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SUBJECT: **Chemistry**  
 PAPER NUMBER: I  
 DATE: 29<sup>th</sup> August 2019  
 TIME: 9:00 a.m. to 11:05 a.m.

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**Useful data:**

Relative atomic masses: O = 16; Mg = 24.

Standard temperature and pressure (stp): 0 °C and 1 atm (760 mm Hg)

 The molar volume for gases at stp = 22.4 dm<sup>3</sup>

 Specific heat capacity of water = 4.2 J g<sup>-1</sup> °C<sup>-1</sup>

 Faraday constant = 96500 C mol<sup>-1</sup>

 Avogadro constant, L = 6.02 x 10<sup>23</sup>
 $Q = It$ 
 $\Delta H = mc\Delta\theta$ 


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**Directions to Candidates**

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions. Write all your answers in the spaces provided in this booklet.
- The mark allocation is indicated at the end of each question. Marks allocated to parts of questions are also indicated in brackets.
- You are reminded of the necessity for orderly presentation in your answers.
- In calculations you are advised to show all the steps in your working, giving your answer at each stage.
- The use of electronic calculators is permitted.
- A Periodic Table is printed on the back of this booklet.

**For examiners' use only:**

Question	1	2	3	4	5	6	7	8	9	10	11	12	Total
Score													
Maximum	6	6	6	6	5	7	6	6	6	6	20	20	100

**Section A**

1. Use the periodic table to give the name of the element with:

- a) an electronic configuration of 2,8,5; \_\_\_\_\_ (1)
- b) a mass number of 39; \_\_\_\_\_ (1)
- c) 16 protons in its nucleus; \_\_\_\_\_ (1)
- d) a noble gas configuration in period 1; \_\_\_\_\_ (1)
- e) 3 electrons in its outer shell; \_\_\_\_\_ (1)
- f) electrons in 3 separate shells but with 7 electrons in the outer shell. \_\_\_\_\_ (1)

**(Total: 6 marks)**

6

2. Oxygen combines with both magnesium and carbon. In the spaces provided, draw dot and cross diagrams showing **all** electrons to represent the bonding that takes place between:

a) magnesium and oxygen to form magnesium oxide;

(2)

b) carbon and oxygen to form carbon dioxide.

(2)

c) Which **ONE** of the compounds in parts (a) and (b):

i) has the higher melting point?

(1)

ii) reacts with alkalis?

(1)

**(Total: 6 marks)**

6

3. In nature carbon exists both as diamond and graphite.

a) Give **ONE** use of each of these forms of carbon.

Diamond: \_\_\_\_\_ (1)

Graphite: \_\_\_\_\_ (1)

b) What property of each form of carbon would make it suitable for the use given in part (a)?

Diamond: \_\_\_\_\_ (1)

Graphite: \_\_\_\_\_ (1)

c) Carbon may reduce oxides of metals that are low in the activity series. Give the equation for the reaction that takes place when carbon reduces copper(II) oxide.

\_\_\_\_\_ (2)

**(Total: 6 marks)**

6

4.

a) Complete the following equations which represent the action of heat on various substances:

i)  $2\text{NaNO}_3 \rightarrow 2\text{NaNO}_2 + \text{_____}$  (1)

ii)  $\text{Cu}(\text{OH})_2 \rightarrow \text{_____} + \text{H}_2\text{O}$  (1)

iii)  $2\text{NaHCO}_3 \rightarrow \text{Na}_2\text{CO}_3 + \text{_____} + \text{_____}$  (2)

b) Silica gel is useful to absorb water vapour from small enclosed places.

i) State whether silica gel must be in its hydrated or anhydrous form for it to absorb water vapour.

\_\_\_\_\_ (1)

ii) When silica gel absorbs water vapour to full capacity, it can be recharged so that it can be reused. State how silica gel can be recharged.

\_\_\_\_\_ (1)

**(Total: 6 marks)**

6

5. A group of students carried out some experiments in order to identify the substances present in air. These experiments allow substances to be removed from air. The table below shows the experiments carried out. Fill in the missing information.

a) (4)

Experiment	Name or formula of substance removed from the sample of air.
Filtration	
Cooling to 0 °C	
Passing over hot copper	
Bubbling into sodium hydroxide solution	

- b) After the experiments in part (a) were carried out, there were still a few substances present in the sample. Give the name of the most abundant substance remaining.

(1)

(Total: 5 marks)

5

6. Two friends are camping and come across a puddle of colourless clear liquid. One of them wants to drink from it but they decide that it is not a good idea because they have studied that it might not be pure water.

- a) Describe a simple chemical test including observations to prove that the liquid contains water.

