

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

AS PHYSICS A

Unit 2 Mechanics, Materials and Waves

Thursday 8 June 2017

Afternoon

Time allowed: 1 hour 15 minutes

Materials

For this paper you must have:

- a pencil and a ruler
- a protractor
- a calculator
- a Data and Formulae Booklet (enclosed).

Instructions

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided.
Do not write outside the box around each page or on blank pages.
- Do all rough work in this book.
Cross through any work you do not want to be marked.
- Show all your working.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You are expected to use a calculator, where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
 - use good English
 - organise information clearly
 - use specialist vocabulary where appropriate.

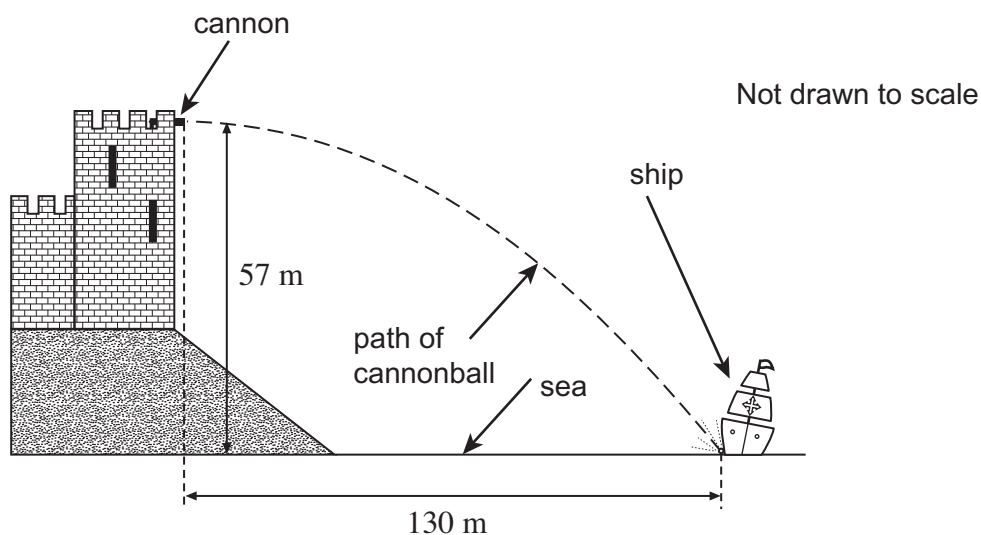
For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
4	
5	
6	
7	
8	
TOTAL	



Answer **all** questions in the spaces provided.

- 1 **Figure 1** shows the path of a cannonball fired horizontally to hit a ship.

Figure 1



The horizontal distance from the cannon to the ship is 130 m and the vertical distance from the cannon to the sea is 57 m.

- 1 (a) (i) Show that the time taken for the cannonball to reach the surface of the sea after being fired from the cannon was 3.4 s. Assume the air resistance was negligible in your answers to part (a).

[2 marks]

- 1 (a) (ii) Calculate the magnitude of the horizontal velocity at which the cannonball was fired. Give your answer to an appropriate number of significant figures.

[2 marks]

magnitude of horizontal velocity = _____ m s⁻¹



- 1 (a) (iii) Calculate the magnitude of the vertical velocity just before the cannonball hit the ship. **[2 marks]**

magnitude of vertical velocity = _____ m s^{-1}

- 1 (a) (iv) Determine, by use of a calculation or scale drawing, the magnitude and direction of the velocity of the cannonball just before it hit the ship. **[4 marks]**

magnitude of velocity = _____ m s^{-1}

direction of velocity = _____

Question 1 continues on the next page

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- 1 (b) (i) Calculate the loss of gravitational potential energy of the cannonball during its flight.

mass of the cannonball = 19 kg

[1 mark]

loss of gravitational potential energy = _____ J

- 1 (b) (ii) Describe the energy changes that take place from the moment the cannonball leaves the cannon until just before it hits the water. You should refer to the effects of air resistance in your response.

