A-LEVEL PAPER 1 PP5 MS

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **1.** |  | | | |
|  |  | | | |
|  |  | | | |
|  | (iii) | | **[8]** | |
| **2.** |  | | | |
|  |  | | | |
|  | (c) | (i) | |  |
|  |  | (ii) | | **[4]** |
| **3.** |  | | | |
|  | **[8]** | | | |

**4.** (a)    Enthalpy change / *ΔH* when 1 mol of a gaseous ion

*Enthalpy change for X+ / -(g) → X+ / -(aq) scores M1 and M2*

**1**

forms aqueous ions

*Allow heat energy change instead of enthalpy change*

*Allow 1 mol applied to aqueous or gaseous ions*

*If substance / atoms in M1 CE = 0*

*If wrong process (eg boiling) CE = 0*

**1**

(b)    *ΔH*(solution) = *ΔH*(lattice) + Σ(*ΔH*hydration)

OR +77 = +905 – 464 + *ΔH*(hydration, Cl-)

OR *ΔH*(hydration, Cl-) = +77 –905 + 464

*Allow any one of these three for M1 even if one is incorrect*

**1**

= –364 (kJ mol–1)

*Allow no units, penalise incorrect units, allow kJ mol–*

*Allow lower case j for J (Joules)*

*+364 does not score M2 but look back for correct M1*

**1**

(c)    Water is polar / water has Hδ+

**1**

(Chloride ion) attracts (the H in) water molecules

(note chloride ion can be implied from the question stem)

*Idea that there is a force of attraction between the chloride ion and water*

*Do not allow H bonds / dipole–dipole / vdW / intermolecular but ignore loose mention of bonding*

*Do not allow just chlorine or chlorine atoms / ion*

*Mark independently*

**1**

(d)    *ΔG = ΔH – TΔS*

*Look for this equation in part (d) and / or (e); equation can be stated or implied by correct use. Record the mark in part (d)*

**1**

*(ΔG = 0 so) T = ΔH / ΔS*

**1**

*T* = 77 × 1000 / 33 = 2333 K (allow range 2300 to 2333.3)

*Units essential, allow lower case k for K (Kelvin)*

*Correct answer with units scores M1, M2 and M3*

*2.3 (K) scores M1 and M2 but not M3*

**1**

Above the boiling point of water (therefore too high to be sensible) / water would evaporate

*Can only score this mark if M3 >373 K*

**1**

(e)    Δ*S* = (Δ*H* – Δ*G*) / *T* OR ΔS = (Δ*G* – Δ*H*) / –*T*

**1**

= ((–15 + 9) × 1000) / 298 OR (–15 + 9) / 298

**1**

= –20 J K–1 mol–1          OR –0.020 kJ K–1 mol–1

(allow –20 to –20.2)          (allow –0.020 to –0.0202)

*Answer with units must be linked to correct M2*

*For M3, units must be correct*

*Correct answer with appropriate units scores M1, M2 and M3 and possibly M1 in part (d) if not already given*

*Correct answer without units scores M1 and M2 and possibly M1 in part (d) if not already given*

*Answer of –240 / –0.24 means temperature of 25 used instead of 298 so scores M1 only*

*If ans = +20 / +0.020 assume AE and look back to see if M1 and possibly M2 are scored*

**1**

**[13]**

**5.**      (a)     (i)      – log[H+] or log 1/[H+]

*penalise missing square brackets here only*

**1**

(ii)     0.81

*2dp required, no other answer allowed*

**1**

(iii)     **M1** mol H+ = 1.54 × 10–3

*if wrong no further mark  
if 1.5 × 10–3 allow M1 but not M2 for 2.82*

**1**

**M2** pH = 2.81

*allow more than 2dp but not fewer*

**1**

(b)     **M1** [H+] = 3.31 × 10–3

**1**

**M2** Ka = or  or using numbers

*do not penalise ( ) or one or more missing [ ]*

**1**

**M3** [HX] = 

*allow conseq on their [H+]2/(4.83 × 10–5) (AE)  
if upside down, no further marks after M2*

