Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
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7	
TOTAL	

General Certificate of Education
Advanced Subsidiary Examination
June 2013

Physics A PHYA2

Unit 2 Mechanics, Materials and Waves

Wednesday 5 June 2013 9.00 am to 10.15 am

For this paper you must have:
- a pencil and a ruler
- a calculator
- a Data and Formulae Booklet (enclosed).

Time allowed
- 1 hour 15 minutes

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.

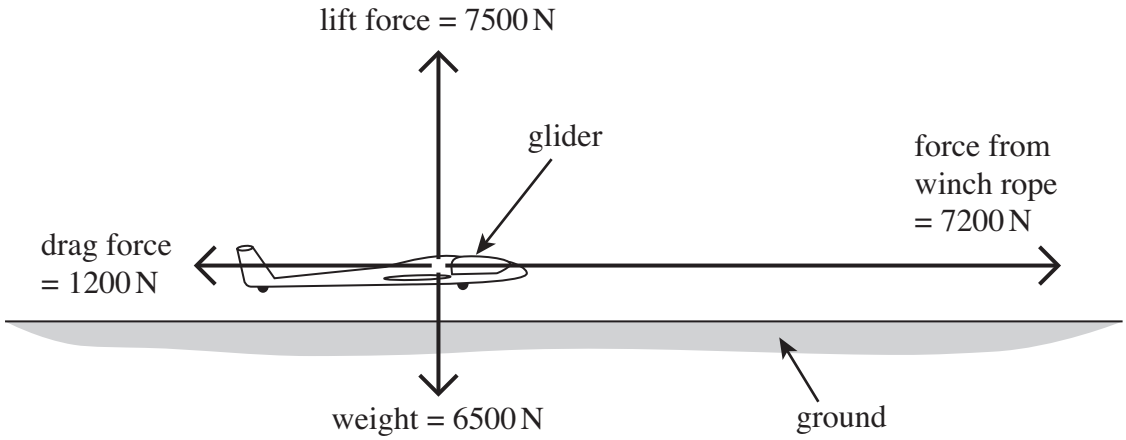
Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 70.
- You are expected to use a calculator where appropriate.
- A *Data and Formulae Booklet* is provided as a loose insert.
- You will be marked on your ability to:
  – use good English
  – organise information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

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

1 Gliders can be launched with a winch situated on the ground. The winch pulls a rope that is attached to the glider. **Figure 1** shows the forces acting on the glider at one instant during the launch.

Figure 1



1 (a) The combined weight of the glider and pilot is 6500 N.

1 (a) (i) Show that the magnitude of the resultant force acting on the glider is about 6100 N.

(2 marks)

1 (a) (ii) Calculate the angle between this resultant force and the horizontal.

angle ..... degrees

(2 marks)

Do not write outside the box

1 (a) (iii) Calculate the resultant acceleration of the glider in **Figure 1**.

resultant acceleration ..... m s^{-2}
(2 marks)

1 (b) The glider climbs a vertical distance of 600 m in 55 s. The average power input to the winch motor during the launch is 320 kW.

1 (b) (i) Calculate the gain in gravitational potential energy (gpe) of the glider.

gain in gpe ..... J
(2 marks)

1 (b) (ii) Calculate the percentage efficiency of the winch system used to launch the glider. Assume the kinetic energy of the glider after the launch is negligible.

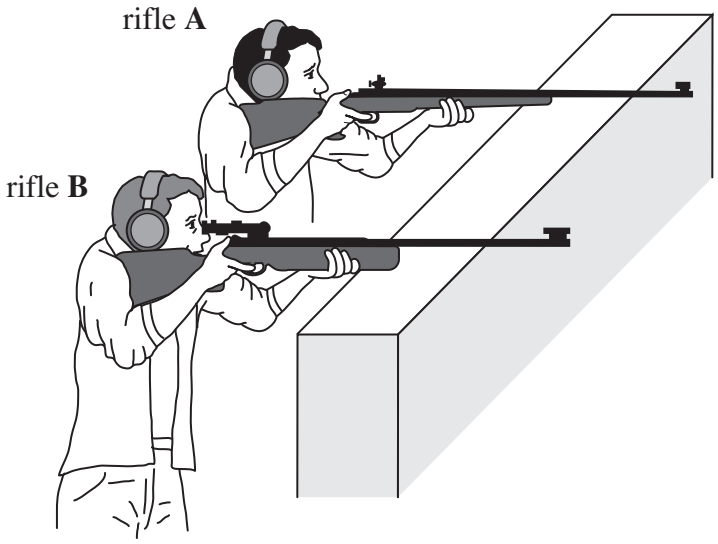
efficiency ..... %
(3 marks)

11

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2 **Figure 2** shows two different rifles being fired horizontally from a height of 1.5 m above ground level.
Assume the air resistance experienced by the bullets is negligible.

