Student No. _____

Barker College

Chemistry

2003
TRIAL
HIGHER SCHOOL
CERTIFICATE

Staff Involved:

PM THURSDAY 7 AUGUST

- RJP*
- KJB
- ASM
- KHW

85 copies

Total marks – 100

General Instructions

- Reading time – 5 minutes

- Working time – 3 hours

- Write using blue or black pen

- Board-approved calculators may be used

- Draw diagrams using pencil

- A Data Sheet and Periodic Table are provided at the back of this paper

- Write your Barker Student Number at the top of this page and on ALL answer pages

| Section I | Pages 2 - 18

Total – 90 marks

This section has two parts, Part A and Part B

Part A

15 marks
- Indicate all answers on the Answer Sheet provided
- Allow about 30 minutes for this part

Part B

75 marks
- Attempt Questions 16 – 28
- Indicate all answers in the spaces provided on the paper
- Allow about 2 hours for this part

| Section II | Pages 19 – 22

10 marks
- Attempt EITHER Question 29 OR Question 30
- Indicate all answers in the spaces provided on paper
- Allow about 30 minutes for this section

Section I

Total marks – 90

Part A

15 marks

Attempt Questions 1–15
Allow about 30 minutes for this part

Use the multiple-choice answer sheet

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 this by writing the word *correct* and drawing an arrow as follows.

correct

(A) ✖   (B) ✖   (C) ◯   (D) ◯
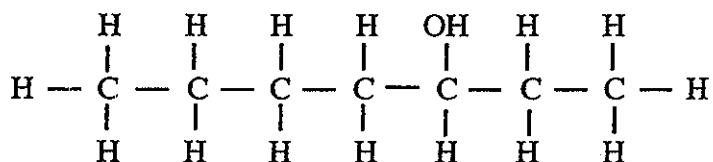
1. Ethylene serves as a monomer from which polymers are made. The correct structural formula for ethylene is:

   (A) $CH_3CH_2 = CH_2$

   (B) $CH_3 = CH_2$

   (C) CH_3CH_3

   (D) $CH_2 = CH_2$

2. Which of the following molecules is an example of a condensation polymer?

   (A) Teflon

   (B) Cellulose

   (C) Polystyrene

   (D) Poly (vinyl chloride)

3. The correct IUPAC name for the following alkanol is:

$$H-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\overset{\displaystyle OH}{\underset{\displaystyle H}{C}}-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-\overset{\displaystyle H}{\underset{\displaystyle H}{C}}-H$$

   (A) 5-heptanol

   (B) 2-hexanol

   (C) 3-pentanol

   (D) 3-heptanol

4. Which statement concerning galvanic cells is correct?

   (A) Reduction occurs at the anode.

   (B) They are also known as electrolytic cells.

   (C) The cathode is assigned a positive charge.

   (D) An external power source must be present.

5. Which acid is **not** found in either food, drink or your stomach?

   (A) 2-hydroxypropane-1,2,3-tricarboxylic

   (B) sulfuric

   (C) acetic

   (D) hydrochloric

6. A group of students carried out an investigation to compare the ability of different types of radiation to penetrate target materials in a vacuum. They used a computer simulation to carry out the investigation. In their investigation they selected a number of sources that emitted different types of radiation and measured the radiation count a distance of 1cm from the source. A time of 10s was allowed for each count. Different materials were placed between the source and the counter, a distance of 0.5cm from the radiation source. Each sample of target material was 0.10mm thick. The students recorded their results in a table.
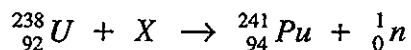
	Alpha radiation source	Beta radiation source	Gamma radiation source
No target	728	791	762
Paper	9	787	746
Aluminium	3	656	733
Gold	0	152	710

The students also measured the radiation produced by a cobalt-60 source under the same conditions and obtained the following results:

No target 793
Paper 780
Aluminium 746
Gold 714

From this information it is reasonable to conclude that the cobalt-60 was emitting:

(A) alpha radiation

(B) beta radiation

(C) gamma radiation

(D) either beta or gamma radiation

7. The equation for the production of the transuranic element plutonium (Pu) is:

$$^{238}_{92}U + X \rightarrow {}^{241}_{94}Pu + {}^1_0n$$

Species X in this reaction is:

(A) a neutron

(B) a proton

(C) an electron

(D) an alpha particle

8. Which of the following scientists did **not** contribute to the historical development of ideas about acids?

(A) Davy

(B) Arrhenius

(C) Lavoisier

(D) Dalton

9. Which of the following is the conjugate acid of $H_2PO_4^-$?

(A) H_2PO_4

(B) H_3PO_4

(C) HPO_4^{2-}

(D) PO_4^{3-}

10. 25 mL of a solution of H_2SO_4 that has a pH of 3 is pipetted into a 250 mL volumetric flask and distilled water added up to 250 mL. What is the pH of the diluted solution?

(A) 0.5
(B) 4.5
(C) 4
(D) 5

11. Acid strength is a measure of the:

(A) concentration of an acid solution

(B) extent to which an acid neutralises a base

(C) extent to which an acid ionises in water

(D) number of acidic protons present in the acid molecule

12. The formation of a coordinate covalent bond **does not** occur in which of the following molecules?

(A) ozone

(B) oxygen

(C) hydronium ion

(D) ammonium ion

13. Chemists are employed in industry to monitor and manage industrial processes. There are many aspects to the role of the chemist. Which of the following is **NOT** a role performed by a chemist working in industry?

(A) The chemist ensures that the raw materials meet specifications and they do not contain impurities that would upset the process.

(B) The chemist ensures that the products are sufficiently pure and free from dangerous contaminants.

(C) The chemist ensures that the products are sold in an ethical and environmentally responsible manner.

(D) The chemist ensures that the workplace remains safe and healthy.