(3)

- b) Mention **TWO** ways that may be used to check if the liquid in part (a) is pure.

(2)

- c) Water may cause iron to rust.

- i) Mention another substance, besides water, which is necessary for iron to rust.

(1)

- ii) Give **ONE** method to prevent rust formation.

(1)

(Total: 7 marks)

7

7.

- a) Complete the following paragraph using words from the word bank below. Each word may only be used once or not at all.

catalyst    fuel    low    endothermic    exothermic    explosive    high

The combustion of hydrogen gas is very \_\_\_\_\_ which makes hydrogen gas suitable as a \_\_\_\_\_. However, in this case two disadvantages are that hydrogen can be \_\_\_\_\_ and that the container for storage must be able to withstand a \_\_\_\_\_ pressure. (4)

- b) Hydrogen can react with heated oxides in a combustion tube. Complete the following equation for the reaction:



(2)

**(Total: 6 marks)**

6

8.

- a) Give **TWO** reasons why copper is considered as a transition element.

Reason 1: \_\_\_\_\_

Reason 2: \_\_\_\_\_ (2)

- b) Give balanced equations to show:

- i) the reaction of copper(II) oxide, CuO, with dilute hydrochloric acid;

(2)

\_\_\_\_\_

- ii) the reaction of copper(II) oxide, CuO, with carbon dioxide.

(2)

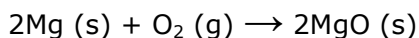
\_\_\_\_\_

**(Total: 6 marks)**

6

9.

- a) Magnesium is a group 2 element. It burns in oxygen with an intense white flame according to the equation:



During this reaction, 40.8 cm<sup>3</sup> of oxygen, measured at 25 °C and 1 atmosphere pressure, were used. Calculate the volume of oxygen at stp.

\_\_\_\_\_ (4)

\_\_\_\_\_

\_\_\_\_\_

- b) Sodium and potassium are in the same group of the periodic table. State whether the reaction of sodium with oxygen is less or more violent than the reaction of potassium with oxygen. Explain your answer.

\_\_\_\_\_ (2)

\_\_\_\_\_

**(Total: 6 marks)**

6

10. Chlorine may be prepared in the lab by the reaction between concentrated hydrochloric acid and manganese(IV) oxide according to the equation:



- a) State **TWO** changes that may be observed during this reaction.

\_\_\_\_\_ (2)

\_\_\_\_\_

- b) The reaction above is a redox reaction. Give the name or formula of the substance which is oxidised. Explain your answer.

\_\_\_\_\_ (2)

\_\_\_\_\_

- c) The chlorine gas produced in the reaction above is bubbled through water producing chlorine water. Describe what happens when blue litmus paper is dropped into chlorine water.

\_\_\_\_\_ (2)

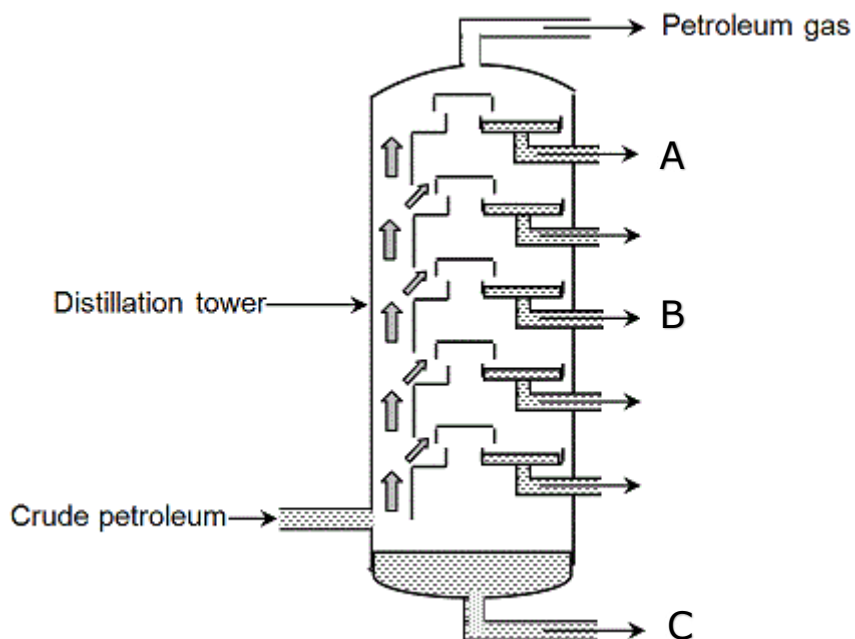
\_\_\_\_\_

**(Total: 6 marks)**

6

**Section B**

11. The diagram below shows a fractionating column which is used to separate the substances present in petroleum.



<http://www.funscience.in/study-zone/Physics/NonRenewableSourcesOfEnergy/>

a) Petroleum is a mixture of hydrocarbons. The list below shows some substances which may be obtained at some of the stages along the length of the column.