Figure 2



2 (a) When rifle **A** is fired, the bullet has a horizontal velocity of 430 m s^{-1} as it leaves the rifle. Assume the ground is level.

2 (a) (i) Calculate the time that the bullet is in the air before it hits the ground.

time ..... s
(2 marks)

2 (a) (ii) Calculate the horizontal distance travelled by the bullet before it hits the ground.

horizontal distance ..... m
(1 mark)

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2 (b) Rifle **B** is fired and the bullet emerges with a smaller horizontal velocity than the bullet from rifle **A**.

Explain why the horizontal distance travelled by bullet **B** will be less than bullet **A**.

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(3 marks)

6

3 A steel ball has a diameter of 2.2×10^{-2} m.

3 (a) Calculate the weight of the steel ball. Give your answer to an appropriate number of significant figures.

density of steel = 8100 kg m^{-3}

weight ..... N

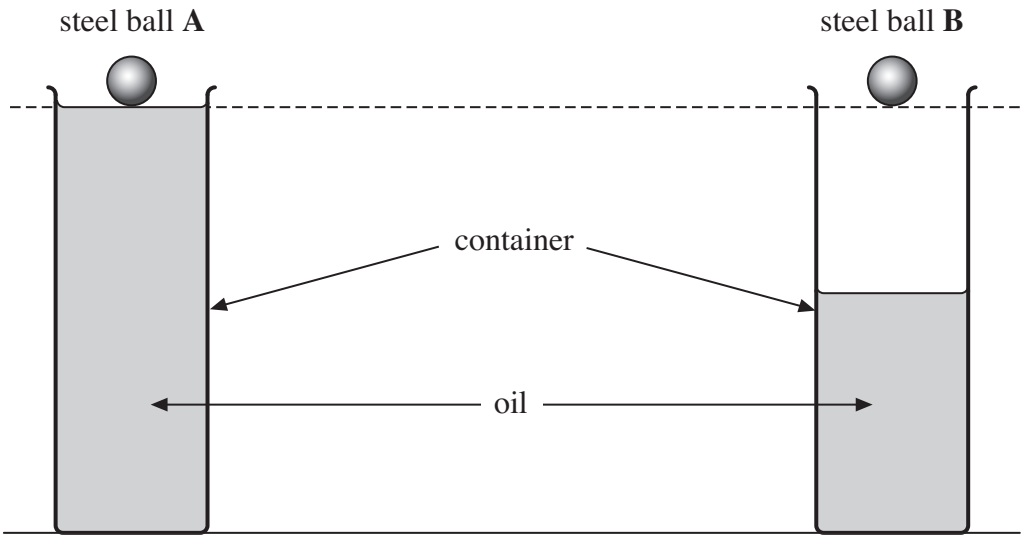
(4 marks)

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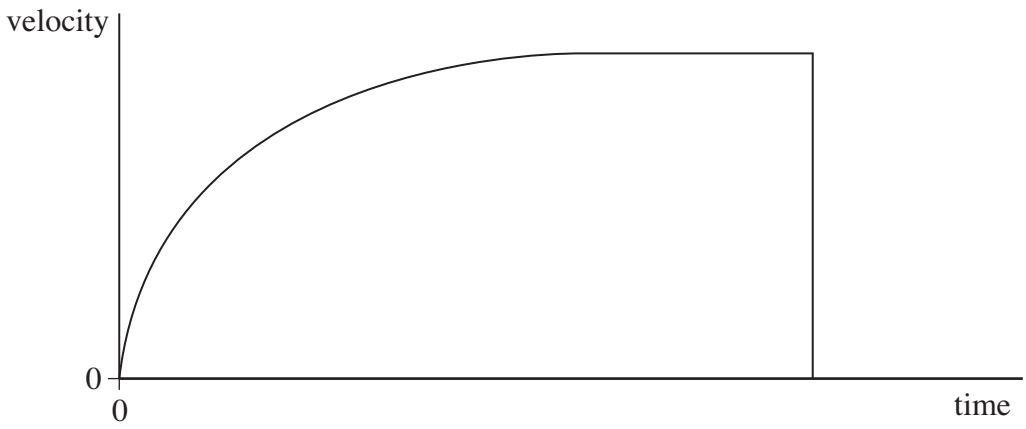
3 (b) **Figure 3** shows two identical steel balls dropped from rest into containers of oil.

