OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS (B) (ADVANCING PHYSICS) PILOT & PHYSICS (B) (ADVANCING PHYSICS) 7731/2861

UNDERSTANDING PROCESSES

Monday **18 JUNE 2001** Morning 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials:
Data, Formulae and Relationships Booklet
Electronic calculator

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Show clearly the working in all calculations, and round 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 values of standard physical constants are given in the Data, Formulae and Relationships Booklet. Any additional data required are given in the appropriate question.
- You are advised to spend about 20 minutes on Section A, 40 minutes on Section B and 30 minutes on Section C.
- You will be awarded marks for the quality of written communication where an answer requires a piece of extended writing.

FOR EXAMINER'S USE		
Section	**Max.**	**Mark**
A	20	
B	40	
C	30	
TOTAL	90	

This question paper consists of 17 printed pages and 3 blank pages.

Registered Charity Number: 1066969
[Turn o

Section A

1 For each of the following frequencies, select and write down the appropriate wavelength from the list below.

(a) VHF radio of 100 MHz: wavelength = ... unit .....

(b) infrared of 10^{13} Hz: wavelength = ... unit .....

30 m, 3 m, 3 cm, 3 mm, 30 μm, 3 μm, 300 nm [2]

2 From the window of a train heading south at 30 m s^{-1} a passenger observes a car moving at 24 m s^{-1} on a road from east to west (Fig. 2.1).

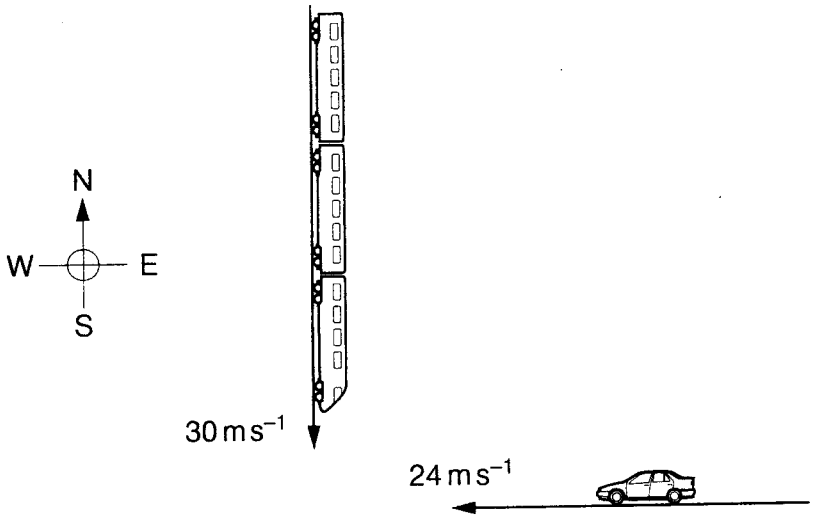

Fig. 2.1

(a) Using information from Fig. 2.1, draw a vector diagram to find the relative velocity at which the car appears to move towards the passenger. Identify the relative velocity on your diagram.

(b) From your diagram, or by calculation, write down the magnitude and direction of the relative velocity.

relative velocity, magnitude = ... m s^{-1}

direction = ... [4]