[2 marks]



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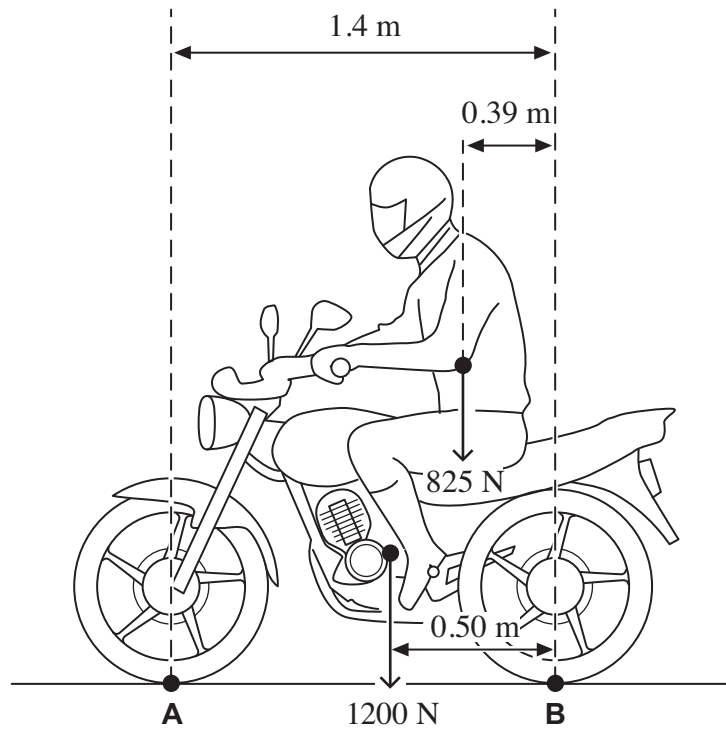
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ANSWER IN THE SPACES PROVIDED**

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- 2 **Figure 2** shows a motorcycle and rider balanced stationary on a level surface. The motorcycle is in contact with the road at **A** and **B**.

Figure 2



The motorcycle has a weight of 1200 N and the rider's weight is 825 N.

- 2 (a) State the Principle of Moments.

[2 marks]

- 2 (b) Calculate the moment of the rider's weight about **B**.
State an appropriate unit for your answer.

[2 marks]

moment = _____ unit = _____



- 2 (c)** Calculate the vertical force that the road exerts on the front tyre at **A** by taking the moments about **B**. Give your answer to an appropriate number of significant figures.

[4 marks]

force = _____ N

- 2 (d)** Calculate the vertical force that the road exerts on the rear tyre at **B**.

[1 mark]

force = _____ N

- 2 (e)** The maximum power of the motorcycle is 9.5 kW and it has a maximum speed of 32 m s^{-1} when travelling on a level road.

Calculate the total horizontal resistive force for this speed.

[2 marks]

force = _____ N

11

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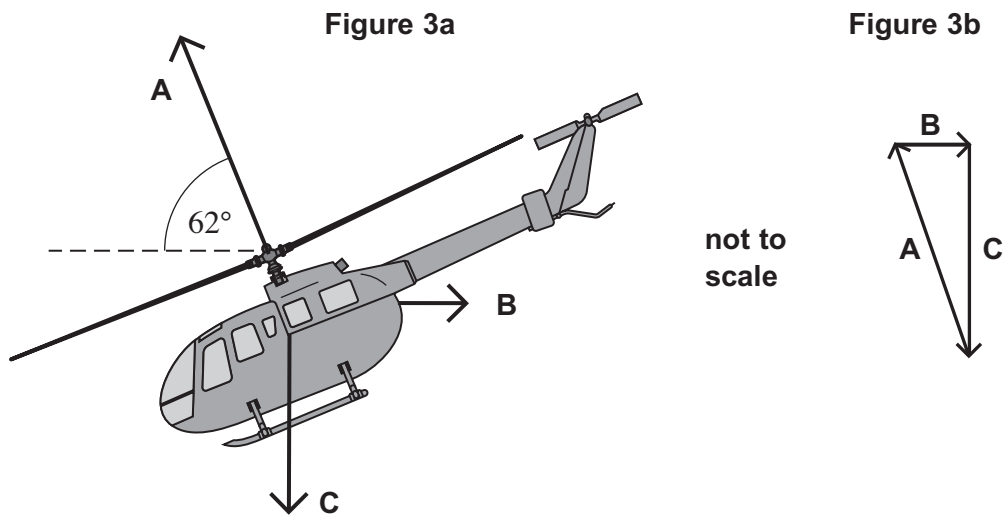


