## SECTION A [40 MARKS]

ANSWER **ALL** QUESTIONS

**Question 1**

**a)** **Directions: For each question, there are four alternatives A, B, C and D. Choose the Correct alternative and circle it. Do not circle more than ONE alternative. If there are more than one choice circled, NO score will be awarded.** **[25]**

i. The molar mass of a substance is defined as the

A mass in grams of 1 litre of that substance.
B mass in grams of 1 mole of that substance.
C number of moles in 1 litre of that substance.
D number of moles in 1 kilogram of that substance.

ii. An impure metal is heated in a vessel. The metal forms vapour which condenses in a receiver while the non-volatile impurities are left behind in the vessel. The process described in the statement above is

A liquation.
B reduction.
C distillation.
D oxidative refining.

iii. Metals are found in the combined state in ores, where they exist as positive ions. During the extraction of metals, the metallic ions must be reduced to the corresponding metal atoms. The correct sequence in the extraction of metal is

A dressing $\rightarrow$ refining $\rightarrow$ reduction $\rightarrow$ concentration.
B dressing $\rightarrow$ concentration $\rightarrow$ refining $\rightarrow$ reduction.
C concentration $\rightarrow$ dressing $\rightarrow$ reduction $\rightarrow$ refining.
D dressing $\rightarrow$ concentration $\rightarrow$ reduction $\rightarrow$ refining.

iv. Gold and platinum are metals popularly used for making ornaments. The property that best describes gold and platinum is they

A are expensive.
B are inactive metals.
C have high melting points.
D react with water and air.

v. The IUPAC name of the compound with the structural formula $CH_3CH=CH_2$ is

A ethane.
B butane.
C propene.
D methyl propane.

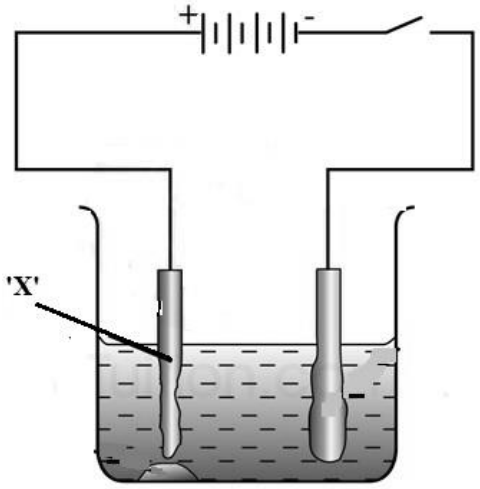
vi. When the temperature of a given sample of a gas is increased at a constant pressure, the volume would

A decrease.
B increase.
C remain same.
D both increase and decrease.

vii. A compound formed between carbon and hydrogen has an empirical formula $CH_4$. If its molecular weight is 32, its molecular formula will be

A $CH_4$.
B $C_2H_4$.
C $C_2H_8$.
D $C_4H_8$.

viii. The figure below represents electro-refining of copper.




The part labelled 'X' in the above diagram should be made up of

A nickel.
B graphite.
C pure copper.
D impure copper.

ix. A gas is used as a refrigerant and propellant. However, it has a negative impact on the environment when used excessively. The gas that is referred to in the statement is

A carbon dioxide.
B liquid nitrogen.
C chlorofluorocarbon.
D carbon tetrachloride.

x. Tshering added a substance 'A' from the halogen group in a beaker of water. After some time, it turned to an orange solution. The substance 'A' is

A iodine.
B chlorine.
C bromine.
D fluorine.

xi. In an experiment to find the presence of $Fe^{2+}$ ions in a compound, the addition of NaOH to the compound would form a

A dirty green ppt. which is insoluble in NaOH.
B reddish-brown ppt. which is insoluble in NaOH.
C dull white ppt. which is soluble in NaOH.
D dirty green ppt. which is soluble in NaOH.

xii. To what temperature should $500cm^3$ of a gas at $20^\circ C$ be heated to expand to a volume $750cm^3$ under constant pressure?

