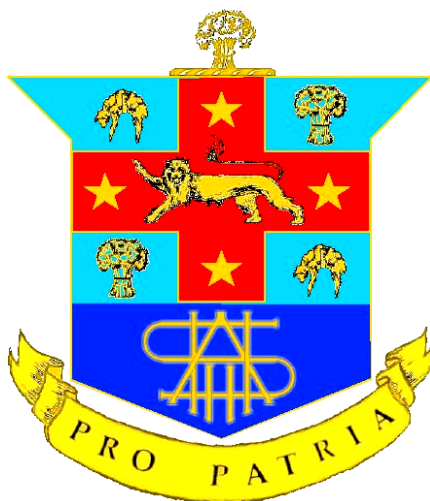




2008

HSC Half-Yearly Examination

Chemistry

General Instructions

Reading time – 5 minutes

Working time – 1.5 hours

Write using blue or black pen

Draw diagrams using pencil

Approved calculators may be used

Write your student number on each section of this booklet

Total marks 60

This examination has two parts, Part A and Part B.

Part A – 8 marks

Attempt Questions 1 – 8.

Allow about 15 minutes for this part.

Part B – 52 marks

Attempt Questions 9 – 20.

Allow about 1 hour and 15 minutes for this part.

Teacher-in-charge: Mrs Davis**Task Weighting: 20%**

Part A.**8 marks**

Attempt questions 1 - 8.

Allow about 15 minutes for this part.

Record your answers on the separate 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 ☐

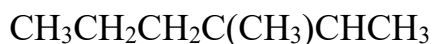
If you think you have made a mistake, put a cross through the incorrect answer and fill in the new answer.

A ☒ B ☒ C ☐ D ☐

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

A ☒ B ☒ C ☐ D ☐
 correct ↖

1. Identify the name of the hydrocarbon shown by the formula below.



- (A) 4-methyl-4-hexyne
(B) 4-methyl-5-hexene
(C) 3-methyl-3-hexene
(D) 3-methyl-2-hexene
2. You carried out a first-hand investigation to monitor mass changes during fermentation. Identify the gas produced during the fermentation process responsible for the observed mass changes.
- (A) ethanol
(B) water vapour
(C) oxygen
(D) carbon dioxide
3. Identify the monomer used to form polyethylene.
- (A) $-\text{CH}=\text{CH}-$
(B) $-\text{CH}_2=\text{CH}_2-$
(C) $(\text{CH}_2-\text{CH}_2)_n$
(D) $\text{CH}_2=\text{CH}_2$

4. Consider the following chemical reaction:



Identify the correct statement.

- (A) the oxidant is $\text{Ag}^+_{(\text{aq})}$
 - (B) $\text{Ni}_{(\text{s})}$ is reduced
 - (C) the oxidation state of Cl in AgCl is zero
 - (D) this is not a redox reaction
5. The equation below illustrates the decay of an isotope of radium.



Identify the particle labelled Z, produced in this reaction?

- (A) Fr - 226
 - (B) Th - 230
 - (C) Ac - 226
 - (D) Rn - 222
6. Which of the following are used to detect radiation from radioactive isotopes?
- (A) Geiger counter, photographic film
 - (B) Geiger counter, radiographic counter
 - (C) Photographic film, synchotron
 - (D) Scintillation counter, radiotracer

7. Ozone reacts with nitric acid according to the following equation.

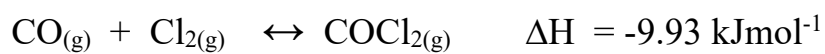


0.66 g of nitrogen monoxide was mixed with an excess of ozone.

What is the maximum volume of nitrogen dioxide produced at 0°C and 100 kPa?

- (A) 0.022 L
- (B) 0.499 L
- (C) 0.500 L
- (D) 0.545 L

8. Phosgene is prepared from the reaction of carbon monoxide and chlorine in the presence of a catalyst.



Which of the following sets of conditions would produce the highest yield of phosgene?

- (A) high temperature, high pressure
- (B) low temperature, low pressure
- (C) low temperature, high pressure
- (D) high temperature, low pressure

Part B.**52 marks**

Attempt questions 9 – 20.

Read the whole of each question before commencing it.

Answer the questions in the spaces provided.

Show full working for questions requiring calculations.

Allow about 1 hour and 10 minutes for this part.

Question 9. (3 marks)

(a) What is a 'biopolymer'?

1M

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(b) Name one biopolymer.

1M

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(c) Describe a potential use of the biopolymer named in (b).

1M

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Question 10. (7 marks)

You carried out a first-hand investigation to compare the reactivity of an alkane and its corresponding alkene.

(a) Recount the procedure used.

3M

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(b) Assess the reliability and validity of the procedure described above.

3M

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(c) Identify the dependent and independent variables for this investigation.

1M

Dependent variable

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Independent variable

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Question 11. (3 marks)

A group of students used spirit burners to carry out an investigation to determine the heat of combustion of ethanol. They burned 0.50 g of ethanol and used the flame to heat 150 mL of water. The temperature of the water rose from 20°C to 34°C.

Use this data to calculate the molar heat of combustion for ethanol.

3M

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Question 12. (4 marks)

A student was asked to perform a first-hand investigation to measure the difference in potential produced by various combinations of metals in electrolytic solutions. The student was provided with three metals (Ag, Al and Zn) and three electrolyte solutions (silver nitrate, aluminium nitrate and zinc nitrate).

- (a) Deduce which combination of the metals supplied should give the highest potential difference. 1M

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- (b) Write a balanced chemical equation for the overall reaction for the metals identified in (a). 1M

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- (c) Calculate the expected potential difference for the combination of metals identified in (a). 2M

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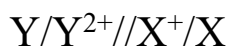
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Question 13. (5 marks)

A galvanic cell was constructed using two metals, X and Y: The cell is represented by:



A voltmeter showed a reading of +1.20 V. Metal X was noted to be the positive electrode.

- (a) Based on a first-hand investigation similar to this, that you have performed, draw a labelled diagram showing what this cell would look like in the laboratory. Include the voltmeter.

2M

- (b) Show the direction of flow of electrons in the external circuit on your diagram.

1M

- (c) (i) Outline the purpose of the salt bridge in this investigation.

1M

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- (ii) Recount how the salt bridge was constructed for your investigation.

1M

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Question 14. (5 marks)

Describe the chemistry of **either** a dry cell **OR** a lead-acid cell and assess its importance to society over the last 100 years or so.

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Question 15. (3 marks)

Describe the use of a named radioisotope in industry.

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Question 16. (4 marks)

(a) Define the term transuranic element.

