



Student Number	
Mark / 43	

Chemistry

HSC Course

Production of Materials

Theory Test • 2006

General Instructions

- Reading time – 5 minutes
- Working time – 45 minutes
- Write using black or blue pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- A Data Sheet and a Periodic Table are provided
- Write your Student Number at the top of this page

Total Marks – 43

Part A – 12 marks

- Attempt Questions 1 – 12
- Allow about 10 minutes for this part

Part B – 31 marks

- Attempt Questions 13 – 21
- Allow about 40 minutes for this part

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Part A – 12 marks

Attempt Questions 1 – 12

Allow about 10 minutes for this part

Select the alternative A, B, C or D that best answers the question. Fill in the response oval completely.

Sample: $2 + 4 =$ (A) 2 (B) 6 (C) 8 (D) 9
A B C D

If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A B C D

If you change your mind and have crossed out what you consider to be the correct answer, then indicate the correct answer by writing the word *correct* and drawing an arrow as follows.

A B C D
correct ↙

Answer Box for Questions 1 – 12

1	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
2	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
3	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
4	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
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9	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
10	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
11	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>
12	A <input type="radio"/>	B <input type="radio"/>	C <input type="radio"/>	D <input type="radio"/>

► *Mark your answers for Questions 1 – 12 in the Answer Box on page 2.*

1 Which of the following substances is the major component of biomass?

- (A) carbon dioxide
- (B) cellulose
- (C) glucose
- (D) methane

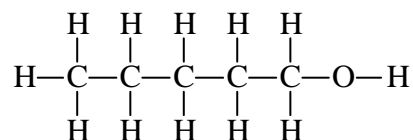
2 What is the main industrial source of ethene from oil refineries?

- (A) Cracking of C₁–C₂ fractions after distillation of crude oil.
- (B) Cracking of C₁₀–C₁₅ fractions after distillation of crude oil.
- (C) Distillation of crude oil.
- (D) Fermentation of sugar from sugar cane.

3 What is the oxidation state of manganese in KMnO₄?

- (A) 3+
- (B) 6+
- (C) 7+
- (D) 8+

4 An alkanol has the following molecular structure...



What is the correct IUPAC name for this alkanol?

- (A) 1 – pentanol
- (B) butylmethanol
- (C) pentyl alcohol
- (D) 5 – pentanol

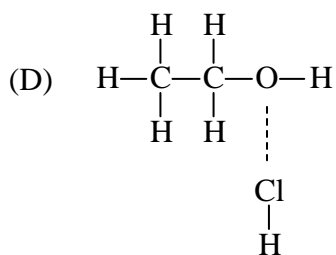
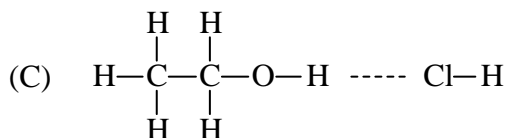
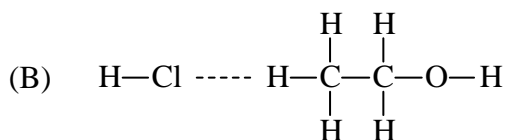
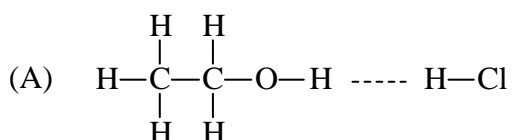
5 Which of these factors will promote the production of ethanol by fermentation?

- (A) abundant oxygen
- (B) cellulase
- (C) limewater
- (D) warmth

6 Which of the following instruments is used to detect radiation?

- (A) electronic balance
- (B) Geiger counter
- (C) oscilloscope
- (D) voltmeter

7 Hydrogen chloride dissolves well in ethanol. Which of the following diagrams shows the interaction between the molecules during the dissolution process?