Figure 3



3 (b) (i) **Figure 4** shows the velocity-time graph for steel ball **A**.

Figure 4



Explain the shape of the graph in **Figure 4**. Your account should include

- how the velocity and acceleration of the steel ball vary with time
- reference to how Newton's First and Second laws of motion apply in this situation.

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

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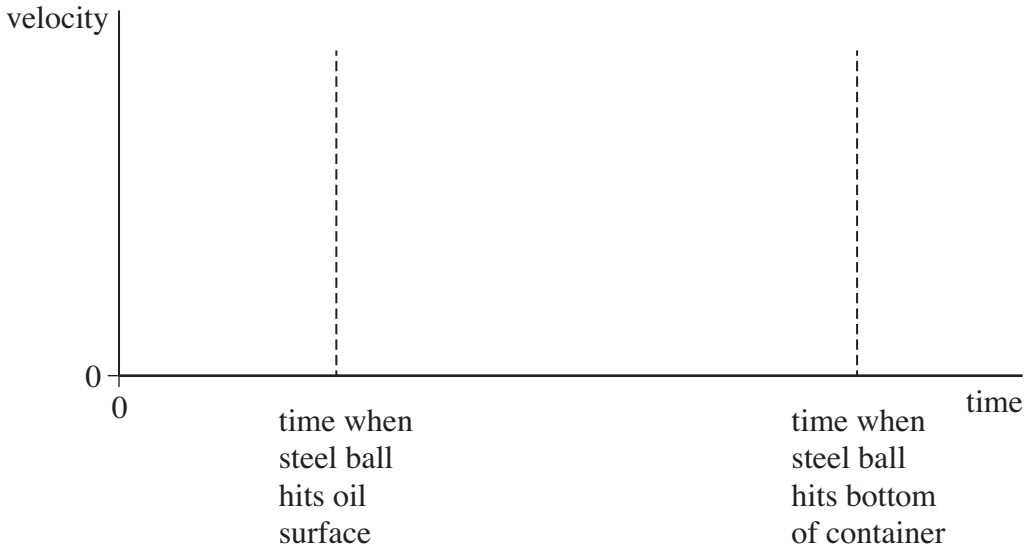
(6 marks)

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3 (b) (ii) On **Figure 5**, sketch the velocity-time graph you would expect to see for steel ball **B**. Assume air resistance is negligible.

Figure 5



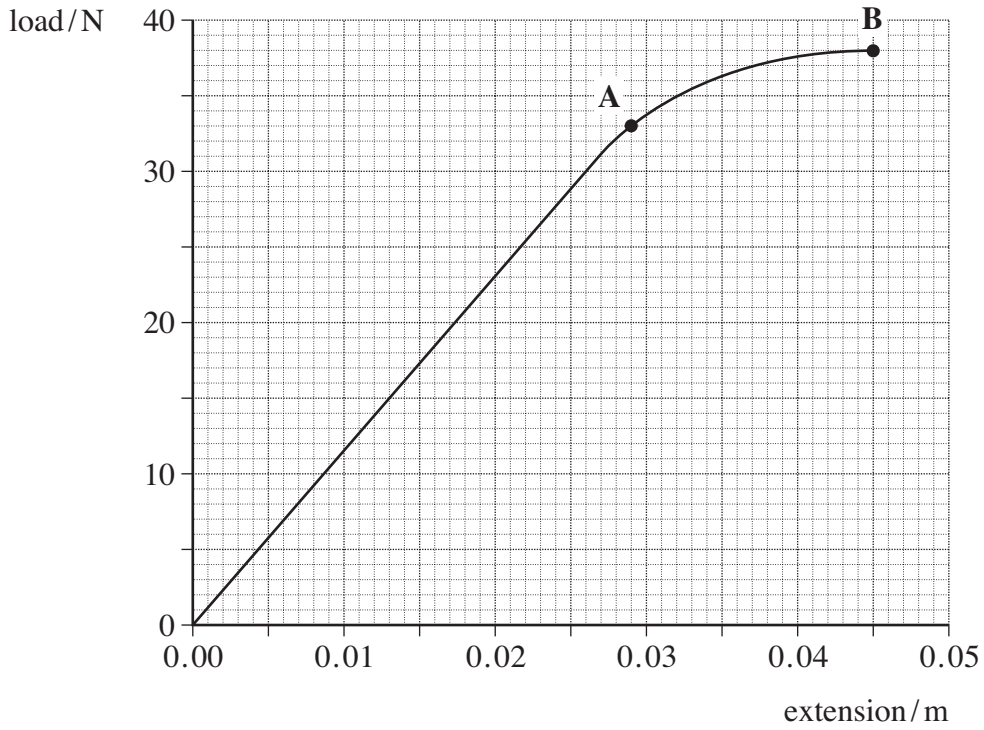
(3 marks)

13

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4 A manufacturer of springs tests the properties of a spring by measuring the load applied each time the extension is increased. The graph of load against extension is shown in **Figure 6**.

Figure 6



4 (a) State Hooke's law.

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(2 marks)

4 (b) Calculate the spring constant, k, for the spring. State an appropriate unit.

spring constant ..... unit .....

(3 marks)

Turn over ▶

Do not write outside the box

4 (c) Use the graph to find the work done in extending the spring up to point **B**.

work done ..... J

(3 marks)

4 (d) Beyond point **A** the spring undergoes *plastic deformation*.

Explain the meaning of the term plastic deformation.

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(1 mark)

4 (e) When the spring reaches an extension of 0.045 m, the load on it is gradually reduced to zero. On the graph in **Figure 6**, sketch how the extension of the spring will vary with load as the load is reduced to zero.

(2 marks)

4 (f) Without further calculation, compare the total work done by the spring when the load is removed with the work that was done by the load in producing the extension of 0.045 m.

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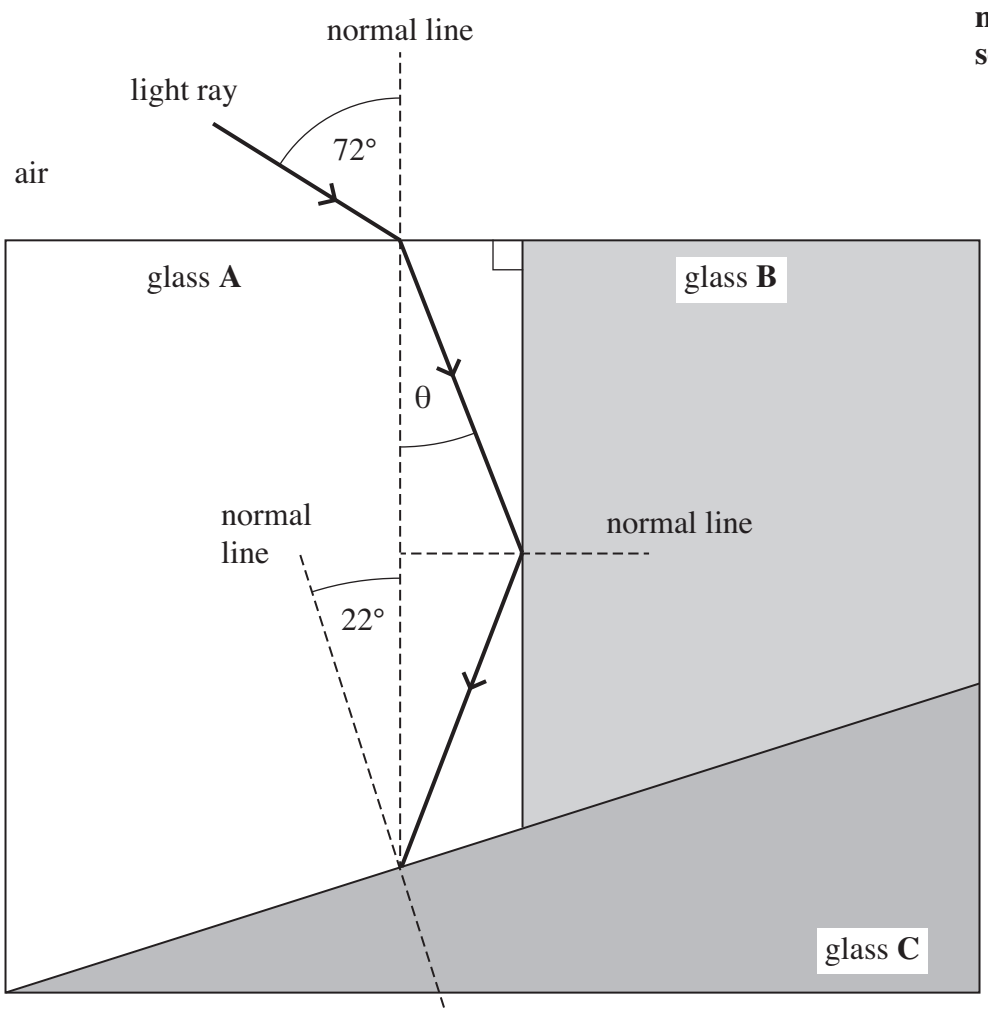
(1 mark)

12

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5 **Figure 7** shows three transparent glass blocks **A**, **B** and **C** joined together. Each glass block has a different refractive index.

Figure 7



5 (a) State the **two** conditions necessary for a light ray to undergo total internal reflection at the boundary between two transparent media.

condition 1 .....

.....

condition 2 .....

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(2 marks)

question 5 continues on the next page

Do not write outside the box

5 (b) Calculate the speed of light in glass **A**.

refractive index of glass **A** = 1.80

speed of light ..... $m\,s^{-1}$

(2 marks)

5 (c) Show that angle θ is about 30°.

(2 marks)

5 (d) The refractive index of glass **C** is 1.40.

Calculate the critical angle between glass **A** and glass **C**.

critical angle ..... degrees

(2 marks)

5 (e) (i) State and explain what happens to the light ray when it reaches the boundary between glass **A** and glass **C**.

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(2 marks)

5 (e) (ii) On **Figure 7** continue the path of the light ray after it strikes the boundary between glass **A** and glass **C**.

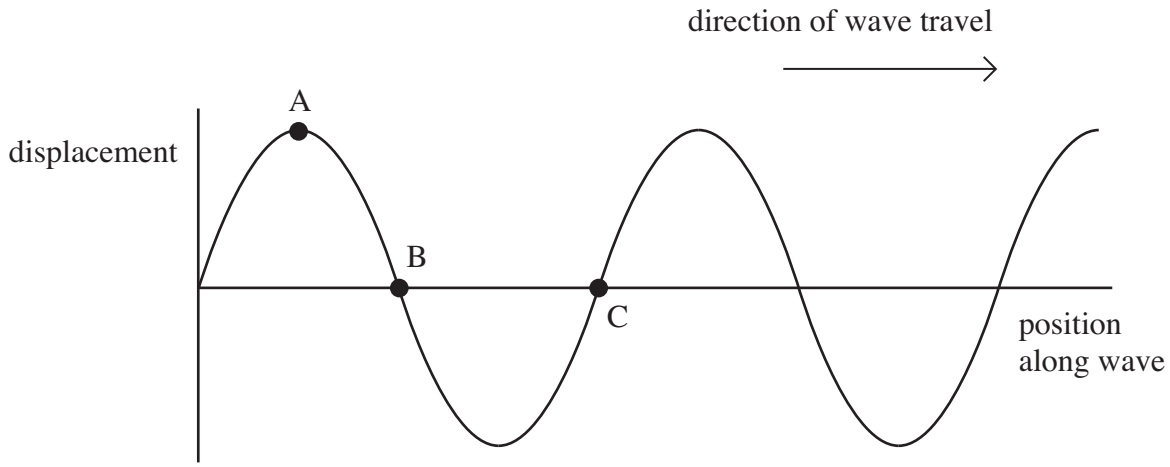
(1 mark)

11

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6 Earthquakes produce transverse and longitudinal seismic waves that travel through rock. **Figure 8** shows the displacement of the particles of rock at a given instant, for different positions along a transverse wave.

Figure 8



6 (a) State the phase difference between

6 (a) (i) points **A** and **B** on the wave .....

6 (a) (ii) points **A** and **C** on the wave. .....

(2 marks)

6 (b) Describe the motion of the rock particle at point **B** during the passage of the next complete cycle.

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(2 marks)

6 (c) A scientist detects a seismic wave that is polarised. State and explain what the scientist can deduce from this information.

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(2 marks)

Turn over ▶

Do not write outside the box

6 (d) The *frequency* of the seismic wave is measured to be 6.0 Hz.

6 (d) (i) Define the frequency of a progressive wave.

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(1 mark)

6 (d) (ii) Calculate the wavelength of the wave if its speed is $4.5 \times 10^3\,m\,s^{-1}$.

wavelength ..... m

(2 marks)

9

7 (a) A laser emits *monochromatic light*.

