

Physics
PAPER 2
Higher Tier

Total Marks

Friday 14 June 2024 – Afternoon

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

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.

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 This question is about static electricity and electric fields.

(a) Look at Figure 1 for Question 1(a) in the Diagram Booklet. It shows three charged objects, X, Y and Z.

Y has a positive charge and is held stationary.

The charge on Y causes X and Z to move in the directions of the arrows.

**Which row is correct for the charges on X and Z?
(1 mark)**

	charge on X	charge on Z
<input type="checkbox"/> A	negative	negative
<input type="checkbox"/> B	negative	positive
<input type="checkbox"/> C	positive	negative
<input type="checkbox"/> D	positive	positive

1 continued.

- (b) Give the meaning of the term ELECTRIC FIELD.
(1 mark)**

- (c) Look at Figure 2 for Question 1(c) in the Diagram Booklet. It shows the electric field around a point charge.**

- (i) State how Figure 2 gives evidence that the point charge is positive.
(1 mark)**

(continued on the next page)

1(c) continued.

- (ii) In Figure 2, X is the distance from the point charge.**

State how Figure 2 gives evidence that the electric field strength decreases as X increases.

(1 mark)

(continued on the next page)

1(c) continued.

- (iii) Look at Figure 3 for Question 1(c)(iii) in the Diagram Booklet. It shows a graph of electric field strength against distance x .**

The equation relating electric field strength to distance, x , is

$$\text{electric field strength} = \frac{A}{x^2}$$

A is a constant.

Using data from the graph in Figure 3, calculate the value of A when $x = 3 \text{ cm}$ (2 marks)

$$A = \underline{\hspace{4cm}} \text{ N cm}^2/\text{C}$$

(Total for Question 1 = 6 marks)

- 2 (a) Look at Figure 4 for Question 2(a) in the Diagram Booklet. It is a circuit diagram.

The current at **P** is
(1 mark)

☐ A 0.05 A

☐ B 0.10 A

☐ C 0.15 A

☐ D 0.20 A

(continued on the next page)

2 continued.

(b) Some students investigate resistors in parallel.

The students set up a circuit containing FOUR identical resistors.

Look at Figure 5 for Question 2(b) in the Diagram Booklet. It shows the circuit used.

The students measure the current from the power supply and the voltage (p.d.) across the resistors.

- (i) On Figure 5 for Question 2(b) in the Diagram Booklet, draw a voltmeter connected to measure the voltage (p.d.) across the resistors.
(1 mark)**

The students remove one resistor and measure the current and voltage again with only 3 resistors in the circuit.

They repeat the measurements of current and voltage with only 2 resistors in the circuit and then with only 1 resistor in the circuit.

(continued on the next page)

2(b) continued.

Look at Figure 6 for Question 2(b) in the Diagram Booklet. It shows a table of their results.

- (ii) Using data from the table in Figure 6, predict the current from the power supply when there are 4 resistors in the circuit.**

(1 mark)

current = _____ mA

- (iii) Look again at Figure 6 for Question 2(b) in the Diagram Booklet. Using data from the table in Figure 6, calculate the resistance of ONLY 1 resistor.**

(3 marks)

resistance = _____ Ω

2(b) continued.

- (iv) Look again at Figure 6 for Question 2(b) in the Diagram Booklet. Using data from the table in Figure 6, explain what happens to the **total resistance of the circuit** as the number of resistors in parallel decreases.
(3 marks)**

(Total for Question 2 = 9 marks)

- 3 (a) A coil of copper wire has a mass of **14.1 g**

The density, ρ , of copper is **8.96 g/cm³**

Calculate the volume of the copper wire.

Use the equation

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

(3 marks)

volume = _____ cm³

(continued on the next page)

3 continued.

- (b) Look at Figure 7 for Question 3(b) in the Diagram Booklet. It gives information about the density of aluminium.**

Explain the difference between the density of solid aluminium and the density of liquid aluminium in terms of the arrangement of particles.

(2 marks)

(continued on the next page)

3 continued.

(c) A student boils some water.

Calculate the amount of thermal energy needed to change 60.0 g of water to steam at its boiling point.