diesel	bitumen	methane (CH <sub>4</sub> )	octane (C <sub>8</sub> H <sub>18</sub> )
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From the list given, choose a substance which may be collected at:

Position B: \_\_\_\_\_

Position C: \_\_\_\_\_ (2)

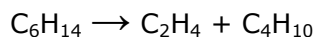
b) Hexane, C<sub>6</sub>H<sub>14</sub>, is collected at position A. Hexane can be broken into smaller hydrocarbons.

i) Give the name of this process and state **ONE** condition necessary for it to occur.

Name of process: \_\_\_\_\_ (1)

Condition: \_\_\_\_\_ (1)

ii) During this process the following reaction occurs:



Give the name of the products.

$\text{C}_2\text{H}_4$ : \_\_\_\_\_

$\text{C}_4\text{H}_{10}$ : \_\_\_\_\_ (2)

iii) In the spaces provided, draw the structures of the **TWO** products obtained in part (b) (ii) showing **all** bonds.

$\text{C}_2\text{H}_4$	$\text{C}_4\text{H}_{10}$

(2)

c) The compound  $\text{C}_2\text{H}_4$  may undergo polymerisation under the right conditions.

i) What is polymerisation?

\_\_\_\_\_  
 \_\_\_\_\_ (2)

ii) Draw the repeating unit of the polymer formed from  $\text{C}_2\text{H}_4$ .

(2)

iii) Give the name of the polymer in part (c) (ii).

\_\_\_\_\_ (1)

d) The two compounds  $\text{C}_2\text{H}_4$ , and  $\text{C}_4\text{H}_{10}$  have different properties.

i) Give the name of the homologous series to which each compound belongs.

Homologous series of  $\text{C}_2\text{H}_4$ : \_\_\_\_\_

Homologous series of  $\text{C}_4\text{H}_{10}$ : \_\_\_\_\_ (2)



- ii) The hydrocarbon  $C_4H_{10}$  may exist as two different compounds having different structures. Give the name of such compounds and draw the structure of  $C_4H_{10}$  which is different from the one in part (b) (iii).

Name: \_\_\_\_\_ (1)

Structure:

\_\_\_\_\_ (1)

- iii) The hydrocarbon  $C_4H_{10}$  burns in a plentiful supply of air to produce carbon dioxide as one of the products. It is important that the reaction is carried out in a plentiful supply of air. Give **TWO** reasons.

\_\_\_\_\_ (2)

- iv) Explain why  $C_4H_{10}$  is considered as a clean fuel when compared to diesel.

\_\_\_\_\_ (1)

**(Total: 20 marks)**

20

12. In chemistry, some reactions reach a dynamic equilibrium between reactants and products.

- a) State what happens while a chemical reaction is in dynamic equilibrium.

\_\_\_\_\_ (1)

- b) Consider the following reaction:



- i) Give the chemical name of  $CH_3COOH$ .

\_\_\_\_\_ (1)

- ii) Give the name or formula of a compound that will react with  $CH_3COOH$  to give the organic products shown in the equation.

\_\_\_\_\_ (1)

- iii) Suggest a suitable catalyst for this reaction.

\_\_\_\_\_ (1)

- iv) Give the homologous series to which  $CH_3COOC_2H_5$  belongs.

\_\_\_\_\_ (1)

- v) Give **ONE** characteristic property of  $CH_3COOC_2H_5$ .

\_\_\_\_\_ (1)

c) CH<sub>3</sub>COOH reacts with sodium hydroxide solution.

i) Give a balanced equation for the reaction between CH<sub>3</sub>COOH and sodium hydroxide solution.

\_\_\_\_\_ (2)

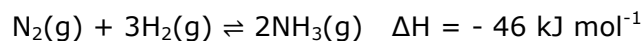
ii) Name the type of reaction in part (c)(i).

\_\_\_\_\_ (1)

iii) Give the name of **ONE** commonly found substance which contains CH<sub>3</sub>COOH.

\_\_\_\_\_ (1)

d) In the Haber Process, nitrogen and hydrogen react to produce ammonia according to the equation:



i) How does the data above indicate whether the reaction is exothermic or endothermic?

\_\_\_\_\_ (1)

ii) The table below gives some experimental conditions to favour the formation of ammonia which may be true or false. Write true or false as applicable. (3)

	<b>True / False</b>
Increase temperature	
Remove the ammonia formed	
Add more nitrogen	

iii) State the industrial conditions of temperature and pressure that are used in this process.