8 Which reaction is classified as an oxidation/reduction reaction?

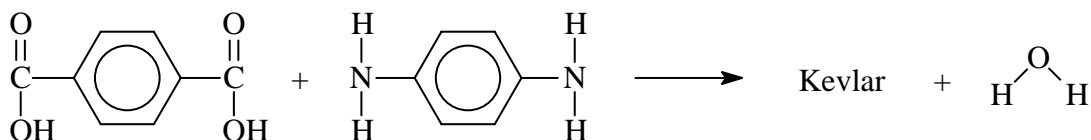
- (A) $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$
- (B) $\text{NaOH}(\text{aq}) + \text{HCl}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
- (C) $\text{AgNO}_3(\text{aq}) + \text{NaCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{NaNO}_3(\text{aq})$
- (D) $\text{Zn}(\text{s}) + \text{H}_2\text{SO}_4(\text{aq}) \rightarrow \text{ZnSO}_4(\text{aq}) + \text{H}_2(\text{g})$

- 9 The diagram shows a three-monomer segment of a polymer.



What is the name of the monomer used for the polymer?

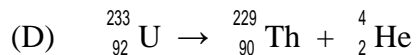
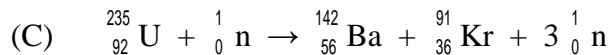
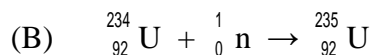
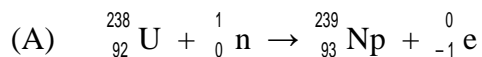
- (A) chloroethene
(B) ethene
(C) 1-chloroethane
(D) 1,2-dichloroethene
- 10 Kevlar™ is a synthetic fibre used to make bulletproof vests. It is formed by condensation polymerisation of the monomers, terephthalic acid and phenylenediamine...



Which of the following is the structural formula of Kevlar?

- (A)
- (B)
- (C)
- (D)

11 Which of the following reactions shows the production of a transuranic element?



12 The chemistry of two types of galvanic cells, Y and Z, are displayed in the table.

<i>Cell</i>	<i>negative electrode reaction</i>	<i>positive electrode reaction</i>
Y	$\text{Pb} + \text{SO}_4^{2-} \rightarrow \text{PbSO}_4(\text{s}) + 2\text{e}^-$	$\text{PbO}_2 + 4\text{H}^+ + \text{SO}_4^{2-} + 2\text{e}^- \rightarrow \text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}$
Z	$\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$	$\text{NH}_4^+ + \text{MnO}_2 + \text{H}_2\text{O} + \text{e}^- \rightarrow \text{Mn}(\text{OH})_3 + \text{NH}_3$

Which substance is reduced in each cell's cathode reaction?

	<i>Cell Y</i>	<i>Cell Z</i>
(A)	lead	sulfate
(B)	lead	zinc
(C)	oxygen	nitrogen
(D)	lead(IV) oxide	manganese(IV) oxide

Part B – 31 marks

Attempt Questions 13 – 21

Allow about 40 minutes for this part

► *Show all relevant working in questions involving calculations.*

Question 13 (2 marks)

Explain the high solubility of iodine in ethanol.

Question 14 (3 marks)

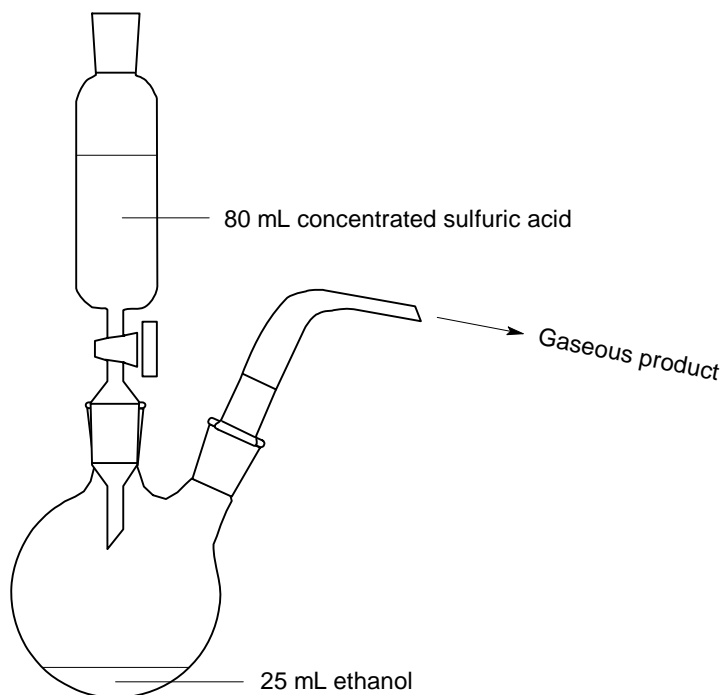
Distinguish between stable and radioactive isotopes and describe conditions under which a nucleus is unstable.