3 Fig. 3.1 shows a graph of two waves A and B.

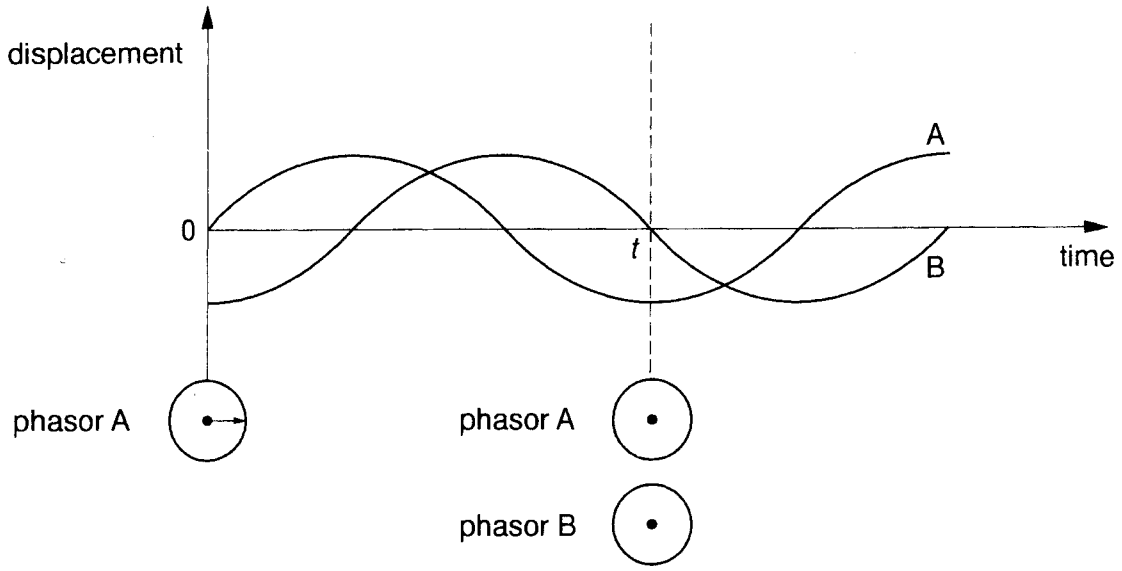

Fig. 3.1

(a) State the phase difference between the two waves A and B.

..... [1]

(b) Draw on Fig. 3.1 phasors to represent A and B at time *t*. Assume that the phasors rotate in an anticlockwise direction. [2]

4 A man loads barrels, each of mass 60 kg, onto a truck whose platform is 1.2 m above the ground.

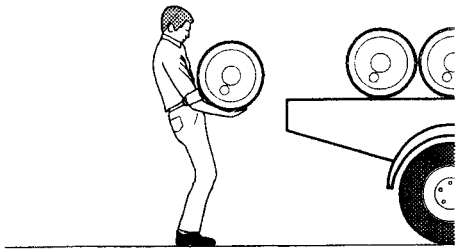

Fig. 4.1a

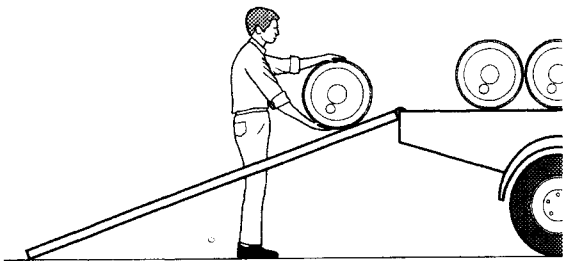

Fig. 4.1b

(a) The barrels are lifted vertically from the ground (Fig. 4.1a). Calculate the increase in gravitational potential energy of each barrel loaded.

energy = ... J [2]

(b) Some barrels are lifted to the same height using a longer route, by rolling them up a plank (Fig. 4.1b). Explain why the increase in gravitational potential energy is the same whatever the route.

.....

.....

..... [2]

5 An ultrasonic 'tape measure' sends out pulses of waves and measures the time for the echo to return from the remote object. When aimed at a wall across a room the echo pulse returns after 15 ms. The speed of sound in air is 340 m s^{-1}. Calculate the distance across the room.

distance = ... m [3]

6 Photons travel from a source S to detectors D and E through three equally spaced slits (Fig. 6.1).

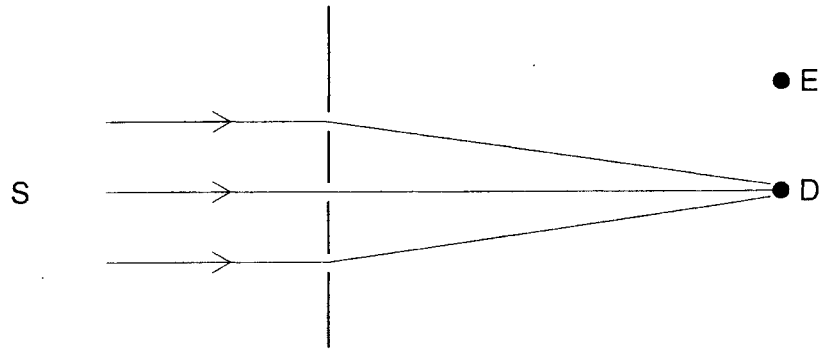

Fig. 6.1

(a) Draw in the space below three phasors associated with the paths from the three slits for the case where D is at a bright maximum of intensity.

