A-LEVEL PAPER 1 PP3 MS

|  |  |  |  |
| --- | --- | --- | --- |
| **1.** |  | | |
|  |  | | |
|  | (c) | **[9]** | |
| **2.** |  | | |
|  |  | | |
|  | (c) | | **[6]** |
| **3.** |  | | |
|  |  | | |
|  |  | | |
|  | **[4]** | | |

**4.** (a)    Enthalpy change (to separate) 1 mol of an (ionic) substance into its ions

*If ionisation or hydration / solution, CE = 0*

*If atoms / molecules / elements mentioned, CE = 0*

*Allow heat energy change but not energy change alone.*

*If forms 1 mol ions, lose M1*

**1**

Forms ions in the gaseous state

*If lattice formation not dissociation, allow M2 only.*

*Ignore conditions.*

*Allow enthalpy change for*

*MX(s)* ***→*** *M+(g) + X−(g) (or similar) for M1 and M2*

**1**

(b)     Any **one** of:

•         Ions are point charges

•         Ions are perfect spheres

•         Only electrostatic attraction / bonds (between ions)

•         No covalent interaction / character

•         Only ionic bonding / no polarisation of ions

*If atoms / molecules mentioned, CE = 0*

**1 max**

(c)     (Ionic) radius / distance between ions / size

*Allow in any order.*

*Do not allow charge / mass or mass / charge.*

**1**

(Ionic) charge / charge density

*Do not allow ‘atomic radius’.*

**1**

(d)     Δ*H*L = Δ*H*a (chlorine) + Δ*H*a (Ag) + I.E(Ag) +EA(Cl) − ΔHfϴ

*Or cycle*

*If AgCl2, CE=0 / 3*

**1**

= 121 + 289 + 732 − 364 + 127

**1**

= (+) 905 (kJ mol−1)

*Allow 1 for −905*

*Allow 1 for (+)844.5 (use of 121 / 2)*

*Ignore units even if incorrect.*

**1**

(e)     M1 Greater

*Do not penalise AgCl2*

**1**

M2 (Born-Haber cycle method allows for additional) covalent interaction

*Allow AgCl has covalent character.*

*Only score M2 if M1 is correct*

***OR***

M1 Equal

M2 AgCl is perfectly ionic / no covalent character

**1**

**[10]**

**5.**       (a)     (i)      addition of small amounts of acid send eqm to left or extra H+removed by reaction with HCO3–

**1**

ratio [H2CO3]/[HCO3–] remains constant hence [H+] and  
pH remain const

**1**

(ii)     pH = 7.41  [H+] = 3.89 × 10–8 mol dm–3

**1**

*K*a = 

**1**

=  = 7.78 × 10–8 mol dm–3

*allow error carried forward mark. Do not penalise twice.*

**1**

(b)     (i)      moles H+ added = 10 × 10–3 × 1.0 = 0.01

**1**

(ii)     moles ethanoic acid after addition = 0.15 + 0.01 = 0.16

**1**

         moles ethanoate ions after addition = 0.10 – 0.01 = 0.09

**1**

(iii)     [H+] = 

**1**

= 1.74 × 10–5 × 

**1**

pH = 4.51

**1**

**[11]**

**6.**      (a)     Hydrogen/H2 gas/bubbles

**1**

1.0 mol dm–3 HCl/H+

**1**

At 298K and 100kPa

*Allow 1 bar instead of 100 kPa  
Do not allow 1 atm*

**1**

Pt (electrode)

**1**

(b)     Li+ + MnO2 + e– → LiMnO2

*Ignore state symbols*

**1**

–0.13(V)

**1**

(c)     Fe3+ ions reduced to Fe2+

*Can score from equation/scheme*

**1**

Because *E*(Fe3+(/Fe2+)) > *E*(H+/H2)/*E*(hydrogen)

*Allow emf/Ecell +ve/0.77V  
Allow Fe3+ better oxidising agent than H+Allow H2 better reducing agent than Fe2+Only award this explanation mark if previous mark given*

**1**

(d)     Moles Cr2O72– =23.7 × 0.01/1000 = 2.37 × 10–4

**1**

1 mol Cr2O72– reacts with 6 mol Fe2+ so moles  
Fe2+ in 25 cm3 = 6 × 2.37 × 10–4 = 1.422 × 10–3

**1**

*M1 × 6*

Moles Fe2+ in 250 cm3 = 1.422 × 10–2

*M2 × 10 or M4/10*

**1**

Original moles Fe2+ = 10.00/277.9 = 0.0360

*Independent mark*

**1**

Moles Fe2+ oxidised = 0.0360 – 0.0142 = 0.0218

*M4 – M3*

**1**

% oxidised = (0.0218 × 100)/0.0360 = 60.5%

*(M5 × 100)/M4  
Allow 60 to 61  
Note Max 3 if mol ratio for M2 wrong  
eg 1:5 gives 67.1%  
1:1 gives 93.4%*

*Note also, 39.5% (39-40) scores M1, M2, M3 and M4 (4 marks)*

**1**

**[14]**

**7.** (a)    (i)      H2 + 2OH- → 2H2O + 2e- / H2 → 2H+ + 2e-

*Any order*

**1**

O2 + 4e- + 2H2O → 4OH- / O2 + 4H+ + 4e- → 2H2O

**1**

(ii)     Hydrogen (electrode) produces electrons

*Ignore reference to salt bridge*

*Do not allow at negative / positive electrode – must identify hydrogen and oxygen*

