

Combined Science  
PAPER 6  
Higher Tier

Total Marks
-------------

Friday 16 June 2023 – Morning

Time: 1 hour 10 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.**

**Turn over**

## **INFORMATION**

**The total mark for this paper is 60.**

**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 labelled 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 in the separate Formulae Booklet and Equation Booklet.**

## **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 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 1 so that the students can determine the resistance of the piece of iron wire.**

**(2 marks)**

**(continued on the next page)**

**Turn over**

**1 continued.**

**(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 2 for Question 1(b)(ii) in the Diagram Booklet. It shows a graph of the results.**

**Draw a straight line of best fit on Figure 2.  
(1 mark)**

**(continued on the next page)**

**Turn over**

**1(b) continued.**

- (iii) Use Figure 2 to estimate the resistance of a 100 cm length of the iron wire.  
(1 mark)**

**resistance =**

**\_\_\_\_\_  $\Omega$**

**(continued on the next page)**

**1(b) continued.**

**(iv) The variable resistor shown in Figure 1 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**

**1 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 =**

\_\_\_\_\_  $\Omega$

**(Total for Question 1 = 9 marks)**

---

**Turn over**



- 2 (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,  $\rho$ , of the object.  
(3 marks)**

**(continued on the next page)**

**2(b) continued.**

**Use the equation**

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

**State the unit.**

**density = \_\_\_\_\_**

**unit \_\_\_\_\_**

**(continued on the next page)**

**2 continued.**

**(c) Aluminium has a melting point of  $660^{\circ}\text{C}$ .**

**The absolute zero of temperature is  $-273^{\circ}\text{C}$ .**

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

**melting point of aluminium =  
\_\_\_\_\_ K**

**(continued on the next page)**

**Turn over**

**2(c) continued.**

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

---

---

---

---

---

**(continued on the next page)**

**2 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)**

**Turn over**

**2(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)**

**Answer space continues on the next page.**

**1** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**2** \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

**Turn over**

**2(d) continued.**

---

---

**(Total for Question 2 = 9 marks)**

---

- 3 (a) Look at Figure 3 for Question 3(a) in the Diagram Booklet. It shows two magnets with their N poles facing each other.**

**On Figure 3, draw the shape and direction of the magnetic field between the two magnets.  
(2 marks)**

- (b) Look at Figure 4 for Question 3(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.**

**(continued on the next page)**



**3(b) continued.**

**Use the idea of magnetic fields in  
your answer.  
(3 marks)**

---

---

---

---

---

---

---

---

---

---

**(continued on the next page)**

**Turn over**

**3 continued.**

**(c) Look at Figure 5 for Question 3(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.**

---

---

**3(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.**

**(continued on the next page)**

**3(c)(ii) continued.**

**Use an equation selected from  
the list of equations given  
in the Formulae Booklet or  
Equation Booklet.  
(2 marks)**

**length of the wire in the magnetic field =**  
**\_\_\_\_\_ m**

**(Total for Question 3 = 9 marks)**

---

- 4 (a) Look at Figure 6 for Question 4(a) 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  $260 \text{ N/m}$ .**

- (i) Calculate the force needed to compress the spring by the amount shown in Figure 6.**

**(continued on the next page)**

**4(a)(i) continued.**

**Give your answer to an appropriate  
number of significant figures.  
(3 marks)**

**force = \_\_\_\_\_ N**

**(continued on the next page)**

**4(a) continued.**

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

**Look at Figure 7 for Question 4(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 7 to help your answer.**

**(3 marks)**

**Answer space continues on the next page.**

**Turn over**

**4(a)(ii) continued.**

---

---

---

---

---

---

---

---

---

**(continued on the next page)**



**4(a) 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)**

**Turn over**

**4 continued.**

**(b) Look at Figure 8 for Question 4(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**

**(continued on the next page)**

**Turn over**

**4 continued.**

**(c) Look at Figure 9 for Question 4(c) in the Diagram Booklet. It shows two forces, P and Q, acting at point X.**

**Complete the diagram in Figure 9 to show the size and direction of the resultant force, R, on point X.**

**(2 marks)**

**(Total for Question 4 = 11 marks)**

---

- 5 (a) An electric car is travelling at a speed of  $16.0 \text{ m/s}$

The total mass of the car is  $1200 \text{ kg}$ .

- (i) Calculate the kinetic energy, in kJ, of the car  
(2 marks)

kinetic energy =

\_\_\_\_\_ kJ

(continued on the next page)

**5(a) continued.**

- (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)**

**time taken =**

**\_\_\_\_\_ hours**

**5(a) continued.**

**(iii) Look at Figure 10 for Question 5(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)**

**Answer space continues on the next page.**

---

---

---

**Turn over**

**5(a)(iii) continued.**

---

---

---

**(continued on the next page)**

**5 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.**

**(continued on the next page)**



**5(b) continued.**

- (i) Comment on this claim.  
(3 marks)**

**Use this equation to support  
your answer**

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

---

---

---

**(continued on the next page)**

**5(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 5 = 11 marks)**

---

**Turn over**

- 6 (a) Look at Figure 11 for Question 6(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.**

**(continued on the next page)**

**6(a) continued.**

- (i) Calculate the weight of the barrel.  
(2 marks)**

**Use the equation**

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

**weight of the barrel =**  
**\_\_\_\_\_ N**

**(continued on the next page)**

**Turn over**

**6(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**

**(continued on the next page)**

**Turn over**

**6(a) continued.**

**(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)**

**6 continued.**

**\*(b) Look at Figure 12 for Question 6(b) in the Diagram Booklet. A student has the equipment shown in Figure 12.**

**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.**

---

---

---

---

---

**Turn over**

**6(b) continued.**

---

---

---

---

---

---

---

---

---

---

---

---

**(Total for Question 6 = 11 marks)**

---

---

**TOTAL FOR PAPER = 60 MARKS**  
**END OF PAPER**