Answer ALL questions in the spaces provided on the Exam Paper. 
All working must be shown. The use of a calculator is allowed. 
Where necessary take the acceleration due to gravity, \( g = 10 \text{ m/s}^2 \).

### Equations for Annual Exam Physics

**Density**
\[ m = \rho V \]

**Pressure**
\[ P = h \rho g \quad P = \frac{F}{A} \]

**Energy and Work**
\[ PE = m g h \quad KE = \frac{1}{2} m v^2 \]
\[ E \text{ (or W)} = P \cdot t \quad W \text{ (or WD)} = F \cdot s \]

**Force**
\[ F = m \cdot a \quad W = m \cdot g \]

**Motion**
\[ \text{average speed} = \frac{\text{total distance}}{\text{total time}} \]
\[ v = u + a \cdot t \]
\[ s = \frac{(u + v) \cdot t}{2} \]
\[ \text{momentum} = m \cdot v \]
\[ s = \frac{1}{2} a \cdot t^2 \]
\[ h = \frac{1}{2} g \cdot t^2 \]

**Electricity**
\[ Q = I \cdot t \quad W = Q \cdot V \]
\[ V = I \cdot R \quad R = R_1 + R_2 + R_3 \]
\[ P = I \cdot V = I^2 \cdot R = \frac{V^2}{R} \]

**Electromagnetism**
\[ \frac{N_1}{N_2} = \frac{V_1}{V_2} \]

**Heat**
\[ H = m \cdot c \cdot \Delta \theta \]

**Waves and Optics**
\[ c = f \cdot \lambda \]
\[ m = \frac{h_i}{h_o} = \frac{\text{image distance}}{\text{object distance}} \]
Section A.                                                                                     This Section carries 40 marks

1. Maria drives her car at 4 m/s in a straight line and increases the speed with a
   constant acceleration of 2 m/s² for 5 s. She then applies the brakes and the car comes steadily to rest in a further 10 s.

a. It can be concluded that the:
   i. initial velocity of the car = _____ m/s 1
   ii. acceleration of the car = _____ m/s² 1
   iii. final velocity of the car 10 s after Maria applies the brakes = _____ m/s 1

b. Calculate the:
   i. velocity of the car after accelerating for 5 s. __________________________________________
                                                                                             2
   ii. deceleration of the car during the final 10 s of its journey. __________________________________________ 3

2. During a football game, Nigel is chosen to kick in a penalty for his team. He kicks the ball weighing 4N so that it moves off with a velocity of 2 m/s at the end of the impact, which lasts for 0.05 s.

a. Calculate the:
   i. mass of the football in kg. __________________________________________ 1
   ii. momentum of the ball in kgm/s just after Nigel kicks it in. __________________________________________ 1
   iii. acceleration in m/s² of the ball during impact. __________________________________________ 2
   iv. force in N acting on the ball during impact. __________________________________________ 2

b. State what happens to the size of the force during impact with Nigel’s shoes if Nigel’s kick on the ball lasts longer than 0.05 s. __________________________________________ 1
c. Alex, the goalkeeper of Nigel’s opposing team catches the ball with his hands. The total resistance acting against the motion of the ball as it travels towards the goalkeeper is 5 N. Calculate the impact force in N acting on the goaler’s hands.

3. a. Underline the correct bold word in each of the following statements:
   i. A charged polythene strip has more / less electrons than protons. 1
   ii. When rubbed with a duster, a cellulose acetate strip becomes positively / negatively charged. 1
   iii. Neutral [or uncharged] objects are repelled / attracted by both positively and negatively charged objects. 1
   iv. Charge is measured in coulombs / amperes. 1

b. Complete the following:
The size of the force of attraction or repulsion between two charged objects depends on:
   • their total amount of charge
   •

1
c. Two metal spheres X and Y on insulating stands are equally and oppositely charged as shown.

State what happens in terms of electron flow when:

i. sphere X is connected to earth?

1

ii. sphere Y is connected to earth?

1

iii. sphere X is connected to sphere Y?

1
4. The figure represents a number of electrical components set up in a circuit.

![Circuit Diagram]

**a.**

i. Meter $M_1$ is the _______________ measuring total current flowing through the circuit.  

ii. Meter $M_2$ is the _______________ measuring the potential difference across resistor $R_1$.  

iii. Electrical components $R_1$ and $R_2$ are connected in _______________.

**b.** The electric current flowing through the circuit is 0.75 A. Calculate the:

i. **potential difference** across resistor $R_1$ in volts,

ii. **potential difference** across the electrical component $R_2$ in volts,

iii. **resistance** of electrical component $R_2$ in $\Omega$,

iv. **power** generated by the battery **through the circuit** in Watts.
5. a. Complete:

_____________ is the flow of heat energy through a material from places of higher temperature to places of lower temperature without any movement [or flow] of the material itself.

b. The diagram below shows the experimental set up to compare the conductivity of different metals. As the wax melts, the plastic ring slides down the metal rod.