14. Atomic absorption spectroscopy (AAS) would be a suitable method for determining the concentration of:

(A) Phosphorus in detergents

(B) Ethanol in wine

(C) Mercury in fish

(D) Nitrogen in fertilisers

15. During the tests for biochemical oxygen demand (BOD), a sample of water is kept in the dark for five days before being tested for its dissolved oxygen level.

What is the purpose of keeping the sample in the dark?

(A) To prevent photosynthesis occurring and adding oxygen to the water.

(B) To prevent photosynthesis occurring and removing oxygen from the water.

(C) To prevent respiration occurring and adding oxygen to the water.

(D) To prevent respiration occurring and removing oxygen from the water.

Section I (continued)

Part B – 75 marks
Attempt ALL questions
Allow about 2 hours for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (5 marks)

Styrene is an example of a commercially significant monomer

(a)   Give another example of a commercially significant monomer, stating both its systematic and common names.   2

systematic name:..

common name:...

(b)   Describe **TWO** uses of polystyrene in terms of its properties.   3

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Marks

Question 17 (8 marks)

Ethanol is currently being used to supplement the use of petrol in cars.

(a) Discuss the need for alternative sources of the compounds presently obtained from the petrochemical industry.

2

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(b) Write a balanced equation for the fermentation of glucose to ethanol.

1

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(c) Assess the potential of ethanol as an alternative fuel by discussing the advantages and disadvantages of its use.

5

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Marks

Question 18 (6 marks)

In class you performed a first-hand investigation to measure the difference in potential of different combinations of metals in an electrolyte solution.

(a)   Draw a neat, fully labelled diagram of the experimental set-up when using iron and copper electrodes in solutions of iron sulfate and copper sulfate respectively. Indicate the direction of electron flow as well as the direction of ion movement in the salt bridge.   **4**

(b)   Calculate the potential $E^{\ominus}$ of the above cell and write the overall equation for the reaction.   **2**

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Marks

Question 19 (5 marks)

Cobalt-60 (Co – 60) is a gamma emitter. It is produced by the neutron bombardment of Co – 59.

(a) Name an instrument that can be used to detect gamma radiation. 1

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(b) Write a nuclear equation to show the formation of Co – 60. 1

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(c) Evaluate Co – 60's use in the treatment of certain cancers. 3

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Question 20 (7 marks)

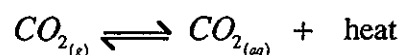Le Chatelier's Principle can be used to predict what happens to a system at equilibrium.
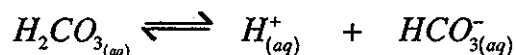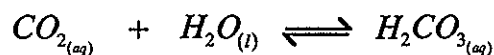
(a)   Define Le Chatelier's Principle.

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(b)   Carbon dioxide is slightly soluble in water and establishes the following equilibria in a fizzy drink.

$$CO_{2(s)} \rightleftharpoons CO_{2(aq)} + \text{heat}$$

The dissolved carbon dioxide reacts with water to form a weakly acidic solution of carbonic acid.

$$CO_{2(aq)} + H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)}$$

$$H_2CO_{3(aq)} \rightleftharpoons H^+_{(aq)} + HCO^-_{3(aq)}$$

Explain, in terms of Le Chatelier's Principle, what will happen to the solubility of carbon dioxide when:

(i)   an open soft drink is warmed

2

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(ii)   a base is added to the fizzy drink

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(c)   Calculate the mass of carbon dioxide released at RTP if the volume of the collected CO_2 gas was 365 mL.

2

Marks

Question 21 (5 marks)

Potassium hydrogen phosphate (K_2HPO_4) forms an amphiprotic species in water that is involved in the buffering of living cells.

(a)   Write an equation showing how K_2HPO_4 can act as an acid in water.   **1**

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(b)   Write an equation showing how K_2HPO_4 can act as a base in water.   **1**

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(c)   From one of your equations above clearly identify a conjugate acid-base pair   **1**

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(d)   Qualitatively describe the effect of the above buffer on the pH of a solution.   **2**

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Marks

Question 22 (6 marks)

(a)   Using acetic (ethanoic) acid and hydrochloric acid in your answer, draw diagrams to represent:

1. a concentrated, weak acid solution   2. a dilute, strong acid solution

Make sure you use correct formulae for ions and molecules in your diagrams.   **2**

Concentrated, weak acid solution   strong, dilute acid solution

(b)   Describe the difference between acetic acid and hydrochloric acid in terms of an equilibrium between the intact molecule and its ions.   **4**

Question 23 (8 marks)

Titration is an important technique for finding accurately the concentration of a solution.

(a)   Describe the correct technique for preparing a standard solution of sodium hydrogen carbonate and the correct technique for conducting a titration to determine the concentration of a solution of sulfuric acid.   **6**

(b)   If 25.0 mL of a 0.0452 M sodium hydrogen carbonate solution gave a mean titre of 17.37 mL of sulfuric acid calculate the concentration of the acid.   **2**

Marks

Question 24 (5 marks)

Ammonia is prepared from its elements via a catalytic reaction known as the Haber process.

(a) Write down the balanced equation for the formation of Ammonia in the Haber process. **1**

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(b) Identify the catalyst used in the Haber process. **1**

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(c) Use Le Chatelier's principle to explain the following data on yields of ammonia at 300°C. **3**

Pressure	100 atm	200 atm
Yield	53%	67%

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Marks

Question 25 (6 marks)

Describe and assess the effectiveness of methods used to purify and sanitise mass water supplies.

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Marks

Question 26 (5 marks)

Chemists monitor changes in the levels of ozone so that further damage can be limited.

(a) Use Lewis electron dot structures to demonstrate the formation of the coordinate covalent bond in ozone.

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(b) The boiling point of oxygen is $-183\,^{0}C$ whereas the boiling point of ozone is $-111\,^{0}C$. Account for this difference.

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Question 27 (6 marks)

In class you analysed, by means of titration, a sample of fertiliser to determine the percentage of sulfate it contained. Below is a typical table of results.

