

Physics
PAPER 2
Higher Tier

Total Marks

Friday 16 June 2023 – Morning

Time: 1 hour 45 minutes

In the boxes below, write your name, centre number and candidate number.

Surname					
Other names					
Centre Number					
Candidate Number					

YOU MUST HAVE

Calculator, ruler, Equation Booklet (enclosed)

YOU WILL BE GIVEN

Diagram Booklet

Formulae Booklet

INSTRUCTIONS

Answer ALL questions.

Answer the questions in the spaces provided in this Question Paper or in the separate Diagram Booklet – 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.

(continued on the next page)

Turn over

INFORMATION continued.

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 provided as a separate booklet.

There may be spare copies of some diagrams.

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.

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) Look at Figure 1 for Question 1(a) in the Diagram Booklet. It shows a prize that is made from a metal star on a plastic base.**

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.

(continued on the next page)

1(a) continued.

**(i) The plastic base has
(1 mark)**

☐ **A gained electrons**

☐ **B gained protons**

☐ **C lost electrons**

☐ **D lost protons**

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

(continued on the next page)

Turn over

1 continued.

- (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 marks)**

(continued on the next page)

1 continued.

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

Look at Figure 2 for Question 1(c) in the Diagram Booklet. It shows a magnified view of part of the surface of the plastic base and a dust particle.

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 marks)

(Total for Question 1 = 7 marks)

- 2 (a) Look at Figure 3 for Question 2(a) in the Diagram Booklet. It shows some of the apparatus that students use to determine the resistance of a piece of iron wire.**

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 marks)

- (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 mark)

- (ii) Look at Figure 4 for Question 2(b) in the Diagram Booklet. It shows a graph of the results.**

Draw a straight line of best fit on Figure 4.

(1 mark)

(continued on the next page)

Turn over

2(b) continued.

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

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 marks)**

(continued on the next page)

Turn over

2 continued.

- (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.
(2 marks)**

Use the equation

$$V = I \times R$$

resistance = _____ Ω

(Total for Question 2 = 9 marks)

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

☐ A condensing

☐ B freezing

☐ C melting

☐ D sublimating

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

Calculate the density, ρ , of the object.
(3 marks)

Use the equation

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

State the unit.

Answer space continues on the next page.

3(b) continued.

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 mark)**

melting point of aluminium = _____ K

(continued on the next page)

3(c) continued.

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

(continued on the next page)

3 continued.

- (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.

(continued on the next page)

3(d) continued.

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 marks)

1 _____

2 _____

(Total for Question 3 = 9 marks)

4 This question is about pressure.

- (a) Look at Figure 5 for Question 4(a) in the Diagram Booklet. It shows windows in an aeroplane.**

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 mark)**

pressure difference = _____ Pa

- (ii) The surface area of the window is 0.094 m²**

**Calculate the size of the force on the window due to the cabin air pressure of 80 000 Pa.
(2 marks)**

Use the equation

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

Answer space continues on the next page.

4(a)(ii) continued.

force = _____ N

(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 marks)**

(continued on the next page)

Turn over

4(a) continued.

- (iv) Look at Figure 6 for Question 4(a)(iv) in the Diagram Booklet. It shows a cross-section through the aeroplane including one window.**

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 marks)

- (b) Look at Figure 7 in the Diagram Booklet. It shows the atmospheric pressure at different heights above the Earth's surface.**

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

Use data from Figure 7 to support your answer.

(3 marks)

Answer space continues on the next page.

4(b)(i) continued.

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

(Total for Question 4 = 11 marks)

- 5 (a) Look at Figure 8 for Question 5(a) in the Diagram Booklet. It shows two magnets with their N poles facing each other.**

**On Figure 8, draw the shape and direction of the magnetic field between the two magnets.
(2 marks)**

- (b) Look at Figure 9 for Question 5(b) in the Diagram Booklet. It 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.**

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 marks)**

Answer space continues on the next page.

5(b) continued.

(continued on the next page)

5 continued.

(c) Look at Figure 10 for Question 5(c) in the Diagram Booklet. It shows a current-carrying wire between the poles of a magnet.

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

1 State the direction of the force on the wire.

2 State the direction of the force on the magnet.

(continued on the next page)

5(c) continued.

(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 in the Equation Booklet.
(2 marks)**

length of the wire in the magnetic field =

_____ m

(Total for Question 5 = 9 marks)

- 6 (a) Look at Figure 11 for Question 6(a) in the Diagram Booklet. It shows a person doing a push-up exercise.

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

Which row of the table is correct for this rotation?
(1 mark)

	provide the upward force	act as a pivot
<input type="checkbox"/> A	arms	hands
<input type="checkbox"/> B	arms	feet
<input type="checkbox"/> C	legs	hands
<input type="checkbox"/> D	legs	feet

(continued on the next page)

6 continued.