\_\_\_\_\_ (2)

iv) State **ONE** reason why in practise compromise conditions are used for this process.

\_\_\_\_\_ (1)

v) Give the name or formula of a suitable catalyst for the reaction in part (d).

\_\_\_\_\_ (1)

vi) State **TWO** uses for ammonia.

\_\_\_\_\_ (2)

**(Total: 20 marks)**

20

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SUBJECT: **Chemistry**  
 PAPER NUMBER: IIB  
 DATE: 29<sup>th</sup> August 2019  
 TIME: 4:00 p.m. to 6:05 p.m.

**Useful data:**

Relative atomic masses: H = 1; C = 12; O = 16; Na = 23; Ag = 108.

Standard temperature and pressure (stp): 0 °C and 1 atm (760 mm Hg)

The molar volume for gases at stp = 22.4 dm<sup>3</sup>

Specific heat capacity of water = 4.2 J g<sup>-1</sup> °C<sup>-1</sup>

Faraday constant = 96500 C mol<sup>-1</sup>

Avogadro constant, L = 6.02 x 10<sup>23</sup>

Q = It

ΔH = mcΔθ

**Directions to Candidates**

- Write your index number in the space at the top left-hand corner of this page.
- Answer **ALL** questions from Section A. Write all your answers for Section A in the spaces provided in this booklet.
- Answer **TWO** questions from Section B. Write all your answers for Section B in the spaces provided in this booklet.
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Score															
Maximum	6	6	6	6	6	6	6	6	6	6	20	20	20	20	100

**Section A: Answer ALL questions.**

1. From the word bank below, select the appropriate separation technique which may be used in the laboratory to obtain each of the following. Each technique may be used once, more than once, or not at all.

filtration	distillation	sublimation
separating funnel	fractional distillation	chromatography

- a) Calcium carbonate from a mixture of calcium carbonate and water. \_\_\_\_\_ (1)
- b) Oil from a mixture of oil and water. \_\_\_\_\_ (1)
- c) Sodium chloride from a mixture of sodium chloride and ammonium chloride.  
\_\_\_\_\_ (1)
- d) Ethanol from a mixture of ethanol (boiling point 78 °C) and methylbenzene (boiling point 110.6 °C). \_\_\_\_\_ (1)
- e) Water from a copper(II) sulfate solution. \_\_\_\_\_ (1)
- f) Iodine crystals from a mixture of iodine and sodium chloride crystals.  
\_\_\_\_\_ (1)

**(Total: 6 marks)**

6

2.

- a) Give the name of a basic oxide.  
\_\_\_\_\_ (1)
- b) What kind of products are formed when a basic oxide is reacted with an acid?  
\_\_\_\_\_ (2)
- c) Sulfur dioxide is an acidic oxide. Give the name of the substance formed when sulfur dioxide reacts with water.  
\_\_\_\_\_ (1)
- d) How does the physical state of basic oxides differ from that of acidic oxides at room temperature?  
Basic oxides: \_\_\_\_\_  
Acidic oxides: \_\_\_\_\_ (2)

**(Total: 6 marks)**

6

3.

a) Give the meaning of diffusion.

\_\_\_\_\_ (1)

b) Why does diffusion take place in liquids and gases but **not** in solids?

Liquids and gases: \_\_\_\_\_ (1)

Solids: \_\_\_\_\_ (1)

c) What is a suspension?

\_\_\_\_\_ (1)

d) Name **ONE** factor that affects the formation of a suspension.

\_\_\_\_\_ (1)

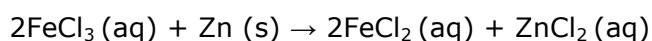
e) Name the process that keeps solid particles in suspension.

\_\_\_\_\_ (1)

**(Total: 6 marks)**

6

4. Study the following reaction:



a) Give the oxidation number of iron:

i) before the reaction took place; \_\_\_\_\_ (1)

ii) after the reaction took place. \_\_\_\_\_ (1)

b) Give **TWO** observations that may be made during the reaction.

Observation 1: \_\_\_\_\_ (1)

Observation 2: \_\_\_\_\_ (1)

c) In this reaction, is the zinc acting as a reducing or oxidizing agent? Explain.

