1. Answer **ALL** questions in Section A and any **FOUR** questions in Section B.

2. Write your answers in the answer book provided. For Section A, there is no need to start each question on a fresh page.

3. Some questions contain parts marked with an asterisk (*). In answering these parts, candidates are required to give paragraph-length answers. In each of these parts, one mark is allocated to assess candidates’ ability in effective communication.

4. Take \( g = 10 \text{ m s}^{-2} \).

5. Unless otherwise specified, all the cells are assumed to have negligible internal resistance.

6. The last page of this question paper contains a list of physics formulae which you may find useful.
Section A (30 marks)
Answer ALL questions in this section.

1. An illuminated object is placed 30 cm in front of a convex lens and a sharp image is formed on a screen on the other side of the lens. The image is of the same size as the object.

(a) Is the image real or virtual? Explain your answer. (2 marks)

(b) In Figure 1, draw a ray diagram to show how the image of the illuminated object is formed.

Hence, or otherwise, determine the focal length of the lens. (4 marks)

2. A commercial building uses a mirror system as shown in Figure 2 to provide lighting for its hall. A concave mirror \( M_1 \) and a convex mirror \( M_2 \) are placed at the position shown to direct sunlight into the hall.

(a) Complete the ray diagram in Figure 2 to show how the two parallel rays are reflected by the mirrors. (2 marks)

(b) If \( M_2 \) is replaced by a plane mirror, how would the lighting of the hall be affected? Explain your answer. (2 marks)
Fill in the details in the first three boxes above and tie this sheet into your answer book.

1. (continued)

![Figure 1](image1)

2. (continued)

![Figure 2](image2)
This is a blank page.
3. Figure 3 shows a water chute in a swimming pool. A boy of mass 50 kg slides down from rest at point \( A \) and reaches point \( B \) with a speed 12 m s\(^{-1}\), where \( A \) is 10 m above \( B \).

(a) Find

(i) the potential energy of the boy at \( A \) (taking the potential energy at \( B \) as zero),

(ii) the kinetic energy of the boy at \( B \). 

(2 marks)

(b) Describe the energy change as the boy slides from \( A \) to \( B \).

(2 marks)

4. A car of mass 1000 kg moves along a straight road with a speed 10 m s\(^{-1}\). It collides with a lorry of mass 3000 kg, which is initially at rest. Immediately after the collision, the lorry moves forward with a speed 4.5 m s\(^{-1}\). The time of contact of the car and the lorry is 0.5 s. Find

(a) the speed of the car immediately after the collision,

(b) the average force acting on the lorry during the collision,

(c) the average force acting on the car during the collision.

(5 marks)
5. In the circuit shown in Figure 4, the light emitting diode will emit light only when the environment is dark or switch $S$ is closed.

(a) Write down

(i) the state of input $A$ (high or low) when the environment is dark,

(ii) the state of input $B$ when $S$ is closed.  

(2 marks)

(b) (i) Write down the state of the output of the logic gate $X$ in each of the following cases:

<table>
<thead>
<tr>
<th>Case</th>
<th>Input $A$</th>
<th>Input $B$</th>
<th>Output (high or low)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>high</td>
<td>high</td>
<td>?</td>
</tr>
<tr>
<td>2</td>
<td>high</td>
<td>low</td>
<td>?</td>
</tr>
<tr>
<td>3</td>
<td>low</td>
<td>high</td>
<td>?</td>
</tr>
<tr>
<td>4</td>
<td>low</td>
<td>low</td>
<td>?</td>
</tr>
</tbody>
</table>

Table 1

(2 marks)

(ii) What kind of logic gate is $X$? 

(1 mark)
6. A rectangular coil is free to rotate in a magnetic field as shown in Figure 5. Initially the coil lies horizontally. The switch is now closed.

(a) State the initial direction of rotation of the coil as seen by the observer.

(b) The coil turns, oscillates a few times about the vertical position and then comes to a rest. Explain the motion of the coil.

Figure 5
Section B (60 marks)
Answer any **FOUR** questions in this section. Each question carries 15 marks.

7. (a) Susan uses the following method to examine John’s reaction time:

She holds a graduated ruler upright with the zero mark starting at the bottom. John lines up his fingers near the bottom of the ruler. (See Figure 6.) Without any warning, Susan releases the ruler and John grips the ruler with his finger as fast as possible. It is found that John grips at the 20 cm mark of the ruler. (See Figure 7.)

