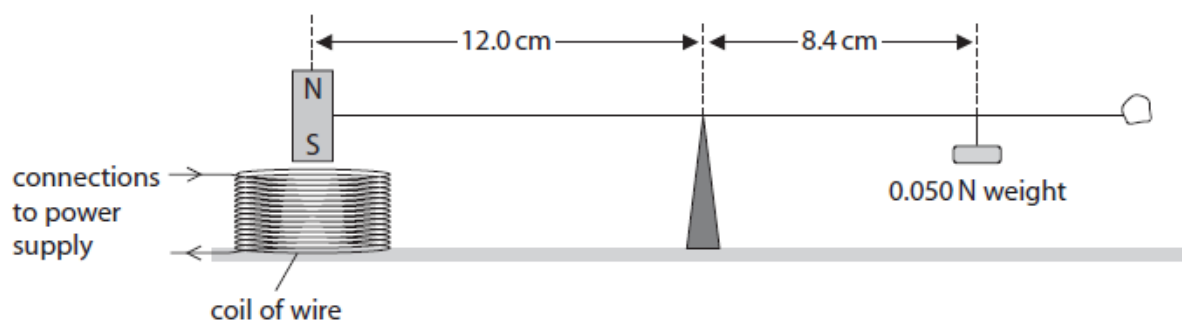


Figure 15

The coil of wire is connected to a d.c. power supply so that there is a current in the coil.

To bring the system back into equilibrium, the student hangs a 0.050 N weight on the rod, 8.4 cm away from the pivot, as shown in Figure 15.

Calculate the size of the force between the magnet and the coil.

(3)

force = ... N

(b) Describe how the student could develop the investigation to determine if the size of the force between the magnet and the coil is directly proportional to the size of the current in the coil.

(4)

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 7 marks)

Q5.

Figure 14 show a rack and pinion system, used on a mountain railway.

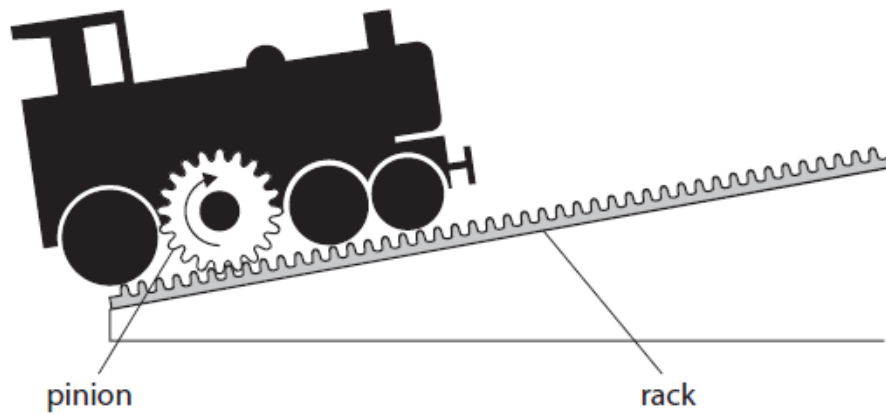


Figure 14

The teeth on the rack are 8.0 cm apart.

Calculate how far along the rack the train moves when the pinion turns through one complete revolution.

(2)

distance = ... m

(Total for question = 2 marks)

Q6.

An electric heater is connected to a 230 V supply.

The power supplied to the heater is 2.6 kW.

Calculate the current in the heater.

(3)

current = ... A

(Total for question = 3 marks)

Q7.

Figure 3 is a diagram of the forces acting on a swing.

The swing is not moving.

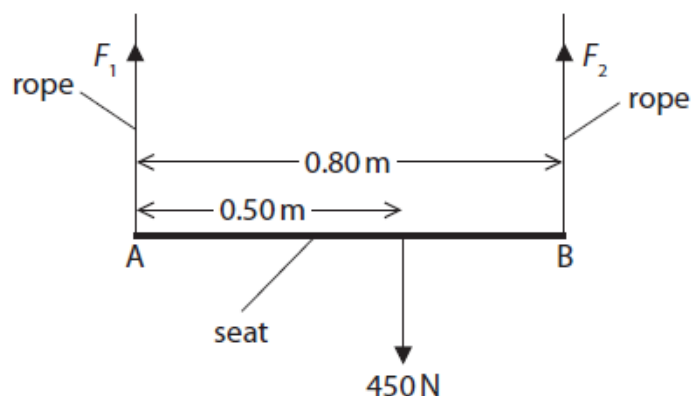


Figure 3

The seat of the swing, AB, is 0.80 m long.

A person of weight 450 N sits on the seat.

The person's weight acts at a distance of 0.50 m from A as shown in Figure 3.

Ignore the weight of the seat.

The upward forces exerted by the ropes on the seat are F_1 and F_2 .

Calculate the force F_2 by taking moments about A.

(3)

force F_2 = ... N

(Total for question = 3 marks)

Q8.

A different circuit is then set up with two resistors as shown in Figure 12.



Figure 12

(i) Calculate the potential difference across the 15 Ω resistor.

(2)

potential difference = ... V

(ii) Calculate the total power dissipated when there is a current of 0.20 A in the two resistors.

Use the equation

$$P = I^2 \times R$$

(2)

power produced W

(Total for question = 4 marks)

Q9.

Figure 10 shows two electrical devices for heating water.

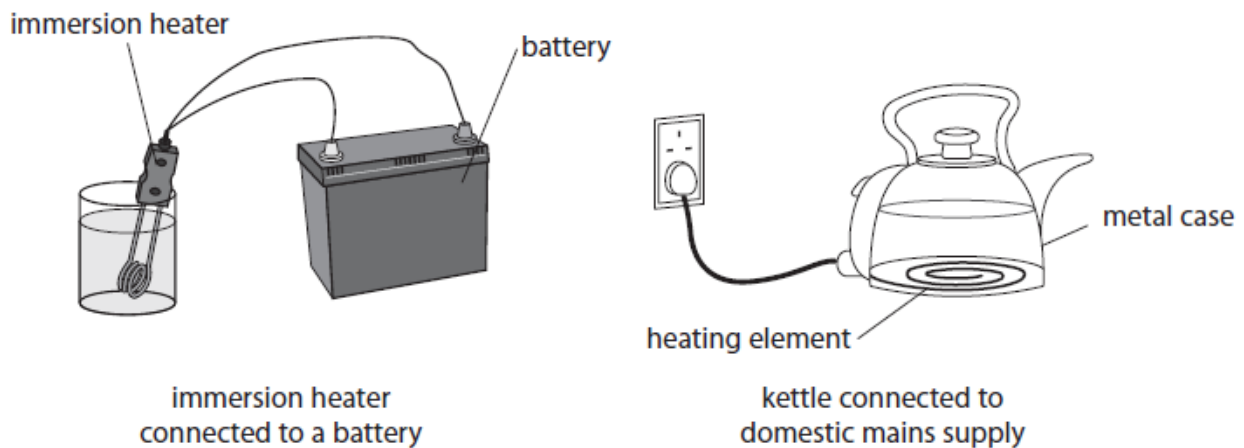


Figure 10

(i) The current in the element of the immersion heater is 14 A.

The power of the immersion heater is 130 W.

Calculate the resistance of the immersion heater.

Give your answer to two significant figures.

(3)

resistance of immersion heater = ... Ω

(ii) The current in the heating element of the kettle is 8.3 A.

State **two** differences between the movement of charge in the heating element of the kettle and the movement of charge in the immersion heater.

- 1
-
- 2
-

(Total for question = 5 marks)

Q10.

Figure 1 shows a lamp connected to a d.c. power supply.

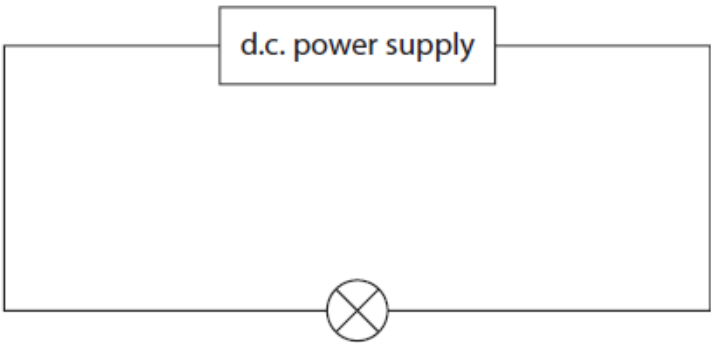


Figure 1

The power supply provides a potential difference (voltage) of 4.5 V.