1M

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(b) Nuclear reactors and linear accelerators play an important role in nuclear chemistry. Describe their role in the production of transuranic elements.

3M

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Question 17. (4 marks)

“The atmosphere contains acidic oxides of sulfur which have been increasing in concentration since the industrial revolution.”

Explain this increase. Include examples, supported by appropriate equations in your answer.

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Question 18. (4 marks)

(a) Define Le Chatelier's principle.

1M

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(b) Outline the factors that can cause a disturbance to a chemical system at equilibrium.

3M

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Question 19. (4 marks)

- (a) A compound containing the iron thiocyanate ion (FeSCN^{2+}) dissolves in water, establishing an equilibrium with iron (III) ions and the thiocyanate ion (SCN^-).

The reaction is endothermic and the equilibrium mixture formed contains ions of FeSCN^{2+} in solution which are red-brown, Fe^{3+} ions in solution which are pale green in colour and SCN^- ions in solution which are colourless.

- (i) Write the equation for this equilibrium reaction.

1M

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- (ii) Explain the colour change that would be observed if the temperature of the mixture were lowered.

3M

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(a) QV™ body wash claims that it is suitable for dry or sensitive skin because it is perfume free, colour free and **has a pH of 5.5**.

Indicator	Colour		pH range
	Low pH	High pH	
Methyl red	red	yellow	4.4 – 6.2
Thymol blue	red	yellow	1.2 – 2.8
Phenol red	yellow	red	6.8 – 8.4
Alizarin yellow	yellow	lilac	10.1 – 12.0
Bromocresol green	yellow	green	3.8 – 5.4
Bromothymol blue	yellow	blue	6.0 – 7.6
Methyl orange	red	yellow	3.1 – 4.4
Phenolphthalein	colourless	magenta	8.3 – 10.0

[illegible]

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Marking Guidelines HY Exam 2008
Year 12 CHEMISTRY

Multiple choice

Question.	Answer
1	D
2	D
3	D
4	A
5	D
6	A
7	B
8	C

9. a.

Marking criteria	Marks
Defines a biopolymer as a polymer produced by living organisms. A polymer is made up of monomer units.	1

9. b.

Marking criteria	Marks
Names one biopolymer	1

9. c.

Marking criteria	Marks
Describes a potential use for the biopolymer identified in 9.b.	1

10. a.

Marking criteria	Marks
Identifies the dependent variable as <i>rate of reaction / colour change/ reactivity of hydrocarbon</i> and identifies the independent variable as <i>degree of saturation of the matching hydrocarbons /alkane vs alkene</i>	1

10. b.

Marking criteria	Marks
Describes a logical sequence that includes the following in the method: - equal volumes of hydrocarbons in separate test tubes - appropriate ratio of volumes of hydrocarbon : bromine water used - absence of U.V. light - test tubes shaken or stirred vigorously - method repeated and class results compared	3
Mentions 3-4 of the above points	2
Mentions 1-2 of the above points	1

10. c.

Marking criteria	Marks
Assesses the validity and the reliability of the procedure with reference to appropriate aspects of the experimental procedure described above	3
Assesses the validity and the reliability of the procedure without using aspects of the procedure in 10.b	2
Identifies an aspect of the experimental procedure that relates to validity and/or reliability	1

11.

Marking criteria	Marks
Calculates, with full working, the following: - Heat released by 0.5g of ethanol as -8.778 kJ - Moles of ethanol used as 0.01085... mol OR energy released per gram as 17.55...kJ/g - Molar heat of combustion of ethanol as 808.8 kJ/mol (or as -808.8 kJ/mol if the statement "the molar heat of combustion is ..." is not given)	3
Calculates, with full working, TWO of the three points outlined above (rounding off before the final answer was the most common source of error)	2
Calculates ONE of the three points outlined above	1

12.

Marking criteria	Marks
Identifies a radioisotope used in industry AND Identifies an industrial use of the isotope AND Thoroughly describes, by providing three features of significance and including the type of radiation released, how the radioisotope is used (nb. NOT properties that make it useful)	3
Identifies a radioisotope used in industry (eg. Am-241) AND Identifies an industrial use of the isotope AND Briefly describes, by providing one feature, how the radioisotope is used	2
Identifies a radioactive element used in industry AND Identifies an industrial use of the isotope	1

13.a.

Marking criteria	Marks
Identifies <i>silver and aluminium</i> as the combination of metals that will give the highest potential difference	1

13. b.

Marking criteria	Marks
Presents an appropriate equation that is balanced for types and numbers of atoms/ions as well as for charge	1

13. c.

Marking criteria	Marks
Calculates the answer as +2.48 V with full working	2
Calculates the answer as +2.48 V with poor working OR Calculates the answer as +2.48, with full working, but omits the units (V)	1

14. a.

Marking criteria	Marks
Presents a correct cell diagram that is fully labelled (Y electrode, X electrode, X ⁺ electrolyte, Y ²⁺ electrolyte, salt bridge, voltmeter, conducting wire, beaker)	2
Presents a poor cell diagram that is fully labelled OR Presents a correct cell diagram that is incompletely labelled	1

14. b.

Marking criteria	Marks
Shows the direction of electron flow from electrode Y to electrode X.	1

14. c. (i).

Marking criteria	Marks
Outlines the purpose of the salt bridge (rather than the consequence of its purpose) as "to allow the migration of ions through it"	1

14. c. (ii)

Marking criteria	Marks
Identifies the materials used (a piece of absorbent paper and a saturated solution of KNO ₃) and outlines how these are used in the construction of a salt bridge	1

15. a.

Marking criteria	Marks
Defines the term transuranic element as "an element with an atomic number higher than 92" and names an example such as neptunium	1

15. b.

Marking criteria	Marks
A thorough description of each named technology covers: * the type/s of particles used for bombardment * information about how the particle is produced and/or treated for bombardment * an example of the transuranic element(s) produced by the technology (eg. neptunium; elements 93,94,95; neutron-rich isotopes) A sound description covers TWO of the above points A limited description covers ONE of the above points	
Describes ONE technology in a thorough manner AND Describes the OTHER technology in a sound manner	3
Describes ONE technology in a sound manner AND Describes the OTHER technology in a limited manner	2
Describes ONE technology in a limited manner	1

16.

Marking criteria	Marks
Thoroughly describes the chemistry of the nominated cell, including – * the oxidation half-equation * the reduction half-equation AND Thoroughly assesses its importance to society by describing TWO benefits to society and / or problems to society AND by making an appropriate judgement.	5
Describes the chemistry of the nominated cell, including TWO aspects of its chemistry (oxidation half-equation, reduction half-equation, electrolyte) AND Assesses its importance to society by describing ONE benefit to society or ONE problem for society and by making an appropriate judgement	4
Answer covers ONE (1 mark), TWO (2 marks) or THREE (3 marks) of the following- * the oxidation half-equation * the reduction half-equation * the identity of the electrolyte * outlines ONE benefit to society or ONE problem for society * a judgement of its importance to society	1 - 3

17. a.

