Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel Level 1/Level 2 GCSE (9–1)

Friday 16 June 2023

Morning (Time: 1 hour 45 minutes)

Paper reference **1PH0/2H**

Physics

PAPER 2

Higher Tier

You must have:
Calculator, ruler, Equation Booklet (enclosed)

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.*
- Calculators may be used.
- Any diagrams may NOT be accurately drawn, unless otherwise indicated.
- You must **show all your working out** with **your answer clearly identified** at the **end of your solution**.

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.
- A list of equations is included at the end of this exam paper.

Advice

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

Turn over ▶

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P 7 2 5 7 5 A 0 1 3 6

Pearson

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

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

1 (a) Figure 1 shows a prize that is made from a metal star on a plastic base.

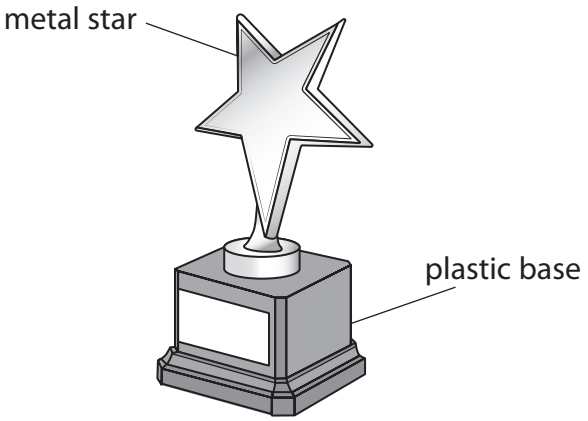

Figure 1

A person starts to clean the prize by rubbing the plastic base with a dry cloth.

The plastic base becomes positively charged and the cloth becomes negatively charged.

(i) The plastic base has

(1)

☒ **A** gained electrons

☒ **B** gained protons

☒ **C** lost electrons

☒ **D** lost protons

(ii) Explain why the cloth has become negatively charged.

(2)

.....

.....

.....

.....

(b) The person then holds the metal star and rubs it with the charged cloth.

The cloth loses its charge.

Explain why the cloth loses its charge.

(2)

(c) The charged plastic base attracts some dust from the air.

Figure 2 shows a magnified view of part of the surface of the plastic base and a dust particle.

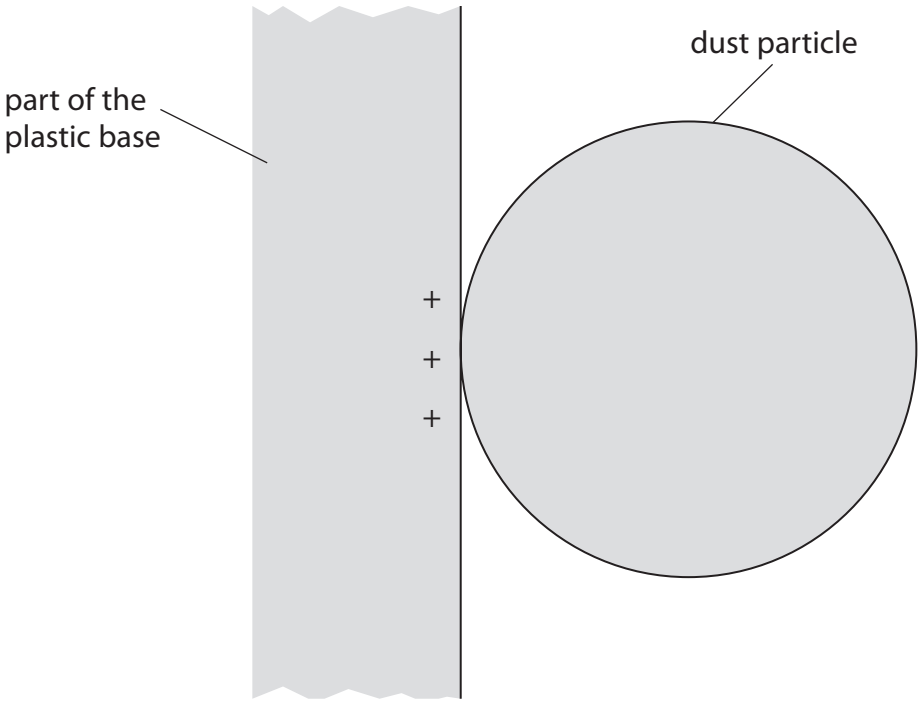

Figure 2

Some of the charges on the plastic base are shown but the charges induced on the dust particle are not shown.

Draw the charges induced on the dust particle in Figure 2.

(2)

(Total for Question 1 = 7 marks)

2 (a) Figure 3 shows some of the apparatus that students use to determine the resistance of a piece of iron wire.

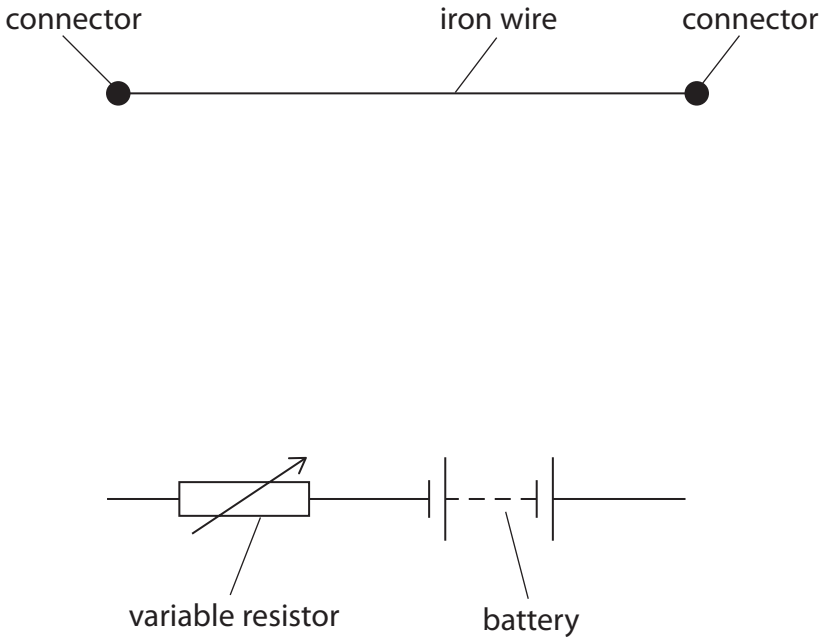

Figure 3

Add connecting wires, a voltmeter and an ammeter to complete the circuit in Figure 3 so that the students can determine the resistance of the piece of iron wire.

(2)

(b) The students extend the investigation to determine how the resistance of the iron wire changes with its length.

(i) Give the name of **one** additional piece of apparatus the students would need.

(1)

.....

(ii) Figure 4 shows a graph of the results.

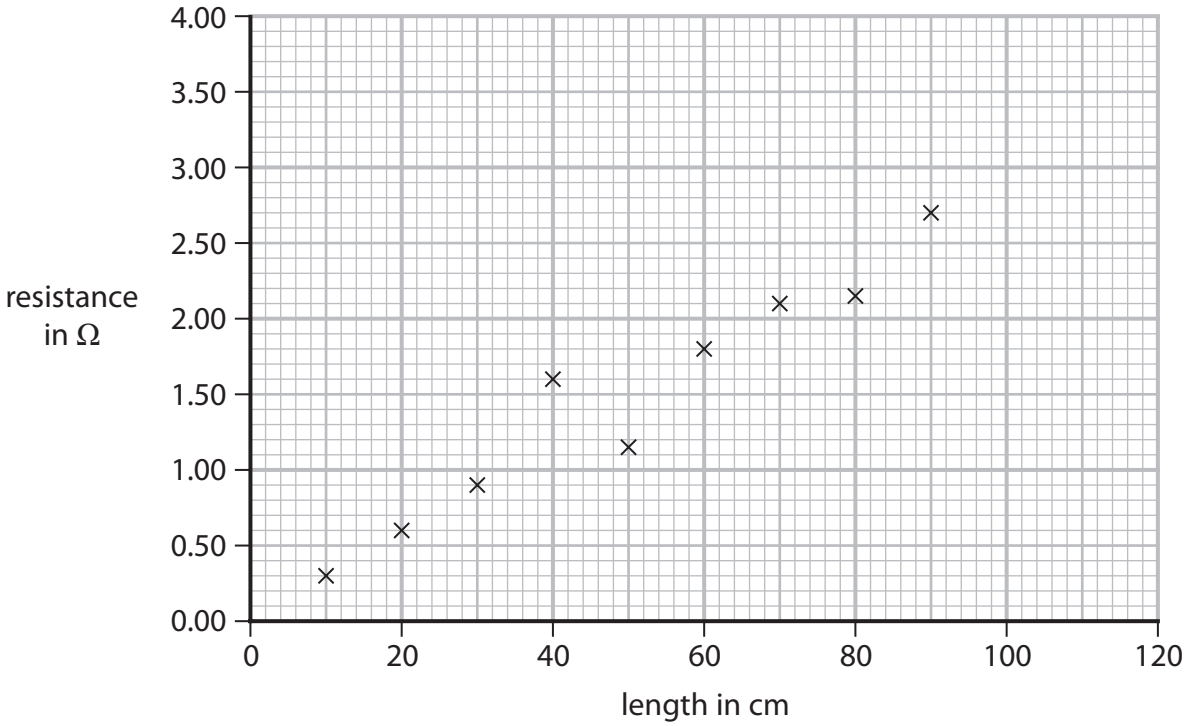

Figure 4

Draw a straight line of best fit on Figure 4.

(1)

(iii) Use Figure 4 to estimate the resistance of a 100 cm length of the iron wire.

(1)

resistance = ... Ω

(iv) The variable resistor shown in Figure 3 is used to prevent the iron wire from becoming too hot.

Explain how the variable resistor is used to prevent the iron wire from becoming too hot.

(2)

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(c) The potential difference (voltage) across another piece of wire is 1.56 *V*.

