MARK SCHEME

EDWEST CHEMISTRY STAGE 3 PAPER 2011

Section One

1. C 16. A
2. D 17. B
3. A 18. B
4. B 19. C
5. D 20. C
6. A 21. D
7. B 22. C
8. C 23. B
9. D 24. D
10. D 25. A
11. D
12. A
13. B
14. C
15. B

Section Two

26. (a) (3)

|  |  |
| --- | --- |
| **Change** | **Effect** |
| Adding dilute nitric acid | DECREASE |
| Adding sodium hydroxide solution | INCREASE |
| Adding silver nitrate solution | INCREASE |

(b) (1)

|  |  |
| --- | --- |
| **Equilibrium constant expression** | [H3AsO4][H+][I-]2  [H3AsO3][I2] |

27 (a) Endothermic (1)

(b) (3)

|  |  |
| --- | --- |
| **Change** | **Effect** |
| Increasing the temperature | INCREASE |
| Increasing the volume of the system | DECREASE |
| Adding a catalyst | INCREASE |

28. (a) Basic (1)

(b) Phosphate ions hydrolyse in water (1)

PO43- + H2O ⇌ HPO42- + OH- (1)

OH- ions produced hence basic (1)

29. (a)

H2CO3 + H2O ⇌ H3O+ + HCO3- (2)

(b) OH (1)

C O

OH

(c) As [H+] increases reverse reaction is favoured (1) which would decrease concentration of H3O+(1)

(d) 3.98 x 10-8 mol L-1 (1)

30. Ethanol and water have H-bonding between molecules (1) and so can disrupt the inter molecular bonds (1). Paraffin has only dispersion forces between molecules (1). Therefore ethanol cannot disrupt bonding and form bonds itself with the paraffin.(1)

31. (a) An excess of 2-propanol is oxidised by acidified KMnO4 (3 marks)

|  |  |
| --- | --- |
| Observations | Colour change from purple to colourless (or pale pink) |
| Structural formula of organic product  Show all atoms | CH3COCH3 |
| Name of organic product | propanone |

(b) Methanoic acid reacts with 1-butanol in the presence of H2SO4 (3 marks)

|  |  |
| --- | --- |
| Observations | Fruity smell produced (accept no visible reaction) |
| Structural formula of organic product  Show all atoms | C4H9OOCH |
| Name of organic product | Butyl methanoate |

32.

|  |  |  |  |
| --- | --- | --- | --- |
| **Species** | **Structure (showing all valence shell electrons)** | **Shape (sketch or name)** | **Polarity of molecule (polar or non-polar)** |
| Silicon hydride  SiH4 | H  H Si H  H | Tetrahedral | Non-polar |
| Hydrogen cyanide  HCN | \\San1-Server\staff\daleke\My Documents\My Pictures\2011-05-24\stars0023.JPG | Linear | Non-polar |
| Sulfite ion  SO32- | \\San1-Server\staff\daleke\My Documents\My Pictures\2011-05-24\stars0024.JPG  No brackets or charge no mark | Pyramidal | Polar |
| Boron trifuoride  BF3 | \\San1-Server\staff\daleke\My Documents\My Pictures\2011-05-24\stars0026.JPG | Trigonal Planar | Non-polar |

33. (a) Repeating unit is (1)

CH3

C CH2

COOCH3

(b) (1)

CH3

C CH2

COOCH3

(c) Addition (1)

(d) Ester (1)

34. (a) 3-methylbutanoic acid (1)

(b) (2)

(CH3)2CHCH2CH2OH + H2O 🡪 (CH3)2CHCH2COOH + 4H+ + 4e-

(c) (3)

((CH3)2CHCH2CH2OH + H2O 🡪 (CH3)2CHCH2COOH + 4H+ + 4e-) x 5

(8H+ + MnO4- + 5e- 🡪 Mn2+ + 4H2O) x 4

--------------------------------------------------------------------------------------------------------------------------------------

5(CH3)2CHCH2CH2OH + 12H+ + 4MnO4- 🡪 5(CH3)2CHCH2COOH + 4 Mn2+ + 11H2O

1 mark for each equation (pay follow through for 3rd equation)

35. (a)

(i) Salt bridge drawn and labelled with suitable salt (1)

(ii) Cathode labelled – Ag/Ag+ (1)