Question 15 (3 marks)

Fowler's *Lecture Experiments in Chemistry* describes the following practical...

Arrange the apparatus as shown in the diagram. Place 25 mL of ethanol in the flask and 80 mL of concentrated sulfuric acid in the dropping funnel.

With care slowly add the sulfuric acid. Heat the mixture cautiously to a steady boil. Collect samples of the gaseous product for testing.



- (a) Write a balanced chemical equation for the reaction occurring in the flask. **(1 mark)**

- (b) Identify the functional group present in the product. **(1 mark)**

- (c) Identify the role of sulfuric acid in the reaction. **(1 mark)**

Question 17 (4 marks)

Using a named example, outline the steps in the production of an addition polymer.

Question 18 (2 marks)

A group of high school students were investigating the reactivity of cyclohexane and cyclohexene with bromine water. Describe the observations that they would have made.

Question 19 (3 marks)

(a) Draw the structural formula of the monomer that forms polystyrene. **(1 mark)**

(b) Describe one use of polystyrene. **(1 mark)**

(c) Explain the use of polystyrene you have given in (b) in terms of its properties. **(1 mark)**

Question 20 (4 marks)

A list of commercial galvanic cells is provided below:

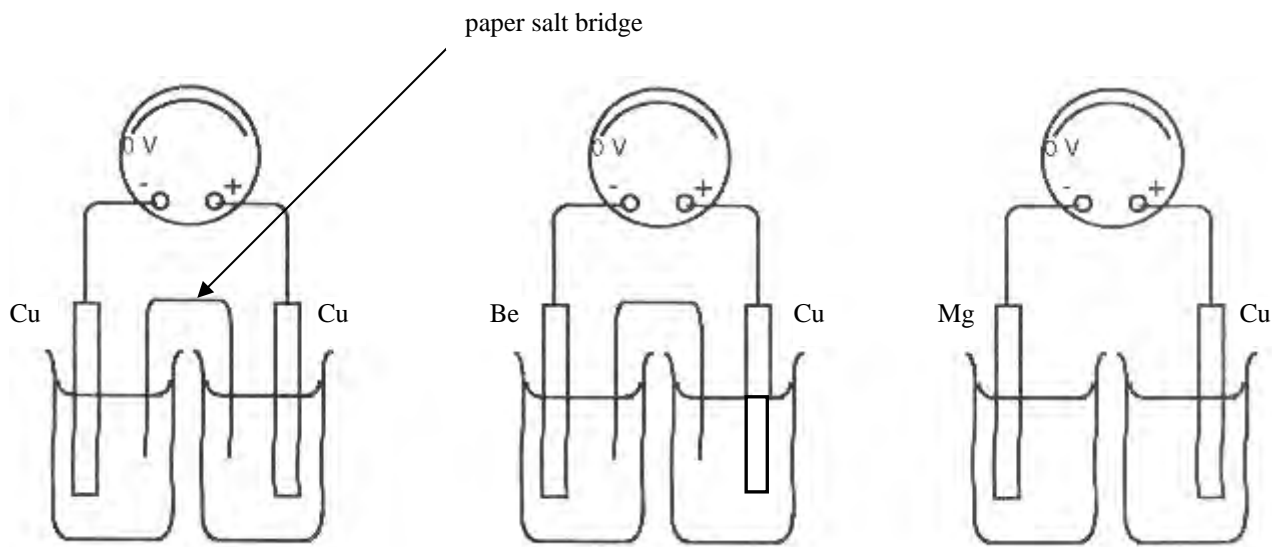
dry cell, lead–acid cell, button cell, fuel cell, vanadium redox cell, lithium cell, liquid junction photovoltaic cell