Titre	Volume (mL)
1	29.50
2	29.35
3	29.42

9.32 g of the original fertiliser were dissolved in 250 mL of deionised water. 10 mL of this solution were pipetted into a conical flask. The burette contained 0.051 M barium chloride.

Calculate the percentage of sulfate in the fertiliser. Show all your working as a means of explaining the chemistry involved.

6

Marks

Question 28 (3 marks)

Human activity impacts on waterways and so it is important to monitor our waterways.

(a) Water quality can be determined by considering factors like turbidity.
     Identify **FOUR** other factors that help determine water quality.   2

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(b) Define the term eutrophication.   1

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End of Section I

Section II
10 marks
Attempt EITHER Question 29 OR Question 30
Allow about 30 minutes for this section

Use the spaces provided on the paper.

Marks

EITHER

Shipwrecks, Corrosion and Conservation

Question 29 (10 marks)

(a) Identify the ion which has the highest concentration in seawater.

1

(b) Account for the origins of dissolved minerals in the oceans.

2

(c) Outline and analyse the impact of the work of Galvani, Volta, Davy and Faraday in understanding electron transfer reactions.

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End of Question 29

OR

Marks

Forensic Chemistry

Question 30 (10 marks)

(a) (i) Define *inorganic compounds*. 1

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(ii) Describe tests you could do in the laboratory to distinguish between two
colourless liquids - ethanol and ethanoic acid (acetic acid). 2

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Marks

(b) Forensic chemists identify materials and trace their origins. Outline precautions that may be necessary to prevent contamination of samples for analysis and discuss ethical issues that may need to be addressed during an analytical investigation.

7

End of Question 30

End of Paper

1. Ethylene serves as a monomer from which polymers are made. The correct structural formula for ethylene is:

   (A) $CH_3CH_2 = CH_2$

   (B) $CH_3 = CH_2$

   (C) CH_3CH_3

   (D) $CH_2 = CH_2$

2. Which of the following molecules is an example of a condensation polymer?

   (A) Teflon

   (B) Cellulose

   (C) Polystyrene

   (D) Poly (vinyl chloride)

3. The correct IUPAC name for the following alkanol is:

   $$H - \overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}} - \overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}} - \overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}} - \overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}} - \overset{\overset{\displaystyle OH}{|}}{\underset{\underset{\displaystyle H}{|}}{C}} - \overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}} - \overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle H}{|}}{C}} - H$$

   (A) 5-heptanol

   (B) 2-hexanol

   (C) 3-pentanol

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4. Which statement concerning galvanic cells is correct?

   (A) Reduction occurs at the anode.

   (B) They are also known as electrolytic cells.

   (C) The cathode is assigned a positive charge.

   (D) An external power source must be present.

5. Which acid is **not** found in either food, drink or your stomach?

   (A) 2-hydroxypropane-1,2,3-tricarboxylic

   (B) sulfuric

   (C) acetic

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	Alpha radiation source	Beta radiation source	Gamma radiation source
No target	728	791	762
Paper	9	787	746
Aluminium	3	656	733
Gold	0	152	710

   The students also measured the radiation produced by a cobalt-60 source under the same conditions and obtained the following results:

   No target   793
   Paper   780
   Aluminium   746
   Gold   714

   From this information it is reasonable to conclude that the cobalt-60 was emitting:

   (A) alpha radiation

   (B) beta radiation

   (C) gamma radiation

   (D) either beta or gamma radiation

7. The equation for the production of the transuranic element plutonium (Pu) is:

   $$^{238}_{92}U + X \rightarrow\ ^{241}_{94}Pu +\ ^{1}_{0}n$$

   Species X in this reaction is:

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8. Which of the following scientists did **not** contribute to the historical development of ideas about acids?

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10. 25 mL of a solution of H_2SO_4 that has a pH of 3 is pipetted into a 250 mL volumetric flask and distilled water added up to 250 mL. What is the pH of the diluted solution?

    (A) 0.5
    (B) 4.5
    (C) 4
    (D) 5

11. Acid strength is a measure of the:

    (A) concentration of an acid solution

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    (C) extent to which an acid ionises in water

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    (B) oxygen

    (C) hydronium ion

    (D) ammonium ion

13. Chemists are employed in industry to monitor and manage industrial processes. There are many aspects to the role of the chemist. Which of the following is **NOT** a role performed by a chemist working in industry?

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    (D) The chemist ensures that the workplace remains safe and healthy.

14. Atomic absorption spectroscopy (AAS) would be a suitable method for determining the concentration of:

    (A) Phosphorus in detergents

    (B) Ethanol in wine

    (C) Mercury in fish

    (D) Nitrogen in fertilisers

15. During the tests for biochemical oxygen demand (BOD), a sample of water is kept in the dark for five days before being tested for its dissolved oxygen level.

What is the purpose of keeping the sample in the dark?

    (A) To prevent photosynthesis occurring and adding oxygen to the water.

    (B) To prevent photosynthesis occurring and removing oxygen from the water.

    (C) To prevent respiration occurring and adding oxygen to the water.

    (D) To prevent respiration occurring and removing oxygen from the water.

Section I (continued)

Part B – 75 marks
Attempt ALL questions
Allow about 2 hours for this part

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Question 16 (5 marks)

Marks

Styrene is an example of a commercially significant monomer

(a) Give another example of a commercially significant monomer, stating both its systematic and common names.

2

    systematic name: chloroethene / ethene / cyanoethene

    common name: vinyl chloride / ethylene / acrylonitrile

(b) Describe **TWO** uses of polystyrene in terms of its properties.

3

    1. Tool handles (screwdriver, chisel) because of its hardness or rigidity

    2. Styrofoam cups because of its rigidity, OR INSULATION (the spaces in the foam are filled with insulating gas held in place (sealed) by non-porous polystyrene.

Marks

Question 17 (8 marks)

Ethanol is currently being used to supplement the use of petrol in cars.

(a) Discuss the need for alternative sources of the compounds presently obtained from the petrochemical industry.

