CHRIST CHURCH GRAMMAR SCHOOL

Year 12 Chemistry
Mid Year Exam 2010

TIME ALLOWED FOR THIS PAPER

Reading time before commencing work: Ten minutes
Working time for the paper: Three hours

MATERIAL REQUIRED/RECOMMENDED FOR THIS PAPER

To be provided by the candidate

Pens, pencils, calculator satisfying the conditions set by Curriculum Council.

To be provided by the supervisor

This Question/Answer Booklet; Multiple-choice Answer Sheet; Chemistry Data Sheet

Section 1	Section 2	Section 3	Totals
Total /25 =	26. 27. 28. 29. 30. 31. 32. 33. 34. 35. 36. Total /70=	37. 38. 39. 40. 41. 42. Total/ 80 =	Section 1 / 25% Section 2 / 35% Section 3 / 40% Total / 100%

STRUCTURE OF THE PAPER

Section	Format	No. of questions set	No. of questions to be attempted	Recommend time (minutes)	Marks Allocated	Marks
1	Multiple Choice	25	ALL	50	25	25%
2	Short Answer	11	ALL	60	70	35%
3	Extended Response	5	ALL	70	77	40%

Instructions to candidates

1. Answer the questions according to the following instructions

Section 1: Answer all questions on the separate Multiple-choice Answer Sheet provided. For each question shade the box to indicate your answer. Use only a blue or black pen to shade the boxes. If you make a mistake, place a cross through the square and shade a new answer. Do not erase or use correction fluid. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any one question.

Section 2 and 3: Write answers in the Question/ Answer Booklet.

2. When calculating numerical answers, show your working or reasoning clearly unless instructed otherwise

3. You must be careful to confine your answers to the specific question asked and to follow instructions that are specific to a particular question.

4. Spare pages are included at the end of the booklet. They can be used for planning your responses and/ or as additional space if required to continue an answer.

    - Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
    - Continuing an answer: If you need to use the space to continue an answer, indicate in the original answer space where an answer is to be continued, i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Section 1 Multiple-choice 25% (25 Marks)

This section has **25** questions. Answer **all** questions on the Multiple-choice Answer Sheet provided. Use only blue or black pen to shade the boxes. If you make a mistake, place a cross through that square. Do not erase or use correction fluid. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is given for any question.

Suggested working time for this section is 50 minutes.

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1. The total number of electrons in the p-orbitals of a phosphorus atom in its ground state is:

   A. 3

   B. 6

   C. 9

   D. 12

2. Hydrogen and chlorine react according to the equation:

   $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$

   3 mole of H_2 and 2 mole of Cl_2 are placed in a vessel and sealed. When reaction is complete the vessel will contain:

   A. 5 mole of HCl

   B. 6 mole of HCl and 1 mole of Cl_2

   C. 4 mole of HCl and 1 mole of Cl_2

   D. 4 mole of HCl and 1 mole of H_2

3. Which one of the following, in the solid state, has a crystal structure which contains discrete molecules?

   A. Magnesium chloride

   B. Hydrogen chloride

   C. Iron (II) chloride

   D. Ammonium chloride

4. Which one of the following statements about dispersion forces in a series of molecules is correct?

   A. An increased molecular mass leads to a greater mass of the molecule and hence stronger dispersion forces.

   B. An increased number of protons and electrons leads to stronger dispersion forces.

   C. Larger electronegativity differences leads to stronger dispersion forces.

   D. The presence of an atom such as O or N bonded to H leads to stronger dispersion forces.

5. 100 mL of 1.00 $molL^{-1}$ HCl is added to a 2.00 g piece of limestone, $CaCO_3$.
   Which of the following will not increase the initial rate of this reaction?

   A. adding 150 mL of 1 $molL^{-1}$ HCl in place of 100 mL of 1 $molL^{-1}$ HCl

   B. adding 100 mL of 2 $molL^{-1}$ HCl in place of 100 mL of 1 $molL^{-1}$ HCl

   C. heating the 100 mL of 1 $molL^{-1}$ HCl before adding it to the limestone

   D. adding 100 mL of 1 $molL^{-1}$ HCl to powdered $CaCO_3$ in place of the single piece of limestone

6. Nitrogen (II) oxide and chlorine react according to the equation:

   $2NO(g) + Cl_2(g) \Leftrightarrow 2NOCl(g); \quad \Delta H = -38 \text{ kJ mol}^{-1}$

   The activation energy for the forward reaction is 62 kJ mol^{-1}.The activation energy of the reverse reaction is therefore:

   A. –62 kJ mol^{-1}

   B. 24 kJ mol^{-1}

   C. 38 kJ mol^{-1}

   D. 100 kJ mol^{-1}

7. Sulfur dioxide and oxygen are mixed to form sulfur trioxide according to:

   $2SO_2(g) + O_2(g) \Leftrightarrow 2SO_3(g)$

   Which one of the following best describes the effect of adding the catalyst V_2O_5 to the equilibrium yield and rate of forward reaction of the mixture?

	Equilibrium yield	Reaction rate
A.	increases	increases
B.	no change	increases
C.	no change	no change
D.	increases	no change

8. Which one of the following lists the elements in order of decreasing first ionisation energy, that is, from highest to lowest?