The specific latent heat of vaporisation of water, L , is $2.26 \times 10^6\text{ J/kg}$

Use the equation

$$Q = m \times L$$

(2 marks)

amount of thermal energy = _____ J

(continued on the next page)

3 continued.

- (d) Look at Figure 8 for Question 3(d) in the Diagram Booklet. Some students measure the volume of a lump of modelling clay using a measuring jug, as shown in Figure 8.**

Using Figure 8, estimate the volume of the modelling clay in cm^3

**You may assume that 1 litre = 1000 cm^3
(2 marks)**

volume = _____ cm^3

(Total for Question 3 = 9 marks)

- 4 (a) Look at Figure 9 for Question 4(a) in the Diagram Booklet. It shows an object at the bottom of a beaker of water.

Look at the diagrams for Question 4(a) in the Diagram Booklet. Which diagram shows the direction of the force exerted by the water on the object at point X?

(1 mark)

☐ Diagram A

☐ Diagram B

☐ Diagram C

☐ Diagram D

(continued on the next page)

4 continued.

- (b) Look at Figure 10 for Question 4(b) in the Diagram Booklet. It shows an ice skater standing on one skate.**

Calculate the force the skate exerts on the ice.

pressure of skate on ice = 4.8×10^7 Pa

area of blade in contact with ice = 1.2×10^{-5} m²

Use the equation

force = pressure \times area

**Give your answer to 2 significant figures.
(3 marks)**

force = _____ N

(continued on the next page)

Turn over

4 continued.

(c) Look at Figure 11 for Question 4(c) in the Diagram Booklet. It shows how atmospheric pressure changes with height above sea level.

**(i) Using the graph, describe how atmospheric pressure changes with height above sea level.
(2 marks)**

(continued on the next page)

4(c) continued.

- (ii) The top of Mount Everest is **8850 m** above sea level.

Using the graph, estimate the atmospheric pressure at the top of Mount Everest.

(1 mark)

pressure = _____ kPa

- (iii) On a different day, the pressure at sea level is **104 kPa** and the pressure at a height of **2500 m** is **74 kPa**

Calculate the percentage change in pressure from sea level to the height of **2500 m**

(2 marks)

percentage change = _____ %

(continued on the next page)

Turn over

4 continued.

- (d) Look at Figure 12 for Question 4(d) in the Diagram Booklet. Figure 12 is a model representing molecules of the Earth's atmosphere.**

Use Figure 12 to explain how the density of the air varies with height above sea level.

(2 marks)

(Total for Question 4 = 11 marks)

- 5 (a) Look at Figure 13 for Question 5(a) in the Diagram Booklet. It represents the Earth.**

Figure 13 shows TWO magnetic compass needles placed near to the Earth's surface, at points **Q and **T**.**

Each magnetic compass needle can rotate about its central dot.

- (i) A compass needle is placed at point **P** and another at point **R**, near to the Earth's surface.**

On Figure 13, draw an arrow at point **P and an arrow at point **R** to show the direction of the compass needle at each point.**

(2 marks)

(continued on the next page)

5(a) continued.

- (ii) Explain why the arrows point in the directions you have drawn in part (i).**

You may draw on Figure 13 to help your answer.

(3 marks)

(continued on the next page)

5 continued.

- (b) Look at Figure 14 for Question 5(b) in the Diagram Booklet. It shows a wire placed between the poles of a U-shaped magnet.**

The wire is connected to a resistor and a battery.

The wire carries a current in the direction shown.

The wire is perpendicular to the magnetic field of the magnet.

- (i) Draw an arrow on Figure 14 to show the direction of the force, F , acting on the wire.**

Label this arrow ' F '.

(1 mark)

- (ii) State ONE practical way of reversing the direction of force F .**

(1 mark)

(continued on the next page)

5(b) continued.

(iii) In Figure 14

- current in the wire = **3.2 A**
- length of wire in the magnetic field = **0.042 m**
- magnitude of the force on the wire = **0.078 N**

Calculate the magnitude of the magnetic flux density between the two poles of the magnet.
(2 marks)

magnetic flux density = _____ T

(Total for Question 5 = 9 marks)

- 6 (a) Which of these is a unit for the moment of a force?
(1 mark)

☐ A N/m^2

☐ B N/m

☐ C N m

☐ D N m^2

- (b) Look at Figure 15 for Question 6(b) in the Diagram Booklet. It shows a claw hammer about to remove a nail from a piece of wood.