\_\_\_\_\_ (1)

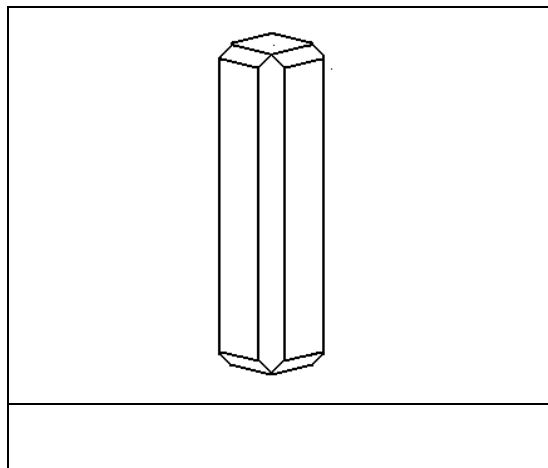
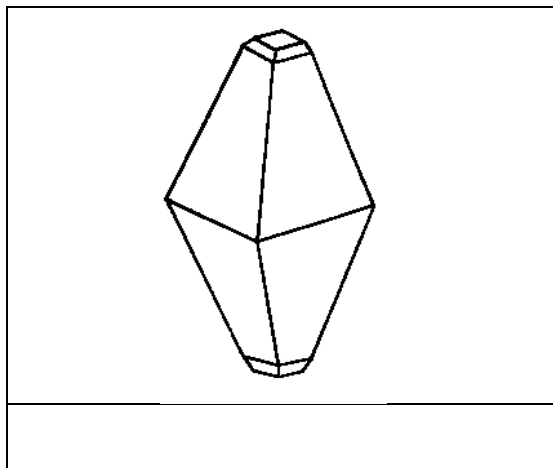
Explanation: \_\_\_\_\_ (1)

\_\_\_\_\_ (1)

**(Total: 6 marks)**

6

5. a) Name the following allotropes of sulfur whose structure may be seen below. (2)



Source: [http://www.uq.edu.au/\\_School\\_Science\\_Lessons/12.18.1.GIF](http://www.uq.edu.au/_School_Science_Lessons/12.18.1.GIF)

- b) What are allotropes?

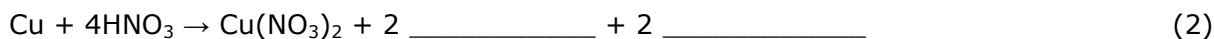
\_\_\_\_\_ (2)

- c) Sulfur combines with metals to form sulfides, which in turn react readily with acids. Write an equation for the reaction of iron(II) sulfide with dilute sulfuric acid.

\_\_\_\_\_ (2)  
**(Total: 6 marks)**

6

6. a) Complete the following equations for the reaction of nitric acid with magnesium and copper respectively.



- b) Why are the products of the reaction between nitric acid and magnesium different from the reaction between nitric acid and copper?

\_\_\_\_\_ (1)

- c) How can nitrogen dioxide be produced from copper(II) nitrate?

\_\_\_\_\_ (1)  
**(Total: 6 marks)**

6



7.

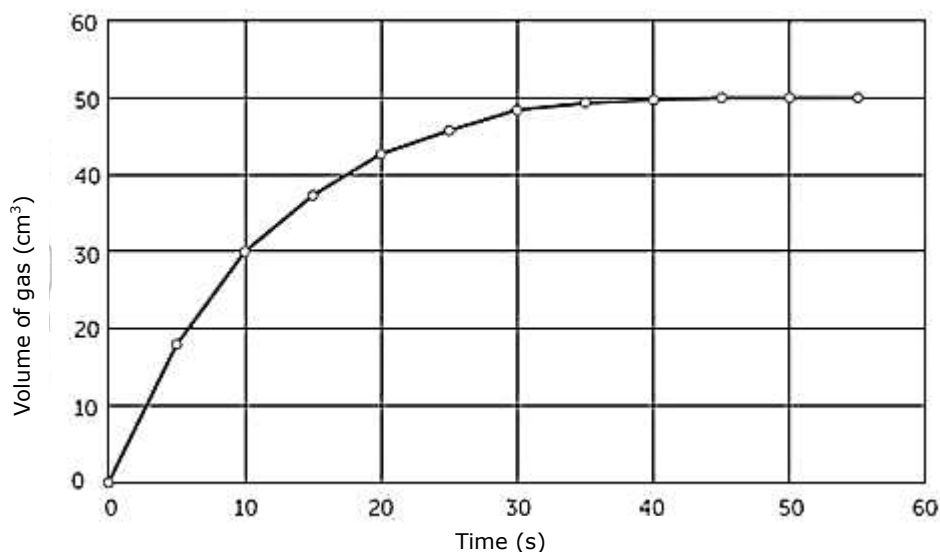
a) List 3 factors which may influence the rate of a chemical reaction.

Factor 1 \_\_\_\_\_

Factor 2 \_\_\_\_\_

Factor 3 \_\_\_\_\_ (3)

b) The following graph shows the rate of a chemical reaction.