A. Rb > K > Na > Li

B. Li > Mg > B > Al

C. Ne > Cl > P > Al

D. Li > C > N > Ne

9. Methanoic acid and ethanoic acid are both weak acids with the following equilibrium constants, K at 25°C:

methanoic acid	$HCOOH \Leftrightarrow HCOO^-(aq) + H^+(aq)$	$K = 1.82 \times 10^{-4}$
ethanoic acid	$CH_3COOH \Leftrightarrow CH_3COO^-(aq) + H^+(aq)$	$K = 1.74 \times 10^{-5}$

Two separate solutions were prepared, one of 0.1 mol L^{-1} methanoic acid and the other of 0.1 mol L^{-1} ethanoic acid. Which one of the following would be present in the highest concentration at 25°C?

A. CH_3COOH in the ethanoic acid solution

B. CH_3COO^- in the ethanoic acid solution

C. HCOOH in the methanoic acid solution

D. $HCOO^-$ in the methanoic acid solution

10. The anaesthetic, nitrous oxide, N_2O, decomposes to form an equilibrium mixture of N_2O, N_2 and O_2 according to the following equation:

$$2N_2O(g) \Leftrightarrow 2N_2(g) + O_2(g)$$

At 25°C, $K = 7.3 \times 10^{37}$ and at 40°C, $K = 2.7 \times 10^{36}$

What valid conclusion can be made from this?

A. The equilibrium concentrations of N_2 and O_2 are equal at 25°C.

B. The equilibrium concentration of N_2O is higher at 25°C than at 40°C.

C. N_2O is less stable at the higher temperature.

D. The forward reaction is exothermic.

11. In which one of the following processes will the ΔH have the opposite sign to that of the other three?

A. $I_2(s) \rightarrow I_2(g)$

B. $Na^+(g) + e^-(g) \rightarrow Na(g)$

C. $CO_2(g) \rightarrow C(s) + O_2(g)$

D. $2NaCl(l) \rightarrow 2Na(l) + Cl_2(g)$

12. Element X has an atomic radius that is smaller than that of sulfur. In chemical reactions, element X commonly forms an ion that has the same electron configuration as the Sc^{3+} ion. Element X could be:

A. oxygen.

B. chlorine.

C. argon.

D. potassium.

13. Zinc metal reacts with 0.1 mol L^{-1} hydrochloric acid to form hydrogen gas and zinc chloride solution. The production of hydrogen gas is more vigorous if the zinc is powdered, rather than in large pieces, because the:

A. activation energy of the reaction is lower.

B. activation energy of the reaction is higher.

C. frequency of collisions between zinc metal and hydrogen ions is higher.

D. fraction of reactant particles with sufficient energy to react is higher.

14. Which one of the following molecules is non-polar, but has polar covalent bonds?

A. tetrafluoromethane, CF_4

B. ammonia, NH_3

C. chlorine, Cl_2

D. water, H_2O

15. Which one of the following could not be explained in terms of hydrogen bonding?

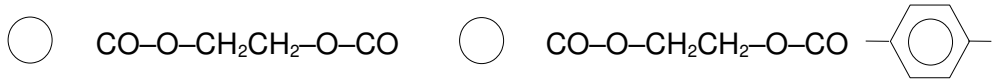
A. The boiling point of NH_3 is higher than CH_4

B. Water mixes readily with C_2H_5OH

C. 1-Propanol has a higher boiling point than propanal

D. CH_2F_2 has a higher boiling point than CH_3F

16. A representation of a section of a polymer chain that has been produced from two different monomers is given below:



The two monomers are:

A. HO ◯ OH and $HOOCCH_2CH_2COOH$

B. HO ◯ COOH and $HOCH_2CH_2COOH$

C. HOOC ◯ COOH and $HOCH_2CH_2OH$

D. HOOC ◯ COOH and $HOCH_2OH$

17. How many structural and geometric isomers, each containing a double bond, have the molecular formula C_5H_{10}?

A. 3
B. 4
C. 5
D. 6

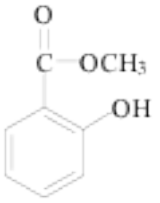
18. The solubility of pentane, 1-propanol and 1-hexanol in water in decreasing order are:

A. 1-propanol > pentane > 1-hexanol
B. pentane > 1-hexanol > 1-propanol
C. 1-hexanol > 1-propanol > pentane
D. 1-propanol > 1-hexanol > pentane

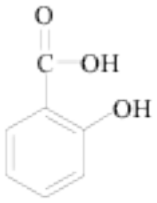
19. Bromine, Br_2, dissolves in unsaturated hydrocarbons and reacts immediately. Which of the following is the best description of this process?

A. Bromine is polar and reacts by adding bromine atoms across the double bond.
B. Bromine is polar and reacts by substituting hydrogen atoms with bromine atoms.
C. Bromine is non-polar and reacts by substituting hydrogen atoms with bromine atoms.
D. Bromine is non-polar and reacts by adding bromine atoms across the double bond.

20. Methyl salicylate (oil of wintergreen) is used as a flavouring agent and it is also used in rubbing compounds. When methyl salicylate is applied to the skin it causes a mild burning sensation that serves as a counter-irritant for sore muscles. It can be produced by means of a reaction in which the salicylic acid is one of the reagents. The structures of methyl salicylate and salicylic acid are shown below:



methyl salicylate



salicylic acid

Which one of the following statements about methyl salicylate and salicylic acid is not correct?