The current in the lamp is 0.30 A.

(i) Calculate the resistance of the lamp.

Use the equation

$$R = \frac{V}{I}$$

(1)

resistance = ... Ω

(ii) Calculate the power supplied to the lamp.

(2)

power = ... W

Q11.

Figure 8 shows a bicycle.

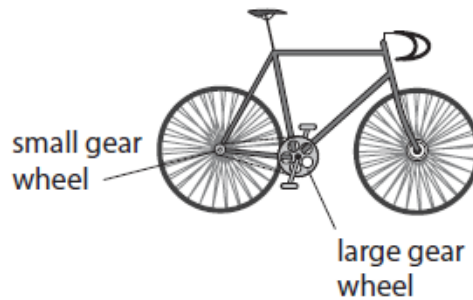


Figure 8

(i) The rider uses the pedals to make the large gear wheel turn.

The large gear wheel moves the chain.
The chain turns the small gear wheel.

The large gear wheel has 48 teeth.

The small gear wheel has 12 teeth.

The large gear wheel turns 2 times each second.

Calculate the number of times that the small gear wheel turns each second.

(2)

..... turns each second

(ii) Oil is applied to the wheel of a bicycle at the point shown in Figure 9.

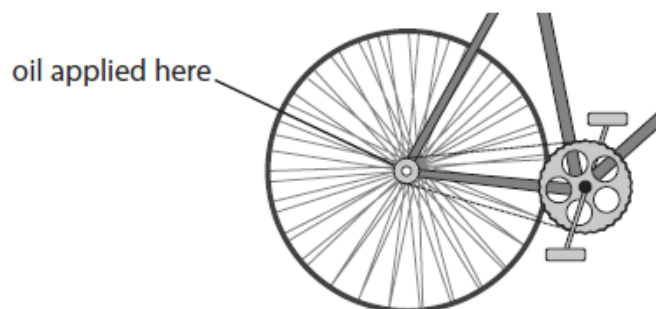


Figure 9

Explain how the oil improves the efficiency of the bicycle.

.....

.....

.....

.....

.....

.....

(Total for question = 5 marks)

Q12.

A student investigates how the current in a lamp changes with the potential difference across the lamp.

The student uses the results to calculate the resistance of the lamp.

The results are shown in the table in Figure 2.

potential difference in V	current in A	resistance in Ω
1.0	0.09	11
2.0	0.14	14
3.0	0.18	17
4.0	0.22	18
5.0	0.26	
6.0	0.30	20

Figure 2

(i) One value of resistance is missing from the table in Figure 2.

Calculate the value of resistance that is missing from the table.

missing resistance = ... Ω

(ii) The student writes this conclusion:

'The resistance of the lamp is directly proportional to the potential difference.'

Comment on the student's conclusion.
Use information from Figure 2 in your answer.

(3)

.....

.....

.....

.....

.....

.....

(iii) The student used a power supply that had fixed output voltage settings.
Each of these outputs was a whole number of volts.

Describe how the student could add a component to the circuit that would provide a continuously variable voltage across the lamp.

(2)

.....

.....

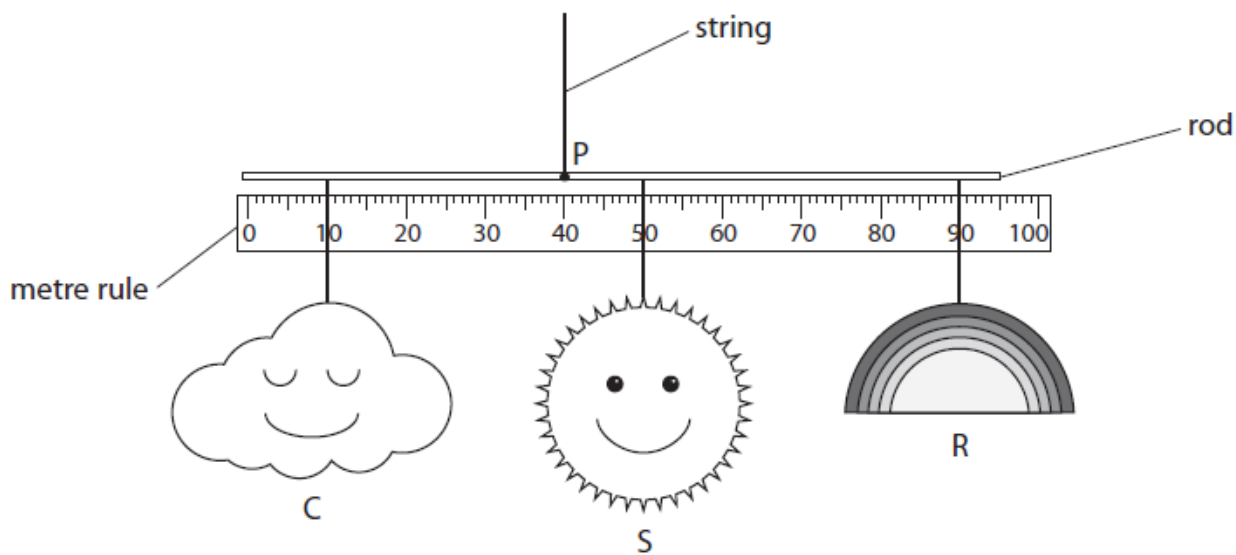
.....

.....

(Total for question = 8 marks)

Q13.

Figure 13 shows a toy that a student makes for a nursery school.
for a nursery school. The rod hangs by a string from the ceiling.



weight of S = 2.0 N

weight of R = 1.0 N

Figure 13

(i) The moment of C about point P is 0.60 Nm.

Calculate the weight of C.

Use the equation

$$\text{moment} = F \times d$$

(2)

weight of C N

(ii) Show that the total moment of S and R about P is 0.70 N m.

(2)

(iii) Using the data in the question and the principle of moments, determine if the toy shown in Figure 13 is in equilibrium.

The rod is very light so its weight can be ignored.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 7 marks)

Q14.

Figure 23 shows an electric car connected to a battery charger.



(Source: © Danil Roudenko/123RF)

Figure 23

The car has a rechargeable battery to drive its motor.

The rechargeable battery provides a potential difference of 330 V and can store up to 64 MJ.

It takes 8 hours for the battery to receive a full charge.

Assume that the charging process is 100% efficient.

(a) Calculate the total charge that flows while the battery is being charged.

(3)

total charge = ... C

(b) Calculate the average charging current.

(3)

current = ... A

(Total for question = 6 marks)

Q15.

Figure 12 shows three toy animals hanging from a rod.

The rod hangs from the ceiling by a string tied to the centre of the rod.

The system is in equilibrium.

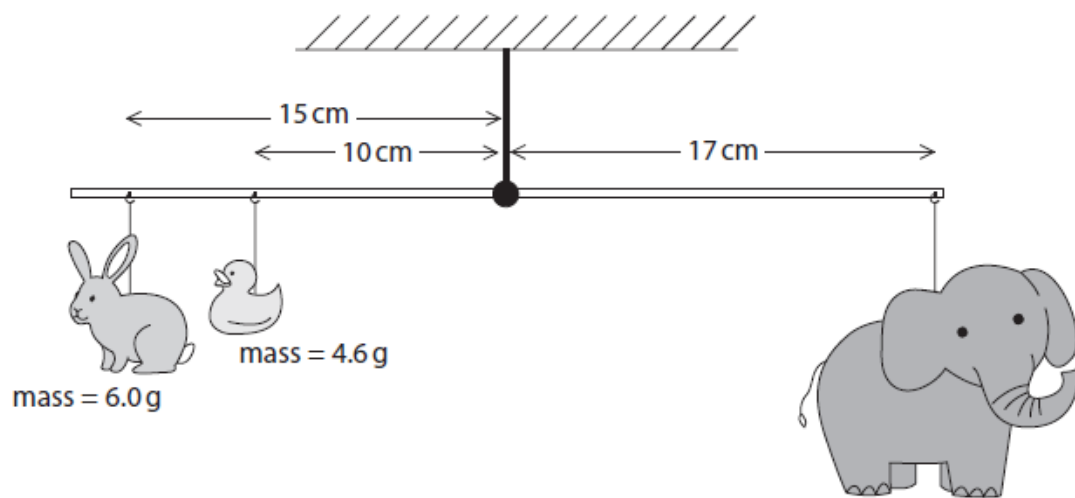


Figure 12

Use the principle of moments to calculate the mass of the toy elephant.

(4)

mass = ... g

(Total for question = 4 marks)

Q16.