The current in the wire is 0.45 *A*.

Calculate the resistance of this piece of wire.

Use the equation

$$V = I \times R$$

(2)

resistance = ... Ω

(Total for Question 2 = 9 marks)

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3 (a) Which of these means changing state from solid directly to gas?

(1)

- ☒ **A** condensing
- ☒ **B** freezing
- ☒ **C** melting
- ☒ **D** sublimating

(b) An object has a mass of 7.22×10^{-2} kg and a volume of 2.69×10^{-5} m^3.

Calculate the density, ρ, of the object.

Use the equation

$$\rho = \frac{m}{V}$$

(3)

State the unit.

density = ... unit .....

(c) Aluminium has a melting point of 660 °C.

The absolute zero of temperature is –273 °C.

(i) Calculate the melting point of aluminium in kelvin.

(1)

melting point of aluminium = ... K

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(ii) Describe the motion of particles in liquid aluminium (above 660 °C).

(2)

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(d) A student determines the volume of a piece of metal by measuring the volume of water that it displaces.

The student wrote the following in his notebook.

> I put some water into a measuring cylinder.
> I put the piece of metal into the water in the measuring cylinder.
> I took the reading of the new water level in the measuring cylinder.
> This was the volume of the piece of metal.

The student's description is incomplete.

Suggest **two** sentences that the student could have included to provide a more complete description of the correct procedure.

(2)

1 .....

.....

2 .....

.....

(Total for Question 3 = 9 marks)

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4 This question is about pressure.

(a) Figure 5 shows windows in an aeroplane.

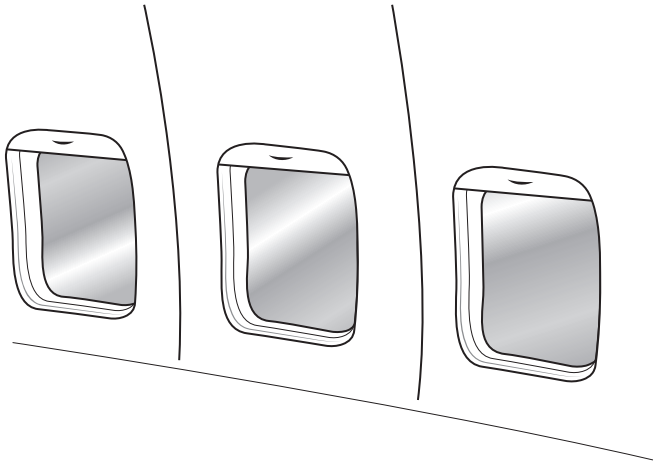

Figure 5

The aeroplane is high above the Earth's surface.

The atmospheric pressure outside the aeroplane is 23 000 Pa.

The air pressure inside the aeroplane is 80 000 Pa.

(i) Calculate the pressure difference between inside and outside of the aeroplane.

(1)

pressure difference = ... Pa

(ii) The surface area of the window is 0.094 m^2.

Calculate the size of the force on the window due to the cabin air pressure of 80 000 Pa.

Use the equation

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

(2)

force = ... N

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(iii) On the same aeroplane, a different window has a smaller surface area.

Explain how the force due to the air pressure inside the cabin on the small window differs from the force on the larger window.

(2)

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(iv) Figure 6 shows a cross-section through the aeroplane including one window.

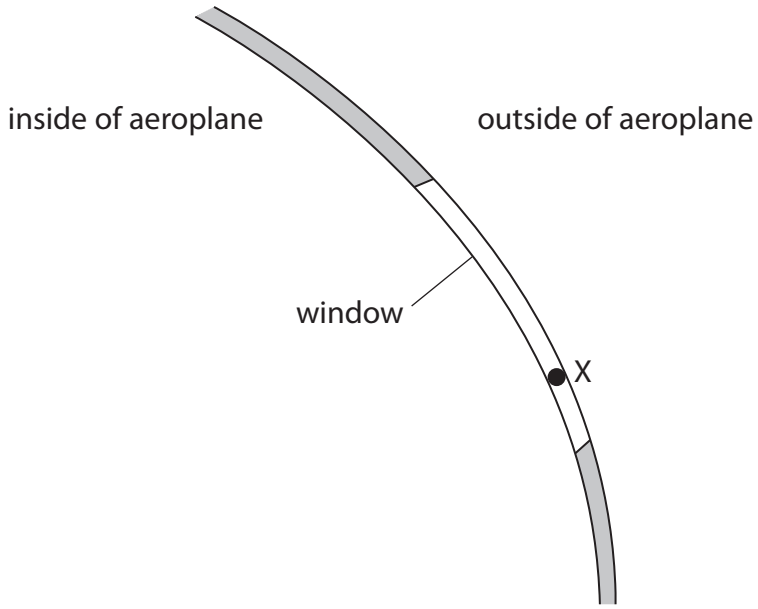

Figure 6

Draw an arrow on Figure 6 to show the direction of the resultant force due to the air pressure inside the cabin on the window at point X.

(2)

(b) Figure 7 shows the atmospheric pressure at different heights above the Earth's surface.

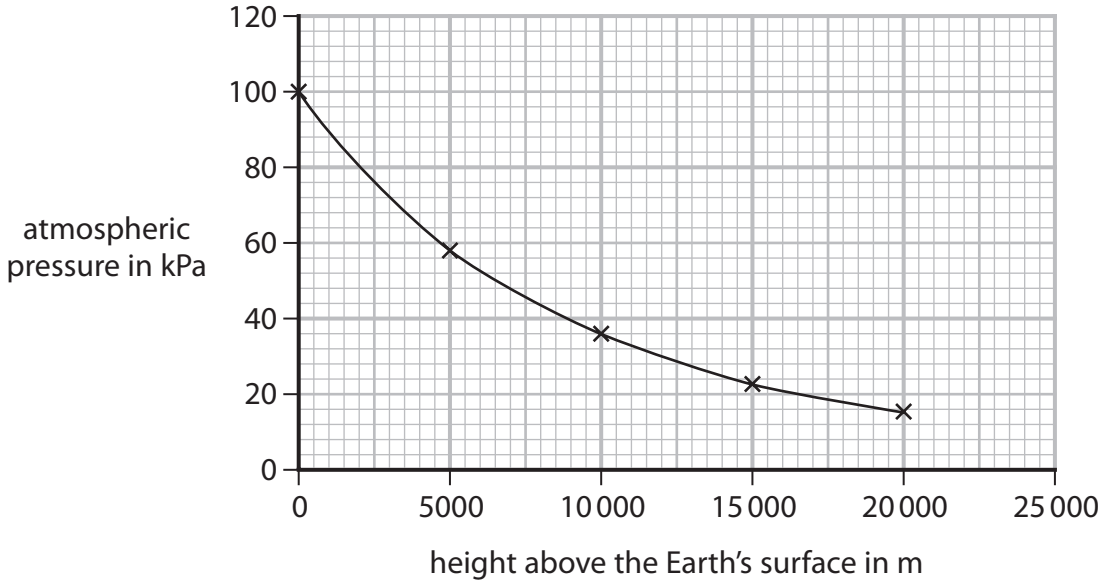

Figure 7

(i) Describe how the atmospheric pressure changes with height above the Earth's surface.

Use data from Figure 7 to support your answer.

(3)

(ii) Suggest **one** reason why the atmospheric pressure changes with height above the Earth's surface.

(1)

(Total for Question 4 = 11 marks)

5 (a) Figure 8 shows two magnets with their N poles facing each other.

Figure 8

On Figure 8, draw the shape and direction of the magnetic field between the two magnets.

(2)

(b) Figure 9 shows a toy that has a plastic cylinder, a plastic base and two similar magnets. Each of the two magnets is in the shape of a ring.

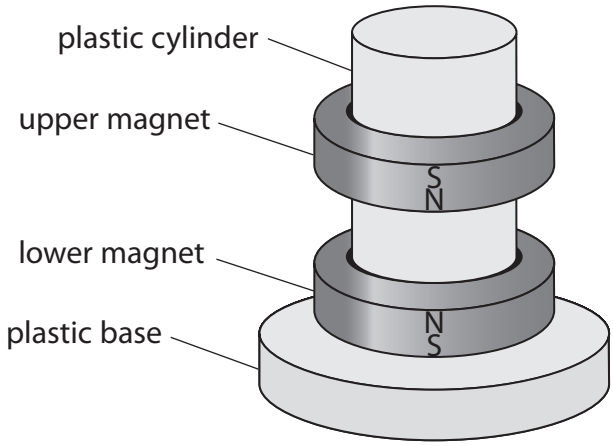

Figure 9

The upper magnet seems to float in the air above the lower magnet.

Describe the forces acting on the upper magnet.

Use the idea of magnetic fields in your answer.

(3)

(c) Figure 10 shows a current-carrying wire between the poles of a magnet.

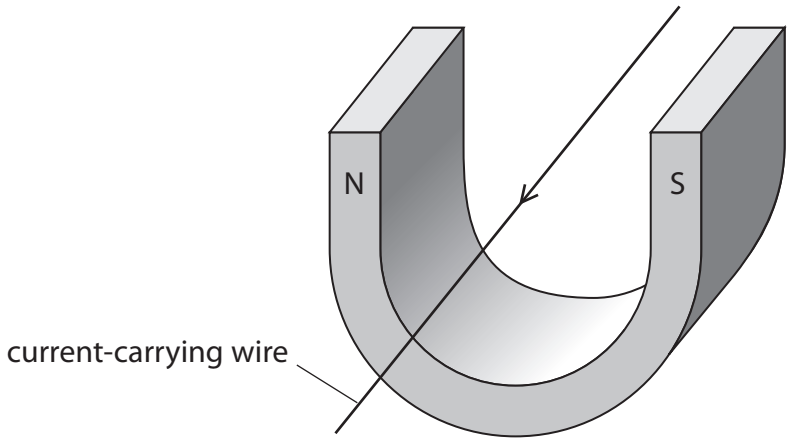

Figure 10

(i) The magnet and the wire each experience a force when there is a current in the wire.

