Neap

Trial Examination 2020

Suggested solutions

QCE Chemistry Units 3&4

Paper 2

QUESTION 1 (6 marks)

a) $K_c = \dfrac{[COCl_2]}{[Cl_2][CO]}$ *[1 mark]*

$= \dfrac{0.020}{0.060 \times 0.040}$

$= 8.3\ M^{-1}$ *[1 mark]*

b) After 3 minutes, the concentration of the product increases and the concentrations of the reactants decrease. *[1 mark]*

The system being cooled means that heat is being removed. The system responds to replace some of the heat by moving in the forward direction (as indicated by the change in concentrations) – that is, the forward reaction is heat producing or exothermic. *[1 mark]*

c) At 5.5 minutes, the concentration of the product is higher than at 2.5 minutes and the concentration of the reactants is lower. *[1 mark]*

As the product is in the numerator of the equilibrium expression, the value of K_c would be higher at 5.5 minutes than at 2.5 minutes. *[1 mark]*

QUESTION 2 (9 marks)

a) Shake an amount of compound A with bromine dissolved in water. *[1 mark]*

If the colour of the bromine clears, then compound A is unsaturated. *[1 mark]*

b) B: HCl *[1 mark]*

D: NaOH *or* OH^- *[1 mark]*

c) functional group of compound E: hydroxyl (or hydroxy) *[1 mark]*

class of organic compound (or homologous series) of compound F: carboxylic acid (or alkanoic acid) *[1 mark]*

d)

Reaction 1	Reaction 2	Reaction 3
addition	**substitution**	**oxidation**

[3 marks]

Award 1 mark for each correct reaction type identified.

QUESTION 3 (7 marks)

a) In an electrolytic cell, the application of electrical energy causes a non-spontaneous reaction, so a single container can be used. *[1 mark]*

In a galvanic cell, a spontaneous redox reaction is used to generate electricity. This is achieved by separating two half-reactions so that electron transfer occurs along a wire, resulting in an electric current. *[1 mark]*

b)

	Anode	Cathode
Positive	**$Cu(s) \rightarrow Cu^{2+}(aq) + 2e^-$**	
Negative		

[2 marks]
1 mark for correct equation.
1 mark for correct location in table.

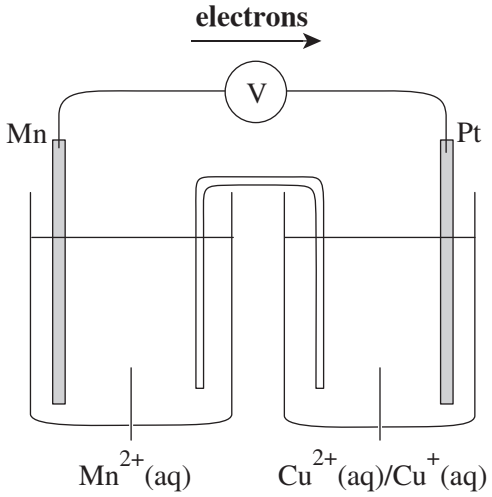
c) silver metal *[1 mark]*

d) Copper ions are stronger oxidants than nickel ions. *[1 mark]*

That is, copper ions accept electrons more readily than nickel ions and will therefore be discharged preferentially while the nickel ions remain in solution. *[1 mark]*

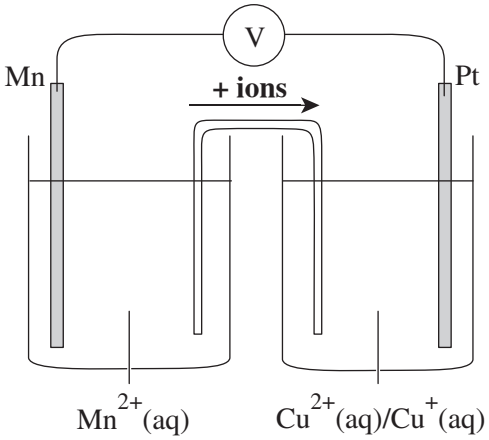
QUESTION 4 (7 marks)

a)



[1 mark]

b)



[1 mark]

c) cell potential = $E°(\text{oxidant}) - E°(\text{reductant}) = +0.16 - (-1.18)$ *[1 mark]*

$= 1.34$ V *[1 mark]*

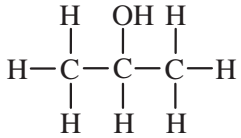
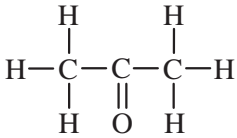
d) $Cu^{2+}(aq) + e^{-} \rightarrow Cu^{+}(aq)$ *[1 mark]*

e) $2Cu^{2+}(aq) + Mn(s) \rightarrow 2Cu^{+}(aq) + Mn^{2+}(aq)$ *[2 marks]*

1 mark for correct reactants and products with state symbols.
1 mark for correct balancing.

