

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

PHYSICS B (ADVANCING PHYSICS)

2861

Understanding Processes

Monday **12 JANUARY 2004** Morning 1 hour 30 minutes

Candidates answer on the question paper.

Additional materials:

Data, Formulae and Relationships Booklet

Electronic calculator

Protractor

Candidate Name	Centre Number	Candidate Number												
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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 Here is a list of four numbers.

0.6 6 60 600

Write down the number that is the best estimate of

(a) the wavelength of visible light, expressed in nm

wavelength = nm [1]

(b) the mass of a typical Advancing Physics student, expressed in kg

mass = kg [1]

(c) the top speed of a supersonic aircraft, expressed in **kilometre** per second.

speed = km s⁻¹ [1]

- 2 An apple falls onto the head of a philosopher sitting beneath an apple tree.

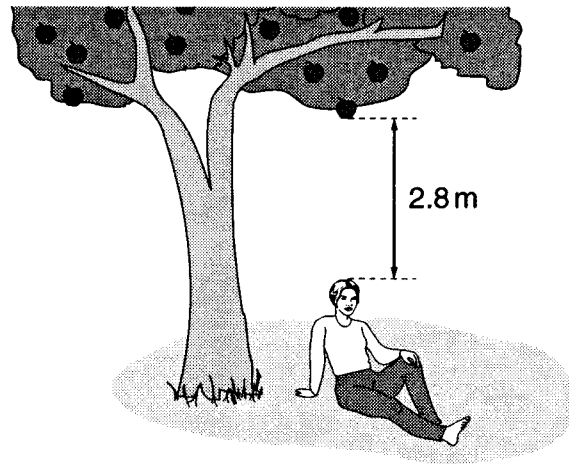


Fig. 2.1

The apple of mass 0.15 kg falls from rest through a vertical height of 2.8 m before striking the philosopher.

- (a) Describe the energy change taking place as the apple falls.

[1]

- (b) (i) Calculate the speed at which the apple is travelling when it strikes the philosopher.

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

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

- (ii) State an assumption you have made.

[1]

- 3 A beam of laser light falls on two closely spaced narrow parallel slits as shown in Fig. 3.1.

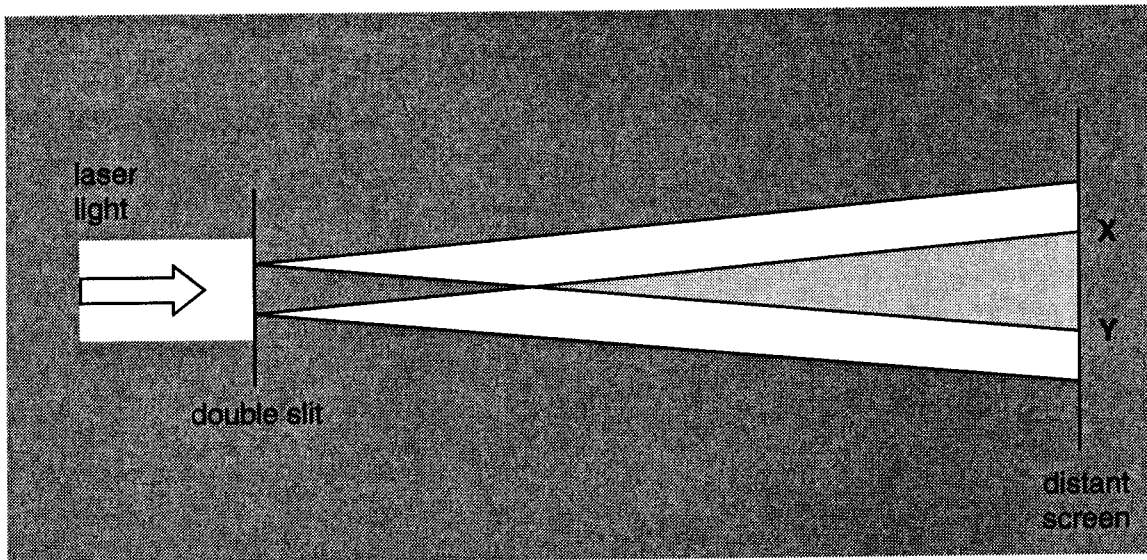
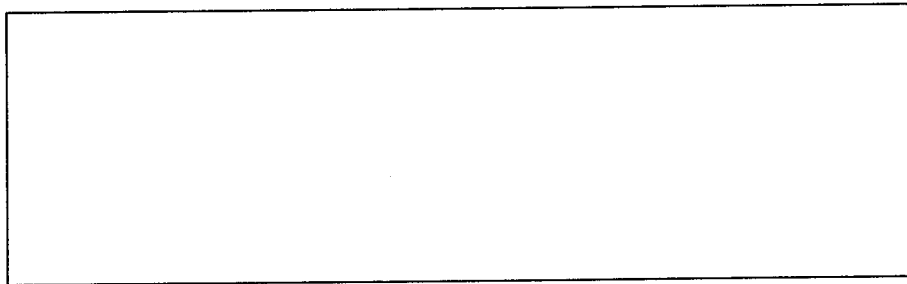