A 195.3K
B 30°C
C 429.5K
D 13.33°C

xiii. Chlorine gas is used as a disinfectant and purifier in hospitals. The volume occupied by 7.1g of chlorine gas at STP is equal to

A 0.224L.
B 2.24L.
C 22.4L.
D 224L.

xiv. Baking soda ($NaHCO_3$**)** is a food processing component which is used as a leavening agent in bakery products. The percentage of oxygen present in baking soda is

A 19.04%.
B 30.76%.
C 47.05%.
D 57.14%.

xv. Saturated hydrocarbons have only single bonds between carbon atoms. Which of the following is a saturated hydrocarbon?

A pentane
B pentene
**C** pentyne
D pentanol

xvi. The enthalpy of the formation of compounds A, B, C and D are –87.02, +16.01, +8.01 and –16.01k.cal mole -1 respectively. The correct order of increasing stability of the compounds is

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

xvii. Although scandium is a member of the d-block elements, it is not a transition metal because of its

A vacant d-orbital.
B complete d-orbital.
C half-filled d-orbital.
D variable oxidation state.

xviii. When metals are required to be obtained with a high degree of purity, the reduction process employed is

A carbon reduction.
B hydrogen reduction.
C aluminum reduction.
D electrolytic reduction.

xix. Pema places a balloon inside a refrigerator at a temperature of 20°C. Interpret the value in Kelvin.

A 263K
B 273K
C 283K
D 293K

xx. Table below shows the information about different variables. Identify the relationship for Charles's law.

| | **Pressure** | **Volume** | **Temperature** |
|---|---|---|---|
| A | constant | increase | decrease |
| B | constant | increase | increase |
| C | increase | constant | decrease |
| D | increase | constant | increase |

xxi. Read the statements given below.

I. The total amount of energy of the system and its surroundings remains constant.
II. Energy can be changed from one form to another.
III. Energy cannot be created or destroyed.

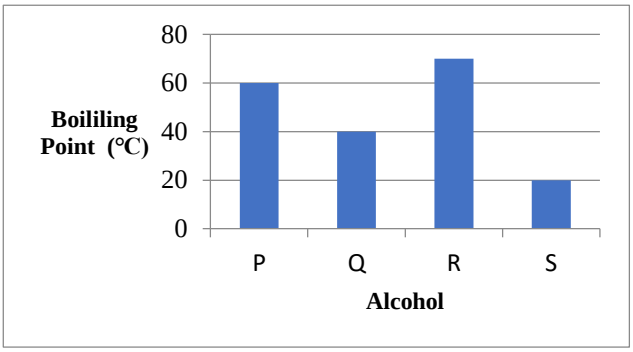
The satements that apply to the law of conservation of energy are

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

xxii. The manufacture of paper in the pulp and paper industry requires the use of

A a reducing agent.
B an oxidizing agent.
C a bleaching agent.
D a dehydrating agent.

xxiii. The figure below represents the boiling point of alcohols P, Q, R and S. Based on the boiling points of the alcohols, which alcohol has the highest volatility?




A P
B Q
C R
D S

xxiv. Galvanizing is the process of applying a protective coat to iron to prevent from rusting. Name the metal used in galvanization.

A Co
B Mn
C Zn
D Ti

xxv. Ethanol is used as a solvent in perfume because it

A oxidizes easily.
B reduces easily.
C dissolves easily.
D evaporates easily.

**b) Fill in the blanks with appropriate word (s).** **[5]**

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| i. | 0.5 moles of a substance X has a mass of 10g. The molar mass of the substance is _____. | |
| ii. | The formula of methane is $CH_4$. The percentage composition of hydrogen in methane is _____. | |
| iii. | In gas law, a balloon and a refrigerator are used to determine the relationship between volume and _____. | |

| | | |
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| iv. | The thermodynamic quantity that expresses the degree of disorder in a system is called _____. | |
| v. | All the organic compounds are represented by a particular formula. The general formula of alcohol is _____. | |