QUESTION 5 (10 marks)

a)

Structural formula of the secondary alcohol	Structural formula of the product
	
IUPAC name: propan-2-ol	**IUPAC name:** propanone

[4 marks]
Award 1 mark for each correct structural formula.
Award 1 mark for each correct IUPAC name.

b) $HCOOH + NH_2CH_3 \rightarrow HCONHCH_3 + H_2O$

[2 marks]
1 mark for correct reactants.
1 mark for correct products.

c) Propane is reacted with chlorine gas using ultraviolet light. *[1 mark]*

One organic product formed from the reaction is 1-chloropropane. *[1 mark]*

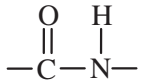
1-chloropropane is reacted with ammonia to form 1-propanamine. *[1 mark]*

A concentrated solution of ammonia in ethanol is used in a sealed reaction vessel so that the ammonia does not escape when heat is applied to cause the reaction. *[1 mark]*

QUESTION 6 (10 marks)

a) 7 amino acids *[1 mark]*

b)



[1 mark]

Note: Students must circle any one of the six peptide bonds shown above.

c) *The amino acid residue on the far right of the polypeptide is derived from glycine (H_2NCH_2COOH), which has a molar mass of 75 g mol^{-1}.*

IUPAC name: 2-aminoethanoic acid *[1 mark]*

d) In chromatography, the mixture being analysed is dissolved in the mobile phase (solvent) and drawn into the stationary phase. *[1 mark]*

As the mobile phase moves through the stationary phase, some components of the mixture are attracted (adsorbed) to the stationary phase while other components continue to move with the mobile phase. *[1 mark]*

As more of the mobile phase moves through the stationary phase, the mixture's components may be released (desorbed) from the stationary phase back into the mobile phase. This process of adsorption–desorption continues as the mobile phase moves, resulting in separation of the mixture's components. *[1 mark]*

e)

Amino acids	Present in the polypeptide: • glycine (2) • threonine (5) • serine (6) • leucine (7)	Not present in the polypeptide: • lysine (3) • valine (4) • tyrosine (8)
Explanation	The spot for the standard amino acid lines up with a spot for one of the amino acids in the hydrolysed polypeptide.	The spot for the standard amino acid does not line up with a spot for one of the amino acids in the hydrolysed polypeptide.

[2 marks]

1 mark for correct classification of one amino acid.

1 mark for correct explanation for the selected amino acid.

f) In electrophoresis, a protein mixture is forced by an electric field to move through a cross-linked gel, which acts as a molecular sieve. *[1 mark]*

Depending on the shape, size and charge of the various proteins in the mixture, each protein will move at a different rate in the gel, resulting in separation. *[1 mark]*

QUESTION 7 (9 marks)

a) The interactions between the side groups of the amino acid residues in a protein chain are responsible for the overall three-dimensional shape or tertiary structure of the molecule. *[1 mark]*

The bonding that holds the tertiary structure in shape may include hydrogen bonds, ionic attraction, covalent disulfide links and dispersion forces. *[1 mark]*

As a result of these interactions, proteins can adopt a variety of shapes, including flat sheets, long helix structures and the configuration of enzymes (which are compact and globular). *[1 mark]*

Each enzyme molecule has a flexible cavity as part of its tertiary structure. This is known as the active site. *[1 mark]*

The active site makes temporary bonds with substrate molecules during catalysis and, after the reaction is complete, these bonds break to release the products of the reaction. *[1 mark]*

b) *Any four significant and relevant points including a balanced equation can be made to achieve the four marks, for example:*

Fermentation uses enzymes from yeast to convert small sugar molecules such as glucose to ethanol and carbon dioxide. *[1 mark]*

$C_6H_{12}O_6(aq) \rightarrow 2C_2H_5OH(aq) + 2CO_2(g)$ *[1 mark]*

This process must take place in the absence of oxygen because other undesired products will form if oxygen is present. *[1 mark]*

Fermentation stops when the concentration of alcohol reaches 10–20% because the enzymes in the yeast are rendered inactive. *[1 mark]*

QUESTION 8 (7 marks)

a) $K_c = \dfrac{[CH_3OCH_3][H_2O]}{[CH_3OH]^2}$

The products were formed from methanol placed into an empty 10 L vessel, therefore $[CH_3OCH_3] = [H_2O]$. *[1 mark]*

Thus, $K_c \times [CH_3OH]^2 = [CH_3OCH_3]^2 = 5.74 \times (0.0186)^2 = 1.985 \times 10^{-3}$

$[CH_3OCH_3] = 0.0445 = 0.045$ M *[1 mark]*

$[H_2O] = 0.045$ M *[1 mark]*

$[CH_3OH] = 0.019$ M *[1 mark]*

b) The mass of reactants and products at equilibrium was produced from the methanol originally injected into the empty vessel. *[1 mark]*

original $m(CH_3OH) = m(CH_3OH)_{eq} + m(CH_3OCH_3)_{eq} + m(H_2O)_{eq}$

$= (0.186 \times 32.05) + (0.45 \times 46.08) + (0.45 \times 18.02)$ *[1 mark]*

$= 35$ g *[1 mark]*

