06 Redox Chemistry

Set A **Answer key**

A From the lesson

29 MARKS

1 **B** NO_2^- [1]

x + 2(−2) = −1, so x = +3.

NO_2 is +4, NH_4^+ is −3 and N_2O is +1.

2 **B** the acid and carbonate [1]

An acid reacting with a carbonate: calcium stays +2, carbon +4, oxygen −2, hydrogen +1 and chlorine −1.

Each of the others has an element uncombined on one side, so its oxidation state changes.

3 **A** The gas is an oxidising agent. [1]

Iodide ions lose electrons to form iodine, so they are oxidised.

The gas takes those electrons, so it is an oxidising agent.

4 **B** chlorine with sodium hydroxide [1]

Chlorine goes from 0 to −1 in NaCl and to +1 in NaClO.

In A two different elements change, C is ordinary redox and D is not redox.

5 **A** 2.0×10^{-4} [1]

Each MnO_4^- takes 5 electrons and each Fe^{2+} gives 1, so MnO_4^- : Fe^{2+} = 1 : 5.

$1.0 \times 10^{-3} \div 5 = 2.0 \times 10^{-4}$ mol. Option D multiplies instead of dividing.

6 **(a)** $Na \rightarrow Na^+ + e^-$ and $Cl_2 + 2e^- \rightarrow 2Cl^-$ [1]

(b) Sodium, because it loses electrons. [1]

7 Copper(II) oxide, because it loses oxygen. [1]

8 **(a)** +6 [1]

(b) +2 [1]

(c) −1, because NaH is a metal hydride [1]

(d) +5 [1]

9 **(a)** Not redox: nitrogen stays −3 and +5. [1]

(b) Not redox: copper stays +2, carbon +4 and oxygen −2. [1]

(c) Redox: nitrogen falls from +5 to +4 and some oxygen rises from −2 to 0. [1]

10 Sulfur dioxide is a reducing agent.

Potassium manganate(VII) and potassium dichromate(VI) are oxidising agents, and both are reduced. [2]

11 $2Fe^{3+} + 2I^- \rightarrow 2Fe^{2+} + I_2$ [1]

12 $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$ and $Fe^{2+} \rightarrow Fe^{3+} + e^-$ (× 6)

$Cr_2O_7^{2-} + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$ [2]

13 $n_{NH_2OH} = 2.50 \times 10^{-3}$ mol and $n_{Mn^{3+}} = 5.00 \times 10^{-3}$ mol, each Mn^{3+} gaining 1 electron.

So each N loses 2 electrons: −1 + 2 = +1 [2]

14 Yes.

Nitrogen is +4 in NO_2, and goes up to +5 in HNO_3 and down to +3 in HNO_2. [2]

15 $n_{MnO_4^-} = 4.000 \times 10^{-4}$ mol. $MnO_4^- + 5Fe^{2+}$, so $n_{Fe^{2+}} = 2.000 \times 10^{-3}$ mol

$c = 2.000 \times 10^{-3} \div 0.0250 = 0.0800$ mol dm^{-3} [2]

16 $n_{Cr_2O_7^{2-}} = 5.100 \times 10^{-4}$ mol, so $n_{Fe^{2+}} = 3.060 \times 10^{-3}$ mol in 25.0 cm^3

0.03060 mol in 250 cm^3, so $M_r = 12.0 \div 0.03060 = 392.2$

$284.0 + 18.0x = 392.2$, so $x = 6$ [3]

B Practice

17 MARKS

17 **D** HNO_3 [1]

In HNO_3: +1 + x + 3(−2) = 0, so x = +5.

NO_2 and N_2O_4 are +4 and NH_4^+ is −3.

18 **A** NF_3 [1]

In HNO_2 nitrogen is +3. In NF_3 each F is −1, so nitrogen is also +3.

NH_4^+ is −3, NO is +2 and NO_2^+ is +5.

19 **B** row B [1]

In $CaSO_4$: +2 + x + 4(−2) = 0, so sulfur is +6.

Nitrogen in HNO_3 is +5, iron in FeO is +2 and carbon in $NaHCO_3$ is +4.

20 **B** K_2SO_3 [1]

Sulfur is +4 in SO_2. In K_2SO_3: 2(+1) + x + 3(−2) = 0, so x = +4.

H_2SO_4 is +6, Na_2S is −2 and $Na_2S_2O_3$ is +2.

21 **D** no change [1]

In $FeTiO_3$ iron is +2 (iron(II)), so +2 + x + 3(−2) = 0 gives titanium +4.

In TiO_2 titanium is also +4.

22 **B** the oxide with hydrochloric acid [1]

Iron is +3 in Fe_2O_3 and +3 in $FeCl_3$: an acid–base reaction.

In A, C and D iron changes between 0, +2 and +3.

23 **A** magnesium with the acid [1]

Magnesium rises from 0 to +2 and hydrogen falls from +1 to 0.

B, C and D are acid–base reactions with no change in oxidation state.

24 **D** $SO_3 + H_2O$ [1]

Sulfur is +6 in SO_3 and in H_2SO_4, and no other oxidation state changes.

A, B and C each have an element whose oxidation state changes.

25 **D** 3 and 4 only [1]

Each Fe^{2+} loses an electron, so it is oxidised, and Cl_2 gains electrons to become Cl^-, so it is reduced.

Chlorine is therefore the oxidising agent, not the reducing agent.

26 **C** Cu loses electrons. [1]

Copper rises from 0 to +2, so it loses electrons.

Nitrogen falls from +5 to +4 in NO_2, so HNO_3 is the oxidising agent. Nitrogen in nitrate is +5, and oxygen stays −2.

27 **A** Ethanol has been oxidised. [1]

Decolourising acidified manganate(VII) shows a reducing agent: manganate(VII) is reduced.

So ethanol is the reducing agent and is itself oxidised.

28 **B** row B [1]

Manganese falls from +7 to +2, so MnO_4^- is reduced.

Sulfur rises from +4 to +6, so SO_3^{2-} is oxidised: it is the reducing agent. H^+ does not change.

29 **D** MnO_4^- to Mn^{2+} [1]

Manganese falls from +7 to +2: reduction, purple to colourless.

A is not redox, and in B and C iodine and iron are oxidised.

30 **D** row D [1]

Cl_2 is an element, 0. In HCl chlorine is −1.

In HClO: +1 + x − 2 = 0, so chlorine is +1. Chlorine disproportionates.

31 **B** chlorine with sodium hydroxide [1]

Chlorine goes from 0 to −1 in NaCl and to +1 in NaOCl.

In A and D two different elements change, and C is not redox.

32 **A** 1 only [1]

Brown iodine formed, so iodide ions were oxidised and X is an oxidising agent.

Any oxidising agent strong enough could do this, such as chlorine, and iodide is oxidised, not reduced.

33

B I and IV only [1]

pH measures the H^+ concentration, and with a metal each H^+ gains an electron (it is reduced to hydrogen).

Strength is how far an acid ionises, not its concentration, and a strong acid turns Universal Indicator red, not orange.