CAMBRIDGE INTERNATIONAL EXAMINATIONS

Cambridge Ordinary Level

MARK SCHEME for the October/November 2014 series

5070 CHEMISTRY

5070/22 Paper 22 (Theory), maximum raw mark 75

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A1 (a) (i) S / sulfur / P / phosphorus (1)

(ii) Fe / iron (1)

(iii) P / phosphorus (1) [1]

(iv) Zn / zinc / As / arsenic (1) [1]

(v) Fe / iron (1) [1]

(vi) H / hydrogen / H_2 / N / nitrogen / N_2 (1) [1]

(b) (i) $4As + 3O_2 \rightarrow 2As_2O_3$ (1) [1]

(ii) (arsenous acid) has a lower concentration of hydrogen ions / hydrochloric acid has higher concentration of hydrogen ions (1)

less frequent collisions (between ions in arsenous acid) / more frequent collisions (between ions) in hydrochloric acid (1) [2]

[Total: 9]

A2 (a) (i) (density generally) increases down the group (1)

(ii) allow between 710 – 860 (°C) (1)
(actual value = 760 °C) [1]

(iii) liquid (no mark on its own)
melting point is below 35 (°C) **AND** boiling point is above 35 (°C) (1) [1]

(b) (i) more reactive down the group / less reactive up the group (1) [1]

(ii) $2Rb + 2H_2O \rightarrow 2RbOH + H_2$ (1) [1]

(iii) reaction which releases heat / releases energy / products have lower energy than reactants / reaction in which ΔH is negative / temperature (of surroundings) increases (1) [1]

(c) $H^- + H_2O \rightarrow OH^- + H_2$ (1) [1]

(d) (i) sodium has low density / nickel has high density (1)

sodium has low melting point / nickel has high melting point / sodium has low boiling point / nickel has high boiling point (1) [2]

(ii) any suitable use e.g. manufacture of margarine / other stated hydrogenation reactions e.g. cyclohexane from benzene / sorbitol from glucose / amines from nitro-compounds / amines from nitriles / alkanes from alkenes / alkanes from alkynes (1) [1]

(iii) nickel ions are different size to copper ions (1)

idea of disruption of layers in metallic structure / layers cannot slide as easily (1)

NOTE: there MUST be some idea of layers / rows or sheets sliding not just atoms sliding [2]

[Total: 12]

A3 (a) water and salts have different boiling points (1)

water evaporates **AND** salts / residues / impurities / solids left in flask (1)

water condenses / turns to liquid in the condenser (1) [3]

(b) (i) Mg^{2+} and Cl^- (1)
IGNORE: state symbols [1]

(ii) 0.0265 / 0.027 / 0.03 (mol/dm^3) (1) [1]

(iii) white precipitate / white solid formed / white deposit formed (1) [1]

(c) 96 g SO_4^{2-} → 233 g $BaSO_4$ (1)

1.24 g SO_4^{2-} → $\frac{233}{96} \times 1.24$ OR 3.0096 / 3.01 g $BaSO_4$ (1)

mass in 50 cm^3 = $3.01 \times \frac{50.0}{1000}$ = 0.151 g (1)

OR (for 1st two steps)

moles SO_4^{2-} = $\frac{1.24}{96}$ OR 0.0129 (1)

mass of $BaSO_4$ = 0.0129×233 OR 3.01 g (1)

OR

mass of SO_4^{2-} in 50 cm^3 = $1.24 \times \frac{50}{1000}$ OR 0.062 g (1)

moles SO_4^{2-} = $\frac{0.062}{96}$ OR 0.000645833 mol (1)

mass $BaSO_4$ = 0.000646×233 = 0.151 g (1) [3]

[Total: 9]

A4 (a) $H^+ + OH^- \rightarrow H_2O$ (1)

(b) (i) 20 (cm^3) / 0.02 dm^3 (1) [

(ii) mol KOH = $0.15 \times \frac{45}{1000}$ OR 6.75×10^{-3} / 0.00675 (1)

mol H_2SO_4 = 0.003375 / 0.0034 (1)

concentration = $0.003375 \times \frac{1000}{20}$ = 0.17 / 0.169 (1) [3]

(c) (i) ethanoic acid has 1 mol of ionisable H per mol of acid / H_2SO_4 has 2 per mol of acid / ethanoic acid is monobasic / H_2SO_4 is dibasic / ethanoic acid has one acidic hydrogen (ion) / sulfuric acid has 2 acidic H^+ ions / ethanoic acid has half as much ionisable hydrogen (1) [1]

(ii) any value between 3 and 6.9 inclusive (1) [1]

(d) (i) **ANY TWO FROM**

- sulfur dioxide / SO_2 (1)
- (sulfur dioxide) oxidised further / (sulfur dioxide) reacts further to form sulfur trioxide (1)
- oxidation product reacts with water to form sulfuric acid / SO_3 reacts with water to form sulfuric acid (1) [2]

(ii) irritates skin / irritates eyes / irritates nose / irritates mouth (1) [1]

[Total: 10]

A5 (a) sodium
barium
magnesium
nickel
copper (1) [1]

(b) (i) voltmeter and two wires either side of voltmeter across the electrodes (1) [1]