(i) Show that John’s reaction time is 0.2 s. (2 marks)

(ii) If a heavier ruler is used, how would the result of the above test be affected? Explain your answer. (2 marks)

(iii) Susan marks the other side of the ruler as shown in Figure 8 so that the reaction time can be read directly.
7. (a) (iii) (continued)

Explain whether Susan’s scale for the reaction time is correct or not.

(3 marks)

(b) John is riding a bicycle along a straight road with uniform speed 10 m s$^{-1}$. At time $t = 0$, he sees a warning signal. John applies the brake for 2 s to bring the bicycle to rest with uniform deceleration. Assume John’s reaction time (i.e. the time lapse between seeing the signal and starting to apply the brake) is 0.2 s.

(i) Find the distance travelled by the bicycle from $t = 0$ to $t = 0.2$ s.

(2 marks)

(ii) Find the distance travelled by the bicycle when it is decelerating.

(2 marks)

*(iii) Using Newton’s laws of motion, explain why it is dangerous for John to carry an excessive amount of goods on the bicycle when he is riding in the street.

(4 marks)
An electric heater has two settings: ‘Low’ and ‘High’. The power output of the heater is 1400 W at the ‘Low’ setting and 2200 W at the ‘High’ setting. The heater is used to cook an egg. The egg is first put into a pot containing 1 kg of water and the heater is operated at the ‘High’ setting. (See Figure 9.) The temperature of the water is recorded every 30 s and the following results are obtained:

<table>
<thead>
<tr>
<th>Time (t/s)</th>
<th>0</th>
<th>30</th>
<th>60</th>
<th>90</th>
<th>120</th>
<th>150</th>
<th>180</th>
<th>210</th>
<th>240</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature (\theta/\degree C)</td>
<td>27</td>
<td>32</td>
<td>44</td>
<td>57</td>
<td>69</td>
<td>81</td>
<td>92</td>
<td>98</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2

(a) Using a scale of 1 cm to 5\(^\circ\)C and 1 cm to 15 s, plot a graph of \(\theta\) against \(t\) on graph paper.

(4 marks)

(b) (i) Find the energy supplied by the heater from \(t = 0\) to \(t = 240\) s.

(2 marks)

(ii) Find the energy absorbed by the water from \(t = 0\) to \(t = 240\) s.
(Note: Specific heat capacity of water = 4200 J kg\(^{-1}\) K\(^{-1}\).)

(2 marks)

(iii) State two reasons to account for the difference between your answers in (i) and (ii).

(2 marks)
(c) After the water boils, the heater is turned to the ‘Low’ setting and the water still boils afterwards. A student argues that this will lengthen the time required to cook the egg. Do you agree? Explain your answer.

(3 marks)

(d) If less water is used in the above cooking process, on the graph in (a), draw the graph of $\theta$ against $t$ you expect to obtain.

(2 marks)
9. Figure 10 shows a vibrator producing straight water waves in a ripple tank. Figure 11 shows a loudspeaker which is emitting low-frequency sounds.

(a) You are given the following equipment:

- a cork,
- a slinky spring,
- a candle and matches,
- a ruler.

Select suitable equipment and describe

(i) a method to demonstrate that the water waves in Figure 10 are transverse, and

(ii) a method to demonstrate that the sound waves in Figure 11 are longitudinal.

(4 marks)

(b) A barrier with an opening is placed in the ripple tank as shown in Figure 10.

(i) Copy Figure 10 into your answer book and draw the wave pattern formed on the other side of the barrier.

Name this wave phenomenon. (3 marks)

(ii) The wavelength of the water waves is increased as shown in Figure 12.

Figure 12
9. (b) (ii) (continued)

(1) Suggest two methods which can be used to increase the wavelength of the water waves.
   (2 marks)

(2) Copy Figure 12 into your answer book and draw the wave pattern formed on the other side of the barrier.
   (2 marks)

Figure 13 shows a loudspeaker unit with two speaker cones, a big one and a small one. One speaker cone emits low-frequency sounds and the other emits high-frequency sounds. The sound waves generated by the speaker cones will bend around the rim of the cones in a way similar to water waves bending around corners of obstacles.

Which cone is more suitable for emitting high-frequency sounds? Explain your answer.

