Name Register Number: Class

For Marker's Use

南僑中學

NAN CHIAU HIGH SCHOOL

PRELIMINARY EXAMINATION 3 2015
SECONDARY FOUR EXPRESS

CHEMISTRY **5073/01**

Paper 1 Multiple Choice **16 Sep 2015, Wednesday**

1 hour

Candidates answer on the OTAS

INSTRUCTIONS TO CANDIDATES
Write your name, register number and class on the OTAS in the spaces provided and also in this question booklet.

There are **forty** questions in this paper Answer all questions. For each question, there are four possible answers, **A, B, C** and **D** Choose the one you consider correct and record your choice in **soft pencil** on the OTAS

Read very carefully the instructions on the OTAS.

INFORMATION FOR CANDIDATES
Each correct answer will score one mark. A mark will not be deducted for a wrong answer Any rough working should be done on the question paper

The use of an approved scientific calculator is expected, where appropriate.

A copy of the Periodic Table is printed on page 13.

Setter: Mr Tien Chee Wai

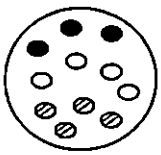
This paper consists of 13 printed pages including the coverpage.

1 The table below shows a list of elements and the symbols for their atoms.

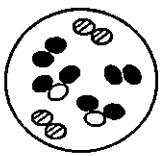
element	symbol for atom
hydrogen	●
oxygen	○
krypton	⊘

Which diagram best shows the arrangement of a mixture of hydrogen, steam and krypton gas in a balloon?

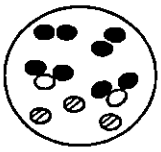
A



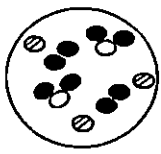
C



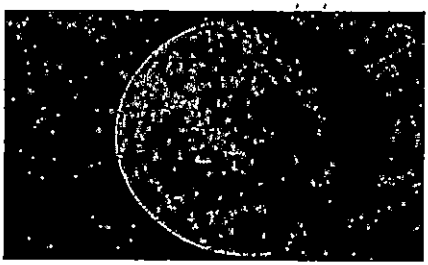
B



D

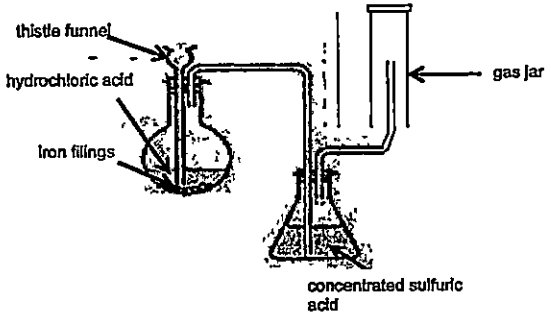


2 The sun-lit side of the planet Mercury has a temperature of 427°C. The dark or night side of the planet has a temperature of -180°C. Which substance may be found on one side of Mercury as a liquid and on the other side as a solid?



	substance	melting point/°C	boiling point/°C
A	oxygen	-219	-183
B	phosphorus	44	280
C	ethane	-183	-87
D	sulfur	115	445

3 The experimental set-up shown below is used to collect the gaseous product of the reaction between iron filings and dilute hydrochloric acid



Which of the following statements about the experimental set-up is **Incorrect**?

- **A** Concentrated sulfuric acid acts as the drying agent.
- **B** The gas jar is inverted to collect a gas that is of low density.
- **C** The iron filings can be replaced with magnesium to produce the same gas.
- **D** It is not necessary to ensure that the end of the thistle funnel is immersed in the hydrochloric acid

4 Which of the following mixtures would be best separated using fractional distillation?

- **A** butane and water
- **B** butanol and water
- **C** ethyl ethanoate and water
- **D** barium carbonate and water

5 You are asked to separate a suspension of silver chloride in a solution of potassium chloride and ammonium chloride so as to obtain all three substances To do this, the following processes can be used: evaporation, filtration and sublimation. In which order should you carry out these processes?

- **A** sublimation, filtration, evaporation
- **B** sublimation, evaporation, filtration
- **C** filtration, evaporation, sublimation
- **D** filtration, sublimation, evaporation

6 The formulas of two substances are given as $Co(NO_3)_2$ and $Co(NO_3)_3$ Which statement is true?

A The two substances are mixtures of cobalt, nitrogen and oxygen.
B The elements are different in the two substances
C Both substances are compounds
D The percentage of cobalt is the same in both substances

7 In an experiment, a solid X is found to melt at 121^0C, the same temperature as the melting point of benzoic acid To check the identity of the solid, some of it is mixed with pure solid benzoic acid. The melting point of the mixture is found to be 115^0C. From this, it can be deduced that X is

A a mixture.
B a pure compound
C not benzoic acid.
D impure benzoic acid

8 An ion of element X has 22 electrons and a mass number of 55 What is the charge on the ion if the number of neutrons is 30?

A +2
B -2
C +3
D -3

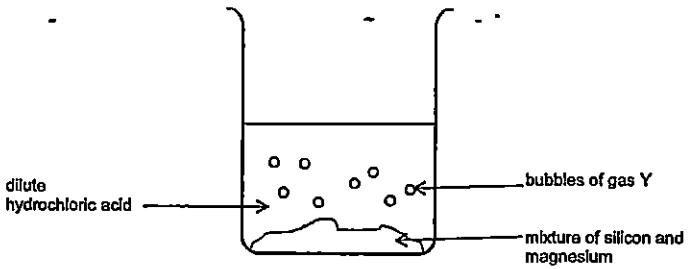
9 Selenium is a chemical element with symbol $^{79}_{34}Se$. It was discovered in 1817 and has an electronic configuration 2 8 18.6 What is the electronic configuration of the selenide ion?

A 2 8
B 2 8.18
C 2 8.18 8
D 2 8 18 2

10 Which one of the following is a compound consisting of small molecules?

A natural gas
B lithium
C heptane
D diamond

11 A mixture of silicon and magnesium was added to a beaker of excess dilute hydrochloric acid as shown in the diagram below At the end of the reaction, the mixture was filtered to obtain the silicon as residue.



Which of the following options indicates correctly the type of particles present in the substances shown in the diagram?

	magnesium	silicon	dilute hydrochloric acid	gas Y
A	ions and electrons	atoms	ions and molecules	molecules
B	atoms	molecules	ions	atoms
C	ions and electrons	molecules	ions and molecules	molecules
D	ions and electrons	atoms	ions	molecules

12 The electronic structures of elements X and Y are
X: 2 8 18.18.8 2
Y. 2 8 6
What are the likely formula and type of bonds in the compound of X and Y?

	formula	bonds
A	XY_2	ionic
B	XY	covalent
C	XY	ionic
D	XY_2	covalent

13 How many oxygen atoms does 62 5g of hydrated copper(II) sulfate, $CuSO_4\ 5H_2O$, contain?

A $6\ 00 \times 10^{23}$
B $7\ 50 \times 10^{23}$
C 1.35×10^{24}
D $5\ 40 \times 10^{24}$

14 Tritium is an isotope of hydrogen with the symbol $^{3}_{1}T$ It reacts with oxygen to form a liquid called tritiated water, T_2O
What is the mass of tritiated water produced when 3g of tritium reacts with 16g of oxygen?