Fig. 3.1

An interference pattern is observed on the distant screen beyond the slits in the region between X and Y.

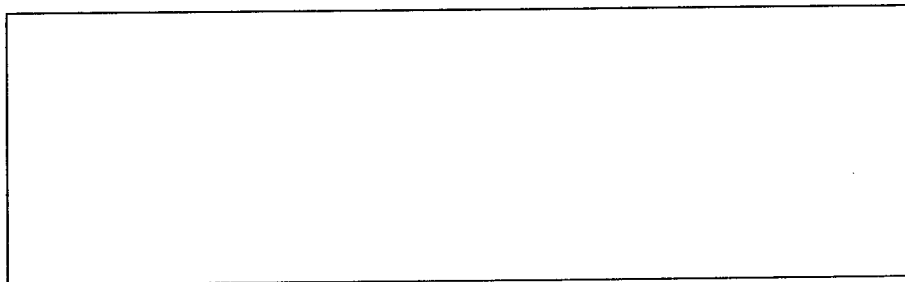
- (a) In the box below, sketch the pattern of light you would expect to see on the screen between X and Y.



[2]

- (b) The laser is replaced by one emitting light of a **longer** wavelength. Nothing else is changed.

In the box below, sketch the pattern of light you would now expect to see on the screen, using the same scale as the sketch above.



[1]

- 4 Radiowaves of wavelength $\lambda = 1500$ m are all around us. They carry a radio programme into our homes.

- (a) Calculate the frequency of a radiowave photon.

$$c = 3.0 \times 10^8 \text{ m s}^{-1}$$

frequency = Hz [2]

- (b) High frequency X-rays of frequency $f = 2.4 \times 10^{17}$ Hz are used in hospitals to obtain images of the internal structure of the body.

Calculate the value of the ratio

$$\frac{\text{energy of an X-ray photon}}{\text{energy of a radiowave photon}}$$

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

ratio = [2]

- 5 A gardener is levelling his lawn using a garden roller.

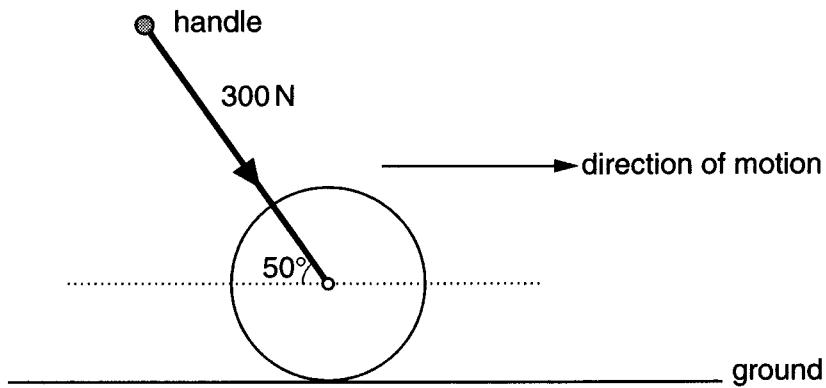


Fig. 5.1

The gardener exerts a force of 300 N through the handle of the roller, as shown in Fig. 5.1.

