06 Redox Chemistry

Set B **Answer key**

A Competition questions

25 MARKS

1 **D** row D [1]

$FeTiO_3$: +2 + x − 6 = 0, so x = +4.

$Fe_2(TiO_3)_3$: 2(+3) + 3x − 18 = 0, so x = +4.

2 **A** carbon dioxide and calcium carbonate [1]

Carbon is +4 in CO_2 and in $CaCO_3$.

In KCN (K +1, N −3) carbon is +2, and in Fe_2C (Fe +2) it is −4.

3 **C** +1, +2, +3 [1]

Bi, Sr, Ca and O give 6 + 4 + 4 − 20 = −6, so the three copper atoms total +6.

Only +1, +2, +3 adds up to +6.

4 **D** two oxidations, highest +6 [1]

Sulfur goes 0, +4, +6, +6, +6: only the first two stages raise it.

In $H_2S_2O_7$, 2 + 2x − 14 = 0 gives +6 for each sulfur, not +12.

5 **C** row C [1]

Sulfur starts at +6. In reaction 1 it stays +6 (0). In reaction 2 it falls to +4 in SO_2 (2).

In reaction 3 it falls to −2 in H_2S (8).

6 **B** nitrogen from +4 to 0 [1]

In NO nitrogen is +2, not +4, so it changes from +2 to 0.

Carbon goes from +2 to +4 and oxygen stays −2, so the reaction is redox.

7 **C** Oxygen is reduced in stage 1. [1]

In stage 1 oxygen falls from 0 to −2, so it is reduced, while nitrogen rises from +2 to +4.

In stage 2 NO_2 (N +4 to +2) is the oxidising agent and SO_2 (S +4 to +6) the reducing agent.

8 **C** 1, 2 and 4 [1]

Sulfur dioxide is an acidic oxide: it does not react with an acid but forms a salt with an alkali. It is a reducing agent, so it decolourises acidified manganate(VII).

Its solution is acidic, so Universal Indicator turns red or orange, not violet.

9 **B** 1 and 3 only [1]

$2FeCl_3 + 2KI \rightarrow 2FeCl_2 + 2KCl + I_2$, so v = w = x = y = 2, and KI is the test for an oxidising agent.

The iodine stays dissolved, giving a yellow-brown solution, not a vapour.

10 **B** 2 and 4 [1]

Nitrogen is +3 in NF_3, and each F_2 goes from 0 to two F^-, gaining 2 electrons.

Nitrogen is only oxidised (it stays −3 in NH_4F), so there is no disproportionation, and F_2 is the oxidising agent.

11 **C** +3 [1]

$n_{ClO_4^-} = 5.00 \times 10^{-3}$ mol, $n_{Ti^{3+}} = 0.0200$ mol, each losing 1 electron.

Each Cl gains $0.0200 \div 5.00 \times 10^{-3} = 4$ electrons: +7 − 4 = +3.

12 **C** AmO_2^{2+} [1]

$n_{Am^{3+}} = 2.40 \times 10^{-4}$ mol and $n_{Cu^{3+}} = 7.20 \times 10^{-4}$ mol, each gaining 1 electron, so each Am loses 3: +3 to +6.

In AmO_2^{2+}, x − 4 = +2 gives +6. The others give +3, +4 and +3.

13 **C** +4 [1]

M starts at +5 in M_2O_5, and $n_M = 2 \times 2.50 \times 10^{-3} = 5.00 \times 10^{-3}$ mol.

$n_{MnO_4^-} = 1.00 \times 10^{-3}$ mol takes 5.00×10^{-3} mol of electrons: 1 per M, so M was at +4.

14 **B** 40.0 [1]

$n_{MnO_4^-} = 3.00 \times 10^{-3}$ mol takes 0.0150 mol of electrons, so $n_{M^{2+}} = 0.0150$ mol = n_{MO}.

$M_r(MO) = 0.84 \div 0.0150 = 56.0$, so $A_r(M) = 56.0 - 16.0 = 40.0$. Option D forgets the oxygen.

