# S2 Science Practice Paper 1 | Density, cells, food energy, circuits, light, acids

## Junior Secondary Science

S2 Science practice paper with worked answers: density calculations, microscope magnification, food energy, series and parallel circuits, lenses and pH concentration.

## 1. Density and experimental skills (16 marks)

*Density is mass divided by volume; the rise in water level gives the volume of an irregular solid.*

| # | Question | Answer and marking notes |
|---|---|---|
| 1 | (a) A metal block has mass 54.0 g and volume 20.0 cm cubed. Find its density. | Density = 54.0 g / 20.0 cm cubed = 2.70 g per cm cubed, which is close to that of aluminium. |
| 2 | (b) Convert 2.70 g per cm cubed into kg per cubic metre. | Since 1 g per cm cubed equals 1000 kg per cubic metre, 2.70 g per cm cubed is 2700 kg per cubic metre. |
| 3 | (c) A measuring cylinder holds 40.0 cm cubed of water; after a stone is added the level rises to 58.0 cm cubed. The stone has mass 44.0 g. Find its density. | The volume of the stone is 58.0 - 40.0 = 18.0 cm cubed, so its density is 44.0 / 18.0 = 2.44 g per cm cubed. |
| 4 | (d) A liquid has density 0.80 g per cm cubed. Find the mass of 250 cm cubed of it. | Mass = density x volume = 0.80 x 250 = 200 g. |

## 2. Cells and the microscope (16 marks)

*Total magnification is the eyepiece power times the objective power; 1 mm = 1000 micrometres.*

| # | Question | Answer and marking notes |
|---|---|---|
| 5 | (a) A microscope has a 10x eyepiece and a 40x objective. Find the total magnification. | Total magnification = 10 x 40 = 400 times. |
| 6 | (b) A specimen is 0.05 mm long. How long is its image at 400 times magnification, in mm? | Image length = 0.05 x 400 = 20 mm. |
| 7 | (c) The field of view is 1.6 mm across and a cell is 0.04 mm in diameter. How many cells can lie in a line across the field? | Number of cells = 1.6 / 0.04 = 40. |
| 8 | (d) A cell has a real diameter of 20 micrometres. What is this in mm? | 20 micrometres = 20 / 1000 = 0.02 mm. |

## 3. Food and energy (18 marks)

*Scale energy with mass; for the burning food use E = m c delta T with water specific heat capacity 4.2 J per g per degree C.*

| # | Question | Answer and marking notes |
|---|---|---|
| 9 | (a) Rice contains 480 kJ per 100 g. Find the energy in one 150 g bowl of rice. | Energy = 480 x 1.5 = 720 kJ. |

| # | Question | Answer and marking notes |
|---|---|---|
| **10** | (b) A student needs 8,000 kJ per day and takes 2,400 kJ at lunch. What percentage of the daily need is this? | Percentage = 2400 / 8000 x 100% = 30%. |
| **11** | (c) Burning 2.0 g of peanut raises the temperature of 100 g of water by 20 degrees C. Given specific heat capacity 4.2 J per g per degree C, find the energy absorbed. | E = m c delta T = 4.2 x 100 x 20 = 8,400 J, that is 8.4 kJ. |
| **12** | (d) From (c), how much energy does each gram of peanut provide? Give the answer in J per g and kJ per g. | Energy per gram = 8,400 J / 2.0 g = 4,200 J per g, that is 4.2 kJ per g. |

## 4. Circuits and electrical power (18 marks)

*Use V = I R and P = V I; for parallel resistors 1/R = 1/R1 + 1/R2; energy billed in kWh.*

| # | Question | Answer and marking notes |
|---|---|---|
| **13** | (a) A 12 ohm resistor is connected across a 6 V battery. Find the current. | I = V / R = 6 / 12 = 0.5 A. |
| **14** | (b) Two 6 ohm resistors in series are connected to a 12 V battery. Find the total resistance and the current. | Total resistance = 6 + 6 = 12 ohm, so I = 12 / 12 = 1 A. |
| **15** | (c) Two 6 ohm resistors are connected in parallel. Find the equivalent resistance. | 1/R = 1/6 + 1/6 = 2/6, so R = 3 ohm. |
| **16** | (d) A 2000 W appliance runs for 3 hours. Find the energy used in kWh and the cost at $1.2 per kWh. | Energy = 2 x 3 = 6 kWh and the cost is 6 x 1.2 = $7.2. |

## 5. Light and lenses (16 marks)

*Angles are measured from the normal; the image in a plane mirror is as far behind as the object is in front; use 1/f = 1/u + 1/v.*

| # | Question | Answer and marking notes |
|---|---|---|
| **17** | (a) A ray makes 55 degrees with the surface of a plane mirror. Find the angle of incidence and the angle of reflection. | Angle of incidence = 90 - 55 = 35 degrees and the angle of reflection is also 35 degrees. |
| **18** | (b) An object is 1.5 m in front of a plane mirror. Find the distance between the object and its image. | The image is 1.5 m behind the mirror, so the distance is 1.5 + 1.5 = 3.0 m. |
| **19** | (c) A convex lens has focal length 10 cm and the object is 30 cm in front of it. Find the image distance. | From 1/f = 1/u + 1/v, 1/10 = 1/30 + 1/v, so 1/v = 2/30 and v = 15 cm, a real image. |
| **20** | (d) From (c), find the magnification and state whether the image is enlarged or diminished. | Magnification = v / u = 15 / 30 = 0.5, so the image is half the height of the object: diminished, inverted and real. |

## 6. Acids, alkalis and concentration (16 marks)

*pH below 7 is acidic; concentration may be in g per dm cubed or mol per dm cubed; dilution and neutralisation conserve moles.*

| # | Question | Answer and marking notes |
|---|---|---|
| **21** | (a) A solution has pH 3. Is it acidic or alkaline, and how many pH units is it from pH 7? | pH 3 is below 7, so the solution is acidic, and it is 7 - 3 = 4 pH units from neutral. |
| **22** | (b) 250 cm cubed of solution contains 5.0 g of solute. Find the concentration in g per dm cubed. | 250 cm cubed is 0.25 dm cubed, so the concentration is 5.0 / 0.25 = 20 g per dm cubed. |
| **23** | (c) 100 cm cubed of 2.0 mol per dm cubed solution is diluted with water to 500 cm cubed. Find the new concentration. | Moles of solute = 2.0 x 0.100 = 0.200 mol, so the new concentration is 0.200 / 0.500 = 0.4 mol per dm cubed. |
| **24** | (d) What volume of 0.1 mol per dm cubed hydrochloric acid neutralises 25 cm cubed of 0.2 mol per dm cubed sodium hydroxide, in a 1 to 1 reaction? | Moles of sodium hydroxide = 0.2 x 0.025 = 0.005 mol, so 0.005 mol of acid is needed: volume = 0.005 / 0.1 = 0.050 dm cubed = 50 cm cubed. |