CARIBBEAN EXAMINATIONS COUNCIL
SECONDARY EDUCATION CERTIFICATE
EXAMINATION

PHYSICS

Paper 02 – General Proficiency

1\frac{1}{2} hours

READ THE FOLLOWING DIRECTIONS CAREFULLY

1. You MUST use this answer booklet when responding to the questions. For each question, write your answer in the space provided and return the answer booklet at the end of the examination.

2. ALL WORKING MUST BE SHOWN in this booklet, since marks will be awarded for correct steps in calculations.

3. Attempt ALL questions.

4. The use of non-programmable calculators is allowed.

5. Mathematical tables are provided.

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

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002492/F 98
You should NOT spend more than 30 minutes on this question.

1.

Figure 1

The apparatus shown in Figure 1 above may be used to investigate how the volume of a fixed mass of gas at constant temperature varies when the pressure is changed. Air is trapped in a uniform glass tube which has a scale behind it calibrated in cm$^3$. As the pressure in the oil chamber is increased using the pump, oil is forced into the glass tube, decreasing the volume of the air. The pressure, in kPa, is indicated by a gauge fitted to the oil chamber.
The graph on page 2 was plotted from data gathered using the apparatus shown in Figure 1.

(a) How would you make sure that the temperature of the gas was constant during the experiment?

(1 mark)

(b) It is suggested that if the temperature is constant, the pressure, \( P \), of a fixed mass of gas is inversely proportional to the volume, \( V \), that is

\[ \frac{I}{V} = k \times P \]  

where \( k \) is a constant.

To test whether the relationship applies in this case, read off values of \( V \) from the graph to complete Table 1 below. Calculate the corresponding values of \( I/V \).

<table>
<thead>
<tr>
<th>Pressure, ( p/\text{kPa} )</th>
<th>Volume, ( V/\text{cm}^3 )</th>
<th>( (I/V)/\text{cm}^3 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>150</td>
<td></td>
<td></td>
</tr>
<tr>
<td>200</td>
<td></td>
<td></td>
</tr>
<tr>
<td>230</td>
<td></td>
<td></td>
</tr>
<tr>
<td>270</td>
<td></td>
<td></td>
</tr>
<tr>
<td>300</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1

(9 marks)

(c) On page 5, plot a graph of \( I/V \) against \( P \).

(8 marks)

(d) What conclusion can you draw from the graph you have plotted? Give a reason for your answer.

(2 marks)
(e) The gradient of the graph is equal to the value of $k$. Find $k$.

(5 marks)

(f) (i) What would be the volume of the air in the tube if the pressure could be increased to 550 kPa? (Assume the equation in (b) on page 3 applies.)

(3 marks)

(ii) The maximum volume of the air in the tube is 65 cm$^3$. Calculate the pressure of the air for this volume.

(2 marks)

Total 30 marks
Figure 2

Figure 2 above shows a polythene rod, resting on two watch glasses which act as a low-friction pivot. A negatively charged rod is brought near to the polythene rod.

(i) If the polythene rod is attracted, what TWO possible conclusions might be drawn?

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(2 marks)

(ii) What conclusion could be drawn if the rods repelled each other?

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(1 mark)
(b) A negatively charged sphere is connected by a copper wire to a positively charged sphere, causing a current to flow, as shown in Figure 3 below.

![Diagram of charged spheres connected by a wire]

Figure 3

(i) Mark, on Figure 3 above, the direction of conventional current flow.  

(1 mark)

(ii) What kind of charge actually moves in the wire?

(1 mark)

(iii) In which direction do the charges move?

From ................. to .................  

(1 mark)

(iv) Name the SI unit of electric charge and give its definition.

(2 marks)

(v) If the current in the wire is 3 μA and it flows for 2 ms, how much charge is transferred through the wire?

(4 marks)
(c) The charge stored in a car battery is usually stated using the non-SI unit amp-hours. One amp-hour is defined as the charge stored in a battery when a current of one ampere is used to charge it for a period of one hour.

