

CHEMISTRY

STAGE 3

2013 Semester 2

Name: _____

Teacher: Circle

Mr Lucarelli

Mr Sander

Ms K Smith

Mr T Faulkner

TIME ALLOWED FOR THIS PAPER

Reading time before commencing work: Ten minutes

Working time for the paper: Three hours

MATERIALS REQUIRED/RECOMMENDED FOR THIS PAPER

To be provided by the supervisor:

- This Question/Answer Booklet
- Multiple Choice Answer Sheet
- Data sheet

To be provided by the candidate:

- Standard items: Pens, pencils, eraser or correction fluid, ruler, highlighter.
- Special items: Calculators satisfying the conditions set by the School Curriculum and Standards Authority for this subject.

IMPORTANT NOTE TO CANDIDATES

- No other items may be taken into the examination room. It is **your** responsibility to ensure that you do not have any unauthorised notes or other items of a non-personal nature in the examination room. If you have any unauthorised material with you, hand it to the supervisor **before** reading any further.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Suggested working time (minutes)	Marks available	Percentage of exam
Section One: Multiple-choice	25	25	50	/50	/25
Section Two: Short answer	11	11	60	/70	/35
Section Three: Extended answer	7	7	70	/80	/40
					/100

Instructions to candidates

1. Answer the questions according to the following instructions.

Section One: Answer all questions on the separate Multiple-choice Answer Sheet provided.

Shade the box for each correct answer.

Marks will not be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any question.

Sections Two and Three: Write answers in this Question/Answer Booklet in blue or black pen.

2. When calculating numerical answers, show your working or reasoning clearly unless instructed otherwise. Final answers to calculations should be expressed to **three (3)** significant figures and include appropriate units.
3. You must be careful to confine your responses to the specific questions asked and to follow any instructions that are specific to a particular question.
4. 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.

Section One: Multiple-choice**25% (50 Marks)**

This section has **25** questions. 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 that square, do not erase or use correction fluid, and shade your new answer. Marks will not be deducted for incorrect answers. No marks will be given if more than one answer is completed for any question.

Suggested working time: 50 minutes.

- Which of the following conversions (which can be performed in a single step) is NOT an example of oxidation?
 - Methanol to methanal
 - Methanol to methanoic acid
 - Methanol to carbon dioxide
 - Methanol to bromomethane

- Consider the elements E to H with the electron configurations shown? Choose the two elements belonging to the same period

E 2, 2

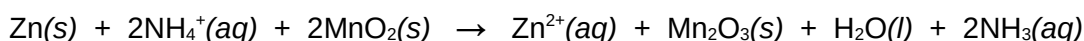
F 2, 6

G 2, 8, 2

H 2, 8, 8, 2

- E, G and H only
- E and G only
- E and F only
- G and H only

- The following reaction occurs in a dry cell battery. Consider the statement regarding this cell.



I $\text{NH}_4^+(\text{aq})$ ions will migrate through the electrolyte to the cathode

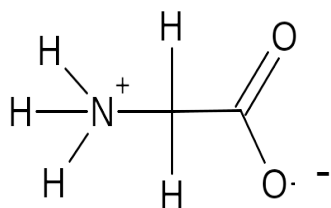
II Zn(s) is present at the anode

III electrons travel from the anode through the electrolyte to the cathode.

The correct statement(s) is/are?

- I only
- I and II only
- II only
- all are correct

4. The species shown here is known as a zwitterion.



Choose the **false** statement regarding this species?

- (a) It has a molecular formula of $\text{H}_5\text{O}_2\text{N}$.
 - (b) It is neutral in charge.
 - (c) It represents an amino acid.
 - (d) It contains both a weakly acidic and a weakly basic ion.
5. Which of the following correctly shows a covalent bond with the strongest bond dipole?
- (a) $\text{F} - \text{F}$
 - (b) $\text{Si} - \text{H}$
 - (c) $\text{S} - \text{H}$
 - (d) $\text{Na} - \text{Cl}$
6. What is the most probable formula and structure for a compound formed from a combination of group 2 and 17 elements? The symbol A represents the group 2 element and B is for the group 17 element.
- (a) A_2B
 - (b) A_2B_3
 - (c) AB_3
 - (d) AB_2
7. Choose the **incorrect** statement regarding hydrogen bonding?
- (a) For relatively small molecules hydrogen bonding is stronger than dispersion forces.
 - (b) Hydrogen bonding in H_2O is more significant than hydrogen bonding in CH_3OH
 - (c) In HCl , hydrogen bonds form between the hydrogen atom of one HCl molecule and one of the lone pairs of a Cl atom from another HCl molecule.
 - (d) Hydrogen bonding is sometimes referred to as a form of extreme dipole-dipole interaction.