(2)

1 State the direction of the force on the wire.

.....

2 State the direction of the force on the magnet.

.....

(ii) The force on the wire is 0.15 N.

The current in the wire is 2.7 A.

The magnet produces a field with a magnetic flux density of 0.50 T.

Calculate the length of the wire in the magnetic field.

Use an equation selected from the list of equations given at the end of the question paper.

(2)

length of the wire in the magnetic field = ... m

(Total for Question 5 = 9 marks)

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6 (a) Figure 11 shows a person doing a push-up exercise.

Figure 11

An upward force is used to cause rotation about a pivot.

Which row of the table is correct for this rotation?

(1)

		provide the upward force	act as a pivot
☒	**A**	arms	hands
☒	**B**	arms	feet
☒	**C**	legs	hands
☒	**D**	legs	feet

(b) Figure 12 shows some of the bones and muscles in an arm.

The arrows show the forces on the forearm when the arm is bent.

The hand is empty.

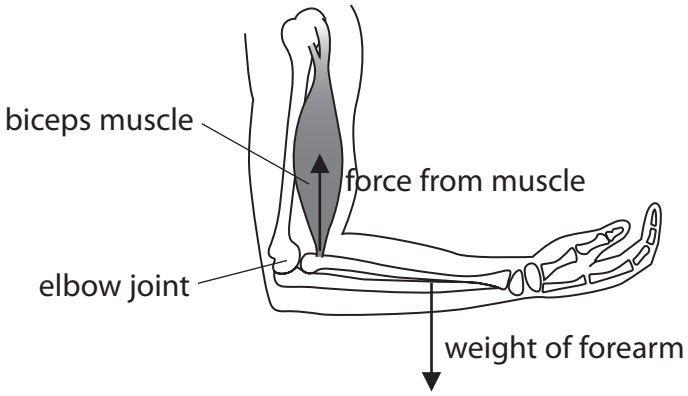

Figure 12

The biceps muscle provides a force to balance the weight of the forearm.

The weight of the forearm can be represented as a single force.

Figure 13 shows a diagram representing the forces and distances involved.

not to scale

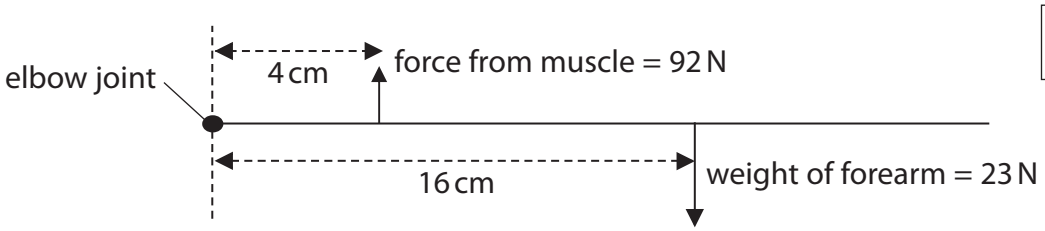

Figure 13

(i) Use the principle of moments to show that the system shown in Figure 13 is in equilibrium.

(2)

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(ii) The person then holds a ball weighing 15 N in their hand.

Figure 14 shows the forces on the forearm and their distances from the elbow joint.

not to scale

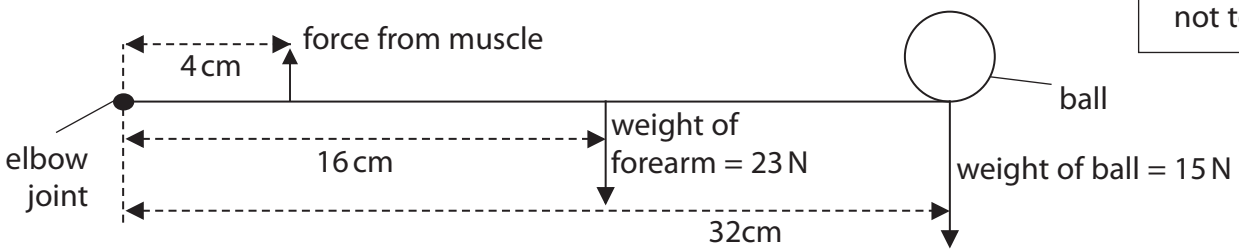


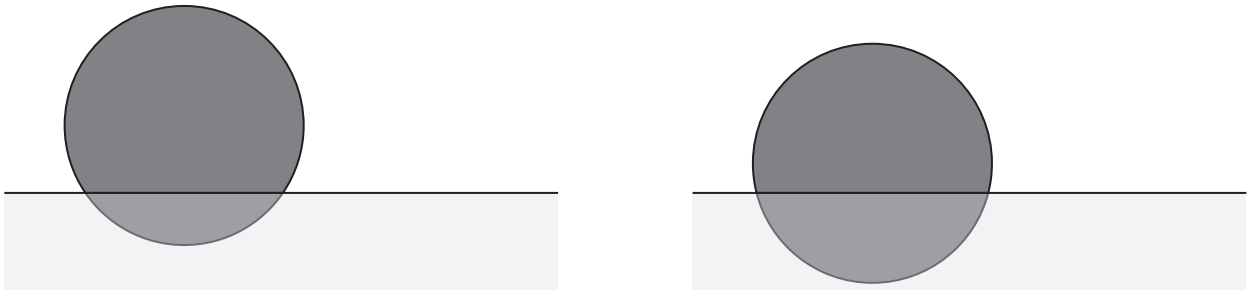
Figure 14

Calculate the force from the muscle that is needed to keep the system in Figure 14 in equilibrium.

(3)

force = ... N

(c) Figure 15 shows a ball floating in seawater and the same ball floating in fresh water.



seawater fresh water

Figure 15

(i) Compare the upthrust on the ball in seawater with the upthrust on the same ball in fresh water.

(1)

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.....

(ii) Explain why there is less of the ball below the surface of the seawater than below the surface of the fresh water.

(3)

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(Total for Question 6 = 10 marks)

7 (a) Figure 16 shows part of the inside of a pen.

The pen contains a spring that can be compressed.

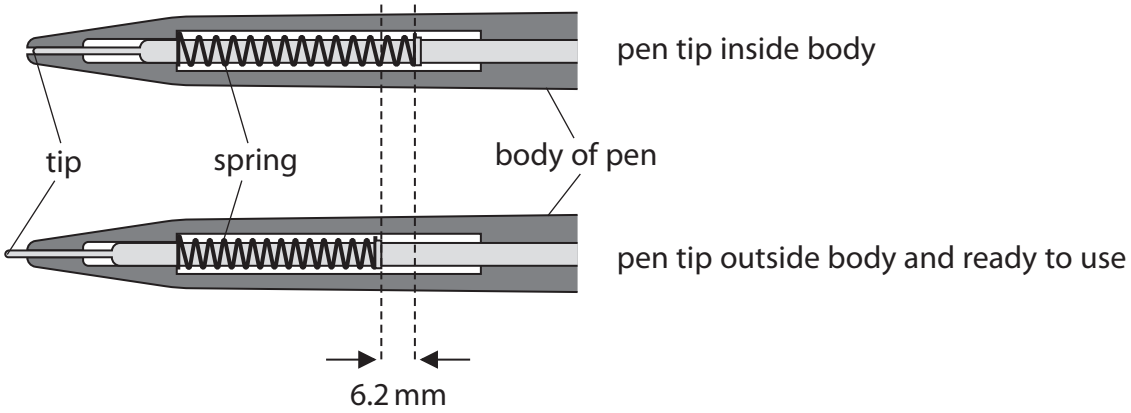

Figure 16

The spring constant of the spring is 260 N/m.

(i) Calculate the force needed to compress the spring by the amount shown in Figure 16.

Give your answer to an appropriate number of significant figures.

(3)

force = ... N

(ii) A student removes the spring from the pen and investigates the compression of the spring.

Figure 17 shows the equipment and the procedure that the student uses.

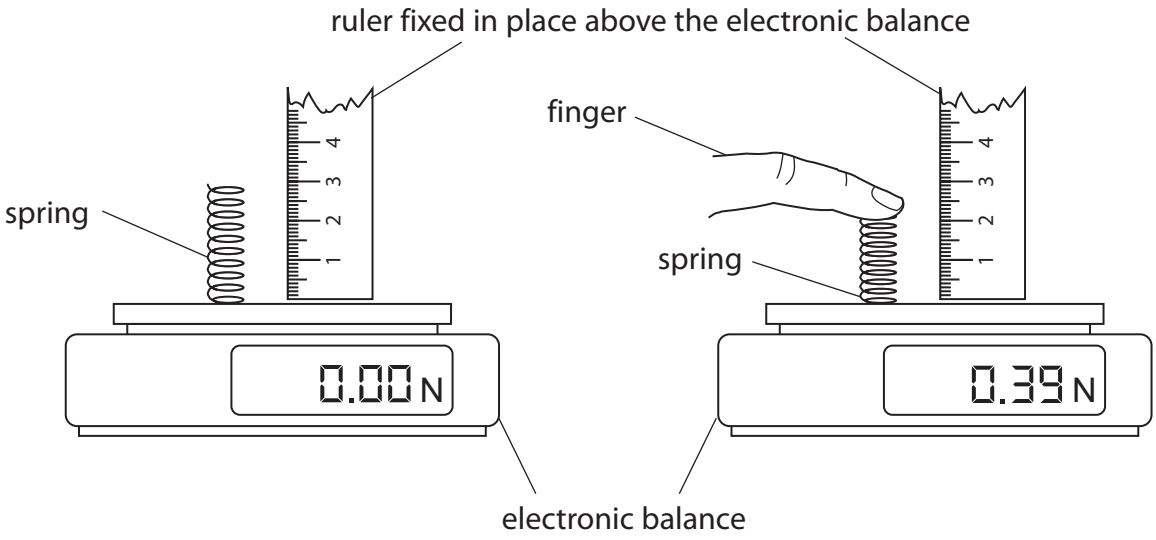

Figure 17

The student presses down on the spring to change its length.

