

Combined Science  
PAPER 3  
Higher Tier

Total Marks
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Thursday 25 May 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.**

## **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 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.**

**Turn over**

**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.**

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**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) Which of these is a scalar quantity?**  
**(1 mark)**

☐ **A acceleration**

☐ **B distance**

☐ **C force**

☐ **D weight**

**(continued on the next page)**

**1 continued.**

**(b) A student has some cupcake cases.**

**Look at the diagrams for Question 1(b) in the Diagram Booklet. One cupcake case is shown in Figure 1.**

**The student drops a stack of cupcake cases with the base facing downwards, as shown in Figure 2.**

**The speed of the falling stack of cupcake cases depends on the number of cupcake cases in the stack.**

**(i) The student also has a stop clock and a metre rule.**

**Describe an investigation to show how the speed of the falling stack of cupcake cases depends on the number of cupcake cases in the stack.**

**(4 marks)**

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

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**Turn over**

**1(b)(i) continued.**

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**(continued on the next page)**

**1(b) continued.**

- (ii) A stack of cupcake cases has a mass of 0.005 kg.**

**Calculate the weight, in newtons, of the stack of cupcake cases.**

**Gravitational field strength = 10 N/kg  
(2 marks)**

**Use the equation**

$$W = mg$$

**weight = \_\_\_\_\_ N**

**(continued on the next page)**

**Turn over**

**1(b) continued.**

**Look at Figure 3 for Question 1(b)(iii) in the Diagram Booklet. It shows a cupcake case that is falling at a constant velocity.**

**(iii) Draw an arrow on Figure 3 to show the force due to air resistance on the cupcake case.  
(1 mark)**

**(iv) State the value of the acceleration of the cupcake case when it is falling at a constant velocity.  
(1 mark)**

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

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- 2 (a) Look at Figure 4 for Question 2(a) in the Diagram Booklet. It shows a football kicked against a wall.**

**The football has a mass of 0.42 kg.**

- (i) The football gains 11 J of gravitational potential energy as it moves from the ground to the wall.**

**Calculate the height at which the ball hits the wall.**

**(3 marks)**

**Gravitational field strength = 10 N/kg**

**Use the equation**

$$\Delta \text{GPE} = m \times g \times \Delta h$$

**height = \_\_\_\_\_ m**

**2(a) continued.**

- (ii) Calculate the kinetic energy of the football when it is moving at a velocity of 12m/s.  
(2 marks)**

**Use the equation**

$$\text{KE} = \frac{1}{2} \times m \times v^2$$

**kinetic energy = \_\_\_\_\_ J**

**(continued on the next page)**

**2(a) continued.**

- (iii) Describe the energy transfers that happen when the ball hits the wall.  
(2 marks)**

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**(continued on the next page)**

**2 continued.**

**(b) A stone is held at rest above the ground.**

**The stone is released and falls until its velocity is 17 m/s.**

**Calculate the distance the stone has fallen when its velocity has reached 17 m/s.  
(2 marks)**

**distance = \_\_\_\_\_ m**

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

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- 3 Look at Figure 5 for Question 3 in the Diagram Booklet. It shows a velocity/time graph for a lift moving upwards in a tall building.**

**(a) For what length of time is the lift at rest during the first 16 s?  
(1 mark)**

☐ **A 1.4 s**

☐ **B 3.0 s**

☐ **C 3.6 s**

☐ **D 4.0 s**

**(continued on the next page)**

**3 continued.**

- (b) Use the graph in Figure 5 to determine the maximum velocity of the lift during the first 16 s.  
(1 mark)**

**maximum velocity = \_\_\_\_\_ m/s**

- (c) Use the graph in Figure 5 to determine the acceleration of the lift during the first 1.4 s.  
(3 marks)**

**acceleration = \_\_\_\_\_ m/s<sup>2</sup>**

**(continued on the next page)**

**Turn over**

**3 continued.**

- (d) Use the graph in Figure 5 to determine the distance that the lift travelled during the first 6.0 s. (3 marks)**

**distance = \_\_\_\_\_ m**

- (e) At 18 s, the lift starts to move downwards.**

**Sketch a line on Figure 5 in the Diagram Booklet to show the lift moving downwards after 18 s. (1 mark)**

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

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- 4 (a) Look at Figure 6 for Question 4(a) in the Diagram Booklet. It shows two technicians, L and M, measuring the speed of sound in air.**