A 9g
B 11g
C 22g
D 44g

15 7 15g of hydrated sodium carbonate ($Na_2CO_3\ nH_2O$) were treated with excess nitric acid to produce 600 cm^3 of carbon dioxide measured at room conditions Calculate the value of n

A 4
B 6
C 8
D 10

16 If 24g of sulfur trioxide (SO_3) contains x atoms, how many atoms (in terms of x) are there in 2.4dm^3 of carbon dioxide (CO_2), measured at r t.p.?

A 0.25x
B 0 33x
C 0.50x
D 1 00x

17 There are two acids, hydrochloric acid and ethanoic acid, of the same concentration (both 1 00mol/dm^3) Which of the following is/are suitable methods to test their strength?

I using a pH meter
II measuring their electrical conductivity
III titration using sodium hydroxide solution

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

18 Which oxide can react with hydrochloric acid as well as with lithium hydroxide?

A calcium oxide
B iron(III) oxide
C lead(II) oxide
D sulfur dioxide

19 A mixture of magnesium bromide and magnesium sulfite is known to contain 3 moles of magnesium ions and 4 moles of bromide ions How many moles of sulfite ions are present?

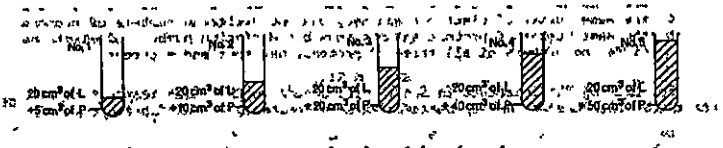
A 1
B 2
C 3
D 4

20 Tartaric acid is a dibasic acid and its salts are used in food The molecular formula of tartaric acid is $H_6C_4O_6$
What are the possible formulas of the salts formed by tartaric acid?

A $K_2H_4C_4O_6$ and $Al(H_3C_4O_6)_3$
B $FeH_3C_4O_6$ and $Li_2H_4C_4O_6$
C $BaH_4C_4O_6$ and $LiH_5C_4O_6$
D $NaH_5C_4O_6$ and $Na_2H_5C_4O_6$

21 When solutions of lead(II) nitrate and potassium iodide are mixed, lead(II) iodide is precipitated The equation for the reaction is as follows

$$Pb(NO_3)_2 + 2KI \longrightarrow PbI_2 + 2KNO_3$$



Different volumes of 1.0 mol/dm^3 aqueous potassium iodide (P) are added to the same volume of 0.5 mol/dm^3 aqueous lead(II) nitrate (L) in each of five test-tubes as shown above. When the precipitate settles, it is found that the amount of precipitate

A are the same in all five test-tubes
B increase stepwise from tube 1 to tube 5
C increase from tube 1 to tube 2, but are the same in tubes 2 to 5.
D increase from tube 1 to tube 3, but are the same in tubes 3 to 5

22 Disproportionation reactions occur when an element is simultaneously oxidised and reduced. The oxidation number of the element will change to both a higher value and a lower value respectively.
Which of the following named elements does not undergo disproportionation?

	element	equation of reaction
A	carbon	$H_2C_2O_4 \longrightarrow H_2O + CO + CO_2$
B	chlorine	$3ClO^- \longrightarrow ClO_3^- + 2Cl^-$
C	nitrogen	$H_2O + 2NO_2 \longrightarrow HNO_3 + HNO_2$
D	sulfur	$2FeSO_4 \longrightarrow Fe_2O_3 + SO_2 + SO_3$

23 In which of the following reactions does $Fe^{2+}(aq)$ act as a reducing agent?

A $Fe^{2+}(aq) + Mg(s) \longrightarrow Fe(s) + Mg^{2+}(aq)$
B $4Fe^{2+}(aq) + SO_3^{2-}(aq) + 6H^+(aq) \longrightarrow 4Fe^{3+}(aq) + S(s) + 3H_2O(l)$
C $Fe^{2+}(aq) + 2OH^-(aq) \longrightarrow Fe(OH)_2(s)$
D $Fe(s) + 2H^+(aq) \longrightarrow Fe^{2+}(aq) + H_2(g)$

24 Metal X is placed between zinc and iron in the reactivity series Which prediction can be made about metal X?

A Metal X displaces magnesium from an aqueous solution of a magnesium salt.
B Metal X reacts with dilute hydrochloric acid to produce oxygen
C Metal X forms a hydroxide which is insoluble in water.
D Metal X is extracted from its ores by electrolysis.

25 The table shows the results of adding weighed pieces of zinc metal in salt solutions of metal P, Q and R

salt solution of metal	initial mass of zinc/g	final mass of zinc after 15 minutes/g
P	6 0	0 0
Q	6 0	6 0
R	6 0	4 5

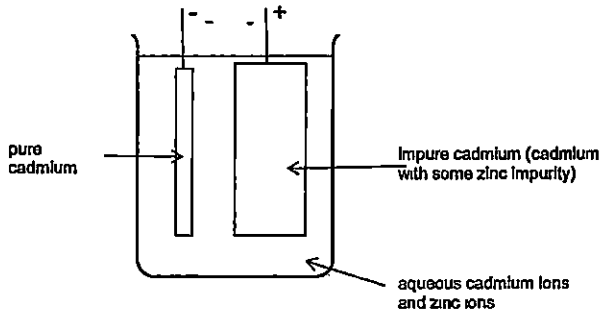
Which of the following shows the correct arrangement of metals in decreasing reactivity?

A P, R, zinc, Q
B R, P, zinc, Q
C Q, zinc, P, R
D Q, zinc, R, P

26 In an experiment, 6 moles of magnesium ions were discharged in the electrolysis of molten magnesium chloride Which amount of metal would be discharged by the same amount of electricity in the following experiments?

A 3 moles of copper(II) ions in the electrolysis of aqueous copper(II) sulfate
B 6 moles of zinc ions in the electrolysis of aqueous zinc chloride.
C 12 moles of calcium ions in the electrolysis of molten calcium fluoride.
D 12 moles of lithium ions in the electrolysis of molten lithium bromide

27 Cadmium is a metal used to make rechargeable batteries. The purification of cadmium by electrolysis is shown below. Cadmium and zinc form ions with the same electric charge



The following results were obtained from an investigation of this process

	mass of pure cadmium electrode/g	mass of impure cadmium electrode/g
at start of electrolysis	140	860
at end of electrolysis	700	260

The percentage of zinc in the impure cadmium is _____

A 6 67%
B 16 3%
C 23 3%
D 93 3%

28 Carbon and silicon are in the same group of the Periodic Table Which of the following formulas is **incorrect**?

A $CaSiO_2$
B SiH_4
C $SiCl_4$
D $HSiCl_3$

29 Astatine (At) is a member of the halogen family. It has a proton number greater than the other halogens It is expected that astatine

A is a coloured liquid at room temperature
B is the halogen with the weakest oxidizing power
C has the lowest melting point.
D is the most reactive halogen

30 Study the following equation:

$C_8H_{18} \longrightarrow C_5H_{12} + C_3H_8 \quad \Delta H = +110kJ$

Which of the following statements is correct?

