THIS IS A LEGACY SPECIFICATION

OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE

PHYSICS B (ADVANCING PHYSICS) 2861

Understanding Processes

OCE/T70535

Candidates answer on the question paper

OCR Supplied Materials:
- Data, Formulae and Relationships Booklet

Other Materials Required:
- Electronic calculator
- Ruler (cm/mm)

Thursday 21 May 2009
Afternoon

Duration: 1 hour 30 minutes

2861

Candidate Forename		Candidate Surname	

Centre Number						Candidate Number				

INSTRUCTIONS TO CANDIDATES

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the boxes above.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- Write your answer to each question in the space provided, however additional paper may be used if necessary.
- Show clearly the working in all calculations and give answers to only a justifiable number of significant figures.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **90**.
- You are advised to spend about 20 minutes on Section A, 40 minutes on Section B and 30 minutes on Section C.
- There are four marks available for the quality of written communication in Section C.
- The values of standard physical constants are given in the Data, Formulae and Relationships Booklet. Any additional data required are given in the appropriate question.
- This document consists of **24** pages. Any blank pages are indicated.

FOR EXAMINER'S USE		
Section	**Max.**	**Mark**
A	**21**	
B	**40**	
C	**29**	
TOTAL	**90**	

Answer **all** the questions.

Section A

1 The graphs of Fig. 1.1 show different relationships between quantities *y* and *x*.

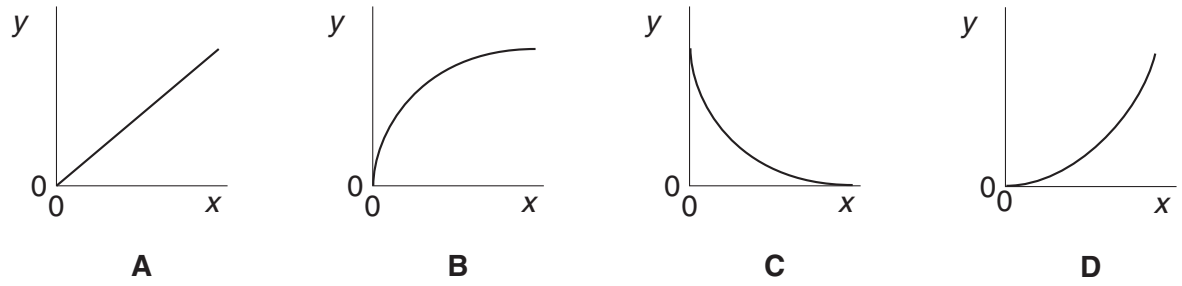

Fig. 1.1

Which graph **A**, **B**, **C** or **D** in Fig. 1.1 is obtained when the y and x axes represent the two quantities given in each case below?

(a) y-axis: the **speed** of a body moving from rest with constant acceleration

x-axis: **time**

answer ..... **[1]**

(b) y-axis: the **acceleration** of a skydiver falling from rest under the combined effects of gravity and air resistance

x-axis: **distance** fallen

answer ..... **[1]**

(c) y-axis: the **kinetic energy** of a golf ball

x-axis: the **speed** of the golf ball

answer ..... **[1]**

2 The speed v of waves in shallow water is given by $v = \sqrt{(Kd)}$, where d is the depth of water and K is a constant.

(a) Make K the subject of the equation, and show that K has the units of acceleration.

[2]

(b) Here is a list of four graphs that could be plotted relating wave speed v and depth d:

A v against d **B** v against d^2 **C** v^2 against d **D** v^2 against d^2

Write down the letter (**A**, **B**, **C** or **D**) of the graph you would plot in order to obtain a straight line through the origin.

answer ..... **[1]**

3 The table shows the wavelengths and frequencies associated with the photons emitted from three different light emitting diodes (LEDs) labelled **P**, **Q** and **R**.

LED	wavelength / 10^{-7} m	frequency / 10^{14} Hz	colour
P	7.0	4.3	
Q	5.2	5.8	
R	4.6	6.5	

The three colours of light emitted by the LEDs are green, red and blue.