8. Which of the following are polar molecules

I CCl_4 II CHCl_3 III CH_2Cl_2

- (a) I and II only
- (b) II only
- (c) II and III only
- (d) III only

9. Consider the ion OH^-

Which of the following shows the total number of protons and electrons for this ion?

	Protons	Electrons
(a)	8	9
(b)	8	7
(c)	9	10
(d)	9	9

10. Which of the following represents a balanced reaction which as written would be useful in producing an electrochemical cell capable of generating an EMF of more than 2.0 volts?

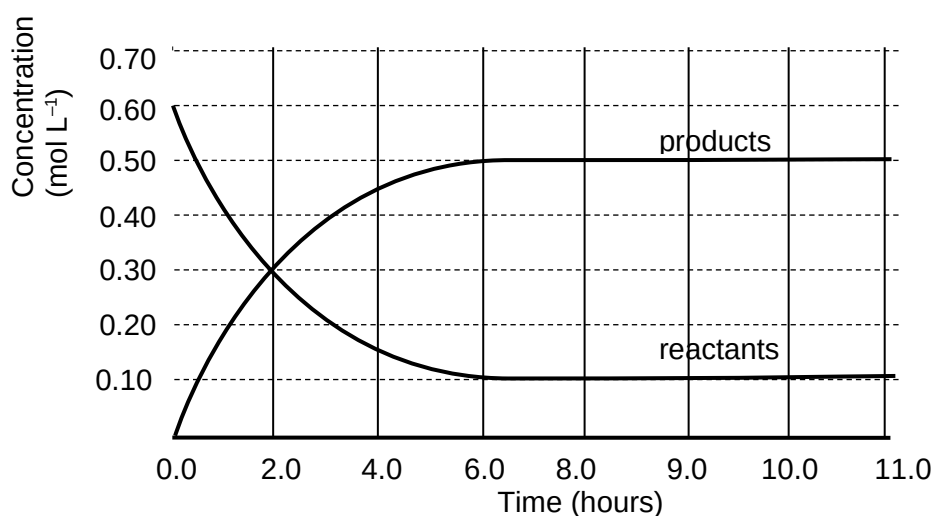
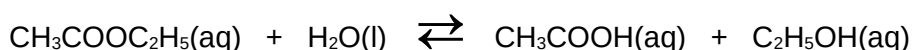
- (a) $\text{Sr}^{2+}(\text{s}) + 2\text{F}^-(\text{aq}) \rightarrow \text{F}_2(\text{aq}) + \text{Sr}(\text{s})$
- (b) $\text{Zn}(\text{s}) + 2\text{H}^+(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{H}_2(\text{g})$
- (c) $3\text{MnO}_4^-(\text{aq}) + 5\text{Cr}(\text{s}) + 24\text{H}^+(\text{aq}) \rightarrow 5\text{Cr}^{3+}(\text{aq}) + 3\text{Mn}^{2+}(\text{aq}) + 12\text{H}_2\text{O}(\text{l})$
- (d) $\text{Zn}(\text{s}) + \text{Br}_2(\text{l}) \rightarrow \text{Zn}^{2+}(\text{aq}) + 2\text{Br}^-(\text{aq})$

11. Which of the following statements is TRUE?

- (a) Heat is absorbed when a liquid vapourises
- (b) Exothermic reactions must occur spontaneously
- (c) The enthalpy change in a reaction is independent of the mass of the reactants
- (d) Endothermic reactions must occur spontaneously

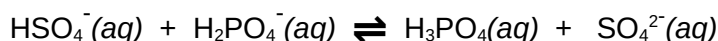
DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

12. Arrange the elements Ne, Kr and Rn in order of first ionisation energy from lowest to highest?
- Ne, Kr then Rn.
 - Rn, Kr and Ne.
 - These elements do not lose electrons and hence do not have ionisation energies.
 - All noble gases have the same ionisation energy.
13. The graph below shows how the concentration of reactants and products change over time for the reaction:



Choose the **correct** statement for this situation.