(a) Compare two of these cells in terms of their use in society. **(2 marks)**

(b) Assess the environmental impact of one of these cells. **(2 marks)**

Question 21 (5 marks)

In order to determine the relative activity of Be, Cu and Mg, a group of students constructed three cells as shown in the diagram, which displays their experimental set up. Each beaker contains a salt solution of the electrode material.



- (a) Describe two variables that would need to be controlled for this investigation. **(2 marks)**

- (b) Evaluate the students' experimental set up. **(3 marks)**



Answers and Marking Scheme

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Part A – 12 marks

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- (A) carbon dioxide
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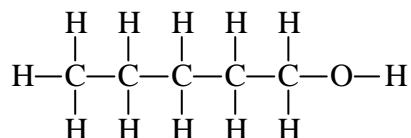
2 What is the main industrial source of ethene from oil refineries?

- (A) Cracking of C_1-C_2 fractions after distillation of crude oil.
- (B) Cracking of $C_{10}-C_{15}$ fractions after distillation of crude oil.
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- (D) Fermentation of sugar from sugar cane.

3 What is the oxidation state of manganese in $KMnO_4$?

- (A) +3
- (B) +6
- (C) +7
- (D) +8

4 An alkanol has the following molecular structure...



What is the correct IUPAC name for this alkanol?

- (A) 1 – pentanol
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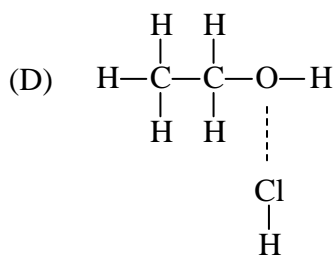
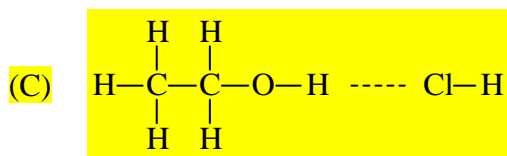
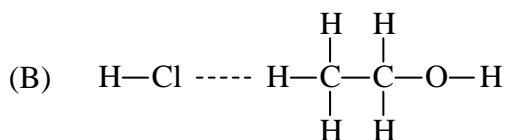
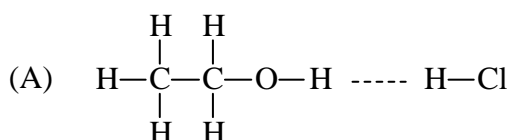
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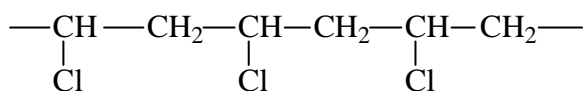
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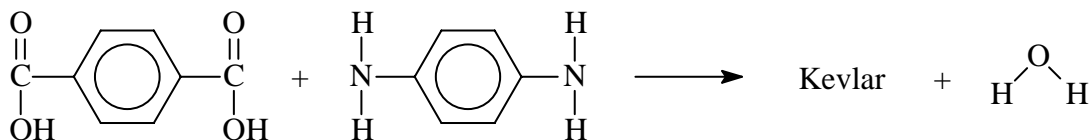
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- 9 The diagram shows a three-monomer segment of a polymer.



What is the name of the monomer used for the polymer?

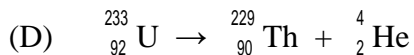
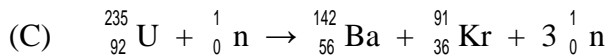
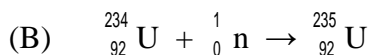
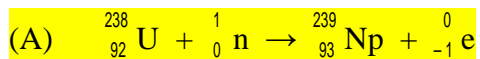
- (A) chloroethene
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- 10 Kevlar™ is a synthetic fibre used to make bulletproof vests. It is formed by condensation polymerisation of the monomers, terephthalic acid and phenylenediamine...



