education

DEPARTMENT: EDUCATION
MPUMALANGA PROVINCE

GERT SIBANDE DISTRICT

GRADE 11

PHYSICAL SCIENCES TOPIC TEST

TOPIC: REDOX REACTIONS

OCTOBER 2023

MARKS: 50

TIME: 1 hour

This question paper consists of 5 pages and 3 data sheets

INSTRUCTIONS AND INFORMATION

1. This question paper consists of FOUR questions. Answer ALL the questions in the ANSWER BOOK.
2. Start EACH question on a NEW page in the ANSWER BOOK.
3. Number the answers correctly according to the numbering system used in this question paper.
4. Leave ONE line between two sub questions, for example between QUESTION 2.1 and QUESTION 2.2.
5. You may use a non-programmable calculator.
6. You are advised to use the attached DATA SHEETS.
7. Show ALL formulae and substitutions in ALL calculations.
8. Round off your final numerical answers to a minimum of TWO decimal places.
9. Write neatly and legibly.

QUESTION 1

Four options (A – D) are given as possible answers to the following questions.

Choose the answer and write only the letter (A – D) next to the question number (1.1 – 1.4)

1.1 Which ONE of the following balanced equations represents a redox reaction?

A $H^+(aq) + OH^-(aq) \rightarrow H_2O(\ell)$

B $Mg(s) + CuSO_4(aq) \rightarrow Cu(s) + MgSO_4(aq)$

C $2NaC\ell(aq) + Pb(NO_3)_2(aq) \rightarrow 2NaNO_3(aq) + PbC\ell_2(s)$

D $H_2SO_4(aq) + Ba(NO_3)_2(aq) \rightarrow BaSO_4(s) + 2HNO_3(aq)$ (2)

1.2 $CuSO_4(aq) + Zn(s) \rightarrow Cu(s) + ZnSO_4(aq)$

The oxidising agent in this reaction is ...

A Cu

B Zn^{2+}

C Cu^{2+}

D Zn (2)

1.3 Study the following incomplete half reaction of an unknown element **Y**.

$$Y^{3+} \rightleftarrows Y^{2+}$$

During the reverse reaction, Y^{2+} Undergoes …

A reduction

B hydrolysis

C oxidation

D neutralisation (2)

1.4 Consider the reaction represented by the balanced ionic equation below.

$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 3S^{2-}(aq) \rightarrow 2Cr^{3+}(aq) + 3S(s) + 7H_2O(\ell)$

When this reaction takes place, …

A the oxidation number of sulphur does not change.

B $S^{2-}(aq)$ is reduced by the $Cr_2O_7^{2-}(aq)$.

C $H^+(aq)$ oxidises the $S^{2-}(aq)$.

D $S^{2-}(aq)$ is oxidised by the $Cr_2O_7^{2-}(aq)$. (2)

[8]

QUESTION 2

The unbalanced equations **1**,**2** and **3** below represent redox reactions.

1: $Mg(s) + HC\ell(aq) \rightarrow \mathbf{X}(aq) + H_2(g)$

2: $HC\ell\ (aq) + Ca(s) \rightarrow CaCl_2\ (aq) + H_2(aq)$

3: $Al(s) + H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + H_2(g)$

2.1 Define reduction in terms of electron transfer. (2)

2.2 Write down the FORMULA of the substance which is:

2.2.1 Represented by letter **X** in REACTION 1. (1)

2.2.2 Oxidised in REACTION 1. (1)

2.2.3 The reducing agent in REACTION 2. Explain the answer in terms of oxidation numbers. (3)

2.3 Consider REACTION 3. Write down the:

2.3.1 FORMULA of the reducing agent. (1)

2.3.2 FORMULA of the substance which under goes reduction. (1)

2.3.3 Reduction half-reactions. (2)

2.3.4 Oxidation half-reactions. (2)

2.3.5 Net equation. (3)

[16]

QUESTION 3

The two reactions I and II below represent the UNBALANCED redox reactions .