[2]

(b) At detector E the three phasors are ↑ → ↓.

(i) Draw the resultant of these three phasors.

(ii) State the ratio of the amplitudes at D and E.

.....

[2]

Section B

7 This question is about the acceleration of a motor car of mass 1200 kg.

The engine and transmission provide, at the wheels, a constant force of 5.0 kN at speeds from zero to 10 m s^{-1}.

(a) Neglecting frictional forces, calculate

(i) the initial acceleration of the car,

acceleration = ... m s^{-2}

(ii) the time taken to reach 10 m s^{-1}.

time = ... s

[4]

(b) Above 10 m s^{-1} the force is no longer constant. Instead the engine and transmission provide a constant power of 50 kW.

(i) Calculate the force developed at a speed of 20 m s^{-1}.

force = ... N

(ii) Draw on the axes on Fig. 7.1 a graph of force against speed for this car. Explain how you obtained the shape of your graph.

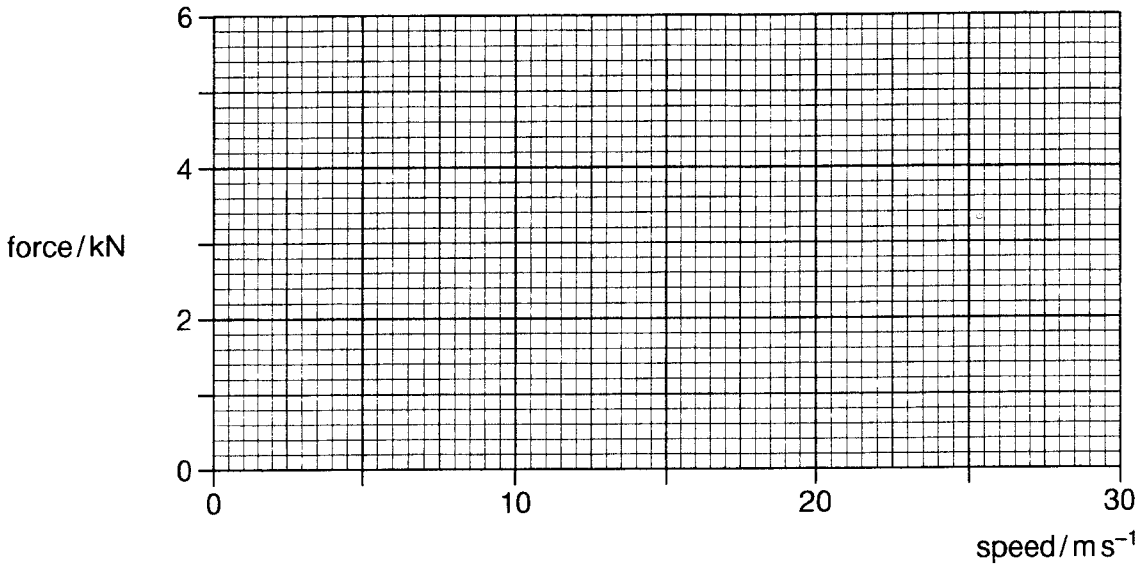

Fig. 7.1

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.....

[6]

8 This question is about a golfer driving balls on a horizontal golf course.

In this question the effects of air resistance are to be ignored.

A golfer drives a ball off the tee with an initial velocity of $42\,m\,s^{-1}$ at an angle of 30° to the horizontal. Fig. 8.1 shows the trajectory of the ball through the air.