The electronic balance measures the force applied to the spring.

Describe how the student can determine the change in length of the spring. You may add to Figure 17 to help your answer.

(3)

(iii) The student finds it difficult to make an accurate measurement of the change in length of the spring using the equipment as shown.

Describe **one** way that the student could improve the procedure.

(2)

(b) Figure 18 shows a different spring hanging from a hook fixed to the ceiling.

A block hangs from the other end of the spring.

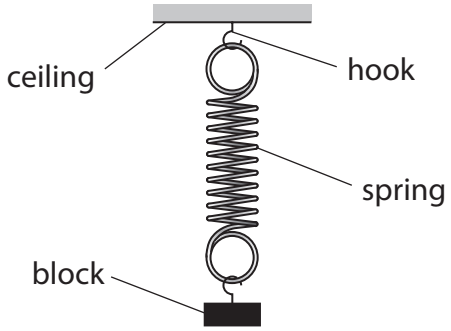

Figure 18

The weight of the spring is 1 N.
The weight of the block is 5 N.

The force exerted on the top of the spring by the hook is

(1)

- ☒ **A** 4 N down
- ☒ **B** 4 N up
- ☒ **C** 6 N down
- ☒ **D** 6 N up

(c) Figure 19 shows two forces, P and Q, acting at point X.

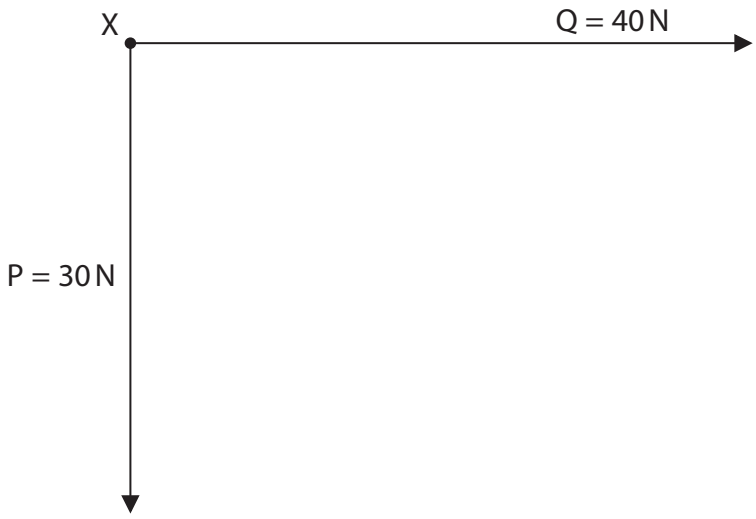

diagram is drawn to scale

Figure 19

Complete the diagram in Figure 19 to show the size and direction of the resultant force, R, on point X.

(2)

(Total for Question 7 = 11 marks)

8 (a) An electric car is travelling at a speed of 16.0 m/s.

The total mass of the car is 1200 kg.

(i) Calculate the kinetic energy, in kJ, of the car.

(2)

kinetic energy = ... kJ

(ii) On a journey, the car transfers energy from the battery at an average rate of 17.5 kW.

The battery in the car transfers a total of 126 MJ of energy before it becomes discharged.

Calculate the time taken for the battery to become discharged on this journey.

Give your answer in hours.

(2)

time taken = ... hours

(iii) Figure 20 shows an electrical device connected to the wheels of an electric car.

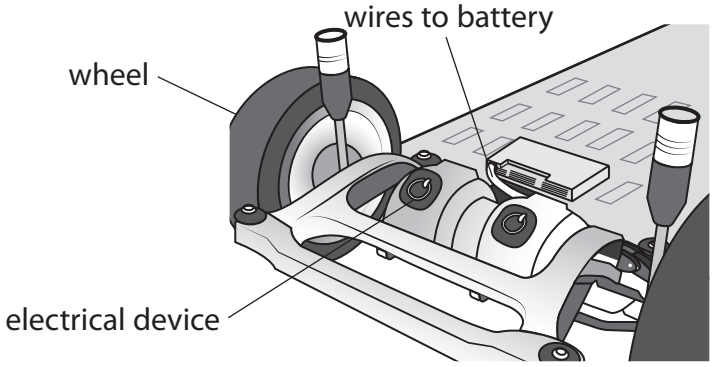

Figure 20

The electrical device is used as a motor when the car accelerates and as a dynamo when the car decelerates.

Explain how using the device can help to increase the time that the car can be driven before the battery becomes discharged.

(2)

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(b) The battery can be recharged at a charging point.

The charging point provides an average current of 15.0 A to the battery, at a potential difference (voltage) of 400 V.

It is claimed that 126 MJ of energy can be transferred to the battery in less than 6 hours.

(i) Comment on this claim.

Use this equation to support your answer

$$t = \frac{E}{I \times V}$$

(3)

.....

.....

(ii) Calculate the total charge that moves into the battery while it is being recharged.

Use the equation

$$E = Q \times V$$

(2)

charge = ... C

(Total for Question 8 = 11 marks)

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9 (a) Figure 21 shows a pulley system that enables a person to lift a heavy barrel.

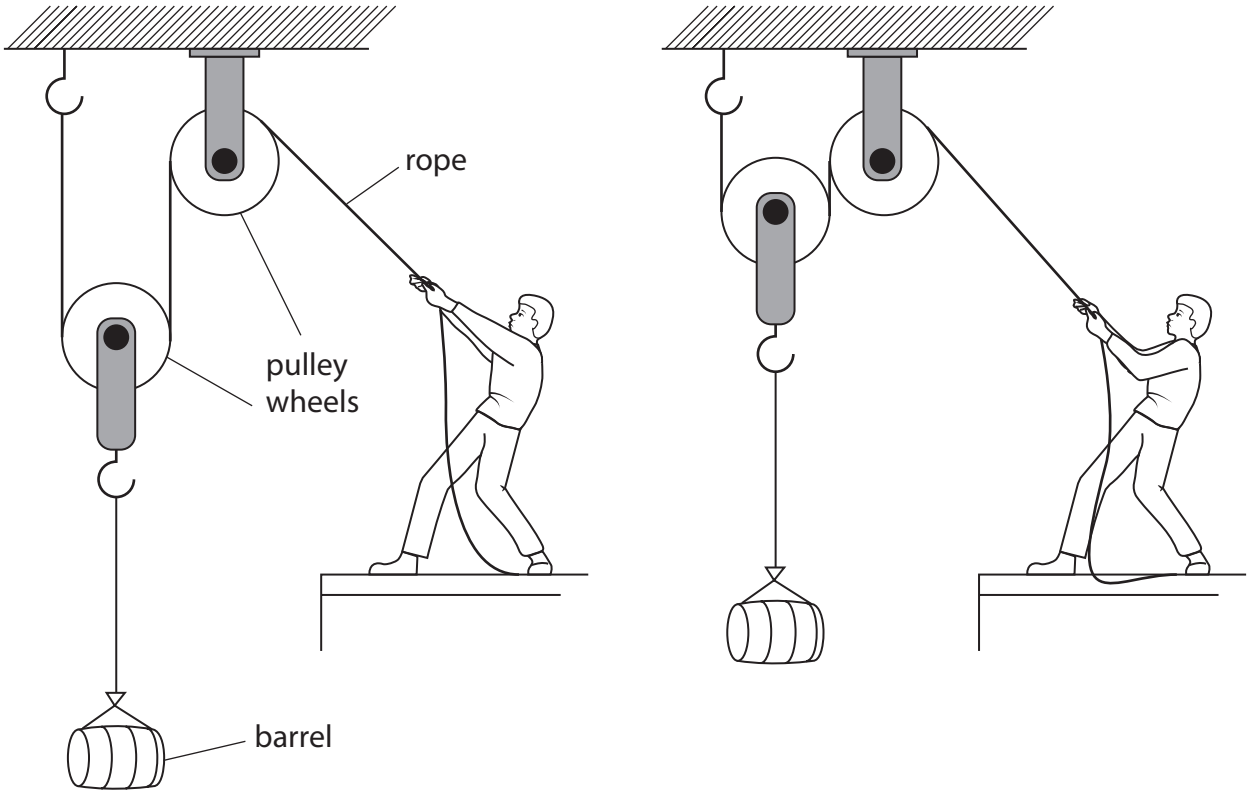

Figure 21

The person pulls down on the rope to make the barrel rise through 1.2 m.

The work done against gravity on the barrel is 1800 J.

(i) Calculate the weight of the barrel.

Use the equation

work done = force × distance moved in the direction of the force

(2)

weight of the barrel = ... N

(ii) The efficiency of the system is 64%.

Calculate the total work done by the person.

Use the equation

$$\text{efficiency} = \frac{\text{(work done against gravity on the barrel)}}{\text{(total work done by the person)}} \times 100\%$$

(2)

work done = ... J

(iii) Some energy is wasted due to friction.

Suggest **another** reason why some energy is wasted in using this pulley system.

(1)

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*(b) A student has the equipment shown in Figure 22.