Which of the following is the structural formula of Kevlar?

- (A)
- (B)
- (C)
- (D)

11 Which of the following reactions shows the production of a transuranic element?



12 The chemistry of two types of galvanic cells, Y and Z, are displayed in the table.

Cell	<i>negative electrode reaction</i>	<i>positive electrode reaction</i>
Y	$\text{Pb} + \text{SO}_4^{2-} \rightarrow \text{PbSO}_4(\text{s}) + 2\text{e}^-$	$\text{PbO}_2 + 4\text{H}^+ + \text{SO}_4^{2-} + 2\text{e}^- \rightarrow \text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}$
Z	$\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$	$\text{NH}_4^+ + \text{MnO}_2 + \text{H}_2\text{O} + \text{e}^- \rightarrow \text{Mn}(\text{OH})_3 + \text{NH}_3$

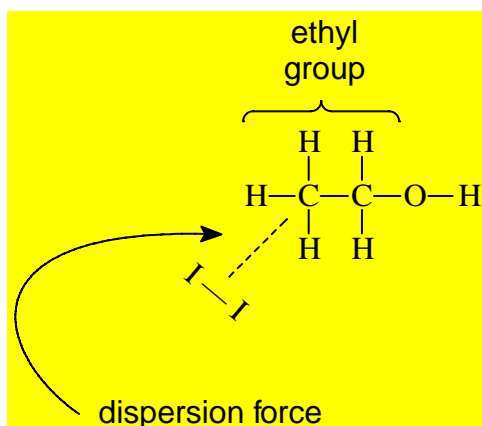
Which substance is reduced in each cell's cathode reaction?

	<i>Cell Y</i>	<i>Cell Z</i>
(A)	lead	sulfate
(B)	lead	zinc
(C)	oxygen	nitrogen
(D)	lead(IV) oxide	manganese(IV) oxide

Part B – 31 marks

Question 13 (2 marks)

Explain the high solubility of iodine in ethanol.



The non-polar iodine molecule is attracted to the non-polar ethyl group on the ethanol via dispersion forces.

- Attraction of non-polar iodine to non-polar ethyl group (1) via dispersion force (1) = 2 marks

Question 14 (3 marks)

Distinguish between stable and radioactive isotopes and describe conditions under which a nucleus is unstable.

A radioisotope spontaneously emits radiation with a change to the composition of its nucleus.

A stable nucleus does not have this behaviour. (1 mark)

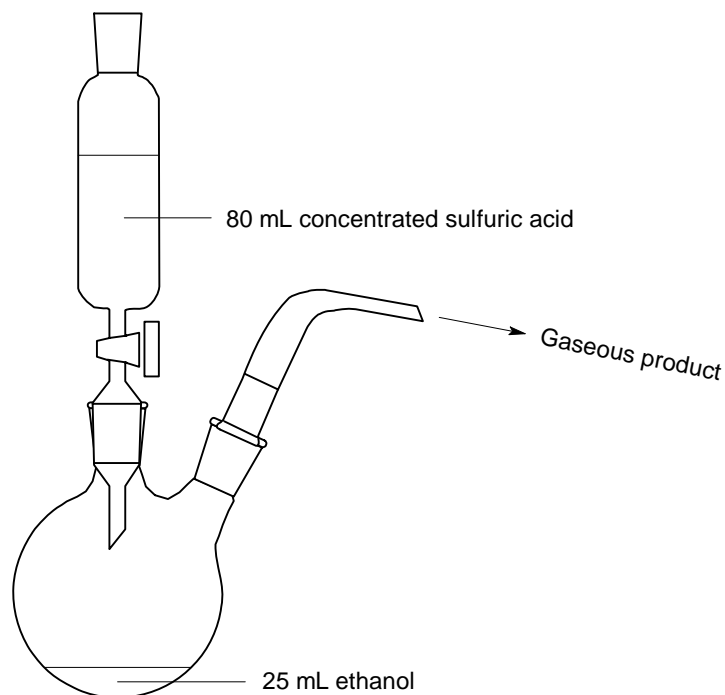
A nucleus is unstable if it has an unstable neutron : proton ratio (1 mark) or its atomic number is greater than 83. (1 mark).