2

Petrol as a fuel for cars comes from non-renewable petroleum hence ethanol as a supplement to petrol can extend the lifetime of petroleum resources. Ethanol is a "cleaner" more environmentally friendly fuel than hydrocarbon petrol (However ethanol does not provide as much energy per kg as petrol)

(b) Write a balanced equation for the fermentation of glucose to ethanol.
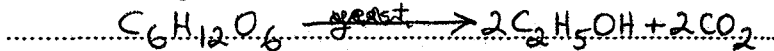
1

$$C_6H_{12}O_6 \xrightarrow{\text{yeast}} 2C_2H_5OH + 2CO_2$$

No ~ 1 mark!

(c) Assess the potential of ethanol as an alternative fuel by discussing the advantages and disadvantages of its use.

5

(1) Ethanol is a renewable resource and can reduce greenhouse gas emissions. These are two wonderful advantages of ethanol as an alternative fuel. However currently much energy is used to distil the ethanol, this produces more greenhouse gases. Other disadvantages are the large agricultural land with its pollution by fertiliser of streams, and much smelly waste from fermentation. If solar energy could be harnessed for distillation, ethanol would have high potential as a fuel alternative. At the moment ethanol's disadvantages outweigh its advantages.

Marks

Question 18 (6 marks)

In class you performed a first-hand investigation to measure the difference in potential of different combinations of metals in an electrolyte solution.

(a) Draw a neat, fully labelled diagram of the experimental set-up when using iron and copper electrodes in solutions of iron sulfate and copper sulfate respectively. Indicate the direction of electron flow as well as the direction of ion movement in the salt bridge.

4

(b) Calculate the potential $E^\ominus$ of the above cell and write the overall equation for the reaction.

2

$$E_{cell}^\ominus = E_{cathode}^\ominus - E_{anode}^\ominus$$
$$= 0.34V - (-0.44V)$$
$$= 0.78V$$

$$E^\ominus = E_{red}^\ominus + E_{oxid}^\ominus$$
$$= 0.34V + 0.44V$$
$$= 0.78V$$
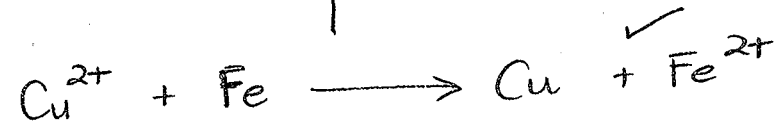
$$Cu^{2+} + Fe \longrightarrow Cu + Fe^{2+}$$

Marks

Question 19 (5 marks)

Cobalt-60 (Co – 60) is a gamma emitter. It is produced by the neutron bombardment of Co – 59.

(a) Name an instrument that can be used to detect gamma radiation. **1**

Geiger (-müller) counter., (scintillation counter)

photographic film

(b) Write a nuclear equation to show the formation of Co – 60. **1**

$$^{59}_{27}Co + ^{1}_{0}n \longrightarrow ^{60}_{27}Co$$

(c) Evaluate Co – 60's use in the treatment of certain cancers. **3**

Co – 60 is an efficient agent for the treatment of some cancers because the [energetic] gamma radiation it emits can penetrate deep into body tissue to kill the cancer cells. It has a short half life and therefore can emit intense enough radiation, but long enough to make its use in therapy machines economical. Even though its gamma radiation kills healthy cells as well as cancerous, Co-60 is very effective for treatment of cancers.

Marks

Question 20 (7 marks)

Le Chatelier's Principle can be used to predict what happens to a system at equilibrium.

(a) Define Le Chatelier's Principle. **1**

If a system at equilibrium is disturbed, then the system will adjust itself to minimise the disturbance (or to partially counteract the disturbance)

(b) Carbon dioxide is slightly soluble in water and establishes the following equilibria in a fizzy drink.

$$CO_{2(a)} \rightleftharpoons CO_{2(aq)} + heat$$

The dissolved carbon dioxide reacts with water to form a weakly acidic solution of carbonic acid.

$$CO_{2(aq)} + H_2O_{(l)} \rightleftharpoons H_2CO_{3(aq)}$$

$$H_2CO_{3(aq)} \rightleftharpoons H^+_{(aq)} + HCO^-_{3(aq)}$$
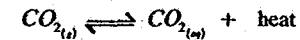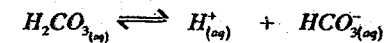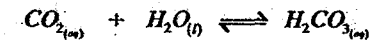
Explain, in terms of Le Chatelier's Principle, what will happen to the solubility of carbon dioxide when:

(i) an open soft drink is warmed **2**

Heat causes the position of equilibrium to shift toward $CO_{2(g)}$. OR HEAT disturbance can be minimised by the endothermic (reverse) reaction proceeding [$CO_{2\,aq}$] decreases [$CO_{2\,g}$] increases ∴ solubility of carbon dioxide decreases

(ii) a base is added to the fizzy drink **2**

A base contains hydroxide ions OH⁻, OH⁻ neutralises the hydrogen ions in solution. This decrease of [H⁺] is minimised by more $H_2CO_{3(aq)}$ ionising In turn this decrease of [H_2CO_3] will be minimised by more $CO_{2\,(aq)}$ forming $H_2CO_{3(aq)}$. Decrease [$CO_{2\,aq}$] minimised by more $CO_{2(g)}$ dissolving ∴ Solubility of $CO_{2(g)}$ increases

(c) Calculate the mass of carbon dioxide released at RTP if the volume of the collected CO_2 gas was 365 mL.

1 mol CO_2 @ RTP = 24.79 L

44.01g CO_2 = 24.79 L

x g = 0.365L

x = 0.648g

Marks

Question 21 (5 marks)

Potassium hydrogen phosphate (K_2HPO_4) forms an amphiprotic species in water that is involved in the buffering of living cells.