A It is a substitution reaction
B The heat of combustion is 110kJ per mole of octane
C The cracking process takes in heat energy.
D The bond breaking process is exothermic

31 Methane reacts very slowly with air at room temperature But if a transition metal T is added to the methane-air mixture, the methane ignites The addition of T

I reduces the activation energy.
II increases the ΔH.
III increases the rate of reaction
IV reduces the energy of the reactants

A I and II only
B II and III only
C I and III only
D all of the above

32 Which of the following conditions will cause the highest rate of reaction between the dilute acids and zinc?

A 10g of zinc lumps and 50 cm^3 of 1mol/dm^3 HCl
B 10g of zinc powder and 50 cm^3 of 1mol/dm^3 HCl
C 10g of zinc lumps and 50 cm^3 of 0 5mol/dm^3 H_2SO_4
D 10g of zinc powder and 25 cm^3 of 1mol/dm^3 H_2SO_4

33 Potassium chlorate solution decomposes according to the equation shown:

$2KClO_3(aq) \longrightarrow 2KCl(aq) + 3O_2(g)$

If 50cm^3 of water is added to the potassium chlorate solution before the reaction begins, what effect will it have on the rate of the reaction and the volume of oxygen produced?

A Both the rate of reaction and the volume of oxygen produced will decrease.
B The rate of reaction will increase but the volume of oxygen produced will decrease
C The rate of reaction will decrease but the volume of oxygen produced will remain unchanged
D The rate of reaction will remain unchanged but the volume of oxygen produced will decrease.

34 Which fertilizer provides the most nitrogen per kg?

A NH_4NO_3
B $NaNO_3$
C $(NH_4)_3PO_4$
D $(NH_4)_2SO_4$

35 Air samples collected from the Central Expressway tunnels were analysed Which of the following substances are likely to be present in the air samples?

I CO
II C_8H_{18}
III NO_x
IV C_2H_4

A I and II
B I and III
C I, II and III
D I, II, III and IV

36 When a mixture X consisting of C_5H_{12}, C_7H_{16}, $C_{10}H_{22}$ and $C_{16}H_{34}$ undergoes fractional distillation, the fraction that is collected at the highest in the column is richer in

A C_5H_{12}
B C_7H_{16}
C $C_{10}H_{22}$
D $C_{16}H_{34}$

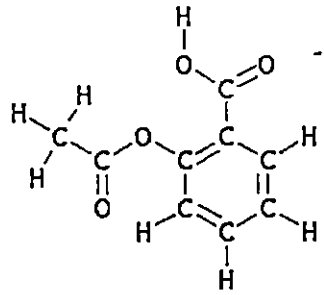
37 What is the total number of straight chain and branched chain isomers for the organic molecule pentene?

A 3
B 4
C 5
D 6

38 Which of the following statements about the alkyne series of hydrocarbons, C_nH_{2n-2} ($n \geq 2$) is true?

A The hydrocarbons are saturated.
B The relative molecular masses of successive members in the series differ by 12.
C The boiling point of alkyne decreases as n increases
D Alkynes decolourise aqueous bromine rapidly.

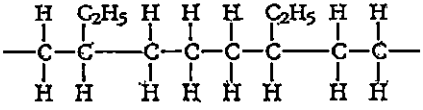
39 Aspirin is one of the most widely used pain relievers in the world It has the structure as shown



From the structure, we can deduce that aspinn

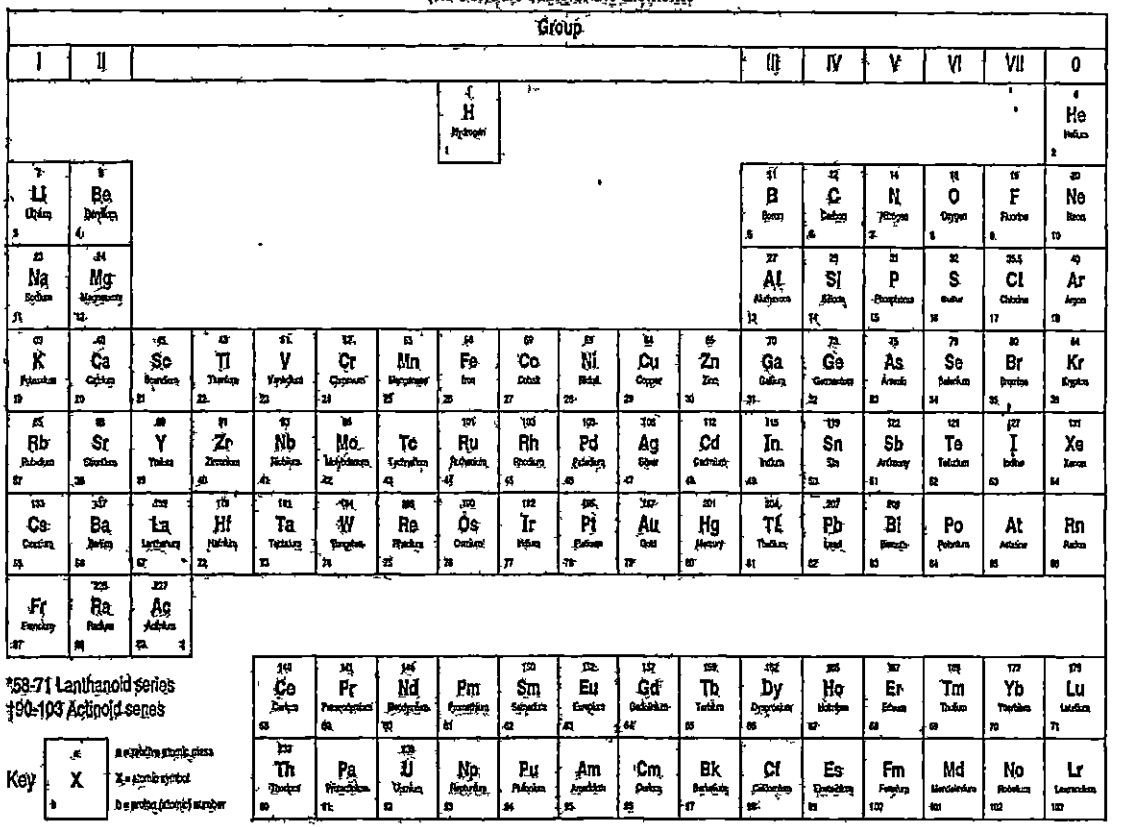
A will turn phenolphthalein pink.
B reacts with ethanoic acid to form an ester
C will produce carbon dioxide when reacted with a carbonate.
D is an unsaturated hydrocarbon

40 Part of a polymer is shown below Which pair of alkenes was used as monomers?



A ethene and propene
B propene and but-1-ene
C ethene and but-1-ene
D propene and but-2-ene

DATA SHEET
The Periodic Table of the Elements



*58-71 Lanthanoid series
†90-103 Actinoid series

Key: X — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.)