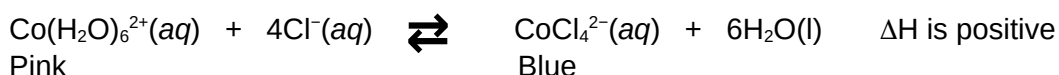
- the equilibrium concentrations were 0.3 mol L⁻¹.
 - the forward and reverse reactions stopped after six hours.
 - the equilibrium constant K is greater than 1.0.
 - the reaction has gone to completion at six hours.
14. Consider the reaction shown here:



Which of the following statements is **incorrect** for this reaction?

- $\text{HSO}_4^-(\text{aq})$ is acting as a Bronsted-Lowrey acid
- $\text{H}_2\text{PO}_4^-(\text{aq})$ is acting as a Bronsted-Lowrey base
- $\text{H}_3\text{PO}_4(\text{aq})$ is acting as a conjugate acid
- $\text{HSO}_4^-(\text{aq})$ is acting as a conjugate base .

15. When chloride ions are added to a solution containing $\text{Co}(\text{H}_2\text{O})_6^{2+}(\text{aq})$, the following equilibrium is established. The mixture is originally quite strongly pink in colour.

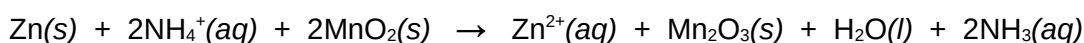


Which of the following statements about the colour of the solution is true?

- I Heating the solution will make it turn blue.
- II Adding some solid potassium chloride will have no effect on the colour.
- III Adding concentrated hydrochloric acid will make the solution turn blue.

- (a) All of the above are correct.
- (b) I, and II only.
- (c) II only
- (d) I, and III only

16. Which of the following correctly identifies the oxidant and reductant in this reaction?



- | | Oxidant (oxidising agent) | Reductant (reducing agent) |
|-----|------------------------------|------------------------------|
| (a) | $\text{Zn}(\text{s})$ | $\text{NH}_4^{+}(\text{aq})$ |
| (b) | $\text{NH}_4^{+}(\text{aq})$ | $\text{Zn}(\text{s})$ |
| (c) | $\text{MnO}_2(\text{s})$ | $\text{Zn}(\text{s})$ |
| (d) | $\text{Zn}(\text{s})$ | $\text{MnO}_2(\text{s})$ |

17. The second ionisation energy for all elements is higher than the first ionisation energy. Which of the following statements gives the best basis for explaining this?

- (a) The second electron is in a higher numbered shell.
- (b) The net positive charge increases as electrons are removed.
- (c) The nuclear charge increases as more electrons are removed.
- (d) The second electron is in a full shell.

18. One mole of ethene is reacted with excess $\text{Br}_2(\text{aq})$ in the presence of ultraviolet light until there is no further reaction. Determine the number of moles of bromine consumed in the reaction.

- (a) 1.0 mol of $\text{Br}_2(\text{aq})$ is consumed.
- (b) 2.0 mol of $\text{Br}_2(\text{aq})$ is consumed.
- (c) 3.0 mol of $\text{Br}_2(\text{aq})$ is consumed.
- (d) 5.0 mol of $\text{Br}_2(\text{aq})$ is consumed.

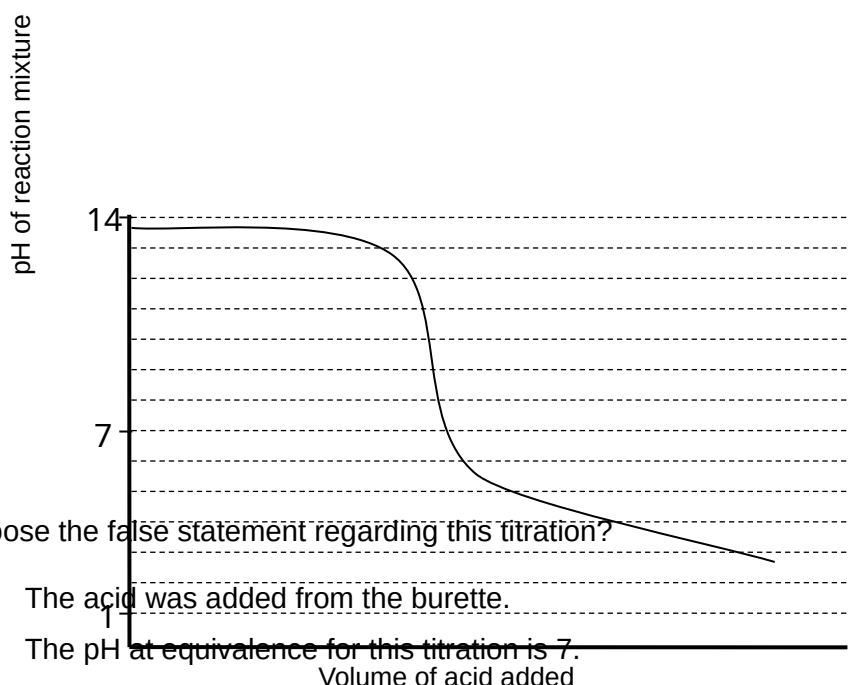
DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