(iii) Direction of electron flow labelled – from Ag to Cu (1)

(iv) Anode labelled – Cu/Cu2+ (1)

(b)

(i) Anode Cu 🡪 Cu2+ + 2e- (1)

(ii) Cathode Ag+ + e- 🡪 Ag (1)

(c) 0.46 V (1)

36. (a) Excludes water and oxygen from the surface of the iron (2) which are two of the reactants needed for rust to form (1)

(b) Fe 🡪 Fe2+ + 2e- -0.44 V

Sn 🡪 Sn2+ + 2e- -0.14V (1)

Fe stronger reductant than Sn (1)

Therefore Fe corrodes as electrochemical cell is formed (1)

(c) Zn 🡪 Zn2+ + 2e- -0.76 V

Fe 🡪 Fe2+ + 2e- -0.44 V (1)

Zn stronger reductant than Fe (1)

Therefore Zn corrodes as electrochemical cell is formed (1)

(d) Electrochemical cell formed (1) where Al and Fe are joined (1)

Al stronger reductant than Fe (1)

Therefore Al corrodes (1)

Section Three

37. (a)

n(KHC4H4O6) = 350/(39.1+1.008+4x12.01+1.008x4+16x6)

= 350/188.18

= 1.8599 mol (1)

n(NaHCO3) = 150/(22.99+1.008+12.01+3x16)

= 150/84.008

= 1.7855 mol (1)

1 mol KHC4H4O6 🡪 1 mol NaHCO3

1.8599 ˃ 1.7855

Therefore NaHCO3 is limiting reagent (2)

If students have correct answer but no working – no marks

(b) n(KHC4H4O6)excess = 1.8599 – 1.7855

= 0.0744 (2)

m(KHC4H4O6) = 0.0744 x 188.18

= 14.0 g (1)

(c) 1.7855 mol NaHCO3 🡪 1.7855 mol CO2 (1)

V(CO2) = (1.7855 x 8.315 x 453)/105

= 64.1 L (2)

(d) Let amount of NaHCO3 = x g

Amount of (KHC4H4O6) = (500-x)g (1)

n(KHC4H4O6) = n(NaHCO3)

(500-x)/188.18 = x/84.008

(500-x)84.008 = 188.18x

42004 - 84.008x = 188.18x

42004 = 188.18x + 84.008x

272.19x = 42004

x = 42004/272.19

= 154 g (2)

m (KHC4H4O6) = 500 – 154

= 346 g (1)

Both answers quoted to 3 significant figures (1)

38.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Final reading (mL)** | 20.60 | 19.65 | 20.75 | 20.80 | 19.05 |
| **Initial reading (mL)** | 4.50 | 3.80 | 5.25 | 5.00 | 3.20 |
| **Titration volume (mL)** | 16.10 | 15.85 | 15.50 | 15.80 | 15.85 |

1. (15.85 + 15.85 + 15.80)/3 = 15.83 mL (1)

(b) 2NaOH + H2SO4 🡪 Na2SO4 + 2H2O (1)

(c) Suitable indicator named (almost any would do) (1)

Titration of strong acid with strong base ` (1)

Equivalence point around pH 7 (1)

End point of indicator somewhere between pH 3-10 due to titration curve (1)

(d) [OH-] = [NaOH] = 10-14/5.0119 x 10-14

= 0.19953 molL-1 (1)

n(NaOH) = 0.02 x 0.19953

= 3.9906 x 10-3 mol (1)

n(H2SO4) = 3.9906 x 10-3/2

= 1.9953 x 10-3 mol (1)

n(H2SO4) = (1.9953 x 10-3 x 500)/15.83

= 0.063023 mol (1)

= n(H2SO4) in 10 mL (1)

C (H2SO4) in battery = 0.063023/0.01

= 6.30 molL-1 (1)

39. (a)

m(C) = (5.51 x 12.01)/44.01 = 1.5036 g

%C = (1.5036 x 100)/2.31 = 65.1% (1)

m(H) = (2.81 x 1.008 x 2)/18.016 = 0.31444 g

%H = (0.31444 x 100)/2.31 = 13.6% (1)

%O = 100 – 65.1 – 13.6 = 21.3% (1)