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PRELIMINARY EXAMINATION 3 2015
SECONDARY FOUR EXPRESS

CHEMISTRY **5073/02**

PAPER 2 **14 Sep 2015, Monday**

1 hour 45 minutes

Additional Materials: Answer paper (4 sheets)

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces provided on the question paper.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
The use of an approved scientific calculator is expected, where appropriate

Section A: Structured Questions [50 marks]
Answer all questions. Write your answers in the spaces provided on the question paper. All working must be shown clearly.

Section B: Data-based and Free-response Questions [30 marks]
Answer all three questions in this section. The last question is in the form of an either/or and only one of the alternatives should be attempted. Start each question on a fresh piece of paper. Fasten your answers securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total marks for this paper is **80**.
A periodic table is provided on page 14.

Setter: Mr J. Chua
Vetters: Mr Tien CW & Mrs Hay MH

Section A: Structured Questions [50m]
Answer all questions in this section in the spaces provided.

A1 Carbon has fifteen known isotopes ranging from carbon-8 to carbon-22.

a) Explain what is meant by isotopes. [1]

b) Complete the table below with the correct number of subatomic particles. [6]

Isotope	Number of protons	Number of electrons	Number of neutrons
$^{8}_{6}C$			
$^{12}_{6}C$			
$^{14}_{6}C$			

c) Carbon-14 is formed in the upper layers of the atmosphere where a free moving nitrogen atom collides with a very energetic neutron in the reaction below, giving off a particle from its nucleus.

$$^{14}N + n \longrightarrow {}^{14}C + \text{Particle } \mathbf{X}$$

i) Name particle **X.** [1]

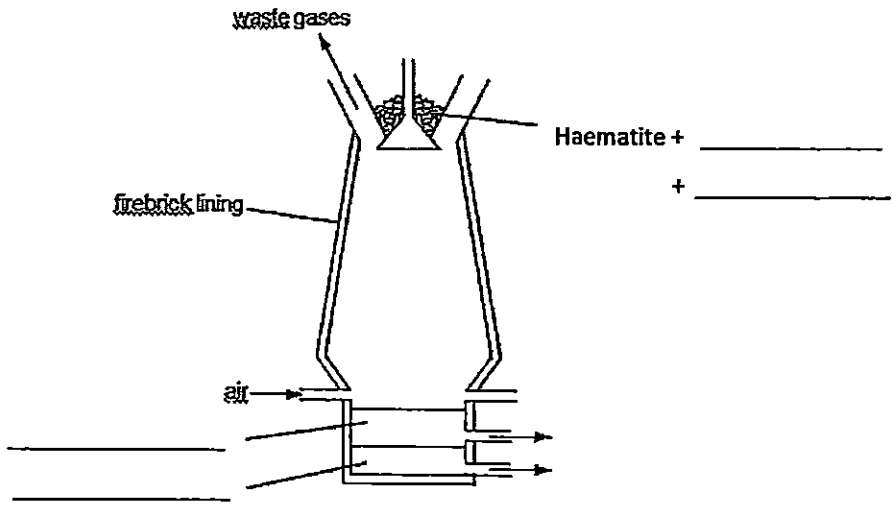
ii) Name another particle that is formed in the upper layers of the atmosphere which is responsible for the destruction of the ozone layer. [1]

d) Due to carbon's special electronic configuration, it is able to form a wide variety of compounds, both organic and inorganic, with many other elements.

i) When carbon reacts with oxygen, an inorganic compound, carbon dioxide is formed. Draw a dot-and-cross diagram for carbon dioxide, showing only the valence electrons. [2]

ii) When methane undergoes substitution reaction with chlorine, dichloromethane is formed as one of the organic products. Draw a dot-and-cross diagram for dichloromethane, showing only the valence electrons. [2]

A2 Iron is extracted from haematite ore industrially in a blast furnace as shown below.



a) Fill in the blanks in the diagram above [4]

b) Write a balanced chemical equation with state symbols for the reduction of haematite by the gases in the blast furnace. [2]

c) Assuming a yield of 65%, calculate the mass of iron that can be extracted from 10 tonnes of haematite ore. [1 tonne = 1000 kg] [2]

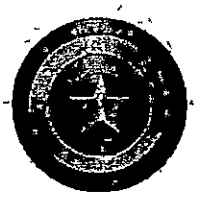
d) Due to contamination of the ore with sulfur, sulfur dioxide is often formed and released into the atmosphere with the waste gases

i) Suggest one harmful effect on the environment by releasing large amount of sulfur dioxide into the atmosphere. [1]

ii) Name a process that can remove sulfur dioxide from the waste gases and write the chemical equation for the reaction. [2]

iii) Name one other possible air pollutant that can be present in the waste gases. [1]

e) Vibranium is a fictional metal that is used to make Captain America's shield. An excerpt below explains how vibranium makes the shield almost indestructible.



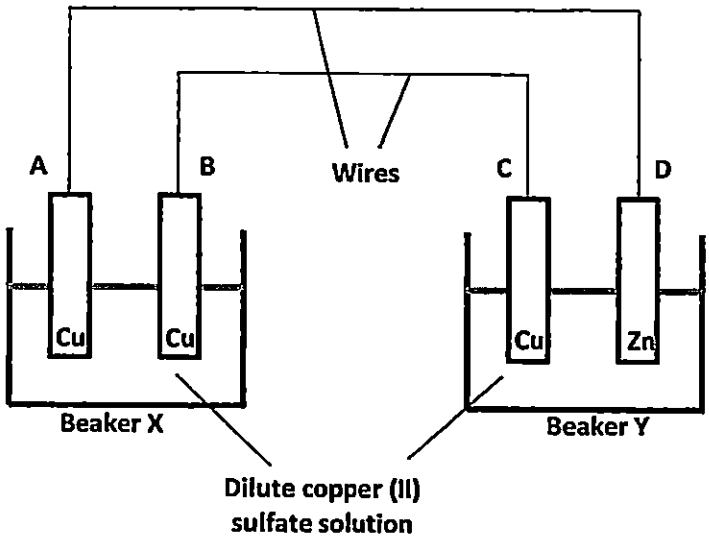
"Vibranium has the unique property to absorb all vibrations as well as kinetic energy directed at it. ***The energy absorbed is stored within the bonds between the molecules that make up the substance*** *.. Using the shield made of vibranium alloy, Captain America is able to cut through other metals ."*

i) State the wrong concept from the bolded sentence in the excerpt above and explain why it is incorrect. [2]

ii) Draw a well-labelled diagram of the likely structure of Vibranium. [3]

iii) Name an alloy that can also be used for the same function as Vibranium as mentioned in the excerpt. [1]

A3 Beaverina sets up the following circuit using different metals as electrodes in an investigation.



a) Suggest which beaker is functioning as the simple cell in the set-up above. [1]

b) Draw arrows on both wires to show the flow of electrons in the circuit above. [1]

c) Complete the table below to predict the observations made. [4]

Location	Observations
Electrode A	
Electrode B	
Electrolyte in X	
Electrolyte in Y	

d) Write the equation for the reaction occurring at electrode B. [1]

e) Predict one change to the observation made at electrode A, if any, when the zinc electrode is replaced by a magnesium electrode. [1]

A4 Sodium sulfite (Na_2SO_3) is often added to preserve food. The amount of sodium sulfite in a piece of meat can be determined through a series of tests shown below.

