OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

PHYSICS B (ADVANCING PHYSICS) **2861**

Understanding Processes

Wednesday **12 JANUARY 2005** Morning 1 hour 30 minutes

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

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 provided 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 give answers to only a justifiable number of significant figures.

INFORMATION FOR CANDIDATES

- You are advised to spend about 20 minutes on Section A, 40 minutes on Section B and 30 minutes on Section C.
- The number of marks is given in brackets [ ] at the end of each question or part question.
- There are four marks 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.

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

This question paper consists of 20 printed pages.

Answer **all** the questions.

Section A

1

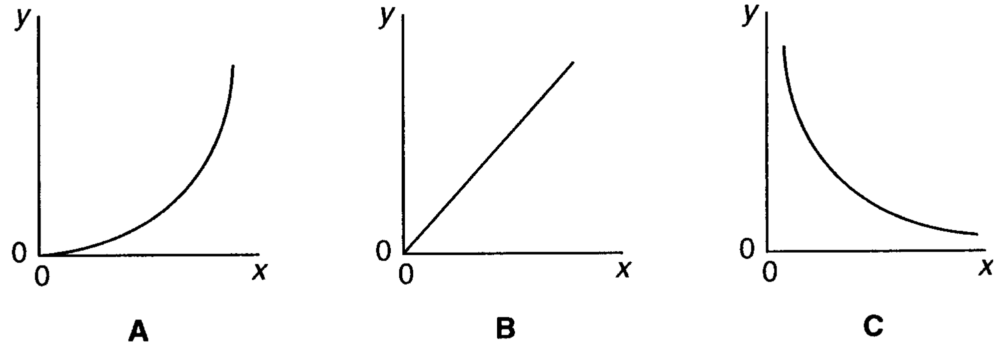


Fig. 1.1

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

(a) *y*-axis: the **kinetic energy** of a tennis ball
x-axis: the **velocity** of the tennis ball

answer ....[1]

(b) *y*-axis: the **acceleration** of objects each experiencing the same force
x-axis: the **mass** of each object

answer ....[1]

2 A narrow beam of light is always reflected from a mirror at an angle *r* equal to the angle of incidence *i*, as shown in Fig. 2.1.

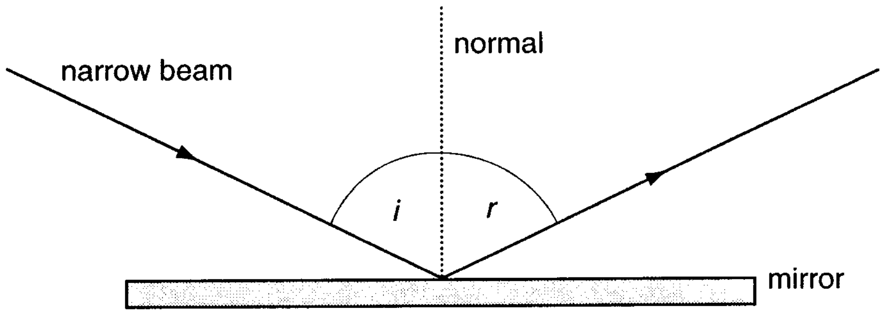


Fig. 2.1

Select from the statements (**A**, **B** and **C**) below the one that is the best explanation of this fact, in terms of the quantum behaviour of photons.

A The angles are equal because the photons rebound elastically from the surface.

B Only for paths very close to the observed path do the phasor amplitudes all combine in phase.