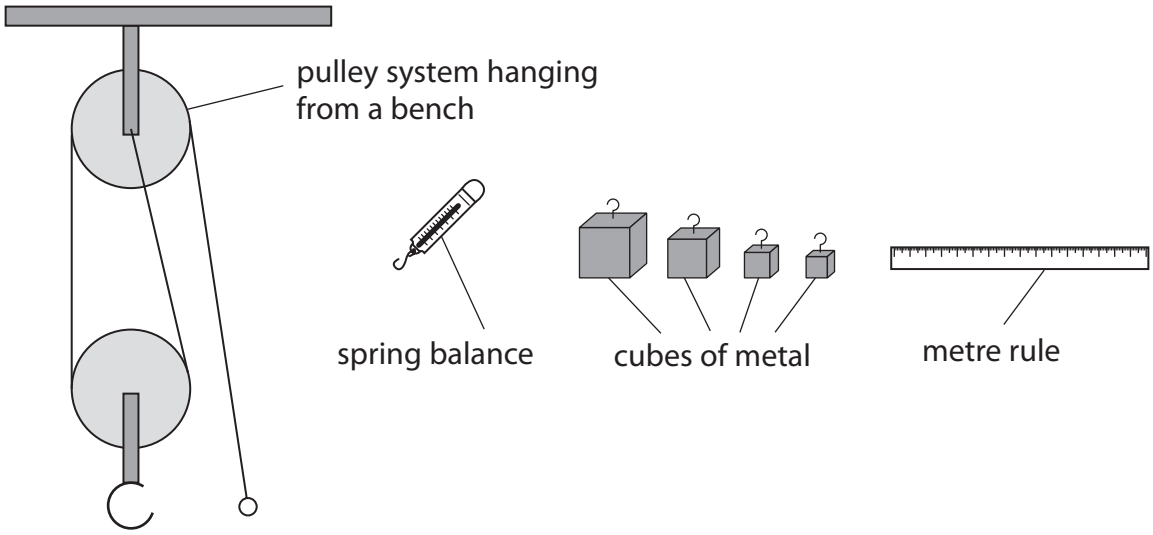

Figure 22

Devise an experiment to investigate how the efficiency of the pulley system varies with the weight of metal being lifted.

Your answer should include how you will use your measurements.

(6)

(Total for Question 9 = 11 marks)

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10 (a) Figure 23 shows a model dynamo.

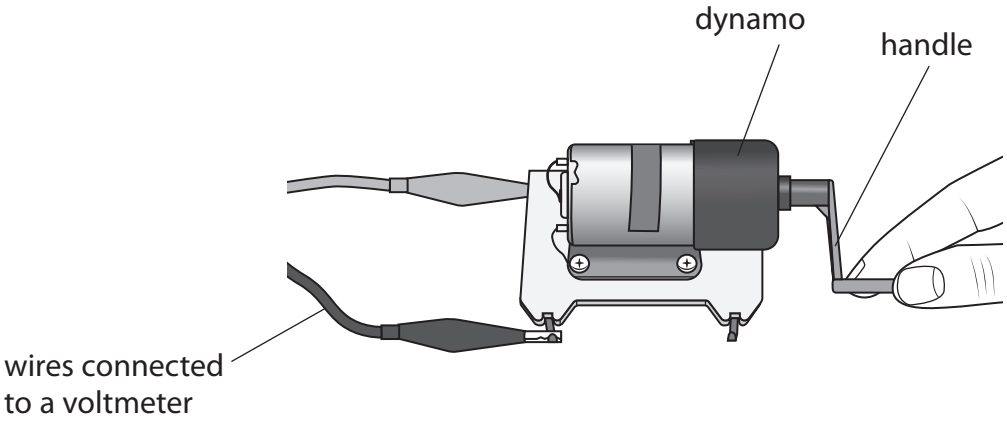

Figure 23

The dynamo contains a coil of wire that can spin inside a permanent magnet.

The dynamo produces a D.C. output.

A teacher connects a voltmeter to the terminals of the dynamo.

The teacher rotates the handle to make the coil spin inside the magnet.

Figure 24(a) shows the reading on the voltmeter.

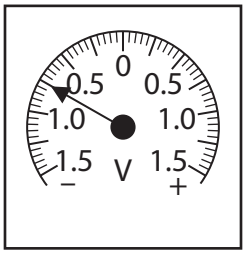

Figure 24(a)

The teacher then rotates the handle differently.

Figure 24(b) shows the new reading on the voltmeter.

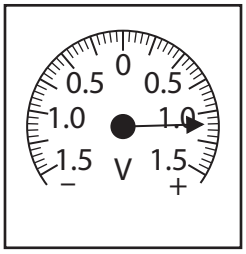

Figure 24(b)

(i) Which row of the table shows how the rotation of the handle has changed between (a) and (b)?

(1)

		speed of rotation	direction of rotation
☒	**A**	(a) faster than (b)	(a) opposite to (b)
☒	**B**	(a) faster than (b)	(a) same as (b)
☒	**C**	(a) slower than (b)	(a) opposite to (b)
☒	**D**	(a) slower than (b)	(a) same as (b)

(ii) The teacher connects the dynamo to a lamp.

It is now more difficult for the teacher to rotate the handle.

Explain why it is more difficult to turn the dynamo when it is connected to a lamp.

(2)

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(b) Figure 25 shows a transformer.

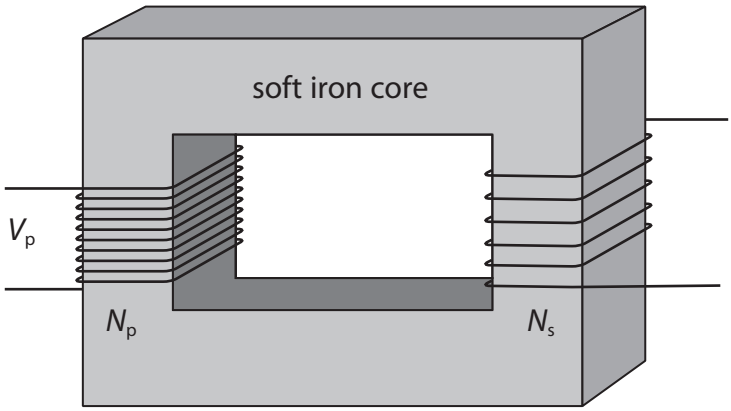

Figure 25

The number of turns on the primary coil, $N_p = 800$

The potential difference across the primary coil, $V_p = 230\,V$

The number of turns on the secondary coil, $N_s = 18$

Calculate the potential difference across the secondary coil.

Use an equation selected from the list of equations at the end of the paper.

(3)

potential difference across the secondary coil = ... *V*

*(c) Figure 26 shows a picture of an electrical device and a simplified drawing of the important parts.

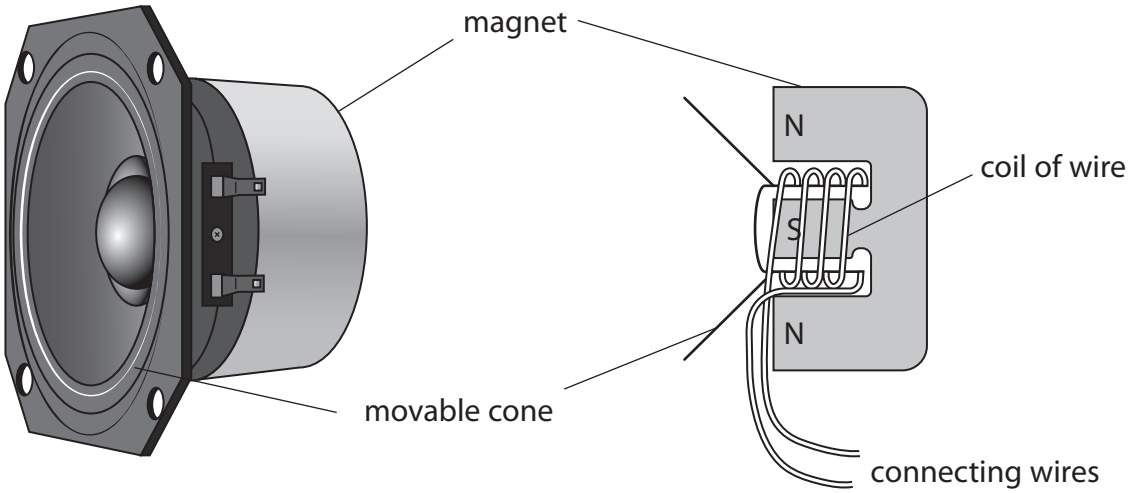

Figure 26

The device can be used as a loudspeaker or it can be used as a microphone.

Compare how the device operates when used as a loudspeaker with how the device operates when used as a microphone.

(6)

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS

Equations

(final velocity)^2 – (initial velocity)^2 = 2 × acceleration × distance

$v^2 - u^2 = 2 \times a \times x$

force = change in momentum ÷ time

$$F = \frac{(mv - mu)}{t}$$

energy transferred = current × potential difference × time

$E = I \times V \times t$

force on a conductor at right angles to a magnetic field carrying a current = magnetic flux density × current × length

$F = B \times I \times l$

$$\frac{\text{potential difference across primary coil}}{\text{potential difference across secondary coil}} = \frac{\text{number of turns in primary coil}}{\text{number of turns in secondary coil}}$$

$$\frac{V_p}{V_s} = \frac{N_p}{N_s}$$

potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil

$V_p \times I_p = V_s \times I_s$

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

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

thermal energy for a change of state = mass × specific latent heat

$Q = m \times L$

to calculate pressure or volume for gases of fixed mass at constant temperature

$P_1 V_1 = P_2 V_2$

energy transferred in stretching = 0.5 × spring constant × (extension)^2

$E = ½ \times k \times x^2$

pressure due to a column of liquid = height of column × density of liquid × gravitational field strength

$P = h \times \rho \times g$

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Mark Scheme (Results)

Summer 2023

Pearson Edexcel GCSE
In Physics (1PH0)
Paper 2H

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Summer 2023
Publications Code 1PH0_2H_2306_MS

General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- 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 may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

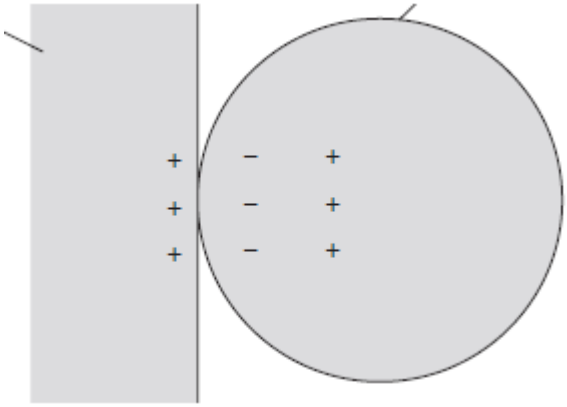
Mark schemes have been developed so that the rubrics of each mark scheme reflects the characteristics of the skills within the AO being targeted and the requirements of the command word. So for example the command word 'Explain' requires an identification of a point and then reasoning/justification of the point.
Explain questions can be asked across all AOs. The distinction comes whether the identification is via a judgment made to reach a conclusion, or, making a point through application of knowledge to reason/justify the point made through application of understanding. It is the combination and linkage of the marking points that is needed to gain full marks.
When marking questions with a 'describe' or 'explain' command word, the detailed marking guidance below should be consulted to ensure consistency of marking.