- 3 (a) Which **one** of the following quantities is **not** a vector?
Tick (✓) the correct answer in the right-hand column.

[1 mark]

Quantity	Tick (✓) the correct answer
velocity	
force	
kinetic energy	
displacement	
momentum	

- 3 (b) The helicopter shown in **Figure 3a** is moving horizontally through still air. The lift force from the helicopter's blades is labelled **A**.



- 3 (b) (i) Name the two forces **B** and **C** that also act on the helicopter.

[2 marks]

B _____

C _____



3 (b) (ii) The force vectors are also shown arranged as a triangle in **Figure 3b**.

State and explain how **Figure 3b** shows that the helicopter is moving at a constant velocity.

[2 marks]

3 (c) The lift force **A** is 11 kN and acts at an angle of 62° to the horizontal.

Calculate the weight of the helicopter.

[2 marks]

weight = _____ N

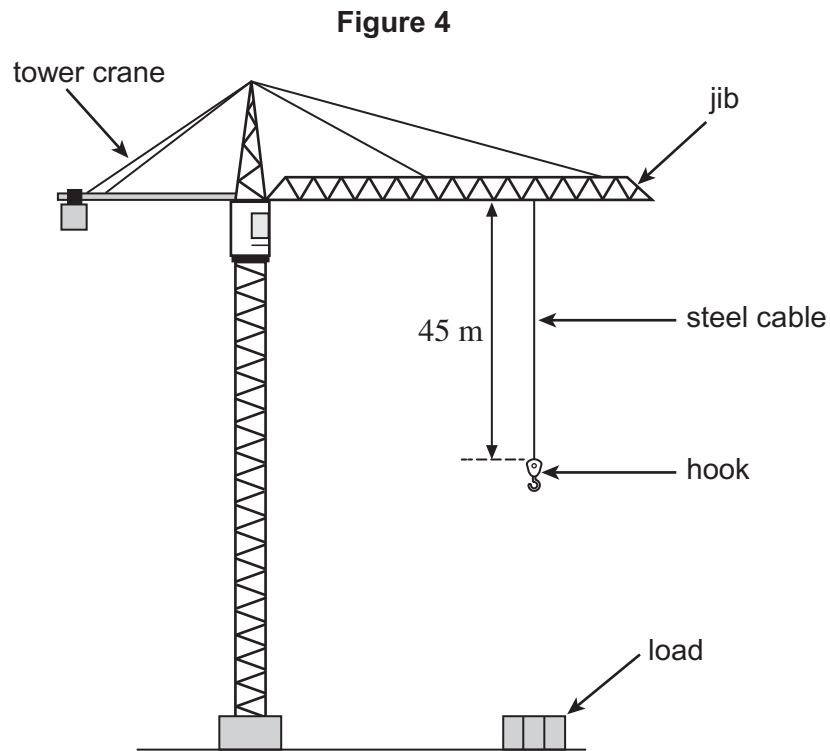
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- 4 **Figure 4** shows a tower crane. The length of the steel cable is 45 m from the jib to the hook. The cross-sectional area of the cable is $6.0 \times 10^{-4} \text{ m}^2$.



- 4 (a) The cable has a mass of 4.7 kg per metre.
Calculate the weight of a 45 m length of cable.

[2 marks]

weight = _____ N



- 4 (b)** The cable would break if the crane attempted to lift a load of 1.3×10^6 N or more.

Calculate the breaking stress of the cable.

