OXFORD CAMBRIDGE AND RSA EXAMINATIONS
Advanced Subsidiary GCE

PHYSICS B (Advancing Physics) **2861**
Understanding Processes

Tuesday **18 JANUARY 2001** Morning 1 hour 30 minutes

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

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 in Section C.

Section A

1 For each of the following speeds, in m s^{-1}, select and write down the nearest value from the list below.

(a) speed of a car ……………………………………………………………………….m s^{-1}

(b) speed of a sound wave in air ……………………………………………………….m s^{-1}

(c) speed of a gamma-ray photon ……………………………………………………….m s^{-1}

3×10^{-1}, 3×10^{1}, 3×10^{2}, 3×10^{3}, 3×10^{6}, 3×10^{8}, 3×10^{9}

[3]

2 A man pushes a loaded wheelbarrow of total mass 60 kg against a constant frictional force of 25 N along a horizontal road.

(a) Calculate the work done in moving 12 m.

work done = ... J [2]

(b) Explain why the weight of the loaded wheelbarrow does not enter the calculation.

....

…………………………………………………………………………………………….[2]

3 A horizontal force of 1500 N is applied to the tow ball of a caravan as shown in Fig. 3.1 (plan view).

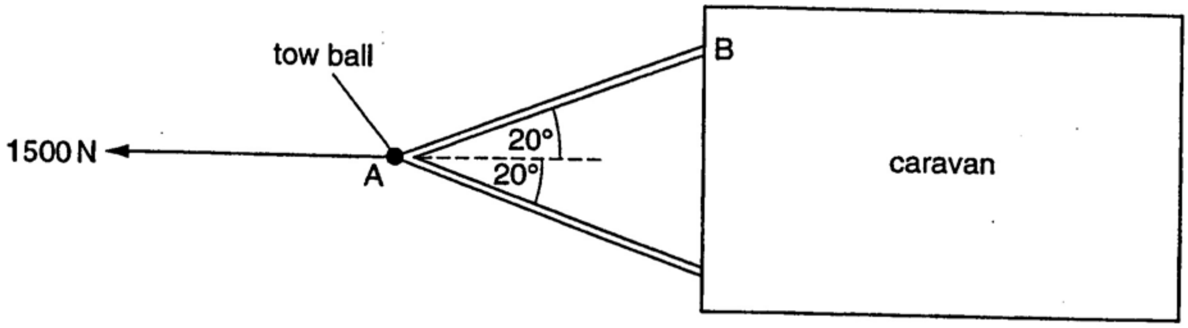

Fig.3.1

Calculate the tension T in the bar AB of the towing bracket.

tension =………………………………….N [3]

4 Fig. 4.1 shows a portion of the electromagnetic spectrum on a logarithmic scale of photon energy.

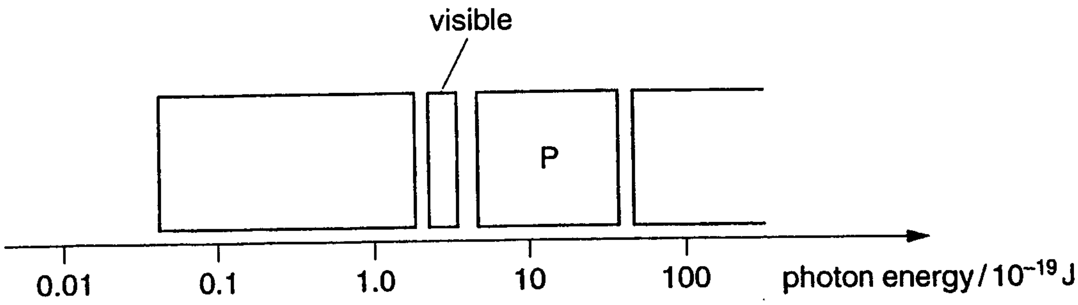

Fig. 4.1

Using Fig. 4.1, write down

(a) the name of the region labelled P……………………………………………….……………..[1]

(b) a photon energy in the visible region…………………………………………………….....[1]