(a) Write an equation showing how K_2HPO_4 can act as an acid in water. **1**

$$HPO_4^{2-} + H_2O \rightleftharpoons PO_4^{3-} + H_3O^+$$

(b) Write an equation showing how K_2HPO_4 can act as a base in water. **1**

$$HPO_4^{2-} + H_2O \rightleftharpoons H_2PO_4^- + OH^-$$

(c) From one of your equations above clearly identify a conjugate acid-base pair **1**

$$HPO_4^{2-}/H_2PO_4^- \; ; \; HPO_4^{2-}/PO_4^{3-} \; ; \; H_2O/OH^- \; ; \; H_2O/H_3O^+$$
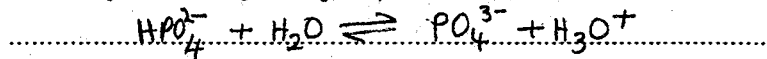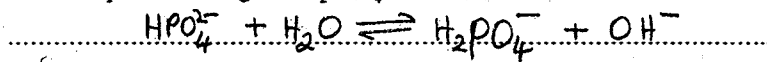
(d) Qualitatively describe the effect of the above buffer on the pH of a solution. **2**

If small amounts of acid or base (H^+ or OH^-) are added to a solution of K_2HPO_4, they will be neutralised so that the pH is almost constant to what it was before the addition of the H^+ or OH^-

Marks

Question 22 (6 marks)

(a) Using acetic (ethanoic) acid and hydrochloric acid in your answer, draw diagrams to represent:

1. a concentrated, weak acid solution   2. a dilute, strong acid solution

Make sure you use correct formulae for ions and molecules in your diagrams. **2**

Concentrated, weak acid solution   strong, dilute acid solution
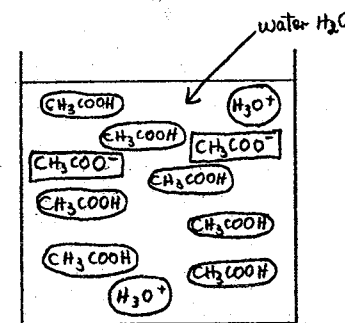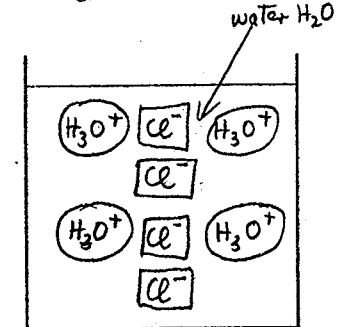
(b) Describe the difference between acetic acid and hydrochloric acid in terms of an equilibrium between the intact molecule and its ions. **4**

Hydrogen chloride molecules react completely with water to form hydronium ions and chloride ions.

$$HCl + H_2O \longrightarrow H_3O^+ + Cl^-$$
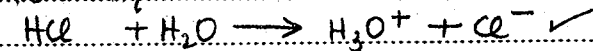
There is no reverse reaction and no equilibrium Ethanoic acid molecules only partially react with water (few percent) to form ethanoate ions and hydronium ions once the reacting species are in equilibrium a constant concentration of species is present.
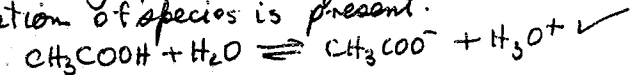
$$CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$$

Question 23 (8 marks)

Titration is an important technique for finding accurately the concentration of a solution.

(a) Describe the correct technique for preparing a standard solution of sodium hydrogen carbonate and the correct technique for conducting a titration to determine the concentration of a solution of sulfuric acid.

6

Pure anhydrous sodium hydrogen carbonate is heated cooled and massed. The appropriate amount is transferred to a (standard) volumetric flask quantitatively + dissolved in distilled water and made up to the mark with distilled water. The solution is shaken thoroughly. A storage bottle is washed with distilled water, rinsed with the standard solution and filled with the standard solution. Bottle labelled. A burette is washed, rinsed with distilled water, rinsed with standard sulfuric acid, fill stem, set to 0.00mL. A pipette is washed, rinsed with (distilled water,) rinsed with the sodium bic?, filled with base using pipette filler to mark, transferred to conical flask (drained 30s). Two drops Methyl orange added. Sulfuric acid titrated until permanent red in yellow. Conical flask has side washed down with distilled water

(b) If 25.0 mL of a 0.0452 M sodium hydrogen carbonate solution gave a mean titre of 17.37 mL of sulfuric acid calculate the concentration of the acid.

$$H_2SO_4 + 2NaHCO_3 \rightarrow Na_2SO_4 + 2CO_2 + 2H_2O \quad (\tfrac{1}{2})^2$$
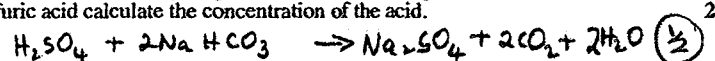
quantity $NaHCO_3 = 0.0250 \times 0.0452$ mol $(\tfrac{1}{2})$

quantity $H_2SO_4 = \tfrac{1}{2} \times 0.0250 \times 0.0452$ mol $(\tfrac{1}{2})$

conc $H_2SO_4 = \dfrac{n}{V}$

$$= \dfrac{\tfrac{1}{2} \times 0.0250 \times 0.0452 \text{ mol}}{0.01737 \text{ L}}$$

$$= 0.0325 \text{ mol L}^{-1} \quad (\tfrac{1}{2})$$

Question 24 (5 marks)

Ammonia is prepared from its elements via a catalytic reaction known as the Haber process.

(a) Write down the balanced equation for the formation of Ammonia in the Haber process.

1

$$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$$

(b) Identify the catalyst used in the Haber process.

1

Fe / Fe_3O_4 (Pt ?)

(c) Use Le Chatelier's principle to explain the following data on yields of ammonia at 300°C.