Marking criteria	Marks
Includes all of the following * An appropriate indicator used is named and the resultant colour also described * an additional indicator that narrows the range and the colour of the result described * a procedure that indicates method used for the tests * a number of samples were tested (repetition)	4
Includes TWO indicators used to test the sample WITH expected colour changes indicated WITH a procedural statement	3
EITHER one useful indicator and resultant colour with procedural statement OR two appropriate indicators named and resultant colour descriptions.	2
One indicator described with the resultant colour described	1

17. b.

Marking criteria	Marks
Two everyday used of indicators described with an explanation of the significance / importance of their use	2
One use of indicators described	1

18. a.

Marking criteria	Marks
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States a minimum of "a system is at equilibrium AND a change is made AND the system changes to counterbalance the change". The best answers added that an equilibrium would then be re-established.	1
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18. b.

Marking criteria	Marks
THREE factors (e.g. concentration, gas pressure, temp) named and the features (or examples) of all THREE outlined.	3
THREE factors mentioned and features of TWO described.	2
EITHER three factors named OR TWO factorss named and the features of ONE given.	1

19.

Marking criteria	Marks
At least * TWO examples of how sulfur oxides are produced AND relate to their increase since the industrial revolution (cause is related to effect) * TWO equations that support the examples for formation of sulfur oxides	4
TWO examples of how the sulfur oxides are formed AND how levels have increased since the industrial revolution (showing cause and effect) with ONE supporting equation	3
EITHER TWO examples of sulfur oxide formation showing cause and effect OR ONE example with cause and effect shown with ONE supporting equation	2
TWO examples of sources of sulfur oxides	1

20. a.

Marking criteria	Marks
Correct equation that shows all species are accounted for WITH ions correct AND charges are balanced WITH an equilibrium symbol AND no other incorrect equations shown	1

20. b.

Marking criteria	Marks
Indicates that * the colour change is to red-brown, * reaction favours the exothermic (formation reactants) equation * the production of FeSCN^{2+} is increased	3
Includes TWO of the above points	2
Colour change described was correct OR A statement related to temperature decrease favouring exothermic reaction	1

HAHS Half-Yearly Examination 2008

Chemistry

Exemplar Answers

Question number	1	2	3	4	5	6	7	8
Answer	D	D	D	A	D	A	B	C

Question 9. (3 marks)

(a) What is a 'biopolymer'?

1M

A biopolymer is a long-chain, naturally occurring polymer. It is ~~a~~ renewable because it is derived from either biomass or found in micro-organisms, which are replaceable, and found in nature the environment naturally. ①

(a) What is a 'biopolymer'?

A biopolymer is a polymer which can be derived from a naturally occurring substance, usually a renewable resource, such as biomass. ①

(b) Name one biopolymer.

1M

Poly(lactic acid) ①

(c) Describe a potential use of the biopolymer named in (b).

1M

~~Medical sutures~~ Medical sutures - poly(lactic acid) is 'resorbable' - that is the body will 'absorb' the PLA and not reject it, eliminating any complication, so it can be used for medical sutures to close wounds and incisions inside the body. ①

(b) Name one biopolymer.

1M

Biopolymer. ①

(c) Describe a potential use of the biopolymer named in (b).

1M

Biopol has potential for use as surgical pins in medicine to be inserted inside the body. ①
Biopol is biodegradable (it decomposes in the body so no surgery is needed to remove it) and biocompatible (the body does not react to it or reject it as a foreign object) which makes it ideal for this use.

Question 10. (7 marks)

You carried out a first-hand investigation to compare the reactivity of an alkane and its corresponding alkene.

(a) Identify the dependent and independent variables for this investigation.

1M

Dependent variable ~~measured through the colour change observed + or lack thereof~~
reactivity (measured through the colour change observed + or lack thereof).

Independent variable amount of Saturation of carbon chain
eg. cyclohexane and cyclohexene.

Independent variable the presence of a double bond
or lack of a double bond

(b) ^{past tense.} Recount the procedure used.

3M

1. Two test tubes were set up with 5 mL of cyclohexene in one and cyclohexane in the other.
2. 3 drops of Bromine water were added to each test tube.
3. A stopper was placed on each test tube.
4. The test tubes were gently agitated.
5. The change in colour was recorded.

NB. * Close shutters of windows to prevent UV light entering.

* Carry experiment in a well-ventilated area.

(b) Recount the procedure used.

3M

1. Equal volumes of cyclohexane and cyclohexene (10 mL) was added to two separate test tubes.
2. 10 drops of bromine water were dropped carefully down the side in each test tube, disturbing the cyclohexane/cyclohexene as little as possible. (2)
3. The mixtures were then observed for colour change and presence of layers.
4. The test tubes were shaken vigorously ^{for 5 shakes of each test tube} and step 3 was repeated.
5. Steps 2-4 were repeated, replacing bromine water with potassium permanganate.
6. Steps 1-5 were repeated, replacing cyclohexane/cyclohexene with hexane and 1-hexene.
7. Class results were collated.

(c) Assess the reliability and validity of the procedure described above.

3M

Reliability is when results can be reproduced independently. This was done in this investigation by having groups perform the investigation independently, ^{following the same method} and collating results with other groups, ~~then~~ which showed similar results. Thus the procedure is very reliable.

Validity is when a procedure allows the collecting of results which relate to the aim of the investigation. The aim was to compare the reactivities of an alkene with its corresponding alkane. This was done by pairing up ~~an~~ alkanes and alkenes of similar structures - cyclohexane with cyclohexene and ~~cyclohexane~~ hexane with 1-hexene. However, a valid procedure also requires that ^{all} ~~any~~ variables were controlled, other than ^{the} independent and dependent ones. This was done in this ~~the~~ procedure by keeping the volumes of the alkane/alkene to 10 mL and keeping the bromine water/potassium permanganate at 10 drops. Amount of shaking was also kept constant. Thus the amount of variants and amount of agitation were eliminated as factors ~~of~~ affecting reactivity. Hence the procedure is very valid as well. (3)

(b) Recount the procedure used.

3M

1. Place 10mls of cyclohexene in one mini testtube and 10mls of cyclohexane in another
2. Add three drops of bromine water to each testtube. Ensure blinds are closed so there is no UV light present
3. Swirl both testtubes equally and observe for any colour changes
4. Record any observations

(c) Assess the reliability and validity of the procedure described above.