The espresso machine shown in Figure 27 is an electrical appliance.



(Source: © tanawaty/123RF)

Figure 27

The espresso machine has an electrical heater connected to a 440 V mains supply.

The power of the electrical heater is 3.5 kW.

(i) The rating of a fuse is the current above which it melts.

Which of these is the most suitable fuse for the espresso machine circuit?

(1)

- ☒ **A** 1 A
- ☒ **B** 5 A
- ☒ **C** 10 A
- ☒ **D** 13 A

(ii) Before the espresso machine can be used, its heater must raise the temperature of some cold water.

The specific heat capacity of water is 4200 J/kg K.

Show that it takes the heater about 90 s to raise the temperature of 1 kg of water from 18°C to 95°C.

Use an equation from the formula sheet.

(3)

(Total for question = 4 marks)

Q17.

Draw a circuit diagram you could use to investigate the relationship between potential difference, current and resistance for a filament lamp.

(3)

(Total for question = 3 marks)

Q18.

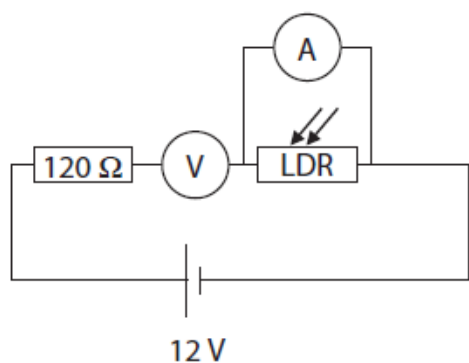
(a) A technician investigates a light-dependent resistor (LDR) connected in series with a $120\ \Omega$ resistor and a voltage source.

The technician measures the voltage across the LDR and also the current in the LDR.

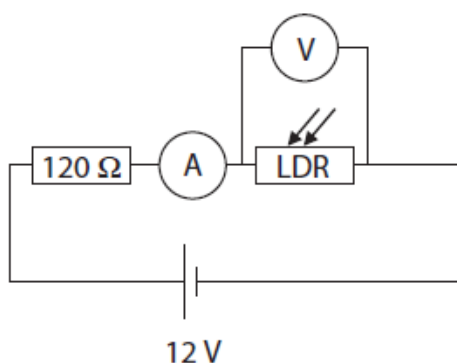
(i) Which **one** of these circuits should the technician use?

Put a cross (☒) in the box next to your answer.

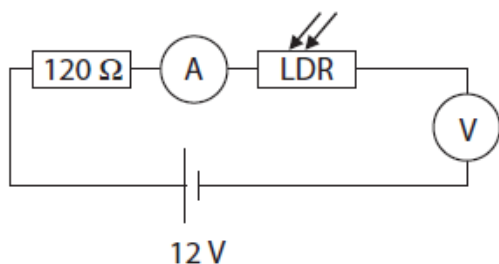
(1)



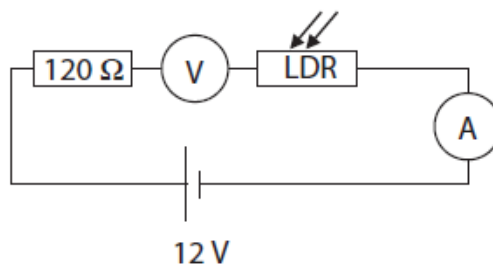
☐ A



☐ B



☐ C



☐ D

(ii) When the LDR is in bright sunlight, its resistance is 185 Ω .
The voltage across the LDR is then 7.2V.

Show that the current in the LDR is about 0.039 A.

(2)

(iii) Complete the sentence by putting a cross (☒) in the box next to your answer.

The current in the 120 Ω resistor is

(1)

- ☐ **A** much more than the current in the LDR
- ☐ **B** much less than the current in the LDR
- ☐ **C** the same as the current in the LDR
- ☐ **D** the opposite of the current in the LDR

(iv) The technician repeats the readings with the LDR in different light conditions.

The table gives two of the readings.

light condition	current in LDR
bright sunlight	0.039 A
cloudy skies	0.028 A

Explain why the two current readings are different.

(2)

.....

.....

.....

.....

*(b) The photograph shows a temporary traffic sign.



The traffic sign uses many small lights all powered by a rechargeable battery. These lights need to be very bright during the day so that they can be seen clearly. They do not need to be as bright at night.

Explain how using a light-dependent resistor can make the energy stored in the battery last longer.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Q19.

Figure 14 shows a demolition ball of mass 400 kg.

The ball is used to demolish a wall.

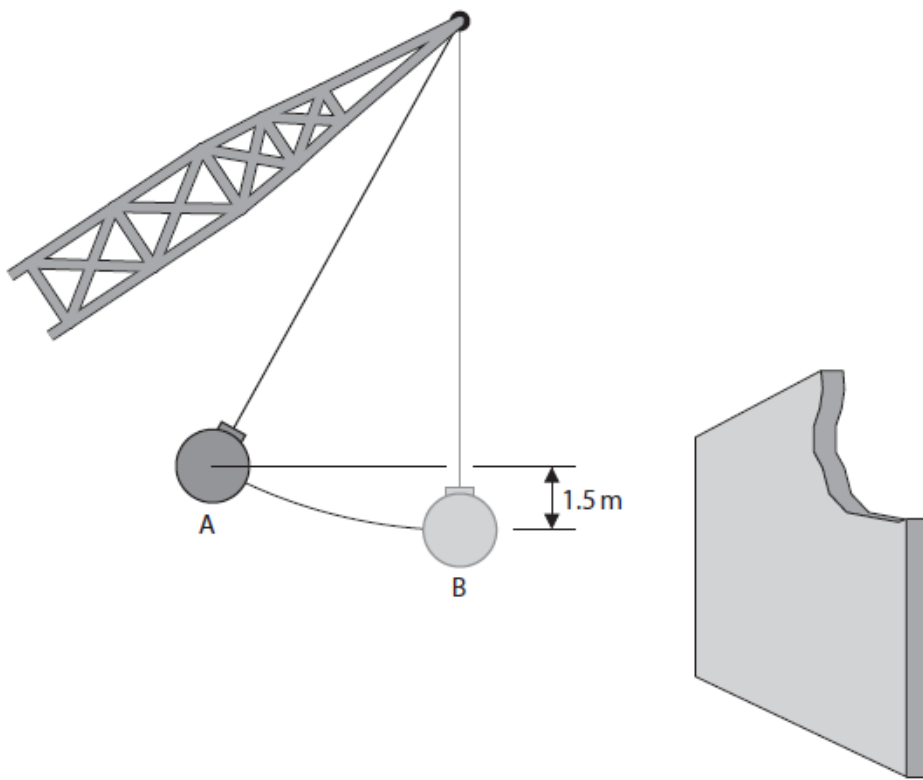


Figure 14

As the ball swings from A to B, it moves through a vertical height of 1.5 m.

(i) Calculate the change in gravitational potential energy.

Take gravitational field strength, g , to be 10 N/kg.

(3)

(ii) The heavy ball comes to rest soon after smashing into the wall. In doing this, the temperatures of the ball, wall and surroundings all increase slightly.

Explain this observation.

(2)

.....

.....

.....

.....

(iii) Which of these quantities of the ball changes in **both** magnitude and direction while the ball is swinging?

Put a cross (☒) in the box next to your answer.

(1)

☒ **A** gravitational potential energy

☐ **B** velocity

- ☐ **C** the gravitational force acting
- ☐ **D** kinetic energy

(Total for question = 6 marks)

Q20.

Some forces act at a distance.

One example is the gravitational attraction between the Moon and the Earth.

Describe an example of another type of force acting at a distance, where the force is **not** gravitational.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q21.

Figure 1 shows the results from an experiment where the potential difference (voltage) across a filament lamp was varied.

The current and voltage were measured.