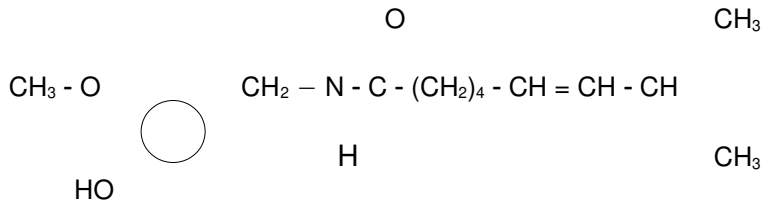
A. Methyl salicylate may be prepared by reaction between salicylic acid and CH_3OH

B. Methyl salicylate contains both an ester and an alcohol functional group.

C. Salicylic acid may also produce an ester other than methyl salicylate with CH_3COOH.

D. Methyl salicylate may be prepared by reaction between salicylic acid and CH_3COOH.

21. Capsaicin is an important component of some pain relief ointments. It is also the major compound responsible for the burning sensation of chilli peppers. A structure for capsaicin is given below.



Which of the following functional groups does a molecule of capsaicin contain?

A. an ester and an amide

B. an ester and an alcohol

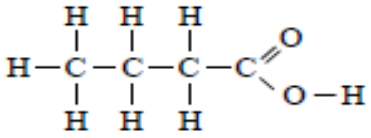
C. an alkene and an amide

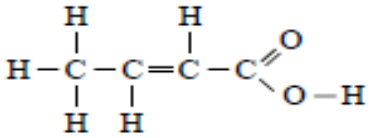
D. a carboxylic and an alcohol

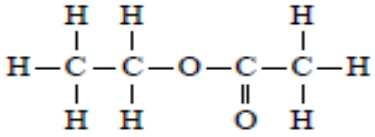
22. A student was given the tasks of identifying a liquid organic compound that contains only carbon, hydrogen and oxygen. The following tests were carried out:

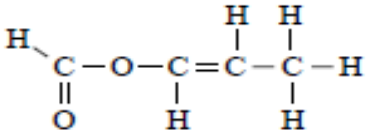
	Procedure	Result
Test 1	Some $Br_2(aq)$ was added to a sample of the compound	A rapid reaction occurred and a colourless product formed
Test 2	Some $Na_2CO_3(s)$ was added to a sample of the compound	A reaction occurred and a colourless gas was evolved

Based on the above results, the compound could be:

A. 

B. 

C. 

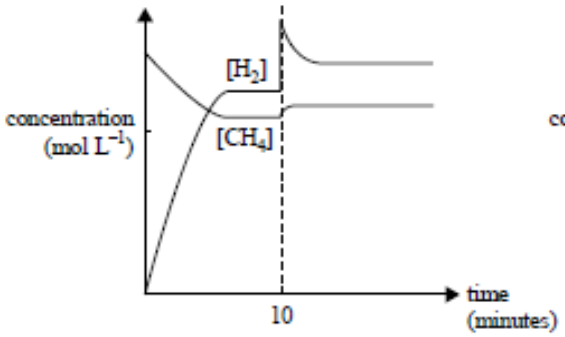
D. 

23. Equal amounts of $CH_4(g)$ and $H_2O(g)$ are added to a reaction vessel and allowed to react.

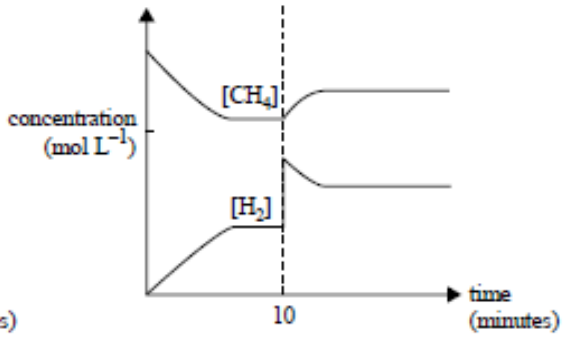
$$CH_4(g) + H_2O(g) \Leftrightarrow 3\ H_2(g) + CO(g)$$

After 10 minutes, equilibrium has been reached. At that time, some H_2 is added to the mixture and equilibrium is re-established. Which one of the following graphs best represents the changes in the concentration of CH_4 and H_2 in the reaction mixture?

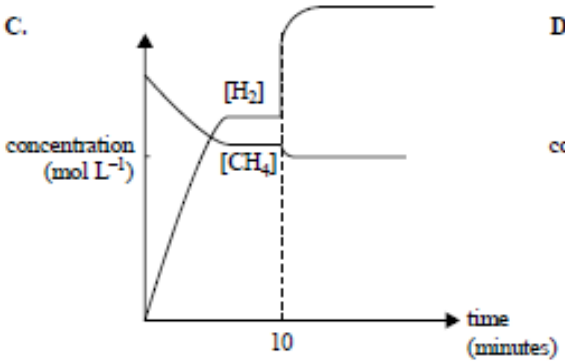
A.



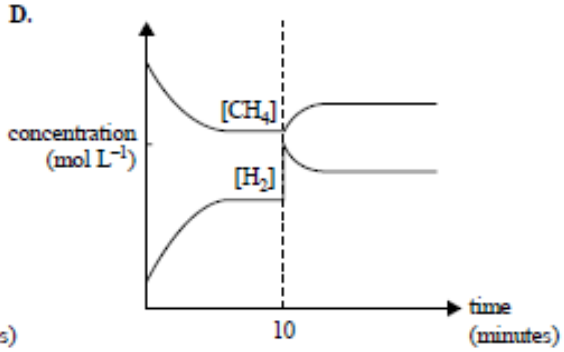
B.



C.



D.