Step 1: Boil the meat with hydrochloric acid to form sodium chloride, water and sulfur dioxide.

Step 2: Collect gas produced and bubble it through 100 cm^3 of water to dissolve sulfur dioxide.

Step 3: Titrate the solution obtained against iodine according to the following reaction.

$$SO_2\,(aq) + 2H_2O\,(l) + I_2\,(aq) \longrightarrow 4H^+\,(aq) + SO_4^{2-}\,(aq) + 2I^-\,(aq)$$

a) Write a balanced chemical equation for the reaction in Step 1. [1]

b) Describe a chemical test to determine if there is any sulfur dioxide present after the gas has been bubbled through water in Step 2. [2]

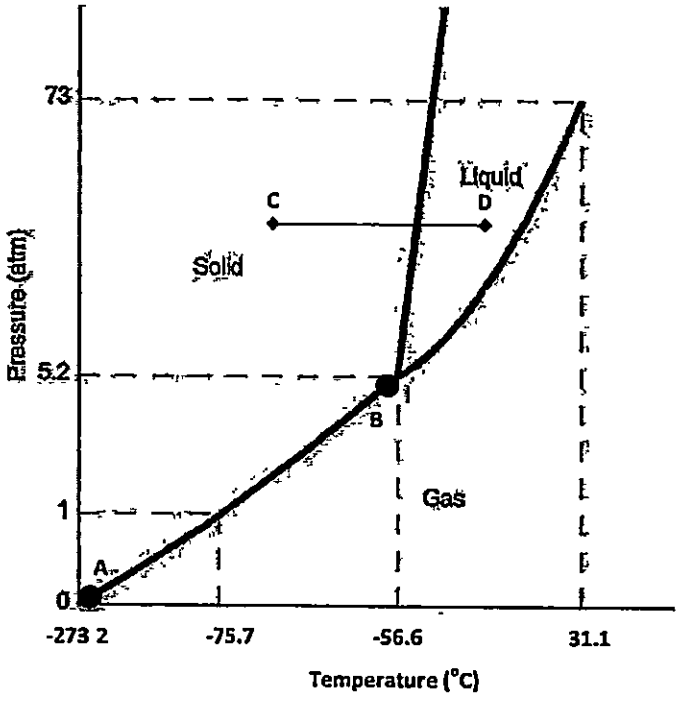
c) It was noted that 12.00 cm^3 of 0.0250 mol/dm^3 of iodine was required for complete reaction in the titration.

i) Calculate the volume of SO_2 produced in Step 2. [2]

ii) Explain, using oxidation states, why the titration in Step 3 involves a redox reaction. [2]

A5 Phase diagram is a chart which shows the physical states of a substance at various temperature and pressure. The chart is divided into regions where the substance exists as a solid, liquid or gas.

The bolded lines in the diagram that separate the regions are known as phase boundaries, where the substance changes from one state to another. Shown below is a phase diagram of carbon dioxide and some of its physical states at various pressure and temperature.



Pressure /atm	Temperature /°C	Physical state
1.0	30.0	Gas
5.0	-70.0	Solid
70	0.0	Liquid

a) Carbon dioxide is being stored under a pressure of 1 atm. Suggest the temperature that it should be kept at such that it is in a solid state. [1]

b) Name the physical process that occurs along the phase boundary from point **A** to point **B**. [1]

c) Using the idea of kinetic particle theory, state what happens to the arrangement and movement of the particles of carbon dioxide when it is heated from point **C** to **D** under constant pressure [2]

Section B: Essay Question [30m]

Answer all three questions in this section. The last question is in the form of an either/or and only one of the alternatives should be attempted.
Begin each question on a ***fresh page*** *with its question number clearly written.*

B6) Although solids of ionic compounds are generally known to be soluble in water, some ionic solids such as calcium hydroxide or silver sulfate are only sparingly soluble (soluble to a small extent) in water.

The solubility of ionic compounds depends on two factors.

- The forces of attraction between the water molecules and the ions of the solid.
- The forces of attraction between the cations and anions of the solid.

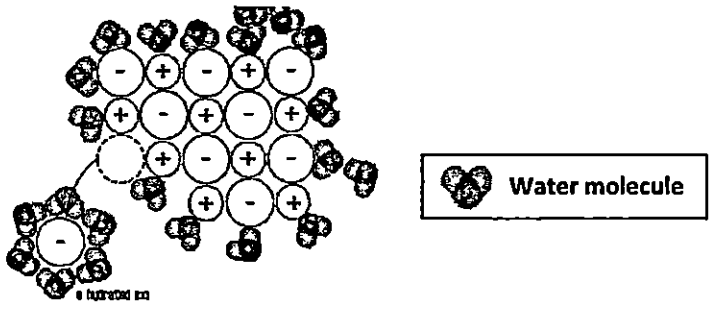


Fig 1: Dissolving of ionic compound in water

The solubility of sparingly soluble ionic compounds can be estimated from its solubility product, K_{sp}, which is a constant value that is only affected by temperature. The higher the K_{sp} value, the more soluble the compound will be.

The table below shows the K_{sp} values of some common ionic compounds.

Compound	Chemical Formula	K_{sp} (mol^2/dm^6) at 25°C
Barium sulfate	$BaSO_4$	1.0×10^{-10}
Calcium carbonate	$CaCO_3$	5.0×10^{-9}
Calcium sulfate	$CaSO_4$	2.0×10^{-5}
Silver chloride	AgCl	2.0×10^{-10}

Table 1

Predicting precipitation

The K_{sp} value can be used to predict whether precipitation of a certain compound will occur when two solutions are mixed together. The ionic product of the concentration of cations and anions present in the mixed solution is compared to the K_{sp} value. For instance,

$$BaSO_4 \rightleftharpoons Ba^{2+} + SO_4^{2-}$$

Ionic product = (Concentration of Ba^{2+} ions in solution) x (Concentration of SO_4^{2-} in solution)

Scenario	Outcome
Ionic product = K_{sp}	No precipitation. Solution is just saturated.
Ionic product < K_{sp}	No precipitation. Solution is not saturated.
Ionic product > K_{sp}	Precipitation is observed. Solution is already saturated.