Assessment Objective		**Command Word**	
Strand	**Element**	**Describe**	**Explain**
AO1		An answer that combines the marking points to provide a logical description	An explanation that links identification of a point with reasoning/justification(s) as required
AO2		An answer that combines the marking points to provide a logical description, showing application of knowledge and understanding	An explanation that links identification of a point (by applying knowledge) with reasoning/justification (application of understanding)
AO3	1a and 1b	An answer that combines points of interpretation/evaluation to provide a logical description	
AO3	2a and 2b		An explanation that combines identification via a judgment to reach a conclusion via justification/reasoning
AO3	3a	An answer that combines the marking points to provide a logical description of the plan/method/experiment	
AO3	3b		An explanation that combines identifying an improvement of the experimental procedure with a linked justification/reasoning

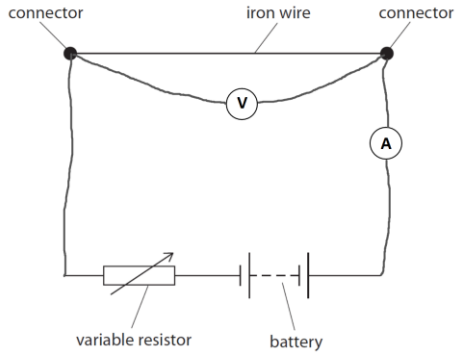
Question number	Answer	Additional guidance	Mark
1(a)(i)	C lost electrons A is incorrect because it would give the base a negative charge B and D are incorrect because protons do not move in this situation.		(**1**) AO1

Question number	Answer	Additional guidance	Mark
1 (a) (ii)	any **two** from electrons have been transferred / moved (1) by friction (1)	 cloth has gained electrons accept negative charge for electrons do not credit positive electrons / protons	(**2**) AO1

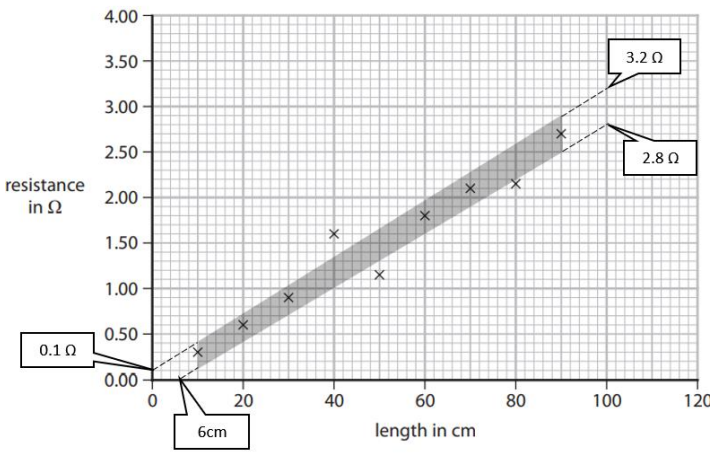
Question number	Answer	Additional guidance	Mark
1 (b)	An explanation linking **two** from electrons transferred (from the cloth) to the metal (1) metal is a conductor (1) electrons travel through person / to earth (1)	accept <u>negative charge</u> for electrons accept star for metal electrons move through metal (metal is) earthed / grounded	(**2**) AO1

Question number	Answer	Additional guidance	Mark
1 (c)	 at least one negative charge on left hand side of dust particle (1) at least one positive charge to the right of the negative charge(s) (1) net negative charge on left hand side / near to base (1) net positive charge to the right of the negative charge / further from base than negative charge (1)	ignore charges drawn on base	(**2**) AO1

Total 7 marks

Question number	Answer	Additional guidance	Mark
2 (a)	voltmeter connected in parallel with the iron wire / any part of the iron wire (1) ammeter connected in series with the iron wire (1) example:  	accept any recognisable symbols. accept symbol drawn over connecting wire do not credit the same type of meter shown in contradictory positions	(**2**) AO1

Question number	Answer	Additional guidance	Mark
2 (b) (i)	**one** from (1) metre rule / metre stick / ruler / (measuring) tape / crocodile clip / other clip / wire cutters / pliers / sliding contact jockey / more (iron) wire	accept scissors ignore additional electrical devices such as ohmmeter / multimeter	(**1**) AO1

Question number	Answer	Additional guidance	Mark
2 (b) (ii)	(ii) Figure 4 shows a graph of the results.  	accept any straight line within the shaded range judge by eye. ignore extrapol-ation for this marking point	(**1**) AO2

Question number	Answer	Additional guidance	Mark
2 (b)(iii)	any number between 2.7 and 3.3 inclusive	allow ecf from (ii) ±0.1Ω	(**1**) AO2

Question number	Answer	Additional guidance	Mark
2 (b) (iv)	explanation linking any **two** from: (variable) resistor increases the resistance (of the circuit) (1) (therefore) keeps the current constant / small(er) (1) because **current** increases temperature of the (iron) wire (1)	accept flow of electrons / charge for current in this context reduces current / limits the current ignore slows the current / charge accept current heats up (iron) wire accept for two marks: adjust variable resistor to keep current constant / small	(**2**) AO2

Question number	Answer	Additional guidance	Mark
2 (c)	substitution (1) 1.56 = 0.45 x R rearrangment and evaluation (1) (R =) 3.5 (ohms)	alternative method rearrangement (1) (R =) $\frac{V}{I}$ **or** (R=) $\frac{1.56}{0.45}$ (substitution and) evaluation (1) (R =) 3.5 (ohms) allow values that round to 3.5 e.g. 3.46(666) 3.47 etc award full marks for the correct answer without working	(**2**) AO2

Total 9 marks (H paper)

Question number	Answer	Mark
3 (a)	☒ D sublimating A is incorrect because it describes a change of state from gas to liquid. B is incorrect because it describes a change of state from liquid to solid C is incorrect because it describes a change of state from solid to liquid	(**1**) AO1

Question number	Answer	Additional guidance	Mark
3 (b)	substitution (1) $(r) = \frac{7.22(\times 10^{-2})}{2.69(\times 10^{-5})}$ evaluation (1) (ρ =) 2680 unit (1) kg / m^3	 2.68 to any power of ten seen allow any value that rounds to 2680; e.g. 2684 accept 2700 allow values in standard form e.g. 2.68 x 10^3 kg m^{-3} allow for three marks: 2.68 to any power of ten **with** a consistent unit, e.g. 2680 kg/m^3 2680 g/dm^3 2.68 g/cm^3 2.68 kg/dm^3 0.00268 kg/cm^3 2 680 000 g/m^3 allow for two marks: • 2680 with no or incorrect unit • 2.68 to any other power of 10 **with** an inconsistent unit of density • correct substitution **with** an inconsistent unit of density allow for one mark: • 2680 to any other power of ten with no or incorrect unit • appropriate unit of density with no or an incorrect value	(**3**) AO2

Question number	Answer	Additional guidance	Mark
3 (c) (i)	933 (1)	do not accept -933 ignore K ignore degrees ignore ^{o}	(**1**) AO2

Question number	Answer	Additional guidance	Mark
3 (c)(ii)	A description to include any **two** from: (motion is) random (1) various {speeds / velocities / kinetic energies} (1) bump into each other / collide (1) fast(er than solid) (1)	 move freely / move in any direction / move around different speeds range of speeds slide over / past each other / touch each other / in contact with each other more kinetic energy (than in solid) ignore bulk properties of liquids e.g. take shape of container. ignore vibrate "random speeds" on its own scores 1 mark	(**2**) AO1

H paper only:

Question number	Answer	Additional guidance	Mark
3 (d)	Any **two** from the following in any order (I took a) reading of the water level in the measuring cylinder without the metal. (1) (I made sure that) the metal was fully immersed / submerged (1) (I) subtracted the two readings / volumes (1)	Answers need not be exactly the same as those given here provided that the meaning is clear. accept measured / read for take a reading accept reading of original level / volume accept starting with a specified amount e.g. 50ml all the metal was under water took one from the other / found the difference ignore: repeat and/or average other measurements such as mass other methods such as Eureka can ideas of spillage reading from bottom of meniscus	(**2**) AO1

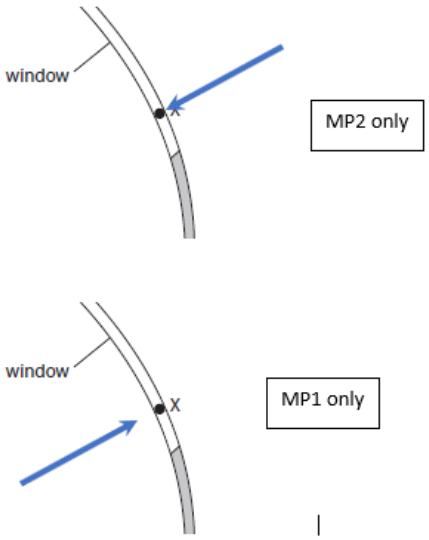
Total 9 marks

Question 4 H paper (question 10 F paper)

Question number	Answer	Additional guidance	Mark
4 (a) (i)	(80 000 – 23 000) 57 000 (Pa) (1)	 -57 000 (Pa)	(**1**) AO2

