A-LEVEL PAPER 1 PP4 MS

|  |  |
| --- | --- |
| **1.** |  |
|  |  |
|  | **[9]** |
| **2.** |  |
|  | **[5]** |
| **3.** |  |
|  |  |
|  | **[4]** |

**4.**      (a)     Heat (energy) change at constant pressure

*Ignore references to standard conditions, but credit specified pressure.*

**1**

(b)     The enthalpy change/heat (energy) change (at constant pressure) in a  
reaction is independent of the route/path taken (and depends only  
on the initial and final states)

**1**

(c)     Δ*H* + 963 = –75 – 432 OR Δ*H* + 963 = – 507 (**M1**)

Δ*H* = –75 – 432 – 963 (**M1** and **M2**)

Δ*H* = **–1470** (kJ mol–1)

Award 1 mark for + 1470

*Award full marks for correct answer*

*Ignore units.*

*Ignore numbers on the cycle*

***M1*** *and* ***M2*** *can score for an arithmetic error*

**3**

**[5]**

**5.** (a)    Cl(g) + e- → Cl-(g)

*State symbols essential*

*Allow e with no charge*

*This and all subsequent equations must be balanced*

**1**

(b)    There is an attraction between the nucleus / protons and (the added) electron(s)

**1**

Energy is released (when the electron is gained)

*Allow product more stable / product has lower energy*

*Allow reaction exothermic / heat released*

*Allow reference to chlorine rather than fluorine*

*Wrong process eg ionisation, boiling CE = 0*

**1**

(c)    (i)      Top line: + e– + F(g)

*Penalise missing / wrong state symbols one mark only*

*Penalise Fl or Cl one mark only*

**1**

Second line from top : + e– +  F2(g)

*Mark independently*

*Allow e with no charge*

**1**

Bottom two lines: +F2(g)

*Penalise each lack of an electron in M1 and M2 each time*

**1**

(ii)      E(F–F) + 732 + 289 + +203 = 348 + 955

E(F–F) = 79

**1**

E(F–F) = 158 (kJ mol–1)

*Award one mark (M2) if M1 wrong but answer = M1 × 2*

*Ignore no units, penalise wrong units but allow kJ mol–*

*Any negative answer, CE = 0*

**1**

(d)     (i)      Experimental lattice enthalpy value allows for / includes covalent interaction / non–spherical ions / distorted ions / polarisation

OR AgF has covalent character

*Allow discussion of AgCl instead of AgF*

*CE = 0 for mention of molecules, atoms, macromolecular, mean bond enthalpy, intermolecular forces (imf), electronegativity*

**1**

Theoretical lattice enthalpy value assumes only ionic interaction / point charges / no covalent / perfect spheres / perfectly ionic

OR AgF is not perfectly ionic

**1**

(ii)     Chloride ion larger (than fluoride ion) / fluoride ion smaller (than chloride ion)

*Penalise chlorine ion once only*

*Allow Cl– and F– instead of names of ions*

*Allow chloride ion has smaller charge density / smaller charge to size ratio but penalise mass to charge ratio*

**1**

Attraction between Ag+ and Cl– weaker / attraction between Ag+ and F– stronger

*For M2 Cl- and F- can be implied from an answer to M1*

*Mark M1 and M2 independently provided no contradiction*

*CE = 0 for mention of chlorine not chloride ion, molecules, atoms, macromolecular, mean bond enthalpy, intermolecular forces (imf), electronegativity*

**1**

**[12]**

**6.** (a)     (i)      [H+][OH–]

**1**

– log [H+]

**1**

(ii)     [H+] = [OH–]

**1**

(iii)     (2.0 × 10–3) × 0.5 = 1.0 × 10–3

**1**

(iv)    [H+] =                     (= 4.02 × 10–11)

**1**

pH = 10.40

**1**

(b)     (i)      Ka  =  [H+][CH3CH2COO-]

          [CH3CH2COOH]