(a) Complete the table by indicating the colour of light emitted by each LED. **[1]**

(b) Calculate the energy of the photon with **least** energy.

the Planck constant = 6.6×10^{-34} J s

energy = ... J **[2]**

4 Fig. 4.1 shows three divers **A**, **B** and **C** on different diving boards.

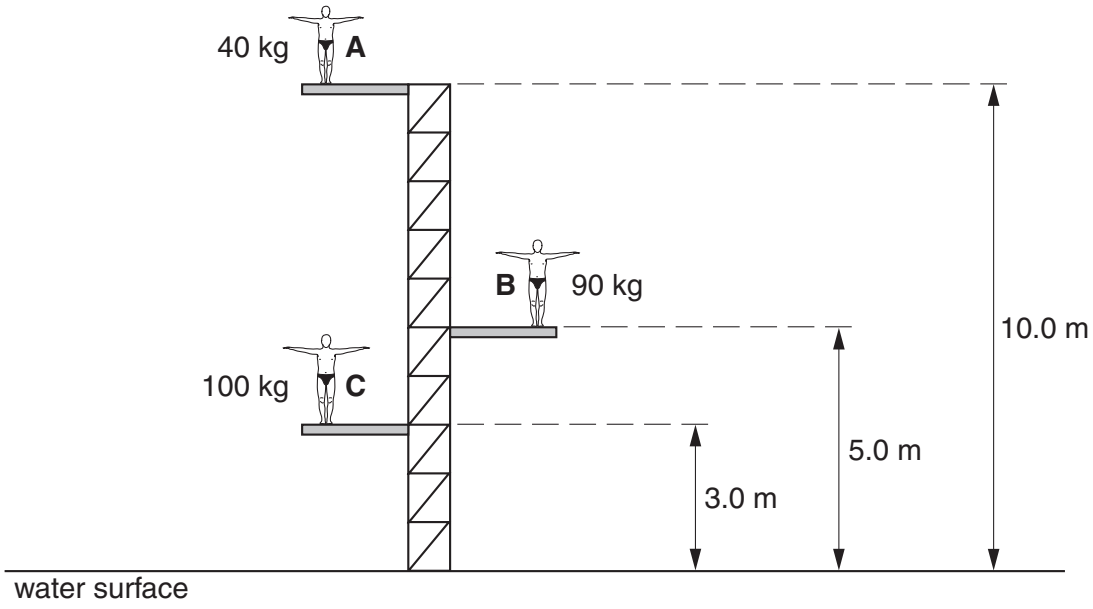

Fig. 4.1

(a) Calculate the weight of the heaviest diver.

weight = ... N **[1]**

(b) Which diver has the greatest gravitational potential energy relative to the water surface?

answer ..... **[1]**

5 A laser emits photons of energy 2.5×10^{-19} J.

The energy is radiated at a rate of 15 mW.

Calculate the number of photons emitted per second by the laser.