Question number	Answer	Additional guidance	Mark
4 (a) (ii)	substitution (1) 80 000 = $\frac{F}{0.094}$ rearrangement and evaluation (1) (F=) 7500 (N)	alternative method re-arrangement (1) (F =) P x A **or** (F=) 80 000 x 0.094 (substitution and) evaluation accept 7520 (N), award full marks for correct answer without working. allow 1 mark max for substitution using pressure of 57 000 **or** an answer that rounds to 5400 e.g. 5358 (calculated net force)	(**2**) AO2

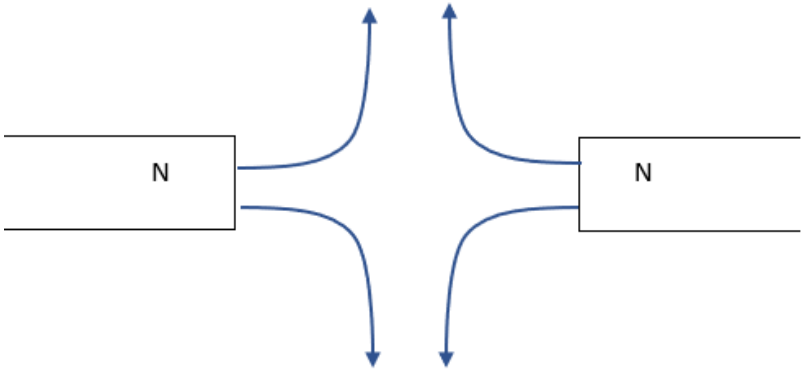
Question number	Answer	Additional guidance	Mark
4 (a) (iii)	force is less (on small window) (1) pressure is the same (1)	force is greater on large window	(**2**) AO1

Question number	Answer	Additional guidance	Mark
4 (a) (iv)	arrow pointing towards outside of aeroplane (1) arrow is normal to surface at X (judge by eye) (1) Examples:  	may be inside or outside of aeroplane. need not touch X do not award if two or more conflicting arrows drawn must touch X or dot at X independent marks	(**2**) AO1

Question number	Answer	Additional guidance	Mark
4 (b) (i)	increase in height results in decrease in pressure (1) non-linear relationship (1) use of numerical data (1) at least two different pressure and height values from the graph	pressure decreases with height accept inversely proportional in this context accept negative correlation double the height does not result in half the pressure pressure not does change evenly description of graph e.g. curved / not straight calculation of change in pressure e.g. 5000m to 10000 m pressure went down by 22	(**3**) AO3

Question number	Answer	Additional guidance	Mark
4 (b) (ii)	any **one** from air becomes less dense (1) smaller weight (of air) above (1) lower temperature (1)	accept oxygen / atmosphere for air air gets thinner / (air) particles further apart / fewer particles / less particles less air above / smaller height of air above ignore change in value of g with height	(**1**) AO1

Total 11 marks

Question number	Answer	Additional guidance	Mark
5 (a)	at least four lines as shown (1) at least two arrows directed away from N poles (1)  	lines must not intersect (cross over) ignore continuation of lines to S of a magnet independent mark do not award if one or more arrows shown pointing towards N pole	(**2**) AO1

Question number	Answer	Additional guidance	Mark
5 (b)	any **three** from	marks can be awarded from a correctly labelled diagram	(**3**) AO1
	magnetic **fields** interact (1)	magnets are in each other's magnetic **field**	
	(force due to) repulsion (between magnets) (1)	repel / push away	
	(repulsion) force upwards (on upper magnet) (1)		
	weight / gravitational force (downwards on upper magnet) (1)	accept gravity (acts downwards)	
	forces equal size / in equilibrium (1)	forces are balanced	
		ignore references to charge	

Question number	Answer	Additional guidance	Mark
5 (c) (i)		independent marks	(**2**) AO1
	1 up(wards) (1)	accept out(wards from the magnet)	
	2 down(wards) (1)	accept in(wards) / into (magnet)	
		allow 1 mark for 1 down / in(wards) AND 2 up / out(wards)	

Question number	Answer	Additional guidance	Mark
5 (c) (ii)	substitution (1) 0.15 = 0.5(0) x 2.7 x L(ength) rearrangement and evaluation (1) (length =) 0.11 (m)	alternative method re-arrangement (1) (length =) $\frac{F}{B \times I}$ Or (length =) $\frac{0.15}{0.5(0) \times 2.7}$ (substitution and) evaluation (1) (length =) 0.11 (m) allow any values that round to 0.11 e.g 0.111 accept 0.1 or 0.i̇ (m) allow 1 mark for answer of 9 (with or without working) award full marks for correct answer without working.	(**2**) AO2

Total 9 marks

Question number	Answer	Additional guidance	Mark
6 (a)	B arms provide an upward force and feet act as a pivot A and C are incorrect because the rotation is not around the hands. D is incorrect because the legs are not providing an upward force that causes rotation		(**1**) AO3

Question number	Answer	Additional guidance	Mark
6 (b) (i)	calculation of both moments (1) moments are equal (size) and opposite direction (1)	4 x 92 and 16 x 23 seen comparison of both moments 368 (=) 368 **or** 4 x 92 = 16 x 23 **or** $16=\frac{4\times92}{23}$ **or** $4=\frac{16\times23}{92}$ accept calculations in Nm	(**2**) AO1, AO2

Question number	Answer	Additional guidance	Mark
6 (b) (ii)	calculation of moment of ball (1) 480 (Ncm) calculation of total clockwise moment (1) 848 (Ncm) calculation of bicep force needed (1) 212 (N) **OR** calculation of moment of ball (1) 480 (Ncm) calculation of additional force from bicep (1) 120 (N) calculation of total bicep force (1) 212 (N)	 15 x 32 seen 368 + 480 seen 848/4 seen 15 x 32 seen 480/4 seen 120 + 92 seen award full marks for correct answer without working. accept conversion of cm to m throughout	(**3**) AO2

Question number	Answer	Additional guidance	Mark
6 (c) (i)	(upthrusts in each case) are equal (1)		(**1**) AO3

Question number	Answer	Additional guidance	Mark
6 (c) (ii)	an explanation linking any **three** of weight of ball = weight of water displaced (1) seawater more dense than fresh water (1) smaller volume of seawater (needs to be) displaced (1) to produce same weight of water (displaced) (1)	accept reverse arguments accept saltwater for seawater upthrust = weight of water displaced accept less seawater displaced to produce same upthrust	(**3**) AO1

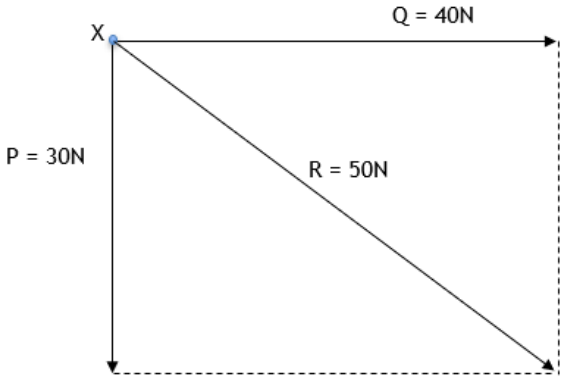
Total 10 marks

Question number	Answer	Additional guidance	Mark
7 (a) (i)	selection and substitution (1) (F=) 260 x 6.2 (x 10^{-3}) evaluation (1) (F=) 1.612 (N) or 1.61 (N) answer to 2 s.f. (1) 1.6 (N)	award 1 mark only for answer of 1.61(2) to any other power of ten, e.g. 1612 (N) independent mark for any answer given to 2 significant figures allow 2 marks for answer of 1600 (N) with or without working 1.60 scores 2 marks award full marks for correct answer without working.	(**3**) AO2

Question number	Answer	Additional guidance	Mark
7 (a) (ii)	a description including read position of top of spring against the ruler (1) read position of top of spring when pressed down (1) subtract the two readings (1) **OR** substitution (1) 0.39 = 260 x change in length rearrangement (1) (change in length =) $\frac{0.39}{260}$ evaluation (1) 1.5 mm unit must be shown	May be seen drawn in figure 17 measure **length** at the start allow value from ruler e.g. 2.9 (cm) measure the **length** when pressed down allow value from ruler e.g. 2.0 (cm) subtract the two measurements allow find the difference for subtract allow calculated value from diagram e.g. 0.9 (cm) ignore repeat (0).0015m unit must be shown	(**3**) AO1

Question number	Answer	Additional guidance	Mark
7 (a) (iii)	description to include change to enable accurate location of top of spring (1) for example: pointer, set square, thin sheet / another ruler (under finger) description of how the change is used (1)	may be seen drawn in Figure 17 move ruler closer to spring compress spring with weight rather than finger ignore photographs make measurements from where pointer / set square / thin sheet / other ruler touches the ruler reduce parallax error prevents fluctuations while measuring ignore repeats ignore unqualified references to accuracy or precision	(**2**) AO3

Question number	Answer	Additional guidance	Mark
7 (b)	D 6 N up A and C are incorrect because the force is upwards B is incorrect because the force is the sum of the two weights given.		(**1**) AO3

Question number	Answer	Additional guidance	Mark
7 (c)	**<u>arrow</u>** (any length) (labelled R) in correct direction (judge by eye) (1) (size of R =) 50N (1)	independent marks  construction lines need not be shown arrow head must be present for MP1 accept answers in range 48N to 52N obtained from scale drawing working need not be shown	(**2**) A01

Total 11 marks

Question number	Answer	Additional guidance	Mark
8 (a) (i)	selection and substitution (1) (KE =) ½ x 1200 x 16(.0)^2 evaluation in kJ (1) (KE =) 150 (kJ)	(KE =) ½ x 1200 x 16(.0)^2 x 10^{-3} accept any value that rounds to 150 e.g. 153.6 award full marks for correct answer without working. award 1 mark for 153.6 or 150 to any other power of ten	(**2**) AO2