5 Fig. 5.1 shows two rotating phasors at a time t = O. The phasors rotate in an anticlockwise direction.

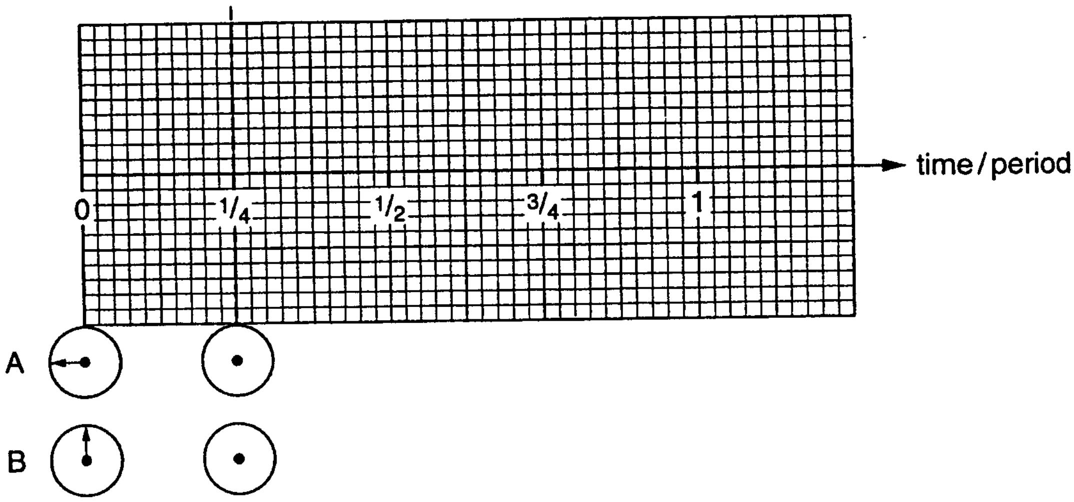

Fig. 5.1

Draw on Fig. 5.1

(a) two phasors showing the positions at t = ¼ period,

(b) two waveforms, labelled A and B, for which the phasor diagrams are appropriate.

[4]

6 An LED emits red light of frequency 5.0×10^{14} Hz.

(a) Calculate the energy of a photon of red light.

energy of photon = ... J [2]

(b) Calculate the number of photons of red light emitted per second when the radiated power of the LED is 2.0 mW.

number of photons per second =...................... [2]

Section B

7 Fig. 7.1 is a graph of height against time for a ball falling freely under gravity and bouncing when it hits the floor.