19. When carbon dioxide gas is dissolved in water, the following equilibrium occurs.



If this solution is heated in an open beaker then carbon dioxide gas escapes. Which of the following occurs when this solution is heated?

- (a) The pH increases.
 - (b) The $\text{H}_2\text{O}(\text{l})$ concentration increases.
 - (c) The hydrogen carbonate ion concentration increases.
 - (d) The equilibrium position is unaffected
20. A student performed an acid base titration while monitoring the pH of the reaction mixture in the conical flask. The following graph shows the change in pH during the titration?



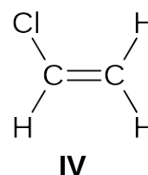
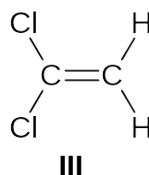
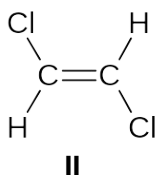
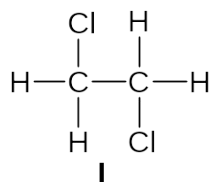
Choose the false statement regarding this titration?

- (a) The acid was added from the burette.
 - (b) The pH at equivalence for this titration is 7.
 - (c) The end point could be found using an indicator like phenolphthalein.
 - (d) At equivalence the solution could contain an ion like the ethanoate ion
21. A 1.0 L solution contains 1.0 mol of NaH_2PO_4 and 1.0 mol of Na_2HPO_4 . Which of the following equations best accounts for what happens when approximately 0.1 mol of hydrochloric acid is added to this solution
- (a) $\text{H}^+(\text{aq}) + \text{H}_2\text{PO}_4^-(\text{aq}) \rightleftharpoons \text{H}_3\text{PO}_4(\text{aq})$
 - (b) $\text{H}^+(\text{aq}) + \text{HPO}_4^{2-}(\text{aq}) \rightleftharpoons \text{H}_2\text{PO}_4^-(\text{aq})$
 - (c) $2\text{H}^+(\text{aq}) + \text{HPO}_4^{2-}(\text{aq}) \rightleftharpoons \text{H}_3\text{PO}_4(\text{aq})$
 - (d) a, b and c are equally valid.

22. The compound $C_4H_{10}O$ has many isomers. How many of these are alcohols?

- (a) 3
- (b) 4
- (c) 5
- (d) 6

23. Which of the following compounds are capable of geometric isomerism?

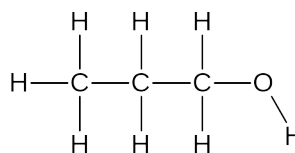
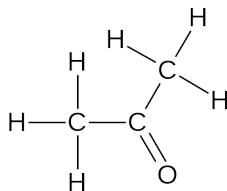
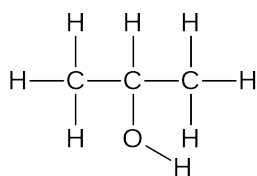


- (a) I, II, III, and IV
- (b) II, III, and IV only
- (c) II and III only
- (d) II only

24. Propanol is heated along with butanoic acid and sulfuric acid. What type of reaction occurs and what is the major organic product formed in this mixture?

- | Reaction type | Major organic product |
|--------------------|-----------------------|
| (a) redox | propanal |
| (b) redox | propanoic acid |
| (c) esterification | propyl butanoate |
| (d) esterification | butyl propanoate |

25. The four substances shown here have similar molar masses.



Choose the alternative showing these in order of increasing boiling point, ie lowest to highest.