Source: <https://eic.rsc.org/cpd/rates-of-reactions/2000010.article>

i) Why is the line of the graph not a straight line?

\_\_\_\_\_ (1)

ii) Give a reason for your answer to part (b) (i).

\_\_\_\_\_ (1)

c) From the graph in part (b), give the time it takes for the reaction to go to completion.

\_\_\_\_\_ (1)

**(Total: 6 marks)**

6

8. A student dissolved 20 g of a salt whose relative molecular mass is  $74 \text{ g mol}^{-1}$ , in  $250 \text{ cm}^3$  of distilled water. As the salt dissolved in the water, it was found that the temperature of the solution increased from  $18 \text{ }^\circ\text{C}$  to  $22 \text{ }^\circ\text{C}$ .

a) How many moles of the substance were dissolved by the student?

\_\_\_\_\_ (1)

b) Calculate the amount of heat energy released during this reaction.

\_\_\_\_\_ (2)

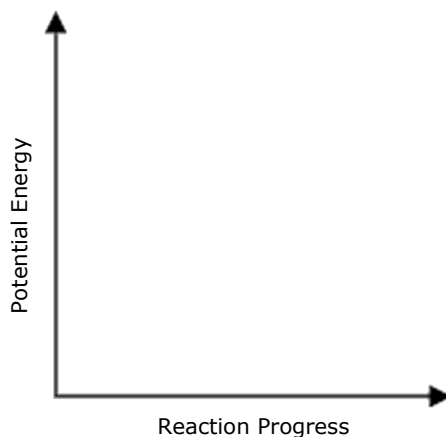
c) Using your answers to parts (a) and (b), calculate the change in heat of solution for the substance used during this experiment.

\_\_\_\_\_ (1)

d) The actual heat of solution for this substance is  $-16.2 \text{ kJ mol}^{-1}$ . Explain the difference between this value and the one obtained in your answer to part (c).

\_\_\_\_\_ (1)

e) In the space provided sketch a diagram for the energy levels of the reactants and the products of this reaction.



(1) 

6

  
**(Total: 6 marks)**

9. This question is about alkanes.

a) In the space provided below, give the molecular and structural formula of pentane. (2)

Molecular formula of pentane	Structural formula of pentane

b) Why is this substance referred to as a saturated hydrocarbon?

\_\_\_\_\_ (1)

c) Give the equation for the reaction of pentane with chlorine.

\_\_\_\_\_ (2)

d) The reaction of pentane with chlorine is rather slow. How can it be made to go faster?

\_\_\_\_\_ (1)

**(Total: 6 marks)**

6

10. This question is about carboxylic acids.

a) Give the name of the following organic substance whose structural formula is shown below. (1)

Structural formula	Name
$  \begin{array}{c}  \text{H} \\    \\  \text{H}-\text{C}-\text{C} \\    \quad // \\  \text{H} \quad \text{O} \\  \quad \quad \backslash \\  \quad \quad \text{O}-\text{H}  \end{array}  $	

b) Draw a circle around the functional group of the organic substance in part (a). (1)

c) What pH value would one expect an aqueous solution of this substance to have?

\_\_\_\_\_ (1)

d) State whether the organic substance in part (a) would react with dilute hydrochloric acid.

\_\_\_\_\_ (1)

e) Give the name and formula of the substance formed when the substance in part (a) reacts with ethanol.

Name: \_\_\_\_\_ (1)

Formula: \_\_\_\_\_ (1)

**(Total: 6 marks)**

6

**Section B: Answer TWO questions from this section.**

11. A series of reactions were performed on substances **A**, **G**, **M**, and **P**. Read the tests and observations presented below to identify all compounds. Some substances might appear in more than one series of reactions.

**A** is a pink powder when freshly prepared. It does not dissolve in water or dilute hydrochloric acid. **A** dissolves in concentrated sulfuric acid to give a blue solution **B** and a gas **C** with a choking smell resembling that of fireworks or burnt matches. **A** dissolves in concentrated nitric acid to give a blue solution **D** and a red-brown gas **E** with a sharp, irritating smell. On heating, **A** forms a black solid **F**.

Solid **G** is soluble in water. On adding hydrochloric acid to a solution of **G**, a white precipitate **H** forms. A white suspension **I** forms if dilute sulfuric acid is added to a solution of **G**. There is no visible change when dilute nitric acid is added to a solution of **G**. **G** imparts no colour to a flame in a flame test. When **G** is heated in air, it decomposes with a crackling sound to produce a yellow solid **J**, a colourless, odourless gas **K** and a red-brown gas **L** with a sharp, biting odour.

