# SOLUTIONS PHYSICS IGCSE P2 V4

## Objective Section

| Q no: | Correct Answer | Explanation (if any) |
|---|---|---|
| 1 | B. A measuring cylinder containing water only. | To measure the volume of an irregularly shaped stone, you can use the displacement method with a measuring cylinder containing water. |
| 2 | C. 40 m | The area under the speed-time graph represents the distance traveled. For a constant speed of 4 m/s over 10 seconds, the distance is speed X time = 4 X 10 = 40 |
| 3 | C. Weight | Weight is the force due to a gravitational field acting on a mass. |
| 4 | C. There is no resultant force and no resultant turning effect. | For an object to be in equilibrium, both the resultant force and the resultant turning effect (torque) must be zero. |
| 5 | C. Thermal | When brakes are applied, most of the kinetic energy of the car is converted into thermal energy due to friction. |
| 6 | A. Emitting a sound wave | Emitting a sound wave does not transfer useful energy in most practical applications. |
| 7 | C. Force 60N, Area 15$m^2$ | Pressure is calculated as Pressure=Force/Area. The least pressure occurs at 4$N/m^2$ |
| 8 | A. P and Q | P (melting) and Q (evaporation) require an input of energy to change state from solid to liquid and liquid to gas, respectively. |
| 9 | A. White surfaces are good reflectors of radiant energy. | White surfaces reflect most of the radiant energy, keeping the house cooler. |
| 10 | B. The diagram showing waves spreading out after passing through a narrow gap. | Diffraction occurs when waves pass through a narrow gap and spread out. |
| 11 | C. Glass, greater than critical angle | Total internal reflection occurs when light travels from a denser medium to a less dense medium at an angle greater than the critical angle. |
| 12 | A. Another permanent magnet | Only another permanent magnet can repel a bar magnet. |
| 13 | C. It has lost electrons. | The rod becomes positively charged by losing electrons. |
| 14 | A. X → Y → Z | The arrangement with resistors in series has the largest resistance, followed by a combination of series and parallel, and then parallel. |
| 15 | B. The live wire only | A fuse must be connected in the live wire to protect the circuit. |
| 16 | B. | The magnetic field around a current-carrying wire forms concentric circles. |
| 17 | C. The student quickly removes the bar magnet from the coil of wire. | The induced voltage is greatest when the change in magnetic flux is fastest. |
| 18 | A. | A neutral atom has equal numbers of protons and electrons. |
| 19 | D. | The symbol representing 27 atomic number and (32+27) 59 mass number. |
| 20 | D. It becomes the nucleus of an element with a lower proton number. | Emission of an alpha particle decreases the proton number by 2. |
| 21 | A. Lead absorbs emissions from radioactive sources. | Lead is used to shield and absorb radiation. |
| 22 | B. rods attract, rods repel | Reversing the connections reverses the polarity of the magnetization. |
| 23 | D. 07:45 | The actual time is the mirror image of the clock time. |
| 24 | C. A heavier base | A heavier base lowers the center of mass, increasing stability. |
| 25 | B. 15 km | Distance = Speed × Time = 60 km/h × 0.25 h = 15 km |

**THEORETICAL PART:**

**Q. No. 1:**

**i)** Marie Curie and Ernest Rutherford were both pioneering scientists in the early 20th century, but they worked in different fields of science. Marie Curie was a physicist and chemist known for her research on radioactivity, while Ernest Rutherford was a physicist who made significant contributions to the understanding of the atomic structure, particularly through his work on the nuclear model of the atom.

**ii)** The term "half-life" refers to the time it takes for half of the atoms in a radioactive substance to undergo radioactive decay. Radioactive decay is a spontaneous process where unstable atomic nuclei lose energy by emitting radiation. Each radioactive isotope has a characteristic half-life, which is the average time it takes for half of the nuclei in a sample to decay.

**iii)** Pauli's exclusion principle: No two electrons in an atom can have the same set of quantum numbers, meaning they cannot occupy the same quantum state simultaneously.

**iv)** Faraday's law of electromagnetic induction states that a change in magnetic flux through a loop of wire induces an electromotive force (EMF) or voltage in the wire. This induced EMF is proportional to the rate of change of magnetic flux and is given by the equation:

$$\text{EMF} = -\frac{d\Phi}{dt}$$

where EMF is the electromotive force, $\Phi$ (phi) is the magnetic flux, and $\frac{d\Phi}{dt}$ (d phi by dt) is the rate of change of magnetic flux with time.

**v)** The electromagnetic field is important because it underlies all electromagnetic phenomena, including electricity, magnetism, light, and radiation. It is fundamental to the behaviour of matter and energy in our universe and is essential for modern technology and our understanding of the natural world.

**Q. No. 2:**

**i)**

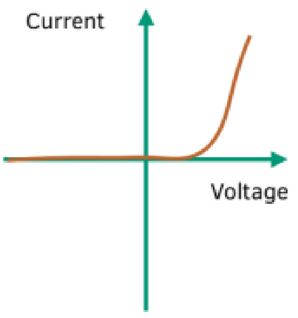



**Fig 3. Current-Voltage Graph For a Diode.** The graph shows that increasing the voltage one way will lead to a rise in current (after a certain voltage). However increasing the voltage the other way does not lead to a rise in current. The diode only works one way.