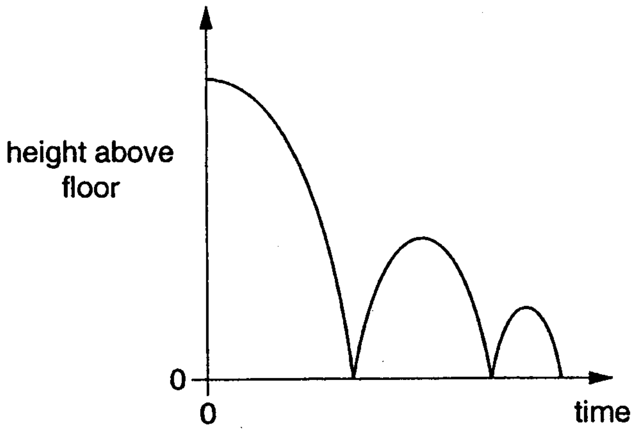

Fig 7.1

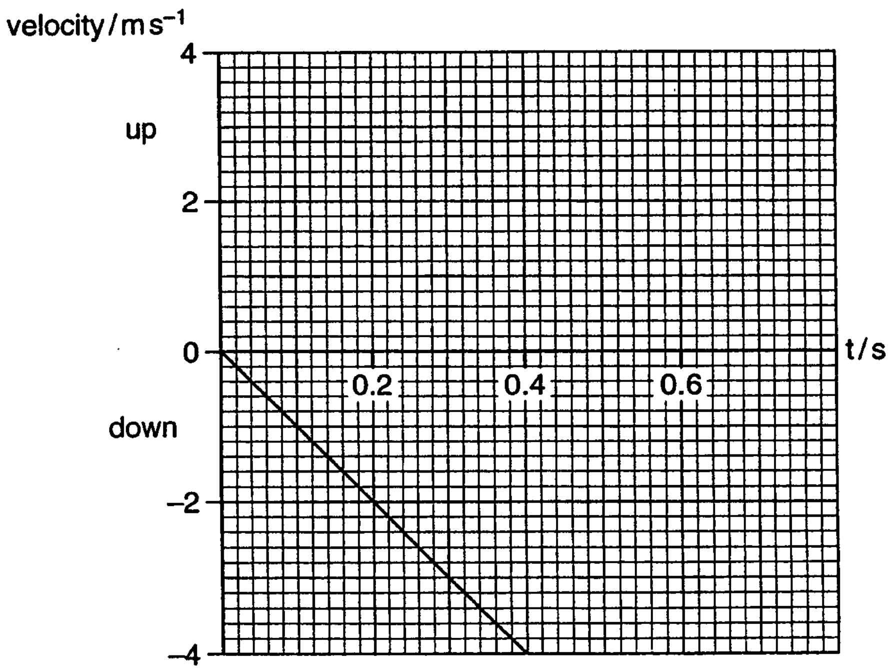

Fig 7.2

The ball is released from rest and hits the floor 0.40 s after release. The first section of a velocity/time graph has been drawn on Fig. 7.2.

(a) Use the graph on Fig. 7.2 to show that

(i) the speed of the ball just before hitting the floor for the first time is 4.0 m s^{-1} ,

(ii) the magnitude of the acceleration of the ball is 10 m s^{-2},

(iii) the ball was released from a point 0.80 m above the floor.

[5]

(b) (i) The speed of the ball just before hitting the floor for the first time is 4.0 m s^{-1}. On bouncing, the ball loses half its kinetic energy. Show that the speed of the ball as it leaves the floor after the first bounce is 2.8 m s^{-1}.

(ii) Draw the velocity/time graph from t= 0.40s to t= 0.60s on Fig. 7.2.

[5]

8 This question is about an aircraft taking off and climbing away from an airport.

(a) A Boeing 737 aircraft of mass 5.8×10^4 kg stands at the end of a runway ready for take off.

The engines provide a constant total thrust of 2.1×10^5 N.

(i) Calculate the initial acceleration of the aircraft as it starts to move.

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

(ii) Calculate the length of runway needed for the aircraft to reach its take-off speed of 85 m s^{-1}, assuming the acceleration is constant.

length =…………………………………….m

(iii) The acceleration of the aircraft is not constant. State one possible reason for this and explain how this might affect the length of runway needed.

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[7]

(b) After take-off the aircraft climbs at an angle of 25° to the horizontal (Fig. 8.1).

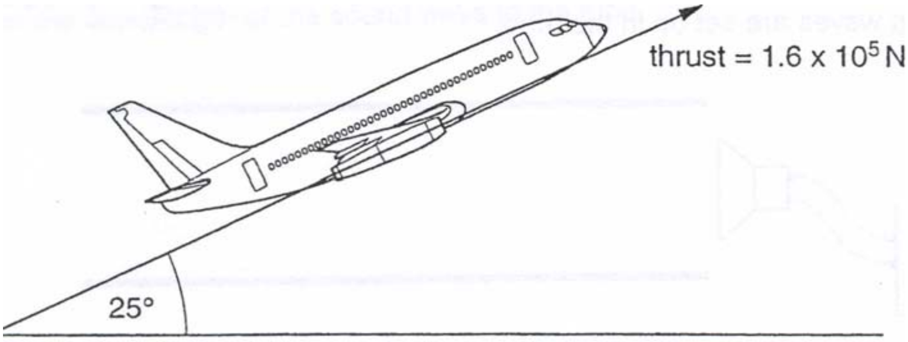

Fig. 8.1

When climbing the engines provide a total thrust of 1.6×10^5 N. Calculate the component of the thrust which contributes to the lift force on the aircraft.

force =....................................N [3]

9 This question is about standing waves of sound in a tube.

(a) (i) A small loudspeaker is placed near to the open end of a tube (Fig. 9.1). Explain how standing waves are set up in the tube.