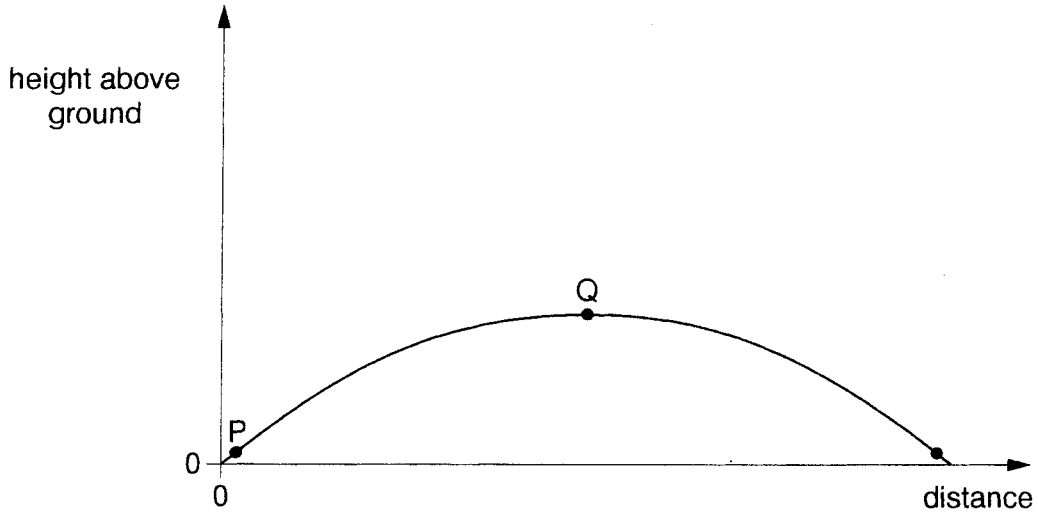

Fig. 8.1

(a) (i) Draw below, a vector diagram showing the horizontal and vertical components (including their magnitudes) of the velocity of the ball at the point P.

(ii) State the horizontal and vertical components of the velocity of the ball at Q.

horizontal component velocity = ...$m\,s^{-1}$

vertical component velocity = ...$m\,s^{-1}$

[6]

(b) Calculate

(i) how long the ball is in the air (consider the vertical component of velocity),

time = ... s

(ii) how far the ball travels to its first bounce (consider the horizontal component of velocity).

distance = ...: m

[4]

9 This question concerns the use of a transmission grating to analyse the spectrum of sodium.

A parallel beam of light from a sodium lamp illuminates a grating with many slits, spaced 2.500 μm apart. Light emerging from the grating forms lines on a screen 3.000 m from the grating (Fig. 9.1).

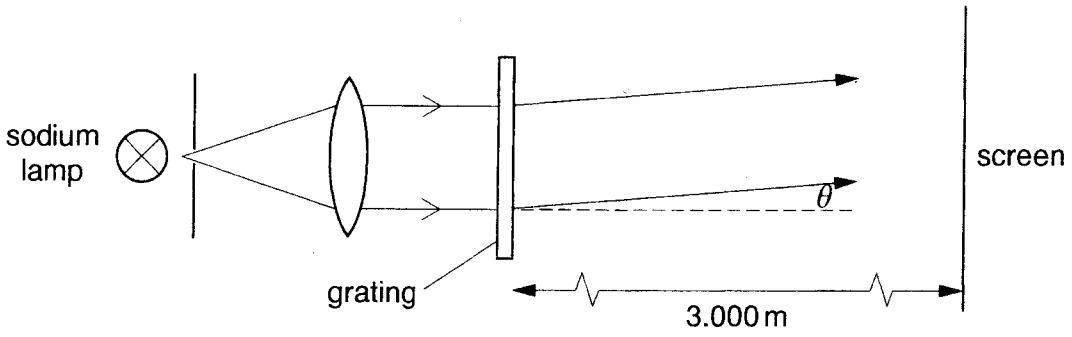

Fig. 9.1

(a) State a relationship between the spacing d of the slits, the wavelength λ of the light and the angle θ at which a bright line appears on the screen.

..... [1]

(b) A sodium lamp emits light of two wavelengths. Calculate

(i) the angles θ_1 and θ_2 for the two lines of wavelength 589.0 nm and 589.6 nm in the second order spectrum ($n = 2$),

θ_1 = ..., θ_2 = ...

(ii) how far apart the two lines are on the screen 3.000 m from the grating.

separation = ... m
[7]

(c) It is observed that the two lines on the screen are just resolved as separate. Show that the resolution is about 0.1% of the wavelength of the light.

.....

.....

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..... [2]

For Examiner's Use

10 This question is about a reflecting telescope.

When observing a distant galaxy, 180 photons of visible light are incident on one pixel of the telescope detector (Fig. 10.1).