The next two questions, 24 and 25, refer to a solution of NaOCl

24. NaOCl is completely dissociated in water to form $Na^+(aq)$ and $OCl^-(aq)$. In solution, OCl^- hydrolyses according to the equation:

$$OCl^-(aq) + H_2O(l) \Leftrightarrow HOCl(aq) + OH^-(aq)$$

100 mL of pure water at constant temperature is added to a 100 mL solution of 0.10 mol L^{-1} NaOCl. Compared to the original NaOCl solution, when the final solution reaches equilibrium again, the

A. $[H^+]$ has decreased.

B. pH of the solution has decreased.

C. concentration of HOCl has increased.

D. value of the equilibrium constant has halved.

25. The HOCl produced in a solution of NaOCl can react further to produce small amounts of chlorine, $Cl_2(aq)$, in water according to the equation:

$$HOCl(aq) + H^+(aq) + Cl^-(aq) \Leftrightarrow Cl_2(aq) + H_2O(l)$$

Which of the following concentrated solutions, when added to a solution of NaOCl, would not raise the concentration of Cl_2 in the solution?

A. NaCl(aq)

B. NaOH(aq)

C. $H_2SO_4(aq)$

D. HOCl(aq)

END OF PART ONE

PART 2 **35% (70 marks)**

This section has **11** questions. Answer all questions. Write your answers in the space provided.

Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page
- Continuing an answer. If you need to use the space to continue an answer, indicate in the original answer space where the answer is continued., i.e. give the page number. Fill in the number of the question(s) that you are continuing to answer at the top of the page.

Suggested working time for this section is 60 minutes.

Question 26 **(1+1=2 marks)**

Write equlilibrium constant expressions for the following:

Equation	$4\ NH_3(g) + 5\ O_2(g) \Leftrightarrow 4\ NO(g) + 6\ H_2O(g)$
Equilibrium constant expression	

Equation	$PCl_3(l) + Cl_2(g) \Leftrightarrow PCl_5(s)$
Equilibrium constant expression	

Question 27 **(2+2= 4 marks)**

Draw a molecule of 1-butene.

1-butene can be polymerized into poly(1-butene). Draw the structure of this polymer, showing all atoms and three repeating units.

Question 28 **(3+3+3=9 marks)**

Account for the following observations:

(a) The melting point of methanal, H_2CO (-21^0C) is lower than that of methanol, CH_3OH (65^0C).

(b) The electrical conductivity of liquid magnesium chloride, $MgCl_2$, is greater than that of liquid silicon chloride, $SiCl_4$.

(c) The melting point of silicon dioxide, SiO_2 (1650^0C) is higher than that of carbon dioxide, CO_2 (-78^0C).

Question 29 **(2+2+2= 6 marks)**

Draw structural formulae and give the IUPAC name for the organic products formed in each of the following reactions. Show all atoms in the structural formula.

(a) When butan-2-ol is oxidized by acidified $K_2Cr_2O_7$.

Structure of organic product	Name of organic product

(b) When 2-pentene reacts with bromine solution.

Structure of organic product	Name of organic product

(c) When methanoic acid reacts with 1-propanol in the presence of $H^+(aq)$

Structure of organic product	Name of organic product

Question 30 **(2+2= 4 marks)**

Write the equation for the reaction that occurs in the following procedures. For full marks, chemical equations should refer only to those species consumed in the reaction and the new species produced. These species may be **ions** [for example $Ag^{+}_{(aq)}$], **molecules** [for example $NH_{3(g)}$, $NH_{3(aq)}$, $CH_3COOH_{(l)}$] or **solids** [for example $BaSO_{4(s)}$, $Cu_{(s)}$, $Na_2CO_{3(s)}$]

(a) Barium nitrate solution is mixed with sodium phosphate solution

Equation _____

(b) propane gas is bubbled through bromine water.

Equation _____

Question 31 **(2+2= 4 marks)**

Write observations for any reactions that occur in the following procedures. In each case describe in full what you would observe, including any:

- Colours
- Odours
- Precipitates (give the colour)
- Gases (give the colour or describe as colourless)

(a) Nitric acid is added to copper (II) carbonate.

Observation; _____

_____

(b) Acidified potassium dichromate solution is added to ethanal.

Observation; _____

_____

Question 32 **(13 marks)**

The graph below represents the concentration of reactants and products at equilibrium for the Haber Process reaction:

$$N_2(g) + 3H_2(g) \Leftrightarrow 2NH_3(g) \quad \Delta H = -92\ kJmol^{-1}$$

At equilibrium, there is no change in the concentrations of each component. Sketch the appropriate changes in concentrations of nitrogen and ammonia if:

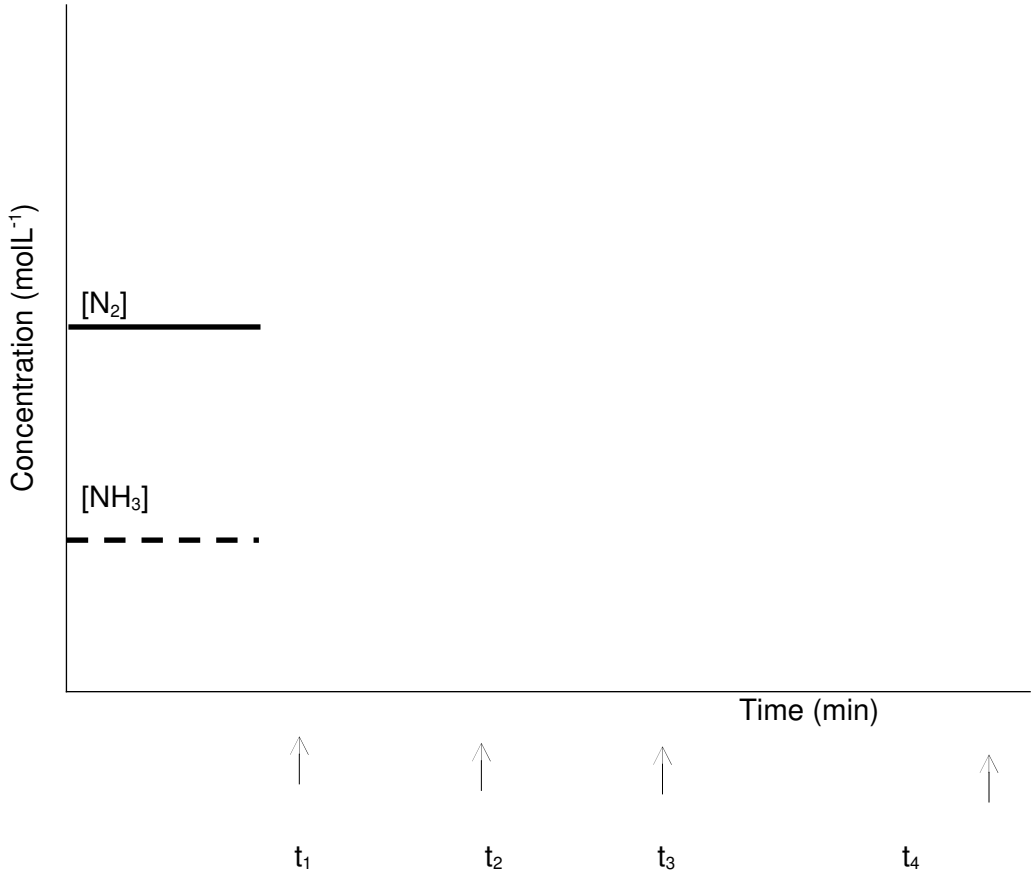
(a) at time t_1 the volume of the vessel was suddenly halved

(b) at time t_2 equilibrium is restored

(c) at time t_3 the temperature is decreased

(d) at time t_4 equilibrium is restored

(2+2+2+2=8 marks)



The equilibrium constant for the reaction before time t_1 was known. Would the equilibrium constant be higher, lower or the same as it was at the following times (just answer "higher", "lower" or "same")

(e) at the time between t_2 and t_3 _____ (1 mark)

(f) at the time after t_4 _____ (1 mark)

At time t_5 (not shown on graph), a catalyst was added to the system. What would be the effect (write "higher", "lower" or "same") of this addition of a catalyst on:

(g) the equilibrium concentration of NH_3 _____ (1 mark)

(h) the rate of the forwards reaction _____ (1 mark)

(i) the value of the equilibrium constant _____ (1 mark)

Question 33 **(3+3= 6 marks)**

(a) Describe and explain the trend in the atomic radius of group I elements, moving from Li to Cs.

_____

_____

_____

_____

(b) Describe and explain the trend in the electronegativities across period 3, moving from Na to Ar

_____

_____

_____

_____

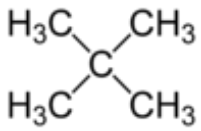
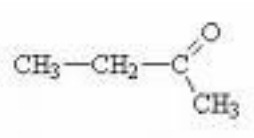
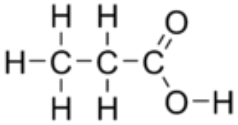
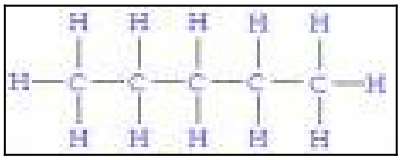
Question 34 **(6 marks)**

For each species listed in the table below, draw the structural formula, representing all valence shell electron electron pairs as either : or – and state the shape of the molecule or ion

Species	Structural formula (showing all valence electrons)	Shape (sketch or name)
sulfur dioxide SO_2		
phosphate ion PO_4^{3-}		
hydrogen cyanide HCN		

Question 35 **(8 marks)**

Complete the following table. Note that the molar masses (M) of all substances are in the range of 70-74 $gmol^{-1}$, and that any differences are insignificant.

Molecule	Major type of intermolecular attraction.(choose from dispersion forces, dipole-dipole forces or hydrogen bonding)	Boiling point ranking (1=highest, 4=lowest)
 dimethylpropane		
 butanone		
 propanoic acid		
 pentane		

Question 36 **(2+3+3=8marks)**

Sketch the following graphs:

(a) the first ionisation energies of the period 3 elements

I.E. ($kJmol^{-1}$)

Na Mg Al Si P S Cl Ar

(b) the melting points of the period 3 elements

m.p.(^0C)

Na Mg Al Si P S Cl Ar

(c) the eleven ionisation energies of sodium

I.E. ($kJmol^{-1}$)

1^{st} 2^{nd} 3^{rd} 4^{th} 5^{th} 6^{th} 7^{th} 8^{th} 9^{th} 10^{th} 11^{th}

END OF PART TWO

Section 3: Extended answer 40% (80 Marks)

This section contains **six (6)** questions. You must answer **all** questions. Write your answers in the spaces provided.

Spare pages are included at the end of the booklet. They can be used for planning your responses and/ or as additional space if required to continue an answer.

- Planning: If you use the spare pages for planning, indicate this clearly at the top of the page.
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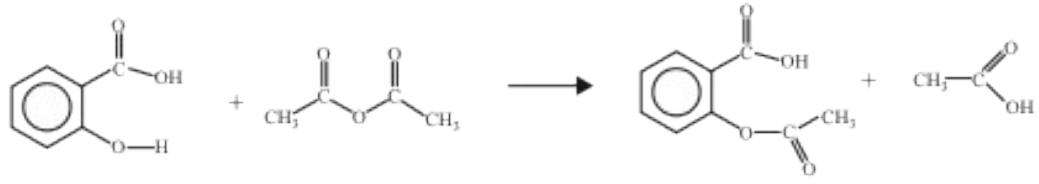
Suggested working time for this section is 70 minutes.

Question 37 (14 marks)

Aspirin, also known as **acetylsalicylic acid** is a drug that is often used as an analgesic to relieve minor aches and pains, as an antipyretic to reduce fever, and as an anti-inflammatory medication.

A sample of aspirin was prepared by reacting 2.20 g of salicylic acid with 4.20 mL of ethanoic anhydride in a conical flask. After heating for 20 minutes the reaction mixture was cooled and white crystals precipitated. The crystals were then collected, dried to constant mass and weighed.

The equation for the reaction is:



salicylic acid (s) ethanoic anhydride (l) aspirin (s)

The following results were obtained

Mass of salicylic acid	2.20 g
Volume of ethanoic anhydride	4.20 mL
Mass of product	2.25 g

(a) Complete the following table (molar mass only) and use the data to answer the questions below.

	Molar mass ($gmole^{-1}$)	Density (gmL^{-1})
Aspirin		Not given
Ethanoic anhydride		1.08
Salicylic acid		Not given

(3 marks)

(b) Calculate the initial amount, in moles, of salicylic acid used in this preparation.

(1 mark)

(b) What initial amount, in moles, of ethanoic anhydride was used?

(2 marks)

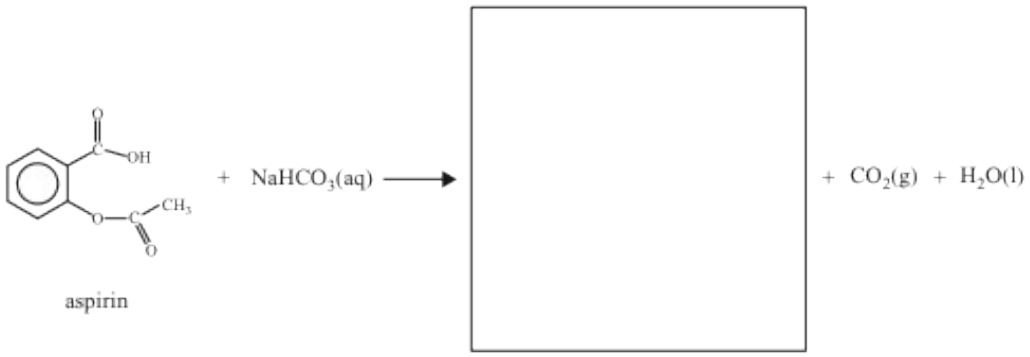
(c) What is the maximum mass of aspirin that can theoretically be produced from these reagents?

(3 marks)

(d) Determine the percentage of salicylic acid converted to aspirin (percentage yield) in this preparation.

(2 marks)

(e) The sodium salt of aspirin is more soluble than aspirin itself. This salt may be synthesised by reaction between aspirin and sodium hydrogen carbonate as follows.



aspirin

(i) In the box provided above, give the complete structure for the **sodium salt of aspirin**

(1 mark)

(ii) Explain why the sodium salt of aspirin is more water-soluble than aspirin.

(2 marks)

Question 38 **(14 marks)**

A compound was analysed to determine its empirical formula. The compound contained nickel, chlorine, carbonate and water and had the general formula $Ni_wCl_x(CO_3)_y.zH_2O$.

1.684 g of the compound was heated to drive off the water. The mass of compound was determined a number of times during the heating and the following data was obtained:

Time (hours)	Mass (g)
0	1.684
1	1.401
2	1.386
3	1.383
4	1.383

(a) Why was the compound heated and measurements of mass taken over a period of 4 hours?

(2 marks)

One third of the anhydrous dry compound was dissolved and H_2S gas was bubbled through the solution. 0.338 g of NiS was precipitated.

Another one third of the anhydrous compound was treated with silver nitrate producing 0.532 g of silver chloride.

The remaining third of the anhydrous compound was analysed by combustion and 0.082 g of carbon dioxide was produced.

(b) Determine the values of w, x, y and z in the general formula above.

(12 marks)

Question 39 **(20 Marks)**

Ethanol is not the only alcohol gaining in popularity as a fuel. Methanol, CH_3OH, is also the subject of considerable research; especially for use in fuel cells. The commercial production of methanol, however, is quite different to that of ethanol and involves a two step process.

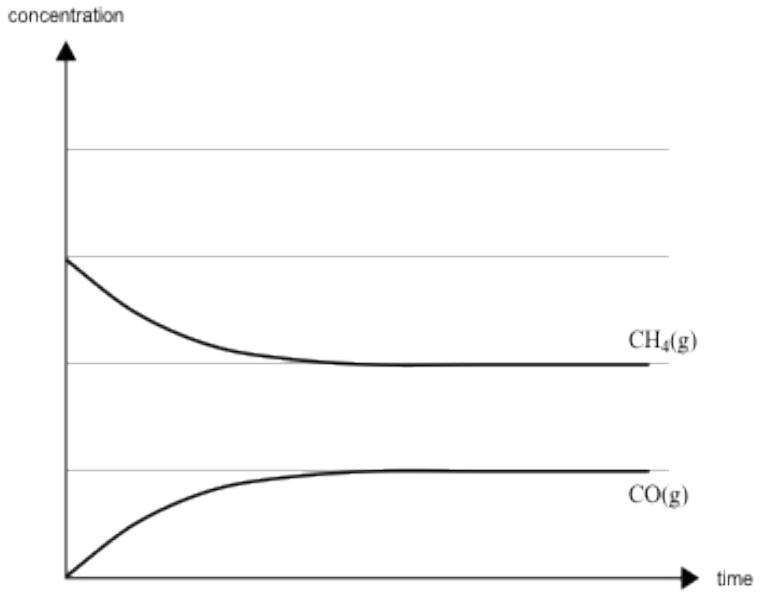
Step 1 Production of hydrogen gas

Large quantities of hydrogen, for industrial use, are produced through steam methane reforming (SMR). Steam reforming converts methane (and other hydrocarbons in natural gas) into hydrogen and carbon monoxide by reaction with steam over a nickel catalyst.

$CH_4(g) + H_2O(g) \Leftrightarrow CO(g) + 3H_2(g)$; $\Delta H = +206$ kJ mol $^{-1}$

Temperatures of about 850°C and pressures of 1000 kPa to 2000 kPa are used in this step.

Some methane and steam are placed in a closed container and allowed to react at a fixed temperature. The following graph shows the change in concentration of methane and carbon monoxide as the reaction progresses.



(a) (i) On the graph above, draw a line to show the change in concentration of hydrogen gas as the reaction progresses. **Label this line H_2.** (2 marks)

(ii) On the graph above, draw a line to show how the formation of carbon monoxide would differ over time in the presence of a catalyst. **Label this line**. (2 marks)

Step 2 Production of Methanol

Hydrogen and carbon monoxide are reacted to form methanol using a mixture of ZnO and CrO_3 as a catalyst.

$CO(g) + 2H_2(g) \Leftrightarrow CH_3OH(g)$ $\Delta H = -92$ kJ mol^{-1}

Temperatures of about 300°C and pressures of 5000 kPa to 10 000 kPa are used in this step.

(b) In terms of equilibrium **and** rate, explain why

(i) elevated temperatures are used in both steps with the temperature used in step 1 being much higher than in step 2.

(3 marks)

(ii) pressures higher than atmospheric are used in both steps, with the pressure used in step 2 being much higher than in step 1.

(3 marks**)**

(iii) a catalyst is used in both steps.

(1 mark)

(c) Identify one way in which the energy efficiency of this method of methanol production can be maximised.

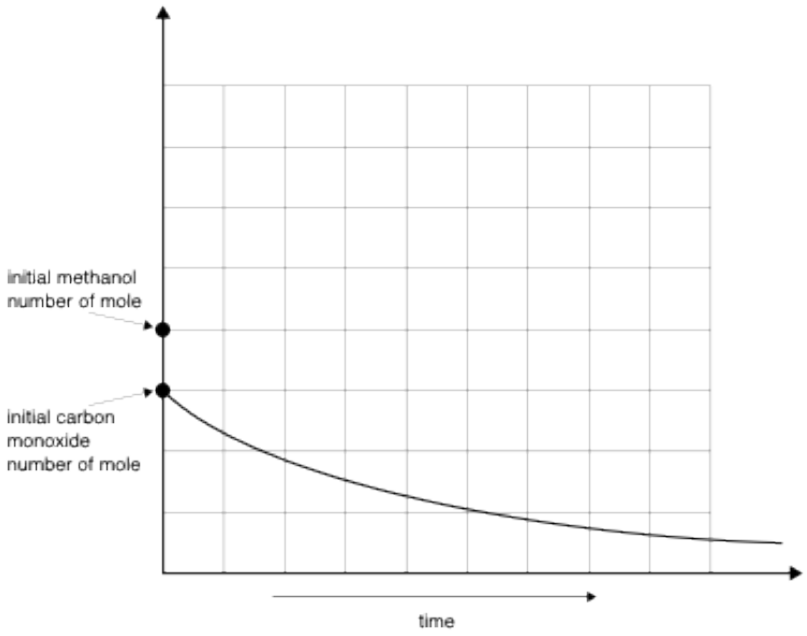
(1 mark)

(d) The following changes are made to a gaseous equilibrium mixture of CO, H_2 and CH_3OH at 300°C. Indicate in the table below the effects on the masses of CO, CH_3OH and H_2 present at the new equilibrium by entering the words 'increase' or 'decrease' or 'no change' as appropriate.

change	effect on mass of CO(g) at equilibrium	effect on mass of CH_3OH(g) at equilibrium	effect on mass of H_2(g) at equilibrium
More H_2 is added at constant temperature and volume.			
The volume of the vessel is increased at constant temperature.			

(6 marks)

(e) The following graph represents the change in the number of mole of carbon monoxide with time during an experiment in which the volume of the vessel is changed at constant temperature.

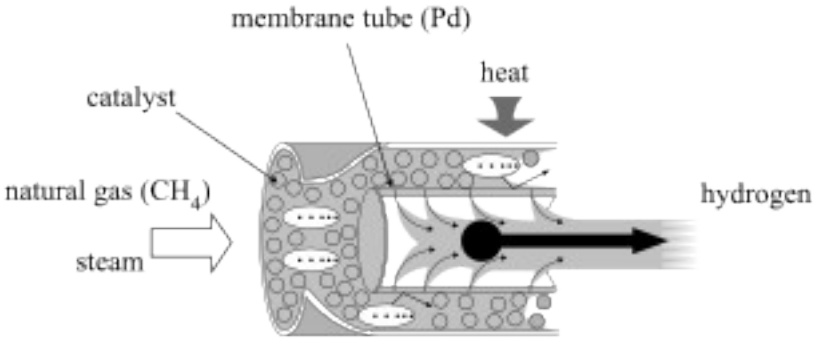


On this graph sketch and label a line showing how the number of mole of methanol would have changed over the same period of time.

(1 mark)

In a newer version of the Steam Methane Reforming (SMR) process described in Step1, the reforming reactions occur in a tube surrounding a palladium membrane. The membrane selectively separates hydrogen from the gas mixture.

The reaction from Step 1 is: $CH_4(g) + H_2O(g) \Leftrightarrow CO(g) + 3H_2(g)$



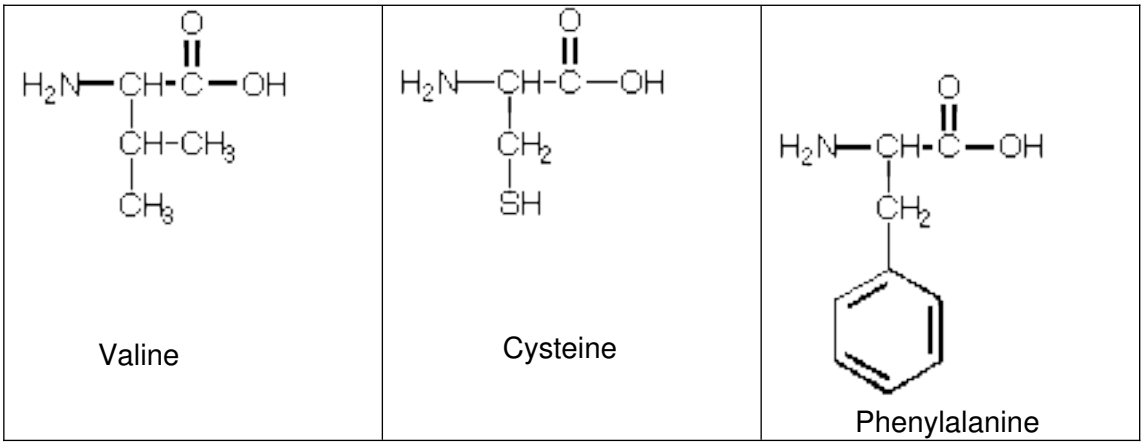
(f) Explain why the separation of hydrogen in this way increases the yield of hydrogen obtained.

(3 marks)

Question 40 **(10 Marks)**

Alpha amino acids are the monomers that living organisms use to produce proteins

(a) The structures of 3 alpha amino acids are shown in the boxes below.



(i) What does the term “alpha” mean?

(1 mark)

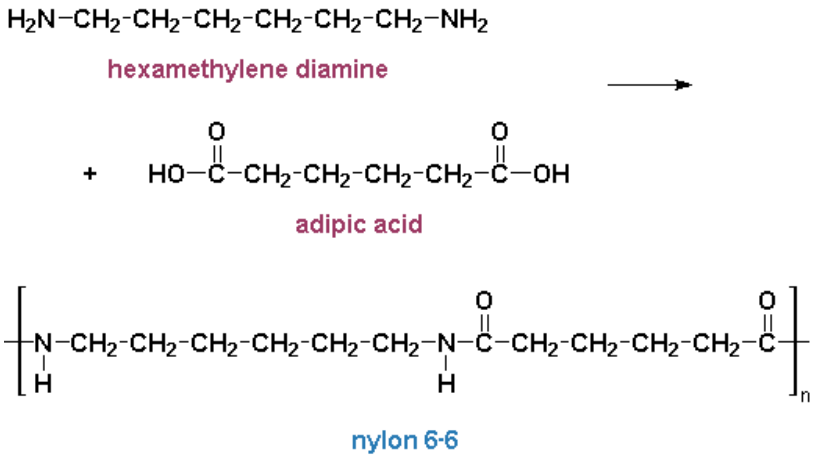
(ii) Draw a structure in the box below showing how peptide (amide) bonds are formed between these three molecules in the order they appear in the boxes above.

(3 marks)

(iii) What is the by product of this reaction and how is it formed?

(2 marks)

(b) The reaction depicted below is the condensation reaction for the production of nylon.



(i) What are the similarities between the polypeptide reaction in (a) Part (ii) and the nylon production above.

(2 marks)

(ii) What are the differences between the reactants in the polypeptide reaction in (a) Part (ii) and the nylon production.

(2 marks)

Question 41 **(10 marks)**

Myrcene is a naturally occurring compound found in the leaves of bay trees. It is known to be a polyunsaturated hydrocarbon (an unsaturated hydrocarbon with an unknown number of double bonds). It can react with hydrogen to produce a saturated hydrocarbon.

In a laboratory investigation, a 1.00 g sample of pure myrcene **reacted completely** with exactly 510 mL of hydrogen gas measured at 20.0°C and 105.0 kPa. In this reaction, myrcene was converted to a saturated alkane with a molecular formula $C_{10}H_{22}$.

(a) What type of reaction has occurred between the myrcene and hydrogen?

(1 mark)

(b) Calculate the number of moles and mass, of hydrogen reacting.

(3 marks)

(c) Calculate the mass of $C_{10}H_{22}$ produced in the reaction.

(2 marks)

(d) Calculate the number of moles of $C_{10}H_{22}$ and hence the number of moles of myrcene in the original sample

(2 marks)

(e) Determine the number of double bonds in each molecule of myrcene.

(2 marks)

Question 42 **(12 marks)**

Select a row (an example is Period 3) of the Periodic Table and describe and explain the relationship between the number of valence electrons and an element's

(i) **bonding capacity** (the number of electrons an atom can gain, lose or share)
(ii) **ionisation energy**
(iii) **physical and chemical properties**

Your answer should be approximately one to two pages in length. Use (i) to (iii) above as sub-headings.

Additional working space

Additional working space

Additional working space

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