C The observed path is the only one along which the momentum of the photon is unchanged.

answer ....[1]

For Examiner's Use

3 Fig. 3.1 shows how the speed of a car changes with time during an emergency stop.

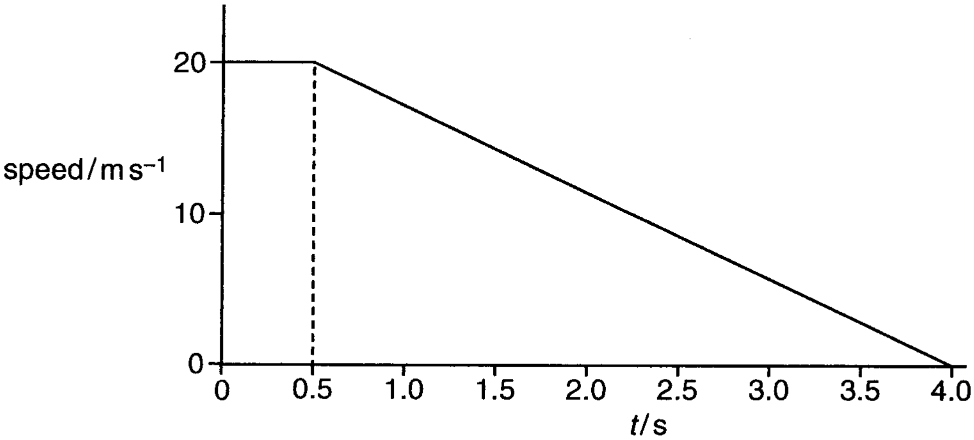


Fig. 3.1

The driver recognises there is a hazard at time $t = 0$, and the car comes to a halt 4.0 seconds later.

Use the graph to find

(a) the initial speed of the car

initial speed = ... $m\,s^{-1}$ [1]

(b) the time taken for the driver to apply the brakes after seeing the hazard

time = ... s [1]

(c) the total stopping distance of the car.

total stopping distance = ... m [2]

[Turn over

For Examiner's Use

4 This question is about a TV remote control device.

(a) The light emitting diode (LED) of a remote control for a TV set emits pulses of radiation of frequency 3.2×10^{14} Hz.

Calculate the energy of each photon of this radiation.

the Planck constant $h = 6.6 \times 10^{-34}$ J s

photon energy = ... J [1]

(b) The sensor in the TV set will respond to a pulse of radiation from the remote control when the signal power received during the pulse is at least 1.0×10^{-7} W.

Calculate the minimum rate at which photons arrive during the pulse.

rate = ... photons per second [2]

For Examiner's Use

5 Fig. 5.1 shows a human reflex test.

The tester, **A**, holds the top of a £20 note, while the person being tested, **B**, holds his hand still, with thumb and forefinger apart and level with the bottom of the note.

Without warning, **A** releases the note.

B must grasp it before it has passed through his fingers.

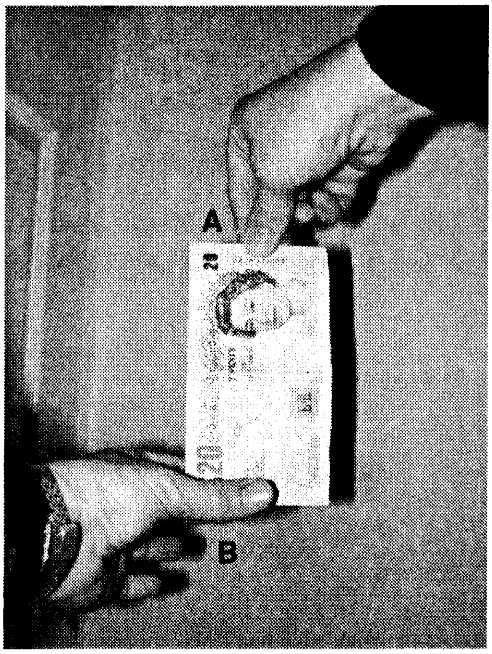


Fig. 5.1

The length of a £20 note is 150 mm.

Show that **B** must react in less than 0.2 s from the release of the note to catch it.
Neglect any effects of air resistance.

$g = 9.8\,\mathrm{m\,s^{-2}}$

[3]

6 This question is about a rocket leaving the surface of a distant planet.

(a) A rocket of mass 10 000 kg lifts off from the surface of the planet with an initial acceleration of 3.1 m s^{-2}.