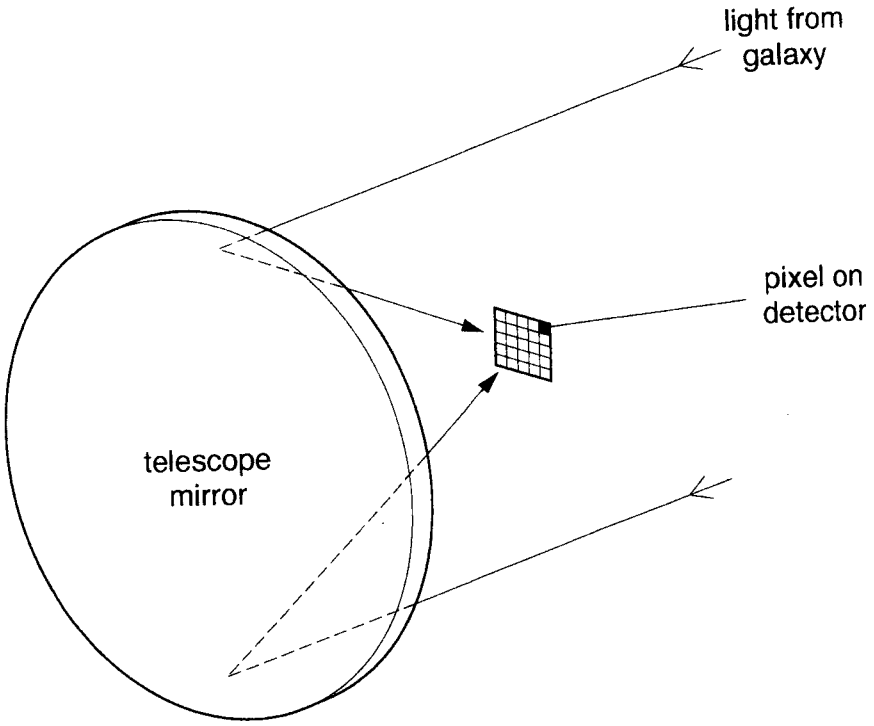

Fig. 10.1

(a) **(i)** Visible light has an average wavelength of 550 nm. Calculate the average energy of each photon detected.

energy = ... J

(ii) Calculate the total energy which fell on this pixel during the observation.

energy = ... J

(iii) The observation lasted 1.0 hour. In each second during this observation, what is the probability of a photon arriving on this pixel?

probability = ... s^{-1}

[5]

(b) The telescope has a parabolic mirror to concentrate light on the detector placed at the focus (Fig. 10.2).

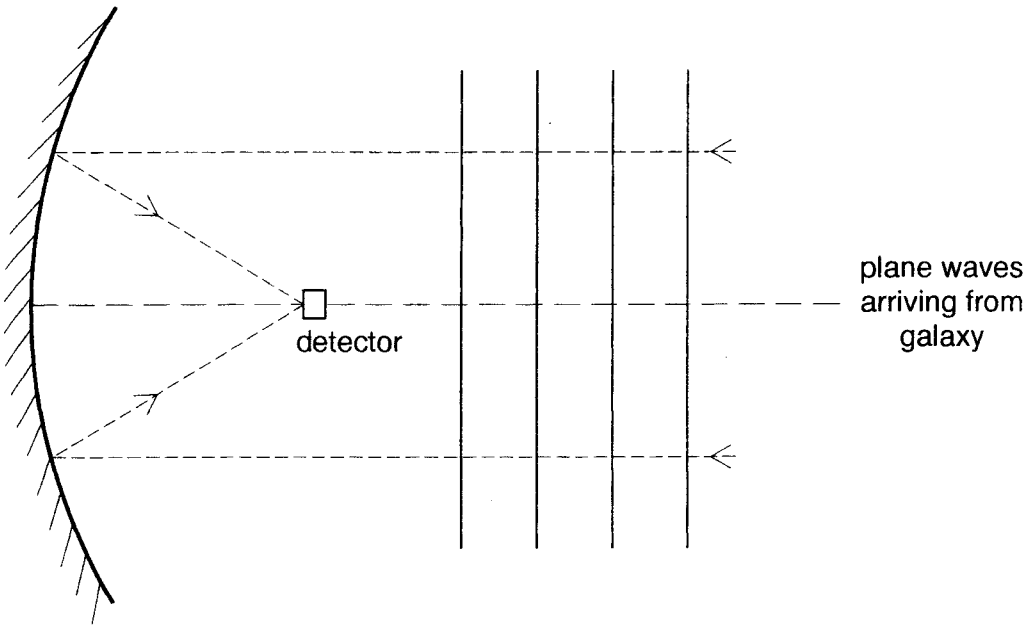

Fig. 10.2

(i) Using the wave point view, plane waves arrive at the mirror. Sketch on Fig. 10.2 wave fronts travelling back from the mirror. [2]