I: $Cr_2O_7^{2-}(aq) + Fe^{2+}(aq) + H^+(aq) \rightarrow Cr^{3+}(aq) + Fe^{3+}(aq) + H_2O(\ell)$

II: $Ag(s) + NO_3^-(aq) \rightarrow NO_2(g) + Ag^+(aq)$

3.1 Define *oxidation* in terms of oxidation number. (2)

3.2 Calculate the oxidation number of:

3.2.1 Chromium (Cr) in $Cr_2O_7^{2-}(aq)$ (2)

3.2.2 Oxygen in H_2O_2. (2)

3.3 Consider REACTION I. Write down the:

3.3.1 FORMULA of the reducing agent. (1)

3.3.2 Reduction half-reaction. (2)

3.4 Consider REACTION II. Write down the:

3.4.1 FORMULA of the oxidising agent. (1)

3.4.2 FORMULA of the substance being reduced. (1)

3.4.3 balanced net ionic reaction by using the half-reactions from the table of standard reduction potentials.

Clearly indicate the following;

(i) Oxidation half-reaction

(ii) Reduction half-reaction

(iii) Balanced net ionic equation (5)

[16]

QUESTION 4

Consider the balanced redox reaction below.

$Fe^{3+}(aq) + H_2(g) \rightarrow Fe^{2+}(aq) + 2H^+(aq)$

4.1 Give a reason why the above reaction is referred to as a redox reaction. (1)

4.2 Define *oxidising agent*. (2)

4.3 From the above reaction, write down the :

4.3.1 FORMULA of the oxidising agent. Explain the answer in terms of electron transfer. (2)

4.3.2 FORMULA of the substance that under goes oxidation.
Explain the answer in terms of oxidation number. (3)

4.3.3 Reduction half-reaction. (2)

[10]

