This paper must be answered in English

1. Write your Name, Class and Class Number in the spaces provided on this page.

2. This paper consists of TWO sections, Section A and Section B. Section A carries 54 marks and Section B carries 36 marks.

3. Answer ALL questions in each section. Write your answers in the spaces provided in this Question-Answer Book. Do not write in the margins. Answers written in the margins will not be marked. Supplementary answer sheets and graph papers will be supplied on request. Write your Name, Class and Class Number on each sheet, and fasten them with a string INSIDE this book.

4. 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.

5. Unless otherwise specified, numerical answers should be either exact or correct to 3 significant figures.

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

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

8. The last page of this question paper contains a list of physics formulae which you may find useful.
Two workers are taking a builder's lift in a construction site. The lift is suspended by a cable in vertical direction. The mass of each worker is 80 kg and the mass of the lift is 500 kg.

(a) The lift is stationary. Find the tension in the cable. (2 marks)

(b) Then, the lift moves upwards with a constant acceleration of 0.1 m s$^{-2}$ for 5 s.

(i) Find the tension in the cable when the lift is accelerating. (2 marks)

(ii) Find the distance travelled by the lift. (2 marks)

(iii) Find the average power of the cable in pulling up the lift. (2 marks)
A roller-coaster cart is designed to move to and fro in a track as shown below.

Initially, the cart is at rest at position \( A \). When all the passengers are aboard, the cart accelerates uniformly by the system from position \( A \) to \( B \) in 8 s. Then the driving force stops. The cart continues to move to a maximum height at position \( C \), which is 80 m above the level of \( B \). The total mass of the cart and the passengers is 2500 kg. Positions \( A \) and \( B \) are at the same level. The air resistance, and the friction between the cart and the railway are negligible.

(a) Find the total potential energy gained by the cart and the passengers from \( B \) to \( C \). (2 marks)

(b) Find the speed of the cart at position \( B \). (2 marks)

(c) Find the acceleration of the cart from \( A \) to \( B \). (2 marks)
A water heater with a rated value of ‘220 V, 900 W’ is filled with 2.5 kg of water. When the water heater is turned on, the heating element at the lowest position of the water tank heats up the water. The initial temperature of the water is 20 °C. Take the specific heat capacity of water to be 4200 J kg$^{-1}$ °C$^{-1}$ and the specific latent heat of vaporization of water to be 2.26 × 10$^6$ J kg$^{-1}$.

(a) What is the resistance of the heating element when the heater works at its rated value? (2 marks)

(b) Suggest a reason for the position of the heating element. (1 mark)

(c) After 20 minutes, the heater is turned off. The temperature of the water inside the tank is 100 °C and some steam comes out from the water tank.

(i) Find the total energy supplied by the water heater. (2 marks)

(ii) Estimate the amount of steam that has come out from the tank. (2 marks)
The set-up below is used to determine the specific latent of heat of vaporization of water. The graph shows the variation of the reading of the electronic balance with time (the total mass of the empty beaker and the heater has already been eliminated). The initial temperature of the beaker of water is 25°C.

(a) How can you estimate the specific heat capacity of water from the graph? Briefly explain. (3 marks)

(b) Find the specific latent heat of vaporization of water from the graph. (3 marks)

(c) Suggest an improvement in the set-up to increase the accuracy of the experiment. (1 mark)
The following figure shows a steam iron in a home with a rated power of 1000W. Inside the steam iron, there is an electric hot plate and a filled water tank. Water drips from the water tank to the hot plate continuously. The water is heated and changes to steam. Given that the specific heat capacity and the specific latent heat of vaporization of water is 4200 J kg\(^{-1}\)°C\(^{-1}\) and 2.26 \times 10^6 J kg\(^{-1}\) respectively and the initial temperature of the water is 25°C.

(a) Assuming all the water dripped on the hot plate changes into steam, find the maximum mass of steam produced by the iron in a second. (3 marks)

(b) If too much water is dripped onto the hot plate, hot water will leak from the iron. Explain briefly. (1 mark)
Fishing in Alaska

Fish is the major food for the native people in Alaska. They go out in boats at night to spear whitefish. Sometimes the fish are too fast, but other times, it seems that the fishermen are being tricked, and they miss when they try to spear the fish. There is a scientific principle behind this.

When light passes through any two substances of different optical densities, the light changes speed and is bent. In the above case, light is bent when it passes from the water to the air. The fishermen’s eyes receive the light and form an image of the fish. They think they see exactly where the fish is. Actually, the fish is lower than they expect.

The technique of spearing fish is to know how far below the image to aim the spear. Another technique is to spear from directly above.

(a) Which phenomenon of light accounts for the bending of light? (1 mark)

(b) How would a fish look from air directly above? State your answer in terms of the size and position of the fish. (1 mark)

(c) What does an observer above the water surface see when he puts a spear into the water at an angle? Explain with a simple ray diagram. (3 marks)
The figure below shows a device used to detect the oil level in an oil tank. \( R \) is a variable resistor (0–100 \( \Omega \)) and \( r \) is a fixed resistor. An ammeter with reading ranging from 0 to 0.6 A is used to measure the current in the circuit. The reading of the ammeter represents different oil levels in the tank.