Question 15 (3 marks)

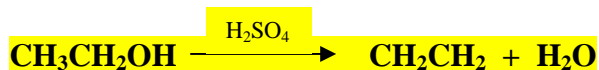
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Arrange the apparatus as shown in the diagram. Place 25 mL of ethanol in the flask and 80 mL of concentrated sulfuric acid in the dropping funnel.

With care slowly add the sulfuric acid. Heat the mixture cautiously to a steady boil. Collect samples of the gaseous product for testing.



- (a) Write a balanced chemical equation for the reaction occurring in the flask. **(1 mark)**



- ▶ *H₂SO₄ not required.*
- ▶ *Molecular formulae are acceptable.*

- (b) Identify the functional group present in the product. **(1 mark)**

The carbon-carbon double bond (C = C)

- (c) Identify the role of sulfuric acid in the reaction. **(1 mark)**

The sulfuric acid is a catalyst.

Question 16 (5 marks)

In Brazil, cars are manufactured to run on pure ethanol and this may soon become a reality in California. Assess the advantages and disadvantages of producing and using pure ethanol as a car fuel.

Advantages (1 – 4 marks)

- *Ethanol is a renewable fuel resource which could replace limited non-renewable fossil fuels.*
- *Ethanol will become cheaper with technological advances, whereas petrol will become dearer.*
- *Ethanol is a clean burning fuel causing less pollution than petrol.*
- *Ethanol has a higher octane rating than petrol, so it burns smoother in a high compression engine.*

Disadvantages (1 – 4 marks)

- *Ethanol produced by conventional fermentation would require huge tracts of land for growing the carbohydrate raw material.*
- *Ethanol fuelled cars are more difficult to start in cold climates.*
- *Ethanol produces less energy per mole, per gram and per volume, thus larger fuel tanks may be required.*

Judgement (1 mark)

Ethanol as a renewable fuel is a viable future fuel to replace petrol which is a non-renewable fuel. The production of ethanol does not pose any technological problems and in the future, cellulosic ethanol production will be a reality replacing the inefficiencies of traditional fermentation production techniques.

Question 17 (4 marks)

Using a named example, outline the steps in the production of an addition polymer.

(1): an addition polymer used as an example.

(1): name of monomer.

(1): double bond of monomer is broken.

(1): monomers link to form a chain of monomers.

Question 18 (2 marks)

A group of high school students were investigating the reactivity of cyclohexane and cyclohexene with bromine water. Describe the observations that they would have made.

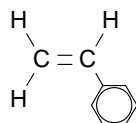
Bromine water will react rapidly with cyclohexene, causing the bromine water to change in colour from dark red/brown to yellow or colourless. There will be no reaction with the cyclohexane; the bromine water remaining dark red-brown in colour.

(1): bromine water reacts rapidly with cyclohexene.

(1): correct colour change of bromine water provided for the alkene reaction.

Question 19 (3 marks)

(a) Draw the structural formula of the monomer that forms polystyrene. **(1 mark)**



(b) Describe one use of polystyrene. **(1 mark)**

CD jewel cases, etc.

(c) Explain the use of polystyrene you have given in (c) in terms of its properties. **(1 mark)**

Polystyrene is a hard, inflexible plastic.

Question 20 (4 marks)

A list of commercial galvanic cells is provided below:

dry cell, lead–acid cell, button cell, fuel cell, vanadium redox cell, lithium cell, liquid junction photovoltaic cell

- (a) Compare two of these cells in terms of their use in society. **(2 marks)**

Compare: show how things are similar or different.

(1): correct use for one cell.

(1): correct use for another cell.