- (a) $A < B < C$
- (b) A same as $C < B$
- (c) $B < A$ same as C
- (d) $B < A < C$

Section Two: Short answer**35% (70 Marks)**

This section has **11** questions. Answer **all** questions. Write your answers in the spaces 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: 60 minutes.

Question 26**[8 marks]**

Write ionic equations and observations for any reactions that occur in the following situations. In each case describe in full what you would observe, including any colours, odours, precipitates (state the colour) and gases evolved (state the colour or describe as colourless). If no change is observed, you should write "no visible change".

(a) Nickel(II) nitrate solution is added to excess sodium phosphate solution.

Equation**(2 marks)****Observation****(2 marks)**

(b) Acidified potassium dichromate solution reacted with oxalic acid ($\text{H}_2\text{C}_2\text{O}_4$) to produce chromium (III) ions, carbon dioxide and water.

Equation**(2 marks)****Observation****(2 marks)****SEE NEXT PAGE**

Question 27**[4 marks]**

Most buffers consist of a solution of a weak acid and its corresponding conjugate base. A solution of potassium hydrogen phosphate (K_2HPO_4) is unusual as it is capable of buffering on its own and is responsible for buffering the cytoplasm of living cells. Use the example of potassium hydrogen phosphate to explain the concept of buffering in aqueous solutions. Include appropriate equations to support your answer.

Question 28**[6 marks]**

The alcoholic beverage wine contains the active ingredient ethanol, $\text{CH}_3\text{CH}_2\text{OH}$. When left exposed to air for long periods the alcohol in wine will become oxidised. This will give the wine an unpleasant taste.

- (a) Given that most wines are slightly acidic, write the **reduction** half equation involved in the oxidation of wine. (2 marks)

- (b) When the alcohol in wine becomes oxidised it may result in one of two different products. Write oxidation half equations showing the formation of each of these products. (3 marks)

- (c) Red wine vinegar is produced by the action of bacteria on red wine. What is the probable role of bacteria in this process? (1 mark)

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

Question 29**[4 marks]**

Explain, with the aid of a **diagram**, how a non-polar hydrocarbon like oil is able to be dissolved in soapy water.

Question 30**[9 marks]**

Complete the table below by giving a brief description of a **chemical test** that could be used to distinguish between the substances listed. List the observations relating to the test for each of the substances.

Substances to be distinguished	Description of chemical test	Observation with Substance 1	Observation with Substance 2
Substance 1 propane Substance 2 2- methyl-2- propanol			
Substance 1 potassium sulfate solution Substance 2 sodium hydroxide solution			
Substance 1 propanone Substance 2 propan-2-ol			

SEE NEXT PAGE

Question 31**[5 marks]**

(a) Write the electronic configuration of a sodium atom and a magnesium atom. (1 mark)

Sodium _____ Magnesium _____

The first five ionisation energies of sodium and magnesium in MJ mol⁻¹ are shown below:

Ionisation	1 st	2 nd	3 rd	4 th	5 th
Sodium	0.502	4.569	6.919	9.550	13.356
Magnesium	0.744	1.457	7.739	10.547	13.636

(b) Account for the difference in the 1st ionisation energies of sodium and magnesium? (2 marks)

(c) Account for the difference in the 2nd ionisation energies of sodium and magnesium? (2 marks)

Question 32**[4 marks]**

Draw complete structural formula for the substances being described.

(a) an alpha amino acid with four carbon atoms (1 mark)

(b) the compound propyl ethanoate (1 mark)

(c) the cis isomer of C₃H₅F (1 mark)

(d) the compound 2-hydroxy hexanoic acid (1 mark)

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

Question 33**[11 marks]**

Complete the following table showing the Lewis structure (electron dot diagram), shape, molecular polarity and name the shape for the three species listed.

