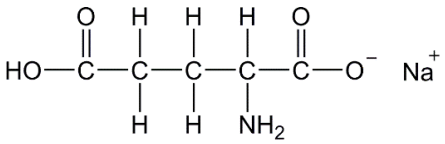
Question 18

Monosodium glutamate (MSG) is a chemical compound found in tomatoes, cheese and other foods.



There is a popular belief that monosodium glutamate causes headaches, sweating, and chest pains in humans after its consumption.

(a) There is approximately 150 mg of MSG in 100 g of ripe tomato.

Determine the concentration of MSG in a ripe tomato in ppm.

(2 marks) **KA4**

(b) The concentration of MSG in a popular brand of soy sauce is 2000 ppm.

Determine the molar concentration ($mol.L^{-1}$) of MSG in soy sauce.

Use the diagram above to determine the molar mass of MSG.

(3 marks) **KA4**

(c) Determine the mass of MSG (in mg) in a 100 mL bottle of soy sauce.

(2 marks) **KA4**

(d) One scientific study showed that a very small number of people developed a mild headache after consuming 5.0 g MSG in one meal.

State the volume of soy sauce (in litres) a human must consume in one meal to increase their risk of developing a mild headache from the consumption of MSG.

Assume that the density of soy sauce is 1 $kg.L^{-1}$

(2 marks) **KA3**

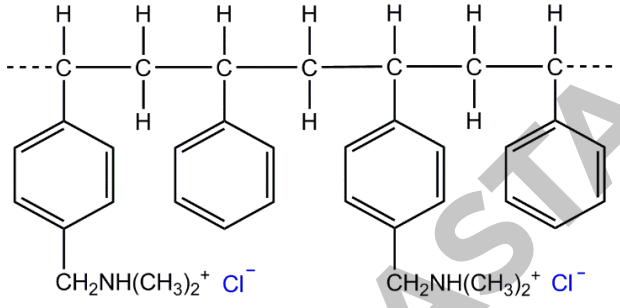
Question 37

Iodine deficiency occurs in children younger than 3 has been linked with impaired mental function and poor physical development.

Analysis of urine samples can determine the concentration of iodine (as I^-).

Iodide ions are removed from urine samples using ion exchange chromatography.

Urine samples were eluted through a column containing an anion exchange resin shown below.



(a) Write an equation to show the exchange of chloride ions (Cl^-) from the anion exchange resin with iodide ions found in urine.

(2 marks) **KA4**

(b) Explain why adding concentrated sodium chloride solution helps to remove iodide ions from the anion exchange resin.

(3 marks) **KA2**

(c) A 2-year-old child was given 50 mg of iodine.

Analysis of the urine samples taken hours later revealed 40 mg of iodine (as I^-) in urine.

State and explain whether this child is at high or low risk of poor physical development.

(3 marks) **KA3**

Question 43

A rapid reaction occurs when nitrogen triiodide (NI_3) is touched lightly with a feather.

The decomposition of nitrogen triiodide is described by the thermochemical equation below.

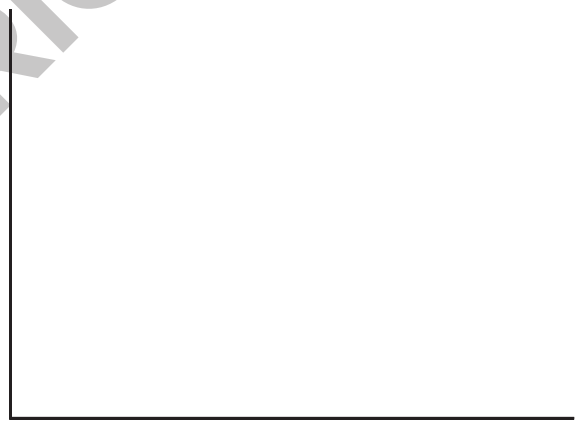
$$2NI_{3\,(s)} \rightarrow 3I_{2\,(g)} + N_{2\,(g)} \qquad \Delta H = -290\ \text{kJ.mol}^{-1}$$

(a) State, giving one reason, whether the reaction is exothermic or endothermic.

(2 marks) **KA1**

(b) Draw an energy profile diagram for the reaction.