Calculate the resultant force acting on the rocket.

resultant force = ... N [2]

(b) The initial thrust on the rocket is 7.5×10^4 N.
Fig. 6.1 shows the two forces acting on the rocket at the moment of lift-off.

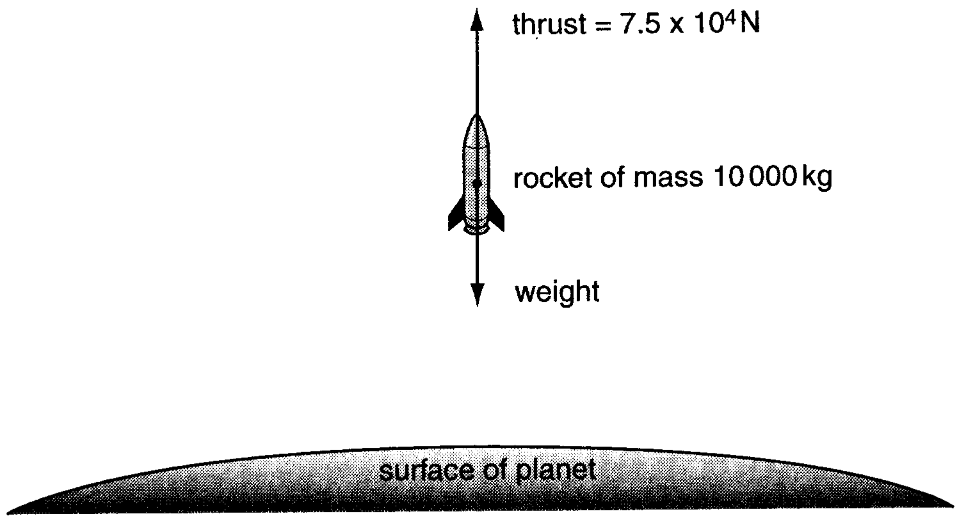


Fig. 6.1

Calculate the initial weight of the rocket.

weight = ... N [1]

(c) Calculate the gravitational field strength at the surface of the planet.

gravitational field strength = ... N kg^{-1} [1]

7 Fig. 7.1 shows a beam supported on two blocks a distance x apart.

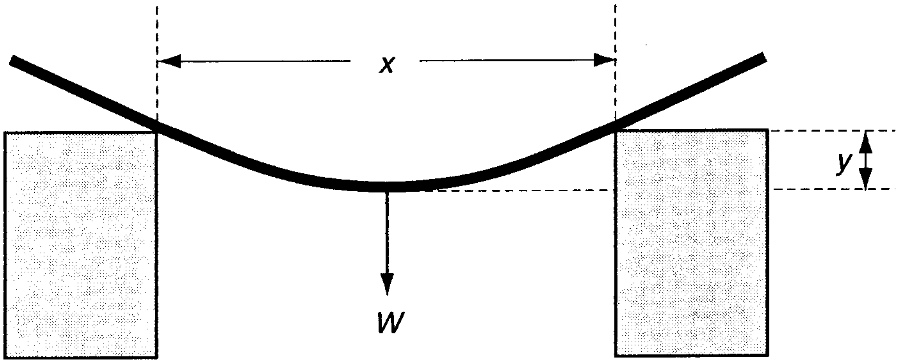


Fig. 7.1

In an experiment, the distance y that the beam sags when a fixed weight W is hung from its centre is measured for different values of the distance x between the blocks.

Here is a set of measurements.

x/m	y/m
0.90	0.080
0.70	0.037
0.50	0.014

A student wishes to check if the relationship between y and x in this experiment is of the form

$$y = kx^2 \text{ where } k \text{ is a constant.}$$

Propose and carry out a test to check if the **data** support the relationship.

test proposed	***working***

State your conclusion.

