NAME: _____

VCE® CHEMISTRY

Practice Written Examination

Reading time: 15 minutes

Writing time: 2 hours 30 minutes

QUESTION AND ANSWER BOOKLET

Section	*Number of questions*	*Number of questions to be answered*	*Number of marks*
A	30	30	30
B	11	11	96
			Total 126

- Students are permitted to bring into the examination room: blue or black pens, pencils, highlighters, erasers, sharpeners and ruler. A scientific calculator is allowed.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 36 pages.
- Answer sheet for multiple choice questions.
- A Data Book PROVIDED BY YOUR TEACHER.

Instructions

- Write your **student name** in the space provided above on this page.
- Check that your **name** is printed on your answer sheet for multiple-choice questions.
- All written responses must be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.
- You may keep the data book.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

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SECTION A - Multiple-choice questions

Instructions for Section A
Answer **all** questions in pencil on the answer sheet provided for multiple-choice questions.
Choose the response that is **correct** or that **best answers** the question.
A correct answer scores 1, an incorrect answer scores 0.
Marks will **not** be deducted for incorrect answers.
No marks will be given if more than one answer is completed for any question.

Question 1

Identify which of the following 1M acid solutions has the greatest number of conjugate ions present.

A. HF

B. HCl

C. HNO_2

D. HCN

Question 2

Benzoic acid (C_6H_5COOH) is a weak acid. Hydrochloric acid (HCl) and sulphuric acid (H_2SO_4) are both strong acids.

A 20.00 mL aliquot of each of these 0.10 M acid solutions were separately titrated against a 0.10 M solution of sodium hydroxide (NaOH).

In order for each acid to completely react with the NaOH.

A. benzoic acid would require a greater volume of NaOH solution than nitric acid and sulphuric acid
B. benzoic acid would require the least volume of NaOH solution
C. sulphuric acid would require more NaOH than benzoic acid and nitric acid. Benzoic acid and nitric acid would require the same volume of NaOH
D. all three acids would require the same volume of NaOH.

Question 3

10.0 g of silver nitrate solution was reacted with 10.0 g of barium chloride solution, according to the following equation:

$$2AgNO_3(aq) + BaCl_2(aq) \rightarrow 2AgCl(s) + Ba(NO_3)_2(aq)$$

The limiting reagent and mass of silver chloride produced respectively are

A. silver nitrate is the limiting reagent and 8.45 g of silver chloride is produced
B. barium chloride is the limiting reagent and 13.8 g of silver chloride is produced
C. neither silver nitrate or barium chloride is a limiting reagent, and 8.45 g of silver chloride is produced
D. neither silver nitrate or barium chloride is a limiting reagent and 10.0 g of silver chloride is produced.

Question 4

A compound contains 1.80 g of carbon, 0.397 mol of hydrogen and 9×10^{22} atoms of oxygen. The empirical formula of the compound is

A. CH_3O
B. CH_2O
C. $C_2H_5O_2$
D. $C_3H_8O_3$

Question 5

When 2 L of hydrogen gas at 5.0℃ temperature and 620mm Hg pressure has the temperature raised to 50.0℃ and the pressure decreased to 330 mmHg, the new volume (L) would be

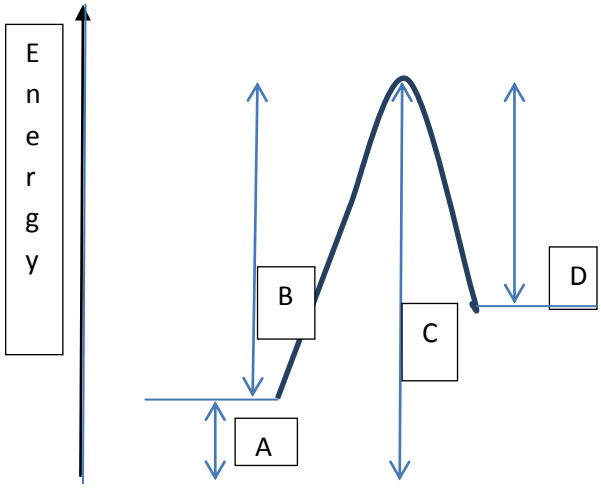
A. $2 \times \frac{5.0}{50.0} \times \frac{620}{330}$

B. $2 \times \frac{50.0}{5.0} \times \frac{330}{620}$

C. $2 \times \frac{333}{278} \times \frac{620}{330}$

D. $2 \times \frac{278}{333} \times \frac{330}{620}$

Question 6

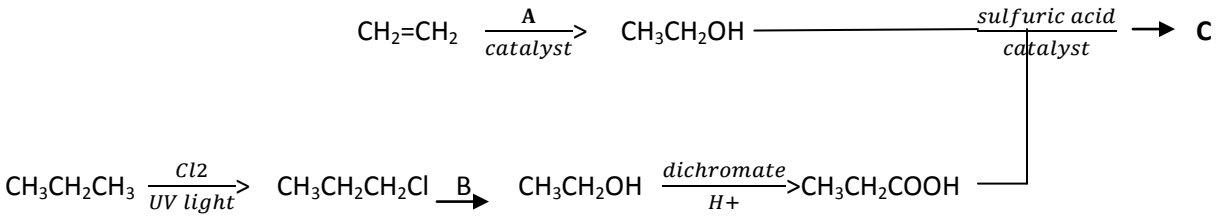


In this graphic representation of a chemical reaction, the arrow that depicts activation energy of the reverse reaction is

A. A
B. B
C. C
D. D

Question 7 and 8 refer to the following information.

A reaction pathway for the preparation of an ester is shown below.



Question 7

The identities of A and B are respectively in that order

A. NaOH and H_2O
B. H+ and NaOH
C. H_2 and NaOH
D. H_2O and NaOH

Question 8

The correct name (IUPAC) for the product **C** is

A. propylethanoate
B. ethylpropanoate
C. ethylpropanoic acid
D. propylethanoic acid.

Questions 9 and 10 refer to the following information.

The lead acid battery is a very commonly used secondary cell, consisting of six cells producing 2 V each in series. The reaction that occurs during the discharge of each of the cells is

$Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$

Question 9

To recharge this battery, which of the following voltages would be required?

A. 2V
B. 6V
C. 12V
D. 14V

Question 10

During recharge of the battery

A. the pH of the electrolyte increases
B. water undergoes oxidation at the negative electrode
C. the half-equation that occurs at the anode is the reduction of lead ions, Pb^{2+} to lead, Pb
D. lead is formed by reduction at the cathode, and the polarity of the anode is positive.

Question 11

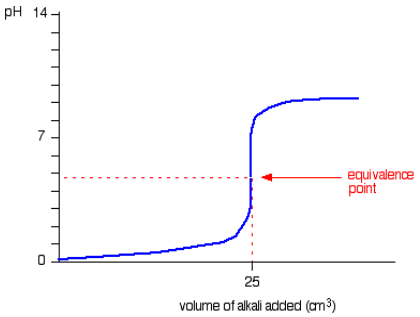
At STP, 2 moles of $KClO_3$ can decompose to produce how many litres of O_2?

A. 22.4L
B. 33.6L
C. 44.8L
D. 67.2L

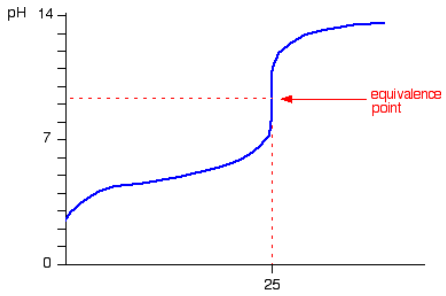
Question 12

Which of the following titration curves represents a weak acid-strong base titration?

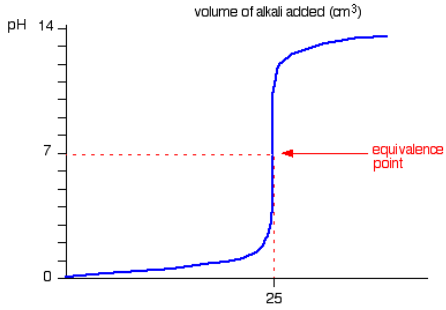
A.



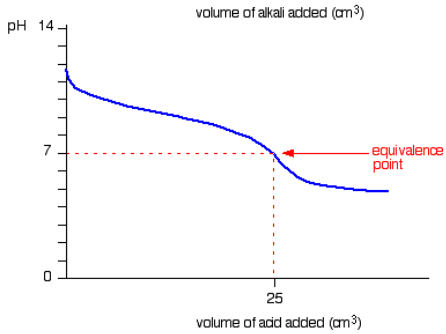
B.