![Diagram showing water at 100°C with metal rods and a plastic ring sliding on wax]

Complete the table below by placing the five conductors in the above diagram in order of conductivity putting the best conductor first.

<table>
<thead>
<tr>
<th>Order of conductivity</th>
<th>Conductor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>iron</td>
</tr>
<tr>
<td>2</td>
<td>copper</td>
</tr>
<tr>
<td>3</td>
<td>aluminium</td>
</tr>
<tr>
<td>4</td>
<td>lead</td>
</tr>
<tr>
<td>5</td>
<td>brass</td>
</tr>
</tbody>
</table>

c. i. Your neighbour wants to order a barbeque metal fork. He has a choice of three metals, copper, brass or iron. Which metal would you advice him to choose for the fork?

____________________________________________________________________________________

ii. Give a reason for your answer.

____________________________________________________________________________________
6. This question is about motion under the influence of the pull of gravity

a. When required, helicopters are used to drop medicines, food, and equipment in areas hit by earthquakes, floods and landslides. Gregg, a helicopter pilot and his crew drop a heavy strong specially packed crate containing tinned food and bottled water from a height of 45 m. Calculate the:

i. time taken in seconds for the crate to reach the ground.

ii. final velocity of the crate in m/s,

b. The table below shows how Gregg’s velocity changes during the first 16 s after dropping from his helicopter as part of an exercise.

<table>
<thead>
<tr>
<th>velocity v / m/s</th>
<th>0</th>
<th>20</th>
<th>40</th>
<th>50</th>
<th>55</th>
<th>57</th>
<th>58</th>
<th>58</th>
</tr>
</thead>
<tbody>
<tr>
<td>time t / s</td>
<td>0</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
<td>12</td>
<td>14</td>
</tr>
</tbody>
</table>

i. Plot a graph of velocity v (y-axis) against the time t (x-axis).

ii. From the graph or otherwise calculate Gregg’s acceleration during the first 4 s of his fall.

iii. From your graph, determine the time taken for Gregg’s parachute to open up.

iv. Calculate the height in m fallen by Gregg before the parachute opens up.

v. Gregg’s acceleration between the 12th and the 16th second of his fall is _____ m/s².

vi. Gregg’s constant velocity between the 12th and the 16th second of his fall is referred to as _____________ velocity during which the resultant force acting on Gregg is _______ N.
GRAPH PAPER
7. **This question is about specific heat capacity and heat energy transfer.**

The diagram below shows a large water heater (geyser) providing a large amount of hot water.

![Diagram of water heater](image_url)

**a.** The geyser contains 250 kg of water at 20°C. Calculate:

1. the change in temperature if this mass of water is heated from 20°C to 45°C,

   

2. the heat energy in J required to heat this mass of water from 20°C to 45 °C given that the specific heat capacity of water is 4200 J/kg °C (4200 J/kg K),

   

3. the time taken in seconds for the 250 kg of water to heat up from 20°C to 45°C given that the power of the heating element is 3000 W.

   

**b.** In practice the time taken for 250 kg of water in the water heater shown above to heat up from 20°C to 45°C is actually around 5 minutes (300 s) more than that calculated in question a. iii. Give a reason for this.

**c.** i. Would you use the above geyser to provide hot water only to wash a few dishes in the kitchen? 

   

ii. Give a reason for your answer.
d. i. Name the process through which heat energy is transferred from the heating element to the water.
__________________________________________________ _________________________

ii. Name the process through which heat energy from the heating element is transferred so that all the water throughout the geyser becomes heated.
__________________________________________________ _________________________

iii. What is the purpose of the lagging material around the heating tank?
__________________________________________________ _________________________

iv. Should the lagging material be made up of: a conductor or insulator?
__________________________________________________ _________________________

v. Give a reason for your choice.
__________________________________________________ _________________________

e. i. What colour would you expect the inside of the water tank to be?
__________________________________________________ _________________________

ii. Give a reason for your answer.
__________________________________________________ _________________________

8. This question is about the design of an experiment on Ohm’s Law.

Georg Simon Ohm (1789 – 1854) was a German Physicist and a high school teacher. Using equipment of his own creation, Ohm discovered the direct proportionality between the potential difference applied across a conductor and the resulting electric current flow. This is now referred to as Ohm's law.

a. Complete: Ohm’s law states that an electric ____________ flowing through a metallic conductor maintained at constant ____________ is directly proportional to the potential difference across its ends.

b. You are required to investigate whether a filament lamp obeys Ohm’s Law. You are provided with the following apparatus: battery, switch, variable resistor, ammeter, voltmeter, a filament lamp and connecting wire. Describe how you would carry out the investigation.

Your answer should include:
i. a circuit diagram of the experimental set-up,
ii. a brief account of how you would carry out the experiment,
iii. a table of results to record the list of observations made,
iv. the result you expect from your investigation,
vi. a sketch of an appropriate graph showing the expected results,
vi. one precaution in order to obtain a reliable conclusion.
i. Circuit diagram

ii. Method

iii. Table of results

iv. Result expected

v. Expected graph

vi. One precaution