**1**

Oxygen (electrode) accepts electrons

*Allow electrons flow to the oxygen electrode*

**1**

(b)    Hydrogen / the fuel / reactants supplied continuously / fed in

*Do not accept oxygen supplied as the only statement*

**1**

(c)    In the fuel cell, a greater proportion of the energy available from the hydrogen–oxygen reaction is converted into useful energy

*Allow less energy wasted / more efficient*

*Do not allow reference to safety*

**1**

(d)    Hydrogen is flammable / H+ corrosive / OH– corrosive / hydrogen explosive

**1**

**[7]**

**8.**      (a)     (i)      Deductions:

         Ionic **(1)**Ions not free to move in the solid state **(1)**Ions free to move when molten or in aqueous solution **(1)**Identity of **P**: Na2O or sodium oxide **(1)**

*N.B. If a formula given this must be correct*

         Equation: Na2O + H2O → 2 NaOH **(1)**

**5**

(ii)     Deductions:

         Covalent  
Intermolecular forces are weak or van der Waals forces,  
or dipole-dipole

*N.B. Any answer including a reference to hydrogen bonding is incorrect*

         Identity of **Q**: SO2 or sulphur dioxide **(1)**

         Equation: SO2 + H2O → H2 SO3**(1)**

*NB Allow max one for SO3*

**4**

(b)     (i)      Amphoteric **(1)**

(ii)     Equation with NaOH

         Al(OH)3 + NaOH → NaAl(OH)4

*OR Al(OH)3(H2O)3 + OH– → [Al(OH)4(H2O)2]– + H2O  
OR Al(OH)3 + OH– → [Al(OH)4]–*

**R** identified as Al(OH)3 or Al(OH)3(H2O)3 **(1)**A balanced equation **(1)**

*N.B. Allow equation with six co-ordinate Aluminium and up to six OH– ligands  
N.B. Allow equation mark if M(OH)3 given in a balanced equation*

         Equation with H2SO4

2Al(OH)3 + 3H2SO4 → Al2(SO4)3 + 6H2O

OR Al(OH)3(H2O)3 + H+ → [Al(OH)2(H2O)4+ + H2O

*NB Allow equations with six co-ordinate Aluminium and up to six H2O ligands NB Allow equation mark if M(OH)3 given in a balanced equation*

Correct Al species as product **(1)**A balanced equation **(1)**

(iii)     Large lattice energy  
or strong covalent bonds  
or ΔHsoln is very positive  
or ΔG is positive  
or sum of hydration energies less than covalent bond energies **(1)**

**6**

**[15]**

**9.**       Linear complex             e.g.        [Ag(NH3)2]+ **(1)**

          Tetrahedral complex     e.g.        [CoCl4]2– **(1)**

          Octahedral complex     e.g.        [Fe(H2NCH2CH2NH2)3]3+

*Species* ***(1)****Charge* ***(1)***

**[4]**

**10.** (a)    2MnO4– + 16H+ + 5C2O42–  2Mn2+ + 8H2O + 10CO2

*For all species correct / moles and species correct but charge incorrect*

**1**

*For balanced equation including all charges (also scores first mark)*

**1**

(b)     Manganate(VII) ions are coloured (purple)

**1**

All other reactants and products are **not** coloured (or too faintly coloured to detect)

*Allow (all) other species are colourless*

*Allow Mn2+ are colourless / becomes colourless / pale pink*

**1**

(c)     The catalyst for the reaction is a reaction product

**1**

Reaction starts off slowly / gradient shallow

**1**

Then gets faster/rate increases / gradient increases

*Allow concentration of MnO4– decreases faster / falls rapidly*

**1**

(d)     Mn2+ ions

*Allow Mn3+ ions*

**1**

(e)     MnO4– + 8H+ + 4Mn2+  5Mn3+ + 4H2O

*Allow multiples*

**1**

2Mn3+ + C2O42–  2Mn2+ + 2CO2

**1**

**[10]**

**11.** (a)     Idea that over time / after storage meter does not give accurate readings

*Do not accept ‘to get an accurate reading’ without further qualification.*

*Allow ‘temperature variations affect reading’.*

**1**

(b)     

*Allow without (aq) symbols.*

*Need at least one set of square brackets around complex ions*

**1**

(c)     pH = –log [H+]

**1**

[H+] = 0.0240

*Do not penalise precision of [H+]*

*Correct answer scores M1 and M2.*

**1**

*Ka* = (0.0240)2 / 0.1 = 5.75 ×10-3 or 5.76 ×10-3

*Correct answer without working loses M1 and M2.*

*Allow 7.58 ×10-3*

**1**

Answer, even if incorrect, given to 3 sig figs

**1**

(d)     Oxygen (in the air) / O2

*Ignore ‘air’ or ‘the atmosphere’ or ‘chemicals in soil’.*

*List principle.*

**1**

(e)     4.0 – 6.9

*Do not penalise precision.*

**[7]**

|  |  |
| --- | --- |
| **12.** |  |
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|  |  |
|  |  |
|  | **[8]** |