Label the activation energy on the diagram.



(3 marks) **KA4**

(c) Explain why a chemist should **not** attempt to store nitrogen triiodide for later use.

(2 marks) **KA2**

Question 62

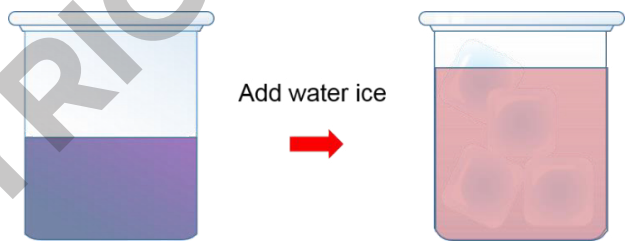
An equilibrium between two different cobalt ions is established when cobalt(II) chloride is reacted with hydrochloric acid solution.

$$\underset{\text{pink}}{Co(H_2O)_{6(aq)}^{2+}} + 4Cl_{(aq)}^{-} \rightleftharpoons \underset{\text{blue}}{CoCl_{4(aq)}^{2-}} + 6H_2O_{(l)} \quad \Delta H = +48\ \text{kJ.mol}^{-1}$$

(a) State and explain, using Le Châtelier's principle, the colour change that occurs when concentrated hydrochloric acid solution is added to the reaction mixture at equilibrium.

(3 marks) **KA2**

(b) The colour of the solution changes from blue to pink when ice water is added to the reaction mixture at equilibrium.



Explain, using Le Châtelier's principle, two reasons why the colour of the solution changes from blue to pink when ice water is added.

(4 marks) **KA2**

Question 69

Ethene (C_2H_4) is a simple hydrocarbon derived from crude oil.

Ethene is used to produce polyethene which is a polymer formed in the reaction of ethene molecules under high pressure.

Ethene is also used in the manufacture of ethanol (C_2H_5OH).

$$C_2H_{4(g)} + H_2O_{(g)} \rightleftharpoons C_2H_5OH_{(g)} \quad \Delta H = -33\ \text{kJ.mol}^{-1}$$

(a) Explain, using Le Châtelier's principle, the advantage of using an excess of steam (H_2O) in the reaction.

(3 marks) **KA2**

(b) State one reason why an excess of ethene is not used in the reaction.

(1 mark) **KA3**

(c) The reaction is carried out at a pressure of 65 atm.

(1) Explain, using Le Châtelier's principle, the advantage of performing the reaction under high pressure.

(3 marks) **KA2**

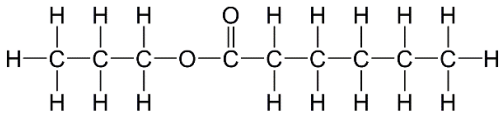
(2) State why higher pressures are not used in this reaction.

(1 mark) **KA2**

Question 104

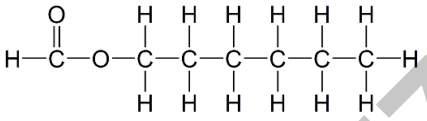
(a) Write the systematic names of the following esters.

(1)



Systematic name: _____

(2)



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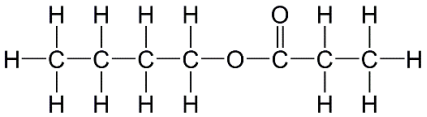
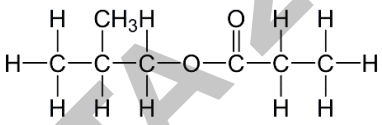
(3)



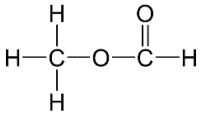
Systematic name: _____

(4)



Systematic name: _____

(5)



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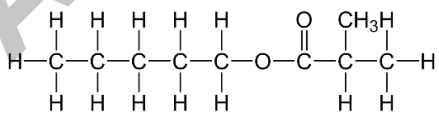
(6)



Systematic name: _____

(12 marks) **KA4**

(b) Draw the extended structural formula of the following esters.