3M

The process was reliable. The procedure described above is not reliable unless repeated several times to obtain the same results.

The procedure is valid because cyclohexene and cyclohexane are very similar compounds differing only by a double bond. Thus any differences in the results they obtain when mixed with bromine water will be due to the presence or lack of a double bond.

The experiment could be more valid if a bromine water control was used.

Question 11. (3 marks)

A group of students used spirit burners to carry out an investigation to determine the heat of combustion of ethanol. They burned 0.50 g of ethanol and used the flame to heat 150 mL of water. The temperature of the water rose from 20°C to 34°C.

Use this data to calculate the molar heat of combustion for ethanol.

3M

$$\begin{aligned}\Delta H &= -m \cdot c \cdot \Delta T \\ &= -150 \times 4.18 \times 14 \\ &= -8778 \text{ J} \\ &= -8.778 \text{ kJ}\end{aligned}$$

$$n_{\text{ethanol}} = \frac{m}{M} = \frac{0.5}{2 \times 12.01 + 6 \times 1.008 + 16.00} = \frac{0.5}{46.068} = 0.01085 \text{ mol}$$

$$\Delta_c H^\theta = \frac{-8778}{0.01085} = -808.77 \text{ kJ}$$

$$\Delta T = 14^\circ \quad 150 \text{ mL}$$

$$\Delta H = -m \cdot c \cdot \Delta T = -150 \times 4.18 \times 14 = -8778 \text{ J} = -8.778 \text{ kJ}$$

$$\Delta H_{\text{c}} = \frac{-8.778}{0.50} = -17.556 \text{ kJ/g}$$

(3)

$$\begin{aligned} \Delta H_{\text{c}}^\ominus &= \Delta H_{\text{c}} \times \text{Molar mass ethanol}, \quad M_{\text{C}_2\text{H}_5\text{OH}} = (12.01 \times 2) + (6 \times 1.008) + (16.00) \\ &= -17.556 \times 46.068 \\ &= -808.8 \text{ kJ/mol} \quad (4 \text{ sig. figs}) \end{aligned}$$

Use this data to calculate the molar heat of combustion for ethanol.

$$\begin{aligned} 0.50 \text{ g ethanol} & \quad \Delta H = -m \cdot c \cdot \Delta T \\ 150 \text{ g water} & \quad = -[150 \cdot 4.18 \cdot 14] \\ \text{temp. change: } 14^\circ & \quad = -8778 \text{ J per } 0.50 \text{ g} \\ & \quad \text{ethanol} \end{aligned}$$

Let heat capacity
of water be
 $4.18 \times 10^{-3} \text{ J kg}^{-1} \text{ K}^{-1}$

$$\begin{aligned} n_{\text{C}_2\text{H}_5\text{OH}} &= \frac{m}{M} \\ &= \frac{0.50 \text{ g}}{46.068 \text{ g mol}^{-1}} \\ &= \frac{0.50}{46.068} \text{ moles} \end{aligned}$$

$$\begin{aligned} -\Delta_{\text{c}} H^\ominus &= -\left[-8778 \div \frac{0.50}{46.068} \right] \\ &= -\left[-8778 \times \frac{46.068}{0.50} \right] \\ &= 808769.808 \\ &= 808.769808 \text{ J mol}^{-1} \text{ (calc. disp.)} \\ &= 808.769808 \text{ kJ mol}^{-1} \text{ (calc. disp.)} \end{aligned}$$

for eth
Molar heat of combustion:
 809 kJ mol^{-1} (3 sig. fig.)

Question 12. (3 marks)

Describe the use of a named radioisotope in industry.

3M

Strontium-90 is used in industry to measure gauge thickness of materials such as paper, iron sheets and aluminium. This ~~is~~ isotope is allowed to emit radiation (beta) through the material being tested, and a detector measures the concentration of the radiation on the other side. The thicker the material the more radiation it absorbs and the lower the reading on the detector. The advantages of Strontium-90 is that it has a long half-life of 28 years so the isotope does not regularly have to be replaced, it also emits low energy radiation meaning that the material being tested absorbs a significant amount of radiation making it safe to work with.

(3)

Describe the use of a named radioisotope in industry.

3M

Sr-90 (Sr-90)

is used to gauge the thickness of paper or metal sheeting in industry.

The beta decay of Strontium passes through the sheeting and detected on the other side by a radioactive detector. If the sheet is normal then normal amounts of radiation will be detected. If the sheet is too thin then there will be high amounts of radiation detected.

Describe the use of a named radioisotope in industry.

3M

Na-24

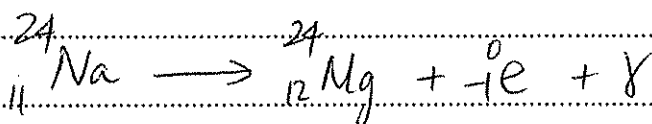
Sodium-24 is used in industry to detect leaks in pipes and oil lines. The Na-24 is released into water where it emits β and γ radiation. As it flows in the water its movement can be traced with a scanner and $\therefore$ leaks or breakages in pipes and/or oil lines can be detected as the scanner detects the β and γ radiation.

Describe the use of a named radioisotope in industry.

3M

Sodium-24 (Na-24) is used in industry to detect leaks in underground piping. Na-24 releases beta and gamma radiation and has a half life of 15 hours which is long enough to carry out investigations for leaks but short enough not to produce damage water bodies and the environment.

Na-24 flows through pipes within water within liquid within the pipes and a gamma radiation detector is used to scan for leakages.



Describe the use of a named radioisotope in industry.

3M

Cobalt-60 is used in industry to ~~irradiate~~ food to ~~be preserved~~ to lengthen food storage time/shelf life. Cobalt-60 releases gamma radiation that kills the harmful bacteria & other such organisms on the food, allowing the food to be safer to eat. The gamma radiation is strong enough to (3) kill the bacteria but not strong enough to make the food radioactive thus making Cobalt-60 suitable for food irradiation. Its relatively long half-life of 5.3 years also means that ~~the machine~~ it does not need to be replaced regularly.

Describe the use of a named radioisotope in industry.

3M

Cobalt-60 is a widely used radioisotope in industrial radiography. It is used to detect any defects, breaks or other forms of structural damage to particularly aircraft but also other metallic structures. A sealed source of ~~Co~~ Co-60 (3) is placed on one side of the section of examination and a radiation detection device such as a Geiger counter is placed directly in line with the Co-60 but on the other side of the metal. Being extremely unstable, Co-60 can release large amounts of gamma rays that can penetrate metal and any forms of structural damage will be indicated by a 'spike' in radiation levels. Co-60 also has a half-life of around 5.3 years making it a medium-long term source for industrial radiography.