TOTAL:50

TABLE 4A: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability ↑

Half-reactions			E^{θ} (V)
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-$	+ 2,87
$Co^{3+} + e^-$	$\rightleftharpoons$	Co^{2+}	+ 1,81
$H_2O_2 + 2H^+ + 2e^-$	$\rightleftharpoons$	$2H_2O$	+1,77
$MnO_4^- + 8H^+ + 5e^-$	$\rightleftharpoons$	$Mn^{2+} + 4H_2O$	+ 1,51
$C\ell_2(g) + 2e^-$	$\rightleftharpoons$	$2C\ell^-$	+ 1,36
$Cr_2O_7^{2-} + 14H^+ + 6e^-$	$\rightleftharpoons$	$2Cr^{3+} + 7H_2O$	+ 1,33
$O_2(g) + 4H^+ + 4e^-$	$\rightleftharpoons$	$2H_2O$	+ 1,23
$MnO_2 + 4H^+ + 2e^-$	$\rightleftharpoons$	$Mn^{2+} + 2H_2O$	+ 1,23
$Pt^{2+} + 2e^-$	$\rightleftharpoons$	Pt	+ 1,20
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-$	+ 1,07
$NO_3^- + 4H^+ + 3e^-$	$\rightleftharpoons$	$NO(g) + 2H_2O$	+ 0,96
$Hg^{2+} + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$	+ 0,85
$Ag^+ + e^-$	$\rightleftharpoons$	Ag	+ 0,80
$NO_3^- + 2H^+ + e^-$	$\rightleftharpoons$	$NO_2(g) + H_2O$	+ 0,80
$Fe^{3+} + e^-$	$\rightleftharpoons$	Fe^{2+}	+ 0,77
$O_2(g) + 2H^+ + 2e^-$	$\rightleftharpoons$	H_2O_2	+ 0,68
$I_2 + 2e^-$	$\rightleftharpoons$	$2I^-$	+ 0,54
$Cu^+ + e^-$	$\rightleftharpoons$	Cu	+ 0,52
$SO_2 + 4H^+ + 4e^-$	$\rightleftharpoons$	$S + 2H_2O$	+ 0,45
$2H_2O + O_2 + 4e^-$	$\rightleftharpoons$	$4OH^-$	+ 0,40
$Cu^{2+} + 2e^-$	$\rightleftharpoons$	Cu	+ 0,34
$SO_4^{2-} + 4H^+ + 2e^-$	$\rightleftharpoons$	$SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + e^-$	$\rightleftharpoons$	Cu^+	+ 0,16
$Sn^{4+} + 2e^-$	$\rightleftharpoons$	Sn^{2+}	+ 0,15
$S + 2H^+ + 2e^-$	$\rightleftharpoons$	$H_2S(g)$	+ 0,14
$2H^+ + 2e^-$	**$\rightleftharpoons$**	**$H_2(g)$**	**0,00**
$Fe^{3+} + 3e^-$	$\rightleftharpoons$	Fe	– 0,06
$Pb^{2+} + 2e^-$	$\rightleftharpoons$	Pb	– 0,13
$Sn^{2+} + 2e^-$	$\rightleftharpoons$	Sn	– 0,14
$Ni^{2+} + 2e^-$	$\rightleftharpoons$	Ni	– 0,27
$Co^{2+} + 2e^-$	$\rightleftharpoons$	Co	– 0,28
$Cd^{2+} + 2e^-$	$\rightleftharpoons$	Cd	– 0,40
$Cr^{3+} + e^-$	$\rightleftharpoons$	Cr^{2+}	– 0,41
$Fe^{2+} + 2e^-$	$\rightleftharpoons$	Fe	– 0,44
$Cr^{3+} + 3e^-$	$\rightleftharpoons$	Cr	– 0,74
$Zn^{2+} + 2e^-$	$\rightleftharpoons$	Zn	– 0,76
$2H_2O + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-$	– 0,83
$Cr^{2+} + 2e^-$	$\rightleftharpoons$	Cr	– 0,91
$Mn^{2+} + 2e^-$	$\rightleftharpoons$	Mn	– 1,18
$A\ell^{3+} + 3e^-$	$\rightleftharpoons$	$A\ell$	– 1,66
$Mg^{2+} + 2e^-$	$\rightleftharpoons$	Mg	– 2,36
$Na^+ + e^-$	$\rightleftharpoons$	Na	– 2,71
$Ca^{2+} + 2e^-$	$\rightleftharpoons$	Ca	– 2,87
$Sr^{2+} + 2e^-$	$\rightleftharpoons$	Sr	– 2,89
$Ba^{2+} + 2e^-$	$\rightleftharpoons$	Ba	– 2,90
$Cs^+ + e^-$	$\rightleftharpoons$	Cs	– 2,92
$K^+ + e^-$	$\rightleftharpoons$	K	– 2,93
$Li^+ + e^-$	$\rightleftharpoons$	Li	– 3,05