[2 marks]

breaking stress = _____ Pa

- 4 (c)** When the crane supports a load, the cable experiences a stress of 300 MPa. The cable obeys Hooke's law. Ignore the weight of the cable and hook.

Young modulus of steel = 2.1×10^{11} Pa

- 4 (c) (i)** Calculate the weight of the load.

[1 mark]

weight = _____ N

- 4 (c) (ii)** The unstretched length of the cable is 45 m.

Calculate the extension of the cable when supporting the load.

[3 marks]

extension = _____ m

Question 4 continues on the next page

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4 (c) (iii) Calculate the stiffness constant k for the cable.

[2 marks]

stiffness constant = _____ N m^{-1}

4 (c) (iv) Calculate the elastic energy stored in the stretched cable.

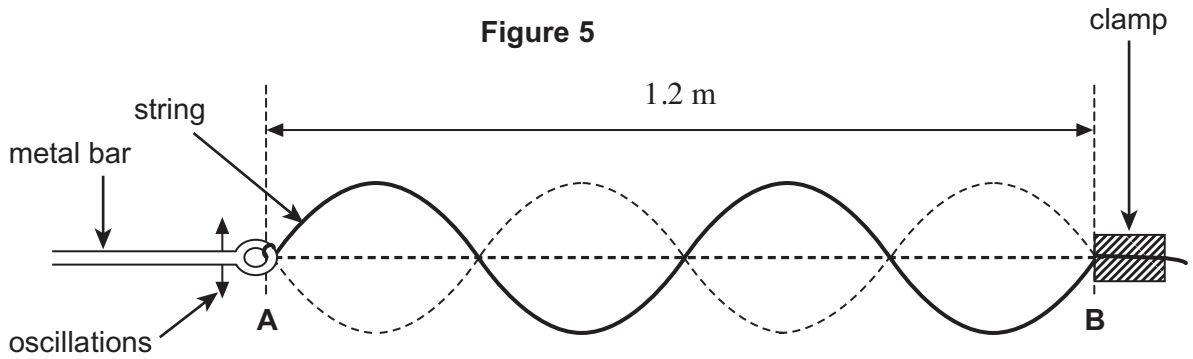
[2 marks]

energy stored = _____ J

12



5 **Figure 5** shows a stationary wave on a string. The string is tied onto a thin metal bar at **A** and fixed at **B**. A vibration generator causes the bar to oscillate at a chosen frequency.



Explain how a stationary wave is formed. Your account should include a description of

- the conditions necessary for a stationary wave to form
- the key features of the stationary wave shown in **Figure 5**.

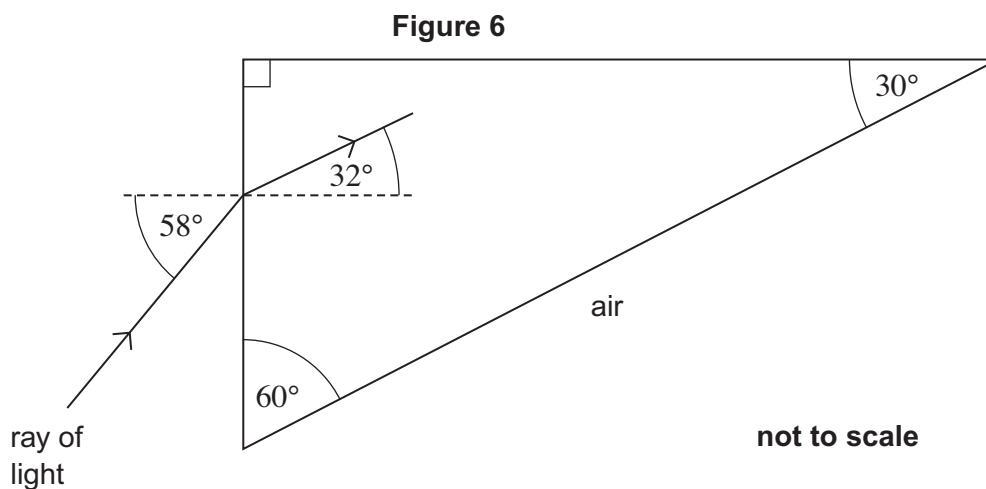
The quality of your written communication will be assessed in your answer.