photons emitted per second = ... **[2]**

6 Fig. 6.1 shows a plan view of an experimental arrangement with loudspeakers in the open air.

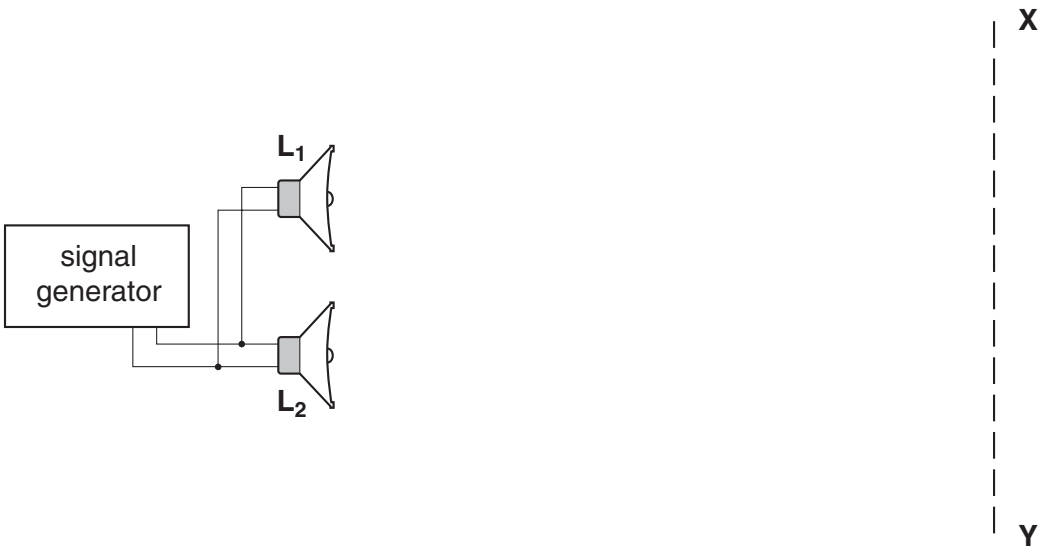

Fig. 6.1

The loudspeakers L_1 and L_2 emit coherent waves of constant frequency which can be heard in the region in front of the speakers. An observer walking along the line **XY** will hear the loudness of the sound change from maximum to minimum and back to maximum several times.

(a) Explain why there are points of **minimum** loudness.

[2]

(b) Suggest **one** change that could be made to the experimental set up that would result in the positions of minimum loudness being **closer** together along the line **XY**.

[1]

7 An ultrasonic 'tape measure' is used to measure the depth of a deep well.

The device sends pulses of ultrasound down the well to the water surface and electronically measures the time for the pulse to return.

In one measurement the pulse returns after 0.67 s.

Calculate the depth of the well.

speed of ultrasound in air = 330 m s^{-1}

depth of the well = ... m **[3]**

8 Photons travel from a monochromatic light source to detectors **X** and **Y** through three equally spaced narrow slits, as shown in Fig. 8.1.

Fig. 8.1

(a) At **X**, the phasors associated with the paths through the three slits combine to produce a resultant phasor amplitude of 5.0.

State the relationship between resultant phasor amplitude and probability of arrival of photons.

[1]

(b) At **Y** the resultant phasor amplitude is 1.25.

Calculate the ratio $R = \dfrac{\text{probability of photons arriving at point } \mathbf{X}}{\text{probability of photons arriving at point } \mathbf{Y}}$.

$R =$ ..... **[1]**

[Section A Total: 21]

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Section B

9 This question is taken from an investigation into bouncing balls.

Ignore any effects of air resistance in this question.

(a) A steel ball is dropped from rest at a height of 3.0 m above a horizontal surface.

(i) Show that the time taken for the ball to reach the surface is about 0.8 s.

acceleration due to gravity = 9.8 m s^{-2}

[2]

(ii) Calculate the vertical speed of the ball as it strikes the surface after falling 3.0 m.

vertical speed = ... m s^{-1} **[2]**

(iii) 16% of the energy of the ball is absorbed in every vertical impact with the surface.

Show that about 70% of the initial energy of the ball will have gone after **seven** successive bounces.

[2]

(b) The same ball is then projected horizontally with a speed v from a height of 3.0 m and strikes the surface after travelling a horizontal distance of 2.2 m, as shown in Fig. 9.1.

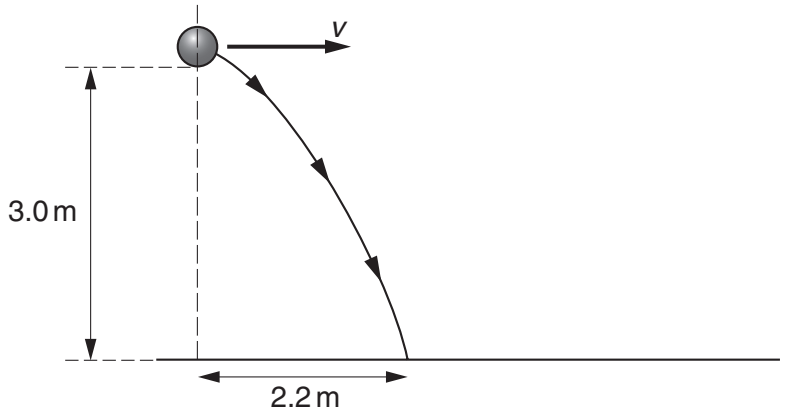

Fig. 9.1

(i) Show that v equals 2.8 m s^{-1}.