(b) Look at Figure 12 for Question 6(b) in the Diagram Booklet. It 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.

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.

(continued on the next page)

6(b) continued.

Look at Figure 13 for Question 6(b)(i) in the Diagram Booklet. It shows a diagram representing the forces and distances involved.

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

(continued on the next page)

6(b) continued.

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

Look at Figure 14 for Question 6(b)(ii) in the Diagram Booklet. It shows the forces on the forearm and their distances from the elbow joint.

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

(3 marks)

force = _____ N

(continued on the next page)

6 continued.

(c) Look at Figure 15 for Question 6(c) in the Diagram Booklet. It shows a ball floating in seawater and the same ball floating in fresh water.

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

(continued on the next page)

6(c) continued.

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

(Total for Question 6 = 10 marks)

- 7 (a) Look at Figure 16 for Question 7(a)(i) in the Diagram Booklet. It shows part of the inside of a pen.

The pen contains a spring that can be compressed.

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 marks)

force = _____ N

(continued on the next page)

7(a) continued.

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

Look at Figure 17 for Question 7(a)(ii) in the Diagram Booklet. It shows the equipment and the procedure that the student uses.

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 marks)**

Answer space continues on the next page.

7(a)(ii) continued.

(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 marks)**

(continued on the next page)

7 continued.

- (b) Look at Figure 18 for Question 7(b) in the Diagram Booklet. It shows a different spring hanging from a hook fixed to the ceiling.**

A block hangs from the other end of the spring.

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 mark)

☐ **A 4 N down**

☐ **B 4 N up**

☐ **C 6 N down**

☐ **D 6 N up**

- (c) Look at Figure 19 for Question 7(c) in the Diagram Booklet. It shows two forces, P and Q, acting at point X.**

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

(2 marks)

(Total for Question 7 = 11 marks)

Turn over

- 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 marks)

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 marks)

Answer space continues on the next page.

8(a)(ii) continued.

time taken = _____ hours

(continued on the next page)

8(a) continued.

(iii) Look at Figure 20 for Question 8(a)(iii) in the Diagram Booklet. It shows an electrical device connected to the wheels of an electric car.

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 marks)**

(continued on the next page)

8 continued.

(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
(3 marks)

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

8(b) continued.

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

Use the equation

$$E = Q \times V$$

charge = _____ C

(Total for Question 8 = 11 marks)

- 9 (a) Look at Figure 21 for Question 9(a) in the Diagram Booklet. It shows a pulley system that enables a person to lift a heavy barrel.

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.
(2 marks)

Use the equation

work done = force \times
distance moved in the direction of the force

weight of the barrel = _____ N

(continued on the next page)

9(a) continued.

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

Calculate the total work done by the person.
(2 marks)

Use the equation

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

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 mark)

(continued on the next page)

Turn over

9 continued.

***(b) Look at Figure 22 for Question 9(b) in the Diagram Booklet. A student has the equipment shown in 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 marks)**

Answer space continues on the next page.

9(b) continued.

(Total for Question 9 = 11 marks)

- 10 (a) Look at Figure 23 for Question 10 in the Diagram Booklet. It shows a model dynamo.**

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.

Look at Figure 24(a) for Question 10(a) in the Diagram Booklet. It shows the reading on the voltmeter.

The teacher then rotates the handle differently.

Look at Figure 24(b) for Question 10(a) in the Diagram Booklet. It shows the new reading on the voltmeter.

(continued on the next page)

10(a) continued.

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

	speed of rotation	direction of rotation
<input type="checkbox"/> A	(a) faster than (b)	(a) opposite to (b)
<input type="checkbox"/> B	(a) faster than (b)	(a) same as (b)
<input type="checkbox"/> C	(a) slower than (b)	(a) opposite to (b)
<input type="checkbox"/> D	(a) slower than (b)	(a) same as (b)

(continued on the next page)

10(a) continued.

(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 marks)**

(continued on the next page)

10 continued.

(b) Look at Figure 25 for Question 10(b) in the Diagram Booklet. It shows a transformer.

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

**The potential difference across the primary coil,
 $V_p = 230\text{ V}$**

**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 in the Equation Booklet.
(3 marks)**

Answer space continues on the next page.

10(b) continued.

potential difference across the secondary coil =

_____ V

(continued on the next page)

10 continued.

***(c) Look at Figure 26 for Question 10(c) in the Diagram Booklet. It shows a picture of an electrical device and a simplified drawing of the important parts.**

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 marks)

Answer space continues on the next page.

10(c) continued.

(Total for Question 10 = 12 marks)

TOTAL FOR PAPER = 100 MARKS
END OF PAPER