**ii)** Resistivity is a measure of a material's ability to resist the flow of electric current. It is denoted by the symbol ρ (rho) and is defined as the resistance R of a material of unit length and unit cross-sectional area. Mathematically, resistivity is given by the formula:

$$\rho = \frac{R \cdot A}{L}$$

where:

- $\rho$ (rho) is the resistivity of the material,
- $R$ is the resistance of the material,
- $A$ (capital A) is the cross-sectional area of the material, and
- $L$ (capital L) is the length of the material.

The unit of resistivity is ohm-meter ($\Omega \cdot \mathrm{m}$).

**iii)** Permanent magnets are materials that retain their magnetization even after being removed from an external magnetic field. They are commonly used in various applications, including electric motors, generators, and magnetic storage devices.

Several materials are used to make permanent magnets:

1. Alnico (Aluminum-Nickel-Cobalt): Alnico magnets are composed of aluminium, nickel, cobalt, and iron. They are known for their strong magnetic properties and high-temperature stability.

2. Ceramic (Ferrite): Ceramic magnets, or ferrite magnets, are made from iron oxide ($Fe_2O_3$) and other metallic elements. They are inexpensive and have good corrosion resistance, but they are relatively weak compared to other types of magnets.

3. Neodymium-Iron-Boron (NdFeB): NdFeB magnets are the strongest type of permanent magnets available commercially. They are made from an alloy of neodymium, iron, and boron and are used in a wide range of applications due to their high magnetic strength.

4. Samarium-Cobalt (SmCo): SmCo magnets are made from an alloy of samarium and cobalt. They are known for their high resistance to demagnetization and are used in applications where high temperatures are involved.

These materials have different magnetic properties and are chosen based on the specific requirements of the application.

**iv)** Heat can be transferred through three main mechanisms: conduction, convection, and radiation.

Conduction is the transfer of heat through a material without any movement of the material itself. It occurs due to the collisions between particles in the material. The rate of heat conduction (\(Q\)) through a material is given by the formula:

$$Q = -kA\frac{dT}{dx}$$

where:

- $Q$ is the rate of heat transfer,
- $k$ is the thermal conductivity of the material,
- $A$ is the cross-sectional area through which heat is transferred,
- $\frac{dT}{dx}$ is the temperature gradient along the direction of heat flow.

This equation shows that the rate of heat transfer is proportional to the temperature gradient and the thermal conductivity of the material, and inversely proportional to the thickness of the material.

**v)**

$$Q = 135 \text{ g} \times 0.43 \text{ J/g}^\circ\text{C} \times 250 \ ^\circ\text{C}$$

$$Q = 135 \times 0.43 \times 250$$

$$Q = 14512.5 \text{ J}$$

**Q. No.3:**

**i)** Solids have a definite shape and volume, high density, low compressibility, strong intermolecular forces, rigid structure, low diffusivity, distinct melting points, and can be crystalline or amorphous.

**ii)** In this scenario, no work is being done on the eraser in the context of physics.
Work is defined as the transfer of energy when a force is applied to an object causing it to move in the direction of the force. The formula for work is:

Work=Force×Distance×cos(θ)

Since the angle θ\theta between the force (towards the center) and the direction of motion (tangential) is 90 degrees, cos(90∘) = 0. Therefore, the work done by the tension force is:

Work=Force×Distance×0=0

**iii)** Radiant energy is a type of energy that is transmitted through electromagnetic waves. It includes visible light, infrared radiation, ultraviolet light, radio waves, microwaves, and X-rays. Radiant energy is produced by the vibrations of electrically charged particles and does not require a medium to travel through, unlike mechanical waves such as sound. It plays a crucial role in various natural and technological processes, including photosynthesis, heating, and communication.

**iv)** To find the centre of mass of a plane lamina, follow these steps:

1. Cut out a flat shape from a material of uniform thickness.

2. Suspend the shape from a pivot point.

3. Hang weights at different points along the shape.

4. Adjust the weights until the shape is balanced.

5. Measure the distances from the pivot to each weight.

6. Calculate the centre of mass using the weighted average of these distances.

7. The result gives you the position of the centre of mass.

**v)** When the teacher increases the frequency of water waves, the speed of the waves remains constant while the wavelength decreases.

The speed of a wave is determined by the medium through which it travels, and for water waves, this speed depends on the depth of the water and other factors. Therefore, changing the frequency of the waves does not alter their speed.

**Q. No. 4:**

**i)** Moment = Force × Distance

Moment = 30N × 0.06m

Moment = 1.8Nm

**ii)** The axles become warm when the wheels turn due to the friction between the axle and the bearings, as well as the friction between the axle and the wheel hub. When the wheels turn, the axle rubs against the bearings and the wheel hub, causing friction. This friction converts some of the mechanical energy of the rotating wheel into heat energy, which raises the temperature of the axle and surrounding components.