Describe the use of a named radioisotope in industry.

3M

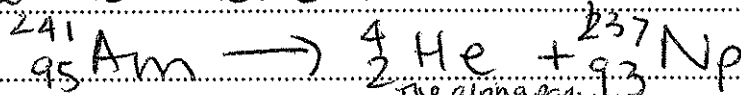
A radioisotope used in industry is Cobalt-60. Cobalt 60 is used to measure the thickness of metal. With a half life of 5.3 years means Cobalt 60 does not need to be replaced often. ~~Cobalt 60 is~~ Radiation (gamma rays) from Cobalt-60 is allowed to travel through the metal. Photographic film is on the other side of the metal. The colour of the photographic film (3) indicates where the metal is thick and where the metal is too

thin. The darker the colour on the photographic film the thinner the metal would be. This allows ~~the~~ any problems to be fixed without destroying part of metal structure to determine if there is any problem.

Describe the use of a named radioisotope in industry.

3M

Americium-241 is widely used in industry ~~for~~ in smoke detectors. Am-241 undergoes alpha decay inside the smoke detector forming Np-237.



When no smoke is present, ~~Am-241~~ ^{the alpha particles} ionises the nitrogen and oxygen present in the air. When smoke is present, it absorbs these alpha particles and so the rate of ionisation drops, which triggers the alarm. Am-241 is a commercial radioisotope used in the production of smoke detectors in the home and in industry, and it is an important radioisotope because it has the potential to save human lives in the case of a fire by providing a warning signal of smoke being present.

Describe the use of a named radioisotope in industry.

3M

~~Sodium~~ Americium 241 is a radioisotope used in the manufacture of smoke alarms.

- it emits alpha and some beta emissions
- when functioning correctly, the high ionising capability of its emissions ($\alpha + \beta$) ^{surrounding} ~~ionises~~ ^{ionizes} the oxygen & nitrogen in the air (immediately completing an electrical circuit).

- When smoke is present however, it absorbs the alpha & beta emissions and ~~prevents completion of~~ leaving oxygen and nitrogen un-ionised, which prevents the completion of the electrical circuit, setting off the alarm.

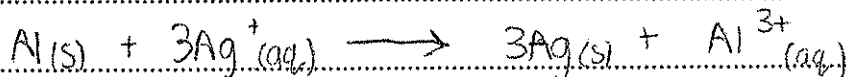
Question 13. (4 marks)

A student was asked to perform a first-hand investigation to measure the difference in potential produced by various combinations of metals in electrolytic solutions. The student was provided with three metals (Ag, Al and Zn) and three electrolyte solutions (silver nitrate, aluminium nitrate and zinc nitrate).

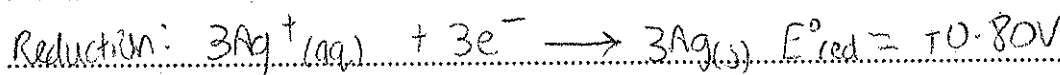
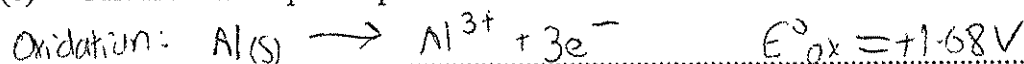
- (a) Deduce which combination of the metals supplied should give the highest potential difference. 1M

strongest oxidant Silver
strongest reductant aluminium

- (b) Write a balanced chemical equation for the overall reaction for the metals identified in (a). 1M



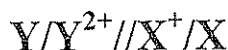
- (c) Calculate the expected potential difference for the combination of metals identified in (a). 2M



$E^\circ_{\text{total}} = E^\circ_{\text{ox}} + E^\circ_{\text{red}} = 1.68 + 0.80 = +2.48\text{V}$

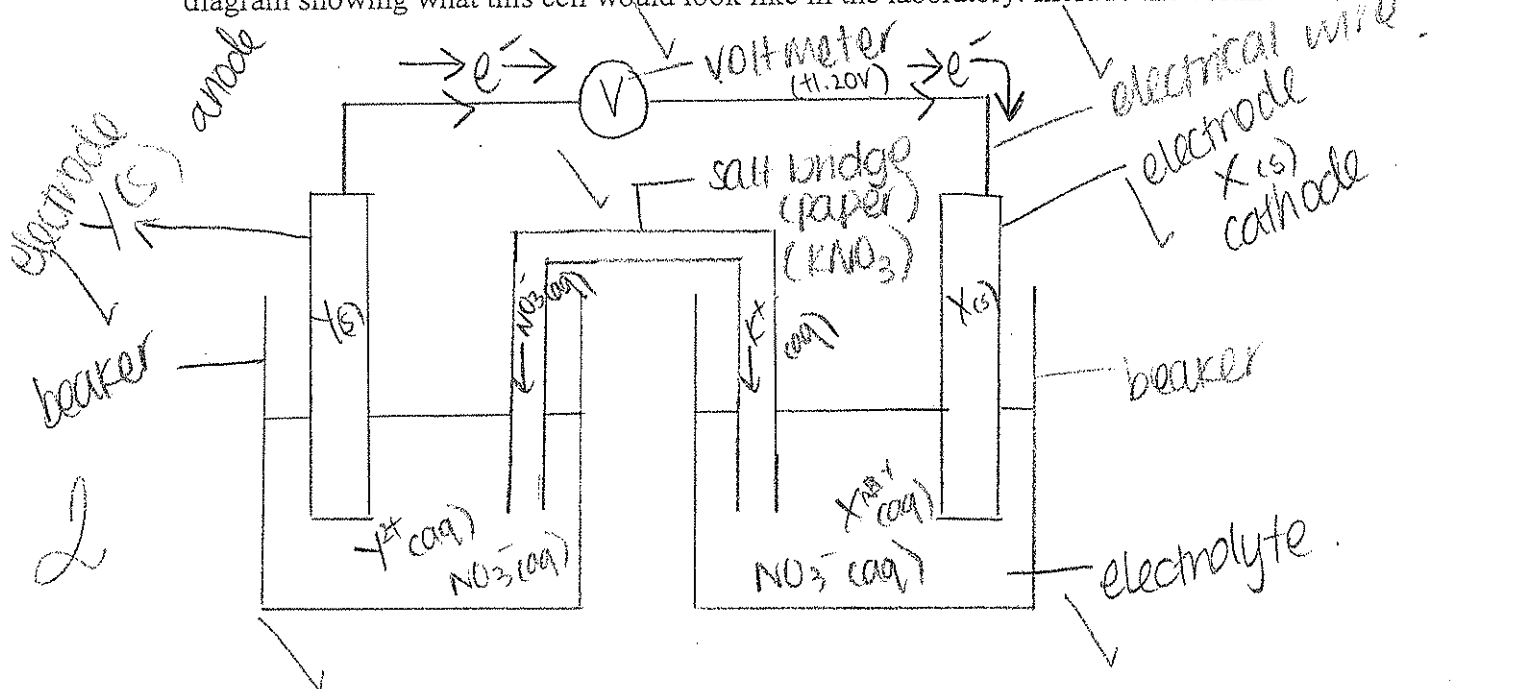
Question 14. (5 marks)

A galvanic cell was constructed using two metals, X and Y: The cell is represented by:



A voltmeter showed a reading of +1.20 V. Metal X was noted to be the positive electrode.

