ELECTROCHEMISTRY

MARKING SCHEME

1. a) $D_{2(g)}$ / $2D^{-}_{(aq)}$ / $D_{2(g)}$ + 2e (1mk)
   b) $A^{2+}_{(aq)}$ / $A_{(s)}$ / $A^{2+}_{(s)}$ + 2e ✓ 1mk
   c) $A_{(s)} \longrightarrow A^{2+}_{(aq)} + 2e$ + 2.80 ✓1/2mk

   $B^{+}_{(aq)} + e \longrightarrow B_{(s)}$ -1.50 ✓ ½

   1.30

2. $Cr_2O_7^{2-}$

   2Cr + (7 x -2) = -2

   2Cr – 14 = -2

   2Cr = -2 + 14

   $$\frac{2}{2}Cr = \frac{+12}{2}$$ ✓ 1

   $$Cr = +6$$

3. Q = It

   Q = 0.5A x (32 x 60 + 10)s

   Q = 0.5A x 1930s

   Q = 965 C used. ½ mk

   Hence:-

   0.44g of p ⟶ 965 C

   ∴ 88g of p ⟶ ?

   $$\frac{88g\,x\,965C}{0.44g} = \frac{84920}{0.44}$$ 1mk

   = 193000 C used to produce 1 mole of p

   But,

   96500 C ⟶ IF = I^{e-}

   ∴ 193000 C ⟶ ?

   $$\frac{=193000C\,x\,IF}{96500C}$$ 1mk

   $$= 2F = 2e-$$

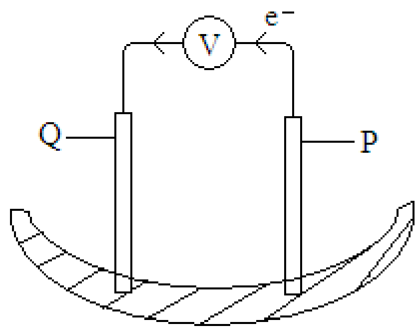
   Hence ions of p gains 2 moles of electrons to form atoms of P.

   Thus the charge on an ion of P is +2 ½ mk

   OR

   P^{2+} is the formular for the ion of P

4. (a)



Direction of the electron flow from P to Q

(b) A more reactive metal loses electrons more easily than a less reactive metal then passes into solution more readily forming positively charged ions. (1mk)

5.(a) (i) Electrolyte for facilitating flow / movement of ions from one electrode to the other

(1mk)

(ii) Oxidizing Hydrogen gas liberated to prevent polarization of the cell and enable contact with electrolyte for electron flow in the external circuit to be achieved. (1mk)

(b) (0.74 + 0.76)V = 1.5 v. (1mk)

6.(a)

×	½
✔	½
✔	½
×	½

(b)

$$Zn_{(s)} + 2Ag^{+}_{(aq)} \longrightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)}$$

$$Mg_{(s)} + Cu^{2+}_{((aq)} \longrightarrow Mg_{(aq)} + Cu_{(s)}$$

(1 mark for any one of the two equations)

7.In liquid HF only F^- who would be available for discharge (1 mark) but in water $OH^-_{(aq)}$ would also be available and be discharged (1 mark).Both $F_{2\,(g)}$ and $O_{2(g)}$ would be produce in this case.

8.a) $(2 \times 1) + (2x) + (3 \times -2) = 0$

$2x = +4$

$x = 2$ (1)

b) $Na_2S_2O_3 + 2HCl \longrightarrow 2NaCl_{(aq)} + SO_2 + S + H_2O$ (1)

b) It is used to determine how the rate of reaction is affected by varying factors (1)

9. a) i) Mg(s)

ii) ½ $Cl_2(g)$

b) $Mg_{(s)} \,/\, Mg^{2+}_{(aq)} \,//\, \frac{1}{2} Cl_{2(g)} \,/\, Cl^-_{(aq)}$ (1)

* Used in manufacture of ammonia ;

10.a)

Metal	Solution containing ion of	Reaction / No reaction
Cu	Zn^{2+}	X(½)
Zn	Ag^+	√(½)
Ag	Pb^{2+}	X(½)

b) Ag, Cu, Zn (½)

11.The colour of the solution changes from ✔ ½ orange to green. This is because the concentration of H^+ ions increases ✔ ½ making the equilibrium to shift to the right ✔ ½ increasing formation of Cr^{3+} ions ✔ ½

12. (a) Brown fumes ✔ ½

(b) $Pb^{2+}_{(aq)} + 2e^- \longrightarrow Pb_{(s)}$ ✔ ½

(c) 96500 x 2 $\longrightarrow$ 207 g

15x 60 x 12 $\longrightarrow \dfrac{207 \times 15 \times 60 \times 12}{96500 \times 2}$ ✔ 1 = 1. 930 ✔ ½

13.a) C ✓1

b) $A_{2(g)} + 2B^{-}_{(aq)} \longrightarrow 2A^{-}_{(aq)} + B_{2(g)}$ E = +0.34v