Cl_2CO	F_2CH_2	SO_4^{2-}
Lewis structure	Lewis structure	Lewis structure
Sketch shape	Sketch shape	Sketch shape
Name shape	Name shape	Name shape
Polarity	Polarity	

Question 34**[7 marks]**

(a) Give the IUPAC name for the following compounds and rank them according to their boiling point. In the table write "1" for the compound with the highest boiling point, down to "4" for the compound with the lowest boiling point. (4 marks)

Compound	Molar mass g mol^{-1}	IUPAC name (2 marks)	Boiling points (1=highest, 4=lowest) (2 marks)
$\text{CH}_3\text{CH}_2\text{COOH}$	74.1		
$\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)_2$	72.1		
$\text{CH}_3\text{CHOHCH}_2\text{CH}_3$	74.1		
$\text{CH}_3\text{COCH}_2\text{CH}_3$	72.1		

- (b) How would the boiling point of the compound propan-2-amine compare with that of $\text{CH}_3\text{CH}_2\text{CH}_3$. Support your answer with reference to intermolecular forces. (3 marks)

Question 35**[6 marks]**

The atomic radii of some of the elements in groups 1-17 of the Periodic Table are shown in the table below. The values are given in nanometres (nm), some radii have been omitted.

Group	1	2	13	14	15	16	17
Period 2 element	Li	Be	B	C	N	O	F
atomic radius in nm	0.134	0.125	0.090	0.077	0.075	0.073	
Period 3 element	Na	Mg	Al	Si	P	S	Cl
atomic radius in nm							

- (a)(i) Describe the trend shown in atomic radius across period 2. (1 mark)

- (ii) Account for this trend in terms of atomic structure. (3 marks)

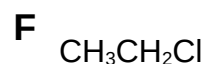
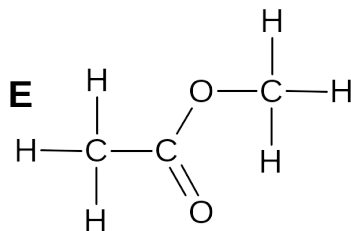
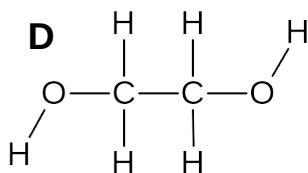
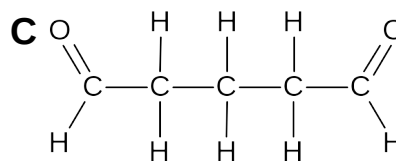
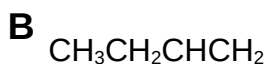
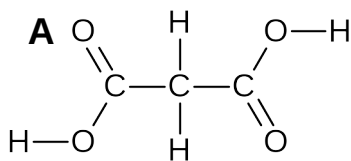
- (b) Mendeleev studied periodic data to make predictions for the properties of elements which had yet to be discovered. Using your knowledge of periodic trends and the data above, estimate values for the atomic radius of: (2 marks)

(i) F _____ (ii) S _____

SEE NEXT PAGE

Question 36**[6 marks]**

A variety of organic compounds, labeled A to F are shown here. Use these compounds to answer the following.



- (a) Using any of the above molecules as monomer(s) draw a structural diagram for a section of a condensation polymer molecule. Your diagram should have two complete repeating units. State the molecule(s) chosen as monomer(s). (3 marks)

- (b) Using any of the above molecules as monomer(s) draw a structural diagram for a section of an addition polymer molecule. Your diagram should have three complete repeating units. State the molecule(s) chosen as monomer(s). (3 marks)

Section Three: Extended answer**40% (80 Marks)**

This section contains **seven (7)** questions. You must answer **all** questions. Write your answers in the spaces provided.

Where questions require an explanation and/or description, marks are awarded for the relevant chemical content and also for coherence and clarity of expression.

Final answers to calculations should be expressed to **three (3)** significant figures and include appropriate units.

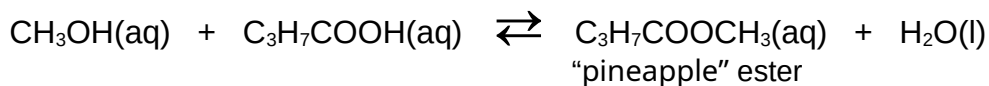
Spare pages are included at the end of this booklet. They can be used for planning your responses and/or as additional space if required to continue an answer.

- 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: 70 minutes.

Question 37**[11 marks]**

Esters are the basis of many naturally occurring odours and are therefore widely used in the creation of artificial flavours. The particular ester shown below is a major component that contributes to the smell of pineapple. A manufacturer wishes to produce this compound as a food additive. The reaction involved is shown:



In a trial procedure to produce this ester a chemist uses 3.40 kg sample of methanol with excess butanoic acid. The methanol used is only 88.5% pure as it contains water which is extremely soluble in methanol and is difficult to remove.