[1]

(ii) By scale drawing, or by some other method of your choosing, calculate the magnitude and direction of the resultant velocity of this ball on impact with the surface.

magnitude of resultant velocity = ... m s^{-1}

direction = ...

[3]

[Total: 10]

10 This question is about using a diffraction grating.

(a) A parallel beam of light of a single wavelength is incident on a diffraction grating as shown in Fig. 10.1.

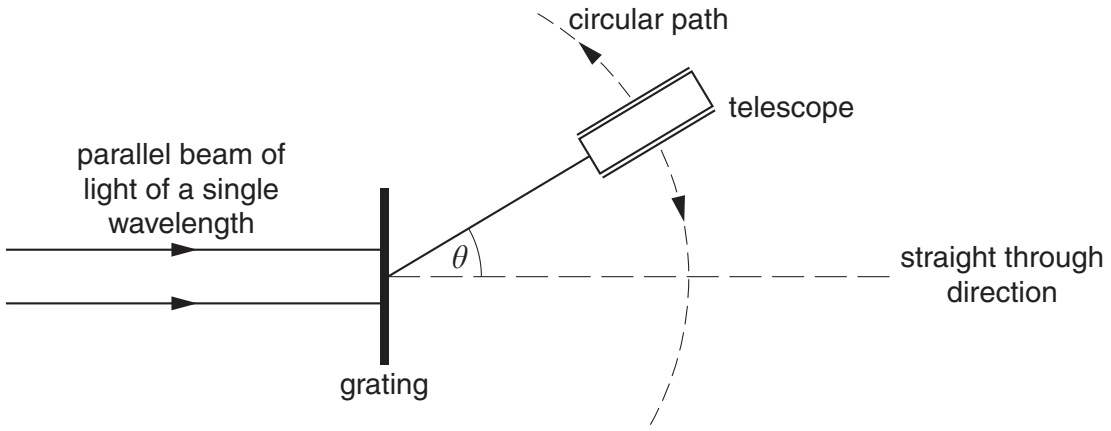

Fig. 10.1

The different orders in the interference pattern produced are observed using a small telescope which can be moved in a circular path around the grating.

(i) The diffraction grating has 500 lines per mm.

Show that the line spacing for this grating is 2.0×10^{-6} m.

[1]

(ii) The wavelength of the light is 660 nm.

Calculate the angle θ at which the **first order** maximum is observed.

θ = ... degrees **[2]**

(iii) Explain why only three orders are visible on either side of the central maximum in this arrangement.

[3]

(b) The experiment is repeated using a parallel beam of white light instead of light of a single wavelength. Nothing else is changed.

The central and first order maxima in the interference pattern produced with the white light are represented in Fig. 10.2.

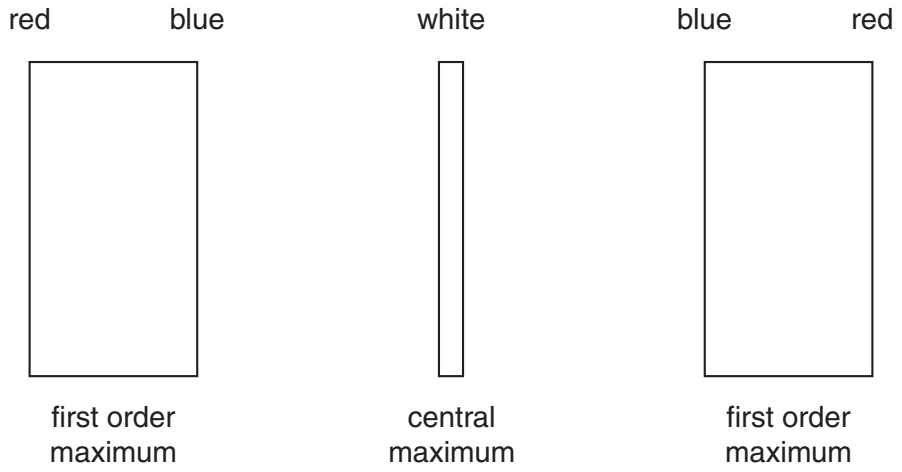

Fig. 10.2

The central maximum is white in colour, but the first order maxima comprise all of the colours in the visible spectrum.

(i) Explain why the blue in the first order spectrum is nearer to the central maximum than the red.

[2]

(ii) Explain why the central maximum is white.

[2]

[Total: 10]

11 This question is about flying a kite.

The rectangular canopy of the kite is shown attached to the flying strings in Fig. 11.1(b). Handles for steering the kite are fixed at the other ends of the strings.

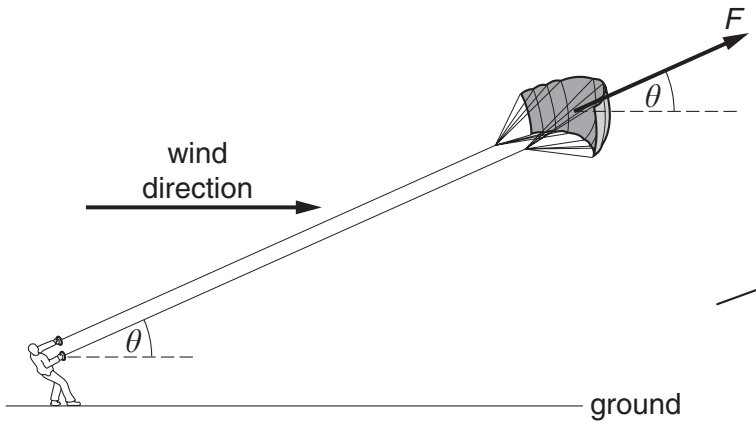

Fig. 11.1(a)

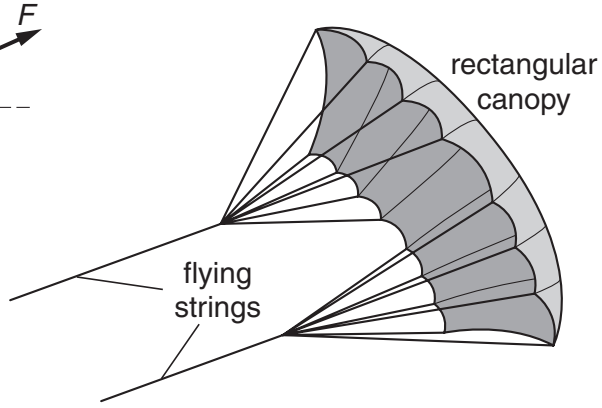

Fig.11.1(b)

Fig. 11.1

(a) Fig.11.1(a) shows the kite hovering in equilibrium in a horizontal wind at a height above the ground. The wind blows from directly behind the person flying the kite.

The action of the wind on the canopy results in a force *F* acting on the canopy as shown. The weight of the kite is negligible.

Fig. 11.2 shows how the magnitude of the force *F* depends upon the angle the strings make with the horizontal, for one particular wind speed.

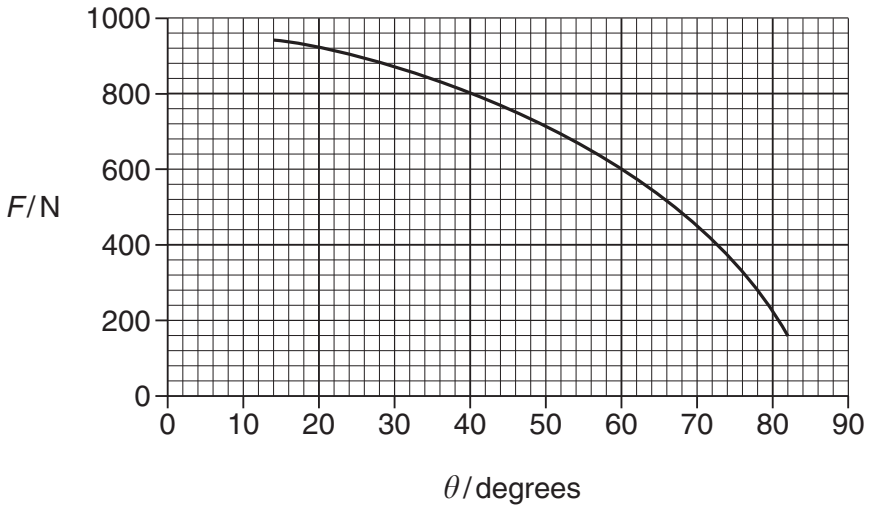

Fig. 11.2

(i) Use the graph to find the force F acting on the kite when the angle θ between the strings and the horizontal is 60°.

$F =$ ..... N **[1]**

(ii) Describe how the magnitude of the force F changes with the height of the kite above the ground.

[1]

(iii) Suggest **one** reason why the force changes in the way you have described.

[1]

(b) The wind **speed** v will also affect the force on the kite as it hovers at a fixed height above the ground in a horizontal wind. The table below shows data for $\theta = 60°$.

wind speed v/m s^{-1}	F/N
3.3	150
5.4	400
7.9	850
10.7	1600

(i) Carry out an **arithmetical test** on these data to show that the force F acting on the kite is related to the wind speed v by the expression $F = kv^2$, where k is a constant.

Make your reasoning clear.

[3]

(ii) Fig. 11.3 shows the forces acting on the person flying the kite when the angle between the strings and the horizontal is 60°. The weight of the person is 760 N.

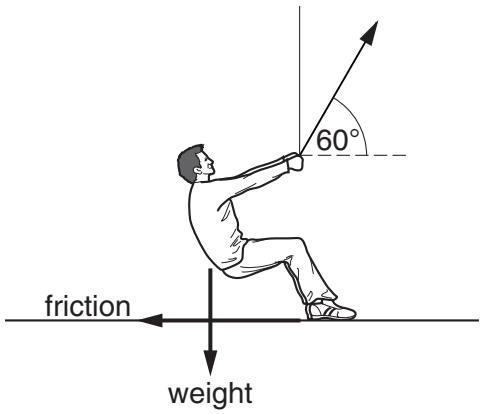

Fig. 11.3

Show that a wind speed of about 8 m s^{-1} would be sufficient to lift him off the ground in this situation. Make your reasoning clear.

[3]

[Total: 9]

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12 This question is about the motion of a car during an emergency stop.

(a) A car of mass 1200 kg is travelling on a horizontal road at 20 m s^{-1}.

(i) Show that the kinetic energy of the moving car is 2.4×10^5 J.

[1]

(ii) When the brakes are applied the car is brought to rest after travelling a further distance of 34 m.

Show that the average force produced by the brakes is about 60% of the weight of the car.

gravitational field strength $g = 9.8\,\text{N kg}^{-1}$

[3]

(b) Fig. 12.1 shows how the speed of a car changes with distance during an emergency stop **from the instant the driver sees the hazard**.

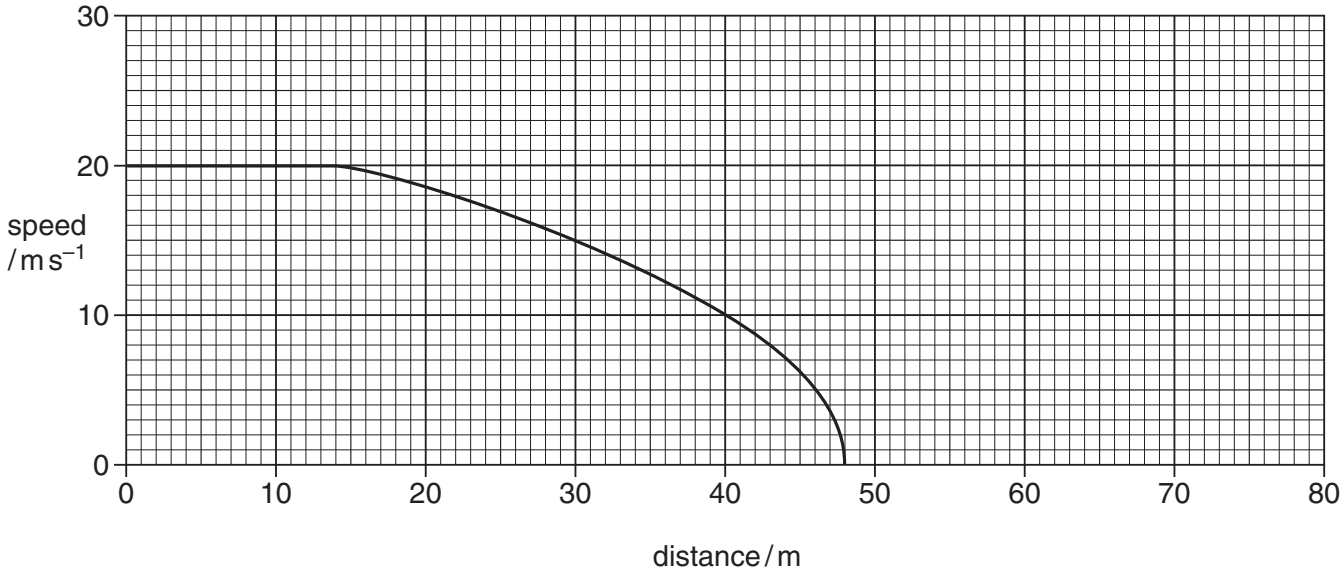

Fig. 12.1

(i) Draw a vertical line on the graph indicating the instant when the brakes are applied. **[1]**

(ii) Using data from the graph

1 show that the time taken for the driver to apply the brakes after seeing the hazard is about 0.7 s.

2 calculate the average deceleration of the car when the brakes are applied.

deceleration = ... $m\,s^{-2}$ **[3]**

(iii) Sketch on the axes of Fig. 12.1 the graph you would expect to obtain when the driver makes an emergency stop from an initial speed of 25 $m\,s^{-1}$.

Use the space below for your working.

[3]

[Total: 11]

[Section B Total: 40]

Section C

In this section of the paper you will choose the context in which you give your answers.

Use diagrams to help your explanations and take particular care with your written English. Up to four marks in this section will be awarded for written communication.

13 In this question you are to choose and describe a method of producing and observing standing waves.

(a) Draw a labelled diagram to show the equipment needed to produce standing waves in the system of your choice, and how it would be arranged.

[4]

(b) State the adjustments that you need to make to the equipment to produce a standing wave, and make clear how you know that a standing wave has been produced.

[3]

(c) Describe the features of a standing wave that can be observed with this apparatus. You may find it helpful to draw a diagram as part of your description.

[3]

(d) Explain the observations you have described in terms of the physics of how standing waves are formed.

[3]

[Total: 13]

14 In this question you are to choose, and write about, a phenomenon in which **quantum behaviour** is important.

(a) State the example of quantum behaviour that you have chosen to describe and explain.

[1]

(b) State the name of a quantum object that shows this behaviour.

[1]

(c) Draw a labelled diagram to show the arrangement of apparatus that would be needed to observe the quantum behaviour.

[4]

(d) Describe **three** observations that can be made with the apparatus.

[3]

(e) Give explanations, in terms of **quantum behaviour**, for the observations you have described.

[3]

[Total: 12]

Quality of Written Communication **[4]**

[Section C Total: 29]

END OF QUESTION PAPER

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