Table 2

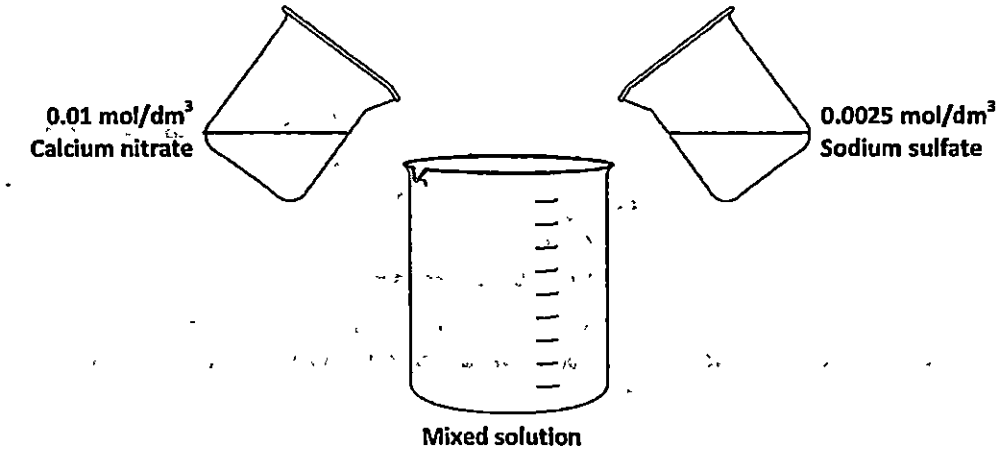
a) Using information from above, explain why sodium chloride is very soluble in water while silver chloride is only sparingly soluble. [2]

b) Predict the relationship between temperature and K_{sp} value of an ionic compound. [1]

c) State the least soluble compound found in **table 1**. [1]

d) Suggest the name of another ionic compound not present in **table 1** that has a very low K_{sp} value [1]

e) Michelle plans to add equal volume of 0.01 mol/dm^3 of calcium nitrate solution to 0.0025 mol/dm^3 of sodium sulfate solution to precipitate out calcium sulfate salt as shown in the diagram below.

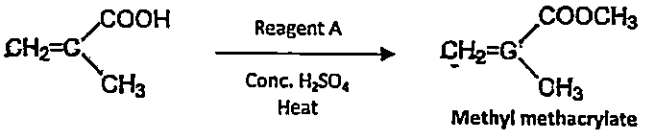


Determine, by calculation of ionic product in the mixed solution, and with reference to **table 1** and **2**, if precipitation of any compound will occur. [3]

f) Without further addition of any reagent, suggest two ways of increasing the amount of solid precipitated out from a saturated solution. [2]

B7) Perspex, also known as acrylic, is a transparent thermoplastic that is made from the polymerisation of a monomer, methyl methacrylate.

The process below shows part of the production process of methyl methacrylate.



Methyl methacrylate

a) Name reagent A. [1]

b) State the type of polymerisation that methyl methacrylate undergoes and the chemical name of perspex. [2]

c) Draw two repeating units in the polymer perspex. [2]

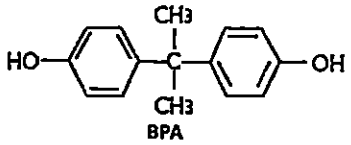
d) Aqueous bromine solution is added to perspex.

i) State the observation made. [1]

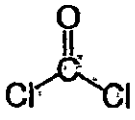
ii) State one conclusion, based on the observation in part di), about perspex. [2]

e) Another type of transparent thermoplastic, polycarbonates, is used to make spectacle lens due to its high strength and ability to block UV light.

Polycarbonate is formed by condensation polymerisation where small molecules of HCl are removed as the polymerisation takes place. The two monomers of polycarbonates are shown below.



BPA



Phosgene

Draw the structure of polycarbonate. [2]

f) State one difference between the polymerisation process of perspex and polycarbonate other than the elimination of small molecules in polycarbonate. [1]

EITHER

B8) The table shows the arrangement of elements made by John Newlands in 1886.

ROW						
1	H	F	Cl	Co, Ni	Br	___
2	Li	Na	K	Cu	Rb	___
3	Be	Mg	Ca	Zn	Sr	___
4	B	Al	Cr	Y		
5	C	Si	Ti	In		
6	N	P	Mn	As		
7	O	S	Fe	Sc		

a) The elements are arranged in vertical column according to their relative atomic masses. State how the elements are arranged in the modern Periodic Table. [1]

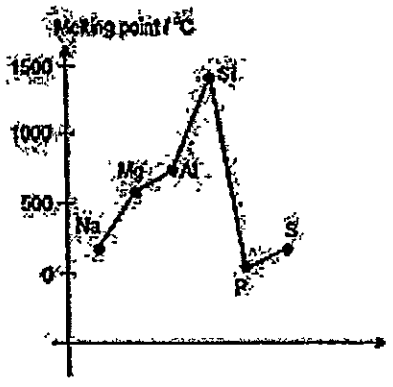
b) Based on the arrangement, determine the first three elements in the last column. List the elements in the order from the top to the bottom. [1]

c) With reference to the elements in the second horizontal row,

i) State which element is wrongly placed and what the new classification of that element in modern Periodic Table? [1]

ii) Explain your answer in **part cI)** using the chemical reaction of the elements with water. Write a suitable chemical equation to support your answer. [3]

d) The graph below shows the melting point of the elements in the second column of Newlands table with the exclusion of fluorine.

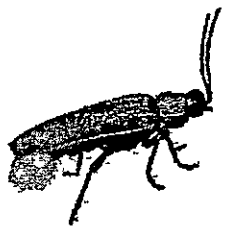


i) Explain why melting point increases from sodium to aluminium in the graph. [2]

ii) Even though silicon, phosphorus and sulfur are all covalent substances, silicon's melting point is far apart from that of phosphorus and sulfur. Explain why this is so. [2]

OR

B8) In the past 60 years, scientists have discovered that a chemical reaction between a naturally occurring chemical called luciferin, together with oxygen, calcium or magnesium, is responsible for the glowing of fireflies. The structural formula of a molecule of luciferin is shown below.



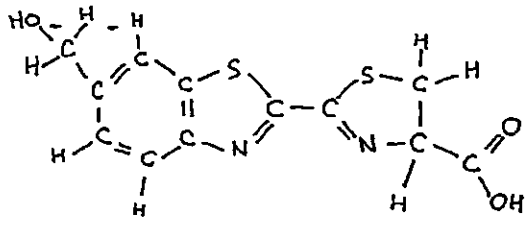


Fig 2: Structural formula of Luciferin

a) State the molecular formula of Luciferin. [1]

b) Calculate the percentage by mass of sulfur in a molecule of Luciferin. [1]

c) A series of chemical tests are performed on a sample of Luciferin.
(i) Suggest the observations for each of the test.
Test 1: Addition of acidified potassium dichromate (VI).
Test 2. Addition of aqueous sodium hydrogen carbonate. [2]

(ii) Draw the full structural formula of the organic product formed in test 1. [1]

d) It is often thought that the production of light by fireflies occurs via the following pathway catalysed by an enzyme luciferase.

$$\text{Luciferin} + O_2 \xrightarrow{\textit{Luciferase}} \text{Oxyluciferin} + CO_2 + \text{Light}$$

(i) State, with reasons, whether the oxidation of Luciferin is an exothermic or endothermic reaction. [1]

(ii) Define what is meant by an enzyme. [1]