C.



D.



Question 13

The volume of water(L) that needs to be added to 500 mL of 6.0 M HCl to make a solution of 1.0 M HCl is

A. 6.0
B. 3.0
C. 2.5
D. 1.5

Question 14

Both zinc metal and aluminium metal are produced by electrolysis. Zinc can be produced industrially by a redox reaction using aqueous conditions, yet aluminium production requires that aluminium is in a molten state.

The reason for this is that

A. water is a stronger oxidant than Al^{3+}, and water will be reduced instead of Al^{3+}
B. water is a weaker reductant than Zn, so Zn is produced from Zn^{2+}
C. zinc is a more reactive metal than aluminium
D. aluminium is a more reactive metal than zinc.

Question 15

Which of the following when placed into water will test as an acid solution?

I HCl(g)

II Excess H_3O^+

III $CuSO_4$

A. I only
B. I and II only
C. I and III only
D. I, II and III

Question 16

The following redox reaction is **not** balanced:

$KMnO_4(aq) + H_2SO_3(aq) \rightarrow K_2SO_4(aq) + MnSO_4(aq) + H_2O(l)$

Which one of the following half equations is the correct reduction half-reaction for the balanced equation?

A. $5SO_3^{2-} + 5H_2O \rightarrow 5SO_4^{2-} + 10H^+ + 2e^-$
B. $SO_3^{2-} + 2H^+ + 2e^- \rightarrow SO_4^{2-} + H_2O$
C. $MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$
D. $2MnO_4^- + 16H^+ + 10e^- \rightarrow 2Mn^+ + 8H_2O$

Question 17

Prior to commencement of an experiment to investigate chemical reactions of certain alkanols in the laboratory, a safety management was completed that included safe disposal of the following chemicals

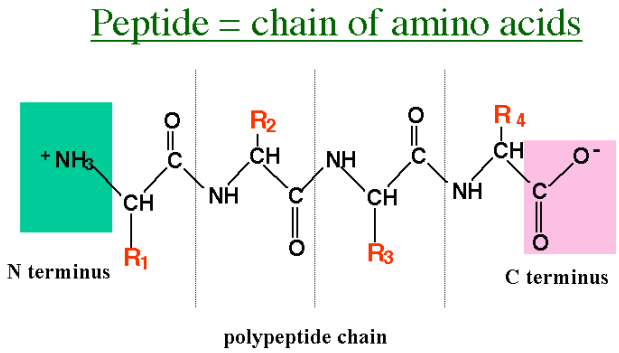
i. 10 mL of 1M ethanoic acid
ii. 5 mL concentrated sulphuric acid
iii. 10 mL of 60% ethanol

Which of the following alternatives describes an appropriate method of disposal of the above wastes?

	10 mL of 1M ethanoic acid	*5 mL concentrated sulphuric acid*	*10 mL of 60% ethanol*
A.	Wash down the sink.	Return to a stock bottle of concentrated H_2SO_4 prepared for the experiment.	Return to a stock bottle of 60% ethanol prepared for the experiment.
B.	Wash down the sink.	Dispose of in hazardous waste bottle for concentrated H_2SO_4.	Dispose of in the hazardous organic waste bottle for alkanols.
C.	Return to a stock bottle of 1M ethanoic acid prepared for the experiment.	Wash down the sink with plenty of water.	Wash down the sink.
D.	Dispose of in hazardous waste bottle for acids.	Return to a stock bottle of concentrated H_2SO_4 prepared for the experiment.	Dispose of in the aqueous waste bottle.

Question 18

A polypeptide containing alanine, leucine, phenylalanine and serine (see diagram below) was hydrolysed. The resulting mixture was analysed using thin layer chromatography with a non-polar stationary phase and a polar solvent.



http://www.ucl.ac.uk/~sjjgsca/ProteinStructure.html

The amino acid that would have the largest R_f value is

A. alanine
B. leucine
C. phenylalanine
D. serine

Question 19

When comparing the type of bonding in the primary and secondary structure of polypeptides and DNA

A. hydrogen bonding occurs in the secondary structure of polypeptides only
B. covalent bonding is found in the primary structure of polypeptides only
C. denaturation temporarily breaks hydrogen bonding both in DNA and polypeptides
D. hydrogen bonding exists in the secondary structure of both polypeptides and DNA.

Question 20

Gravimetric analysis was used to determine the salt content of tomato sauce**.** A precipitate of silver chloride was produced, dried and weighed. The sources of error in the analysis included

I Insoluble materials not filtered out before forming the precipitate

II The volume of silver nitrate solution added to form the precipitate was not in excess

III Forming a precipitate that is too soluble

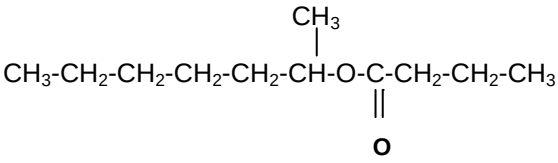
IV Adding too much silver nitrate solution to form the precipitate

Which of these errors could account for less than the expected mass of silver chloride being formed?

A. I only
B. I and II only
C. II and III only
D. III and IV only

Question 21

What is the correct systematic name (IUPAC) for the alcohol from which the following compound was synthesised from?



A. heptan-1-ol
B. propan-1-ol
C. heptan-2-ol
D. butan-1-ol

Question 22

What type of reaction is involved in the formation of fats and oils and what is the key functional group of fats and oils?

A. Condensation reaction and a carboxy functional group.
B. Condensation reaction and an ester functional group.
C. Esterification reaction and a hydroxyl functional group.
D. Esterification reaction and an amine functional group.

Question 23

The four stages involved in the preparation of sulphuric acid for industrial use can be summarised as follows:-

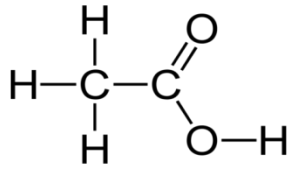
Steps: 1 2 3 4

S -----> SO_2 ----> SO_3 ----> $H_2S_2O_7$ --------> H_2SO_4

In which of these steps does the oxidation number **not** change?

A. 1 and 2
B. 2 and 3
C. 2 and 4
D. 3 and 4

Question 24



In the laboratory preparation of the above molecule

A. ethanol is oxidised, using acidified potassium dichromate
B. ethanol is mixed with water and concentrated sodium hydroxide
C. ethanol is reduced, using an acidified dichromate solution
D. ethyl ethanoate is condensed, using water and heat.

Question 25

Consider the equilibrium:

$$C_2H_6(g) \leftrightarrows C_2H(g)_4 + H_2(g) \quad \Delta H = + \text{ve kJmol}^{-1}$$

In order to increase the yield

A. the temperature should be decreased and the pressure increased
B. the temperature should be decreased and the pressure decreased
C. the temperature should be increased and the pressure increased
D. the temperature should be increased and the pressure decreased.

Question 26

Given the data,

$2W(s) + 3O_2(g) \rightarrow 2WO_3(s)$ $\Delta H = -1685.4$ kJ mol $^{-1}$

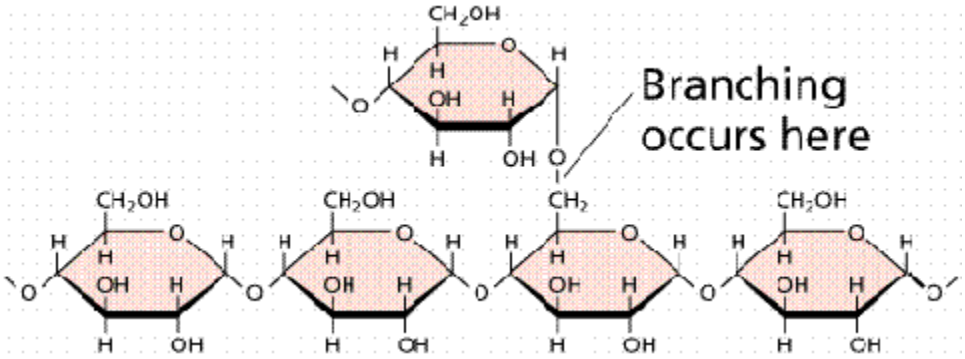
$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\Delta H = -477.84$ kJ mol^{-1}

The enthalpy change for the following reaction

$WO_3(s) + 3H_2(g) \rightarrow W(s) + 3H_2O(l)$ will be:

A. +125.94 kJ mol^{-1}
B. +1558.96 kJ mol^{-1}
C. -364.86 kJ mol^{-1}
D. -968.64 kJ mol^{-1}

Question 27



http://www.fas.org/irp/imint/docs/rst/Sect20/A12.html

Condensation to form the above biomolecule involves the following in the reaction

A. the monomer having the functional –COOH group plus water as a product
B. the monomer having the functional –OH group plus water as a product
C. the monomer having the functional –CO group plus H^+ as a catalyst
D. the monomer having the functional group -CHO plus H^+ as a catalyst.

Question 28

Table spreads were tested to determine if any of them were completely saturated. A chemical test using iodine was carried out. The following fatty acids were used as controls. For which of the following fatty acids would there have been no colour change observed?

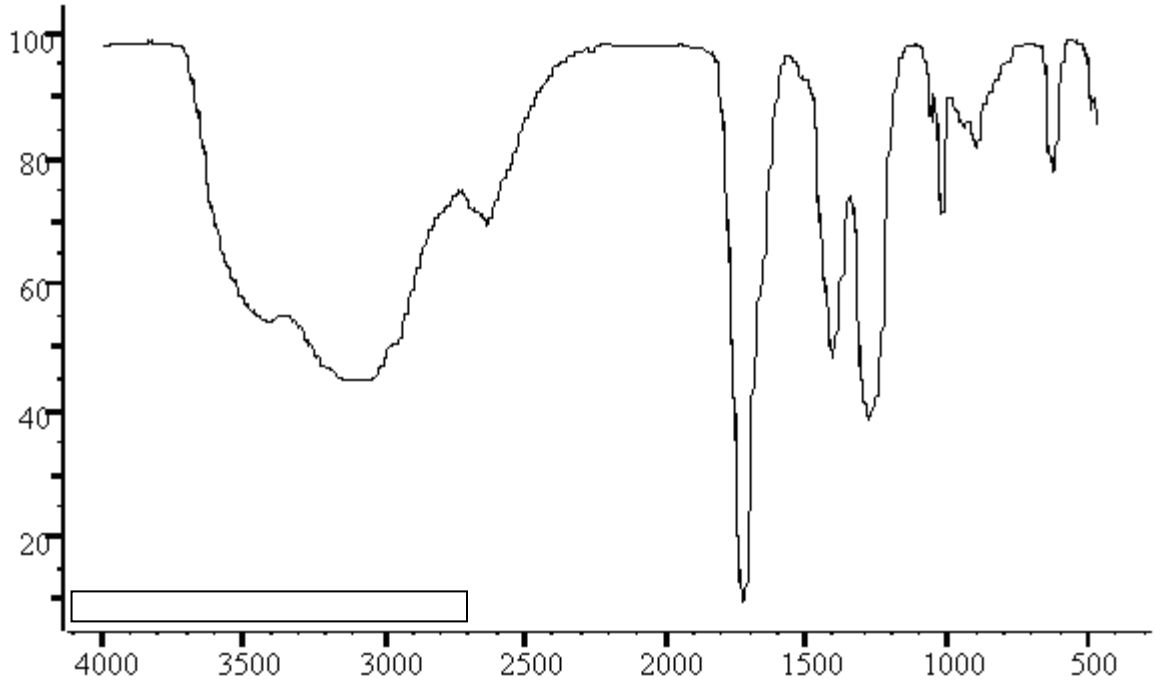
A. Oleic acid
B. Palmitoleic acid
C. Palmitic acid
D. Linoleic acid

Question 29

A section of one strand of DNA has the following sequence: AAT GGCTTA, where the letters represent the following bases: A is adenine, T is thymine, G is guanine and C is cytosine. The number of hydrogen bonds present in this section between the two strands of the DNA double helix would be

A. 24
B. 23
C. 22
D. 21

Question 30



http://www.chemistry.ccsu.edu/glagovich/teaching/316/ir/images/ir

The IR spectrum of a compound with the formula $C_2H_4O_2$ is given above.

The possible semi structural formula of this compound is

A. CH_3CH_2OH
B. CH_3COOH
C. $CH_2(OH)CH_2(OH)$
D. CH(OH)CH(OH)

SECTION B

Instructions for Section B
Answer **all** questions in the spaces provided. Write using a black or blue pen.
To obtain full marks for your responses you should

- give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks

- show all working in your answer to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working

- make sure chemical equations are balanced and that formulas for individual substances include an indication of state; for example, $H_2(g)$; NaCl(s).

Question 1 (10 marks)

a. Ethanol can be produced for use as a biochemical fuel from the fermentation of glucose using sugar cane. Write a thermochemical equation for this reaction, using ΔH as either > or < than 0.

1 mark

_____

b. The optimum pH is between 6.1-6.8 and temperature between 20-30℃. Give 2 reasons for this.

2 marks

_____

_____

_____

_____

c. Explain the reason that biochemical fuels are not considered to contribute to an increase in atmospheric carbon dioxide. 1 mark

_____

_____

_____

d. As industry should take care to reduce wastes, pollution and energy used, give one use of a product from the fermentation of glucose. 1 mark

e. When oxygen is present, the products of the fermentation process are altered and the pH of the product decreases.
Explain the reason for this using a chemical equation. 2 marks

f. A certain fuel can be 100% octane or it can be mixed to have a composition of 90% octane and 10% ethanol. Compare the energy value obtained from 100 mL of each fuel.
The density of octane = 0.703 gcm-1. The density of ethanol is 0.789 gcm-1. 3 marks

Question 2 (13 marks)

The %w/v of nitrogen in a solution of cloudy ammonia was determined by the following steps, using a back titration.

1. 25.0 ml of the cloudy ammonia solution was pipetted into a volumetric flask and diluted to 200.0 ml.

2. 20.0 ml aliquots of the thoroughly mixed, diluted ammonia solution were treated with 50.0 mL of 0.250 M sulphuric acid, according to the equation:

$$2NH_3(aq)+H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$$

3. 3 drops of **indicator** was added to the diluted ammonia solution prior to each titration.

4. The unreacted acid from step 2 was determined by titration with standardized 0.202 M sodium hydroxide solution. The titration values (mL) were 14.05, 13.90, 13.85, 13.80 and 13.65 mL.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

a. For the titration of ammonia with sulphuric acid, which is a suitable indicator to use, methyl orange or phenolphthalein? Explain the reason for your choice of indicator. 1 mark

_____

_____

_____

b. Calculate the average titre (mL) of sodium hydroxide used in the titration with the unreacted sulphuric acid. 1 mark

_____

_____

c. Find the average number of moles of unreacted sulphuric acid from step 2. 1 mark

_____

_____

d. Find the moles of excess sulphuric acid initially added to the ammonia solutions in step 2. 1 mark

e. Find the average number of moles of sulphuric acid which reacted with ammonia in step 2. 1 mark

f. Find the average number of moles of ammonia in a 20.0 ml aliquot. 1 mark

g. Find the %m/v of Nitrogen in the original 25.0ml solution of cloudy ammonia.
3 + 1 (sig figs) marks

h. State and explain the effect on the %w/v if the pipette used to deliver the 20.0 ml aliquot had been washed with only distilled water before filling with the ammonia solution. 1 mark

i. A titration is a method of accurately finding the concentration of a chemical in a solution. A titration was done to find the concentration of acetic acid in a solution using standardized 0.104 M sodium hydroxide solution and phenolphthalein as indicator. (Colourless in acid and pink in base). Describe two examples of errors, (random and or systematic) which could occur in this experiment and state how their effects could be minimised. 2 marks

Question 3 (9 marks)

a. Atomic Absorption Spectroscopy was used to determine the concentration of sodium in an electrolyte sports drink.

i. What property of sodium does AAS use to identify this element? 1 mark

_____

_____

ii. Potassium is also present in the electrolyte sports drink. Why does it not affect the measurement of the concentration of sodium by AAS? 2 marks

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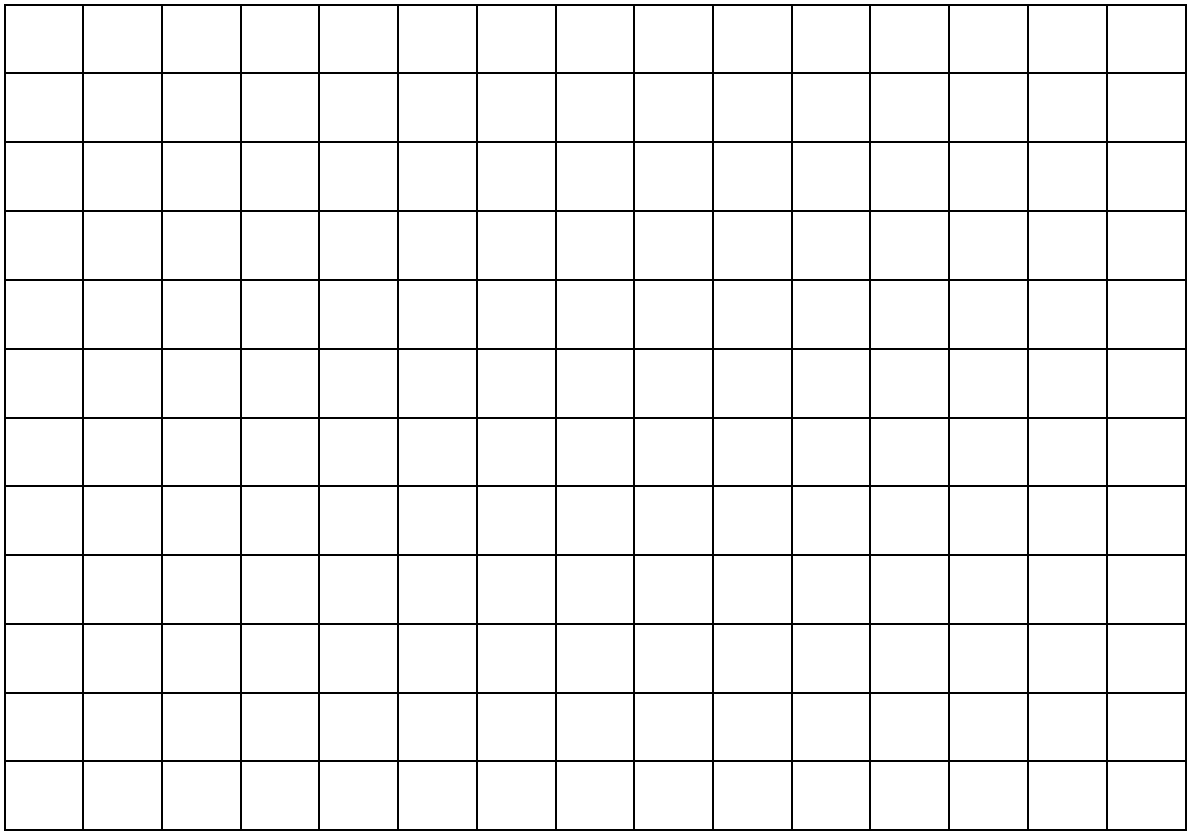
_____

b. The following table shows the results for the determination of sodium in the electrolyte sports drink.

A 1.0 mL sample of the drink was used, and diluted with water to 20.0mL.

Standard	Concentration of standards (ppm)	Absorbance
1	0.00	0.02
2	0.10	0.57
3	0.20	1.12
4	0.30	1.67
5	0.40	2.22
6	0.50	2.77
unknown	Electrolyte sports drink	1.85

Graph the results for the standards in mgL^{-1}. 2 marks



c. From the graph determine the concentration of the sodium in the sample ($mg\ L^{-1}$). 1 mark

_____

d. Determine the concentration of sodium (%W/V) in the electrolyte sports drink. 2 marks

_____

_____

_____

e. Account for the reason that the standard solution 1 does not have zero absorbance. 1 mark

_____

_____

Question 4 (10 marks)

Water pollution containing lead compounds derived from lead ores in the mining industry is continually monitored. The concentration of lead ions (Pb^{2+}) in polluted water can be determined by adding sodium sulphate solution to 500.00 mL of the water. The presence of lead ions was mainly in the form of lead nitrate.

a. Write a balanced equation for this precipitation reaction. 1 mark

_____

b. Derive the balanced ionic equation for this reaction, including states. 1 mark

_____

c. The lead sulphate precipitate was dried in an oven at 105℃ and weighed at regular time intervals according to the following table:

Weighing Number	Mass (g)
1	0.09832
2	0.09734
3	0.09513
4	0.09510
5	0.09515

Explain the reason why 5 weighings were required. 1 mark

_____

_____

_____

d. Calculate the mass (g) of lead in the precipitate. 3 marks

e. Calculate the molarity of the Pb^{2+} ions in the polluted water sample. 2 marks

f. Determine if the amount of lead is within the legal limit of 10 ppb for lead in water. 1 mark

g. The water was further analysed and found to contain traces of barium ion. How would this have affected the calculated result for the concentration of Pb^{2+}? 1 mark

Question 5 (9 marks)

a. Methanol can be used as camping stove fuel. Calculate the energy released per gram of methanol. 2 marks

b. The Enthalpy of Neutralisation of sodium hydroxide solution and hydrochloric acid is -58kJmol^{-1}.

i. Calculate the energy released if 50.0 ml of 0.10 M sodium hydroxide is reacted with 50.0mL 0.10 M hydrochloric acid. 2 marks

ii. Find the rise in temperature to the mixture if 50.0 ml of 0.0250 M NaOH solution is rapidly mixed with 10.0 ml of 0.100 M HCl. Assume zero heat loss. 2 marks

c. To find the enthalpy of solution of ammonium chloride solid, 5.00 g of pure solid was rapidly dissolved in 100.0 ml of distilled water in an insulated calorimeter. The table shows the temperature changes over nine minutes.

	Time (mins)	Temperature (^{o}C)
	Start	15.0
	1	15.0
	2	15.0
Ammonium chloride added →	3	15.0
	4	13.5
	5	13.0
	6	12.6
	7	12.3
	8	12.3
	9	12.3

i. Use the data to calculate $\Delta H_{solution}$ for ammonium chloride. 2 marks

_____

_____

_____

_____

_____

_____

ii. Why is it important to rapidly dissolve the ammonium chloride? 1 mark

_____

_____

Question 6 (8 marks)

Consider the following equilibrium for reaction

$$2NOCl_{(g)} \rightleftharpoons 2NO_{(g)} + Cl_{2(g)} \quad \Delta H > 0$$

At a particular temperature $K = 2x10^{-3}$ M

a. Write an expression for the equilibrium constant for this reaction. 1 mark

_____

_____

b. A mixture of NOCl, NO and Cl_2 not at equilibrium in a closed system at the same temperature and allowed to react, had a reaction quotient of $2x10^{-2}$ M. Explain in which direction the reaction moves to reach equilibrium. 1 mark

_____

_____

_____

_____

c. **i.** Explain the effect of an increase in temperature on the magnitude of K. 2 marks

_____

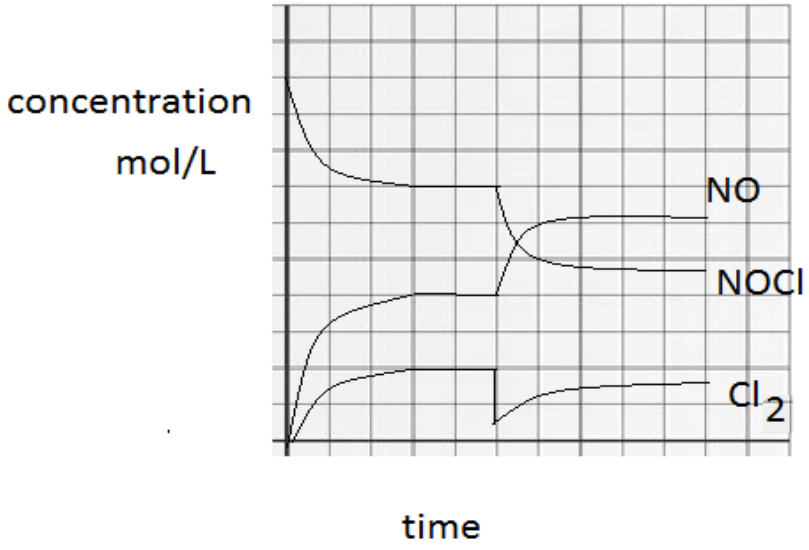
_____

_____

_____

ii. A different equilibrium for the above reaction was set up by putting 3.0 mol of NOCl in a 2.0 L vessel. If at equilibrium there were 0.70 mol of Cl_2, find all equilibrium concentrations hence K. 2 marks

d. The graph shows the above reaction reaching equilibrium and the effect of one change.



Once equilibrium was first achieved explain the reason for the initial change in concentrations of the mixture and the change in concentration of NOCl, NO and Cl_2 which resulted. 2 marks

Question 7 (10 marks)

A 500 mL sample of methane was mixed with 900 mL of oxygen in a sealed piston and the mixture was sparked.

a. Write an equation for the complete combustion of methane, including states. 1 mark

b. Determine the composition of the final mixture. All gases were measured at the same temperature and pressure. 3 marks

c. Methane is a fuel that comes from different energy sources. Compare the combustion of fuel in a gas-fired plant to that of a coal fired plants, explaining which offers greater advantage to the environment. 2 marks

d. Methane can be used as a constituent of biogas. Give one advantage of using biogas as an energy source, when compared to using methane, the main component of natural gas. 1 mark

e. Biodiesel can be produced by a chemical reaction between vegetable oils and an alcohol.

Cottonseed oil has a composition of 54% linoleic fatty acid and 19% of oleic fatty acids plus other saturated fatty acids.

i. Write the chemical equation for the alkaline hydrolysis of a triglyceride containing only linoleic acid. 1 mark

_____

ii. Give the IUPAC name of the product that is not a fatty acid. 1 mark

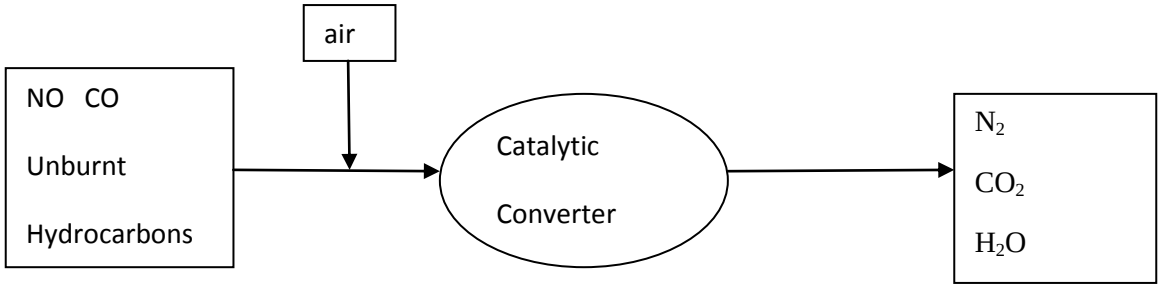
_____

iii. Bromine can be used for the detection on unsaturated fatty acids. For one mole of linoleic fatty acid, how many moles of bromine would be required? 1 mark

_____

Question 8 (7 marks)

New modern cars sold in Australia have a catalyst fitted in the exhaust system to reduce the amount of air pollution emitted from cars that use carbon-based fuels. The diagram below shows part of the process:



a. Write a balanced equation, including states to show the conversion carbon monoxide and nitrogen monoxide reacting together to form the non-toxic gases. 1 mark

_____

b. Explain the significance of the emission of unburnt hydrocarbons to the owner of the car. 1 mark

_____

_____

_____

c. The energy change for the complete combustion of the carbon based fuel can be shown using an energy profile. Sketch a diagram of this reaction pathway, without a catalyst, indicating the activation energy and the enthalpy of reaction. 1 mark

d. Using the same diagram, draw a reaction pathway for this reaction with the addition of the catalyst in the exhaust system. 1 mark

e. Describe how a catalyst alters the reaction pathway. 1 mark

_____

_____

_____

f. Use the collision theory to explain how an increase in temperature could be used to increase the rate of this reaction. 2 marks

_____

_____

_____

_____

Question 9 (9 marks)

a. Zinc metal can be extracted from an aqueous solution of zinc ions by electrolysis. Explain why zinc metal can extracted using an aqueous solution, whereas a molten salt is used for aluminium

2 marks

_____

_____

_____

_____

_____

b. Students set up an experiment in the laboratory to simulate the extraction of zinc metal from an aqueous solution of zinc ions by electrolysis, using inert carbon electrodes and 100 mL of 1.00 M $ZnSO_4$ solution and 25^0C.
Write a half equation for the oxidation reaction. 1 mark

_____

c. Calculate the electric current, (A) supplied to the cell during electrolysis, that deposited a mass of 1.20 g on the electrode after 30.0 minutes. Express your answer to an appropriate number of significant figures. 4 marks

_____

_____

_____

_____

_____

_____

_____

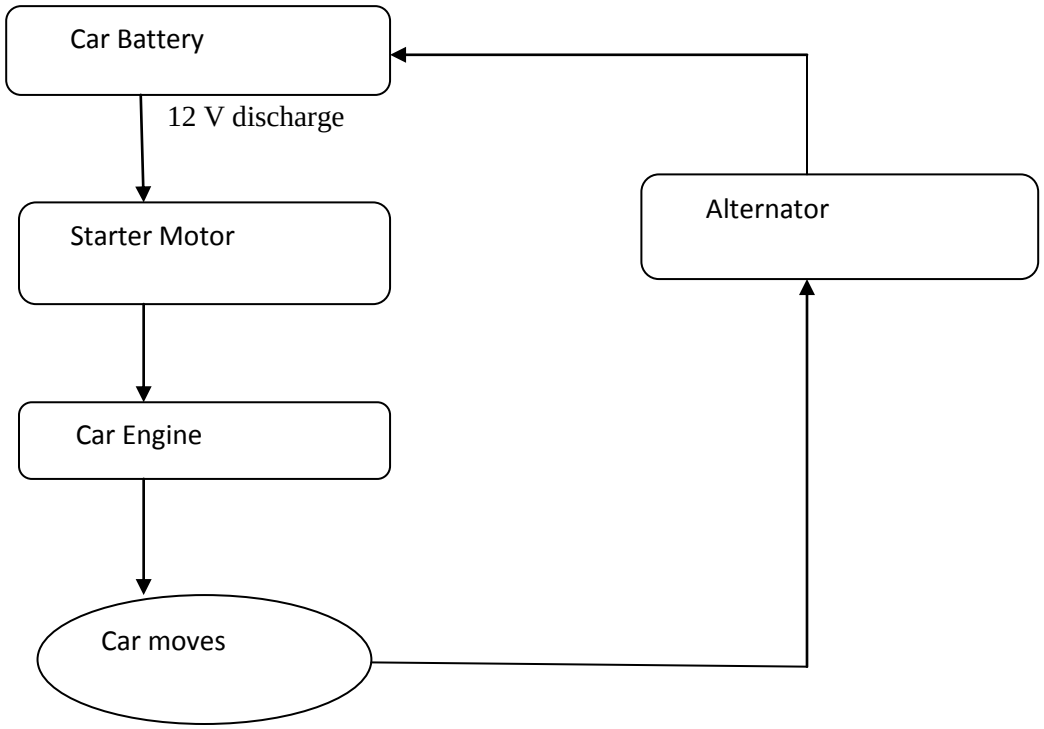
_____

d. Some students decided to investigate electrolysis of a solution containing 1M $ZnSO_4$ solution and 1M $MgSO_4$ solution mixed under the same laboratory conditions. Predict the results to be expected.

2 marks

Question 10 (7 marks)

The flow chart below shows the important sequence of events which occurs when a 'lead-acid' battery is used to start a car engine



The overall reaction during discharging is as follows:

$$Pb(s) + PbO_2(s) + 4H^+(aq) + 2SO_4^{2-}(aq) \rightarrow 2PbSO_2(s) + 2H_2O(l)$$

a. When the battery was used to start the car engine, write the reaction that occurred at the anode.
1 mark

_____

_____

b. **i.** As the car engine operates, describe the type of energy conversion from the alternator to the car battery. 1 mark

_____

ii. What would be the half-cell reaction occurring at the negative terminal during this process? 2 marks

_____

c. What is the electric charge Q passing through the battery, when the car is supplied with a current of 50.0 Amps for 10 seconds? 1 mark

_____

_____

_____

_____

d. Explain why cars that use a petrol engine are an inefficient way of using energy. 1 mark

_____

_____

e. What is an important consideration when disposing of lead acid batteries? 1 mark

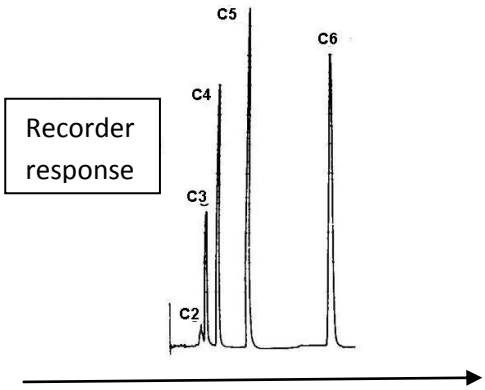
_____

_____

_____

Question 11 (4 marks)

The following chromatogram was obtained for a mixture of five alkanes; decane, octane, heptane, hexane and propane separated using gas-liquid chromatography. The solubility of the alkanes in the liquid phase was directly proportional to the relative molecular mass of the alkanes.



a. Identify (name) the alkane which was in the greatest amount. Explain your reasoning. 2 marks

_____

_____

_____

_____

b. Identify (name) the alkane which was adsorbed to the stationary phase the least strongly. 2 marks

_____

_____

_____

_____

Section A: Multiple Choice Answer Sheet

NAME: _____

For each multiple choice question, shade letter of your choice.

Question				
1	A	B	C	D
2	A	B	C	D
3	A	B	C	D
4	A	B	C	D
5	A	B	C	D
6	A	B	C	D
7	A	B	C	D
8	A	B	C	D
9	A	B	C	D
10	A	B	C	D
11	A	B	C	D
12	A	B	C	D
13	A	B	C	D
14	A	B	C	D
15	A	B	C	D
16	A	B	C	D
17	A	B	C	D
18	A	B	C	D
19	A	B	C	D
20	A	B	C	D
21	A	B	C	D
22	A	B	C	D
23	A	B	C	D
24	A	B	C	D
25	A	B	C	D
26	A	B	C	D
27	A	B	C	D
28	A	B	C	D
29	A	B	C	D
30	A	B	C	D

Solution Pathway

Note: Teachers will need to provide the VCAA data booklet, unmarked, for student use during this Exam.

SECTION A: Multiple Choice Answers

Question 1 Answer: B

HCl is a strong acid and will have the greatest number of conjugate ions present. HCN will have the least number of conjugate ions present.

From the Data book, the acidity constants indicate

HF $K_a = 7.6 \times 10^{-4}$

HNO_2 $K_a = 7.2 \times 10^{-4}$

HCN $K_a = 6.3 \times 10^{-10}$

Question 2 Answer: C

The key point is the same amount of mole of each acid is required to react with NaOH, the base.

Sulphuric acid, $\mathbf{H_2SO_4}$, is diprotic, and will require twice the amount of NaOH and thus twice the volume. The H^+ concentration is the important factor when considering the amount of NaOH needed, not whether the acid is a weak or a strong acid.

Question 3 Answer: A

$2AgNO_3\,(aq) + BaCl_2\,(aq) \rightarrow 2AgCl(s) + Ba(NO_3)_2(aq)$

Initially

$n(AgNO_3) = \frac{10.0}{(107.9+14.0+48.0)}$ $\qquad$ $n(BaCl_{2)} = \frac{10.0}{(137.3+2x35.5)}$

$= 0.0589$ mol $\qquad$ $= 0.048$ mol

Determine limiting reagent:

$n(AgNO_3) = 0.0589/2 = n(BaCl_2) = 0.0295$ mol

$n(BaCl_2) = 0.048 \times 2 = n(AgNO_3) = 0.096$ mol needed

$n(AgNO_3)$ is limiting

$m(AgCl)$ produced $= n(AgNO_3) \times 2/2 \times (107.9 + 35.5)$

$= 0.0589 \times (107.9 + 35.5)$

$= 8.4$g

Question 4 Answer: D

	C	H	O
Mole(n)	1.80/12.01	0.397	$9x10^{22}/6.02 \times 10^{23}$
	0.15	0.397	0.15
Simplest ratio	0.15/0.15	0.397/0.15	0.15/0.15
	1	2.64	1

Simplest whole number ratio (x 3) as 2.62 = 2 2/3 = 8/3

	3	8	3

Empirical formula is $C_3H_8O_3$

Question 5 Answer: C

$V_2 = P_1V_1t_2/P_2t_1$

$= 2 \times \frac{333}{278} \times \frac{620}{330}$

Question 6 Answer: D

Question 7 Answer: D

Question 8 Answer: B

Question 9 Answer: D

To recharge the voltage has to be greater than the 12V.

Question10 Answer: D

Recharge pH decreases.

At the cathode (-) $PbSO_4(s) + 2e^- \rightarrow Pb(s) + SO_4^{2-}$

At the anode (+) $Pb O_4 (s) + 2H_2O(l) \rightarrow PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^-$

Question 11 Answer: D

$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

2 mole $KClO_3(s)$ yields 3 mole O_2

3 mole O_2 = 3 x 22.4L = 67.2L

Question 12 Answer: B

A starting pH close to 4 indicates a weak acid, e.g. ethanoic acid, as does the gradual rise in pH until the equivalence point. The sharp rise in pH indicates that the base added is strong, e.g. sodium hydroxide. At

the equivalence point, the weak salt, e.g. sodium ethanote is slightly basic, beyond the equivalence point, the curve flattens as excess strong base is added, at the pH of a strong base, close to 14.

Question 13 Answer: C

C1V1 = C2V2 **Author- sub script required?**

6 x 0.5 = 1.0 x V2

V2 = 6.0 x 0.5/1.0 = 3.0 L

Therefor initially have 0.5 L so 2.5 L needs to be added.

Question 14 Answer: A

Using information from the data book and the electrochemical series, water is a stronger oxidant than the aluminium ion, but weaker than the zinc ion. Therefore the zinc ion can be in an aqueous state, but for the reduction of aluminium, water needs to be absent, thus the aluminium is in a molten state.

Question 15 Answer: D

$CuSO_4$ is the salt of a weak base and a strong acid when it hydrolyses in water. All three are correct.

Question 16 Answer: D

$5x\ (SO_3^{2-} + H_2O(l) \rightarrow SO_4^{2-} + 2H^+ + 2e^-)$

$\underline{2x\ (MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O)}$

$2MnO_4^-(aq) + 5SO^{2-}(aq) + 6H^+(aq) \rightarrow 2Mn^{2+}(aq) + 5SO_4^{2-}(aq) + 3H_2O(l)$

Question 17 Answer: B

Question 18 Answer: D

Serine is an amino acid with a polar –OH R group. Alanine, leucine and phenylalanine have non polar R groups. Serine would have moved the furthest in a polar solvent, resulting the largest R_f.

Question 19 Answer: D

Question 20 Answer: C

I Insoluble materials not filtered out before forming the precipitate would lead to an overestimate.

II The volume of silver nitrate solution added to form the precipitate was not in excess.

III Forming a precipitate that is too soluble.

IV Adding too much silver nitrate solution to form the precipitate would have no effect.

Question 21 Answer: C

Naming the compound firstly, the longest continuous chain of carbon atoms must be identified.

Question 22 Answer: B

Question 23 Answer: D

Question 24 Answer: A

$C_2H_5OH + H_2O \rightarrow CH_3COOH + 4H^+ + 4e^-$ ethanol is oxidised, using acidified potassium dichromate solution.

Question 25 Answer: D

$C_2H_6(g) \leftrightarrow C_2H_4 + H_2(g)$ ΔH + ve

The reaction is endothermic. Therefore to increase the yield, need to increase the temperature. The system will move in the forward direction to partially oppose the change and to remove the heat. With 2 particles on the right hand side and one on the left hand side, lowering the pressure will favour a move in the forward direction to increase the pressure.

Question 26 Answer: A

Given the data,

$(2W(s) + 3O_2(g) \rightarrow 2WO_3(s)$ $\Delta H = -1685.4$ kJ) reverse equation /2

$(2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\Delta H = -477.84$ kJ) x 1.5

The enthalpy change for the following reaction

$WO_3(s) + 3H_2(g) \rightarrow W(s) + 3H_2O(l)$ will be $(+1685.4/2) – (477.84 \times 1.5) = +125.94$ kJ

Question 27 Answer: B

Starch is a polysaccharide, and contains the hydroxyl, -OH functional group involved with the linkage. Water is formed as a side product.

Question 28 Answer: C

Palmitic acid. A colour change would have not have been observed as it does not have any double bonds, therefore palmitic acid would not have reacted with iodine**.**

Question 29 Answer: D

The complementary base pairing is adenine with thymine using 2 hydrogen bonds and guanine with cytosine using 3 hydrogen bonds. The section AATGGCTTA has a total of 21 hydrogen bonds between the two strands in the double helix of DNA .

Question 30 Answer: B

Carboxylic acids show a strong, wide band for the O–H stretch. Unlike the O–H stretch band observed in alcohols, the carboxylic acid O–H stretch appears as a very broad band in the region 3300-2500 cm^{-1}, centred at about 3000 cm^{-1}. There is also a C=O carbonyl stretch about 1700 cm^{-1}

SECTION B

Question 1 (10 marks)

a. $C_6H_{12}O_6(aq) \rightarrow 2CH_3CH_2OH(aq) + 2CO_2(g) \quad \Delta H < 0$ (1)

b. As the rate of reaction involves enzymes, which are proteins, outside of the optimal temperature, at higher temperature would become denatured and ineffective rate at lower temperatures

Outside the pH range the enzymes would become denatured. (2)

c. The plant material used for the biofuel consumes carbon dioxide from the atmosphere under the process of photosynthesis used to produce glucose i.e. carbon neutral. (1)

d. Any one reasonable suggestion:
Carbon dioxide is a by-product that can be sold to manufacturers of carbonated drinks.
The waste and cooling water can be used for water irrigation of the plant crops.
The protein rich remains can be sold as animal feed, or recycled for use as a fertiliser for crops. (1)

e. If oxygen is present in the fermentation tank, it brings about the oxidation of ethanol (to ethanal) and then to ethanoic acid, lowering the pH

$C_2H_5OH(aq) + O_2(g) \rightarrow CH_3COOH(aq) + H_2O(l)$ (2)

f. D = m/V density of octane = 0.703 gcm^{-1} density of ethanol = 0.789 gcm^{-1}

C_8H_{18} = -5464kJ mol-1 100% octane

= (8 x 12.0 + 18 x 1.0) $gmol^{-1}$

Energy of 100 ml 5464 x (0.703) x .100 = 384 kJ

90% octane + 10% ethanol

C_2H_5OH = 1364 kJ mol -1 (2 x 12.0 + 6 x 1 + 19) =

Energy of octane in 90 ml = 5464 x (0.703) x 0.090 = 345 kJ

Energy of ethanol in 10 ml = 1364 x (0.789) x 0.010 = 10.1kJ

Total energy in 100 mL of ethanol-10 = 355.1kJ compared to 100% octane = 345kJ (3)

Question 2 (13 marks)

a. Ammonia is a weak base and sulphuric acid is a strong acid. Methyl orange has an end point in the pH range of 3.1 – 4.4 and is suitable. Phenolphthalein is used with a strong base and a weak acid, have an endpoint in the range of 8.3 and is not suitable.

(1)

b. Using concordant results (=/- 0.1mL) = (13.85+13.80+13.90) ÷ 3 = 13.85ml. (1)

c. $n(H_2SO_4)$unreacted = n(NAOH) x ½ = c x V x ½ = 0.202 x 0.01385 x ½ =0.001399mol
=0.0140 (3sig fig) (1)

d. $n(H_2SO_4)$initially added = c x V = 0.250 x 0.050 = 0.125mol (3 sig fig) (1)

e. $n(H_2SO_4)$ reacted with ammonia = initial – excess = 0.1250 – 0.00139885 = 0 0111 mol (3 sig fig)

(1)

f. $n(NH_3) = n(H_2SO_4)$ x 2/1 =0.0222 mol (3 sig fig) (1)

g. $n(NH_3)$undiluted = 0/0222023 x 200/25 = 0.1776 mol (1)
n(N) = $n(NH_3)$ = 0.1778 mol
m(N) = n x M = 0.1776 x 14.0 = 2.487g in 25ml (1)
%m/V = 2.487/25 x 100 = 9.95% (1) (1 mark for 3 sig fig) (4)

h. The percentage m/V would be less than the true value as the NH_3 would have been diluted, using less initial sulphuric acid; in turn more NaOH to react with the unreacted sulphuric acid. (1)

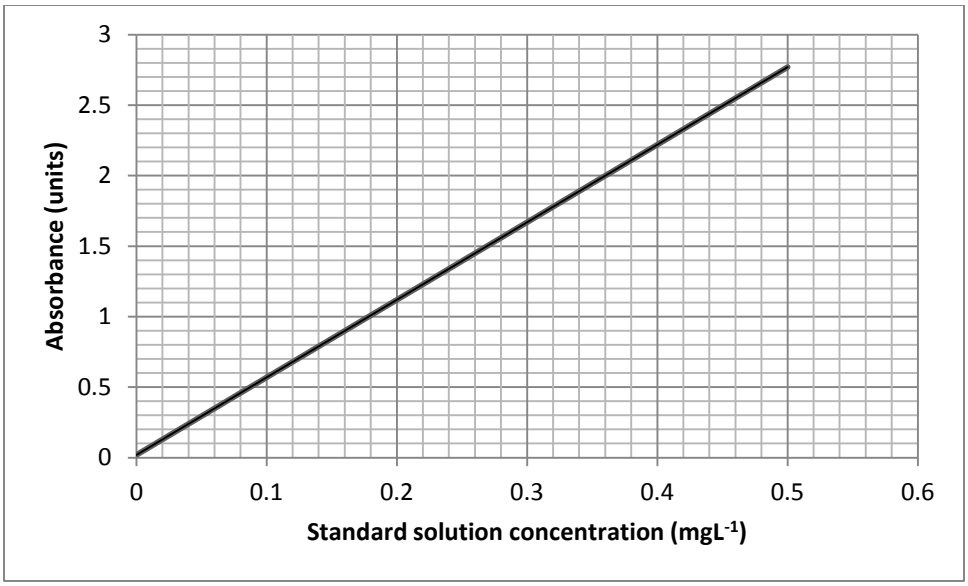
i. A random error would be not filling the part below the tap on the burette before the first titration. This is minimised by repetition. Another random error would be not ensuring the same depth of colour of the indicator for each end point. This is minimised by keeping one solution at the end point for reference. Ensure all further solutions have the same depth of colour.

A (systematic) error would be the pipette does not deliver the stated volume when correctly filled and delivered. This can be minimised by calibrating the pipette prior to titration. (2)

Question 3 (9 marks)

a. **i.** Each element has a unique absorption spectrum. Sodium would show absorption of a particular wavelength unique to sodium. (1)

ii. AAS is set to measure the concentration of sodium, using a sodium lamp. Potassium has a different number of protons in the nucleus and different electron configuration to sodium. The attraction of the potassium nucleus for the electrons will be different to that of sodium. Sodium will absorb different wavelengths to potassium. (2)



ppm = mgL^{-1}

(1) axis correctly labelled

Independent variable x axis and dependent variable y axis

(1) Straight line of best fit accurate
(2)

b. From the graph, an absorbance of 1.85 will give a concentration of 0.33mgL^{-1} of sodium in the diluted sample. (1)

c. The sports drink will contain 0.33 x 20 = 6.6 mgL^{-1} = 6.6 x $10^{-3}gL^{-1}$ = 6.6 x 10^{-4}%w/v. (2)

d. The AAS machine was not calibrated prior to use, or the distilled water has some sodium contamination in it. (2)

Question 4 (10 marks)

Water pollution containing lead compounds derived from lead ores in the mining industry is continually monitored. The concentration of lead ions (Pb^{2+}) in polluted water was determined by adding sodium sulphate solution to 500.00 mL of the water. The presence of lead ions was mainly in the form of lead nitrate.

a. $Pb(NO_3)_2(aq) + Na_2SO_4(aq) \rightarrow PbSO_4(s) + 2NaNO_3(aq)$ (1)

b. $Pb^{2+}(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s)$ (1)

c. By weighing to constant mass, ensures removal of water. The result for the percentage of lead will be more accurate. (1)

d. Calculate the mass (g) of lead in the precipitate

0.09513

0.09510

0.09515

Av mass $PbSO_4(g) = 0.028538/3=0.09513g$ (1)
$n(PbSO_4) = m/M = 0.09513/(207.2 + 32.1 + 4 \times 16.0) = 0.0003156mol$ (1)
$n(Pb) = n(PbSO_4) = 0.0003156mol$
$m(Pb) = n \times M = 0.0003156 \times 207.2 = 0.064788g$ (1). (3)

e. Calculate the molarity of the Pb^{2+}ions in the polluted water sample

$C=n/v$
$C(Pb) = 0.0003156/.5000$
$=6.312 \times 10^{-4}$ mol L^{-1} (2)

f. The amount of lead is

$m(Pb) = 6.312 \times 10^{-4} \times 207.2\ gL^{-1} = 0.137gL^{-1}$
$m(Pb) = 0.13078464 \times 10^{6} = 1.30784 \times 10^{5}$ ppb
The amount of lead well over the legal limit. (1)

g. The barium ion would have also formed a precipitate and thus resulted in an overestimate for the calculated concentration of lead ion. (1)