(4 marks)
10. (a) A transformer is used to operate a ‘110 V, 1000 W’ electric cooker at its rated value from the 220 V a.c. mains supply in Hong Kong. The primary coil of the transformer has 5000 turns and the efficiency of the transformer is 80%. Find

(i) the number of turns in the secondary coil of the transformer,

(ii) the operating resistance of the cooker,

(iii) the power input of the transformer,

(iv) the current flowing in the primary coil of the transformer.

(8 marks)

(b) Figure 14 shows a travel cooker and the label attached on it. The cooker has a voltage selector switch as shown in Figure 15.
10. (b) (continued)

(i) A fuse is installed in the cooker. Explain the function of the fuse.  

(2 marks)

*(ii) Two students make the following remarks about using the cooker in Hong Kong:

John: The voltage selector switch should be set to 120 V and the output of the cooker would be 360 W.

Peter: The voltage selector switch should be set to 240 V and the output of the cooker would be less than 360 W.

Explain whether each of the above remarks is correct.  

(5 marks)
11. (a) \( X \) and \( Y \) are two radioactive nuclides with half lives of 12 hours and 2.6 years respectively. Both nuclides decay by emitting a \( \beta \) particle to form stable product nuclides.

(i) After emitting a \( \beta \) particle, how would the atomic number and mass number of nuclide \( X \) be changed?

(2 marks)

(ii) Describe the changes in activity (in disintegrations per second) of a specimen of nuclide \( X \) and a specimen of \( Y \) after one day.

(2 marks)

(iii) Comment on the following statement:

The mass of a specimen containing nuclide \( X \) will be reduced by approximately half in 12 hours.

(2 marks)

(b) A factory produces aluminium sheets 1 mm in thickness. The thickness of the sheets is monitored by a gauge. (See Figure 16.) A \( \beta \) source is used in the gauge.

(i) Explain why \( \alpha \) and \( \gamma \) sources are not used in the gauge.

(2 marks)

(ii) Which of the nuclides \( (X \text{ or } Y) \) is more suitable to use as the radioactive source? Explain your answer.

(2 marks)
11. (b) (continued)

*(iii) The count rate recorded should be around 90 counts per second when the thickness of the aluminium sheet is 1 mm. On a certain day when the gauge is operating properly, the following data is recorded:

<table>
<thead>
<tr>
<th>Time/s</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
<th>50</th>
<th>60</th>
<th>70</th>
<th>80</th>
<th>90</th>
<th>100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recorded count rate/counts per s</td>
<td>90</td>
<td>89</td>
<td>91</td>
<td>90</td>
<td>90</td>
<td>88</td>
<td>66</td>
<td>64</td>
<td>90</td>
<td>89</td>
<td>89</td>
</tr>
</tbody>
</table>

Table 3

Describe and explain the variation in the readings in Table 3.

(5 marks)

END OF PAPER
Useful Formulae in Physics

(a) Relationships between initial velocity \( u \), uniform acceleration \( a \), final velocity \( v \) and displacement travelled \( s \) after time \( t \):

\[
v = u + at
\]

\[
s = ut + \frac{1}{2}at^2
\]

\[
v^2 = u^2 + 2as
\]

(b) Potential energy gained by a body of mass \( m \) when raised through a height \( h \) is \( mgh \).

(c) Kinetic energy of a body of mass \( m \) moving with speed \( v \) is \( \frac{1}{2}mv^2 \).

(d) \( \text{Power} = \text{force} \times \text{velocity} \)

(e) Equivalent resistance of two resistors \( R_1 \) and \( R_2 \):

(i) \( \text{in series} = R_1 + R_2 \)

(ii) \( \text{in parallel} = \frac{R_1 R_2}{R_1 + R_2} \)

(f) \( \text{Power} = \text{potential difference} \times \text{current} \)
Physics I

1. (b) 15 cm

3. (a) (i) 5000 J
   (ii) 3600 J

4. (a) 3.5 m s\(^{-1}\)
   (b) 27000 N
   (c) 27000 N

7. (b) (i) 2 m
   (ii) 10 m

8. (b) (i) 528 kJ
   (ii) 306.6 kJ

10. (a) (i) 2500
    (ii) 12.1 \(\Omega\)
    (iii) 1250 W
    (iv) 5.7 A