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

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.
1. You are to spend no more than $\frac{1}{2}$ hour on this question.

(a) (i) A small block of wood (mass 0.50 kg) slides from rest down an inclined track with negligible friction. The distance, $x$, travelled after certain times, $t$, was measured and the graph of $x$ against $t$ plotted, page 2. Use the graph to complete Table 1 below.

<table>
<thead>
<tr>
<th>$x/m$</th>
<th>0</th>
<th>0.50</th>
<th>0.80</th>
<th>1.00</th>
<th>1.20</th>
<th>1.40</th>
<th>1.50</th>
</tr>
</thead>
<tbody>
<tr>
<td>$t/s$</td>
<td>0</td>
<td>0.50</td>
<td>0.80</td>
<td>1.00</td>
<td>1.20</td>
<td>1.40</td>
<td>1.50</td>
</tr>
<tr>
<td>$t^2/s^2$</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 1**

(ii) State which of the timings is the least accurate and explain why.

(iii) Use data in your Table 1 to plot a graph of $t^2$ against $x$ on the graph paper on page 4.

(iv) Find the slope, $S$, of your graph.

(v) Given that $\frac{2}{a} = S$, where $a$ is the acceleration of the block down the slope, find $a$.

(vi) Calculate the force which must be acting on the block to cause the acceleration.

(vii) If the block reaches the end of the track after 1.6 s, calculate its final speed.

Total 29 marks

GO ON TO THE NEXT PAGE
2. (a) A beam of $\beta$-particles enters an area with a magnetic field at right angles to its path as shown in Figure 1. Draw on Figure 1 the path of the $\beta$-particles. (2 marks)

\[ \begin{array}{cccccc}
  & X & X & X & X & X \\
  & X & X & X & X & X \\
  & X & X & X & X & X \\
  & X & X & X & X & X \\
  & X & X & X & X & X \\
  & X & X & X & X & X \\
  & X & X & X & X & X \\
  & X & X & X & X & X \\
 \end{array} \]

**Figure 1**

(b) Another beam of $\beta$-particles enters the electric field between two charged metal plates as shown in Figure 2. Draw on Figure 2 the path of the $\beta$-particles between the plates. (1 mark)

\[ \begin{array}{ccccccc}
  + & + & + & + & + & + \\
  \end{array} \]

**Figure 2**

(c) Nitrogen (N-17) is a rare, radioactive isotope of nitrogen with atomic number 7. N-17 emits a beta ($\beta$)-particle to form an isotope of oxygen (O).

(i) Write down the number of protons, neutrons and electrons in a neutral atom of N-17.

Protons

Neutrons

Electrons (3 marks)

(ii) Write the nuclear reaction for the emission of the $\beta$-particle.

(3 marks)

(iii) The $\beta$-particle is emitted at high speed. Explain the source of the energy of the $\beta$-particle.

(1 mark)

GO ON TO THE NEXT PAGE
(iv) Use the information provided below to find the expected energy of the $\beta$-particle.

Mass of N-17 = 17.00845 u
Mass of O-17 = 16.99913 u
Mass of $\beta$-particle = 0.00055 u
Unified mass unit (u) = $1.66 \times 10^{-27}$ kg
Speed of light = $3.00 \times 10^8$ m s$^{-1}$

(5 marks)

Total 15 marks
3. (a) Draw clear and identifiable circuit symbols for the logic gates in Table 2 below.

<table>
<thead>
<tr>
<th>LOGIC GATE</th>
<th>SYMBOL</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOR</td>
<td></td>
</tr>
<tr>
<td>NOT</td>
<td></td>
</tr>
<tr>
<td>NAND</td>
<td></td>
</tr>
<tr>
<td>OR</td>
<td></td>
</tr>
</tbody>
</table>

Table 2

(4 marks)

(b) Complete the truth tables (Table 3 and Table 4) for the two-input logic gates below.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

NOR
Table 3

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

AND
Table 4

(4 marks)
(c)

Headlamp Switch (HS)  
5V ON = 1  
 OFF = 0  

Ignition Switch (IS)  
5V ON = 1  
 OFF = 0  

Door Switch (DS)  
5V ON = 1  
 OFF = 0  

AND  
Y  
X  
AND  
Z  
Alarm Circuit

Figure 3

(i) The logic circuit shown in Figure 3 can be used to warn a driver that he is about to leave his car with the headlights switched ON. Table 5 represents the truth table for the logic of the circuit. Complete Table 5.

<table>
<thead>
<tr>
<th>INPUT</th>
<th>OUTPUT</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HS</td>
<td>IS</td>
<td>DS</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
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<td>1</td>
<td>0</td>
<td>1</td>
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<tr>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

(6 marks)

(ii) Examine the result in the Z column and write out in words the conditions under which the alarm will sound.

(2 marks)

Total 16 marks
4. (a) (i) State the laws of reflection.

(ii) An object is placed in front of a plane mirror as in Figure 4.

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Figure 4

On Figure 4 draw the image of this object.

(iii) Draw two rays of light leaving point A on the object and received by an observer at points between P and P'. Show how these rays appear to come from the image.
(iv) Explain how real and virtual images are formed. State whether the image of the object in Figure 4 is real or virtual.

(3 marks)

(b) (i) The beam from a laser in Kingston, Jamaica is reflected from a plane mirror on a satellite. The reflected beam is received in Port of Spain, Trinidad. Figure 5 illustrates this situation diagrammatically. On the diagram draw the normal from the mirror to the earth's surface. (1 mark)

![Diagram of Kingston, Jamaica and Port of Spain, Trinidad with a mirror and 3600 km and 2100 km distances indicated.]

Figure 5

(ii) Use the information given on the diagram to determine the angle of incidence of the laser light on the mirror.

(3 marks)

Total 14 marks
5. (a) Explain the meaning of the following terms and state the SI unit in which EACH is measured.

(i) Constant speed

(ii) Acceleration

(b) The graph represents the motion of a cruise ship after its engines have been turned off.

Graph of Speed vs Time for Cruise Ship

(i) Calculate the deceleration of the ship.
(ii) Calculate the distance the ship travels while decelerating to rest.


(3 marks)

(iii) If the ship has a mass of $2.5 \times 10^7$ kg, calculate the magnitude of the force acting on the ship during deceleration.


(3 marks)

(iv) What is the nature of the force acting on the ship which leads to the deceleration and how does it cause the ship to slow down?


(2 marks)

(v) What is the MAIN energy change as the ship slows down?


(1 mark)

Total 16 marks

END OF TEST