(1) ethyl methanoate

(2) octyl ethanoate

(3) ethyl butanoate

(4) 2-methylpropyl pentanoate

(5) methyl 2-ethylhexanoate

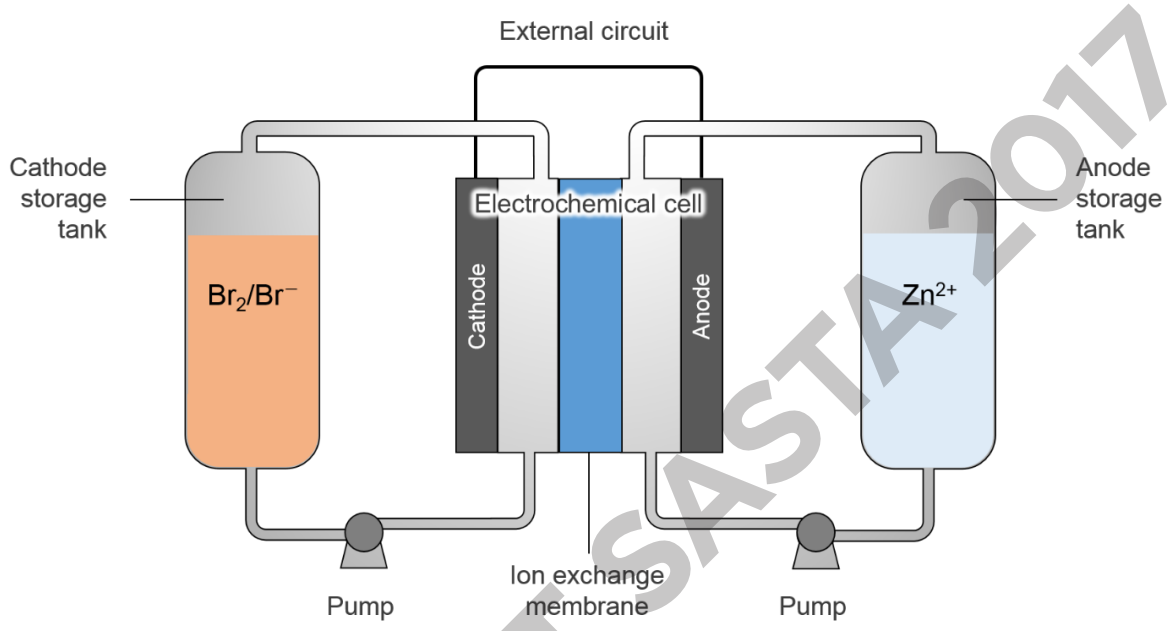
(6) 2-methylbutyl 2-methylpropanoate

(12 marks) **KA4**

Question 134

Zinc-bromine batteries (ZBBs) are devices composed of zinc-bromine flow cells.

One type of zinc-bromine flow cell is shown in the diagram below.



Electric current is used to charge the zinc-bromine battery.

(a) Unbalanced redox half-equations describing the charging reactions are given below.

Anode	Zn^{2+}	→	Zn
Cathode	Br^-	→	Br_2

(1) Balance the half-equations above. (4 marks) **KA4**

(2) State whether the anode is the negative or positive electrode when the cell is charging.

_____ (1 mark) **KA4**

(3) Name the material forming on the surface of the anode electrode during the charging reaction.

_____ (1 mark) **KA4**

(4) State the direction of electron flow in the external circuit during charging.

_____ (1 mark) **KA4**

Question 146

Dryland salinity is the movement of dissolved salts to the soil surface in groundwater.

Dryland salinity is an increase in the concentration of salts near the soil surface.

(a) State why salts are concentrated at the soil surface.

_____

_____ (1 mark) **KA1**

(b) Soils with a high clay content are greatly affected by increasing salinity.

(1) Calcium ions (Ca^{2+}) flocculate clay particles which maintains soil structure.

State the property of calcium ions that permits the flocculation of clay particles in soils.

_____ (1 mark) **KA1**

(2) Sodium ions (Na^{+}) are transported to the soil surface in groundwater.

Na^{+} in groundwater is exchanged with Ca^{2+} that is adsorbed to clay particles in soils.

Write an equation to show the exchange of sodium and calcium cations in soils.

_____ (2 marks) **KA1**

(3) Explain a consequence for the exchange of sodium and calcium cations in soils.