Increasing reducing ability ↓

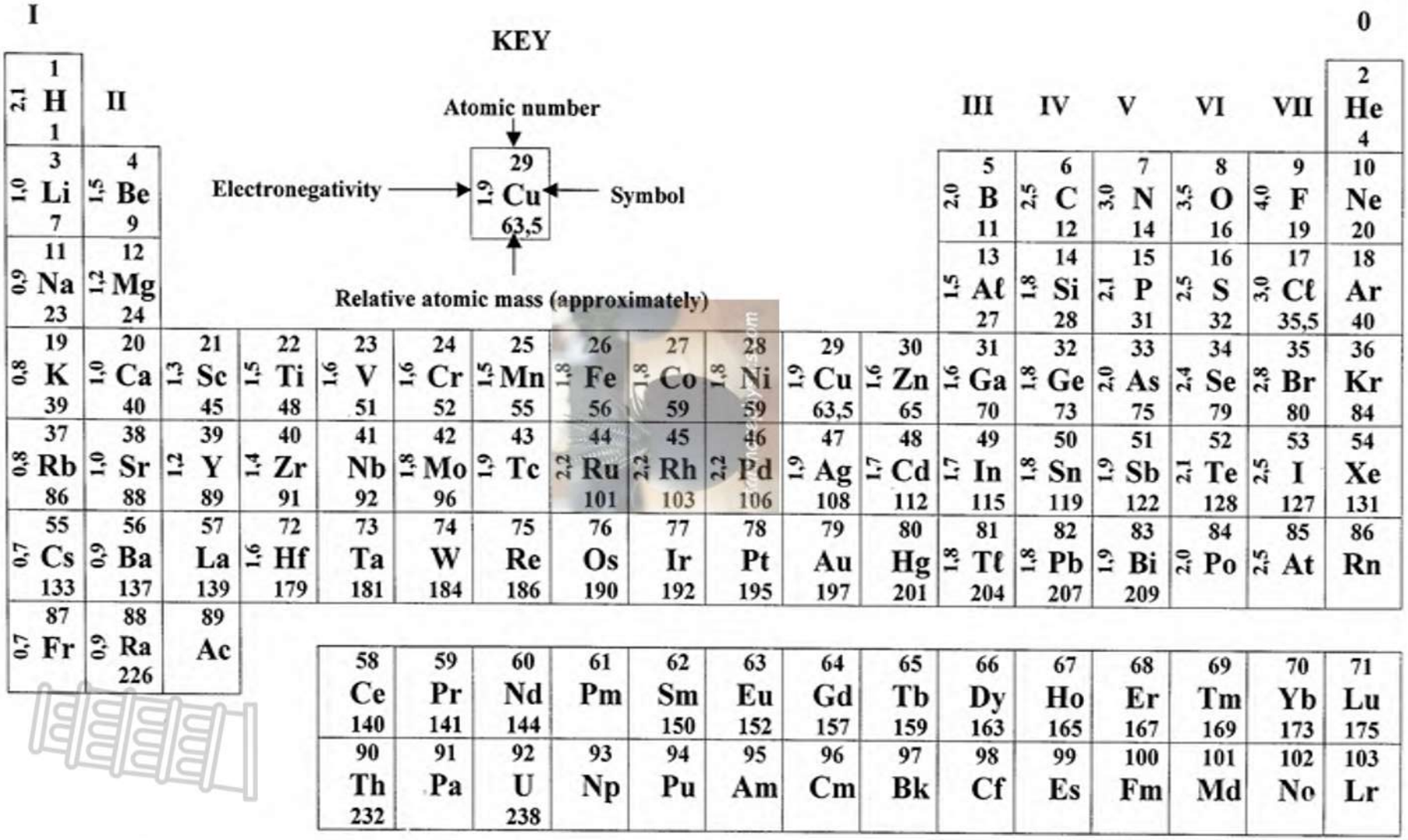
TABLE 4B: STANDARD REDUCTION POTENTIALS

Increasing oxidising ability ↓

Half-reactions	E^{θ} (V)
$Li^+ + e^- \rightleftharpoons Li$	− 3,05
$K^+ + e^- \rightleftharpoons K$	− 2,93
$Cs^+ + e^- \rightleftharpoons Cs$	− 2,92
$Ba^{2+} + 2e^- \rightleftharpoons Ba$	− 2,90
$Sr^{2+} + 2e^- \rightleftharpoons Sr$	− 2,89
$Ca^{2+} + 2e^- \rightleftharpoons Ca$	− 2,87
$Na^+ + e^- \rightleftharpoons Na$	− 2,71
$Mg^{2+} + 2e^- \rightleftharpoons Mg$	− 2,36
$A\ell^{3+} + 3e^- \rightleftharpoons A\ell$	− 1,66
$Mn^{2+} + 2e^- \rightleftharpoons Mn$	− 1,18
$Cr^{2+} + 2e^- \rightleftharpoons Cr$	− 0,91
$2H_2O + 2e^- \rightleftharpoons H_2(g) + 2OH^-$	− 0,83
$Zn^{2+} + 2e^- \rightleftharpoons Zn$	− 0,76
$Cr^{3+} + 3e^- \rightleftharpoons Cr$	− 0,74
$Fe^{2+} + 2e^- \rightleftharpoons Fe$	− 0,44
$Cr^{3+} + e^- \rightleftharpoons Cr^{2+}$	− 0,41
$Cd^{2+} + 2e^- \rightleftharpoons Cd$	− 0,40
$Co^{2+} + 2e^- \rightleftharpoons Co$	− 0,28
$Ni^{2+} + 2e^- \rightleftharpoons Ni$	− 0,27
$Sn^{2+} + 2e^- \rightleftharpoons Sn$	− 0,14
$Pb^{2+} + 2e^- \rightleftharpoons Pb$	− 0,13
$Fe^{3+} + 3e^- \rightleftharpoons Fe$	− 0,06
$2H^+ + 2e^- \rightleftharpoons H_2(g)$	**0,00**
$S + 2H^+ + 2e^- \rightleftharpoons H_2S(g)$	+ 0,14
$Sn^{4+} + 2e^- \rightleftharpoons Sn^{2+}$	+ 0,15
$Cu^{2+} + e^- \rightleftharpoons Cu^+$	+ 0,16
$SO_4^{2-} + 4H^+ + 2e^- \rightleftharpoons SO_2(g) + 2H_2O$	+ 0,17
$Cu^{2+} + 2e^- \rightleftharpoons Cu$	+ 0,34
$2H_2O + O_2 + 4e^- \rightleftharpoons 4OH^-$	+ 0,40
$SO_2 + 4H^+ + 4e^- \rightleftharpoons S + 2H_2O$	+ 0,45
$Cu^+ + e^- \rightleftharpoons Cu$	+ 0,52
$I_2 + 2e^- \rightleftharpoons 2I^-$	+ 0,54
$O_2(g) + 2H^+ + 2e^- \rightleftharpoons H_2O_2$	+ 0,68
$Fe^{3+} + e^- \rightleftharpoons Fe^{2+}$	+ 0,77