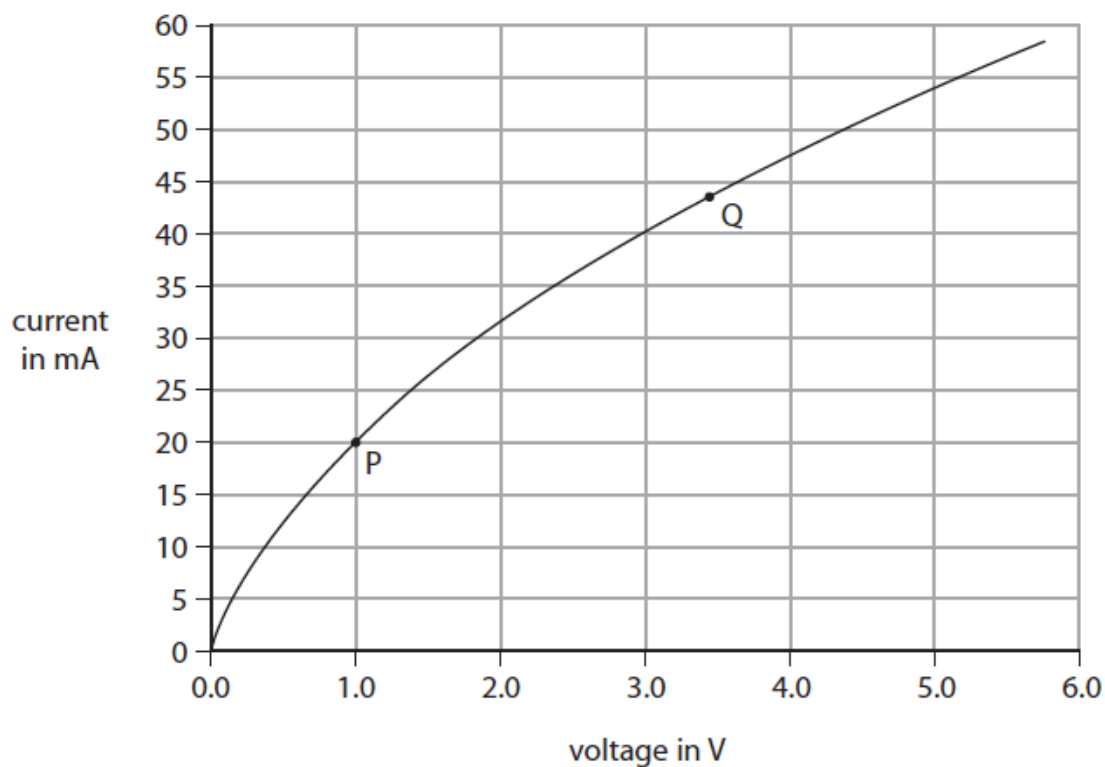


Figure 1

(i) Describe the relationship between the current and the voltage as shown in the graph in Figure 1.

(2)

.....

.....

.....

.....

(ii) Use the values of the voltage and current at point P and at point Q on the graph in Figure 1 to complete the table in Figure 2.

(2)

	voltage in V	current in mA
point P		
point Q		

Figure 2

(iii) Calculate the resistance of the filament lamp when the voltage is 4.5 V and the current is 51 mA.

Use the equation

$$R = \frac{V}{I}$$

(2)

resistance = ... Ω

(iv) Explain why the resistance of the filament lamp changes as the voltage across it increases.

(3)

.....

.....

.....

.....

.....

.....

(Total for question = 9 marks)

Q22.

A student investigates moments of forces.

Figure 14 shows the apparatus used.

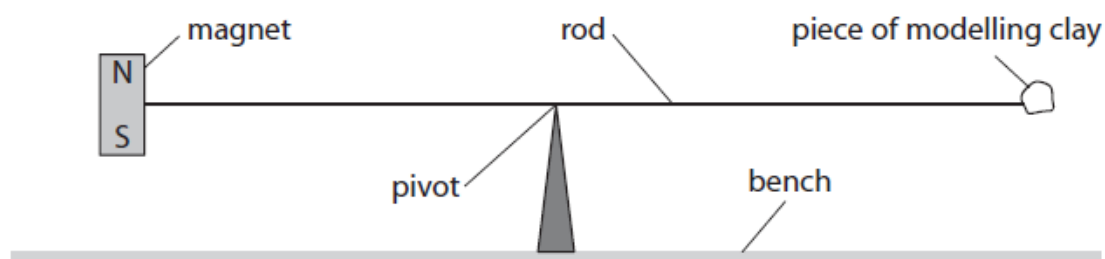


Figure 14

The pivot is under the centre of the rod.

A magnet is fixed to one end of the rod.

A piece of modelling clay is fixed to the other end of the rod.

The system is in equilibrium.

The student reverses the direction of the current in the coil.
Describe how the student can bring the system back into equilibrium without making any changes to the magnet.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q23.

A student investigates how the resistance of a thermistor varies with temperature.

Figure 7 shows a graph of the results of this investigation.

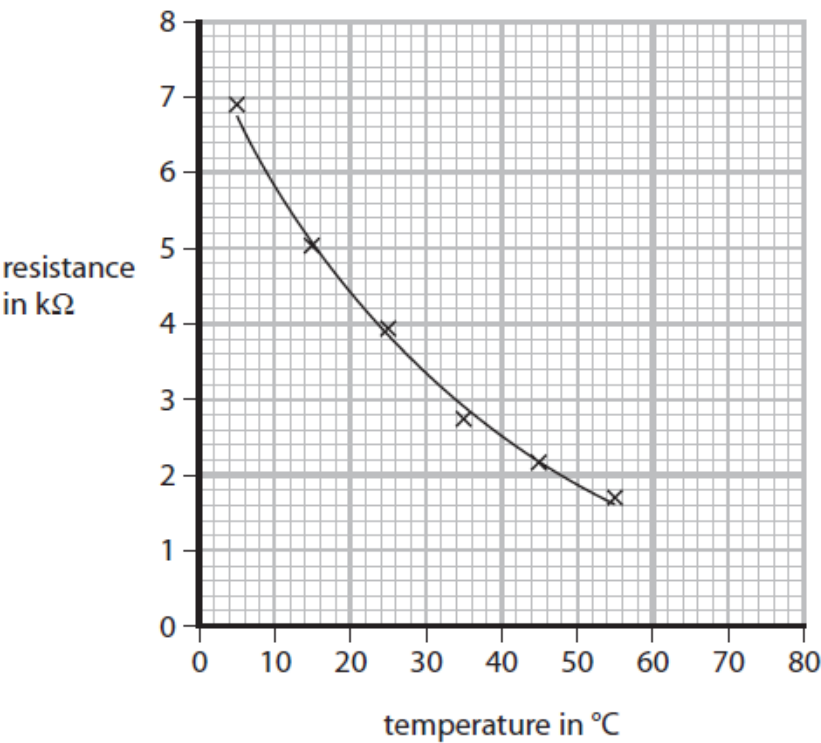


Figure 7

(i) Describe how the resistance of this thermistor varies with temperature.

(2)

.....

.....

.....

.....

(ii) Draw the tangent to the curve at a temperature of 30 °C, to find the rate of change of resistance with temperature at 30 °C.

State the unit.

(3)

rate of change of resistance with temperature at 30 °C = ... unit
.....

(Total for question = 5 marks)

Q24.

Figure 7 shows a drone.



© Liubov Kotliar/123RF

Figure 7

The drone has four spinning blades.

The upward force produced enables the drone to rise in the air.

The speed at which the blades spin is measured in turns per minute.

Figure 8 shows how the upward force produced by the four blades depends on the speed at which the blades spin.

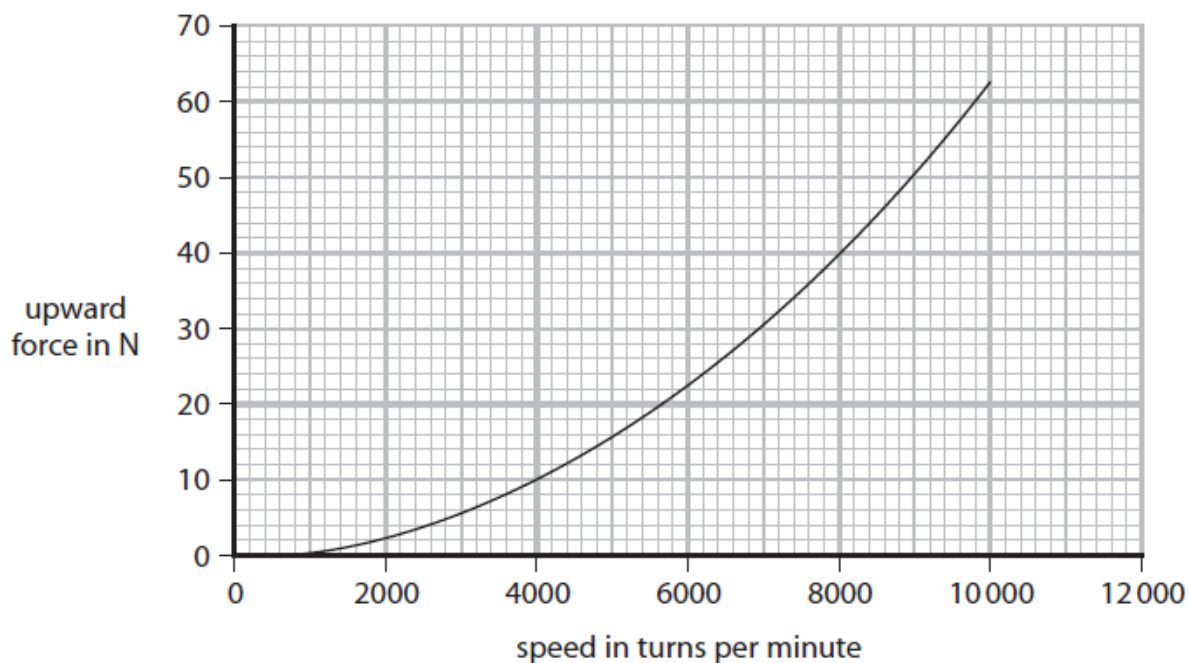


Figure 8

Describe the relationship between upward force and speed shown by this graph.