Half equation

$A_{2(g)} + 2e \longrightarrow 2A^{-}(aq)$ 1.42v

$2B^{-}_{(aq)} \longrightarrow B_2 + 2e$ x

1.42 + x = 0.34

x = -1.08✓1

Reduction potential is + 1.08✓1 $B_{2(g)} + 2e \longrightarrow 2B^{-}_{(aq)}$

14. a) +1 + x + (4x - 2) = 0

+1 + x – 8 = 0

x = 8 – 1

= +7✓1

b) (2x + 1) + y + (3x – 2) = 0

+2 + y – 6 = 0

y = 6 – 2

= +4✓1

15. $Cu^{2+}_{(aq)} + 2e^{-} \longrightarrow Cu_{(s)}$

64g deposited by 2 x 96500C

2.39g will be deposited by $\frac{2.39}{64} \times 2 \times 96500C$ ✓ ½

= 7207C✓ ½

Q = It ⇒7207 = 4 x y x 60

$y = \frac{7207}{4 \times 60}$ ✓ ½

y = 30✓ ½

16. a)i) U✓1

It's the one with more negative electrode potential. ✓1

ii) U and W✓1

E cell = + 0.79 - -2.36✓ ½

= 3.15V✓ ½

iii) Reference electrode✓1

b) i) $Z_{(s)} \longrightarrow Z^{2}{}_{aq}{}^{+} + 2e^{-}$✓1

$2V^{+}_{(aq)} + 2e^{-} \longrightarrow 2\ V_{(s)}$ ✓1

ii) $Z_{(s)}\ /\ Z^{2+}_{(aq)}\ //\ 2V^{+}_{(aq)}/\ V_{(s)}$ ✓1

iii) e.m.f = + 0.34 - -0.76✓ ½

$=1.10\ v$ ✓ ½

iv) $Z(s) + 2V^{+}_{(aq)} \longrightarrow Z^{2+}_{aq} + 2v_{(s)}$ E^{θ} cell = 1.10v✓1

v) Generate electric current ✓1

vi) – Provide electrical continuity between solutions✓1
- Potassium nitrate✓1
- Potassium chloride✓1

17. a) Hydrogen
Hydrogen is the reference electrode for standard measurement
1mk

b) i) Zn
ii) Br_2
1mk

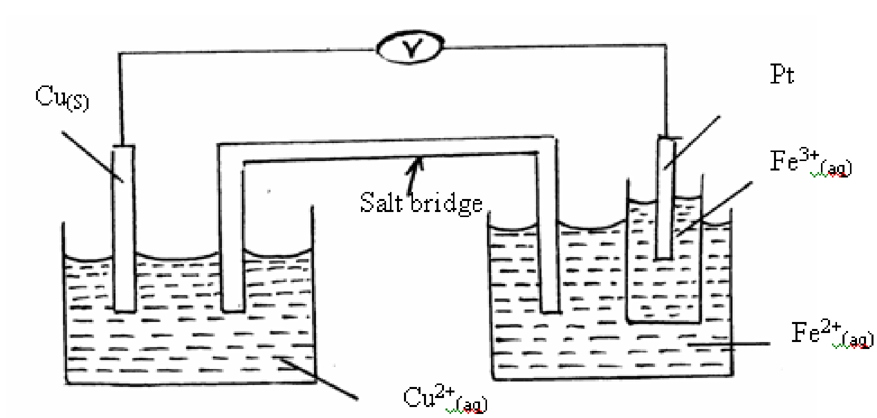
c) $Zn_{(s)} + Br_{2(aq)} \longrightarrow 2Br_{(aq)} + Zn^{2+}_{(aq)}$

e.m.f = 1.07 – (-0.76)
=+1.83v
2mks

d) $2Fe^{3+}_{(aq)} + Cu_{(s)} \longrightarrow 2Fe^{2+}_{(aq)} + Cu^{2+}_{(aq)}$ 1mk

$Cu_{(s)}$ / Cu^{2+}_{aq} // $Fe^{2+}_{(aq)}$ / $Fe^{3+}_{(aq)}$ Pt
1M 1M 1M

e)



g) i) Q = It

Q in faradays = $\frac{It}{96500}$ = $\frac{1.8 \times 3 \times 60 \times 60}{96500}$

= 0.2014F

ii) AL^{3+} 3e^{-} $\longrightarrow$ Al

1 mole of alluminium needs = 3F

∴ Moles of alluminium deposited

$\frac{0.2014}{3}$

= 0.06713

iii) Mass deposited = R.F.M x m,oles

= 0.0671 x 27

= 1.8117$_{(g)}$ 2mks

18. a)i) magnesium ✓ ½

Zinc ✓ ½

They are more recictive (electropositive) than iron✓1

ii) $Fe_{(s)} \longrightarrow Fe^{2+}{}_{(aq)} + 2e$✓1

$Cu^{2+}{}_{(aq)} + 2e \longrightarrow Cu(s)$ ✓1

b) i) Copper ✓1

ii) $Fe^{2+}{}_{(aq)}$, $Sn^{2+}{}_{(aq)}$, $Cu^{2+}{}_{(aq)}$ Ag^{+} (Any two 1 mark)

iii) Tin ✓1

c) Q = It

Q = 2 x 10 x 60 = 1200C ✓ ½

$Cu^{2+}{}_{(aq)} + 2\,e \longrightarrow Cu_{(s)}$ ✓ ½

2F $\longrightarrow$ 64g✓ ½

2 x 96500c $\longrightarrow$ $\frac{64 \times 1200}{2 \times 96500}$✓ ½

= 0.398g✓ ½

d) i) X ✓ ½

has the highest std electrode potential ✓ ½

ii) Yes ✓ ½

R is more reactive than x

OR E.m.f is – ve for the reaction $R + 2x^{+} \longrightarrow R^{2+} + 2x$

iii) $2x_{(s)} / 2x^{+}_{(aq)} // R^{2+}_{(aq)} / R_{(s)}$ ✓1

↑ Salt bridge ✓ ½