(iii) Draw a well-labelled energy profile diagram for the oxidation of Luciferin, clearly showing the pathways for the catalysed and non-catalysed reactions. [3]

~~End of paper~~~

☺ What in the world isn't Chemistry? ☺

The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 0
											1 H hydrogen 1						4 He helium 2
7 Li lithium 3	9 Be beryllium 4											11 B boron 5	12 C carbon 6	14 N nitrogen 7	16 O oxygen 8	19 F fluorine 9	20 Ne neon 10
23 Na sodium 11	24 Mg magnesium 12											27 Al aluminium 13	28 Si silicon 14	31 P phosphorus 15	32 S sulfur 16	35.5 Cl chlorine 17	40 Ar argon 18
39 K potassium 19	40 Ca calcium 20	45 Sc scandium 21	48 Ti titanium 22	51 V vanadium 23	52 Cr chromium 24	55 Mn manganese 25	56 Fe iron 26	59 Co cobalt 27	59 Ni nickel 28	64 Cu copper 29	65 Zn zinc 30	70 Ga gallium 31	73 Ge germanium 32	75 As arsenic 33	79 Se selenium 34	80 Br bromine 35	84 Kr krypton 36
85 Rb rubidium 37	88 Sr strontium 38	89 Y yttrium 39	91 Zr zirconium 40	93 Nb niobium 41	96 Mo molybdenum 42	– Tc technetium 43	101 Ru ruthenium 44	103 Rh rhodium 45	106 Pd palladium 46	108 Ag silver 47	112 Cd cadmium 48	115 In indium 49	119 Sn tin 50	122 Sb antimony 51	128 Te tellurium 52	127 I iodine 53	131 Xe xenon 54
133 Cs caesium 55	137 Ba barium 56	139 La lanthanum 57 *	178 Hf hafnium 72	181 Ta tantalum 73	184 W tungsten 74	186 Re rhenium 75	190 Os osmium 76	192 Ir iridium 77	195 Pt platinum 78	197 Au gold 79	201 Hg mercury 80	204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	– Po polonium 84	– At astatine 85	– Rn radon 86
– Fr francium 87	– Ra radium 88	– Ac actinium 89 †															

*58-71 Lanthanoid series
†90-103 Actinoid series

140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	– Pm promethium 61	150 Sm samarium 62	152 Eu europium 63	157 Gd gadolinium 64	159 Tb terbium 65	162 Dy dysprosium 66	165 Ho holmium 67	167 Er erbium 68	169 Tm thulium 69	173 Yb ytterbium 70	175 Lu lutetium 71
232 Th thorium 90	– Pa protactinium 91	238 U uranium 92	– Np neptunium 93	– Pu plutonium 94	– Am americium 95	– Cm curium 96	– Bk berkelium 97	– Cf californium 98	– Es einsteinium 99	– Fm fermium 100	– Md mendelevium 101	– No nobelium 102	– Lr lawrencium 103

Key: a / X / b — a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

NCHS
Sec 4 Preliminary Examinations 3, 2015

Section A: MCQ (40 marks)

1. D	2. D	3. D	4. B	5. C	6. C	7. C	8. C	9. C	10. C
11. A	12. C	13. C	14. B	15. D	16. A	17. B	18. C	19. A	20. C
21. D	22. D	23. B	24. C	25. D	26. D	27. A	28. A	29. B	30. C
31. C	32. D	33. C	34. A	35. C	36. A	37. C	38. D	39. C	40. C

ANSWERS

Section A: Structured Questions [50m]
Answer all questions in this section in the spaces provided

A1

a) Isotopes are atoms of the same element with different number of neutrons but same number of protons [1]

b)

Isotope	Number of protons	Number of electrons	Number of neutrons
$^{8}_{6}C$	6	6	2
$^{12}_{6}C$	6	6	6
$^{14}_{6}C$	6	6	8

[2] for each isotope if all correct.
[1] if at least one correct

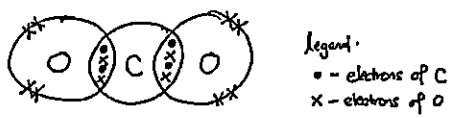
c)

i) Proton [1]

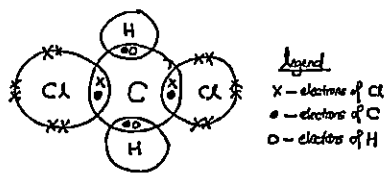
ii) Chlorine atom/free radical [1]

d)

i)

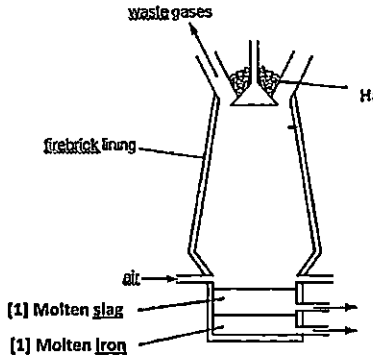


ii)



[1] for correct bonding electrons, [1] for correct non-bonding electrons

A2 a)



b) Fe_2O_3 (s) + 3 CO (g) → 2Fe (l) + 3 CO_2 (g)
[1] for correct balanced equation
[1] for correct ss (not given if equation is wrong)

c) Mass of iron in 10 tonnes of haematite = 2 (56) / (2(56) + 3(16)) x 10
= 7 00 tonne [1]

Mass of iron extracted = 65/100 x 7.00
= 4.55 tonne (3sf) [1]

d)

i) Sulfur dioxide reacts with water vapour in the air to form acid rain [1]

ii) Flue gas desulfurization [1]

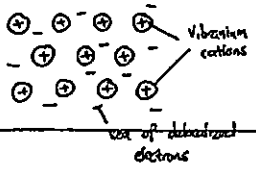
$SO_2 + CaCO_3 \rightarrow CaSO_3 + CO_2$ [1]
and/or
$SO_2 + CaO \rightarrow CaSO_3$

iii) Carbon monoxide / Nitrogen oxides [1]

e) i) Metals are not made up of molecules [1]

They are made up of positive metal cations surrounded by a sea of free and mobile electrons. [1]

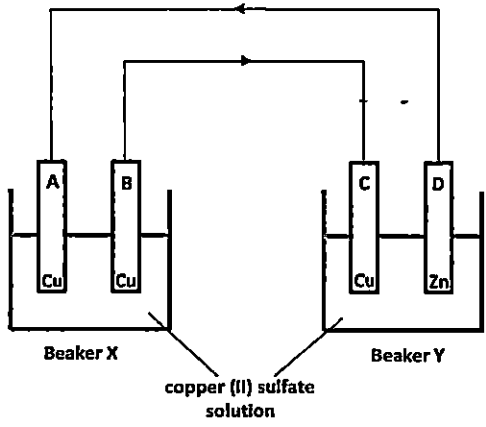
ii)



[1] for correct arrangement
[1] for balanced charges
[1] for labels

iv) High carbon steel / Manganese steel [1]

A3



a) Beaker Y [1]

b) Draw arrows on both wires to show the flow of electrons in the circuit above. [1]

c)