(2)

.....

.....

.....

.....

(Total for question = 2 marks)

Q25.

A student is given a low voltage power supply and 1 m of resistance wire.

The student uses these and other pieces of equipment to measure the resistance of just 50 cm of the resistance wire.

Draw a diagram of the circuit that the student should use.

Your circuit diagram should identify the pieces of equipment that the student uses.

(3)

Q26.

Figure 23 shows two small boats pulling a much larger ship.

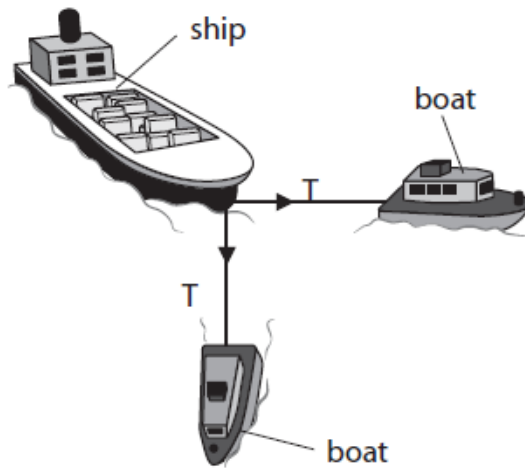


Figure 23

The ship is connected to the boats with ropes.

The tension, T , in each of the ropes has a magnitude of 20 kN.

The ropes are at right angles to each other.

Draw a vector diagram and use it to determine the resultant force that the boats exert on the ship.

(4)

magnitude of resultant force on the ship = ... kN

(Total for question = 4 marks)

Q27.

Figure 7 shows two astronauts in space pushing at a satellite.

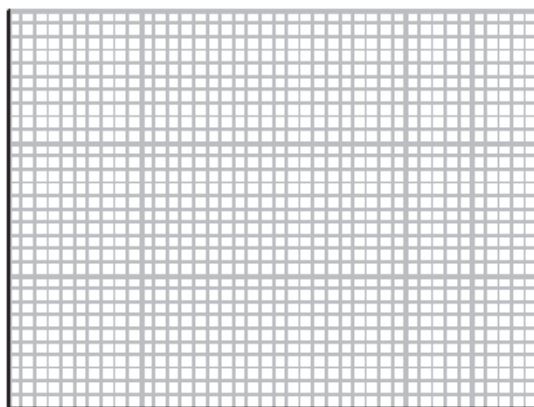


Figure 7

(i) The force F_1 is 3.0 N and the force F_2 is 2.0 N, acting at right angles to each other.

Draw a vector diagram to scale showing these forces.

(2)



(ii) Use the diagram in (i) to estimate the magnitude of the resultant force acting on the satellite.

(2)

resultant force = ... N

(Total for question = 4 marks)

Q28.

A man monitors how much money he spends on electricity.
He uses a device which calculates the cost of electrical energy used.
He connects his 2.9 kW electric kettle to the 230 V mains supply.

(i) Calculate the current in the kettle element.

(3)

current = ... A

(ii) The device shows that in one week the total cost of the electrical energy used by the kettle is 97 p.

1kW h of electrical energy costs 17 p.

Calculate the length of time for which the kettle has been switched on during the week.

(3)

time = ... hours

Q29.

A resistor is connected to a power supply.

The potential difference across the resistor is 6.0 V.

(i) Which of these corresponds to a potential difference of 6.0 V?

(1)

☐ **A** 6.0 joules per ohm

☐ **B** 6.0 amps per coulomb

☐ **C** 6.0 joules per coulomb

☐ **D** 6.0 amps per ohm

(ii) The resistor remains connected for a period of time.

The current in the resistor is 200 mA.

A total charge of 42 C flows through the resistor.

Calculate, in minutes, the time taken for this amount of charge to flow through the resistor.

(3)

time = ... minutes

(iii) Calculate the total energy transferred by the 6.0 V power supply when a charge of 42 C flows through the resistor.

(2)

energy = ... J

Q30.

*Figure 24 shows a wooden block connected to a weight by a string. The string goes over a pulley.

The surfaces of the table and the wooden block are both rough.

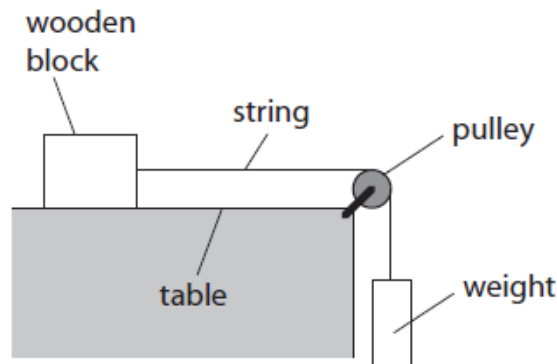


Figure 24

The wooden block moves across the table at a constant horizontal velocity.

Several vertical and horizontal forces act on the wooden block as it moves.

Explain how the forces keep the wooden block moving across the table at a constant horizontal velocity.

Your answer should refer to all forces acting on the wooden block.

You may add to the diagram to help with your answer.

(6)

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

(Total for question = 6 marks)

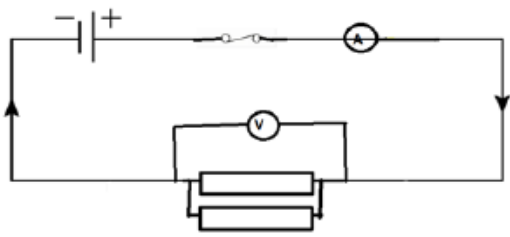
Mark Scheme

Q1.

Question Number	Answer	Mark
*	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. AO1(6 marks) Circuit diagram including - power supply - ammeter - voltmeter - filament lamp - means of varying potential difference Description of method - measure current with ammeter - measure potential difference with voltmeter - vary the potential difference - calculate the resistance - repeat and compare	(6) AO 1 2

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	- An explanation that demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific, enquiry, techniques and procedures lacks detail. (AO1) - Presents an explanation that is not logically ordered and with significant gaps. (AO1)
Level 2	3-4	- An explanation that demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry, techniques and procedures is not fully detailed and/or developed. (AO1) - Presents an explanation of the procedure that has a structure, which is mostly clear, coherent and logical with minor steps missing. (AO1)
Level 3	5-6	- An explanation that demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry, techniques and procedures is detailed and fully developed. (AO1) - Presents an explanation that has a well-developed structure, which is clear, coherent and logical. (AO1)

Q2.

Question number	Answer	Additional guidance	Mark
(i)	 voltmeter in parallel across resistor (1) second resistor in parallel (1)		(2)

Question number	Answer	Additional guidance	Mark
(ii)	potential difference/ voltage (drop across resistors in parallel) (1) current (in the circuit) (1)	voltmeter reading ammeter reading	(2)

Question number	Answer	Additional guidance	Mark
(iii)	1 Ω	one ohm	(1)

Question number	Answer	Additional guidance	Mark
(iv)	Comments to include: the (overall) resistance decreases as the number of resistors (in parallel) increases (1) the relationship is non-linear (1) any two relevant values from the graph (1)	decreases at a decreasing rate the relationship is inversely proportional scores first 2 marks	(3)

Q3.