**1**

         =            [H+]

          [CH3CH2COOH]

**1**

[H+] = √(1.35 × 10–5) × 0.125      (= 1.30 × 10–3)

**1**

pH = 2.89

**1**

(c)     (i)      (50.0 × 10–3) × 0.125 = 6.25 × 10–3

**1**

(ii)     (6.25 × 10–3) – (1.0 × 10–3) = 5.25 × 10–3

**1**

(iii)     mol salt formed = 1.0 × 10–3

**1**

[H+] = Ka ×   [CH3CH2COOH]

                      [CH3CH2COO–)

**1**

= (1.35 × 10–5) × (= 7.088 × 10–5)

**1**

pH = 4.15

**1**

**[16]**

**7.** (a)     To remove the oxide layer on the aluminium

*Do not allow ‘cleaning’ or ‘removal of grease’.*

*Do not allow ‘removal of impurities’ without qualification.*

**1**

(b)     An appropriate method for delivering H2 gas over a Pt electrode

*Need H2 gas and Pt electrode labelled (allow gas delivered directly below the electrode).*

**1**

The Pt electrode must clearly be in contact with a solution of a named acid.

*Ignore any concentration or pressure values.*

*Ignore absence of bubbles.*

*Allow if electrode is below outer acid level.*

**1**

(c)     The carbonate ion reacts with the acid (in the SHE) / reaction between carbonate and Al3+

*Lose this mark if aluminium carbonate formed but mark on.*

**1**

Reaction given (either equation or products specified)

***OR*** H+ / Al3+ concentrations change / cell e.m.f. altered

**1**

**[5]**

**8.** (a)     To prevent it coming into contact/reacting with oxygen/air

*Allow because it reacts with air/oxygen*

*And because with air/oxygen it forms an oxide. (Oxide, if identified, must be correct :- P4O10, P2O5, P4O6, P2O6)*

**1**

(b)     One molecule contains 4P and 10O/the molecular formula is P4O10

*Allow exists as P4O10*

*Do not allow reference to combination of two P2O5 molecules*

*Ignore any reference to stability*

**1**

(c)     P4O10 is a bigger molecule (than SO3)/greater Mr/more electrons/ greater surface  
area

*Penalise SO2 for one mark (max 1)*

*CE = 0 if mention of hydrogen bonding/ionic/ giant molecule/breaking of covalent bonds*

**1**

Van der Waals / vdW forces between molecules are stronger/require more energy  
to break