Location	Observations
Electrode A	The electrode grows larger in size [1]
Electrode B	The electrode grows smaller in size [1]
Electrolyte in X	The blue solution remains unchanged. / no change is observed. [1]
Electrolyte in Y	The blue solution fades to a lighter colour. [1]

d) $Cu \rightarrow Cu^{2+} + 2e^-$ [1]

e) Electrode A grows larger in size at a faster rate [1]

A4 a) $Na_2SO_3 + 2HCl \rightarrow 2NaCl + H_2O + SO_2$ [1]

a) Test the remaining gas with a filter paper soaked in acidified $KMnO_4$. [1]

If purple $KMnO_4$ turns colourless, SO_2 is still present. If $KMnO_4$ remains purple, SO_2 is not present. [1]

c) i)

Mole of iodine reacted = 12/1000 x 0.0250 = 0.000300 mol [1]

Mole of SO_2 formed from step 2 = 0 000300 mol

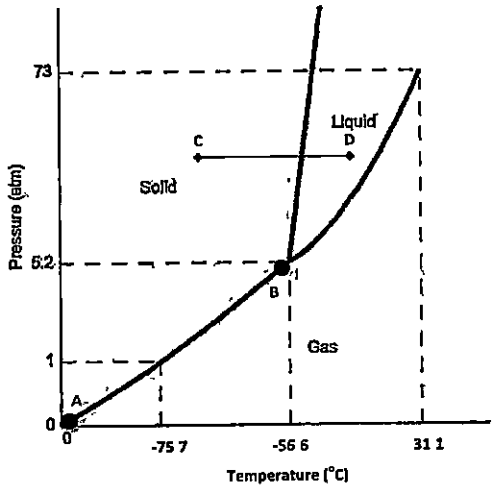
Vol of SO_2 produced = 0 000300 x 24 = 0 00720 dm^3 [1]

ii) SO_2 is oxidized to SO_4^{2-} as the oxidation state of S increases from +4 to +6. [1]

I_2 is reduced to I^- as the oxidation state of I decreases from 0 to -1 [1]

Thus, this is a redox reaction

A5



b) Below -75 7°C. [1]

b) Sublimation/condensation/deposition. [1]

c) The particles of carbon dioxide are initially arranged very closely in an orderly manner, vibrating about fixed positions at point C. [1]

When it is heated to point D, the particles are now spaced slightly further apart in a disorderly manner, sliding past one another randomly. [1]

Section B Essay Question [30m]

B7) a) Water molecules attract the Na^+ and Cl^- ions much stronger than the attraction between the both ions. Hence, it is very soluble in water. [1]

However, the attraction between the Ag^+ and Cl^- ions are much stronger than the attraction between water molecules and the ions Hence, it is only sparingly soluble. [1]

b) The higher the temperature, the higher the K_{sp} values or vice versa [1]

c) Barium sulfate [1]

d) Lead (II) chloride/sulfate / All carbonates except SPA. [1]

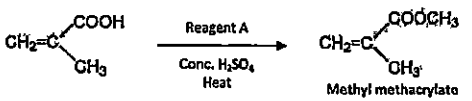
e) Ionic product = $[Ca^{2+}][SO_4^{2-}]$ = (0 01/2) (0 0025/2) [1]
= $6\ 25 \times 10^{-6}$ mol^2/dm^6 [1]

Since ionic product is lesser than K_{sp}, there will be no precipitation. [1]

f) Evaporating the solvent to increase concentration of the ions present [1]
Lower temperature to lower K_{sp}. [1]

B8) Perspex, also known as acrylic, is a transparent thermoplastic that is made from the polymerisation of a monomer, methyl methacrylate

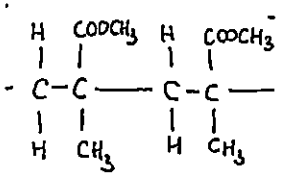
The process below shows part of the production process of methyl methacrylate



a) Methanol [1]

b) Addition polymerisation. [1]
Poly(methyl methacrylate) [1]

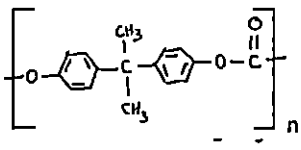
c)



[1] for correct structure
[1] for 2 repeating units

d) The red brown solution remains unchanged [1]
Perspex is a saturated organic molecule. [1]
(Hydrocarbon not accepted)

e)



[1] for correct structure
[1] for bracket and n

f) There is no mass loss in the polymerisation of Perspex while polycarbonate has a larger mass than the monomers used in the polymerisation. [1]
or
The types of monomers used in both polymerisation are different
or
The linkages formed between the monomers are different.

EITHER

B9) a) The elements are arranged according to the proton number / atomic number [1]

b) I, Cs, Ba. [1]

c) i) Cu. It is classified as a transition metal in the modern Periodic Table. [1]

ii) Cu does not react with cold water [1] while the rest of the elements in the row will react vigorously with cold water. [1]

$2\ Li + 2H_2O \rightarrow 2\ LiOH + H_2$ (Na, K or Rb all accepted) [1]

d)

i) The melting points increase from Na to Al as the charge of the metal cations increases [1] from +1 to +3,

causing the metallic bonds to be stronger, therefore requiring increasing amount of energy to overcome [1]

ii) Even though, they are all covalent substances, Si has a very high melting point due to strong covalent bonds between the Si atoms in the giant molecular structure, hence requiring large amount of energy required to overcome them [1]

The melting point drops sharply for P and S as they both have simple molecular structure where lesser amount of energy is required to overcome the weak van der Waal's forces between the molecules. [1]

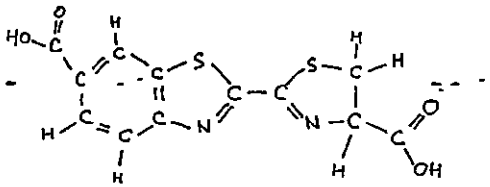
OR

B9) a) $C_{12}H_{10}N_2S_2O_3$ [1]

b) % mass of S = 2(32) / (144 + 10 + 28 + 64 + 48) x 100 = 21.8% (3sf) [1]

c) (i) Test 1: Acidified $K_2Cr_2O_7$ turns from orange to green. [1]
Test 2: Effervescence is observed. [1]

(ii)



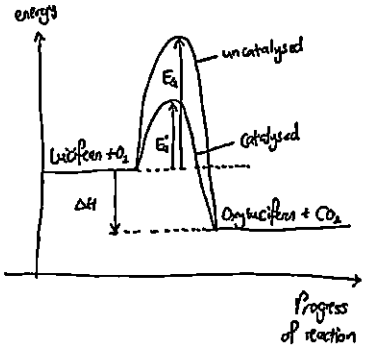
[1] for correct structure

d)

(i) The oxidation of Luciferin is an <u>exothermic</u> reaction Energy in the form of <u>light is given off</u>. [1]

(ii) An enzyme is a <u>biological catalyst</u> [1]

(iii)



[1] for correct shape of graph (exo)
[1] for correct labels of axes, reactants and products
[1] for correct label of ΔH and E_a and E_a'