**1**

**M4** [HX] = 0.227

*allow 0.225 – 0.23*

**1**

(c)     **M1** extra/added OH– removed by reaction with H+ or the acid

**1**

**M2** correct discussion of equn shift i.e. HX  H+ + X– moves to right

**1**

**OR**

ratio  remains almost constant

(d)     (i)      **M1** mol HY = (50 × 10–3) × 0.428 = 0.0214

***OR*** [Y] = .0236 × 

*mark for answer*

**1**

**M2** [H+] = 1.35 × 10–5 × 

***OR*** 1.35 × 10–5 = [H+] × 

***OR*** [H+] = 1.35 × 10–5 × 

***OR*** 1.35 × 10–5 = [H+] × 

*must be numbers not just rearrangement of Ka expression*

*If either HY value or Y– value wrong, (apart from AE -1) lose M2 and M3*

**1**

**M3** [H+] = 1.22 ×10–5

*mark for answer*

**1**

**M4** pH = 4.91

*allow more than 2dp but not fewer*

***allow M4 for correct pH calculation using their [H+] (this applies in (d)(i) only)***

**1**

**If Henderson Hasselbalch equation used:**

**M1** mol HY = (50 × 10–3) × 0.428 = 0.0214

**OR** [Y] = .0236 × 

*mark for answer*

**1**

**M2** p*K*a = 4.87

**1**

**M3** log = –0.043

          log = –0.043

*If either HY value or Y– value wrong, (apart from AE-1) lose M3 and M4*

**1**

**M4** pH = 4.87 – (– 0.043) = 4.91

*allow more than 2dp but not fewer*

**1**

(ii)     Can score full marks for correct consequential use of their  
HY and Y– values from d(i)

**M1** Mol HY after adding NaOH = 0.0214 – 5.0 × 10–4 = 0.0209

*AE in subtraction loses just M1  
If wrong initial mol HY (i.e. not conseq to part d(i)) or no subtraction or subtraction of wrong amount, lose M1 and M3*

**1**

**M2** Mol Y– after adding NaOH = 0.0236 + 5.0 × 10–4 = 0.0241

*AE in addition loses just M2  
If wrong mol Y– (i.e. not conseq to part d(i)) or no addition or addition of wrong amount lose M2 and next mark gained*

**1**

**M3** [H+] = 1.35 × 10–5 ×  (= 1.17 × 10–5)

          if convert to concentrations

          [H+] = 1.35 × 10–5 ×  (= 1.17 × 10–5)

**1**

*if HY/Y– upside down, no further marks*

**M4** pH = 4.93

*allow more than 2dp but not fewer*

*NOT allow M4 for correct pH calculation using their [H+] (this allowance applies in (d)(i) only)*

**1**

**If Henderson Hasselbalch equation used:**

*Can score full marks for correct consequential use of their HY and Y– values from d(i)*

**M1** Mol HY after adding NaOH = 0.0214 – 5.0 ×10–4 = 0.0209

*AE in subtraction loses just M1  
If wrong initial mol HY (i.e. not conseq to part d(i)) or no subtraction or subtraction of wrong amount lose M1 and M3*

**1**

**M2** Mol Y– after adding NaOH = 0.0236 + 5.0 × 10–4 = 0.0241

*AE in addition loses just M2  
If wrong mol Y– (i.e. not conseq to part d(i)) or no addition or addition of wrong amount lose M2 and next mark gained*

**1**

**M3** log  = –0.062

*if HY/Y–– upside down, no further marks*

**1**

**M4** pH = 4.87 – (– 0.062) = 4.93

*allow more than 2dp but not fewer*

**1**

**[18]**

**6.**      (a)     most powerful reducing agent:   Zn;

**1**

(b)     (i)      reducing species:                            Fe2+

**1**

(ii)     oxidising species:                            Cl2;

**1**

(c)     (i)      standard electrode potential            1.25 V;

**1**

(ii)     equation: Tl3+ + 2 Fe2+ → 2Fe3+ + Tl +   balanced;

**1**

         correct direction;

**1**

(d)     (i)      moles KMnO4 = 16.2 × 0.0200 ×10–3 = 3.24 ×10–4;

**1**

moles H2O2 = Moles KMnO4 × 5 / 2 = 8.10 × –4;

**1**

8.10 × 10–4 moles H2O2 in 25 cm38.10 × 10–4 × 1000 / 25 in 1000 cm3 = 0.0324 mol dm–3;