....[3]

[Section A Total: 20]

For Examiner's Use

Section B

8 Speed skiing is claimed to be 'the fastest non-motorised sport on Earth'.

In this sport, competitors, starting from rest, accelerate under gravity down a very steep slope. They are then timed over the next 100 m length of slope. (Fig. 8.1)

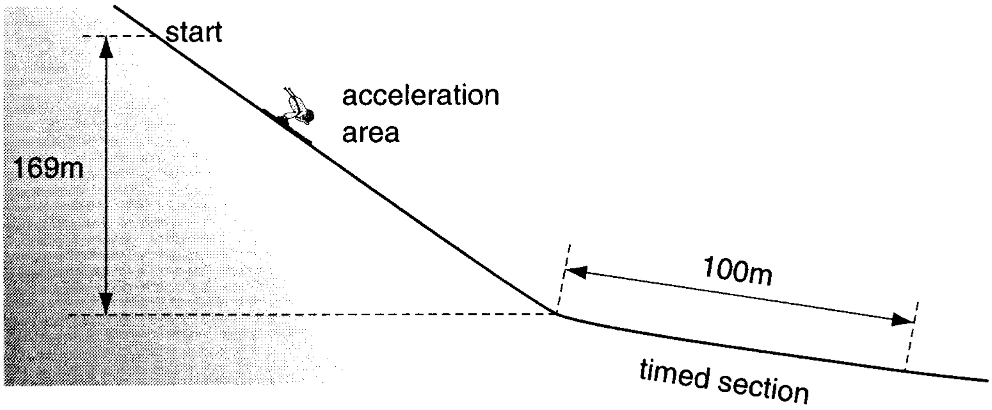


Fig. 8.1

(a) (i) The **vertical** drop in the acceleration area is 169 m.

Show that the **maximum** possible speed at which a competitor could enter the timed section is about 60 m s^{-1}.

$g = 9.8\,\text{m}\,\text{s}^{-2}$

[2]

(ii) Suggest why the **actual** speed at which a competitor enters the timed section is likely to be a lot less than 60 m s^{-1}.

[1]

(b) In a recent competition, a skier completed the 100 m timed section of the course in 2.12 s.

Find his **average** speed through the timed section.

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

For Examiner's Use

(c) The timed section of the course is 100 m long and drops a vertical distance of 26 m. The angle of the slope is 15 degrees to the horizontal.

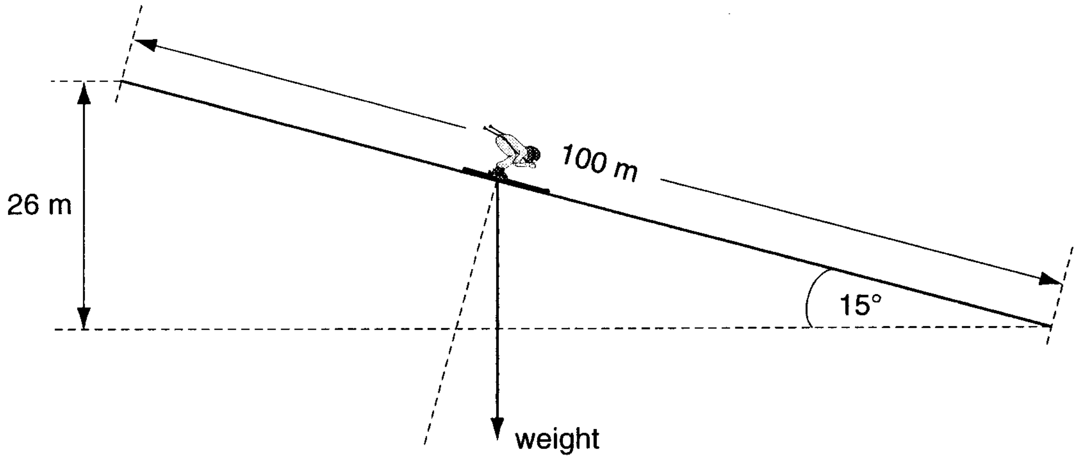


Fig. 8.2

Fig. 8.2 shows a skier of mass 72 kg travelling down the timed section of the course.