Question 5 (9 marks)

a. $M(CH_3OH) = (12.0 + 4 \times 1.0 + 16.0) = 32$ g mol^{-1}
Energy released per g = 725/32 = 22.7 kJ g^{-1} (1)

b. **i.** $NaOH(aq) + HCl(aq) \rightarrow NaOH(aq) + H_2O(l)$
n(NaOH) = n(HCl), reacting exactly
n(NaOH) = c x V
= 0.1 x 0.05
=0.005 mol
1 mol NaOH releases 58kJ
Energy released = 58 x 0.005 mol = 0.29kJ(1) - 2 sig.fig
(2)

ii. Determine the limiting reagent

n(NaOH) = c x V = 0.250 x 0.0500 = 0.0125mol
n(HCl) = c x V = 0.100 x 0.0100 = 0.00100 mol
n(NaOH) is inexcess, n(NaOH) reacted is 0.00100mol (1)
Energy(J) = 58 x 0.00100 x 1000J = m x SHC,cp x ΔT = 60 x 4.18 x ΔT
$\Delta T = \frac{58}{(60\,x4.18)}$ = 0.23℃ (1) - 2 sig.fig (2)

c. **i.** Δt = 15-12.3 = 2.7℃ (1)
$\Delta H = \frac{mxSHCx\Delta T}{1000\,x\,n} = \frac{100x4.18x2.7}{1000x\frac{5.00}{53.492}}$ = +12 kJmol^{-1} (1 + 1 correct sign for enthalpy) (2)

ii. This ensures a quick dissolving to give the largest temperature fall, without heat being absorbed or lost to the surroundings. (1)

Question 6 (8 marks)

a. $K = \frac{[NO]^2[Cl_2]}{[NOCl]^2}$ M (1)

b. As the reaction quotient is 2 x 10^{-2} is therefore larger than k, the reaction must move to the left, increasing the concentration of reactants and decreasing the concentration of products to establish equilibrium. (1)

c. i. The forward reaction is endothermic. To partially oppose the increase in temperature, the reaction will move in the forward direction. The magnitude of K will increase. (2)

ii. $2NOCl \rightleftharpoons 2NO + Cl_2$

	2NOCl	2NO	Cl_2
Initial *n*	3.0	0	0
To reach equilibrium	-1.4	1.4	0.7
At equilibrium, *n*	1.6	1.4	0.7
C=[n/V] $molL^{1}$	0.8	0.7	0.35

(1)

$K = \frac{(0.7)^2 x 0.35}{(0,8)^2} \frac{M3}{M2} = \frac{0.1715}{0.64}$

K = 0.268 M

K= 0.27 M (1)

(2)

d. The $[Cl_2]$ was decreased by its removal.(1)
To partially oppose the change, the reaction moves to the right to increase $[Cl_2]$
[NO] increases and the [NOCl] decreases. (1) (2)

Question 7 (10 marks)

a. $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$ (1)

b.

	CH_4	+	$2O_2$	→	CO_2	+	$2H_2O$
Mole ratio	1		2		1		2
Volume ratio	1		2		1		2
Volume at same pressure and temp.	500mL		900mL				
Determine if a reagent is limiting	500 mL		500x2 = 1000ml needed Limiting (1)				
Volumes of reaction	450mL reacts		900mL reacts		450mL produced		900mL produced
Final volumes present (4 x1/2)	500-450 = 50ml unreacted		0		450mL		900mL

(3)

c. A gas fired plant offers greater advantage to the environment than a coal fired plant. Less CO_2 is released per MW of electricity. The combustion of gas produces fewer pollutants, such as unburnt carbon, soot, smoke particles with increased risk of respiratory disease and sulfur dioxide a precursor of acid rain. (2)

d. Methane in biogas is generated for the decay of organic waste material. It can be used in small scale generators for heating or electricity.

Any one of the following points: (1)

This has advantages of reducing rubbish and release of methane gas, a greenhouse gas, thus helping to reduce global warming.

It is a renewable fuel, and would reduce the need for fossil fuels.

It is a readily available and economic source of energy to a wider community, the waste can be used as a fertiliser.

e. i $C_{57}H_{98}O_6(l) + 3H_2O(l) \rightarrow C_3H_8O_3(l) + 3\ C_{17}H_{31}COOH(l)$ (1)
ii propan(e)-1,2,3- triol (not glycerol) or 1,2,3 – propane- triol (1)
iii linoleic acid has 2 double bonds; 1 mole of linoleic acid would require 2 mole of bromine for addition or bromine to each double bond (1)

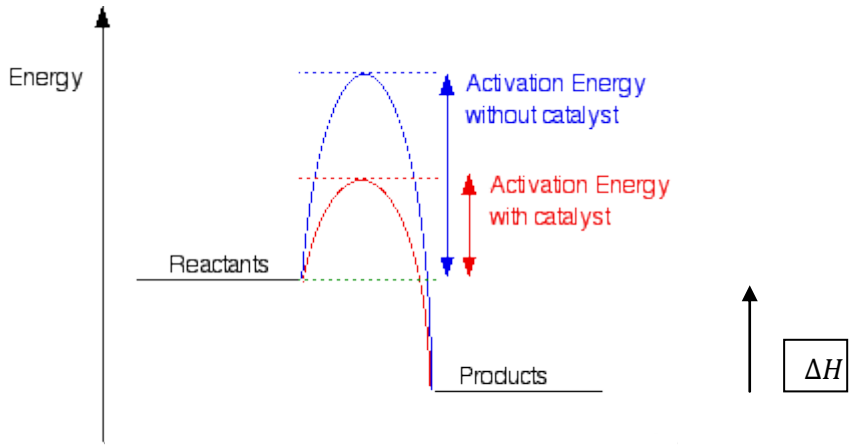
(3)

Question 8 (7 marks)

a. $2CO(g) + 2NO(g) \rightarrow 2CO_2(g) + N_2(g)$ (1)

b. The presence of unburnt hydrocarbons indicates incomplete combustion of the carbon-based fuel, and inefficient energy from the fuel due to reduced complete combustion. The owner would require more fuel per same distance and buy more fuel for the same distance trip. (1)

c.



(1)

http://www.chemguide.co.uk/physical/basicrates/energyprofiles.html

d. On diagram in c. Must have the same ΔH but alternative pathway with lower activation energy (1)

e. A catalyst reduces the energy required to break the bonds of the reactants. Consequently a higher proportion of reactant particles collide with sufficient energy greater than the required activation energy. (There are more successful collisions using the alternative pathway and the rate of reaction increases.) (1)

f. As the temperature is increased, particles move faster. There is a higher proportion of reactants with more kinetic energy (1) and thus there are more successful or fruitful collisions per unit of time.(1) (2)

Question 9 (9 marks)

a. From the electrochemical series, water is a stronger oxidant than the aluminium ion and so would be reduced rather than the aluminium ion. The zinc ion is a stronger oxidant than water, so an aqueous electrolyte can be used for the zinc ion. (2)

b. $2H_2O(l) \rightarrow O_2(g) + 4H^+(aq) + 4e^-$ (1)

c. $Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$

$n(Zn) = \frac{1.205}{65.4} = 0.018425mol$

$n(e^-) = 2 \times 0.0184 = 0.023685mol$ (1)

$Q = n(e^-) \times F = 0.023685 \times 96500 = 3556C$ (1)

$I = Q/t = \frac{3556}{(30.0 \times 60)} = 1.9756$ (1) = 1.98 A (3 sig fig) (1) (4)

d. The predicted result would be no change to results as Mg^{2+} is a weaker oxidant that Zn^{2+} when the electrolysis is carried out under the same laboratory conditions. (2)

Question 10 (7 marks)

a. At the anode(-) electrode $Pb(s) + SO_4^{2-}(aq) \rightarrow PbSO_4(s) + 2e^-$ (1)

b. i.Mechanical energy to electrical to chemical energy (1)
ii at the negative electrode when recharging $PbSO_4(s) + 2e^- \rightarrow Pb(s) + SO_4^{2-}(a)$ (2)

c. $Q = I \times t = 50.0 \times 10.0 = 500C$ (1)

d. The conversion of the chemical energy in petrol to mechanical energy and kinetic energy for the car to move is a very inefficient process, with 20-25% efficiency. There is significant loss of energy at thermal energy. (1)

e. One of: Lead is a heavy metal or sulphuric acid is corrosive. Both are harmful to the environment. (1)

Question 11 (4 marks)

a. C5 was in the greatest amount. It has the greatest area under the peak. C5 would be octane as it would be the hydrocarbon with the second longest retention time. (2)

b. Propane adsorbed to the stationary phase the least strongly as it has the lowest relative molecular mass of the five hydrocarbons. All 5 alkanes would be soluble in the stationary phase but less bonding by dispersion forces would occur with a smaller molecular mass. (2)