$NO_3^- + 2H^+ + e^- \rightleftharpoons NO_2(g) + H_2O$	+ 0,80
$Ag^+ + e^- \rightleftharpoons Ag$	+ 0,80
$Hg^{2+} + 2e^- \rightleftharpoons Hg(\ell)$	+ 0,85
$NO_3^- + 4H^+ + 3e^- \rightleftharpoons NO(g) + 2H_2O$	+ 0,96
$Br_2(\ell) + 2e^- \rightleftharpoons 2Br^-$	+ 1,07
$Pt^{2+} + 2e^- \rightleftharpoons Pt$	+ 1,20
$MnO_2 + 4H^+ + 2e^- \rightleftharpoons Mn^{2+} + 2H_2O$	+ 1,23
$O_2(g) + 4H^+ + 4e^- \rightleftharpoons 2H_2O$	+ 1,23
$Cr_2O_7^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$	+ 1,33
$C\ell_2(g) + 2e^- \rightleftharpoons 2C\ell^-$	+ 1,36
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$	+ 1,51
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$	+1,77
$Co^{3+} + e^- \rightleftharpoons Co^{2+}$	+ 1,81
$F_2(g) + 2e^- \rightleftharpoons 2F^-$	+ 2,87

↑ Increasing reducing ability

TABLE 3: THE PERIODIC TABLE OF ELEMENTS



I	II	III	IV	V	VI	VII	0
1 2,1 H 1							2 He 4
3 1,0 Li 7	4 1,5 Be 9	5 2,0 B 11	6 2,5 C 12	7 3,0 N 14	8 3,5 O 16	9 4,0 F 19	10 Ne 20
11 0,9 Na 23	12 1,2 Mg 24	13 1,5 Aℓ 27	14 1,8 Si 28	15 2,1 P 31	16 2,5 S 32	17 3,0 Cℓ 35,5	18 Ar 40
19 0,8 K 39	20 1,0 Ca 40	21 1,3 Sc 45	22 1,5 Ti 48	23 1,6 V 51	24 1,6 Cr 52	25 1,5 Mn 55	26 1,8 Fe 56	27 1,8 Co 59	28 1,8 Ni 59	29 1,9 Cu 63,5	30 1,6 Zn 65	31 1,6 Ga 70	32 1,8 Ge 73	33 2,0 As 75	34 2,4 Se 79	35 2,8 Br 80	36 Kr 84
37 0,8 Rb 86	38 1,0 Sr 88	39 1,2 Y 89	40 1,4 Zr 91	41 Nb 92	42 1,8 Mo 96	43 1,9 Tc	44 2,2 Ru 101	45 2,2 Rh 103	46 2,2 Pd 106	47 1,9 Ag 108	48 1,7 Cd 112	49 1,7 In 115	50 1,8 Sn 119	51 1,9 Sb 122	52 2,1 Te 128	53 2,5 I 127	54 Xe 131
55 0,7 Cs 133	56 0,9 Ba 137	57 La 139	72 1,6 Hf 179	73 Ta 181	74 W 184	75 Re 186	76 Os 190	77 Ir 192	78 Pt 195	79 Au 197	80 Hg 201	81 1,8 Tℓ 204	82 1,8 Pb 207	83 1,9 Bi 209	84 2,0 Po	85 2,5 At	86 Rn
87 0,7 Fr	88 0,9 Ra 226	89 Ac															