**c) Write true or false for the following statements.** **[5]**

| | | | |
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| i. | The gram molecular mass of oxygen molecule is 16g. | | |
| ii. | There are equal number of atoms in 12 grams of carbon and 12 grams of chlorine. | | |
| iii. | Butanol is the fourth member in the homologous series of alcohol. | | |
| iv. | Electronegativity of halogens increases down the group. | | |
| v. | 1 mole of electrons means $6.023 \times 10^{22}$ electrons. | | |

**d) Match each item under Column A with the item in Column B. Rewrite the correct pairs by writing the alphabet against the number in the space provided.** **[5]**

| Answer | Column A | Column B |
|---|---|---|
| i…….. | i. Endothermic reaction | a) $K_2SO_4.Al_2(SO_4)_3$ |
| ii…….. | ii. Complex ion | b) esterification |
| iii……. | iii. Emperical formula | c) fluorine |
| iv……. | iv. Concentrated sulphuric acid | d) simple ratio |
| v…….. | v. Prevents tooth decay | e) $K_4[Fe(CN)_6]$ |
| | | f) $\Delta H > 0$ |

## SECTION B [60 MARKS]

ATTEMPT **ANY SIX** QUESTIONS

**Question 2**

a) Design a simple experiment to purify ores of copper. Mention clearly the cathode, anode, pure metal and impure metal in your experiment. **[3]**

b) Why is Titanium is used to replace knee and hip joints. Justify your response with **TWO** points. **[2]**

c) Write the electronic configuration in s, p, d, f notation for oxygen and iron. **[2]**

d) For public safety, police use breathalyzer to test the level of alcohol.

i. Name the colored compound used in a breath analyzer. **[1]**

ii. Explain the working principle of breath analyzer. **[2]**

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**Question 3**

a) Complete the table given below. **[3]**

| Gas | Mole(s) | Gram Molecular Weight (g) | Number of molecules | Molar Volume | |
|---|---|---|---|---|---|
| $O_2$ | 1 | 32 | $6.023 \times 10^{23}$ | A. _____ | |
| $SO_2$ | 1 | 64 | B. _____ | 22.4L | |
| $H_2$ | 2 | C. _____ | $1.204 \times 10^{24}$ | 44.8L | |

b) Explain decomposition reaction with the help of an example. **[2]**

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c) The chemical reaction below shows the combustion of ethanol and petrol.

**$CH_3CH_2OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O \quad \Delta H = -1367$ KJ/mol**
**(ethanol)**

**$C_8H_{18} + 12.5O_2 \longrightarrow 8CO_2 + 9H_2O \quad \Delta H = -1367$ KJ/mol**
**(octane)**

If you are given a choice to select fuel for a car, which one would you choose? Give **TWO** reasons**.** **[2]**

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d) To make hand sanitizer, pure ethanol is diluted with water. To prepare 200ml of 70% ethanol, determine the volume of water and pure alcohol required. **[2]**

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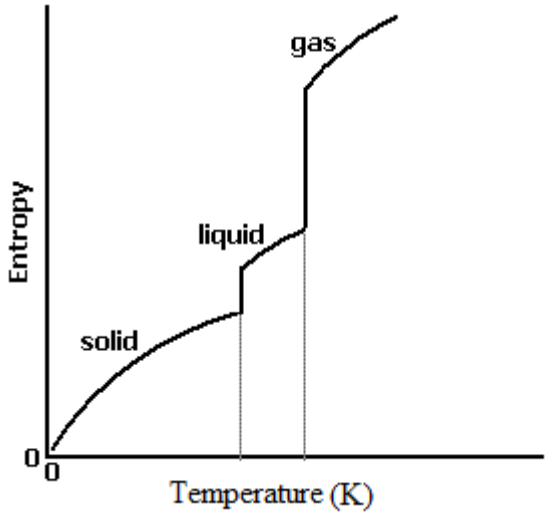
e) Figure below shows the entropy of three states of water with change in temperature.