Question number	Answer	Additional guidance	Mark
(i)	17.7 (A)		(1) AO1

Question number	Answer	Additional guidance	Mark
(ii)	(The resistance) increases		(1) AO1

Question number	Answer	Additional guidance	Mark
(iii)	B 5 A fuse A is incorrect because it has a smaller value than the expected current C and D are incorrect because they have a much higher value than the expected current		(1) AO1

Question number	Answer	Additional guidance	Mark
(iv)	An explanation linking two of thick(er) wires have low(er) resistance (1) less thermal energy transferred (in the wires)(1) less potential difference / voltage (drop) across the wires (1)	allow reverse argument allow so wires do not get hot allow less voltage is lost more current can be carried	(2) AO1

Q4.

Question number	Answer	Additional guidance	Mark
a	recall and substitution (1) (force x 12.0 =) 0.050 x 8.4 rearrangement (1) (force =) $\frac{0.050 \times 8.4}{12.0}$ evaluation (1) (force =) 0.035 (N)	allow substitution and rearrangement in either order award full marks for the correct answer without working. if no other marks scored then award 1 mark for answers that round to 29 (eg 28.57) (substitution mark)	(3) AO2

Question number	Answer	Additional guidance	Mark
b	a description to include four of the following measure the value of current (1) measure force or distance(1) vary the current (1) restore equilibrium of system (1) calculate ratio between force and current or distance and current (1) if ratio is the same then they are proportional (1)	accept calculate for measure increase weight or move (existing) weight to new position plot a graph of force / distance against current graph would be a straight line (through the origin)	(4) AO3

Q5.

Question number	Answer	Additional guidance	Mark
	counting teeth on the pinion (1) evaluation (1) 1.6 (m)	allow between 18 and 22 inclusive 20 x 0.08 ecf number of teeth answer in range 1.44 to 1.76 scores 2 marks award full marks for the correct answer without working power of 10 error scores 1 mark maximum	(2) A03.1

Q6.

Question number	Answer	Additional guidance	Mark
	substitution into $P = V \times I$ (1) $2600 = 230 \times I$ rearrangement (1) $I = P \div V$ evaluation (1) 11 (A)	Substitution and re-arrangement in either order $I = 2600 \div 230$ for 2 marks allow answers that round to 11 award full marks for correct answer without working allow $I = 2.6 \div 230$ for 1 mark allow 0.011 (A) for 2 marks max if no other marks scored, award 1 mark for $2.6 \text{ kW} = 2600 \text{ W}$	(3)

Q7.

Question number	Answer	Additional guidance	Mark
	any correct moment (1) 450×0.50 or 225 or $0.80 \times F_2$ substitution into prin. of moment equation (1) $450 \times 0.50 = 0.80 \times F_2$ evaluation (1) 280 (N) (for question at end)	allow 450×0.3 moment taken about B allow statement of prin. of moments accept numbers which round to 280 such as 281.25 award full marks for correct answer without working.	(3)

Q8.

Question number	Answer	Additional guidance	Mark
(i)	recall and substitution (1) $V = 0.20 \times 15$ evaluation (1) 3 (V)	7(V) gains 1 mark (use of $15 + 20$) award full marks for the correct answer without working	(2)

Question number	Answer	Additional guidance	Mark
(ii)	addition and substitution (1) (P=) $0.20^2 \times 35$ evaluation (1) 1.4 (W)	award full marks for the correct answer without working	(2)

Q9.

Question Number	Answer	Additional guidance	Mark
(i)	recall and substitution into $P = I^2 \times R$ (1) $130 = 14^2 \times R$ rearrangement (1) $R = \frac{130}{14^2}$ evaluation to 2 sig fig (1) (R =) = 0.66 (Ω)	substitution and rearrangement may be in either order alternative route: $V \left(= \frac{P}{I} \right) = \frac{130}{14} \text{ OR } 9.3 \text{ V}$ (1) $R \left(= \frac{V}{I} \right) = \frac{9.3}{14}$ (1) award full marks for the correct answer without working award 2 marks for 0.663.. or 0.67	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	rate of flow of charge in the immersion heater is greater than in the kettle / heating element (1) the direction of the flow of charge in the kettle / heating element keeps changing (whereas it remains in the same direction in the immersion heater) (1)	accept reverse arguments more charge per second in the immersion heater allow (in this context) faster (rate of) flow in immersion heater 14 coulombs per sec in immersion heater and 8.3 coulombs per sec in kettle / heating element flows both ways in the kettle / heating element (one way in the heater) simply referring to alternating current and direct current is not enough	(2)

Q10.

Question number	Answer	Additional guidance	Mark
(i)	Substitution and evaluation (1) 15 (Ω)		(1) A02.1

Question number	Answer	Additional guidance	Mark
(ii)	select / recall (1) (power =) $V \times I$ or (power =) $I^2 \times R$ or (power =) $\frac{V^2}{R}$ substitution and evaluation (1) (power =) 1.4 (W)	(power =) 4.5×0.3 $0.3^2 \times 15$ $\frac{4.5^2}{15}$ allow 1.3(5) (W) award full marks for the correct answer without working	(2) AO2.2

Q11.

Question Number	Answer	Additional guidance	Mark
(i)	(In every second), distance moved by chain around large gear = distance moved by chain around small gear (1) $2 \times 48 = \text{turns} \times 12$ rearrangement and evaluation (1) 8 (turns each second)	accept use of gear ratio seen or implied e.g. 4:1 or 4/1 or 48:12 or 48/12 or converse e.g. 1:4 award full marks for the correct answer without working	(2)

Question Number	Answer	Additional guidance	Mark
(ii)	An explanation linking reduces friction/amount of thermal energy transferred (1) extra useful energy is available/less input energy is required (1) efficiency = useful energy transferred (by the bicycle) ÷ total energy supplied (to the bicycle) (1)	(oil provides) lubrication less energy wasted allow for the last two mark points; either less input energy is required to produce the same output for 2 marks or more output energy is available for the same input energy for 2 marks	(3)

Q12.

Question Number	Answer	Additional guidance	Mark
(i)	recall and substitution into $V = IR$ (1) $5.0 = 0.26 \times R$ rearrangement (1) $(R =) \frac{5.0}{0.26}$ evaluation (1) $19 (\Omega)$	accept substitution and rearrangement in either order $(R =) \frac{V}{I}$ $\frac{5.0}{0.26}$ scores 2 marks accept answers that round to $19 (\Omega)$ (e.g. 19.23) accept answer written table if not written on answer line. award full marks for the correct answer without working	(3)

Question Number	Answer	Additional guidance	Mark
(ii)	a comment that includes the following points idea that resistance increases with potential difference (1) idea that doubling the potential difference does not result in doubling of resistance (1) OR $V = \text{constant} \times R$ is not supported by this data (1) correct processing of data from the table to support either of the above mark points (1)	idea that equal increments of potential difference do not cause equal increments of resistance reverse argument e.g. if student was correct then equal increments of p.d. would cause equal increment of resistance if student was correct then current would be constant ignore simple quoting of data for this mark	(3)

Question Number	Answer	Additional guidance	Mark
(iii)	A description that includes add a variable resistor (1) with in series (with the lamp / power supply) (1) OR add a potential divider (1) with in parallel with power supply (1)	marks may be obtained from a circuit diagram rheostat accept between / before / after for in series potentiometer across the power supply ignore replacing power supply / using fixed resistor(s) / LDR / thermistor in both cases, second mark conditional on first mark	(2)

Q13.

Question number	Answer	Additional guidance	Mark
(i)	substitution and rearrangement (1) (force = $\frac{\text{moment}}{\text{distance}}$) = $\frac{0.6}{3 \times 10^{-1}}$ evaluation (1) 2(.0) (N)	reject $0.6 \times 3 = 1.8$ award full marks for the correct answer without working ignore significant figures 2(.0) to any other power of ten scores 1 mark maximum	(2) AO2.1

Question number	Answer	Additional guidance	Mark
(ii)	correct calculation of one moment (1) correct calculation of second moment and adding of moments seen (1)	show that question either 2×0.1 or 1×0.5 seen $2(.0) \times 0.1(0) + 1(.0) \times 0.5$ scores 2 marks $0.2 + 0.5$ scores 2 marks accept calculations in alternative units (e.g. N cm) if correct conversion(s) seen if no other marks scored, the addition of two other moments can score 1 mark maximum	(2) AO2.1

Question number	Answer	Additional guidance	Mark
(iii)	explanation linking three from: {sum of / total } clockwise moments = {sum of / total } anticlockwise moments (1) for a system in equilibrium / balance (1) clockwise and anticlockwise moments compared (1) so rod not in equilibrium (1)	about the same point / about a point e.g. clockwise moment > anticlockwise moment or reverse argument 0.7 > 0.6 0.7 ≠ 0.6 rod will rotate clockwise MP4 can only be scored if MP3 awarded	(3) A03.2

Q14.