Possible answers include: dry cell (radios, clocks, CD players, calculators), lead-acid cell (car batteries), button cell (watches, calculators, hearing aids, pacemakers), fuel cell (power plant, space vehicles), vanadium redox cell (possible replacement for lead-acid battery), lithium cell (cameras, watches, computers), liquid junction photovoltaic cell device (smart window, watch faces).

- (b) Assess the environmental impact of one of these cells. **(2 marks)**

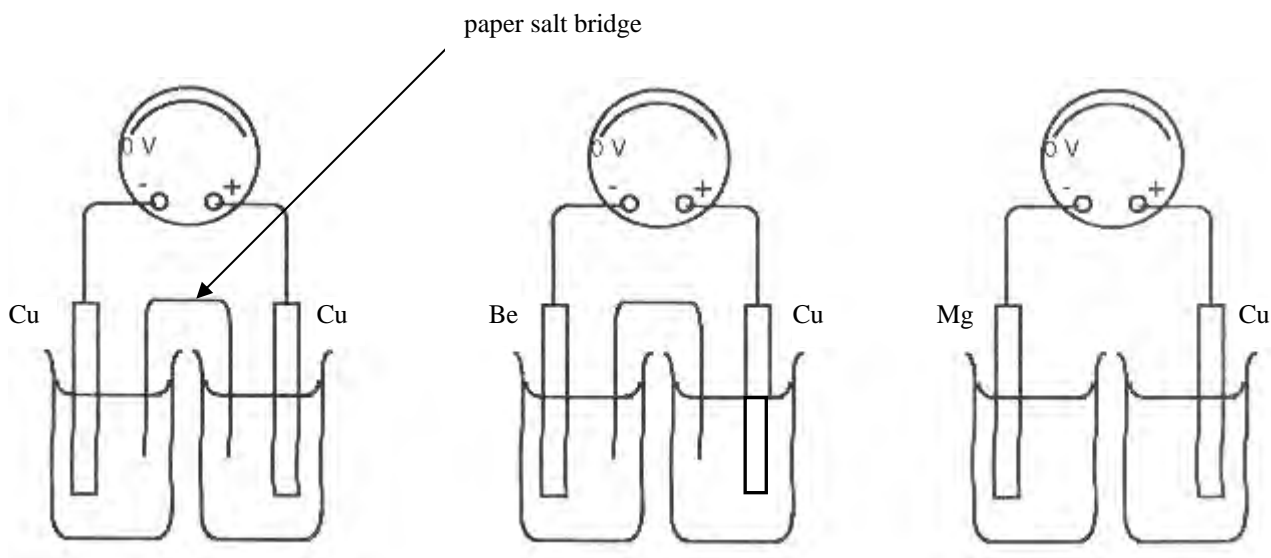
Assess: make a judgement of value, quality, outcomes, results or size.

(1): assessment mark: is the cell harmful or not harmful to the environment?

(1): impact mark: correct description of the impact the cell has on the environment. E.g., lead-acid cell contains sulfuric acid; the acid refuse from this cell can act as a pollutant.

Question 21 (5 marks)

In order to determine the relative activity of Be, Cu and Mg, a group of students constructed three cells as shown in the diagram, which displays their experimental set up. Each beaker contains a salt solution of the electrode material.



- (a) Describe two variables that would need to be controlled for this investigation. (2 marks)

Only concentration of electrolytes and temperature will affect the cell voltage. (c.f. Nernst Equation)
► **The surface area of the electrodes will affect the current output not the voltage.**

(1): one variable controlled.

(1): one variable controlled.

- (b) Evaluate the students' experimental set up. (3 marks)

The experimental set up is poor for several reasons. (1) Cu/Cu cell is not necessary since it would not produce any voltage and if any it should be a Be/Mg cell, which would increase the accuracy of determining the potential difference between these two metals.

(2) No salt bridge; hence no voltage would be generated in this cell. Therefore, this experimental set up would not be adequate to determine the relative activities of the three metals.

(1): one issue identified

(1): one issue identified

(1): one elaboration of any one of the above issues. Note, the elaboration will inherently have a judgement statement and is only awarded if the issue is correct.