3
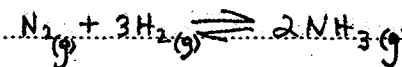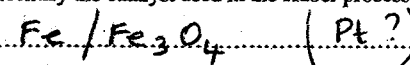
Pressure	100 atm	200 atm
Yield	53%	67%

The yield at 200 atmospheres pressure is higher than at 100 atm. If we imagine the equilibrium mixture at 100 atm and then disturb the equilibrium to 200 atm, the system tries to minimise the increased pressure by reducing the number of molecules causing the collisions with the container. By shifting the position of equilibrium to NH_3 (RIGHT) 4 molecules are changed to 2. Less molecules, less collisions per second, lessened pressure but higher yield of ammonia

Marks

Question 25 (6 marks)

Describe and assess the effectiveness of methods used to purify and sanitise mass water supplies.

6

Water from the catchment area is passed through grids of iron to remove vegetation and carcases of animals. Flocculation of very fine negatively charged silt particles is achieved by adding substances containing Fe^{3+} or Al^{3+} ions. The enlarged silt particles sink into the mud at the bottom of the dam.

The water is filtered through a bed of sand to remove any small particles in the water

The water might still contain microorganisms such as giardia or cryptosporidium, these can be killed by chlorination. Either chlorine gas or sodium hypochlorite can be bubbled/added to the water while fluoride ions don't sanilise they can assist dental strength of the population.

Some minute silt particles do get to the domestic households particularly after heavy rain in the catchment, but the physical methods + chemical methods are very effective in purifying and sanitising huge volumes of mass water supplies

Marks

Question 26 (5 marks)

Chemists monitor changes in the levels of ozone so that further damage can be limited.

(a) Use Lewis electron dot structures to demonstrate the formation of the coordinate covalent bond in ozone.

2

approach of oxygen molecule   Result   these two electrons form the coordinate covalent bond in ozone.
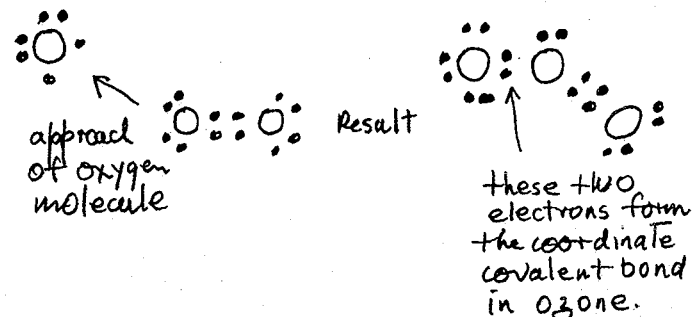
(b) The boiling point of oxygen is $-183\,^{\circ}C$ whereas the boiling point of ozone is $-111\,^{\circ}C$. Account for this difference.

3

oxygen molecules have 16 electrons
ozone molecules have 24 electrons
ozone ∴ has higher dispersion forces
ozone is polar, oxygen is non-polar
ozone has extra dipole-dipole forces between its molecules ∴ more energy needed to separate liquid ozone molecules than oxygen
∴ higher boiling point of ozone than oxygen.

Question 27 (6 marks)

In class you analysed, by means of titration, a sample of fertiliser to determine the percentage of sulfate it contained. Below is a typical table of results.

Titre	Volume (mL)
1	29.50
2	29.35
3	29.42

9.32 g of the original fertiliser were dissolved in 250 mL of deionised water. 10 mL of this solution were pipetted into a conical flask. The burette contained 0.051 M barium chloride.

Calculate the percentage of sulfate in the fertiliser. Show all your working as a means of explaining the chemistry involved.

6

Average titre of barium chloride $= 29.42 mL$.

$$Ba^{2+} + SO_4^{2-} \longrightarrow BaSO_4$$
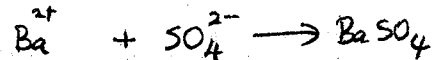
quantity $Ba^{2+} = 0.02942 \times 0.051$ mol

quantity $SO_4^{2-} = 0.02942 \times 0.051$ mol

BUT THIS WAS ONLY IN 10mL of fertiliser solution

in 250mL of fertiliser is :

$$= \frac{250}{10} \times \frac{0.02942}{1} \times 0.051 \text{ mol } SO_4^{2-}$$

which all came from the 9.32g fertiliser

mass of $SO_4^{2-} = \frac{250}{10} \times \frac{0.02942}{1} \times \frac{0.051}{1} \times 96.06 g$

% sulfate in sample $= \frac{250}{10} \times \frac{0.02942 \times 0.051 \times 96.06}{9.32} \times 100$

$$= 38.7 \%$$

Question 28 (3 marks)

Human activity impacts on waterways and so it is important to monitor our waterways.

(a) Water quality can be determined by considering factors like turbidity. Identify **FOUR** other factors that help determine water quality.

2

dissolved oxygen

concentration of common ions

hardness

acidity (pH)   TDS

(b) Define the term eutrophication.

1

The conversion of deep lakes into firm land by the cyclic algal blooms and death filling up the lake. Eventually the shallow lakes change to swamps + marshes + finally firm land.

End of Section I

Section II
10 marks
Attempt EITHER Question 29 OR Question 30
Allow about 30 minutes for this section

Use the spaces provided on the paper.

Marks

EITHER

Shipwrecks, Corrosion and Conservation

Question 29 (10 marks)

(a) Identify the ion which has the highest concentration in seawater.

1

chloride

(b) Account for the origins of dissolved minerals in the oceans.

2

The dissolution of salts by water passing through thermal vents in sea floor the leaching of soils by rain and ground water into run-off into oceans.

-19-

Marks

(c) Outline and analyse the impact of the work of Galvani, Volta, Davy and Faraday in understanding electron transfer reactions.

7

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The work of scientists including Luigi Galvani, Allesandro Volta, Humphry Davy and Michael Faraday, in the l eighteenth and then nineteenth centuries improved our understanding of oxidation – reduction reactions and role in generating electricity. The importance of electrolytes in these processes was also increasingly understood

Luigi Galvani (1737 – 1798)
Galvani investigated the effect of static charges on the nerves and muscles of frog's legs. He showed that the muscles twitched when a charge was applied. Following further experimentation, he discovered that the muscle would twitch without the application of a static charge as long as two different metals formed the circuit with the muscle tissue. He wrongly concluded that the tissues themselves produced an electric fluid that moved between the nerves and the muscles. He called this animal electricity.