When the tank is full, the contact is at \( Q \) and the reading of the ammeter is 0.6 A. The voltage of the battery is 12 V. Neglect the resistance of the ammeter.

(a) Find the resistance of \( r \). (2 marks)

(b) When the tank is empty, the contact is at \( P \). Find the reading of the ammeter when the tank is empty. (2 marks)
(c) A voltmeter is used instead of an ammeter, such that the reading of the voltmeter increases when the oil level increases.

(i) Complete the circuit in the figure below by adding the voltmeter at the correct position. (1 mark)

(ii) Find the reading of the voltmeter when the tank is empty. (2 marks)

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Answers written in the margins will not be marked.
The figure below shows a d.c. motor.

(a) What are the directions of movement of sides $AB$ and $CD$ of the coil at the moment shown in the figure? (2 marks)

(b) Suggest two ways to reverse the direction of the movement of the coil. (2 marks)

(c) By increasing the resistance in the circuit, will the turning speed on the coil be increased? Explain briefly. (2 marks)
(a) It is found that passengers taking New York–Hong Kong flight would receive radiation equivalent to that of three X-ray scans (about 20 μSv for each X-ray scan). The high radiation of New York–Hong Kong flight is due to the long flight time and also the high flight altitude.

(i) What kind of radiation may the passengers receive inside the plane? (1 mark)

(ii) State a main source of this background radiation. (1 mark)

(b) John places a radioactive source 20 cm in front of a GM tube and measures the count rate as the figure belows. A region of magnetic field pointing into the paper is formed between the radioactive source and the GM tube. As a result, the count rate recorded at position $P$ decreases while the count rate at position $Q$ increases.

What kind of radiation is recorded when the GM tube is held at position $Q$? Explain your answer. (2 marks)
Section B (36 marks)

Answer ALL questions in this section and write your answers in the spaces provided in this Question-Answer Book.

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10 A car of mass 1100 kg is initially at rest at point $P$. At $t = 0$, the brake is released and the car accelerates downwards on a rough road which is $20^\circ$ to the horizontal as shown below.

(a) Complete the free body diagram of the car in the box below. Label all the forces. (2 marks)

(b) (i) If the friction between the car and the road $PQ$ is 1000 N, find the acceleration of the car along $PQ$. (2 marks)

Answers written in the margins will not be marked.
(ii) The distance between $P$ and $Q$ is 80 m. Find the speed of the car at position $Q$. (2 marks)

(c) The car then moves a further 20 m from $Q$ to $R$ and collides with a stationary lorry of mass 4000 kg. Assume that the road $QR$ is smooth. The car and the lorry move together after the collision.

(i) Find the speed of the car and the lorry after the collision. (2 marks)

(ii) Find the total loss in kinetic energy of the car and the lorry during the collision. (2 marks)

(iii) State the energy conversion during the collision. (1 mark)
11 The following figure shows two loudspeakers, \( A \) and \( B \), connected to the same signal generator. The generator produces sound waves at 500 Hz. Initially, only \( A \) is switched on. The speed of sound is \( 340 \text{ m s}^{-1} \).

(a) The following figure shows the displacement-time graph of an air molecule at \( P \).

(i) Indicate the values for \( t_1 \) and \( t_2 \).

(ii) In the following figure, draw the displacement-distance graph of the sound wave along \( AP \) at \( t = 0.002 \text{ s} \). (5 marks)
(b) Then $B$ is also switched on. One can hear a series of loud and faint sounds when walking across in front of the loudspeakers. What happens to the loudness of sound heard at $P$? Explain briefly. (3 marks)

(c) In daily life, one cannot hear similar changes in loudness when walking across in front of the loudspeakers of a hi-fi system playing a song. Explain why. (1 mark)
In the following figure, a $\beta$ source is used in a detergent factory to monitor the amount of detergent filled in plastic bottles. A detector is placed at a level to which detergent is expected to fill up and it faces the source.

(a) Explain why an $\alpha$ source and a $\gamma$ source are not suitable for the system. (2 marks)

(b) Explain how the monitoring system can detect bottles of detergent that have not been filled up to the required level. (4 marks)
A student uses a step-down transformer to connect a '110 V, 1500 W' oven to the 220 V mains supply as shown.

(i) What is the current passing through the oven when the oven is operating at its rated value? (2 marks)

(ii) It is known that the current in the coil $A$ is 7 A. What is the efficiency of the transformer? (3 marks)

(iii) It is known that the number of turns in coil $B$ is 150 turns. Find the number of turns in coil $A$. (2 marks)
(b) The figure below shows how electrical power from a power station is transmitted over long distance to residential areas. Transformers are also used in this case.

(i) What is the main difference in structure between transformers \( T_1 \) and \( T_2 \)?

(ii) Hence, explain briefly how this arrangement of transformers can reduce the power loss in transmission.
Useful Formulae in Physics

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

\[
\begin{align*}
\quad v &= u + at \\
\quad s &= ut + \frac{1}{2}at^2 \\
\quad v^2 &= u^2 + 2as 
\end{align*}
\]

(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) Power = force \( \times \) velocity

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

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

(ii) \( \text{in parallel} = \frac{R_1R_2}{R_1 + R_2} \)

(f) Power = voltage \( \times \) current