**1**

hence g dm–3 = mol dm–3 × *M*r *=* 0.0324 × 34 = 1.10;

*(penalise use of an incorrect H2O2 to KMnO4 ratio by two marks)*

**1**

(ii)     PV = nRT;

**1**

hence V = nRT / P  
= 8.10 × 10–4× 8.31 × 298/98000;

**1**

= 2.05 × 10–5;

**1**

units m3;

*(mark consequentially to answers in (c)(i))  
(allow correct answers with other units)  
(answers to (c)(i) and (ii) must be to 3 significant figures; penalise once only)*

**1**

**[14]**

**7.** (a)     (i)      absorbs (certain frequencies of) (white) light / photons

*not absorbs white / u.v. light*

**1**

d electrons excited / promoted

*or d electrons move between levels / orbitals*

*d electrons can be implied elsewhere in answer*

**1**

the colour observed is the light not absorbed / light  
reflected / light transmitted

*allow blue light transmitted*

*penalise emission of light in M3*

**1**

(ii)     ΔE is the energy gained by the (excited) electrons (of Cu2+)

*allow:*

*•    energy difference between orbitals / sub-shells*

*•    energy of photon / light absorbed*

*•    change in energy of the electrons energy lost by  
     excited electrons*

*•    energy of photon / light emitted*

**1**

h (Planck's) constant

**1**

*v* frequency of light (absorbed by Cu2+(aq))

*do not allow wavelength*

*If energy lost / photon lost / light emitted in M1 do not penalised light emitted*

**1**

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

*note that [CuCl4–]2– is incorrect*

*penalise charges shown separately on the ligand and overall*

*penalise HCl*

**1**

tetrahedral

**1**

Cl– / Cl / chlorine too big (to fit more than 4 round Cu)

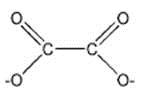
*allow*

*water smaller than Cl–*

*explanation that change in shape is due to change in  
co-ordination number*

**1**

(b)



*allow:*

*•    ion drawn with any bond angles*

*•    ion in square brackets with overall / 2- charge shown  
     outside the brackets*

*•    ion with delocalised O=C–O bonds in carboxylate  
     group(s)*

**1**

lone pair(s) on O– / O

*allow position of lone pair(s) shown on O in the diagram even if the diagram is incorrect.*

**1**

(c)     (i)      [Cu(H2O)6]2+ + 2C2O42– → [Cu(C2O4)2(H2O)2]2– + 4H2O

product correct

**1**

equation balanced

**1**

6

*note can only score M3 and M4 if M1 awarded or if complex in equation has 2 waters and 2 ethanedioates*

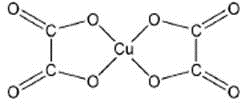
**1**

octahedral

*If this condition is satisfied the complex can have the  
wrong charge(s) to allow access to M3 and M4 but not M1*

**1**

(ii)



*ignore charges*

*diagram must show both ethanedioates with correct bonding*

*ignore water*

**1**

90°

*allow 180°*

*mark bond angle independently but penalise if angle incorrectly labelled / indicated on diagram*

**1**

**[17]**

**8.** (a)    Variable / many oxidation states

**1**

(b)     V2O5 + SO2 → V2O4 + SO3

*Equations can be in either order*

*Allow multiples*

**1**

V2O4 + ½O2 → V2O5

**1**

(c)     (i)      In a different phase / state from reactants

**1**

(ii)     Impurities poison / deactivate the catalyst / block the active sites

*Allow (adsorbs onto catalyst AND reduces surface area)*

**1**

(d)     (i)      The catalyst is a reaction product

**1**

(ii)     Mn2+ / Mn3+ ion(s)

**1**

(iii)    4Mn2+ + MnO4− + 8H+ → 5Mn3+ + 4H2O

*Equations can be in either order*

**1**

2Mn3+ + C2O42− → 2Mn2+ + 2CO2

**1**

**[9]**

|  |  |  |
| --- | --- | --- |
| **9.** | (a) |  |
|  | (b) |  |
|  | (c) |  |
|  | (d) |  |
|  | (e) |  |
|  | (f) |  |
|  |  | |
|  |  | |
|  | (g) |  |
|  | (h) |  |
|  | (i) | **[14]** |