Allesandro Volta (1745 – 1827)
Volta was a friend of Galvani who disagreed with his interpretation of the frog experiments. He demonstrated electric currents could be produced, by alternating two different metals(copper and zinc disks) in a stack, and separating them with cardboard, soaked in brine. This stack of conductors and an electrolyte was called Volta Pile. Volta thought (incorrectly) that it was the contact between the metals that generated the electrical current

Humphrey Davy (1778 – 1829)
Davy experimented with improved versions of Volta's Pile to pass electric currents into water and other electro including molten salts. The electrical energy caused the decomposition (electrolysis) of the electrolytes throug which it passed. He produced the first samples of sodium, potassium and calcium by this method. Davy corre reasoned that the electric currents were generated by chemical reactions.

Michael Faraday (1791 – 1867)
Faraday initially worked with Davy as his assistant. Later, he extended Davy's experiments and developed quantitative laws relating to the quantity of electrical charge transferred and the mass of products formed durir electrolytic decomposition reactions. He measured the amount of charge in his experimental electrolytic cells i terms of the volume of oxygen released from a second sulfuric acid electrolytic cell connected in series with hi cell.

The complete understanding of the redox reactions in terms of electron and ion transfer was not fully understo until the end of the nineteenth century. The theory of ions as proposed by Arrhenius and the discovery of the electron by Thomson allowed chemists to fully understand the processes involved.

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End of Question 29

OR

- 20 -

Marks

Forensic Chemistry

Question 30 (10 marks)

(a)   (i)   Define *inorganic compounds*.   1

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  (ii)   Describe tests you could do in the laboratory to distinguish between two colourless liquids - ethanol and ethanoic acid (acetic acid).   2

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Marks

(b)   Forensic chemists identify materials and trace their origins. Outline precautions that may be necessary to prevent contamination of samples for analysis and discuss ethical issues that may need to be addressed during an analytical investigation.   7

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End of Question 30

End of Paper

Student No. ___3C3___

Marks

(c) Outline and analyse the impact of the work of Galvani, Volta, Davy and Faraday in understanding electron transfer reactions.

7

Galvani is credited with the first production of an electric current. He joined two different metal wires together and stuck the ~~conjoined~~ ends into the muscle of (freshly extracted) from a frog. He noticed the muscle contract (due to the passage of current). Galvani incorrectly concluded that it was the muscle which generated the current naming the phenomenon 'animal electricity'.

Volta realised that it was not the muscle but the metals in solution which generated the current. Volta is credited with the first production of a galvanic cell. He sandwiched a sheet of brine soaked cardboard (cardboard soaked in NaCl) between a ~~Cu~~ copper and a tin electrode. Volta was able to produce greater currents by his development of the volta pile which utilised stacks of electric cells. Volta incorrectly concluded that it was contact between pairs of metals which generated the electric current.

Davy ~~used~~ used improved versions of Volta's pile in order to electrolytically decompose many substances including the electrolysis of water. Davy was the first person to correctly identify the current generated. He proposed that the current was generated due to a chemical reaction occurring

End of Question 29

OR

P.T.O

7

Faraday was (initially) Davy's assistant. Faraday extended Davy's work with decomposition reactions. Faraday also created a device to measure the size of a current ~~travelling through a~~ the Faraday's sulfuric acid coulometer produced ~~and~~ ~~broke down~~ oxygen gas and measured its volume. Faraday discovered that the volume of oxygen gas produced was proportional to the current travelling through the circuit.

All four chemists have impacted on the understanding of electron transfer reactions. Originally through the discovery that a current could be generated ~~and~~ (Galvani) and the production of equipment to generate a current (Volta). Then later ~~with the~~ through the correct understanding of the electron transfer chemical reactions ~~causing~~ involved (Davy) and a means to determine the rate of electron transfer – current (Faraday).

Too much detail in the earlier paragraphs. Answer will need to be far more succinct in the HSC.

This paragraph is good and shows the impact.

Student No. _____ 360

Marks

(c) Outline and analyse the impact of the work of Galvani, Volta, Davy and Faraday in understanding electron transfer reactions.

7

Galvani was the first to stumble upon electron transfer reactions between metals. He had created a circuit with frogs legs, 2 different metals and a static electric charge when he found that the frog's legs still twitched (saw electricity) without a static charge as long as the 2 metals were in contact to create the circuit. Although his conclusions were incorrect as to the reason for this, the made the initial breakthrough impact was that he 'opened the door' for further research into this field of science. Volta used Galvani's findings and with them he believed that biological material wasn't necessary for electric flow. He thus created the voltaic Pile, a stack of alternating different metals separated by brine soaked cardboard. This was the first battery or Galvanic cell. The impact was that now people could generate power via this 'Pile' which utilised electron transfer reactions revolutionised science and and the world. Davy, using an improved Voltic Pile, was the first to carry out electrolysis of water e molten salts. He thus produced the first samples of Ca^{2+}, K^+, Na^+ and also figured that it was a chemical change in the Voltic Pile (a chemical reaction between metals) that was causing the flow of electrons. Thus, Davy impacted by making the vital connection that a chemical reaction was the base of the electron transfer taking place.

Faraday used Davy's work and results to attempt to establish a set of rules e results relating to the amount of charge produced in relation to the quantity of reactants. The impact of this was that it created the first Quantitative laws/figures to do with electron transfer reactions which thus increased the understanding of the topic.

End of Question 29

OR

Using the 4 above scientists's vital results/conclusions refined versions and understanding of electron transfer reactions were compiled at a later date.

Markers comments for Shipwrecks Question   RJP

29

(a)   A lot of students said Na^+ or $NaCl$ but I only accepted chloride or Cl^-.

