1. **B** – 0.250 mol × 6.02 × 10^{23} mol^{-1} = 1.51 × 10^{23} molecules.

2. **B** – 6 protons + 7 neutrons = mass number 13, giving $^{13}_{6}C$.

3. **A** – sulfur (Z = 16) fills orbitals to $3p^4$.

4. **C** – n(C_2H_5OH) = 4.50 g / 46 g mol^{-1} = 0.0978 mol; 2 mol CO_2 per mol ethanol → 0.196 mol CO_2.

5. **B** – The concentration falls from about 0.083 mol dm^{-3} to 0.060 mol dm^{-3} in 10 s (Δ[H_2O_2] ≈ 0.023 mol dm^{-3}). Rate = 0.023 / 10 ≈ 2.3 × 10^{-3} mol dm^{-3} s^{-1}.

6. **C** – NH_3 has four electron domains (one lone pair) giving a trigonal pyramidal shape.

7. **B** – mobile electrons allow charge flow, giving electrical conductivity.

8. **C** – Raising the temperature spreads the energy distribution: more particles have higher energies, the peak moves right and lowers, but particle number (area) stays the same.

9. **A** – delocalised electrons in graphite allow conduction; diamond has none and is extremely hard.

10. **A**. Liquid M contains four carbon atoms and a terminal -CHO group, so the correct name is butanal.

11. **D** – low temperature and high pressure enhance intermolecular forces and particle volume effects.

12. **C** - 0.12 g Mg ÷ 24.3 g mol^{-1} = 4.94 × 10^{-3} mol.
    Mg + Cl_2 → $MgCl_2$ (1 : 1).
    Mass $MgCl_2$ = 4.94 × 10^{-3} mol × 95.3 g mol^{-1} ≈ 0.47 g.

13. **A –** Q = 500 g × 4.18 J g^{-1} $°C^{-1}$ × 10.9 °C = 2.28 × 10^4 J = 22.8 kJ

    Fuel mass burned = 20.24 g − 19.48 g = 0.76 g

    $\Delta H_{(comb)}$ per gram = 22.8 / 0.76 ≈ 3.0 × 10^1 kJ g^{-1} (exothermic)

14. **C** - Applying Hess's law:
    2 Δ_a□H(Ag) + 1462 + 249.2 – 141.1 + 798 – 2969 = –31 → 2 Δ_a□H(Ag) ≈ 570 kJ mol^{-1} → Δ_a□H(Ag) ≈ 285 kJ mol^{-1}.

15. **A**. The H-O-N angle is determined by a bent arrangement around the oxygen (≈104°), while the nitrogen is trigonal-planar, giving an O-N-O angle of ≈120°.

16. **D** – higher T favours the endothermic reverse reaction, shifting left and lowering Kc.

17. **C** – Silicon forms a tetrahedral network of strong covalent bonds throughout the lattice, requiring very high energy to break.

18. **A** – energy/CO_2: CH_4 = 890 kJ; ethanol ≈ 685 kJ; propane ≈ 740 kJ; octane ≈ 684 kJ – highest for methane.

19. **C** - The spectrum displays four distinct groups of multiplets (ignoring the TMS reference at 0 ppm), indicating four chemically non-equivalent sets of protons.

20. **C** – NH_3 accepts H^+ to form NH_4^+, so is the base.

21. **B** – $[H^+] = \sqrt{(Ka \times c)} = 4.24 \times 10^{-4}$ mol dm^{-3}; pH = 3.37 ≈ 3.38.

22. **A** – combining the balanced half-equations in acidic conditions yields $2\ ClO_2 + SO_3^{2-} + H_2O \rightarrow 2\ Cl^- + SO_4^{2-} + 2\ H^+$.

23. **B –** Zinc is oxidised to Zn^{2+}/ZnO at the anode, releasing electrons that travel through the external circuit from Zn to Ag. At the cathode, Ag_2O is reduced:

    $Ag_2O + H_2O + 2e^- \rightarrow 2Ag + 2OH^-$

24. **A** – electrophilic addition of liquid bromine across the C=C gives a di-bromo product.

25. **B** – hydroxylation occurs by syn addition; the resultant diol is meso due to an internal plane of symmetry.

26. **C** – NH_3 accepts H^+ to form NH_4^+, so is the base.

27. **C** – CH_3COOCH_3 contains the –COO– linkage characteristic of esters, whereas A is a ketone, B is a carboxylic acid and D is an ether.

28. **B** – bromine (group 17) is a halogen; the others are misclassified.

29. **B** – $\Delta H° = [4(90)+6(–286)] – [4(–46)+0] = –1172$ kJ ≈ $–1.17 \times 10^3$ kJ.

30. **D** – $q = (100 + 1.5)\ g \times 4.18\ J\ g^{-1}\ K^{-1} \times 7.3\ K \approx 3.10$ kJ.
    $n(KOH) = 1.500\ g / 56.1\ g\ mol^{-1} = 0.0268$ mol.
    $\Delta H = –q/n \approx –116$ kJ mol^{-1} (exothermic).