Question number	Answer	Additional guidance	Mark
(a)	Rearrangement of equation (1) $Q = \frac{E}{V}$ Substitution including change of unit (1) 64 MJ = 64 000 000 J $Q = \frac{64000000}{330}$ Answer and unit (1) $Q = 190\,000$ (C)	allow answers that round to 190 000, e.g. 193 939 if the calculation is worked throughout without changing MJ to J, then maximum of 2 marks unless unit matches quantity	(3)

Question number	Answer	Additional guidance	Mark
(b)	Rearrangement (1) $I = \frac{Q}{t}$ Conversions and substitution (1) 190 (kC) = 190 000 (C) 8 hours = 8 × 3600 (s) = 28 800 (s) $I = \frac{190\,000}{28\,800}$ Evaluation (1) = 6.6 (A)	ecf from (a) (6.5972) if 193 939 used then accept 6.7	(3)

Q15.

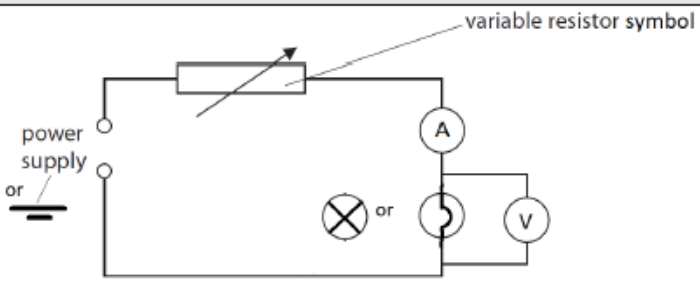
Question Number:	Answer	Additional Guidance	Mark
	recall clockwise moment = anticlockwise moment (1) moment = force x (perpendicular) distance (1) substitution (1) $m \times 17 = (6 \times 15) + (4.6 \times 10)$ rearrangement and evaluation (1) $m = 8.0$ (g)	calculations need not include g (which cancels out from all terms) substitution and rearrangement in either order $m \times 17 = 90 + 46$ $m = \frac{(6 \times 15) + (4.6 \times 10)}{17}$ $m = 136 / 17$ award full marks for correct answer without working	(4) AO 1 1 AO 2 1

Q16.

Question number	Answer	Mark
(i)	C	(1)

Question number	Answer	Additional guidance	Mark
(ii)	Equating the same variable in both equations (1) $\Delta Q = m \times c \times \Delta\theta = P \times t$ Rearrangement (1) $t = \frac{(m \times c \times \Delta\theta)}{P}$ Substitution and evaluation (1) $t = \frac{(1 \times 4200 \times 77)}{3500}$ $= 92 \text{ s}$	allow $\Delta\theta$ seen as 95 – 18 92.4 evaluation must be seen to at least 2 s.f. at some point in the working	(3)

Q17.

Question number	Answer	Mark
	 ammeter with correct symbol, in series with the lamp (1) voltmeter with correct symbol, in parallel with the lamp (1) valid method of changing the potential difference (1)	(3)

Q18.

Question Number	Answer	Acceptable answers	Mark
(a)(i)	B	.	(1)

Question Number	Answer	Acceptable answers	Mark
(a)(ii)	substitution $V = 0.039 \times 185$ (1) evaluation 7.215 (which is about 7.2) (V) (1)	Substitution $7.2 = I \times 185$ (1) transposition $I = 7.2 \div 185$ (1)	(2)

Question Number	Answer	Acceptable answers	Mark
(a)(iii)	C (same as)		(1)

Question Number	Answer	Acceptable answers	Mark
(a)(iv)	An explanation to include The resistance (of the LDR) changes Greater resistance when in the dark	LDR has less resistance in the light	(2)

Question Number		Indicative Content	Mark
QWC	*(b)	An explanation linking some of the following. - less current is used at night-time - Resistance (of LDR or circuit) would increase with less ambient light - Higher resistance will allow less current (in the circuit) (ORA) - Less current in circuit means less energy from the battery - Less power required in the dark ORA for light conditions - Less current means less energy transferred (per second) - Total energy transferred is less during night time (than it would otherwise have been) due to the higher resistance of the LDR	(6)
Level	0	No rewardable content	
1	1 - 2	- A limited explanation linking the light level to EITHER resistance OR current. eg. It increases the resistance in the dark. - the answer communicates ideas using simple language and uses limited scientific terminology - spelling, punctuation and grammar are used with limited accuracy	
2	3 - 4	- A simple explanation linking the light level to TWO of resistance, current, energy. eg. At night-time its resistance would increase. This would reduce the current from the battery - the answer communicates ideas showing some evidence of clarity and organisation and uses scientific terminology appropriately - spelling, punctuation and grammar are used with some accuracy	
3	5 - 6	- A detailed explanation linking the light level to resistance AND current, AND energy. e.g. At night-time the resistance would be more. This would reduce the current and mean that the battery will not have to supply as much energy. - the answer communicates ideas clearly and coherently uses a range of scientific terminology accurately - spelling, punctuation and grammar are used with few errors	

Q19.

Question number	Answer	Additional guidance	Mark
(i)	Recall GPE = $m \times g \times \Delta h$ (1) Substitution = $400 \times 9.8 \times 1.5$ (1) Evaluation = 5900 (J) (1) (which is nearly 6000 J)	accept 5880 (J)	(3)

Question number	Answer	Additional guidance	Mark
(ii)	An explanation that combines identification – knowledge (1 mark) and reasoning (1 mark) - energy is dissipated/scattered (1) - into the surroundings (1)	energy from a loss of ball's PE / its gain in KE ends up as (kinetic) energy of molecules (of ball / wall / air)	(2)

Question number	Answer	Mark
(iii)	B velocity	(1)

Q20.

Question number	Answer	Additional guidance	Mark
	An answer that combines the following points of understanding to provide a logical description: named force (acting at a distance) (1) situation (1)	e.g. magnetic force between two (magnetic) poles	(2)

Q21.

Question number	Answer	Additional guidance	Mark
(i)	A description including as the potential difference (voltage) increases so does the current (1) idea of gradient of graph decreasing as V increases (1)	positive correlation at a decreasing rate non-linear not directly proportional	(2) AO3

Question number	Answer	Additional guidance	Mark									
(ii)	Award one mark for each row of the table <table><tr><td></td><td>voltage in V</td><td>current in mA</td></tr><tr><td>point P</td><td>1(.00)</td><td>20</td></tr><tr><td>point Q</td><td>3.4 ±0.1</td><td>43 ±1</td></tr></table>		voltage in V	current in mA	point P	1(.00)	20	point Q	3.4 ±0.1	43 ±1	ignore any units added in the boxes	(2) AO2
	voltage in V	current in mA										
point P	1(.00)	20										
point Q	3.4 ±0.1	43 ±1										

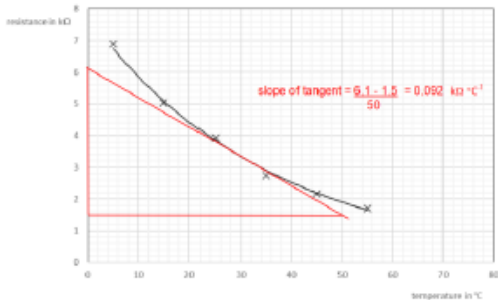
Question number	Answer	Additional guidance	Mark
(iii)	substitution (1) $(R =) \frac{4.5}{51(\times 10^{-3})}$ evaluation (1) 88.(2) (Ω)	0.088(2) or 8.8(2) or 0.88(2) or 0.09 seen scores 1 mark 0.088(2) kΩ or 0.09 kΩ scores 2 marks award full marks for correct answer without working	(2) AO2

Question number	Answer	Additional guidance	Mark
(iv)	an explanation linking any three of: identification of resistance increasing (1) heating (of the filament) (1) because of more collisions (1) of electrons (with ions / atoms / other electrons) (1)	temperature increases	(3) AO1

Question number	Answer	Additional guidance	Mark
	move the (position of) the (0.050 N) weight (1) to the other side of the pivot/3.6 cm from the magnet (1)	adjust mass of modelling clay reduce (mass of modelling clay) by taking some away add (additional) weight between pivot and magnet scores 2 marks	(2) AO3

Q23.