- (a) Show that the horizontal component of the force is about 200 N.

[1]

- (b) The gardener pushes the roller with this force at a steady speed of 0.6 m s^{-1} in a straight line, as he rolls a strip of grass.

Calculate the power required.

power = W [2]

- 6 Fig. 6.1 shows the profile of a wave at a particular instant.

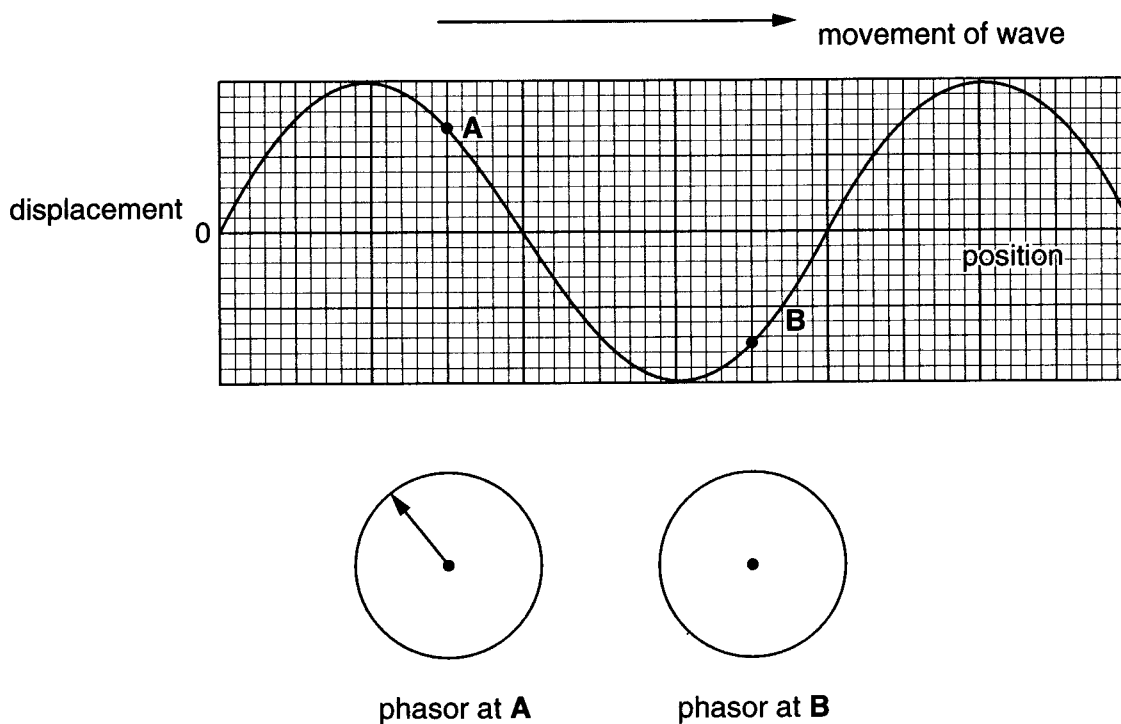


Fig. 6.1

The wave is moving from left to right in the diagram. The phasor arrow corresponding to **point A** on the wave is shown in the circle below the wave profile.

- (a) Complete the diagram by drawing in the phasor arrow corresponding to **point B** on the wave. [1]
- (b) Draw on the axes of Fig. 6.1 another wave of the same amplitude and wavelength, but which has a 180° (π radian) phase difference with the wave shown. [2]

[Section A Total: 20]

Section B

7 This question is about a camera lens.

The amount of light reflected from the lens of a camera can be reduced considerably by coating the surface with a thin film of transparent material. A lens surface treated in this way is said to be 'bloomed', as shown in Fig. 7.1.

