S1 Science Practice Paper 1 | Lab safety, units, states of matter, density, heat transfer, microscope

Junior Secondary Science

S1 Science practice paper 1 with solutions: lab safety, units, states of matter and the particle model, density, energy and heat transfer, microscopes and cells.

1. Laboratory safety and apparatus (16 marks)

A group of S1 students heat a liquid in the laboratory. The Bunsen safety flame is about 800 C and the luminous flame about 500 C; the test tube holds 24 cm3 and must be at most one third full when heated; two balance readings are 12.35 g and 7.80 g with a container of 5.20 g; a measuring cylinder with 1 cm3 graduations reads 42 cm3.

#	Question	Answer and marking notes
1	(a) What is the temperature difference between the safety flame and the luminous flame?	Answer: 800 - 500 = 300 C.
2	(b) What is the largest volume of liquid the tube may hold while being heated?	Answer: 24 / 3 = 8.0 cm3.
3	(c) What is the total of the two readings, and the net mass of the sample after subtracting the container?	Answer: 12.35 + 7.80 = 20.15 g; 20.15 - 5.20 = 14.95 g.
4	(d) The uncertainty is half of the smallest graduation. What is it in cm3, and what is the percentage error of the reading?	Answer: uncertainty = 1 / 2 = 0.5 cm3; percentage error = 0.5 / 42 x 100 = 1.2%.

2. Measurement and unit conversion (16 marks)

Science records use consistent units. A set of measurements: length 2.5 m, mass 0.45 kg, volume 750 mL, time 45 minutes, temperature 25 C.

#	Question	Answer and marking notes
5	(a) Convert 2.5 m into centimetres.	Answer: 2.5 x 100 = 250 cm.
6	(b) Convert 0.45 kg into grams.	Answer: 0.45 x 1000 = 450 g.
7	(c) Convert 750 mL into litres and into cm3.	Answer: 750 / 1000 = 0.75 L; 1 mL equals 1 cm3, so it is 750 cm3.
8	(d) Convert 45 minutes into seconds, and 25 C into kelvin (K = C + 273).	Answer: 45 x 60 = 2700 s; 25 + 273 = 298 K.

3. States of matter and the particle model (18 marks)

200 g of ice is heated from -10 C until it becomes water at 100 C. Specific heat capacity of ice is 2.1 J/(g C), latent heat of fusion of ice is 334 J/g, specific heat capacity of water is 4.2 J/(g C). In the particle model, particles in a solid vibrate about fixed positions, in a liquid they slide past each other, and in a gas they move freely.

#	Question	Answer and marking notes
9	(a) How much energy is needed to warm the ice from -10 C to 0 C?	Answer: 200 x 2.1 x 10 = 4200 J.

#	Question	Answer and marking notes
10	(b) How much energy is needed to melt all the ice at 0 C, and does the temperature change during melting?	Answer: 200 x 334 = 66800 J; the temperature stays at 0 C during melting because the energy breaks the regular arrangement of particles.
11	(c) How much energy is needed to heat the water from 0 C to 100 C?	Answer: 200 x 4.2 x 100 = 84000 J.
12	(d) What is the total energy needed for the whole process, in kJ?	Answer: 4200 + 66800 + 84000 = 155000 J = 155 kJ.

4. Density and floating (18 marks)

The density of a stone is found by displacement: the cylinder reads 50 cm3 before and 74 cm3 after the stone is added, and the stone has a mass of 60 g. A wooden block has a volume of 20 cm3 and a mass of 12 g; a liquid has a volume of 250 cm3 and a mass of 200 g; the density of water is 1.0 g/cm3.

#	Question	Answer and marking notes
13	(a) What is the volume of the stone and its density?	Answer: volume = 74 - 50 = 24 cm3; density = 60 / 24 = 2.5 g/cm3.
14	(b) Calculate the density of the wooden block and state whether it floats or sinks in water.	Answer: density = 12 / 20 = 0.6 g/cm3, which is less than 1.0 g/cm3, so the block floats.
15	(c) What is the density of the liquid?	Answer: 200 / 250 = 0.8 g/cm3.
16	(d) If 250 cm3 of the liquid is mixed with 500 cm3 of water (volumes add up), what is the density of the mixture?	Answer: mass = 200 + 500 = 700 g; volume = 250 + 500 = 750 cm3; density = 700 / 750 = 0.93 g/cm3.

5. Energy and heat transfer (16 marks)

A 2000 W kettle heats 1.5 kg of water from 20 C to 100 C; specific heat capacity of water is 4200 J/(kg C). Another 500 g of water cools by 6 C in 10 minutes. A metal rod has ends at 100 C and 20 C and conducts 20 J each second. Solar radiation is 500 W/m2; a black surface absorbs about 90 per cent and a silver surface about 20 per cent.

#	Question	Answer and marking notes
17	(a) How much energy is needed, and at 2000 W what is the minimum time in seconds and in minutes?	Answer: energy = 1.5 x 4200 x 80 = 504000 J; time = 504000 / 2000 = 252 s = 4.2 minutes.
18	(b) How much energy does that cup of water lose in the 10 minutes?	Answer: 500 x 4.2 x 6 = 12600 J.
19	(c) What is the temperature difference along the rod, and how much energy is conducted in one minute?	Answer: difference = 100 - 20 = 80 C; energy = 20 x 60 = 1200 J.
20	(d) By how many percentage points do the two surfaces differ, and how much energy does the black surface absorb per square metre each second?	Answer: 70 percentage points; 500 x 0.9 = 450 W/m2, i.e. 450 J each second per square metre.

6. Microscopes and cell observation (16 marks)

A compound microscope has a 10x eyepiece and 10x and 40x objectives. With the 10x objective the field of view is 1.8 mm across and about 36 cells are visible. A cell is 0.5 mm long in reality.

#	Question	Answer and marking notes
21	(a) What is the total magnification with the 10x and with the 40x objective?	Answer: 10 x 10 = 100 x; 10 x 40 = 400 x.
22	(b) Under the 40x objective, what is the image length of the cell in mm?	Answer: 0.5 x 400 = 200 mm.
23	(c) With the 40x objective, what is the field diameter? (Magnification rises four times, so the diameter shrinks to one quarter.)	Answer: 1.8 / 4 = 0.45 mm.
24	(d) Field area is inversely proportional to the square of magnification. About how many cells are visible with the 40x objective?	Answer: 36 / (4 x 4) = 36 / 16 = 2.25, so about 2 whole cells are seen.