S4 Combined Science Practice Paper (Set 2): Measurement and Errors, Density, Specific and Latent Heat, Waves and Lenses, Refraction and Critical Angle, Atomic Structure and Bonding, Mole and Gas Volume, Titration, Energy and Efficiency (100 marks)

S4 | Combined Science | Time: 75 minutes | Total: 100 marks | 24 questions

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Part 1: Measurement and Errors (16 marks)

Give answers to 3 significant figures unless stated.

1. Write 0.00456 m in standard form and convert it to micrometres (um). [4]

2. A ruler with a smallest division of 1 mm gives the length of a rod as 12.4 cm. Find the percentage error (2 significant figures). [4]

3. A metal block has mass 84.6 g and dimensions 3.0 cm x 2.5 cm x 2.0 cm. Find its volume and density. [4]

4. Evaluate (2.34 + 1.2) / 0.50 and state how many significant figures the result should carry. [4]

Part 2: Thermal Physics (17 marks)

Take the specific heat capacity of water as 4200 J kg^-1 K^-1.

5. Heat 0.50 kg of water from 22 C to 78 C. Find the energy required. [4]

6. An electric heater of 1500 W has an efficiency of 80%% (only 80%% of the electrical energy heats the water). It heats 1.5 kg of water from 20 C to 100 C. Find the time needed in seconds and minutes. [5]

7. Melt 0.20 kg of ice at 0 C completely into water at 0 C. The specific latent heat of fusion is 3.34 x 10^5 J kg^-1. Find the energy required. [4]

8. Mix 0.30 kg of water at 80 C with 0.20 kg of water at 20 C. Assuming no heat loss, find the final temperature. [4]

Part 3: Waves and Light (17 marks)

Give angles to 0.1 degree.

9. Sound travels at 340 m/s in air with a frequency of 170 Hz. Find the wavelength. [4]

10. A convex lens has focal length 10 cm and an object is placed 15 cm in front of it. Find the image distance and magnification, and describe the image. [5]

11. Light enters glass of refractive index 1.5 from air at an angle of incidence of 30 degrees. Find the angle of refraction. [4]

12. Find the critical angle of that glass and state the two conditions for total internal reflection. [4]

Part 4: Atomic Structure and Bonding (16 marks)

Use integer relative atomic masses.

13. Chlorine has two isotopes, Cl-35 and Cl-37, with abundances of 75% and 25% respectively. Find the relative atomic mass of chlorine and the number of neutrons in Cl-35. [4]

14. Magnesium (atomic number 12) reacts with oxygen (atomic number 8) to form magnesium oxide. Write the electronic configurations of Mg2+ and O2- and explain why each is stable. [4]

15. Sodium chloride melts at 801 C but iodine (I2) melts at only 114 C. Explain the difference in terms of structure and bonding. [4]

16. 50.0 cm3 of 0.10 M AgNO3 is mixed with 100.0 cm3 of 0.10 M NaCl and AgCl precipitates. Write the net ionic equation and find the mass of precipitate (molar mass of AgCl = 143.3 g/mol). [4]

Part 5: Mole and Solutions (17 marks)

Take the Avogadro constant as 6.02 x 10^23 mol^-1 and the molar volume at room conditions as 24 dm3/mol.

17. Find the number of moles and the number of molecules in 8.8 g of carbon dioxide (molar mass 44 g/mol). [4]

18. What volume does 4.4 g of carbon dioxide occupy at room conditions? [5]

19. A 2.0 M stock solution is available. To prepare 250 cm3 of 0.20 M solution, what volume of stock is needed? [4]

20. 25.0 cm3 of sodium hydroxide solution needs 20.0 cm3 of 0.100 M hydrochloric acid to reach the end point (1:1 mole ratio). Find the concentration of the sodium hydroxide. [4]

Part 6: Energy and Efficiency (17 marks)

Take g = 10 m/s2.

21. A crane lifts a 20 kg load through 5 m at constant speed in 10 s. Find the work done and the average power. [4]

22. A lamp takes 60 W of input power, of which 9 W becomes light. Find its efficiency. If it is used 5 hours a day at $1.2 per kWh, find the cost for 30 days. [5]

23. Burning 0.50 kg of coal (energy value 3.0 x 10^7 J/kg) heats 20 kg of water with an efficiency of 40%. Find the temperature rise of the water. [4]

24. A hydroelectric plant takes 200 kg of water per second falling 10 m, with an efficiency of 60%. Find the output power. [4]