- (a) Based on a first-hand investigation similar to this, that you have performed, draw a labelled diagram showing what this cell would look like in the laboratory. Include the voltmeter. 2M



- (b) Show the direction of flow of electrons in the external circuit on your diagram. 1M

(c) (i) Outline the purpose of the salt bridge in this investigation.

1M

The salt bridge ~~must be~~ completes the circuit.

It allows the flow of ~~anions~~ ^(in each beaker) ions, so that the electrical neutrality can be maintained, or else the reaction will just stop.

(c) (i) Outline the purpose of the salt bridge in this investigation.

1M

The salt bridge allowed the migration of ions from one beaker to the other in order to maintain balanced charge in each beaker.

(ii) Recount how the salt bridge was constructed for your investigation. Saturated

1M

Filter paper was cut into strips and allowed to soak in KNO_3 solution for 5 minutes. One end of it was then placed in each beaker as shown.

Question 15. (4 marks)

(a) Define the term transuranic element and identify an example of a transuranic element.

1M

Transuranic elements are man made elements with an atomic number greater than 92. An example of a transuranic element would be Plutonium.

(b) Nuclear reactors and linear accelerators play an important role in nuclear chemistry.

Describe their roles in the production of transuranic elements.

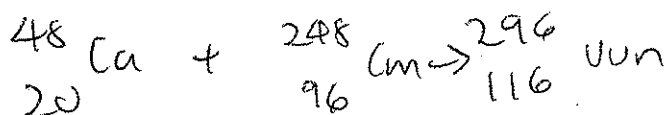
3M

~~Nuclear~~ Nuclear reactors produce neutron rich elements.

In a nuclear reactor, the controlled decay of Uranium produces neutrons; ~~then~~ these neutrons are then fired at a target atom & fuses with it, forming a new element. These neutrons need not be first built up to extremely high speeds as they have no charge, so the target atom can't repel it.

Linear ~~reaction~~ accelerators produce neutron deficient elements.

Small charged particles ^(e.g. H^+ , H^{2+}) are accelerated to extremely high speeds in a particle accelerator by using alternating magnetic & electric fields & then shot at a target atom, fusing with it, forming a new element. E.g.



(a) Define the term transuranic element and identify an example of a transuranic element.

1M

A transuranic element is an ^{artificially synthesised} element with atomic number greater than 92 (i.e. uranium). They are produced in either nuclear reactors or high energy particle accelerators. An example of a transuranic element is curium.

(b) Nuclear reactors and linear accelerators play an important role in nuclear chemistry. Describe their roles in the production of transuranic elements.

3M

Transuranic elements with atomic numbers 93, 94 and 95 are produced in nuclear reactors. In nuclear reactors, the controlled decay of uranium (radioactive) provides a source of neutrons that are ^{used to} bombard ~~at~~ target atoms. Neutrons fuse with these atoms to produce ^{atoms of} transuranic elements. Transuranic elements with atomic number greater than 95 (i.e. 96 and onwards) are produced in high energy particle accelerators - linear accelerators being one such example. In linear accelerators, charged nuclei (e.g. helium ~~atom~~, nuclei, heavy nuclei of other atoms) are accelerated to high speeds & bombarded at target atoms, causing the nuclei and target atoms to fuse, and produce a transuranic element.

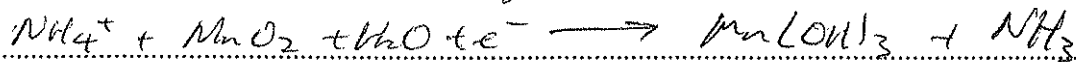
Question 16. (5 marks)

Describe the chemistry of either a dry cell OR a lead-acid cell and assess its importance to society over the last 100 years or so.

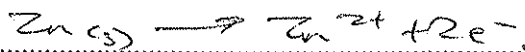
5M

A dry cell consists of an electrolyte paste containing

MnO₂ and NH₄Cl which undergoes reduction.



Surrounded by a zinc casing which undergoes ~~reduction~~ oxidation.



The zinc forms the anode and the paste, together with a carbon graphite rod forms the cathode. The electrons go ~~for~~ out of the cathode, through an external circuit (e.g. lamp) and into the anode. The invention of the dry cell was very important to society as it enabled ~~a~~ devices to become truly portable. This also led to the production of many ~~one~~ portable devices such as CD-players, toys and calculators. Before the invention of the dry cell,

batteries were large and consisted of electrolytic solutions which were heavy and cumbersome and prone to leakage. With the invention of the dry cell, weight was significantly reduced and risks of leaks were also reduced. The dry cell has had an enormous impact on society allowing ~~the portability~~ of portability of common devices that otherwise would have required a mains supply. Hence, dry cells can still be prone to leakage as the zinc casing is eaten away. Its commonness and cheapness coupled with its non-rechargeability has also caused waste ~~management~~ management issues in society, where landfills are taken up by used dry cells leading to environmental damage.

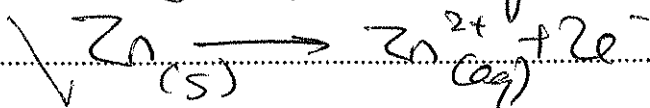
Question 16. (5 marks)

Describe the chemistry of either a dry cell OR a lead-acid cell and assess its importance to society over the last 100 years or so.