**L fires a starting pistol.**

**M starts a stopwatch when first seeing the smoke from the starting pistol.**

**M stops the stopwatch when hearing the bang made by the starting pistol.**

**The distance between L and M is 120 m.**

**M's reaction time is 0.23 s.**

**The speed of sound in air is 330 m/s.**

**(continued on the next page)**



**4(a) continued.**

- (i) Calculate M's reaction time as a percentage of the time sound takes to travel from L to M.  
(3 marks)**

\_\_\_\_\_ %

**(continued on the next page)**

**Turn over**

**4(a) continued.**

**(ii) Which of these would improve the technicians' measurement of the speed of sound?  
(1 mark)**

- ☐ **A Use a firework 'banger' instead of the starting pistol.**
- ☐ **B Use a stop clock that measures time in minutes.**
- ☐ **C Increase the distance between L and M.**
- ☐ **D Decrease the distance between L and M.**

**(continued on the next page)**

**4 continued.**

- (b) Look at Figure 7 for Question 4(b) in the Diagram Booklet. Figure 7 shows the difference in refraction of sound waves and light waves when these waves travel from air into water.**

**Explain why the refraction of the sound wave is different from the refraction of the light wave in Figure 7.**

**(3 marks)**

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**Turn over**

**4 continued.**

**(c) Light is one example of an electromagnetic wave.**

**Light can transfer energy from a lamp to the leaf of a plant, causing chemical reactions in the leaf.**

**Describe examples of TWO other electromagnetic waves transferring energy.  
(4 marks)**

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

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

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**4(c) continued.**

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

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

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- 5 (a) Look at the Figure 8 for Question 5(a) in the Diagram Booklet. It shows the symbol for a nucleus of americium-241.

Americium-241 is a radioactive isotope of americium.

Americium-241 decays by emitting alpha ( $\alpha$ ) particles.

- (i) Which of these is the symbol for another radioactive isotope of americium?  
(1 mark)



(continued on the next page)

**5(a) continued.**

**(ii) Which of these is the approximate maximum distance that alpha particles can travel in air at normal atmospheric pressure?  
(1 mark)**

☐ **A    5 mm**

☐ **B    5 cm**

☐ **C    5 m**

☐ **D    5 km**

**(iii) Look at Figure 9 for Question 5(a)(iii) in the Diagram Booklet. Complete the equation in Figure 9 for americium-241 decaying into neptunium (Np).  
(3 marks)**

**(continued on the next page)**

**5 continued.**

**(b) Look at Figure 10 for Question 5(b) in the Diagram Booklet.**

**The activity of a radioactive source is measured as 128 Bq.**

**This is shown as a point on the graph in Figure 10.**

**The half-life of this radioactive source is 17 s.**

**Use this information to plot three more points on the graph grid in Figure 10 to show how the activity of the source changes with time.**

**(3 marks)**

**(continued on the next page)**



**5 continued.**

- (c) Describe what happens in the nucleus of an atom when a positron is emitted.  
(2 marks)**

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**(Total for Question 5 = 10 marks)**

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- 6 (a) An atom of mass  $6.6 \times 10^{-26}$  kg is moving with a velocity of 480 m/s.

Calculate the momentum of the atom.  
(3 marks)

momentum = \_\_\_\_\_ kg m/s

(continued on the next page)

**6 continued.**

**(b) Look at Figure 11 for Question 6(b) in the Diagram Booklet. It shows a ball before and after it collides with a wall.**

**The arrows show the direction of movement of the ball.**

**Before the collision, the momentum of the ball is  $0.80 \text{ kg m/s}$ .**

**After the collision, the momentum of the ball is  $0.60 \text{ kg m/s}$  in the opposite direction.**

**The ball is in contact with the wall for a time of  $70 \text{ ms}$  during the collision.**

**Calculate the force exerted on the ball by the wall.  
(3 marks)**

**Use an equation selected from the list of equations in the Equation Booklet.**

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

**6(b) continued.**

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

**(continued on the next page)**

**Turn over**

**6 continued.**

**\*(c) Look at Figure 12 for Question 6(c) in the Diagram Booklet.**

**Newton's second law can be stated as**

**force = mass  $\times$  acceleration**

**A student is provided with a trolley and a runway on a bench, as shown in Figure 12, and access to other equipment.**

**Describe a procedure the student could use to investigate how the acceleration of the trolley depends on the force applied to the trolley.**

**You may add to the diagram in Figure 12 to help your answer.  
(6 marks)**

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

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**6(c) continued.**

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**(Total for Question 6 = 12 marks)**

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