S1 Science Practice Paper

S1 | Science | Time: 60 minutes | Total: 100 marks | 24 questions

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Part 1: Laboratory Safety and Measurement Units

Study the data below and answer the questions, showing all steps.

1. A beaker holds 1250 cm³ of water. After pouring it into 3 measuring cups of 250 cm³ each, how much remains in the beaker in cm³, and in litres? Also convert 0.045 kg of salt into grams and milligrams.

Answer: Poured out = 3 x 250 = 750 cm³, so 500 cm³ remains, i.e. 0.5 L. Mass = 0.045 x 1000 = 45 g = 45000 mg. Since 1 L = 1000 cm³ and 1 kg = 1000 g, every conversion moves the point three places for each prefix step.

2. A balance reads 12.48 g for a beaker plus sample, and the empty beaker was earlier found to weigh 8.72 g. Find the sample mass and explain why the answer keeps only two decimal places.

Answer: Sample mass = 12.48 - 8.72 = 3.76 g. The beaker reading 8.72 g is reliable only to 0.01 g, and in addition or subtraction the answer cannot be more precise than the least precise value, so two decimal places are kept. Writing 3.7600 g would overstate the precision.

3. A Bunsen flame is about 800 °C and room temperature is 25 °C. Find the temperature difference and express it in K, and explain why a water bath, not a direct flame, is used for flammable liquids.

Answer: Difference = 800 - 25 = 775 °C. Since one Celsius degree equals one kelvin, the interval is also 775 K; the two scales differ only in their zero point. A water bath peaks at about 100 °C, heats evenly and has no naked flame, so flammable vapour cannot ignite and the temperature is far easier to control.

4. 50 cm³ of concentrated sulphuric acid is added slowly to 200 cm³ of water. Find the percentage by volume of acid in the mixture and state the correct safe procedure for dilution.

Answer: Total volume = 50 + 200 = 250 cm³, so the acid is 50 / 250 x 100% = 20% by volume. Add the acid slowly to the water while stirring, never water to concentrated acid: dilution releases much heat, and water floating on the acid would boil and spatter corrosive liquid.

Part 2: States of Matter, the Particle Model and Density

Study the data below and answer the questions, showing all steps.

5. A metal block has a mass of 270 g and a volume of 3 cm³. Find its density, suggest which metal it is (aluminium 2.7, iron 7.9 g/cm³) and state whether it floats or sinks in water.

Answer: Density = mass / volume = 270 / 3 = 2.7 g/cm³, matching aluminium. Water is 1.0 g/cm³, so the denser metal (2.7 > 1.0) sinks. For equal volume a higher density means particles packed more closely and therefore more mass per unit volume.

6. 100 g of ice melts at 0 °C. Given a specific latent heat of fusion of 334 J/g, find the energy needed in J and kJ, and describe what happens to the particles while the temperature stays constant.

Answer: Energy = 100 x 334 = 33400 J = 33.4 kJ. The temperature stays at 0 °C because the energy supplied breaks the regular lattice arrangement: particles change from vibrating in fixed positions to sliding past one another, so no energy is left to raise the temperature.

7. 100 cm³ of gas at 1.0 atmosphere is compressed by a piston to 25 cm³ at constant temperature. Find the new pressure and use the particle model to explain the rise.

Answer: Volume falls by a factor of 4, so at constant temperature the pressure rises in the same ratio: 1.0 x 4 = 4.0 atm. The same number of particles occupies less space, so they hit the walls more often; each collision transfers the same average momentum, hence a greater force per unit area.

8. A 20 m steel rail warms by 30 °C; the linear expansivity of steel is 1e-05 per °C. Find the expansion in mm and explain why gaps are left between rails.

Answer: Expansion = 20 x 1e-05 x 30 = 0.0072 m = 7.2 mm. On heating, particles vibrate with larger amplitude and their average spacing grows, so the whole rail lengthens. Without gaps the rails would push against each other on hot days and buckle, which can derail trains.

Part 3: The Microscope and Cell Structure

Study the data below and answer the questions, showing all steps.

9. A microscope has a 10x eyepiece and a 40x objective. Find the total magnification, and the real diameter of a cell drawn 20 mm across in the field of view (in mm and µm).

Answer: Total magnification = 10 x 40 = 400x. Real diameter = drawing length / magnification = 20 / 400 = 0.05 mm = 50 µm. One millimetre equals 1000 µm, and magnification enlarges the image only, not the cell itself.

10. Match the nucleus, chloroplast and cell membrane to their main functions (storing genetic material, carrying out photosynthesis, controlling what enters and leaves), and explain why chloroplasts are not seen in onion epidermis cells.

Answer: Nucleus: stores genetic material (DNA) and controls cell activities; chloroplast: contains chlorophyll and carries out photosynthesis; cell membrane: selectively permeable, controlling movement in and out. Onion epidermis lies in an underground bulb, receives no light and does not photosynthesise, so it has no chloroplasts and looks colourless, which is why it is used to show the cell wall and nucleus.

11. A cell is about 50 µm across. How many such cells in a row make 1 cm, and name two structures found in plant cells but not in animal cells.

Answer: 1 cm = 10 mm = 10000 µm, so 10000 / 50 = 200 cells fit end to end. Plant cells alone have a cell wall of cellulose (support) and chloroplasts (photosynthesis); a mature plant cell also has a large central vacuole. Animal cells have only a membrane and no wall, so their shape is less fixed.

12. A leaf surface measures 20 mm by 20 mm with 250 stomata per mm² on the lower epidermis. Find the total number of stomata and explain their role in gas exchange.

Answer: Area = 20 x 20 = 400 mm², so there are 400 x 250 = 100,000 stomata. Each stoma is opened and closed by two guard cells: when open, carbon dioxide diffuses in for photosynthesis while oxygen and water vapour diffuse out; closing them limits water loss, so stomata balance gas exchange against water conservation.