(b)   Needed leaching into groundwater (1 mark) and hydrothermal vents (1 mark)

(c)   **Outline (sketch in general terms, indicate the main features of)**

Had to outline the work (say what they did) for each of Galvani, Volta,, Davy and Faraday. (max four marks for this, 1 mark for each)

Analyse (Identify components and the relationship between them; draw out and relate implications)

Had to say something about the work in the context of understanding of electron transfer.

Galvani – discovery of electricity (before that only static electricity)

Volta – first battery etc.

Davy – Chemical reactions responsible for the current

Faraday – quantified electrolysis (electron transfer)

A concluding paragraph that summed up the impact of the four of them on electron transfer reactions.

Max of 3 marks for this section.

To get a mark of 7, it also had to read well.

(15) done well by most students

17c) • This question was not answered well. Many general statements were made that gave me actual facts or meaning without specific explanation eg - "can be easily made" "is CO_2 neutral"
"burns clean"
"is expensive"
The best answers gave succinct facts with specific detail of 2 significant advantages, 2 significant disadvantages, and a judgement of ethanol's suitability as an alternative fuel.

• Be careful of your expressions - eg "it saves the greenhouse" - What is the greenhouse it is saving?

• A zero mark answer said that ethanol -
"is more efficient"
"obtained from a natural source"
"environmentally friendly"
All of these expressions need qualifying. Oil is also "natural". The waste from fermentation is not environmentally friendly.

• An answer that gained 5 points

"Ethanol has potential as an alternative fuel because it
- is a renewable resource, produced from fermentation of sugar cane or corn; the products of combustion are CO_2 & H_2O which are non-polluting and can be recycled to grow more plants; it is presently a petrol extender (10% of present fuel) without car engine modifications.
However there are, as yet, several disadvantages which need to be overcome. Although it is renewable, the vast land areas needed would cause deforestation and land degradation. Production of fertilisers, running machinery for ploughing, planting, harvesting and distilling all require vast amounts of energy which is currently supplied by fossil fuels. This fossil fuel use would have to be replaced by solar energy for the CO_2 emissions of ethanol combustion to be considered recyclable.
At the present ethanol's disadvantages still outweigh its advantages, and the present price & availability of petrol from oil makes ethanol an unviable alternative."

• The above answer was a bit long but did not go over the page!

Many good English

Most marks are lost because of 2 things
1) General waffle rather than facts
2) Very poor English - grammar, spelling & expression

eg "Ethanol can be obtained from plant sugars (glucose) and is therefore more environmentally friendly than fossil fuels, which contribute to the greenhouse effect"

"therefore" and "which" join the parts of this sentence assuming linked, consistent facts with a cause + effect relationship
BUT
Ethanol coming from plants has nothing to do with fossil fuels contributing to the greenhouse effect, without lots of other links in between.

Comments Q 16

Most common mistake was reversing
the systematic and common names
or putting poly- in front. This
was a monomer question.

b) Polystyrene —

Use	Property
tool handles (1/2)	Hard + rigid (1/2) due to large chain stiffening side group (1/2) of the benzene ring
(disposable plastic wine glasses or CD covers) (1/2)	transparent due to low (1/2) crystallisation

one of these (1/2)
— insulated coffee cups,
— packaging, or
— insulation around electrical components
— bean bag type furniture

gas can be blown
into the polymer
filling the spaces
between the polymer (1)
chain. It still
has some rigidity
but the gas makes
it an insulator

Marker's Comments - Questions 17 - 19

17 a)

The Facts

The petrochemical industry is the plastics (polymer) industry. The compounds are polymers. The chemicals for these are ethene + propene & the catalytic cracking of crude oil. Crude oil is a non-renewable resource that is running out. So to keep making plastics, renewable/alternative sources of ethene + propene are needed. eg ethanol from biomass or polymers from plants + bacteria.

Answers that got full marks

"Petrochemicals that are the basis for the plastics industry (ethene + propene) are mostly obtained from the cracking of fractions of crude oil. Crude oil is a non-renewable resource and world reserves are expected to be depleted in the next 2-4 decades. It is therefore necessary to consider alternative sources of ethene and propene, such as ethanol from biomass, or develop biopolymers in plants and bacteria."

"The basic chemicals used in the petrochemical industry are ethene and propene. These are obtained from the catalytic cracking of oil. Since oil is a non-renewable resource and being quickly depleted, it will soon no longer be able to supply the chemicals needed for production of plastics in the petrochemical industry. Therefore it would be advisable to have alternative sources of propene + ethene eg ethanol, or to develop plastics that can be grown in plants or bacteria."

Q 18 a) neat with correct apparatus
            iron & copper electrodes
            anode & cathode correctly labelled
            ion flow correctly directed   } ½ each.
            electrolytes correctly labelled
            voltmeter present
            salt bridge labelled with suitable solution
            electron flow in correct direction

        —1 if attached to a battery

    b) $CuSO_4 + Fe \rightarrow Cu + FeSO_4$ was not accepted

Q 19 a) <u>Accepted</u>   Geiger counter   Scintillation counter
                            Cloud chamber   Photographic film

    b) No half marks   — be careful where the numbers
        are placed and that upper & lower case are observed

    c) To get 3 marks the following had to be mentioned

        • emits γ rays which penetrate deep into tissue
        • kills cancerous cells
        • can kill healthy cells also so must be specifically
            targetted to avoid harming the patient
        • has a half life of ~5 years
        • the half life makes predictian & use of the isotope
            in hospital equipment economical. (replace after 5years)
        • the γ emissions are high intensity & thus effective in small doses

    Many students waffled with information that would suit
    any radio isotope. Some students were obviously
    mixing it up with technetium or iodine wanting
    to use it to diagnose, or inject it, or ingest it.

    The half-life needed to be stated because short
    & long when talking about radioisotopes is very relative,
    50·3 years is short compared to 15 years but quite
    long compared to 15 minutes.