15 **C** +5 [1]

0.2 mol of I^- gives 0.10 mol of I_2 and loses 0.2 mol of electrons. The other 0.02 mol of I_2 (0.04 mol of I atoms) comes from the oxide.

0.04 mol of I atoms gain 0.2 mol of electrons: 5 each, so the oxide iodine is +5.

16 **C** +3 [1]

$n_{FeC_2O_4} = 4.0 \times 10^{-4}$ mol, each giving 1 + 2 = 3 electrons: 1.2×10^{-3} mol.

$n_{MnO_4^-} = 3.0 \times 10^{-4}$ mol, so each Mn gains 4: +7 − 4 = +3.

17 **A** SO_2 [1]

2 mol of H_2S (S −2) lose 4 mol of electrons in reaching 0.

So 1 mol of the other sulfur must gain 4 electrons: it starts at +4, as in SO_2.

18 **B** 0.150 mol [1]

Cl +5 to +7 loses 2 electrons. Cl +5 to −1 gains 6. So three chlorate(VII) form for each chloride: $4KClO_3 \rightarrow 3KClO_4 + KCl$.

$0.200 \times 3/4 = 0.150$ mol.

19 **B** 0.133 mol/dm^3 [1]

$n_{S_2O_3^{2-}} = 2.0 \times 10^{-3}$ mol, so $n_{I_2} = 1.0 \times 10^{-3}$ mol and $n_{Cu^{2+}} = 2.0 \times 10^{-3}$ mol.

$c = 2.0 \times 10^{-3} \div 0.015 = 0.133$ mol/dm^3.

20 **B** 6.40 mg/dm^3 [1]

4.00×10^{-3} mol $S_2O_3^{2-}$ needs 2.00×10^{-3} mol I_2, from 2.00×10^{-3} mol $MnO(OH)_2$, from 1.00×10^{-3} mol O_2.

$1.00 \times 10^{-3} \times 32.0 = 0.0320$ g = 32.0 mg in 5.00 dm^3, so 6.40 mg/dm^3.

21 **B** 0.050 [1]

$n_{BaSO_4} = 0.583 \div 233.4 = 2.50 \times 10^{-3}$ mol in 25.0 cm^3, so 0.0250 mol of sulfate in 250 cm^3.

Each $S_2O_3^{2-}$ gives $2SO_4^{2-}$, so $n_{S_2O_3^{2-}} = 0.0125$ mol in 0.250 dm^3: 0.050 mol dm^{-3}.

22 **A** 0.0440 [1]

$n_{S_2O_3^{2-}} = 2.20 \times 10^{-3}$ mol, so $n_{I_2} = 1.10 \times 10^{-3}$ mol. $3I_2$ needs $6H^+$, so $n_{H^+} = 2.20 \times 10^{-3}$ mol.

H_2SO_4 gives $2H^+$: 1.10×10^{-3} mol in 0.0250 dm^3 = 0.0440 mol dm^{-3}.

23 **C** 2.80 [1]

$n_{S_2O_3^{2-}} = 4.0 \times 10^{-3}$ mol, $n_{I_2} = 2.0 \times 10^{-3}$ mol, $n_{CO} = 0.010$ mol.

$0.010 \times 28.0 = 0.280$ g in 0.100 dm^3 = 2.80 g dm^{-3}.

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B 40 cm^3 **[1]**

Each formula unit contains two C_2O_4 groups, so 2.0×10^{-3} mol is oxidised.

$n_{MnO_4^-} = 2/5 \times 2.0 \times 10^{-3} = 8.0 \times 10^{-4}$ mol, $V = 8.0 \times 10^{-4} \div 0.020 = 0.040$ dm^3.

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B 11.4 cm^3 **[1]**

$2MnO_4^- + 5H_2C_2O_4$: 2.5×10^{-4} mol of each, so the acid is limiting (it needs only 1.0×10^{-4} mol of MnO_4^-).

$n_{CO_2} = 2 \times 2.5 \times 10^{-4} = 5.0 \times 10^{-4}$ mol $\times$ 22.7 dm^3 = 11.4 cm^3.