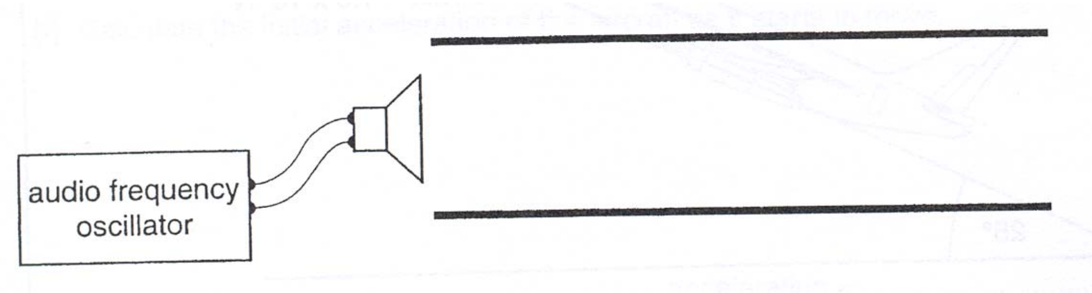

Fig. 9.1

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(ii) Suggest one way in which the presence of a standing wave could be detected in such a tube.

…………………………………………………………………………………………………

…………………………………………………………………………………………………

[4]

(b) The speed of sound in the air in the tube is 340 m s^{-1}. The loudspeaker emits a note of frequency 1.7 kHz.

(i) Calculate the wavelength of the sound wave in the tube.

wavelength =…………………………………….m

(ii) Fig. 9.2 shows the tube of length 0.20 m. Sketch the standing wave in the tube.

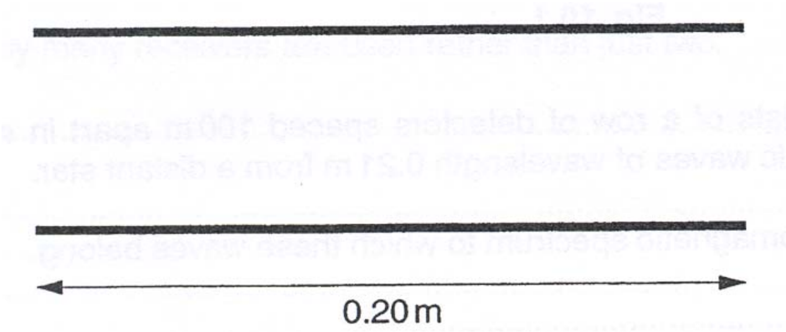

Fig. 9.2

[3]

(c) The air in the tube is replaced with carbon dioxide gas in which the speed of sound is 240 m s^{-1}. Calculate the length of tube which would be required to produce the same standing wave pattern at the same frequency of 1.7 kHz in carbon dioxide gas.

length of tube =...................... m [3]

10 This question is about a telescope interferometer.

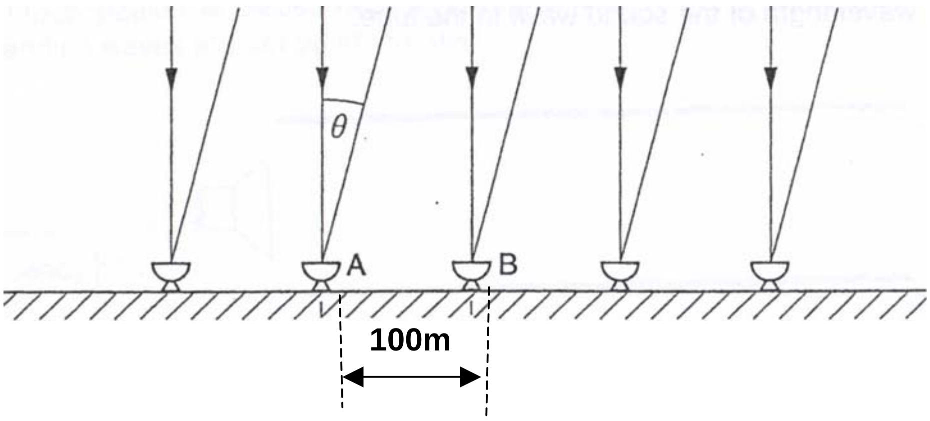

Fig. 10.1

The telescope (Fig. 10.1) consists of a row of detectors spaced 100 m apart in a straight line. They detect electromagnetic waves of wavelength 0.21 m from a distant star.

(a) State the part of the electromagnetic spectrum to which these waves belong.