**PRACTICAL PORTION:**

**Q. No. 1:**

**a)** Cold Resistance: Initially low due to lower filament temperature.

Operating Resistance: Increases as filament temperature rises.

Steady-State Resistance: Stabilizes at a higher value than cold resistance.

Failure: This can occur if the current is too high, leading to filament overheating and breakage.

**b) i)**

$R = \frac{V}{I}$

$R = \frac{V}{0.070}$

$R = \frac{V}{0.070}$

$R \approx \frac{V}{0.070}$

$R \approx \frac{V}{0.070}$

$R \approx 142.857\,\Omega$

**ii)**

$V = IR$

$V = 0.070 \times 142.857$

$V \approx 10\,\mathrm{V}$

**iii)**

$P = VI$

$P = 10 \times 0.070$

$P = 0.7\,\mathrm{W}$

**c) i)** Since the lamps are connected in parallel to the cell, the potential difference (voltage) across each lamp is the same as the e.m.f. of the cell. Therefore, the e.m.f. of the cell is the same as the potential difference across one lamp, which is 10 volts.

**ii)**

$$\frac{1}{R_{\text{total}}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_{\text{total}}} = \frac{1}{142.857} + \frac{1}{142.857}$$

$$\frac{1}{R_{\text{total}}} = \frac{2}{142.857}$$

$$R_{\text{total}} = \frac{142.857}{2}$$

$$R_{\text{total}} = 71.429\,\Omega$$

**Q. No. 2:**

**a) i)** As the light enters the block, its speed decreases due to the change in medium, as described by Snell's Law, which states that the ratio of the sine of the angle of incidence to the sine of the angle of refraction is equal to the ratio of the speeds of light in the two media.

**ii)** The wavelength of the light also decreases as it enters the block because the speed of light in the denser medium (glass) is slower than in air, leading to a decrease in the wavelength according to the formula V = fλ, where v is the speed of light, f is the frequency (which remains constant), and λ is the wavelength.

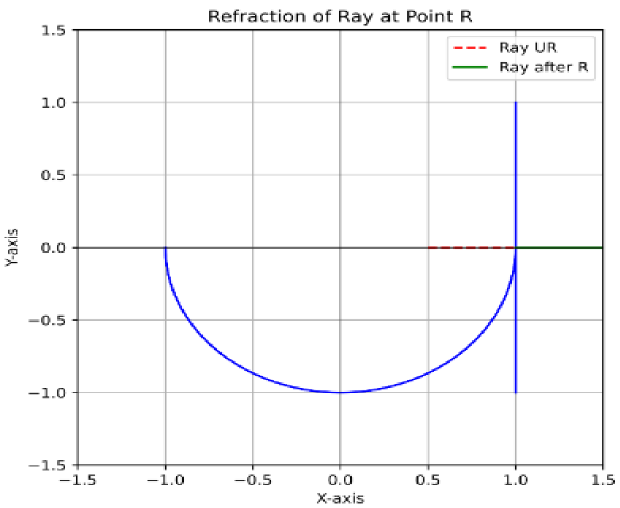
**b)**

$$v = \frac{c}{n}$$

$$v = \frac{3.00 \times 10^8}{1.48}$$

$$v \approx 2.03 \times 10^8 \text{ m/s}$$

**c)**




**Q. No. 3:**

**a) i)** Copper is used for the pipes because it is a good conductor of heat. This means that it can efficiently transfer heat from the solar panel to the water circulating through the pipes.

**ii)** The pipes and the metal backing sheet are painted black to increase their absorption of solar radiation. Black surfaces absorb more sunlight and convert it into heat energy more effectively than lighter-coloured surfaces.

**iii)** An insulating material is attached to the metal backing sheet to reduce heat loss from the back of the solar panel. Insulation helps to maintain the temperature of the water inside the pipes by preventing heat from escaping into the surrounding environment.

**iv)** The presence of the glass sheet increases the energy collected by the water by creating a greenhouse effect. The glass allows sunlight to enter the solar panel, but it traps the heat inside, increasing the temperature of the panel and the water flowing through it.

**b)**

$$Q = mc\Delta T$$

Where:

$Q$ = Energy (in joules)

$m$ = Mass of the substance (in kg)

$c$ = Specific heat capacity of the substance (in J/(kg °C))

$\Delta T$ = Change in temperature (in °C)

Given:

$m = 250 \text{ kg}$

$c = 4200 \text{ J}/(\text{kg }^\circ\text{C})$

$\Delta T = 38^\circ C - 16^\circ C = 22^\circ C$

$$Q = 250 \text{ kg} \times 4200 \text{ J}/(\text{kg }^\circ\text{C}) \times 22^\circ C$$

$$Q = 250 \times 4200 \times 22 \text{ J}$$

$$Q = 2,310,000 \text{ J}$$

Since the water absorbs 25% of the energy falling on the solar panel, the total energy falling on the solar panel can be calculated as:

$$E_{\text{total}} = \frac{Q}{0.25}$$

$$E_{\text{total}} = \frac{2{,}310{,}000 \text{ J}}{0.25}$$

$$E_{\text{total}} = 9,240,000 \text{ J}$$