Explain the meaning of the term monochromatic light.

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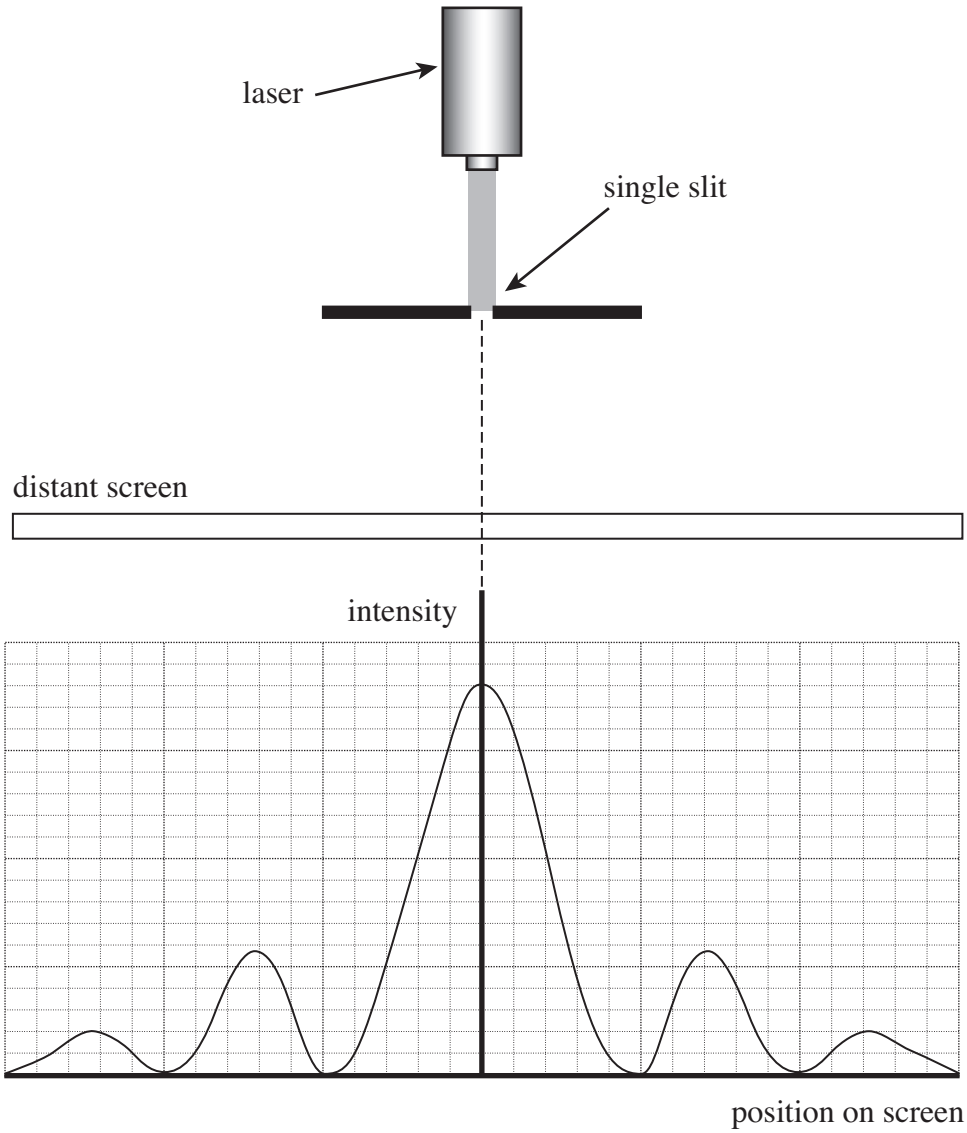
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(1 mark)

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7 (b) **Figure 9** shows a laser emitting blue light directed at a single slit, where the slit width is greater than the wavelength of the light. The intensity graph for the diffracted blue light is shown.

Figure 9



The laser is replaced by a laser emitting red light.

7 (b) On the axes shown in **Figure 9**, sketch the intensity graph for a laser emitting red light.
(2 marks)

question 7 continues on the next page

Do not write outside the box

7 (c) State and explain **one** precaution that should be taken when using laser light.

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(2 marks)

7 (d) The red laser light is replaced by a non-laser source emitting white light.

Describe how the appearance of the pattern would change.

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(3 marks)

8

END OF QUESTIONS

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