………………………………………………………………………………………………………[1]

(b) Explain why, when the star is directly overhead, the signals received by the line of detectors will interfere constructively to give a maximum signal.

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[3]

(c) Consider just two detectors A and B.

(i) Write down an expression for the path difference between the signals received by A and B from a star in a direction () to the vertical (overhead position).

…………………………………………………………………………………………………..

(ii) Calculate the smallest value of θ for the signal to be a minimum for the waves.

θ = ………………………………………..[4j

(d) Suggest why many receivers are used rather than just two.

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[2]

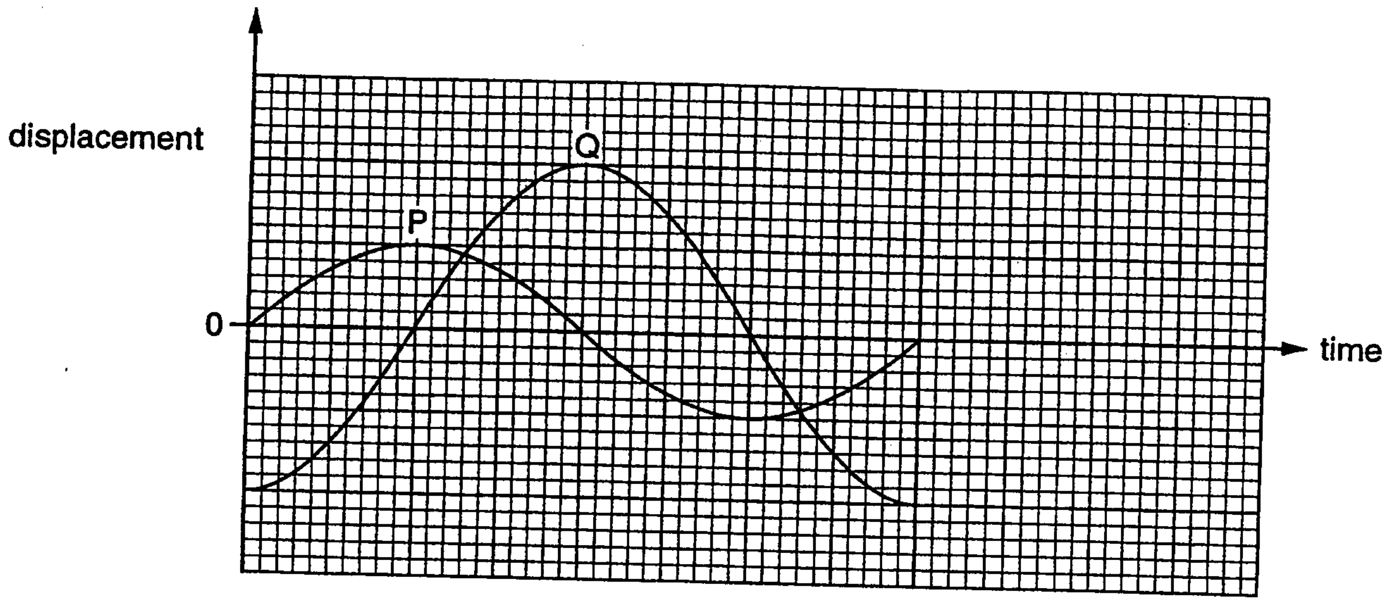
Section C

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 the superposition of waves.

Fig. 11.1



(a) Fig. 11.1 shows the waveforms P and Q from two sources. Draw on Fig. 11.1 the waveform which corresponds to the superposition of the two waveforms P and Q.

[4]

(b) (i) Give an example you have studied in which the superposition of waves occurs.

……………………………………………………………………………………………[1]

(ii) Describe the apparatus you would use and the observations you would make to investigate this example of the superposition of waves.

[4]

(iii) Describe how the idea of superposition of waves helps to explain the observations you would have made.

[4]

12 This question is concerned with measuring the accelerations of objects.

(a) Name a real situation in which you might wish to measure the acceleration of an object.

…… [1]

(b) For this situation, describe

1. the apparatus you would use,
2. the measurements you would make,
3. how you would use your measurements to determine the acceleration.

[8]

(c) Describe what steps can be taken to ensure that the measurements are as accurate as possible.

[4]

Quality of Written Communication [4]