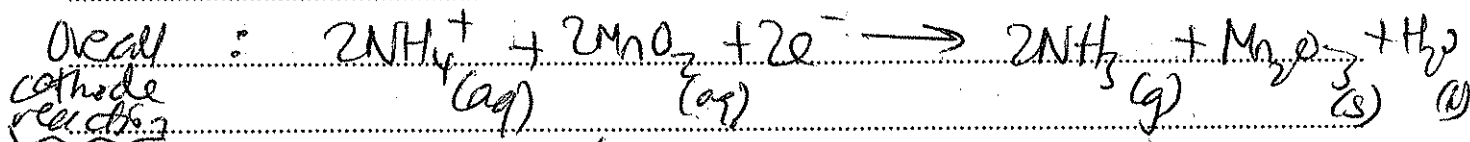
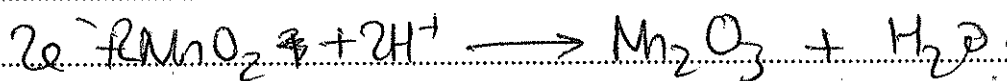
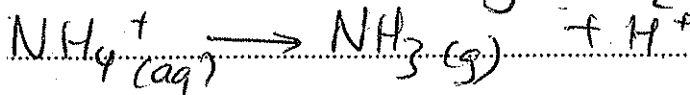
5M

Chemistry of Dry Cell:

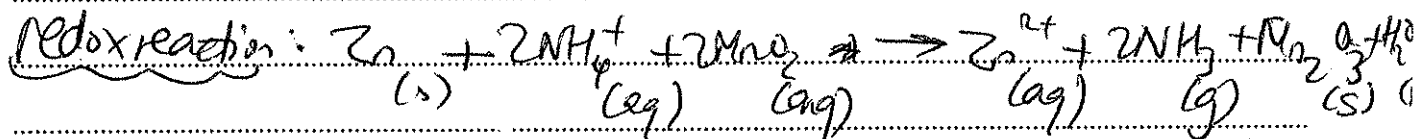
Anode: outer zinc casing



Cathode: carbon rod surrounded by MnO_2



Electrolyte: $\text{NH}_4\text{Cl} / \text{ZnCl}_2$ in a MnO_2 paste



Importance to society: The dry cell is very important to society, especially over the past 100 years. They have allowed the development of ^{portable} electronic devices. For example, the radio was developed into the portable walkman, which was more convenient to carry and provided news access at an instant.

* ~~the~~ to go to ~~become~~ develop from being wind-up.

* torches to be used when camping. Previously, kerosene lamps were used, which released carbon dioxide when burnt which has contributed to the greenhouse effect causing global warming. The use of dry cells in torches hindered this.

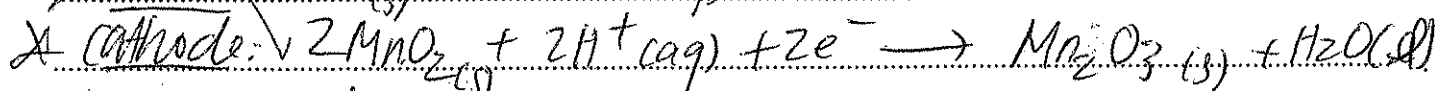
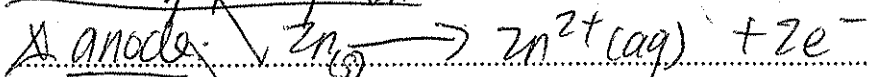
*

Question 16. (5 marks)

Describe the chemistry of either a dry cell OR a lead-acid cell and assess its importance to society over the last 100 years or so.

5M

Chemistry of dry cell : reactions that occur at: electrolyte:



Importance to society

5 * The development of the dry cell enabled the development of such portable devices, as portable radios, torches, toys, clocks, etc. This impacted greatly on society & therefore was of great importance as it reduced society's reliance on power points to supply a source of energy & thus society was made more mobile.

* As technological advances in batteries followed however, there was a decline in the importance of the dry cell battery, as more sophisticated batteries were introduced. These such batteries had a longer lifetime and supplied a more stable voltage and thus ~~was~~ detracted from the importance of the dry cell to ~~the~~ society.

assessment

* Despite its declining importance however, the dry cell had an immense impact and was of great importance to society when it was first developed. To this day, it still retains this importance as it is still ~~commonly~~ use extensively used throughout society in devices essential to our education & entertainment. eg. calculator, radios, alarms, torches, etc.

Question 17. (6 marks)

- (a) QV™ body wash claims that it is suitable for dry or sensitive skin because it is perfume free, colour free and has a pH of 5.5.

The table below shows the pH range of a number of indicators.

Indicator	Colour		pH range
	Low pH	High pH	
Methyl red	red	yellow	4.4 – 6.2 –
Thymol blue	red	yellow	1.2 – 2.8
Phenol red	yellow	red	6.8 – 8.4
Alizarin yellow	yellow	lilac	10.1 – 12.0
Bromocresol green	yellow	green	3.8 – 5.4 –
Bromothymol blue	yellow	blue	6.0 – 7.6 –
Methyl orange	red	yellow	3.1 – 4.4
Phenolphthalein	colourless	magenta	8.3 – 10.0

Explain how indicators could be used to verify the claim that the pH of the QV™ body wash is 5.5. In your answer you should identify which indicator/s could be used and justify your choice. 4M

Indicators can be used to verify this claim by first taking a sample of QV, mixing it with water, then applying the indicator and observing any colour change. By following this procedure, the first test the QV sample with bromocresol green. If the colour change is green, then the pH of the QV is ≥ 5.4 (if yellow ≤ 3.8). Next test a sample of QV with bromothymol blue, if the colour change is yellow, then the pH of the QV is ≤ 6 . Therefore at this point the pH of QV is narrowed down to 5.4 and 6. Next take another sample of QV and test it with methyl red, if the colour change is orange, then this ~~means~~ moving the pH to be close to 5.5, consistent with the other two tests. Repeat this procedure to

This question continues on the next page.

try to establish reliability of a wide range of QV samples.

Explain how indicators could be used to verify the claim that the pH of the QV™ body wash is 5.5. In your answer you should identify which indicator/s could be used and justify your choice. 4M

Squirt a sample of QV™ body wash onto a white, clean plate and sprinkle a thin layer of R/Sol onto the sample. Add a few drops of Bromocresol green to the sample. If the indicator turns green, then sample is

to close to 5.5. If otherwise, then sample 18/4 of the pH it claims. This experiment should also be performed with Bromothymol blue as the indicator. pH is close to 5.5 if it turns yellow. To enhance ~~reliability~~ validity, the ~~above~~ experiment should also be tested with Methyl red as the indicator. If the methyl red turns orange, pH should be close to 5.5. Repetitions of all the above steps should be taken at least 2 more times. ✓

This question continues on the next page.