**M** is a white solid which is insoluble in water. **M** reacts with hydrochloric acid to produce a solution **N**. On addition of aqueous potassium hydroxide to **N**, a white precipitate **O** forms. This white precipitate dissolves on adding more potassium hydroxide. In a flame test, **M** imparts no colour to the flame. **M** is thermally stable.

A pale green solution of **P** produces a white precipitate on addition of silver nitrate. A separate solution of **P** gives a mud-green precipitate **Q** on addition of dilute sodium hydroxide. **Q** quickly darkens from mud-green to rust brown **R** on exposure to air. On heating, solid **R** reacts vigorously with aluminium to form a molten metal **S** and a white solid **T**.

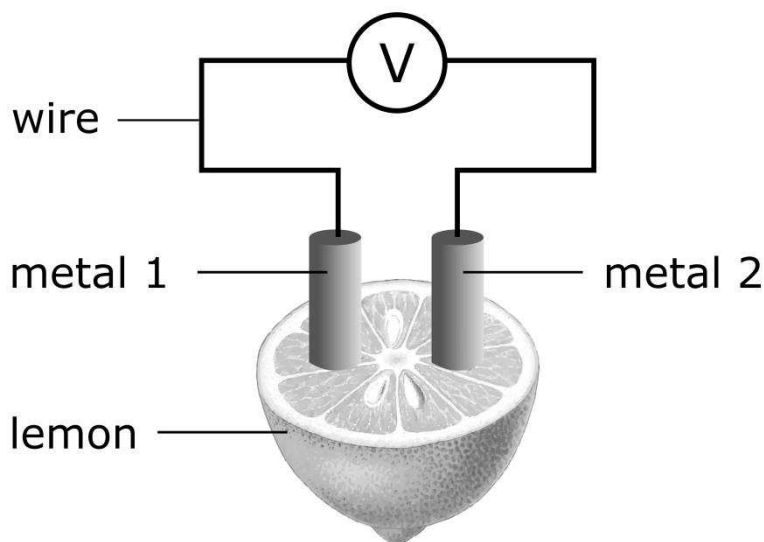
Give the formula or name of the following substances. (When naming compounds make sure to include the oxidation state where relevant.)

- a) A, B, C, D, E, F. (6)
- b) G, H, I, J, K, L. (6)
- c) M, N, O. (3)
- d) P, Q, R, S, T. (5)

**(Total: 20 marks)**

12. Electricity can be used to drive chemical reactions, but chemical reactions may also be used to produce electricity.

- a) Pauline wants to electroplate a metal spoon with silver using electrolysis. Pure silver is used as the anode while the spoon acts as the cathode in a solution containing silver ions.
- i) Draw a diagram for the apparatus described above. The diagram should clearly:
    - show how the equipment will be set up; (3)
    - indicate the polarity of both electrodes; (1)
    - name a suitable solution containing silver ions. (1)
  - ii) Write an ionic half equation for the reaction taking place at the cathode (spoon). (2)
  - iii) During the experiment, describe what happens to the:
    - size of the silver anode; (1)
    - concentration of silver ions in solution. (1)
  - iv) The apparatus is set up with a current of 4.8 A for 15 minutes. Calculate:
    - the quantity of charge used in the experiment; (2)
    - the amount (in moles) of electrons that pass through the solution; (1)
    - the increase in mass at the anode. (2)
- b) John investigates the voltage across two metals inserted in a lemon as shown in the diagram below. The results are shown in the table that follows.



	<b>Metal 1</b>	<b>Metal 2</b>	<b>Voltage</b>
<b>Experiment A</b>	Copper	Zinc	0.11 V
<b>Experiment B</b>	Magnesium	Zinc	0.18 V
<b>Experiment C</b>	Copper	Magnesium	0.26

- i) Identify the metal being oxidized in each of experiments A, B, and C. (3)
- ii) Why is the voltage between zinc and copper the smallest? (1)
- iii) Why is the voltage across copper and magnesium the largest? (1)
- iv) From the results obtained in this experiment place the three metals in increasing order of reactivity. (1)