(ii) iron and silver (1) [1]

(c) ANY TWO FROM

- the zinc corrodes instead of the iron / zinc reacts instead of the iron (1)
- zinc is more reactive (than iron) / zinc is more reactive (than steel) / zinc higher in the reactivity series (than steel / iron) OR reverse argument (1)
- the zinc loses electrons in preference to the iron (1)

IGNORE: sacrificial protection without qualification [2]

[Total: 5]

B6 (a) sodium chloride is giant ionic structure / has a continuous structure of ions / ions in lattice (1)

strong (attractive) forces between the ions / lot of energy needed to break ionic bond (1)

chlorine is a (simple) molecule / chlorine has simple covalent structure (1)

chlorine has weak forces between the molecules / small amount of energy required to separate molecules / not much energy needed to break intermolecular forces / chlorine has weak van der Waals' forces (1) [4]

(b) in molten sodium chloride ions can move but ions can't move in solid / ions can only move in molten sodium chloride (1) [1]

(c) sodium ion 2, 8 and + charge (1)
chloride ion 2, 8, 8 and – charge (1) [2]

(d) at the negative electrode / cathode reduction takes place which is gain of electrons (by sodium) (1)

at the positive electrode / anode oxidation takes place which is loss of electrons (by chloride) (1)

OR

sodium ions are reduced because they gain electrons (1)

chloride ions are is oxidised because they lose electrons (1)

OR

sodium is reduced because oxidation number of sodium decreases (1)

chloride / chlorine is oxidised because the oxidation number of chlorine increases (1) [2]

(e) $2NH_3 + 3Cl_2 \rightarrow N_2 + 6HCl$ (1) [1]

[Total: 10]

B7 **(a)** alkenes (1)

(b) melting points increase (1)

increase in melting point from even number to odd number of carbon atoms is less than from odd to even number / the increase is less for some atoms than others / any reference to the regular zigzag nature of the increase (1) [2]

(c) C_9H_{20} (1) [1]

(d) **(i)** $C_{11}H_{24} \rightarrow C_2H_4 + C_3H_6 + C_6H_{14}$ (1) [1]

(ii) **ANY TWO FROM**

- (hydrocarbons with) longer chains not in high demand / more longer chains produced than used / shorter chains in more demand / fewer short chains produced than used (1)
- so (more) petrol / gasoline is made (1)
- to produce alkenes / to make ethane (1) [2]

(e) **(i)** 16 g methane → 27 g HCN (1)

500 g methane → $500 \times \frac{27}{16} \times \frac{65}{100} = 548$ g (1)

OR

$\frac{500}{16} = 31.25$ mol methane (1)

$31.25 \times 27 \times \frac{65}{100} = 548$ g (1) [2]

(ii) $Ca(OH)_2 + 2HCN \rightarrow Ca(CN)_2 + 2H_2O$ (1) [1]

[Total: 10]

B8 (a) (i) concentration of ethanoate = 0.45 mol / dm^3 (1)

mass = $0.45 \times 59 \times \frac{200}{1000}$ = 5.31 / 5.3 g (1)

(ii) $\frac{0.17}{300}$ = 5.67×10^{-4} / 5.7×10^{-4} (mol / dm^3 / s) (1) [1]

(iii) rate of reaction decreases with time / reaction slows down (1)
concentration (of H^+ ions) decreases / concentration (of reactants) decreases / concentration (of ethyl ethanoate) decreases (1)
collision frequency reduced (1) [3]

(b) $Fe^{2+}(aq) + 2OH^-(aq) \rightarrow Fe(OH)_2(s)$
correct formulae (1)
correct state symbols (dependent on correct formulae) (1) [2]

(c) filter (off iron) (1)

heat filtrate to crystallisation point then leave to crystallise / evaporate off some of the water from filtrate then leave to crystallise / partially evaporate filtrate and leave to crystallise
AND
dry crystals with filter paper (1) [2]

[Total: 10]

B9 **(a)** decreases with increase in temperature (1)

reaction is exothermic / increasing temperature favours reaction which absorbs heat (1) [2]

(b) increases with increasing pressure (1)

increasing pressure causes reaction to go in direction of decreasing number of moles / smaller volume (1) [2]

(c) **ANY ONE FROM**

- low(er) temperature makes reaction rate too slow (1)
- high(er) temperature decreases percentage yield (1)
- low(er) temperature increases percentage yield (1)
- this temperature (i.e. 350–450) gives a (relatively) high rate and low yield (1)

ANY ONE FROM

- low(er) pressure gives poor yield (1)
- high(er) pressure increases yield (1)
- high(er) pressure expends too much energy (1)
- high a pressure too expensive (1)
- high(er) pressure gives a higher rate (1)
- high pressure a safety risk (1)
- this pressure (i.e. 200–300) gives a high yield and high rate (1) [2]

(d) speeds up the reaction / lowers the activation energy (1)

lowers energy costs / less energy used (1) [2]

(e) molar mass of $(NH_4)_3PO_4$ = 149 (1)

$\frac{42}{149} \times 100 = 28.19\% / 28.2\%$ (1) [2]

[Total: 10]