C H O

Ratio by mass 65.1 13.6 21.3

Ratio by mol 65.1/12.01 13.6/1.008 21.3/16

5.42 13.49 1.33

Divide by smallest 5.42/1.33 13.49/1.33 1.33/1.33

4.075 10.143 1

4 10 1

Empirical formula C4H10O (4)

1. 4 x 12.01 + 1.008 x 10 + 16 = 74.12 (1)

Therefore molecular formula = empirical formula

Molecular formula = C4H10O (1)

Draw and name two possible structures of compound X (4 marks)

|  |  |
| --- | --- |
| Structure  CH3CH2CH2CHO | Structure  CH3CHCH3CHO |
| Name  Butanal | Name  methylpropanal |

Draw and name two possible structures of compound Y. (4 marks)

|  |  |
| --- | --- |
| Structure  CH3CH2CH2COOH | Structure  CH3CHCH3COOH |
| Name  Butanoic acid | Name  Methylpropanoic acid |

40. (a)

n(Mg2P2O7) = 0.0364/(24.31x2 + 2x30.97 + 16x7)

= 0.0364/222.56

= 1.63551 x 10-4 mol (1)

2 mol MgNH4PO4 🡪 1 mol Mg2P2O7 (1)

n(MgNH4PO4) = 2 x 1.63551 x 10-4 mol

= 3.27102 x 10-4 mol (1)

n(MgNH4PO4) = n(PO43-) in 20 mL = 3.27102 x 10-4 mol (1)

n(PO43-) in 250 mL = (3.27102 x 10-4 x 250)/20

= 4.0888 x 10-3 mol (1)

m(PO43-) = 4.0888 x 10-3 x (30.97 + 16 x 4)

= 0.38831 g

% = (0.38831 x 100)/6.15

= 6.31% (1)

(b) (4)

|  |  |  |  |
| --- | --- | --- | --- |
| **Action** | **Calculated result would be too low** | **No effect on calculated result** | **Calculated result would be too high** |
| **A.** All of the MgNH4PO4 was not precipitated. | **√** |  |  |
| **B.** All of the fertiliser did not dissolve. | **√** |  |  |
| **C.** The conical flask had been previously washed with water but not dried. |  | **√** |  |
| **D.** The MgNH4PO4 precipitate was not washed with water. |  |  | **√** |

Makes no difference to the number of mol of phosphate ions transferred to the conical flask. (1)

(c) 50.0 kg of fertiliser contains 5.00 kg of K (1)

n(K) = 5000/39.1 = 127.88 mol

n(K) = n(KNO3) = 127.88 mol (1)

m(KNO3) = 127.88(39.1 + 14.01 + 16x3)

= 12930 g

= 12.9 kg (1)

1. Soluble (1) and also contains N which is a nutrient. (1)

41.

(a) m(Cu) = 98% x 106 g

= 980 000 g (1)

n(Cu) = 980 000/63.55

= 15421 mol (1)

1 mol Cu 🡪 1 mol CuFeS2 (1)

15421 mol Cu 🡪 15421 mol CuFeS2 (1)

m(CuFeS2) = 15421 x (63.55 + 55.85 + 32.06 x 2)

= 15421 x 183.52

= 2.83 tonnes (1)

(b) n(Cu) = 15421 mol

1 mol Cu = 3 mol SO2 (1)

15421 mol Cu = 3 x 15421 mol SO2

= 46263 mol SO2 (1)

150 x V(SO2) = 46263 x 8.315 x 1773

V(SO2) = (46263 x 8.315 x 1773)/150

= 4.55 x 106 L (2)

(c) Acid rain (1)

42.

Some points to consider

* Solubility and boiling points will depend upon extent of H-bonding
* All are alcohols so have –OH group and will H-bond
* Strength of H-bond will depend on the extent to which the –OH group is exposed and available for bonding
* Compounds differ as they are all isomers of C4H9OH
* 1-butanol and 2 - methyl -1-propanol are primary alcohols
* 2 – butanol is a secondary alcohol
* 2 – methyl -2 – propanol is a tertiary alcohol
* Structural formulas would be good if drawn
* Expect primary alcohols to be more soluble and have a highest BPts as –OH is more exposed and available for H-bonding
* Tertiary alcohol will be least soluble and lowest Bpt as H-bonding is weakest of the compounds as –OH group is least exposed
* Need to discuss solubility as between molecules that can form intermolecular bonds with each other
* All exhibit dispersion forces