Question number	Answer	Additional guidance	Mark
(i)	A description to include as temperature increases resistance decreases (1) non-linear / decreasing gradient (1)	ORA allow exponential / inversely proportional in this context curve gets less steep as temperature increases ignore negative correlation unqualified quoted values are insufficient	(2) A03.1

Question number	Answer	Additional guidance	Mark
(ii)	uses a right-angled triangle to calculate slope with a line of grazing incidence at $\theta = 30^\circ \text{C}$ (1)  evaluation (1) (-) 0.092 ($\text{k}\Omega / ^\circ \text{C}$) unit (1) $\text{k}\Omega / ^\circ \text{C}$ or $\text{k}\Omega ^\circ \text{C}^{-1}$	tangent seen and used, drawn between $\theta = 25$ and $35 ^\circ \text{C}$ accept for 2 marks either between 0.087 and 0.097 ($\text{k}\Omega / ^\circ \text{C}$) or between 87 and 97 ($\Omega / ^\circ \text{C}$) kohm/K or kohm K^{-1}	(3) A03.2

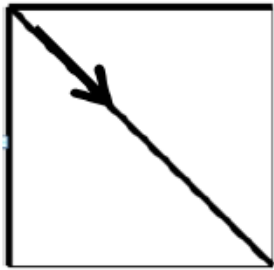
Q24.

Question number	Answer	Additional guidance	Mark
	(upward) force increases with speed (1) relationship is non-linear (1)	allow reverse argument changing rate / increases exponentially/ initially no upward force (until 1000 turns per minute)	(2)

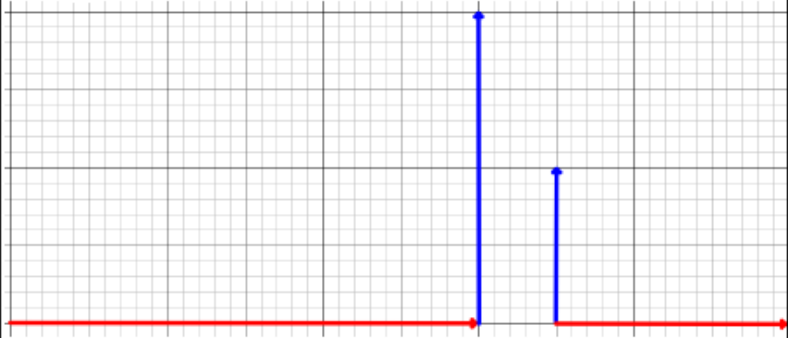
Q25.

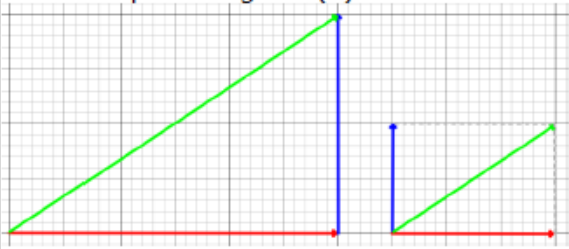
Question number	Answer	Additional guidance	Mark
	a diagram of a circuit including all of the following: power supply / cell(s) / battery identifiable resistance wire an ammeter a voltmeter (1) plus any two from ammeter in series (1) voltmeter in parallel (1) indication of tapping off / using 50cm of resistance wire (1)	accept symbols accept ohmmeter with resistance wire only ignore lamp(s) / additional resistors allow ohmmeter (across wire) instead of ammeter and voltmeter for 1 mark e.g. (crocodile) clips	(3) AO2.2

Q26.

Question number	Answer	Additional guidance	Mark
	Scale drawing two lines at right angles (1) a correct scaling (for example 10kN equivalent to 1 cm) / a completed square or triangle(1) diagonal in correct direction (1) 28 kN (1)	 judge by eye accept answers from 25 kN to 30 kN accept use of Pythagoras award full marks for correct answer without working.	(4)

Q27.

Question number	Answer	Mark
(i)	- two vector arrows at rights angles representing the forces (1) - two vector arrows in proportion (1) examples: 	(2)

Question number	Answer	Additional guidance	Mark
(ii)	- drawing shows a completed triangle or parallelogram (1)  - Evaluation 3.6 N (1)	±0.2 N may be calculated using Pythagoras theorem	(2)

Q28.

Question Number	Answer	Acceptable answers	Mark
(i)	Substitution (1) $2900 = 230 \times \text{current}$ Transposition (1) $\frac{2900}{230}$ Evaluation (1) 13 (A)	Award full marks for correct answer with no working Allow substitution and transposition in either order Ignore powers of ten errors until evaluation Allow numbers which round up to 13	(3)

Question Number	Answer	Acceptable answers	Mark
(ii)	Substitution (1) $97 = 2.9 \times \text{time} \times 17$ Transposition (1) $\frac{97}{2.9 \times 17}$ OR $\frac{97}{49.3}$ Evaluation (1) 2.0 (h)	Award full marks for correct answer with no working Allow substitution and transposition in either order Ignore powers of ten errors until evaluation Allow $\frac{97}{17} = 5.7$ for 1 mark Allow numbers which round up to 2.0	(3)

Q29.

Question Number:	Answer	Mark
(i)	C 6.0 joules per coulomb The only correct answer is C <i>A is not correct because 1 volt is 1 joule per coulomb</i> <i>B is not correct because 1 volt is 1 joule per coulomb</i> <i>D is not correct because 1 volt is 1 joule per coulomb</i>	(1) AO 1 1

Question Number:	Answer	Additional Guidance	Mark
(ii)	recall and substitution (1) $42 = \frac{200 \times t}{(1000)}$ rearrangement (1) $t = \frac{42 (\times 1000)}{200 (\times 60)}$ evaluation (1) (t =) 3.5 (minutes)	accept substitution and rearrangement in either order 2.1 to any power of 10 or 3.5 to any power of 10 scores 2 marks 3 minutes 30 seconds award full marks for correct answer without working	(3) AO 1 1 AO 2 1

Question Number:	Answer	Additional Guidance	Mark
(iii)	recall and substitution (1) (E =) 42×6.0 evaluation (1) (energy =) 250 (J)	(using $E = VIt$) (E =) $6.0 \times 200 (\times 10^{-3}) \times 2.10 (\times 10^2)$ accept 252 (J) award full marks for correct answer without working	(2) AO 1 1 AO 2 1

Q30.

Question number	Indicative content	Mark
	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive, and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. A01 Horizontal forces • tension in the string/pull of the string • tension is one of the horizontal forces acting on the wooden block • friction between the table and the wooden block • friction acts in the opposite direction to the tension • friction opposes motion • the force due to friction is equal to the force provided by the tension • the forces are balanced /equal and opposite • no resultant force, so the block moves at a constant (horizontal) velocity	(6)

	Vertical forces • (normal) reaction (force) upwards between the table and the wooden block • contact force • weight of block downwards • the weight (force of gravity) and the (normal) reaction are equal and opposite / balanced • the block does not move up or down • tension caused by the force due to gravity on the weight • vertical forces on the block do not affect horizontal velocity. labels on the diagram should be considered when marking candidates do not have to indicate the forces as horizontal and vertical	
--	---	--

Level	Mark	Descriptor
	0	No rewardable material.
Level 1	1-2	- Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas lacks detail. (AO1) - Presents an explanation with some structure and coherence. (AO1)
Level 2	3-4	- Demonstrates physics understanding, which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas is not fully detailed and/or developed. (AO1) - Presents an explanation that has a structure which is mostly clear, coherent and logical. (AO1)
Level 3	5-6	- Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas is detailed and fully developed. (AO1) - Presents an explanation that has a well-developed structure which is clear, coherent and logical. (AO1)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels
	0	No rewardable material.	e.g. - At each level, as well as content, the scientific coherency of what is stated will help place the answer at the top, or the bottom, of that level.
Level 1	1–2	<u>Additional guidance</u> Elements of physics present i.e. isolated knowledge of principles two unconnected statements from any section	<u>Possible candidate responses</u> contact force weight pulls block friction tension in string weight acts downward reaction
Level 2	3–4	<u>Additional guidance</u> Some knowledge of principles with a logical connection made in one section and statement from the other section OR Detailed knowledge of principles with logical connections made in one section	<u>Possible candidate responses</u> There is friction between the table and the block and this opposes motion weight of block acts downwards

Level 3	5-6	<u>Additional guidance</u> Detailed knowledge of principles with logical connections made in one section and statement from the other section	<u>Possible candidate responses</u> Friction and tension are equal and opposite there is no resultant /no acceleration The weight (of the block) and the(normal) reaction are equal and opposite
---------	-----	--	--