S2 Integrated Science Practice Paper (Set 2) | Density and floating, pressure and hydraulics, series and parallel circuits, heat capacity, refraction and energy pyramid

S2 Integrated Science | Time allowed: 60 minutes | Total: 100 marks | 24 questions

Question 1 Density and Floating

Show the formula and all working in each part.

1. A wooden block has mass 240 g and volume 300 cm3. Find its density. (2 marks)

> **Answer:** Density = mass / volume = 240 / 300 = 0.80 g/cm3.

2. Will the block float or sink in water? Explain your answer. (3 marks)

> **Answer:** It floats because its density 0.80 g/cm3 is less than the density of water, 1.0 g/cm3.

3. A metal piece has mass 54 g and volume 20 cm3. Find its density and state whether it floats in water. (5 marks)

> **Answer:** Density = 54 / 20 = 2.7 g/cm3, which is greater than 1.0 g/cm3, so it sinks.

4. An object of volume 200 cm3 is fully immersed in water. Find the upthrust on it, take g = 10 N/kg. (6 marks)

> **Answer:** Mass of water displaced = 200 g = 0.200 kg; upthrust = 0.200 x 10 = 2.0 N.

Question 2 Pressure and Hydraulic Jack

Write down the formula and state the unit in each part.

5. A box weighs 300 N and touches the floor over an area of 0.5 m2. Find the pressure on the floor. (3 marks)

> **Answer:** Pressure = force / area = 300 / 0.5 = 600 Pa.

6. If the same box is placed on its side with contact area 0.15 m2, find the new pressure. (4 marks)

> **Answer:** Pressure = 300 / 0.15 = 2000 Pa; the smaller the contact area, the larger the pressure.

7. What is the water pressure at a depth of 3 m? (density of water 1000 kg/m3, g = 10 N/kg) (4 marks)

> **Answer:** Pressure = rho x g x h = 1000 x 10 x 3 = 30 000 Pa.

8. A hydraulic jack has a small piston of area 5 cm2 with a force of 50 N; the large piston has area 200 cm2. Find the pressure transmitted and the force on the large piston. (5 marks)

> **Answer:** Pressure = 50 / 5 = 10 N/cm2 (100 000 Pa); force on large piston = 10 x 200 = 2000 N, a force gain of 40 times.

Question 3 Series and Parallel Circuits

Show the formula; give current in A and voltage in V.

9. A 12 ohm resistor is connected to a 6 V supply. Find the current. (4 marks)

> **Answer:** I = V / R = 6 / 12 = 0.5 A.

10. Resistors of 4 ohm and 6 ohm are in series with a 12 V supply. Find the total resistance, the current and the voltage across the 4 ohm resistor. (5 marks)

> **Answer:** R = 4 + 6 = 10 ohm; I = 12 / 10 = 1.2 A; V across 4 ohm = 1.2 x 4 = 4.8 V.

11. Resistors of 6 ohm and 12 ohm are in parallel across a 12 V supply. Find the equivalent resistance, the total current and the current in the 12 ohm resistor. (5 marks)

> **Answer:** 1/R = 1/6 + 1/12 = 1/4, so R = 4 ohm; total current = 12 / 4 = 3 A; current in 12 ohm = 12 / 12 = 1 A.

12. The parallel circuit runs for 5 minutes (300 s). Find the power and the electrical energy used. (4 marks)

> **Answer:** P = V x I = 12 x 3 = 36 W; E = P x t = 36 x 300 = 10 800 J.

Question 4 Heat and Specific Heat Capacity

Take the specific heat capacity of water as 4200 J/(kg C) and of aluminium as 900 J/(kg C).

13. How much heat is needed to raise 2 kg of water from 20 C to 50 C? (5 marks)

> **Answer:** Q = m x c x dT = 2 x 4200 x 30 = 252 000 J.

14. A 0.5 kg aluminium block absorbs 4500 J of heat. Find its temperature rise. (4 marks)

> **Answer:** dT = Q / (m x c) = 4500 / (0.5 x 900) = 10 C.

15. 200 g of water at 80 C is mixed with 300 g of water at 20 C. Assuming no heat loss, find the final temperature. (5 marks)

> **Answer:** Final temperature = (200 x 80 + 300 x 20) / 500 = 22 000 / 500 = 44 C.

16. Explain why coastal areas have a smaller day-night temperature range than inland areas. (3 marks)

> **Answer:** Water has a large specific heat capacity (4200), so its temperature changes slowly when it gains or loses heat; the sea moderates coastal temperature and the range is smaller.

Question 5 Magnification, Refraction and Critical Angle

Take the speed of light as 3 x 10^8 m/s and the refractive index of glass as 1.5.

17. An object is 6 mm high and its image is 24 mm high. Find the magnification. (4 marks)

> **Answer:** Magnification = image height / object height = 24 / 6 = 4.

18. The Moon is 384 000 km from the Earth. How long does light take to travel from the Moon to the Earth? (4 marks)

> **Answer:** t = 3.84 x 10^8 / 3 x 10^8 = 1.28 s.

19. Light enters glass of refractive index 1.5 from air at an angle of incidence of 45 degree (sin 45 = 0.707). Find the angle of refraction. (5 marks)

> **Answer:** n = sin i / sin r, so 1.5 = 0.707 / sin r, sin r = 0.4713 and r = 28.1 degree.

20. Find the critical angle for light travelling from glass (n = 1.5) to air. (3 marks)

> **Answer:** sin c = 1 / n = 1 / 1.5 = 0.667, so c = 41.8 degree; total internal reflection occurs beyond 41.8 degree.

Question 6 Energy Pyramid in an Ecosystem

Assume only 10% of the energy is passed to the next trophic level.

21. Producers fix 40 000 kJ of energy. Find the energy available to primary consumers. (3 marks)

> **Answer:** 40 000 x 10% = 4000 kJ.

22. Continue to find the energy available to secondary and tertiary consumers. (4 marks)

> **Answer:** Secondary consumers: 4000 x 10% = 400 kJ; tertiary consumers: 400 x 10% = 40 kJ.

23. Find the energy lost as heat between producers and primary consumers, and its percentage. (5 marks)

> **Answer:** Energy lost = 40 000 - 4000 = 36 000 kJ, which is 36 000 / 40 000 x 100% = 90%.

24. Explain why food chains usually have no more than four to five trophic levels. (5 marks)

> **Answer:** Only about 10% of energy passes on at each level, so by the fourth or fifth level too little energy remains to support another level; hence food chains are short.