Which state of water has the lowest entropy? Why? **[1]**

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**Question 4**

a) Sonam conduced an experiment to study the behavior of a gas to verify a law. The table shows the data obtained from her observations.

| **Experiment** | **Pressure (atm)** | **Temperature (K)** | **Volume (ml)** |
|---|---|---|---|
| Round 1 | 2.4 | 300 | 20 |
| Round 2 | 2.4 | 315 | 21 |
| Round 3 | 2.4 | 331 | 22 |

i. Which law did Sonam verify? **[1]**

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ii. Which variable is kept constant? **[1]**

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iii. Predict the volume of the gas at 307 K. **[1]**

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b) Respiration is a biochemical process. Describe the energy changes that take place during aerobic respiration. **[2]**

c) A chemistry teacher asked a group of students to conduct an experiment on the action of alkalis on some compounds of transition elements. They were provided with NaOH(aq) and $ZnSO_4$(aq). The chemical reaction that took place is shown below.

$$\mathbf{ZnSO_4(aq) + 2NaOH(aq) \longrightarrow Zn(OH)_2(s) + Na_2SO_4(aq)}$$

i. With reference to the above statement, write down the procedure to carry out the experiment. **[2]**

ii. What will be the colour of the precipitate formed? **[0.5]**

iii. Name the precipitate formed. **[0.5]**

iv. Suggest **TWO** precautions that must be taken while carrying out the experiment. **[2]**

**Question 5**

a) What is spurious alcohol? Why is it unfit for human consumption? **[2]**

b) When zinc reacts with hydrochloric acid, the reaction is vigorous due to the release of hydrogen gas as show in the equation below.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$ *[Atomic weight of Zinc = 65]*

i. If 26g of Zn is added to dilute HCl, what will be the volume of hydrogen evolved at STP? **[2]**

ii. What will happen to the volume of hydrogen gas evolved if the amount of zinc is doubled? **[1]**

c) Study the table below which shows information about three metals.

| Metal | % of metal on the Earth's crust | Cost in (Nu) per kg |
|---|---|---|
| Aluminium | 8.1 | 200 |
| Copper | 4 | 750 |
| Gold | 0.0000001 | 4,268,986 |

i. Why is gold very expensive? **[1]**

ii. Suggest **TWO** reasons why we should recycle aluminium beverage cans? **[2]**

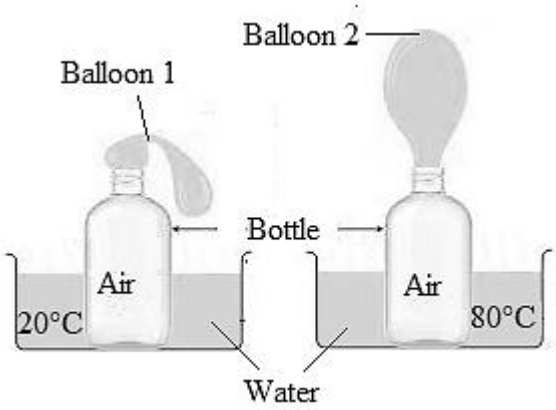
iii. Using the knowledge of metallurgy, which pot would you buy for cooking aluminium or copper pot? Why? **[2]**

**Question 6**

a) "Alcohol is also highly correlated with domestic violence, motor vehicle accidents and suicide in Bhutan. Alcohol is a multi-faceted problem and requires a multi-stakeholder approach. Just leaving it to the Health Ministry is not solving the issue"- Dr. Chencho Dorji, Sr. Consultant Psychiatrist, JDWNRH. *Kuensel dated 27th April 2019.*

Develop an alcohol policy to minimize alcohol-related issues in the country. **[3]**

b) Study the figure given below and answer the questions that follow.




i. Which gas law is associated with the phenomenon? **[1]**

ii. Explain why balloon 2 gets inflated? **[2]**

iii. What will happen to balloon 1 if the temperature of water is increased to 90°C? **[1]**

c) Gold (Au) and Platinum (Pt) are the two elements belonging to the same period in the periodic table.

i. Write **TWO** properties that are common to both the elements. **[2]**

ii. State **ONE** difference based on their chemical property. **[1]**

**Question 7**

a) Study the table given below and answer the following questions.