- (i) State the principle of moments.
(2 marks)

(continued on the next page)

Turn over

6(b) continued.

(ii) Calculate the force F_2 shown in Figure 15.

Use the following data

- $F_1 = 11.4 \text{ N}$
 - $d_1 = 24.5 \text{ cm}$
 - $d_2 = 3.7 \text{ cm}$
- (3 marks)

$F_2 = \underline{\hspace{4cm}} \text{ N}$

(continued on the next page)

6 continued.

(c) Look at Figure 16 for Question 6(c) in the Diagram Booklet. It shows a system of gears used in a clock.

(i) Gear wheel **P rotates clockwise at a rate of 1·0 revolution per MINUTE.**

Calculate the rotation rate of gear wheel **Q in revolutions per HOUR.**

(2 marks)

rotation rate of Q = _____ revolutions per hour

(continued on the next page)

6(c) continued.

- (ii) Describe how a gear wheel could be added to the system to give a clockwise rotation with **DOUBLE** the rotation rate of gear wheel Q.**

Your answer should refer to

- the position of the gear wheel**
 - the number of teeth in the gear wheel.**
- (2 marks)**

(Total for Question 6 = 10 marks)

Turn over

- 7 (a) Look at Figure 17 for Question 7(a) in the Diagram Booklet. It shows an athlete training with a push sled.

The athlete pushes the sled with a force of **645 N**

Calculate the distance the sled moves when the force of **645 N** does **7440 J** of work on the sled.

Give your answer to an appropriate number of significant figures.

(3 marks)

distance moved = _____ m

(continued on the next page)

7 continued.

(b) Look at Figure 18 for Question 7(b) in the Diagram Booklet. It shows an electric motor lifting a set of masses.

- (i) Describe an experiment, using the apparatus in Figure 18, to determine the gravitational potential energy gained by the masses as they are lifted.**

Your description should include any measuring devices to be used.

You may add to the diagram in Figure 18 if it helps your answer.

(4 marks)

Answer space continues on the next page.

7(b)(i) continued.

(continued on the next page)

7(b) continued.

- (ii) In one experiment, the change in gravitational potential energy of the masses was **5.8 J**

The total mass lifted was **320 g**

Calculate the vertical height the masses travelled through.

Use **$g = 10 \text{ N/kg}$**
(2 marks)

height = _____ m

(continued on the next page)

7(b) continued.

(iii) The efficiency of the motor was **59%**

State **ONE** reason why the motor was not **100%** efficient.

(1 mark)

(Total for Question 7 = 10 marks)

- 8 (a) A student investigates how current varies with potential difference across a filament lamp.**

The student uses a power supply, a variable resistor, the filament lamp and two meters.

Look at Figure 19 for Question 8(a) in the Diagram Booklet. Part of the circuit diagram is shown in Figure 19.

On Figure 19, complete the circuit diagram needed for this investigation.

(3 marks)

(continued on the next page)

8 continued.

- (b) Another student repeats the investigation in part (a) using a data logger.**

The data logger records observations using sensors instead of meters. The sensors are connected to a computer to collect and display the observations.

The data logger collects 555 pairs of data in 2 minutes.

Look at Figure 20 for Question 8(b) in the Diagram Booklet. It shows the results.

- (i) Suggest ONE advantage of using a data logger instead of meters in this investigation. (1 mark)**

(continued on the next page)

8(b) continued.

- (ii) Look again at Figure 20 for Question 8(b) in the Diagram Booklet. Describe how current varies with potential difference in the graph in Figure 20.
(2 marks)**

(continued on the next page)

8(b) continued.

(iii) Look again at Figure 20 for Question 8(b) in the Diagram Booklet. Use data from the graph in Figure 20 to show how the resistance changes with potential difference for the filament lamp.

(2 marks)

(continued on the next page)

8 continued.

