

## Unit 2

### Electricity & thermal physics

#### Electric current and potential difference

Unit	Topic	Content
2.1	Charge and current. Drift velocity.	Electric current as rate of flow of charge. $I = \Delta Q/\Delta t$ Law of conservation of charge applied to currents at a junction. Use of ammeters. An understanding of the equation $I = nAQ u$ . The distinction between metals, semiconductors and insulators in terms of this equation. Typical carrier drift speeds in metals should be known.
2.2	<ul style="list-style-type: none"> <li>• Electrical potential difference.</li> <li>• E.m.f. of a cell.</li> <li>• Energy transferred electrically.</li> </ul>	P.d. as Work done/charge ie $V$ or $\mathcal{E} = W/Q$ or as power/current ie $V$ or $\mathcal{E} = P/I$ Electrical working: $\Delta W = IV\Delta t$ Use of voltmeters in circuits.
2.3	Current – potential difference relationships.	Measurements and typical graphs for wire filament lamp, ohmic resistor, thermistor & and semiconductor diode. Ohm's law.
2.4	Resistance and resistivity. Power dissipation.	$R = V/I$ $R = \rho l/A$ Experimental measurement of resistivity.

#### Electrical circuits

Unit	Topic	Content
2.5	<ul style="list-style-type: none"> <li>• Conservation of energy in circuits.</li> <li>• Internal resistance.</li> </ul>	<ul style="list-style-type: none"> <li>• Circuit e.m.f. = <math>\Sigma IR</math>.</li> <li>• <math>V = \mathcal{E} - Ir</math></li> <li>• Measurement of internal resistance.</li> <li>• Practical significance (eg car battery and e.h.t. power supply).</li> </ul>
2.6	Series and parallel circuits.	Formulae for resistors in series and in parallel: $R = R_1 + R_2 + R_3$ and $1/R = 1/R_1 + 1/R_2 + 1/R_3$ Use of ohmmeters.
2.7	Change of resistance with temperature and illumination. The thermistor and light dependent resistor.	Qualitative effects and experimental treatment of the effect of temperature on the resistance of a metal and on a negative temperature coefficient (NTC) thermistor. Explanation of the change of resistance of metals with temperature. Understanding that LDR resistance decreases as illumination increases.
2.8	Potential divider.	Practical applications. Potential dividers that are controlled by temperature or by illumination. Investigate 'output' voltage of a potential divider circuit.

## Heating matter

Unit	Topic	Content
2.9	Definition and meaning of specific heat capacity.	<ul style="list-style-type: none"> <li>Measurement of specific heat capacities of solids and liquids: a direct method using an electric heater will be expected.</li> <li>Emphasis on calculation of energy transferred. Sources of serious experimental error should be identified and understood.</li> <li>Energy transfer = <math>mc\Delta T</math></li> </ul>
2.10	<ul style="list-style-type: none"> <li>Change of state.</li> <li>Specific latent heat.</li> </ul>	<ul style="list-style-type: none"> <li>Energy is needed to pull molecules apart.</li> <li>Energy transfer = <math>L\Delta m</math></li> <li>Direct experimental methods only. A method using an electric heater will be expected.</li> </ul>
2.11	<ul style="list-style-type: none"> <li>Pressure.</li> <li>The behaviour of gases</li> <li>The absolute scale of temperature.</li> </ul>	<ul style="list-style-type: none"> <li>Solids transmit force, fluids transmit pressure.</li> <li>Application of <math>p = F/A</math>.</li> <li>Experiment demonstrating that for a fixed mass of gas at constant V                             <math display="block">p/T = \text{constant}</math> </li> <li>Temperature and pressure sensors.</li> <li>Concept of absolute zero of temperature.                             <math display="block">T/K = \theta^{\circ}\text{C} + 273</math> </li> </ul>

## Kinetic model of matter

Unit	Topic	Content
2.12	Ideal gas equation.	Experiment demonstrating that for a fixed mass of gas at constant T $pV = \text{constant}$ For ideal gases: $pV = nRT$ In calculations the amount of gas will be given in moles.
2.13	<ul style="list-style-type: none"> <li>Kinetic model of an ideal gas.</li> <li>Brownian motion.</li> </ul>	<ul style="list-style-type: none"> <li>The assumptions on which the model is founded.                             <math display="block">p = \frac{1}{3} \rho [c^2]</math> </li> <li>Average kinetic energy of molecules proportional to kelvin temperature.</li> <li>Use of the model to explain the change of pressure with temperature.</li> </ul>

## Conservation of energy

Unit	Topic	Content
2.14	Internal energy.	For real gases the random distribution of potential and kinetic energy amongst molecules. Appreciation that hot and cold objects have different concentrations of internal energy.
2.15	Heating. Electrical and mechanical working. The first law of thermodynamics.	Random interchange of energy between bodies in thermal contact, resulting in energy flowing from hot to cold. Forces moving either charges or masses. Ordered processes, independent of temperature difference. The increase in internal energy equal to the sum of the energy given by heating and working.
2.16	The heat engine. Efficiency. The heat pump.	Work done by engine when energy flows from a hot source to a cold sink. Efficiency of energy transfer as useful output divided by input. Maximum thermal efficiency $= (T_1 - T_2)/T_1$ Work needed to pump energy from cold to hot.