i. Complete the table and determine the empirical formula of the unknown compound. **[2]**

| **Element** | **Percentage by weight** | **Atomic ratio** | **Simplest ratio** |
|---|---|---|---|
| Carbon | 26.7% | 2.22 | **A** _____ |
| Hydrogen | 2.2% | **B** _____ | 1 |
| Oxygen | 71.1% | 4.44 | **C** _____ |
| Empirical Formula: _____ | | | |

ii. If the relative molecular mass of the unknown compound is 90, what is the molecular formula of the compound? **[2]**

b) Mention **FOUR** steps involved in the commercial production of ethanol from molasses. **[2]**

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c) Draw the structural formula for the following hydrocarbons. **[2]**

| **Ethene** | **2-methyl propan-2-ol** |
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d) Table below shows the relationship between nuclear charge and effective nuclear charge. Fill in the missing information. **[2]**

| **Element** | **Nuclear charge (Z)** | **Shielding electrons (S)** | **Effective nuclear charge ($Z_{eff}$) ($Z_{eff}$ = Z - S)** | |
|---|---|---|---|---|
| | | | **1st shell** | **Valence shell** |
| $_{11}$Na | **A.** _____ | 10 | **B.** _____ | 1 |
| $_{6}$C | +6 | **C.** _____ | 0 | **D.** _____ |

**Question 8**

a) Name the catalyst used in the following processes. **[1]**

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| Haber's process: | |
| Contact process: | |

b) What do you mean by ideal gas? **[1]**

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c) Why do industries prefer to store gases in cylinders under high pressure? Name the gas law applied here. **[2]**

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d) Ideal gas law describes the relationship between pressure, volume, temperature and the number of moles for an ideal gas. Derive ideal gas equation. **[3]**

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e) Study the properties of halogens given in the table below.

| Element | Atomic number | Boiling Point (°C) |
|---|---|---|
| F | 9 | -188 |
| Cl | 17 | -35 |
| Br | 35 | 58 |
| I | 53 | 184 |

i. Plot a bar graph using the information given in the table. **[2]**

ii. Explain the reason for the trend shown in the bar graph. **[1]**

**Question 9**

a) Answer the following questions.

i. Halogens belong to which group? **[1]**

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ii. How are halogens stored? **[1]**

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iii. Using an electron dot diagram, show the formation of ionic compound of NaCl. **[2]**

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b) Karma has $3.613 \times 10^{24}$ atoms of helium gas. If a balloon holds 3 grams of helium, how many balloons can be filled? **[3]**

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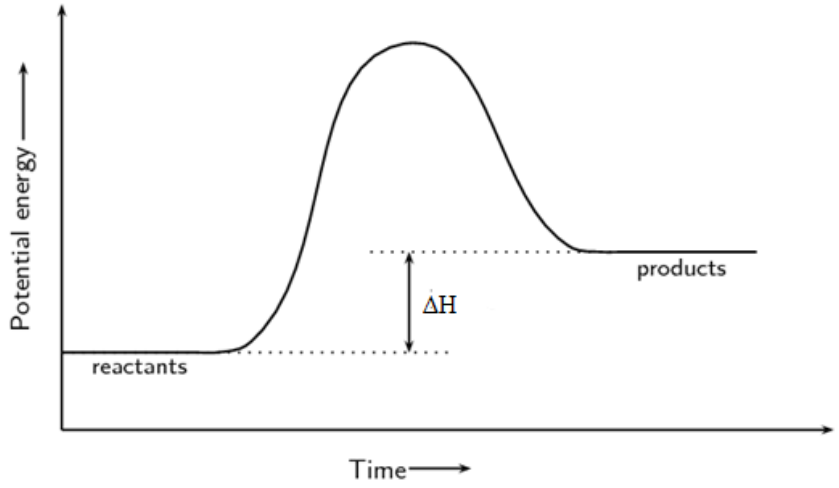
c) Figure below shows the energy diagram of the decomposition of mercury oxide.




i. Name the type of thermochemical reaction involved. **[1]**

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ii. How do we calculate enthalpy change in the reaction? **[1]**

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iii. Determine the value of enthalpy. **[1]**

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