Different samples of QVTM body wash should be tested in case the pH of one bottle differs greatly from the rest of the other. This also enhances reliability of the experiment.

great answer. 4

* QVTM could be coloured, influencing the colour presented by the ~~the~~ indicator

Explain how indicators could be used to verify the claim that the pH of the QVTM body wash is 5.5. In your answer you should identify which indicator/s could be used and justify your choice. 4M

Indicators are used to identify the pH of a solution. Therefore by selecting the correct indicators it can be proved that QVTM has a pH of around 5.5. First a sample of the body wash is placed in a ~~beaker~~ beaker. Bromocresol green should then be added and ~~mixed~~ mixed. If the solution turns green then the pH of the body wash must be ~~above~~ above 5.4. Methyl red is then used as it has a range of 4.4 to 6.2. Methyl red is then added to a new sample of the body wash the stirred. The colour change should be a mixture of yellow and red therefore turning orange. (As 5.5 is between 4.4 and 6.2). If the mixture turns orange then the pH of the body wash must be between 4.4 and 6.2. Repetition of this experiment will produce the most accurate results. ✓

(b) Describe TWO other everyday uses of indicators.

2
2M

Indicators can be used to test the pH levels of swimming pools. pH must be maintained at range 6-7.5. This ensures the prevention of micro organisms developing in the pool thus contaminating it. If the pool water is too acidic, it can harm our skin and irritate eyes. ✓
* ~~test~~ Soils. Soils require a certain pH range that ensures that it is provided with the required nutrients. When pH levels are too high some nutrients ~~are~~ become insoluble in the soil and thus the plants need to be provided with these nutrients by using fertilisers. ✓

Question 18. (4 marks)

(a) Define Le Chatelier's principle.

(disturbance) ✓

1M

If a system is at equilibrium, & a change is imposed on that equilibrium, the system will try to counteract this disturbance & hence establish a new equilibrium. ✓

great answer

(b) Outline the factors that can cause a disturbance to a chemical system at equilibrium.

3M

Change in temperature, ✓ an increase or decrease on an endothermic ~~reaction~~ or exothermic reaction would cause the equilibrium to shift to either left or right to counteract change. Increase in temp on exo reaction causes equilibrium to shift to left to counteract change. ✓
Change in pressure - an increase in pressure would cause equilibrium to shift to the side with the less moles. Only gases will be affected by this change. ✓
Change in concentration - a decrease or increase in reactants or products will cause a shift in equilibrium. Increase in reactants causes equilibrium to counteract the increase with a decrease & thus shift to left, produce more reactants. ✓

(b) Outline the factors that can cause a disturbance to a chemical system at equilibrium.

Essentially three factors can cause a disturbance to a chemical system at equilibrium - a change in temperature, pressure or concentration.

* Temperature - When temperature is increased within a system, the equilibrium will shift so as to favour the reaction direction that will decrease the ~~pressure~~ ^{temperature} i.e. the endothermic rxn. Conversely a temperature decrease causes equilibrium to shift so as to favour the exothermic rxn direction that will increase heat.

* Pressure - when pressure is increased within a system in equilibrium, the equilibrium will shift to favour the reaction direction that will produce less gaseous molecules & thereby decrease pressure. Conversely an ~~increase~~ decrease in temperature will cause equilibrium to favour the rxn direction that will increase the pressure (side with more gaseous molecules). This only applies to gases at equilibrium.

* concentration - when the concentration is increased, the system will favour the reaction direction that will use up the excess amounts of whatever substance was added. Conversely, when the concentration of a substance is decreased within a system in equilibrium (eg - by removing a product or reactant), then the system will favour the reaction direction that will produce more of the substance whose concentration has been decreased.

Question 19. (4 marks)

"The atmosphere contains acidic oxides of sulfur which have been increasing in concentration since the industrial revolution."

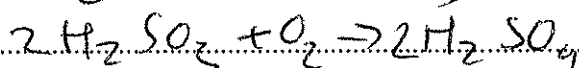
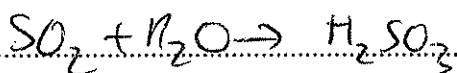
Explain this increase. Include examples, supported by appropriate equations, in your answer.

4.
4M

Since industrial revolution increases in smelting of sulfide ores

eg. $ZnS_{(s)} + 3O_{2(g)} \rightarrow 2ZnO_{(s)} + 2SO_{2(g)}$ and combustion of fossil fuels in power plants and engines.

$S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$ These increase the amount of SO_2 in the atmosphere. SO_2 is an acidic oxide, and will react with water in atmosphere to produce acidic rain.



great answer!

Since industrial revolution, there has been an increasing

Demand for metals to produce equipment, energy to power cars, vehicles, industrial equipment. These release SO_2 into the environment as shown in the equations above. Result is increase in cars possible by increased affordability + ~~cheaper~~ (due to wage increases + production decreases, thanks to mass production)

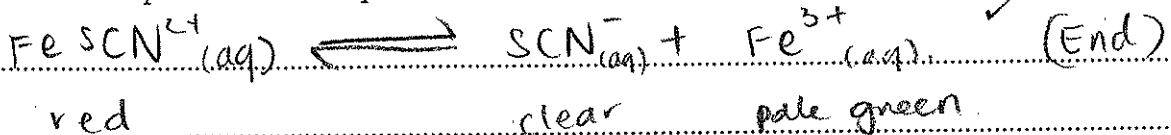
- ✓ Increasing energy needs, thanks to appliances that use electricity + ~~oil~~ electricity + ~~oil~~ means more production of energy in power plants (+ release of SO_2 in the process).
- ✓ Other processes increase such as burning fossil fuels, industrial sewage treatment, concrete process of producing sulphuric acid, production of paper also release SO_2 .

Smelting of iron ores release SO_2 . Smelting creates useful metals such as iron + zinc needed to create more equipment due to industrialisation i.e. more production equipment, cars, other consumer goods.

Question 20. (4 marks)

- (a) A compound containing the iron thiocyanate ion (FeSCN^{2+}) dissolves in water, establishing an equilibrium with iron (III) ions and the thiocyanate ion (SCN^-).
The reaction is endothermic and the equilibrium mixture formed contains ions of FeSCN^{2+} in solution which are red-brown, Fe^{3+} ions in solution which are pale green in colour and SCN^- ions in solution which are colourless.

- (i) Write the equation for this equilibrium reaction.



- (ii) Explain the colour change that would be observed if the temperature of the mixture were lowered.

By Le Chatelier's principle, as ~~the~~ a system at equilibrium ~~will~~ if disturbed will readjust its equilibrium to minimise the disturbance. When the temperature of the mixture ~~is~~ lowered, the system will readjust to increase the temp by favouring the exothermic reaction. In this case the exothermic reaction would produce $\text{FeSCN}^{2+}(\text{aq})$ ~~which~~ hence the colour of the solution will change to a red-brown colour.

good answer!