*Do not allow just more vdW forces*

*Ignore any reference to dipole-dipole forces*

**1**

(d)     P4O10 + 6H2O ࢐ 4H3PO4

*Allow correct ionic equations*

*Ignore state symbols*

**1**

pH must be in the range –1 to +2

*Allow –1 to +2*

*Mark independently*

**1**

(e)     (i)      3MgO + 2H3PO4 → Mg3(PO4)2 + 3H2O  
OR MgO + 2H3PO4 → Mg(H2PO4)2 + H2O  
OR MgO + H3PO4 → MgHPO4 + H2O

*Allow MgO + 2H+ → Mg2+ + H2O*

*Allow magnesium phosphates shown as ions and ionic equations*

*Ignore state symbols*

**1**

(ii)     MgO is sparingly soluble/insoluble/weakly alkaline

*Excess/unreacted MgO can be filtered off/separated*

**1**

(iii)    An excess of NaOH would make the lake alkaline/toxic/kill wildlife

*Allow pH increases*

**1**

**[9]**

**9.**      (a)     Brown ppt/solid

**1**

Gas evolved/effervescence

**1**

2[Fe(H2O)6]3+ + 3CO32– → 2Fe(H2O)3(OH)3 + 3CO2 + 3H2O

*Must be stated, Allow CO2 evolved. Do not allow CO2 alone*

*Correct iron product (1) allow Fe(OH)3 and in equation*

*Balanced equation (1)*

**2**

(b)     White ppt/solid

**1**

Colourless Solution

*Only award M2 if M1 given or initial ppt mentioned*

**1**

[Al(H2O)6]3+ + 3OH– → Al(H2O)3(OH)3 + 3H2O

*Allow [Al(H2O)6]3+ + 3OH– → Al(OH)3 + 6H2O*

**1**

Al(H2O)3(OH)3 + 3OH– → [Al(OH)6]3– + 3H2O

*Allow formation of [Al(H2O)6–x(OH)x](x–3)– where x = 4,5,6*

*Allow product without water ligands*

*Allow formation of correct product from [Al(H2O)6]3+*

**1**

(c)     Blue ppt/solid

**1**

(Dissolves to give a) deep blue solution

*Only award M2 if M1 given or initial ppt mentioned*

**1**

[Cu(H2O)6]2+ + 2NH3 → Cu(H2O)4(OH)2 + 2NH4+

*Allow [Cu(H2O)6]2+ + 2NH3 → Cu(OH)2 + 2NH4+ + 4H2O*

*Allow two equations: NH3 + H2O → NH4+ + OH–*

*then [Cu(H2O)6]2+ + 2OH– → Cu(OH)2 + 4H2O etc*

**1**

Cu(H2O)4(OH)2 + 4NH3 → [Cu(H2O)2(NH3)4]2+ + 2OH– + 2H2O

*Allow [Cu(H2O)6]2+ + 4NH3 → [Cu(H2O)2(NH3)4]2+ + 4H2O*

**1**

(d)     Green/yellow solution

**1**

[Cu(H2O)6]2+ + 4Cl– → [CuCl4]2– + 6H2O

**1**

**[14]**

**10.** (a)     Manganate would oxidise / react with Cl−

**1**

Because *E*ϴ for MnO4− is more positive than that for Cl2 / 1.51 – 1.36 = +0.15 (V)

*Must refer to data from the table for M2.*

**1**

(b)     Moles of H+ = 25 × 0.0200 × 8 / 1000 = 4.00 × 10−3

**1**

Moles of H2SO4 = 2.00 × 10−3 (4.00 × 10−3 / 2)

*Allow consequential marking on incorrect moles of H+*

**1**

Volume H2SO4 = 4.00 (cm3) (2.00 × 10−3 × 1000 / 0.500)

*Allow consequential marking on incorrect moles of H2SO4*

*Accept 4 cm3.*

*8 cm3 scores 2 marks.*

*Do not penalise precision.*

*Correct answer without working scores M3 only.*

**1**

(c)     (i)      MnO4−  +  4H+  +  3e−  →  MnO2  +  2H2O

*Allow multiples, including fractions.*

*Ignore state symbols.*

**1**

(ii)     Can’t see end point due to brown colour

**1**

Larger titre (than expected)

*Allow the idea that with two reactions can’t make use of titre in calculations.*

*Do not allow ‘an inaccurate result’ without qualification.*

**1**

(d)     Solution (very) dilute / lots of water

**1**

**[9]**

**11.** (a)      3C2O42− + [Co(H2O)6]2+ → [Co(C2O4)3]4− + 6H2O

*Accept multiples.*

*Equation must have cobalt(II) hexaaqua ion.*

**1**

(b)     Ethanedioate ion reduces iron(III) ion **or**

iron(III) ion oxidises ethanedioate ion

*Allow answer using equations.*

**1**

****(CO2 / C2O42−) more negative than  (Fe3+ / Fe2+) **or**

**** (Fe3+ / Fe2+) >  (CO2 / C2O42−)

**or** e.m.f. positive **or** cell voltage = +1.26

**1**

**[3]**

|  |  |  |  |
| --- | --- | --- | --- |
| **12.** | (a) |  | |
|  | (b) |  | |
|  | (c) | |  |
|  | (d) | |  |
|  | (e) | |  |
|  |  | | |
|  | (f) | |  |
|  | (g) | |  |
|  | (h) | | **[14]** |