Part 4: Forces and Pressure

Study the data below and answer the questions, showing all steps (take g = 9.8 N/kg).

13. A student has a mass of 5 kg. Find her weight on Earth and explain how weight differs from mass in unit and in direction.

Answer: Weight W = m x g = 5 x 9.8 = 49 N. Mass in kilograms measures the amount of matter and is the same everywhere; weight in newtons is the gravitational force on the object, always directed towards the centre of the Earth, and it would be smaller on the Moon.

14. A book weighs 20 N and its cover touches the desk over 0.05 m by 0.20 m. Find the pressure on the desk and state how it changes when the book stands on its edge.

Answer: Contact area = 0.05 x 0.20 = 0.01 m², so pressure = 20 / 0.01 = 2000 Pa. Standing on its edge shrinks the area while the weight stays the same, so the pressure rises sharply; the same book marks a soft surface more deeply, which is why a blade is sharpened thin.

15. A tank holds water 2.5 m deep; the density of water is 1000 kg/m³. Find the water pressure at the bottom and explain why a dam is thicker at its base.

Answer: p = ϱgh = 1000 x 9.8 x 2.5 = 24500 Pa. Liquid pressure depends only on depth, density and g, not on the shape of the container. Pressure grows with depth, so the base of a dam takes the greatest load and must be thickest to avoid being pushed over or leaking.

16. A box of mass 3 kg is pushed with 10 N against a friction of 4 N. Find the resultant force and acceleration, and state what happens if the push falls to 4 N.

Answer: Resultant = 10 - 4 = 6 N, so a = F / m = 6 / 3 = 2 m/s². If the push drops to 4 N the resultant is zero: the box does not accelerate (Newton first law) and, if already moving, would slide at constant velocity until another force acts.

Part 5: Energy and Simple Circuits

Study the data below and answer the questions, showing all steps.

17. An appliance runs on 220 V drawing 2.0 A for 3 hours. Find its power, the energy used in kWh and the cost at $1.2 per kWh.

Answer: Power P = VI = 220 x 2.0 = 440 W. Energy = 440 W x 3 h = 1320 Wh = 1.32 kWh, so cost = 1.32 x 1.2 = $1.58. One kilowatt-hour is 1000 W for one hour, so a modest appliance left on for many hours still costs real money.

18. Resistors of 6 Ω and 4 Ω are connected in series to a battery with a current of 0.5 A. Find the total resistance, the battery voltage and the voltage across each resistor.

Answer: Total resistance = 6 + 4 = 10 Ω, so V = IR = 0.5 x 10 = 5.0 V. The voltages are 0.5 x 6 = 3.0 V and 0.5 x 4 = 2.0 V, which add to 5.0 V: in a series circuit the current is the same everywhere and the voltages divide in ratio to the resistances.

19. A lamp takes in 100 J of electrical energy each second and emits 20 J as light. Find the efficiency, the energy lost as heat each second, and explain why an LED lamp saves energy.

Answer: Efficiency = 20 / 100 x 100% = 20%, so 80 J per second is lost as heat. An incandescent filament turns most of its input into heat, while an LED converts a larger share into light, so it needs less input for the same brightness.

20. A 2000 W kettle runs on 220 V. Find the current it draws and explain why a Hong Kong socket and its fuse rating (3 A or 13 A) must match that current.

Answer: I = P / V = 2000 / 220 = 9.09 A. Because 9.09 A exceeds 3 A, a 13 A socket is needed. A fuse melts and breaks the circuit once the current passes its rating, preventing the cable from overheating and starting a fire; too low a rating trips constantly, too high a rating removes the protection.

Part 6: Acids, Alkalis and Common Substances

Study the data below and answer the questions, showing all steps.

21. Solution A has pH 2, B has pH 5 and C has pH 7. Arrange them from most to least acidic and find how many times more hydrogen ions A has than B.

Answer: Lower pH means more acidic, so the order is A (pH 2), then B (pH 5), then C (pH 7, neutral). Each pH unit is a tenfold change, so a difference of 3 units means 10^3 = 1000 times more hydrogen ions in A than in B.

22. 25 cm³ of 0.1 M sodium hydroxide is neutralised by 0.1 M hydrochloric acid. Find the volume of acid needed and the moles of sodium chloride formed, and write the equation.

Answer: Equation: NaOH + HCl -> NaCl + H2O, a 1:1 ratio. Moles of NaOH = 0.1 x 25/1000 = 0.0025 mol, needing the same 0.0025 mol of HCl, i.e. 0.0025 / 0.1 = 25 cm³. The NaCl formed is also 0.0025 mol; equal concentrations and a 1:1 ratio give equal volumes.

23. Classify oxygen, water, air and salt solution as element, compound or mixture, and describe one method of separating salt solution back into salt and water.

Answer: Oxygen is an element (one kind of atom); water is a compound (hydrogen and oxygen chemically bonded in a fixed ratio); air is a mixture of nitrogen, oxygen and carbon dioxide in variable proportions; salt solution is a mixture. Distillation boils off the water, condenses and collects it, leaving the salt behind, so both are recovered.

24. 0.24 g of magnesium reacts with excess dilute sulphuric acid (relative atomic mass 24). Find the moles and room-temperature volume of hydrogen produced (24 dm³/mol) and describe a test for the gas.

Answer: Moles = 0.24 / 24 = 0.01 mol of Mg. The equation Mg + H2SO4 -> MgSO4 + H2 is 1:1, so 0.01 mol of hydrogen forms, occupying 0.01 x 24 = 0.24 dm³ = 240 cm³. Test: put a burning splint near the gas; hydrogen burns with a squeaky pop.