(i) Calculate the weight of the skier.

$g = 9.8\,\mathrm{N\,kg^{-1}}$

weight = ... N [1]

(ii) By scale drawing, or some other method of your choosing, show that the component of the weight in the direction parallel to the slope is about 180 N.

[2]

(iii) The speed of the skier through the timed section is constant.

Explain how this can be so.

[1]

[Total: 9]

[Turn over

9 This question is about a method of finding the wavelength of light from a laser.

A thin, parallel beam of light of a single wavelength falls on a diffraction grating, as shown in Fig. 9.1.

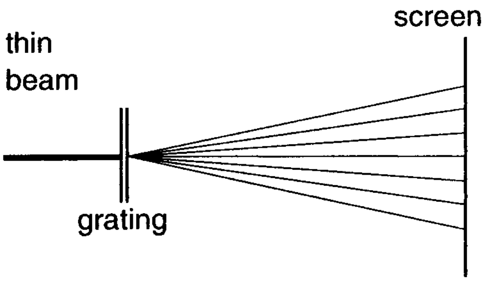


Fig. 9.1

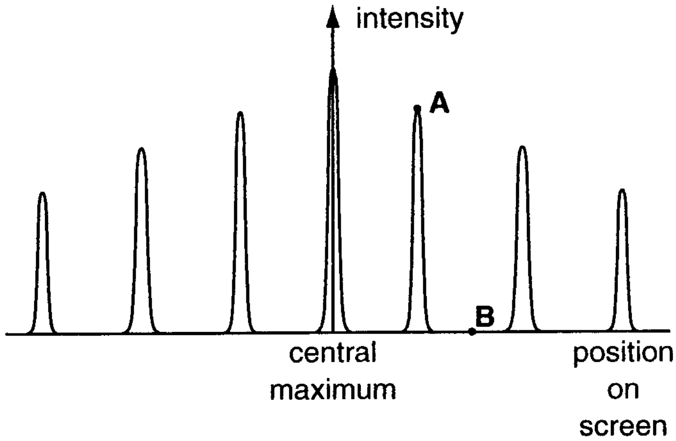


Fig. 9.2

Light passes through the grating and a regular pattern of light and dark regions is observed on the screen.

(a) Fig. 9.2 shows how the intensity pattern varies across the central region of the screen.

(i) Describe **two** important features of the intensity pattern shown in Fig. 9.2.

first feature

second feature

[2]

(ii) Explain the difference in intensity between points **A** and **B** in the pattern (Fig. 9.2), using the idea of **superposition** of waves.

[2]

(b) Fig. 9.3 shows the experimental arrangement in more detail.

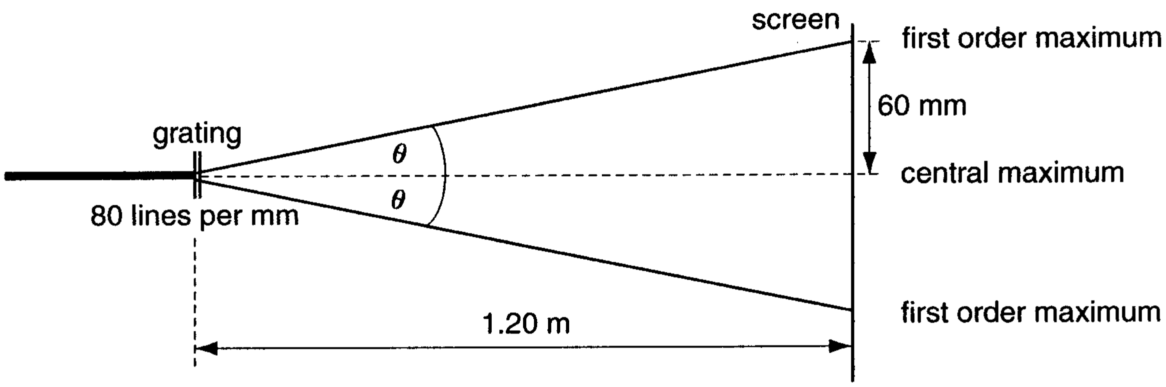


Fig. 9.3

(i) The grating has 80 lines per mm.
Show that the spacing d between the lines on the grating is 1.25×10^{-5} m.

[1]

(ii) The distance between the central maximum and first order maximum is measured on the screen and found to be 60 mm.
The screen is 1.20 m away from the grating.

Show that the first order maximum is observed at an angle θ of about 3° to the straight through direction.

[2]

(iii) Calculate the wavelength λ of the light, using the information above.

[2]

(c) Suggest **one** change that could be made to the experimental arrangement to improve the accuracy of the wavelength measurement. Explain your reasoning.

[2]

[Total: 11]

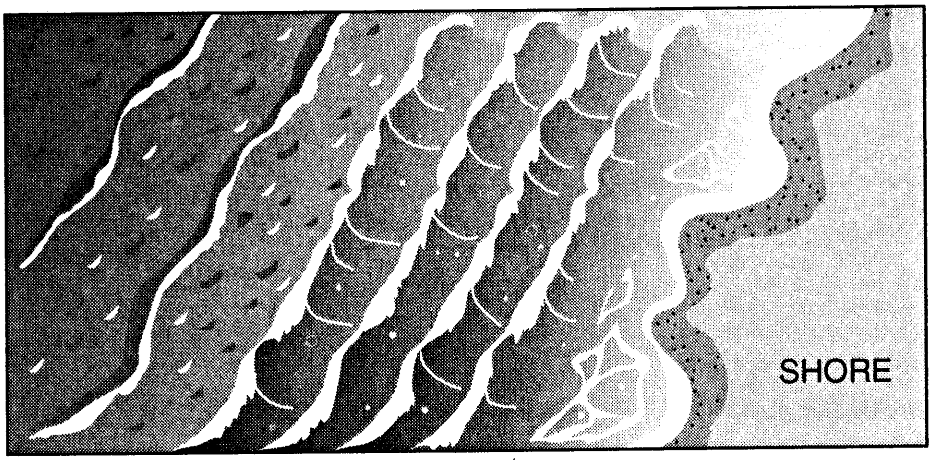
[Turn over

For Examiner's Use

10 This question is about wave energy.

Fig. 10.1 shows a group of waves travelling across the sea towards a beach.

velocity of group of waves = 12 m s^{-1}



each 1 m^2 of the sea surface carries energy towards the shore at 12 m s^{-1}

Fig. 10.1

(a) The energy ε carried by every 1 m^2 of surface of the sea is given by

$$\varepsilon = \tfrac{1}{2} g \rho x^2$$

where g is the gravitational field strength
ρ is the density of the sea water
and x is the amplitude of the waves in the group.

Show that $\frac{1}{2} g \rho x^2$ has the units J m^{-2}. Take the units of g as N kg^{-1}.

[2]

For Examiner's Use

(b) Waves with a peak-to-trough height of 1.8 m approach a beach as shown in Fig. 10.2.

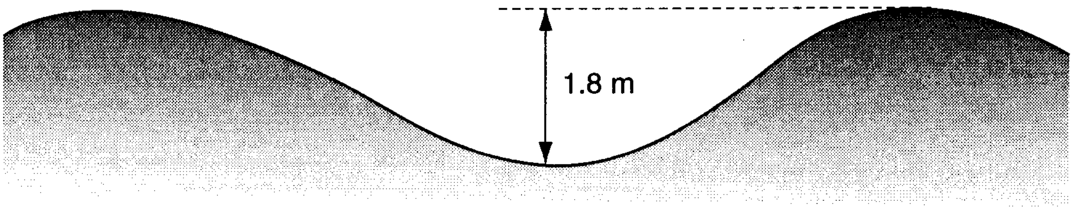


Fig. 10.2

(i) State the amplitude x of these waves.

x = ... m [1]

(ii) Calculate the energy ε carried by these waves per m^2 of sea surface, using the equation given in **(a)**.

$\rho = 1030\,kg\,m^{-3}$
$g = 9.8\,N\,kg^{-1}$

ε = ... $J\,m^{-2}$ [2]

(iii) The wave energy is being carried onto the beach with the group of waves shown in Fig. 10.1 at a velocity of $12\,m\,s^{-1}$.

Show that the energy arriving per second on a 1.0 m length of the beach is about 49 kW.

[2]

(iv) Calculate the power delivered by these waves to a 0.5 km length of beach. Express your answer in megawatt.

power = ... MW [2]

(v) Suggest **one** possible consequence, or use, of this wave power being delivered to the shore.

[1]

[Total: 10]

[Turn over

11 This question is about the quantum behaviour of photons.

Yellow light of a single wavelength falls on the vertical surface of a soap film.
Photons of the light reflect from the film and horizontal bands can be seen in the soap film, as shown in Fig. 11.1. The bands are alternately yellow and black.

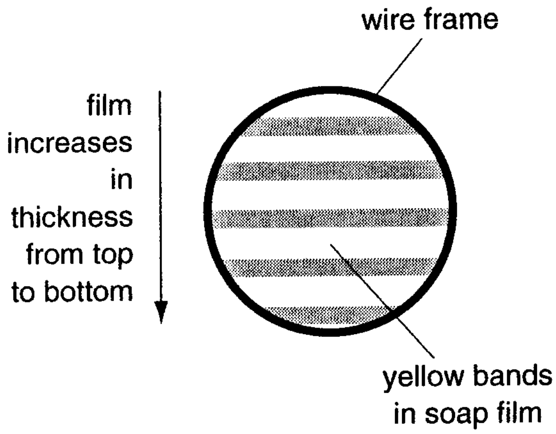


Fig. 11.1

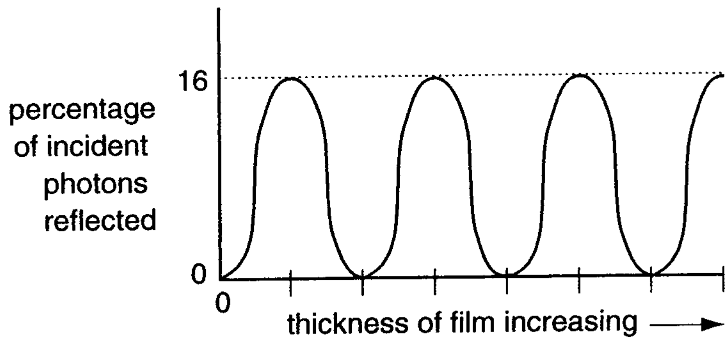


Fig. 11.2

(a) Fig. 11.2 shows how the **percentage** of incident photons **reflected** by the film varies as its thickness changes.

Use the information in Fig. 11.2 to describe in words how the percentage of photons reflected varies with the thickness of the soap film.

[3]

(b) An incident photon can reflect off either the **front** or **back** surface of the soap film to reach the detector. If it does not reflect, it will pass through the film. (Fig. 11.3)

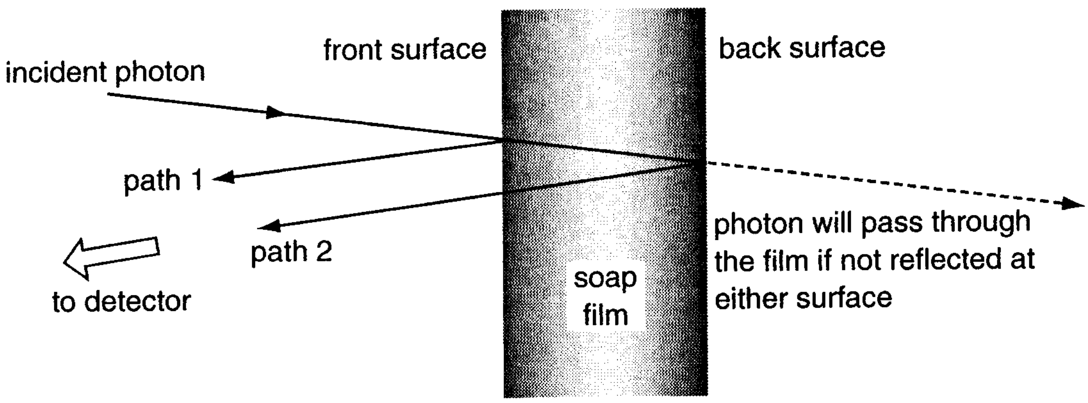
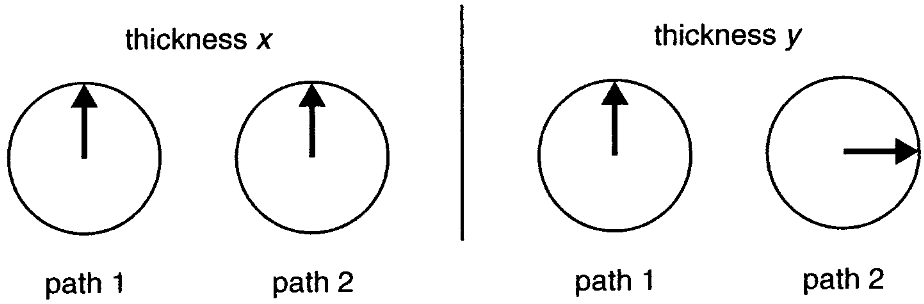


Fig. 11.3

For Examiner's Use

Some photons reach the detector after reflecting from two different places on the film where the film thickness is *x* and *y*.

Rotating phasors for the two paths of a photon reaching the detector are shown below, for the two thicknesses of film. (scale: 1 cm represents amplitude 2.0)



(i) By scale drawing or some other method of your choosing, calculate the magnitude of the **resultant** phasor amplitude in each case.

Each phasor has an amplitude of 2.0.

thickness *x*

resultant phasor amplitude = ...

thickness *y*

resultant phasor amplitude = ... [3]

(ii) Show that the **probability** of photons being reflected from film of thickness *x* is **twice** that from film of thickness *y*.

[2]

(iii) At certain thicknesses of film, dark bands are produced indicating that few, if any, photons are reflected there.

How do you account for this?

[2]

[Total: 10]

[Section B Total: 40]

[Turn over

For Examiner's Use

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. In this section, four marks are available for the quality of written communication.

12 In this question, you are to write about a method of measuring the distance to a remote or inaccessible object.

(a) **(i)** State the distance measurement to be made.

[1]

(ii) Estimate the distance to be measured.

[1]

(b) **(i)** Draw a clear diagram to show the arrangement of apparatus required to collect data for the measurement of this distance. Label the important items of equipment.

[4]

(ii) Describe how your method works, and what data you would collect.

[3]

(c) **(i)** Show how the data can be used to find the distance to the remote object.

[3]

(ii) State **one** factor that may limit the accuracy achieved in this measurement of distance.

[1]

[Total: 13]

[Turn over

For Examiner's Use

13 In this question, you are to choose and write about one method of producing and observing standing waves.

(a) State the example of standing waves you have chosen.

[1]

(b) Draw a diagram to show the arrangement of apparatus, or the physical situation, required to produce these standing waves. Label the important parts of your diagram.

[4]

(c) Describe what you would do to produce a standing wave in this situation.

[2]

For Examiner's Use

(d) **(i)** Sketch the simplest wave that could be produced in the situation you have described. Label the positions of any displacement nodes or antinodes with the letters **N** and **A** respectively.

[2]

(ii) Use your knowledge of physics to explain how this standing wave is produced.

[2]

(e) Sketch a different standing wave that could be produced in this situation, and describe what changes you would need to make to your system in order to produce it.

[2]

[Total: 13]

Quality of Written Communication [4]

[Section C Total: 30]

END OF QUESTION PAPER