(a) Name the "pineapple" ester. _____ (1 mark)

(b) Explain with the aid of a diagram why water is extremely soluble in methanol. (2 marks)

SEE NEXT PAGE

(c) What maximum mass of ester can the chemist expect?

(4 marks)

(d) On completion of the procedure and extraction of the ester in (c) the chemist found the process had a yield of 68.5%. What mass of ester was actually produced? (2 marks)

(e) What does the yield of this reaction suggest about the equilibrium constant for the reaction? (2 marks)

SEE NEXT PAGE

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

Question 38**[14 marks]**

The fuel methanol can be manufactured using an equilibrium reaction that is **exothermic** and involving 91 kJ per mole of CH_3OH produced. The reaction is operated by passing a mixture of hydrogen gas and carbon monoxide gas over a mixture of copper, zinc oxide, and alumina. The process is operated at a pressure of 50-100 atm and a temperature of 250 °C.

(a) (i) Use all of this information to write a balanced chemical equation for the manufacture of CH_3OH . (2 marks)

(ii) What is the purpose of the mixture of copper, zinc oxide, and alumina?

(1 marks)

(b) Conducting the synthesis of methanol at a high pressure has several advantages, state two advantages of producing methanol this way and use your knowledge of chemical principles to support your answer. (6 marks)

Advantage 1: _____

Explanation based on chemical principles: _____

Advantage 2: _____

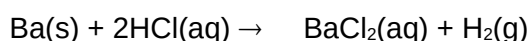
Explanation based on chemical principles: _____

- (c) Based on chemical principles alone, pressures well above 300 atm would be even more advantageous. Suggest why such higher pressures are not used. (1 mark)

- (d) The chosen temperature of 250°C may be something of a compromise. Explain what this means. (3 marks)

Question 39**[11 marks]**

A student carried out an experiment with some barium and a hydrochloric acid solution. In this experiment, the student added a granule of barium with a mass of 0.859 g to a conical flask containing 85.5 mL of 0.0951 mol L⁻¹ hydrochloric acid. This resulted in the formation of hydrogen gas as shown here.



- (a) What was the pH of the solution in the flask prior to adding the barium granule? (2 marks)

(b) Determine the number of moles of barium and hydrochloric acid initially present in the flask. (2 marks)

(c) How many moles of hydrogen gas could be expected from this experiment? (2 marks)

(d) Calculate the volume of H_2 gas that would be expected if the gas were collected at 28.0°C and 104 kPa . (2 mark)

(e) The student repeated this experiment using a granule of calcium of similar dimensions to the granule of barium.

(i) What difference would you expect in reaction rate? (1 mark)

(ii) Explain your answer to (i). (2 marks)

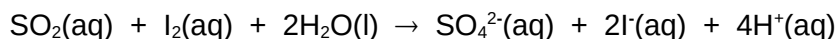
SEE NEXT PAGE

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

Question 40**[13 marks]**

Wines often contain a small amount of sulfur dioxide that is added as a preservative. The amount of sulfur dioxide added needs to be carefully calculated; too little and the wine goes bad; too much and the wine tastes of sulfur dioxide.

The sulfur dioxide content of a wine can be tested by titration with an aqueous iodine solution, $I_2(aq)$. The reaction involved is shown here:



- (a) What species is oxidised in this reaction? Support your answer with an explanation. (2 marks)

Species that has been oxidised _____

Explanation: _____

- (b) Suggest how the end point of this titration might be observed. You may assume the wine is almost colourless and that the iodine solution is added from the burette. (2 marks)

- (c) What problem would you encounter by having the $I_2(aq)$ solution in the burette? (2 marks)

- (d) The sulfur dioxide content of a white wine sample was found by titration with iodine. In this procedure a laboratory technician measured 50.0 mL of white wine and diluted this to 250.0 mL. She then titrated 20.0 mL samples of the diluted wine with 0.00215 mol L⁻¹ aqueous iodine, I₂(aq). On average 16.40 mL of iodine solution was needed for equivalence. Determine the concentration of sulfur dioxide in the original wine sample in mol L⁻¹. (4 marks)

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

- (e) The generally accepted maximum concentration of sulfur dioxide in wine is 0.25 g L⁻¹. Higher concentrations will make the wine taste unpleasant and concentrations less than 0.01 g L⁻¹ are insufficient to preserve the wine. Comment on the effectiveness of the sulfur dioxide in the wine analysed in (d). (3 marks)