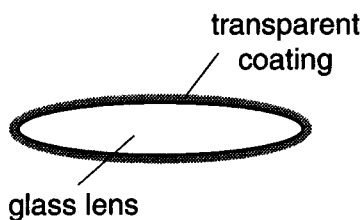


Fig. 7.1

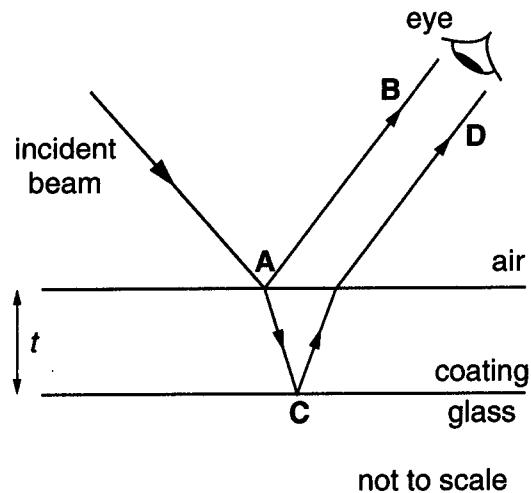


Fig. 7.2

A narrow beam of green light, of a particular wavelength, is incident on the coated surface of the lens, as shown in Fig. 7.2.

The light is partially reflected from this surface along the path **AB**.

Light passing through to the lower surface of the coating is partially reflected at **C**, and emerges along the path **CD**.

(a) The thickness t of the coating is such that the resultant intensity of green light entering the eye is very small, and the lens appears dark.

(i) What must be true about the light reaching the eye along the two paths shown?

[1]

(ii) Explain how the resultant intensity of green light reflected from the transparent coating in this way can be a minimum.

[2]

(iii) Suggest and explain why the minimum is not necessarily zero.

[2]

(b) When the surface of this bloomed lens is viewed in white light, consisting of many wavelengths, the lens appears purple in colour.

Explain this observation.

[3]

(c) Blooming a lens surface reduces the intensity of reflected light for a wide range of wavelengths.

Suggest and explain **one** effect on the image produced in a camera fitted with a 'bloomed' lens.

[2]

[Total: 10]

8 This question is about a violin.

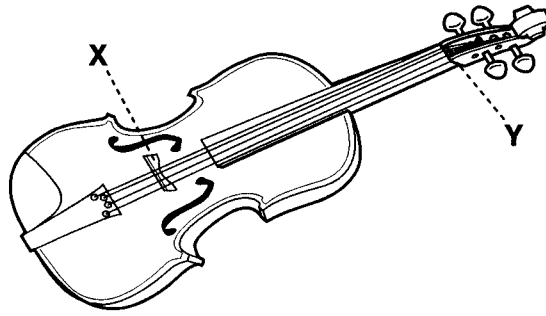


Fig. 8.1

Fig. 8.1 shows a violin with its four strings in place. Each string is in tension between the bridge **X** and the nut **Y**. At **X** and **Y** the movement of the strings is restricted.

(a) Fig. 8.2 shows one of the four strings on the violin.

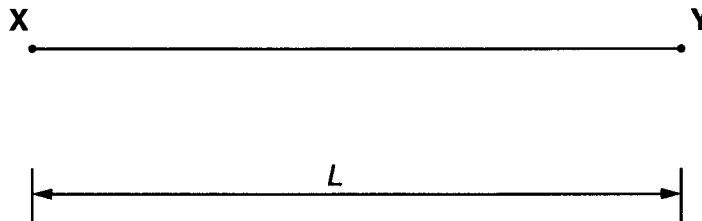


Fig. 8.2

(i) Draw on Fig. 8.2 the lowest frequency standing wave that can be obtained on the string. Label any nodes and antinodes with the letters 'N' and 'A' respectively. [2]

(ii) The length L of the string between **X** and **Y** is 0.40 m.

State the wavelength of the standing wave you have drawn.

wavelength =m [1]

(iii) The frequency of the lowest frequency standing wave is 440 Hz.

Calculate the velocity v of the transverse wave on the string.

velocity = m s⁻¹. [2]