**(Total: 20 marks)**

- 
13. Humanity's use of fossil fuels to generate electric power and for transportation has been having serious consequences on the Earth.
- a) Show the main products of complete combustion of fossil fuels by writing the chemical equation for the combustion of propane,  $C_3H_8$ , a main ingredient of LPG. (2)
  - b) The combustion of heavier fuels, such as diesel ( $\sim C_{12}H_{26}$ ), is more likely to produce a solid pollutant.
    - i) Identify this pollutant. (1)
    - ii) Why is the pollutant in part (b) (i) considered to be dangerous? (1)
    - iii) Why is diesel more likely than LPG to produce this pollutant? (1)
  - c) LPG is being used as an aerosol propellant and refrigerant to replace a particular group of compounds.
    - i) Name the class of compounds which were widely used as aerosol propellants and refrigerants. (1)
    - ii) Identify the damage that was being done by this class of compounds. (1)
  - d) Fossil fuels are often desulfurized. Discuss why it is important to remove sulfur from fuels. Your answer should:
    - i) name the product formed by the combustion of sulfur; (1)
    - ii) link this product to the formation of acid rain through a balanced chemical equation; (2)
    - iii) list **TWO** effects of this product or acid rain on the environment or humans. (2)
  - e) Nitrogen dioxide is another pollutant gas generated by cars.
    - i) How is this pollutant gas formed? (2)
    - ii) Name a measure adopted in cars to reduce emission of nitrogen dioxide and other pollutant gases. (1)
  - f) Power stations are trying to reduce the amount of gas produced in part (d) (i) from being released into the atmosphere by passing it through calcium oxide. Write a chemical equation, including state symbols, for this reaction. (3)
  - g) The dependence on crude oil to make fuels means that this finite resource will run out or become more expensive, affecting the production of many other chemicals which are made from it. Name **TWO** other products derived from crude oil besides fuels and the fractions obtained from fractional distillation. (2)

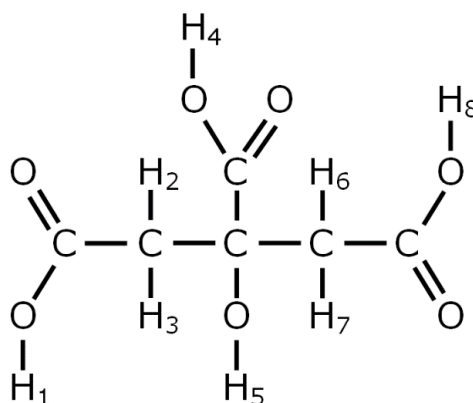
**(Total: 20 marks)**

14. Citric acid is a carboxylic acid with a variety of uses, mainly in foods and beverages. As a laboratory technician you are to prepare a standard solution of citric acid and find its basicity by titrating it with a standard solution of sodium hydroxide.

- a) In the first part of the experiment, 250 cm<sup>3</sup> of a standard solution of 0.50 mol dm<sup>-3</sup> citric acid is to be prepared.
- Name the flask used to prepare a standard solution. (1)
  - The formula of citric acid is C<sub>6</sub>H<sub>8</sub>O<sub>7</sub>. Calculate its RMM. (1)
  - Calculate the mass of citric acid that needs to be dissolved in 250 cm<sup>3</sup> of distilled water to make a solution of concentration 0.50 mol dm<sup>-3</sup>. (2)
- b) In the second part of the experiment, 25.0 cm<sup>3</sup> of the previously prepared standard citric acid solution are transferred to a clean conical flask. A few drops of an indicator are added. The solution is titrated against 2.00 mol dm<sup>-3</sup> sodium hydroxide.
- Name the apparatus used to transfer 25.0 cm<sup>3</sup> of the standard solution. (1)
  - Why is the solution transferred to a conical flask rather than another container? (1)
  - How is the conical flask cleaned before the citric acid is transferred to it? (1)
  - How is the burette cleaned before the sodium hydroxide is transferred to it? (2)
  - Why is a white tile placed under the conical flask? (1)
- c) The results for the titration are shown in the table below.

2 <sup>nd</sup> reading / cm <sup>3</sup>	21.0	39.8	18.7	37.5	18.7
1 <sup>st</sup> reading / cm <sup>3</sup>	0.0	21.0	0.0	18.7	0.0
Titre value / cm <sup>3</sup>	21.0	18.8	18.7	18.8	18.7

- From the table, calculate the volume of 2.00 mol dm<sup>-3</sup> sodium hydroxide required to neutralise 25.0 cm<sup>3</sup> of citric acid. (1)
  - Hence, calculate the amount (in moles) of sodium hydroxide used. (1)
  - What is the amount (in moles) of citric acid present in 25.0 cm<sup>3</sup> of solution? (1)
  - Hence, what is the basicity of citric acid? (1)
- d) The structural formula of citric acid is shown below. The hydrogen atoms have been numbered for ease of reference. Which hydrogen atoms are likely to dissociate? Explain your answer. (4)



- With reference to your answer to part (c) (iv), write a chemical equation for the reaction of citric acid (C<sub>6</sub>H<sub>8</sub>O<sub>7</sub>) with sodium hydroxide. (2)

**(Total: 20 marks)**