Calculate the charge stored in a 40 amp-hour battery using the SI unit for charge.

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( 3 marks)

Total 15 marks

3. (a) Table 2 below lists types of waves and their sources. Complete the table by filling in the blank spaces. In the third column, state whether the waves are transverse or longitudinal.

<table>
<thead>
<tr>
<th>Type of Wave</th>
<th>Source</th>
<th>Transverse or longitudinal?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infra-red radiation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sound waves</td>
<td>Loud-speaker</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TV transmitter</td>
<td></td>
</tr>
</tbody>
</table>

Table 2

( 5 marks)

(b) Figure 4 below shows a wave spreading out from the point S. The wave hits the barrier and is reflected. On the diagram, draw TWO reflected wavefronts and mark, with an X, the point from which they appear to come.

( 3 marks)

Figure 4

GO ON TO THE NEXT PAGE
(c) Figure 5 below is a graph which represents the variation of the displacement, \( y \), with time, \( t \), as a wave passes a certain point.

![Graph showing displacement over time]

**Figure 5**

(i) Use the graph to find the amplitude of the wave.

.................................................................................................................. (1 mark)

(ii) How long does one complete cycle of the wave take?

.................................................................................................................. (1 mark)

(iii) Calculate the frequency of the wave.

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.................................................................................................................. (2 marks)

(iv) What other information would be needed to calculate the wavelength of the wave?

.................................................................................................................. (1 mark)

(v) On Figure 5 above, draw another wave which has the SAME amplitude but HALF the frequency.

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Total 15 marks
4. (a) Radioactive tracers are sometimes used in medicine. Describe how a radioactive isotope is used as a tracer in the human body.

   (2 marks)

(b) Nuclei which emit only $\alpha$-particles are NOT normally used as radioactive tracers in the human body. Give TWO reasons why this is so.

   (2 marks)

(c) The radioactive isotope of iodine, $^{131}_{53}$I, is used to study blood circulation. This isotope has a half-life of 8 days.

   (i) Explain what is meant by the HALF-LIFE of the isotope.

   (1 mark)

   (ii) Give the symbol for another possible isotope of iodine.

   (2 marks)

   (iii) Other isotopes are available with half-lives of 20 seconds and 2 years. Explain why 8 days is a suitable half-life for medical uses.

   (2 marks)
(iv) A sample of $^{131}_{53}$I is introduced into a person's body. After how many days will $\frac{7}{8}$ of the sample have decayed?

(3 marks)

(d) When a nucleus of $^{131}_{53}$I decays, it emits a $\beta$ - particle and $\gamma$ - radiation and becomes xenon, for which the symbol is Xe. Write an equation for a nuclear reaction to represent this decay.

(2 marks)

Total 14 marks
5. (a) State Archimedes' principle.

(b) A tree is many times heavier than a nail. In terms of the forces acting on the two objects, explain why a tree floats in water but a nail sinks.

(c) The apparatus shown in Figure 6 below is used in the determination of the density of a rock.
(i) Use the information given in Figure 6 to find the volume of the rock in cm³.

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(3 marks)

(ii) State the volume of the rock in m³. ................................................................. (1 mark)

(1 m³ = 1 x 10⁶ cm³)

(iii) If the rock has a mass of 0.12 kg, find its density in kg m⁻³.

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(3 marks)

(iv) Would the rock float or sink in the liquid bromoform which has a density of 4000 kg m⁻³? Explain your answer.

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(2 marks)

(d) On Earth, the gravitational field strength is much larger than that on the Moon. If a piece of rock were taken from the Moon to the Earth, state what change, if any, there would be in the mass, weight and density of the rock.

Mass ..........................................................................................................................................

Weight ..........................................................................................................................................

Density .........................................................................................................................................

(3 marks)

Total 16 marks

END OF TEST