(ii) From the point of view of quantum behaviour, a single photon arrives at the focus via the mirror, with a certain probability. Use ideas of quantum behaviour of a photon to explain how the shape of the mirror is designed to optimise the probability of arrival of a photon at the detector.

.....

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.....

.....

..... [3]

[Turn over

Section C

In this section of the paper you have the opportunity to write about some of the physics you have studied independently.

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

11 This question is about measuring the distance to a remote object.

(a) Thunder and lightning occur simultaneously. The distance away of a lightning flash can be estimated from measuring the time between seeing the flash and hearing the thunder. Estimate the distance away when the flash is seen 5.0 s before the thunder is heard. (The speed of sound in air is 340 $m\,s^{-1}$.)

[2]

(b) **(i)** Give an example of a remote object.

..... [1]

(ii) For your chosen object, describe how you would measure its distance from you. You should describe

1. the principle on which your measurements would be made,
2. the measurements you would make,
3. how you would combine those measurements to calculate the distance to the object.

[6]

(iii) State two of the uncertainties in your measurements and describe how they affect the error in your value for the distance away of the object.

[4]

12 This question is about diffraction.

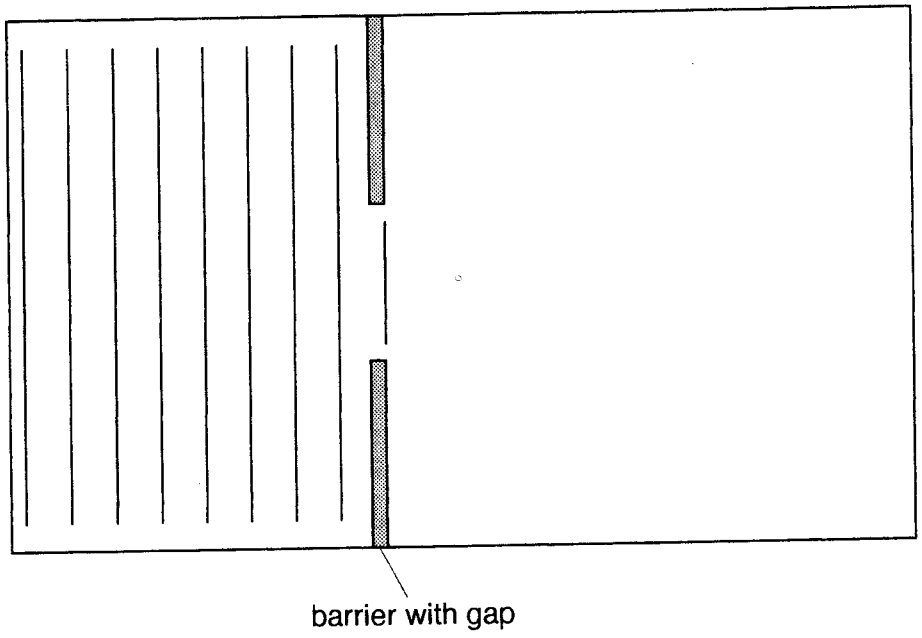

Fig. 12.1

(a) Fig. 12.1 shows a diagram of plane waves in a ripple tank, approaching a barrier with a gap in it. The solid lines represent wave fronts. Complete the diagram on Fig. 12.1 by showing **three** wave fronts which have passed through the gap. [3]

(b) **(i)** Give one practical situation, other than a ripple tank, in which diffraction may be observed.

..... [1]

(ii) Describe the apparatus you would set up to observe diffraction in your chosen situation. Give suitable dimensions for the components of the apparatus.

[5]

(iii) Suggest what observations you might make of the diffracted waves.

[4]

Quality of Written Communication ..... [4]