(c) Which of these equations is correct?
(1 mark)

☐ A $\text{time} = \frac{\text{charge}}{\text{current}}$

☐ B $\text{time} = \text{charge} \times \text{current}$

☐ C $\text{time} = \frac{\text{power}}{\text{energy}}$

☐ D $\text{time} = \text{power} \times \text{energy}$

(continued on the next page)

8 continued.

(d) The unit of work is the joule.

Starting with the meaning of work, we may obtain an equivalent unit of work as **Nm**

Using work = **F** × **d**

unit of work = unit of force × unit of distance = **Nm**

The unit of potential difference is the volt.

Explain how, starting with the meaning of potential difference, we may obtain an equivalent unit of potential difference.

(2 marks)

Answer space continues on the next page.

8(d) continued.

(Total for Question 8 = 11 marks)

- 9 (a) Which of these changes of state describes sublimation?**
(1 mark)

- ☐ **A from gas to liquid**
- ☐ **B from liquid to solid**
- ☐ **C from solid to gas**
- ☐ **D from solid to liquid**

(continued on the next page)

9 continued.

(b) Look at Figure 21 for Question 9(b) in the Diagram Booklet. It shows a sealed aerosol can.

The sealed can is taken from a cold room into a warm room.

If the volume of the can remains the same, which of these does NOT change?

(1 mark)

- ☐ **A the pressure inside the can**
- ☐ **B the mean speed of the particles inside the can**
- ☐ **C the mean distance between the particles inside the can**
- ☐ **D the mean size of the momentum of the particles inside the can**

(continued on the next page)

9 continued.

- (c) Look at Figure 22 for Question 9(c) in the Diagram Booklet. It shows a storage heater.**

The storage heater contains bricks.

The bricks are heated electrically.

The electrical heater supplies 210 kJ of energy to each brick in the storage heater.

One brick has a mass of 5.8 kg

The specific heat capacity for the brick is 860 J/kg K

- (i) Use this data to calculate the increase in temperature of the brick.
(2 marks)**

temperature increase = _____ °C

(continued on the next page)

Turn over

9(c) continued.

- (ii) The actual temperature increase will be smaller than you calculated in (i).**

Explain why the actual temperature increase will be smaller than the value in (i).

(2 marks)

(continued on the next page)

9 continued.

***(d) Describe an investigation to determine the value for the specific heat capacity of water.**

Your answer should include details of

- **the apparatus needed**
- **the experimental procedure**
- **how the value may be calculated from the measurements taken.**

**You may draw a diagram to help your answer.
Use the blank page in the Diagram Booklet for
Question 9(d) if required.**

(6 marks)

Answer space continues on the next 2 pages.

Turn over

9(d) continued.

[illegible]

Turn over

9(d) continued.

(Total for Question 9 = 12 marks)

- 10 (a) Look at Figure 23 for Question 10(a) in the Diagram Booklet. It shows a magnet being dropped through a coil.**

The coil is connected to a sensitive voltmeter.

- (i) Explain why the voltmeter shows a reading as the magnet passes through the coil.
(3 marks)**

(continued on the next page)

10(a) continued.

- (ii) A student develops this investigation to find out how the reading on the voltmeter depends on the height the magnet is dropped from.**

Look again at Figure 23 for Question 10(a) in the Diagram Booklet. Describe how the student could use the arrangement in Figure 23 to do this investigation.

(4 marks)

Answer space continues on the next page.

10(a)(ii) continued.

(continued on the next page)

10 continued.

***(b) A transformer converts a voltage of 11 000 V to 230 V**

Explain how the design of this transformer enables the voltage to be converted from 11 000 V to 230 V

Your answer should include

- **details of the structure of a transformer**
- **how a transformer works, using ideas of electromagnetic induction**
- **how the design of this transformer enables this exact voltage of 230 V to be obtained.**

**You may draw a diagram to help your answer.
Use the blank page in the Diagram Booklet for
Question 10(b) if required.
(6 marks)**

Answer space continues on the next 2 pages.

Turn over

10(b) continued.

[illegible]

Turn over

10(b) continued.

(Total for Question 10 = 13 marks)

TOTAL FOR PAPER = 100 MARKS
END OF PAPER