[6 marks]

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- 6 **Figure 6** shows a glass prism in air. Light is directed into the prism at an angle of incidence of 58° . The path of the ray of light is shown as it enters the prism.



- 6 (a) (i) Calculate the refractive index of the glass.

[2 marks]

refractive index = _____

- 6 (a) (ii) Calculate the critical angle for the glass–air boundary.

[2 marks]

critical angle = _____ degrees

- 6 (b) Show, on **Figure 6**, the path of the ray of light until it emerges from the prism.

[2 marks]

6

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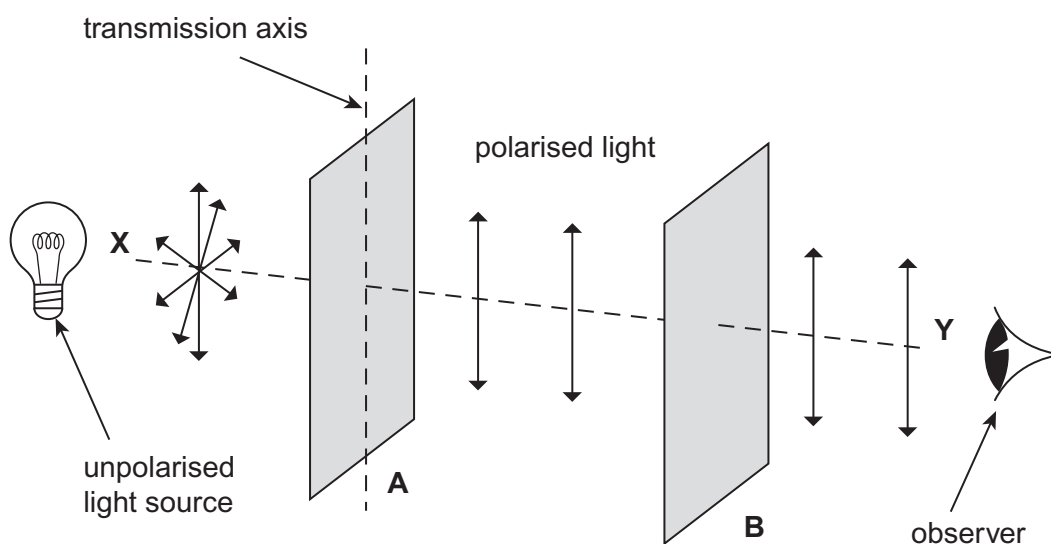


7 (a) Define the amplitude of a wave. [1 mark]

7 (b) State **one** difference between a transverse wave and a longitudinal wave. [1 mark]

7 (c) **Figure 7** shows two identical polarising filters, **A** and **B**, and an unpolarised light source. The arrows indicate the plane in which the electric field of the wave oscillates.

Figure 7



The light reaching the observer is polarised.

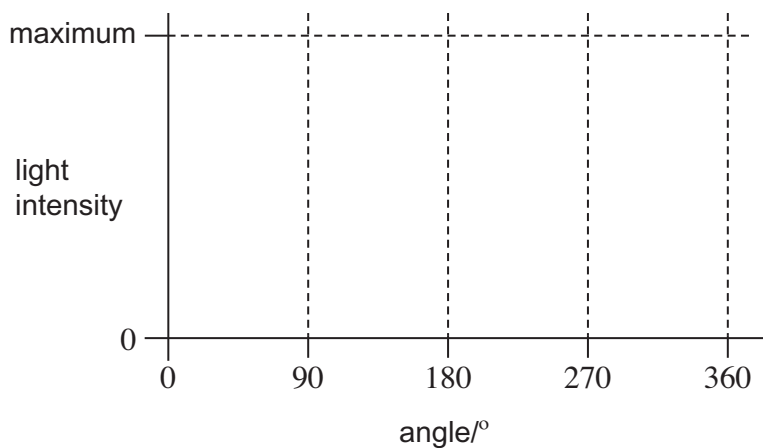
7 (c) (i) Draw the direction of the transmission axis on filter **B** in **Figure 7**. [1 mark]



- 7 (c) (ii) The polarising filter **B** is rotated clockwise through 360° about line **XY** from the position shown in **Figure 7**.

