C A R I B B E A N   E X A M I N A T I O N S   C O U N C I L

S E C O N D A R Y   E D U C A T I O N   C E R T I F I C A T E
E X A M I N A T I O N
P H Y S I C S
P a p e r   0 3   –   G e n e r a l   P r o f i c i e n c y

1   h o u r

16 J A N U A R Y   2 0 0 3   (u.m.)

In addition to the 1 hour, candidates are allowed a reading time of 10 minutes. Writing may begin during the 10-minute period.

READ THE FOLLOWING DIRECTIONS CAREFULLY

1. Answer ANY THREE questions.
2. ALL WORKING MUST BE SHOWN in your answer booklet, since marks will be awarded for correct steps in calculations.
3. The use of non-programmable calculators is allowed.
4. Mathematical tables are provided.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

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1. (a) Explain what is meant by EACH of the following terms when applied to a wave in a medium:

(i) A progressive wave
(ii) A pulse
(iii) A longitudinal wave
(iv) A transverse wave

(8 marks)

(b) Some ships employ sound waves for determining the depth of water below them. (see Figure 1)

![Diagram of a ship with ultrasonic transmitter/receiver showing reflected and transmitted waves]

Figure 1

These sound waves have frequencies above the range of the human ear and are therefore called ultrasonic. A short pulse of such a sound is emitted by the transmitter. It travels to the ocean floor and is 'echoed' back to a receiver close to the transmitter. The depth of the ocean can then be determined from the time that elapses between the transmission and reception of the pulse.

(i) What difficulty will be encountered if the transmitter were to send a continuous sound wave?

(3 marks)

(ii) Why it is necessary for the transmitter to use pulses of sound?

(2 marks)

(c) (i) The ultrasonic transmitter has a frequency of 40 kHz and the wave velocity is 1500 m s\(^{-1}\). What is its wavelength?

(3 marks)

(ii) The time taken for the echo to return is 200 ms, calculate the depth of the ocean.

(4 marks)

Total 20 marks
2. (a) (i) State Archimedes' principle.

(ii) Describe with the aid of a diagram a laboratory experiment to verify this principle. (8 marks)

(b) A block of volume $2 \times 10^{-4}$ m$^3$ and density $10^4$ kg m$^{-3}$ is suspended from a spring balance and fully immersed in a liquid of density $10^3$ kg m$^{-3}$.

(i) a) Calculate the weight of the block and the upthrust on it when it is fully immersed in the liquid.

b) Use your results to determine the reading of the spring balance when the block is fully immersed in the liquid.

(ii) What is the density of the resulting liquid if 1 litre of the above liquid is completely mixed with 2 litres of another liquid of density 900 kg m$^{-3}$? (12 marks)

(g, acceleration of gravity = $10$ ms$^{-2}$)

Total 20 marks
3. (a) (i) Define ‘convection’ and list THREE differences between convection and radiation.

(ii) Draw a simple diagram showing how the direction of sea breezes is determined by convection. \[\text{(8 marks)}\]

(b) Figure 2 shows a cross section of a solar air heater. The principles of its operation are similar to those of a solar water heater.

![Diagram of solar air heater]

\[\text{Figure 2}\]

(i) What are the functions of

a) the glass?

b) the coconut fibre?

c) the blackened aluminium sheet?

(ii) Explain how the physical properties of these materials make them especially suitable for these functions. \[\text{(7 marks)}\]

(c) Air enters the heater at 30 °C and leaves at 100 °C. Calculate the energy absorbed by 0.1 kg of air as it passes through the heater. \[\text{(Specific heat capacity of air } = 1040 \text{ J kg}^{-1} \text{ K}^{-1})\] \[\text{(3 marks)}\]

(d) List TWO methods by which the temperature of the air leaving the heater can be increased. \[\text{(2 marks)}\]

Total 20 marks
4. (a) Figure 3 below shows a simple d.c. motor connected in a circuit.

![Figure 3](image)

Use the figure to explain how the motor is able to rotate continuously. (8 marks)

(b) Suppose a bar magnet is mounted so that it can rotate between the poles of an electromagnet as shown in Figure 4. The switch S is initially open.

![Figure 4](image)

(i) Describe and explain in detail the motion of the magnet when the switch S is closed.

(ii) The d.c. supply is replaced by an a.c. supply what would be the motion of the bar magnet. (12 marks)

Total 20 marks
5.  (a)  (i) Define the terms 'work', 'energy' and 'power'.
(ii) Distinguish between kinetic and gravitational potential energy.  

(b) Figure 5 below shows a body of mass 6 kg moving at constant velocity along a horizontal, frictionless plane. When it reaches point A, a constant horizontal force is applied until it reaches point B. The force is then removed and the body travels up a smooth inclined plane BC until it comes to rest at C.

![Figure 5]

Given that the velocity at A is 15 m/s and that the distance AB is 110 m and the force applied between A and B is 37.5 N

Calculate

(i) the work done by the force and hence the average power exerted over this distance if the force acts for 4 seconds

(ii) the kinetic energy at B

(iii) the vertical height of C above B.

(12 marks)

Total 20 marks

END OF TEST