_____

_____

_____

_____

_____ (3 marks) **KA2**

(4) Gypsum is a water-soluble material that contains hydrated calcium sulfate ($CaSO_4.2H_2O$).

State and explain, using Le Châtelier's principle, why farmers add gypsum to soils that have high sodicity (high concentration of Na^{+}).

_____

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_____

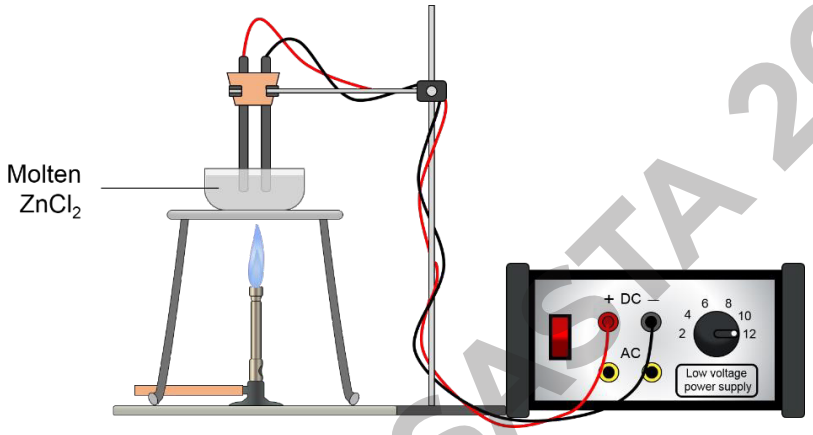
_____ (3 marks) **KA2**

Question 153

Zinc (Zn) can be prepared in the laboratory from the electrolysis of zinc chloride, $ZnCl_2$.

Zinc chloride is transferred to a crucible and heated constantly using a Bunsen burner.

Graphite electrodes are placed in the molten zinc chloride and each electrode is connected to a 12V power supply.



(a) A yellow-green gas is emitted from the positive electrode.

(1) Name the gas.

_____ (1 mark) **KA1**

(2) Write a half-equation to show the formation of the gas at the positive electrode.

_____ (2 marks) **KA4**

(b) Zinc metal is formed at the negative electrode.

(1) State whether zinc ions are oxidised or reduced at the negative electrode.

_____ (1 mark) **KA1**

(2) Write a half-equation to show the formation of zinc at the negative electrode.

_____ (2 marks) **KA1**

(c) Explain why the electrode reactions stop when the Bunsen burner is removed.

_____

_____

_____

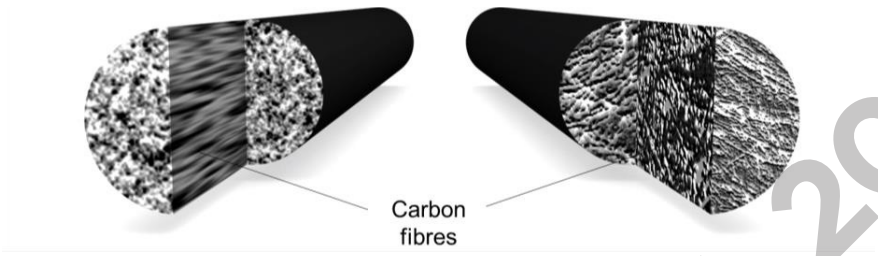
_____

_____ (2 marks) **KA2**

Question 159

Carbon fibre reinforced polymer is a composite material that is composed of a thermoset polymer matrix with carbon fibres as a reinforcement.

Carbon fibres are 5 – 10 micrometres in diameter and composed of carbon atoms.



(a) Carbon fibre composites are used in modern rockets that are used to shuttle satellites into space.

Explain the economic advantage of using carbon fibre composites in rockets.

(2 marks) **KA3**

(b) Polyepoxides are a family of thermoset polymers that are used as the matrix in carbon fibre composites.

The presence of epoxy makes carbon fibre composites rigid.

Explain why thermoset polymers such as polyepoxides are rigid.

(2 marks) **KA2**

(c) Carbon fibre composites can be recycled using various methods.

(1) Explain why carbon fibre composites cannot be melted down in air.

(2 marks) **KA2**