58 Ce 140	59 Pr 141	60 Nd 144	61 Pm	62 Sm 150	63 Eu 152	64 Gd 157	65 Tb 159	66 Dy 163	67 Ho 165	68 Er 167	69 Tm 169	70 Yb 173	71 Lu 175
90 Th 232	91 Pa	92 U 238	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

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PHYSICAL SCIENCES TOPIC TEST

TOPIC: REDOX REACTIONS

OCTOBER 2023

MARKING GUIDELINES

MARKS: 50

These marking guidelines consist of 3 pages

QUESTION 1

1.1 B✓✓ (2)

1.2 C✓✓ (2)

1.3 C✓✓ (2)

1.4 D✓✓ (2)

[8]

QUESTION 2

NOTE: in all equations, phases and charge on electron can be ignored.

2.1 The gain of electrons.✓✓ (2)

2.2.1 $MgCl_2$✓ (1)

2.2.2 Mg✓ (1)

2.2.3 Ca✓

From Ca to Ca^{2+}✓oxidation number increases.✓ (3)

2.3.1 Al✓ (1)

2.3.2 H_2SO_4/H^+✓ (1)

2.3.3 $2H^+(aq) + 2e^- \rightarrow H_2(g)$✓✓ (2)

2.3.4 $Al(s) \rightarrow Al_3^+(aq) + 3e^-$✓✓ (2)

2.3.5 $6H^+(aq) + 2Al(s)$✓ $\rightarrow 3H_2(g) + Al^{3+}(aq)$✓ **(Bal:✓)** (3)

[16]

QUESTION 3

3.1 The increase in oxidation number.✓✓ (2)

3.2.1 2(Cr)+ 7(O) = -2

2(Cr) + (-14) = -2

Cr = +6✓✓ (2)

3.2.2 2(H) + 2(O) = 0

2(1) + 2(O) = 0

O = -1✓✓ (2)

3.3.1 Fe^{2+}✓ (1)

3.3.2 $Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^-$✓ $\rightarrow 2Cr^{3+}(aq) + 7H_2O(\ell)$ ✓ (2)

3.4.1 NO_3^-✓ (1)

3.4.2 NO_3^- ✓ (1)

3.4.3 $Ag(s) \rightarrow Ag^+(aq) + e^-$ ✓

$NO_3^-(aq) + 2H^+(aq) + e^-$ ✓ $\rightarrow NO_2(g) + H_2O(l)$ ✓

$Ag(s) + NO_3^-(aq) + 2H^+(aq)$ ✓ $\rightarrow Ag^+(aq) + NO_2(g) + H_2O(l)$ ✓ (5)

[16]

QUESTION 4

4.1 It involves electron transfer. ✓ (1)

4.2 A substance that is reduced. ✓✓

OR: A substance that gains electrons. (2)

4.3.1 Fe^{3+} ✓

Fe^{3+} gains electron ✓ to form Fe^{2+} (2)

4.3.2 H_2 ✓

From H_2 to H^+, ✓ there is increase in oxidation number. ✓

OR: Oxidation number changes ✓ from o to +2 ✓ (3)

4.3.3 $Fe^{3+}(aq) + e^-$ ✓ $\rightarrow Fe^{2+}(aq)$ ✓ (2)

[10]

TOTAL: 50