Question number	Answer	Additional guidance	Mark
8 (a) (ii)	selection and substitution (1) $17.5 (\times 10^3) = \frac{126 (\times 10^6)}{t}$ re-arrangement and evaluation (1) (t=) 2(.0) (h)	alternative method selection and rearrangement (1) $(t =) \frac{E(nergy)}{P(ower)}$ or $(t=) \frac{126 (\times 10^6)}{17.5 (\times 10^3)}$ (substitution and) evaluation (1) (t=) 2(.0) (h) award full marks for correct answer without working. allow 1 mark for 7(.2) to any power of ten (incorrect time conversion) allow 1 mark for 2(.0) to any power of 10 (POT error)	(**2**) AO2

Question number	Answer	Additional guidance	Mark
8 (a) (iii)	an explanation linking (energy transfers when the car is decelerating) (from) kinetic energy (store) (1) (to) chemical energy (store) (1)	 idea of energy that would be otherwise wasted uses an electrical pathway {electric current / electricity / emf} produced allow mechanical for kinetic in this context recharges battery increases available energy store of battery more useful energy available	(**2**) AO2

Question number	Answer	Additional guidance	Mark
8 (b) (i)	**either** calculation of time: substitution (1) (t =) $\frac{126\ (\times 10^6)}{15 \times 400\ (\times 3600)}$ evaluation (1) (t=) 5.8(3) (h) conclusion (1) claim is justified as the time is less (than 6 hours) **or** calculation of energy: substitution (1) 6 (x 3600) = $\frac{E}{15 \times 400}$ rearrangement and evaluation (1) E = 130 MJ conclusion (1) claim is justified as energy (in 6 hours) is more than (126 MJ) required.	accept correct time conversion e.g. 5h 50 min 350 min 21 000 s award 2 marks for correct answer without working. award 1 mark for answer of either 2.1 or 5.8(3) to any other power of ten allow relevant comment based on incorrectly calculated time (independent mark) accept 129.6 MJ accept 129 600 000 J allow relevant comment based on incorrectly calculated energy (independent mark)	(**3**) AO3

Question number	Answer	Additional guidance	Mark
8 (b) (ii)	substitution (1) 126 (x 10^6) = Q x 400 re-arrangement and evaluation (1) (Q =) 315 000 (coulombs)	alternative method re-arrangement (1) (Q =) $\frac{E}{V}$ **or** (Q =) $\frac{126 (x 10^6)}{400}$ (substitution and) evaluation (1) (Q =) 315 000 (coulombs) accept answers rounding to 320 000 (coulombs) allow one mark for answers rounding to 3.2 to any other power of ten award two marks for correct answer without working.	(**2**) AO2

Total 11 marks

Question number	Answer	Additional guidance	Mark
9 (a) (i)	substitution into work done = force x distance (1) 1800 = force x 1.2 rearrangement and evaluation (1) (force =) 1500 (N)	alternative method rearrangement (1) $(\text{force} =) \frac{\text{work (done)}}{\text{d(istance moved)}}$ **or** (force =) $\frac{1800}{1.2}$ (substitution and) evaluation (1) (force =) 1500 (N) if no other marks scored allow one mark for answer of 500 (N) or 4500 (N) award full marks for correct answer without working.	(**2**) AO2

Question number	Answer	Additional guidance	Mark
9 (a) (ii)	substitution (1) 64 = $\frac{1800 \times 100}{\text{total work done}}$ **or** 0.64 = $\frac{1800}{\text{total work done}}$ rearrangement and evaluation (1) (work done =) 2800 (J)	alternative method re-arrangement (1) (total work done =) $\frac{\text{work done on barrel} \times 100}{\text{efficiency}}$ **or** (work done=) $\frac{1800 \times 100}{64}$ **or** (work done=) $\frac{1800}{0.64}$ (substitution and) evaluation (1) (work done =) 2800 (J) allow values that round to 2800; e.g. 2812.5 award full marks for correct answer without working.	(**2**) AO2

Question number	Answer	Additional guidance	Mark
9 (a) (iii)	any **one** of additional mass in the system (1) rope stretches (1)	 (bottom) pulley / rope has {mass / weight} ignore references to the mass / weight of barrel tension in rope ignore references to consequences of friction such as air resistance, heat or sound. ignore pulling at an angle ignore references to person	(**1**) AO1

Question number	Indicative content	Mark
***9(b)**	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. Use of equipment • Provide a measurable load; for example hang a cube on one end of the system / on spring (balance) • Provide a measurable effort; for example hang spring balance on other end of system • Method to measure distances moved; for example use metre rule Obtaining relevant data • Measure weight of cube with spring balance • Take reading of spring balance when being pulled • Measure height by which the cube is raised • Measure distance moved by (end of) spring balance. Processing results • calculate work done on cube = obtained weight x obtained distance • calculate work done by student = obtained force x obtained distance • calculate efficiency as (calculable) work done on cube / (calculable) work done by student • inspect results to look for relationship between weight of cube and efficiency • plot graph of efficiency against weight	**(6)** AO3

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1–2	• Analyses the scientific information but understanding and connections are flawed. (AO3) • An incomplete plan that provides limited synthesis of understanding. (AO3)
Level 2	3–4	• Analyses the scientific information and provides some logical connections between scientific enquiry, techniques and procedures. (AO3) • A partially completed plan that synthesises mostly relevant understanding, but not entirely coherently. (AO3)
Level 3	5–6	• Analyses the scientific information and provide logical connections between scientific enquiry, techniques and procedures. (AO3) • A well-developed plan that synthesises relevant understanding coherently. (AO3)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels 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.
	0	No rewardable material.	
Level 1	1–2	Additional guidance At least two uses of equipment	Possible candidate responses Hang cubes on hook Spring balance on ring
Level 2	3–4	Additional guidance At least two methods of obtaining relevant data from use of equipment.	Possible candidate responses Measure weight of cube with spring balance. Hang cube on hook. Pull on other end. Measure how far cube has gone up. OR Put cube on hook. Put spring balance on ring. Pull and read force. Measure how far spring balance moves.
Level 3zz	5–6	Additional guidance At least two methods of obtaining relevant data from correct use of equipment and at least two descriptions of processing that data.	Possible candidate responses Use spring balance to measure weight of cube and force needed by student. Measure height that cube was raised by. Calculate work done by multiplying force and distance moved in each case.

Total 11 marks

Question number	Answer	Additional guidance	Mark
10 (a) (i)	C (a) slower than (b) and (a) opposite to (b) B and D are incorrect because the direction of the readings are opposite and so the rotations must be opposite A is incorrect because the value in (a) is less than the value in (b) and so the rotation cannot be faster		(**1**) AO1

Question number	Answer	Additional guidance	Mark
10 (a) (ii)	**either** an answer in terms of magnetic fields and forces: current in the (dynamo) coil generates a magnetic field (1) (interaction of) fields cause force (that opposes motion) (1) **OR** an answer in terms of output energy and input work: energy is being transferred to the lamp (1) additional work is being done (by teacher) / additional energy is necessary (1)	accept lamp uses (thermal / heat / light) energy (to light up) ignore reference to greater (electrical) resistance	(**2**) AO1

Question number	Answer	Additional guidance	Mark
10 (b)	substitution into $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ (1) $\frac{230}{V_s} = \frac{800}{18}$ rearrangment (1) $(V_s =) \frac{18 \times 230}{800}$ evaluation (1) (Vs =) 5.2 (V)	alternative method re-arrangement (1) $(V_s =) \frac{V_p \times N_s}{N_p}$ substitution (1) $(V_s =) \frac{18 \times 230}{800}$ evaluation (1) (Vs =) 5.2 (V) allow values that round to 5.2 (e.g. 5.175) award 1 mark for answers that round to 10 000 (e.g. 10 222) award full marks for correct answer without working.	(**3**) AO2

Question number	Indicative content	Mark
***10(c)**	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. Basic facts • Sound is vibrations (of air) • Loudspeaker emits / gives out sound • Loudspeaker is an output device • Microphone accepts / takes in sound • Microphone is an input device Principles of operation • Alternating current or (electrical) signal sent into a loudspeaker • Loudspeaker cone / coil vibrates (air) • Motor effect in loudspeaker • Microphone cone / coil is vibrated by air/sound • Alternating current / (electrical) signal is produced by microphone • Electromagnetic induction in microphone Details of operation of loudspeaker • Alternating current or (electrical) signal in coil produces changing magnetic field • (changing) Force between magnetic field of coil and magnet. • Frequency / amplitude of sound depends on frequency / amplitude of alternating current Details of operation of microphone • Coil oscillates in a magnetic field • Generates an alternating p.d. (across the wires) / alternating current /signal • Frequency / amplitude of alternating p.d. / current depends on amplitude / frequency of the sound	**(6)** AO2

Level	Mark	Descriptor
	0	• No awardable content
Level 1	1-2	• The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. • Lines of reasoning are unsupported or unclear. (AO2)
Level 2	3-4	• The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. • Lines of reasoning mostly supported through the application of relevant evidence. (AO2)
Level 3	5-6	• The explanation is supported throughout by linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. • Lines of reasoning are supported by sustained application of relevant evidence. (AO2)

Level	Mark	Additional Guidance	General additional guidance – the decision within levels 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.
	0	No rewardable material.	
Level 1	1–2	Additional guidance Basic facts	Possible candidate responses A loudspeaker vibrates to make sound.
Level 2	3–4	Additional guidance Principles of operation supported by basic facts. Facts may be implied by principles.	Possible candidate responses Sound vibrates the coil in the microphone. This makes a signal. OR A loudspeaker uses the motor effect to vibrate the cone and make a sound.
Level 3	5–6	Additional guidance Principles and details of operation. Principles may be implied by details. One device may be more developed than the other but both devices must be referenced.	Possible candidate responses Alternating current in the loudspeaker coil makes the coil move inside the magnet. This forces the cone to vibrate and produce sound. The microphone makes an alternating current.

Total 12 marks