Sketch, on the axes below, how the light intensity reaching the observer varies as filter **B** is rotated.

[2 marks]



- 7 (d) State **one** application, other than in education, of a polarising filter and give a reason for its use.

[2 marks]

7

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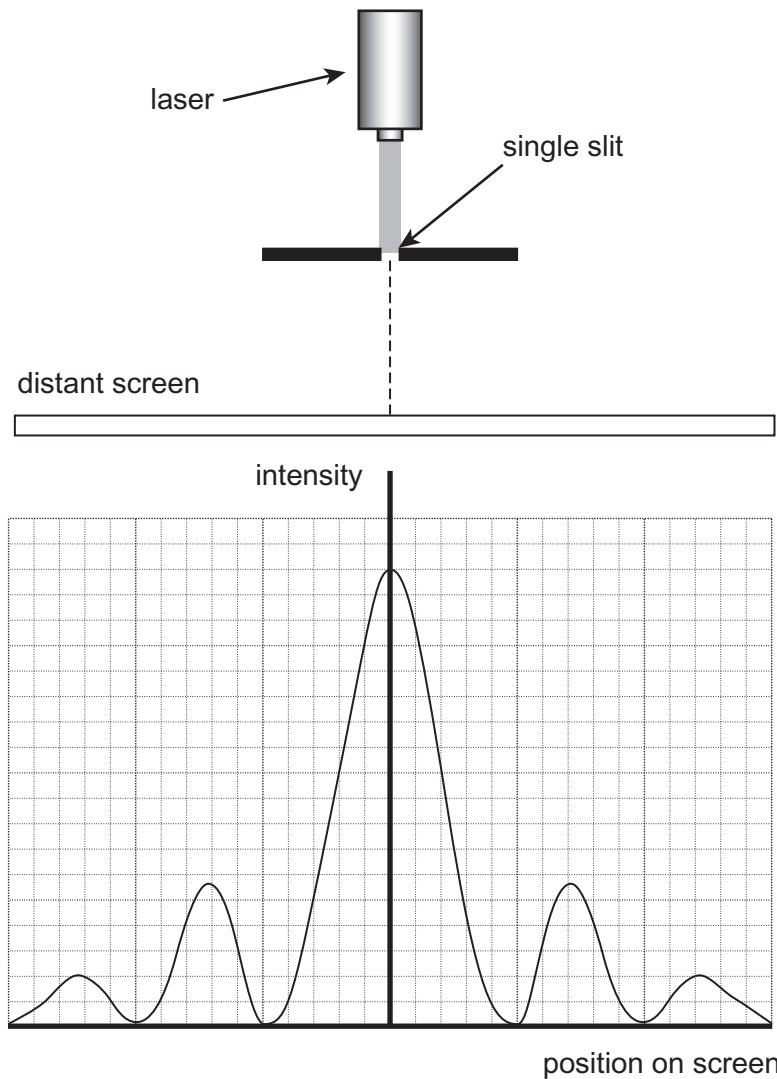
8 (a) A laser emits monochromatic light.

Explain the meaning of the term monochromatic light.

[1 mark]

8 (b) **Figure 8** shows a laser emitting red light directed at a single slit, where the slit width is greater than the wavelength of the light. **Figure 8** also shows how the intensity of the diffracted red light falling on the screen varies with position on the screen.

Figure 8



The laser is replaced with a laser emitting blue light.

Sketch, on the axes in **Figure 8**, the intensity graph for the laser emitting blue light.

[2 marks]



8 (c) State and explain **one** precaution that should be taken when using laser light. **[2 marks]**

8 (d) The blue laser light is replaced with a non-laser source emitting white light.
Describe how the appearance of the pattern would change. **[3 marks]**

END OF QUESTIONS

8



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