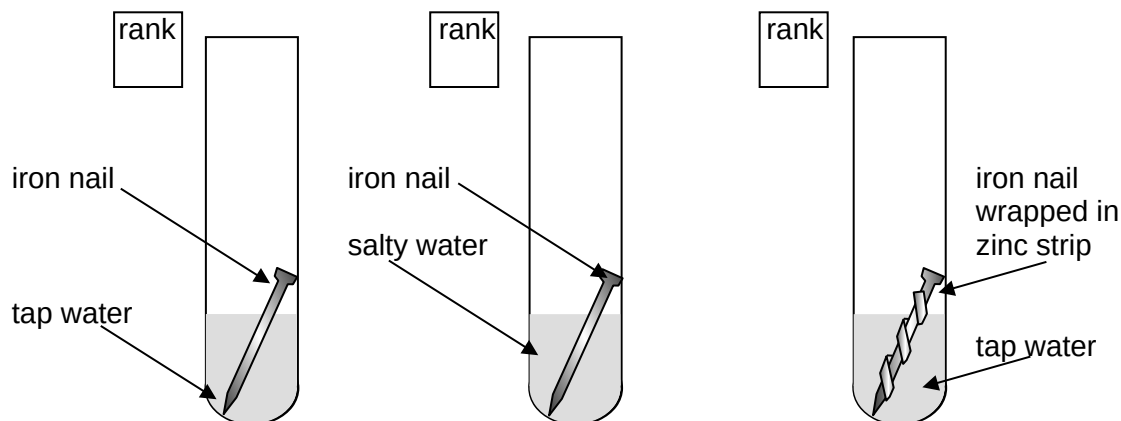
Question 41**[9 marks]**

Dioxin is a dangerous pollutant that needs to be closely monitored in our food and the environment. The formula of dioxin is $C_{12}H_4O_2Cl_4$. On combustion, the chlorine in dioxin is completely converted into hydrogen chloride gas. An impure sample of dioxin with a mass of 3.600g was burnt in oxygen. The hydrogen chloride produced was bubbled through 50.00 mL of 1.030 mol L^{-1} potassium hydroxide solution. The resulting solution was titrated with a standard solution of 0.500 mol L^{-1} sulfuric acid. End point was achieved using 23.65 mL of the sulfuric acid solution. Calculate the percentage, by mass, of dioxin in the impure sample.

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

Question 42**[13 marks]**

The corrosion of iron is a redox process that causes iron and steel structures to decay and become degraded over time. In an investigation into the corrosion process a student placed some iron nails into a variety of different environments and observed the extent of corrosion that occurred. He compared the extent of corrosion by looking for the amount of orange/brown deposit that formed in the test tubes.



(a) What is the likely chemical composition of the orange/brown precipitate? (2 marks)

(b) Rank the three tubes 1 (the most corrosion) to 3 (the least corrosion). Place your ranking in the boxes above. (2 marks)

(c) Explain how the zinc strip and iron nail used above could be arranged to make an electrochemical cell that would produce an electric current. You can use any of the glassware usually available in a school laboratory. If you are using any other reagents to produce your cell you should note this. Include a labelled diagram of your electrochemical cell and give a detailed description of how it operates. (9 marks)

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

SEE NEXT PAGE

Question 43**[9 marks]**

A 3.210 g sample of an organic compound containing the elements carbon, hydrogen and chlorine only is burnt in air. All of the water produced during the compounds combustion was absorbed by bubbling the gas mixture of combustion products through some pure sulfuric acid. The resulting sulfuric acid mixture increases in mass by 0.6446 g.

(a) What is the mass of hydrogen in the sample of organic compound? (2 marks)

The remaining products of combustion are then passed through a sodium hydroxide solution, thus absorbing any carbon dioxide present as sodium carbonate. Addition of excess calcium nitrate solution yields a precipitate of calcium carbonate. When washed and dried the resulting calcium carbonate was found to have a mass of 4.810 g.

(b) Determine the mass of carbon in the sample of organic compound. (2 marks)

(c) Determine the organic compound's empirical formula. (4 marks)

(d) Draw a possible structure for the compound (1 marks)

(e) Name the compound (1 marks)

END OF PAPER :)**SEE NEXT PAGE**

Additional working space

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

Additional working space

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF