

SECTION A [40 MARKS]
ANSWER ALL QUESTIONS

Question 1

- a) **Direction: For each question, there are FOUR responses: A, B, C and D. Choose the corresponding letter of your response and CIRCLE it neatly. NO score will be awarded if you circle more than ONE letter.** [25]

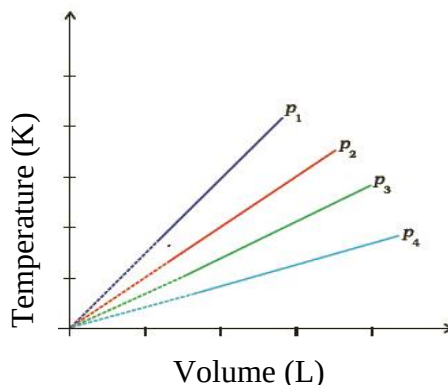
- i. The volume of a gas theoretically becomes zero at 0K. The value of the temperature in degree Celsius at 0K is

A 0°C .
B 100°C .
C 273°C
D -273°C .

- ii. A balloon filled with warm air rises up. This phenomenon proves

A Boyle's Law.
B Charles' Law.
C Avogadro's Law.
D Gay-Lussac's Law.

- iii. The figure given below represents four different plots at different pressures.



The correct sequence for the pressure is

A $P_4 > P_3 > P_2 > P_1$.
B $P_1 > P_2 > P_3 > P_4$.
C $P_2 > P_1 > P_3 > P_4$.
D $P_1 > P_3 > P_4 > P_2$.

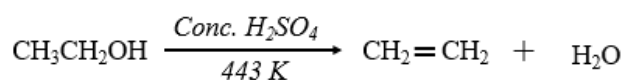
iv. If the pressure of a certain amount of a gas is reduced to $1/6^{\text{th}}$ of its initial pressure at a fixed temperature, then the final volume of the gas would increase by

- A six times.
- B two times.
- C four times.
- D eight times.

v. If you are asked to prepare a denatured alcohol, which among the following substances will you use as a denaturant?

- A Ethanal
- B Ethanol
- C Propanol
- D Methanol

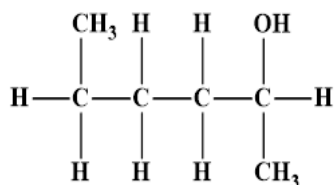
vi. The equation below shows a chemical property of alcohol.



The concentrated sulphuric acid in the reaction is a/an

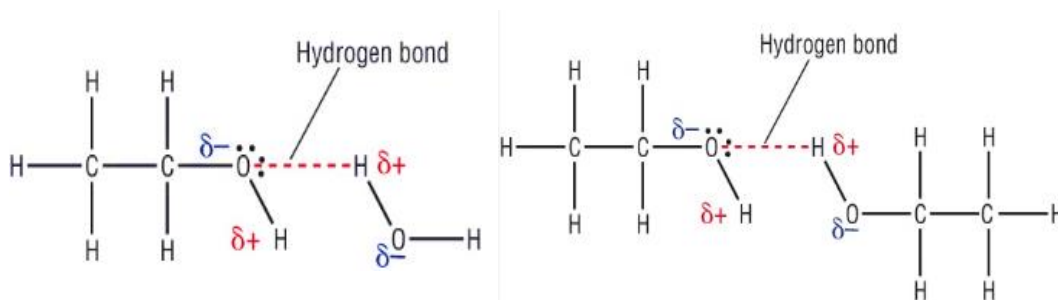
- A reducing agent.
- B oxidising agent.
- C protonating agent.
- D dehydrating agent.

vii. The IUPAC name of the given compound is



- A 2-hexanol.
- B 4-hexanol.
- C 5-hexanol.
- D 2,2-dimethylbutanol.

- viii. The figure given below shows the formation of intermolecular hydrogen bonding.



This property of ethanol results in

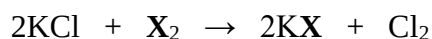
- A lower solubility and lower boiling point.
 - B lower solubility and higher boiling point.
 - C higher solubility and lower boiling point.
 - D higher solubility and higher boiling point.
- ix. Which of the following methods of concentrating an ore correctly matches with its principle?
- A Magnetic separation → difference in the density of the ore and gangue
 - B Froth floatation → preferential wetting properties of the ore and gangue
 - C Leaching → difference in the size of the particles of the ore and gangue
 - D Gravity separation → difference in the magnetic properties of the ore and gangue
- x. The table given below displays the properties of different metals.

Metal	Density (gcm^{-3})	Reactivity
Lead	11.34	No reaction with water.
Copper	8.94	No reaction with water.
Aluminum	2.70	No reaction with water.
Iron	7.86	Reacts with water and air.

Based on the given properties, the most suitable metal to make a canister for beverages is

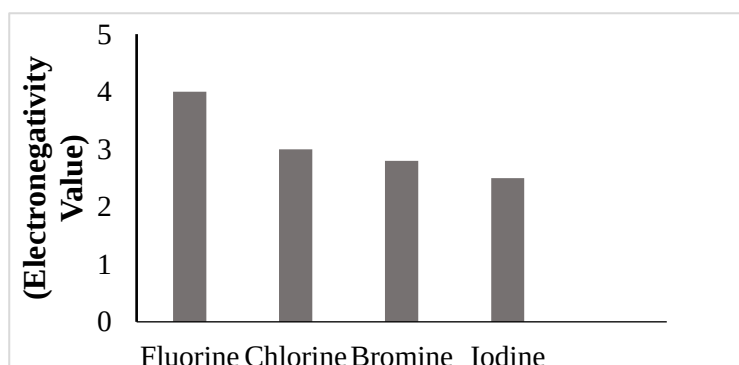
- A lead.
- B iron.
- C copper.
- D aluminium.

- xi. The most suitable reducing agent that can be used to reduce ZnO to Zn metal is
- A carbon.
 - B hydrogen.
 - C aluminium.
 - D carbon monoxide.
- xii. A student bought a tube of toothpaste but returned it to the shop as one of the compositions was missing in it. The missing composition could be
- A NaI.
 - B NaF.
 - C NaCl.
 - D NaBr.
- xiii. While carrying out an experiment, a student added a substance **X** to a solution of potassium chloride. The equation for the reaction is given below.



In the above reaction, substance **X** is most likely to be

- A iodine.
 - B fluorine.
 - C chlorine.
 - D bromine.
- xiv. The figure below is a graph that shows the electronegativity trend of halogens.



This trend is mainly due to

- A increase in the atomic size, down the group.
- B decrease in the atomic size, down the group.
- C increase in the atomic mass, down the group.
- D decrease in the atomic mass, down the group.

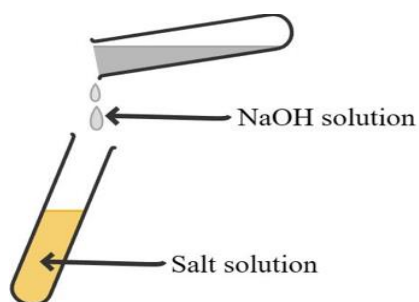
- xv. Generally, d- block elements are transition elements. Which among the following d-block elements is not a transition element?
- A Iron
 - B Zinc
 - C Copper
 - D Cobalt

- xvi. The box given below shows different conditions for the formation of coordinate compounds.

- I. Vacant d-orbitals
- II. Smaller cationic size
- III. Has at least a lone pair of electrons

Which of the following conditions in the central metal ion favours the formation of coordinate compounds?

- A I and II
 - B I and III
 - C II and III
 - D I, II, and III
- xvii. Sonam observed a reddish brown precipitate when a few drops of sodium hydroxide solution was added to 5 cm³ of salt solution as shown in the figure below. The salt solution is most likely to be



- A FeCl₂ solution.
- B FeCl₃ solution.
- C CuSO₄ solution.
- D ZnSO₄ solution.

xviii. Tungsten is used in making the filaments of an electric bulb because it has

- A low density.
- B high density.
- C low melting point.
- D high melting point.

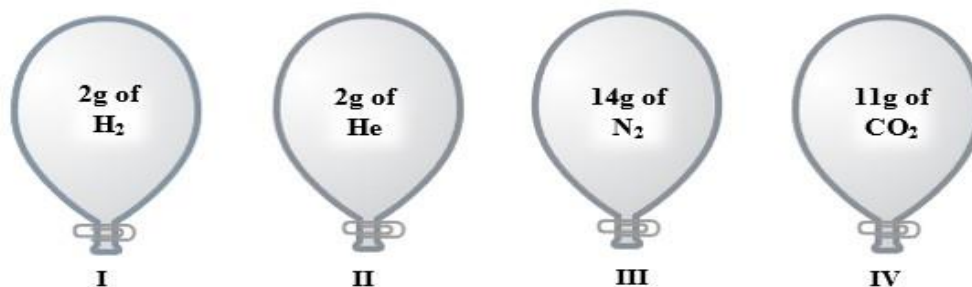
xix. The table below shows the percentage abundance of isotopes of copper.

Isotopes of copper	Percentage of abundance (%)
Cu-63	69.17
Cu-65	30.83

The relative atomic mass of copper is

- A 63.00.
- B 63.62.
- C 65.00.
- D 65.62.

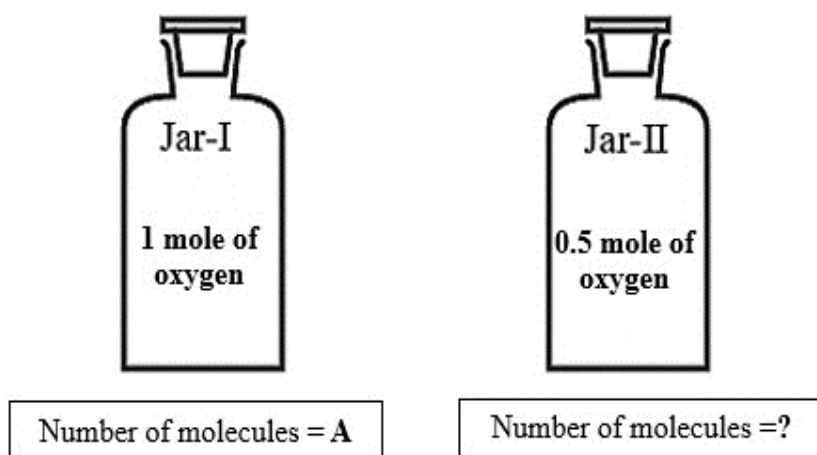
xx. The figure below shows balloons filled with different gases at STP.



Which of the two balloons contain equal number of particles?

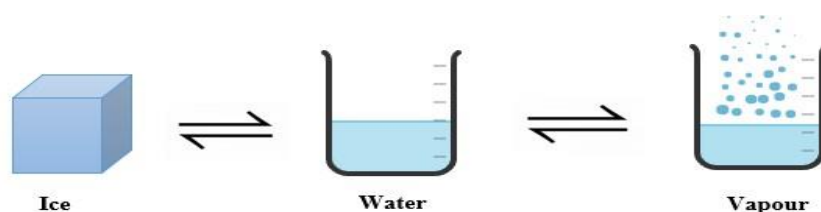
- A I and II
- B I and III
- C II and III
- D III and IV

- xxi. Paracetamol ($\text{C}_8\text{H}_9\text{NO}_2$) is the most common analgesic used worldwide and is recommended as first line therapy in pain conditions by the World Health Organization. Its gram molecular mass is
- A 150 g.
B 151 g.
C 152 g.
D 153 g.
- xxii. The figure below shows two jars containing different amounts of oxygen gas.



- The number of oxygen molecules in Jar II is
- A $A/5$.
B $A/4$.
C $A/3$.
D $A/2$.
- xxiii. A compound X has an empirical formula of CH_3 and molar mass of 30 g mol^{-1} . The compound X is
- A ethane.
B butane.
C pentane.
D propane.

xxiv. The figure given below shows the conversion of ice to water vapour.



In which of the following conversions is the value of ΔH greater than zero?

- A Ice $\rightarrow$ water
- B Water $\rightarrow$ ice
- C Water vapour $\rightarrow$ ice
- D Water vapour $\rightarrow$ water

xxv. The table below represents four different reactions with their entropy values. Which reaction has the lowest disorderliness?

	Reaction	ΔS (JK^{-1})
A	$2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$	-187.95
B	$\text{NH}_4\text{Cl}(\text{s}) \rightarrow \text{NH}_3(\text{g}) + \text{HCl}(\text{g})$	284.55
C	$2\text{C}(\text{s}) + 2\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g})$	2.96
D	$\text{H}_2\text{O}(\text{l}) \rightarrow \text{H}_2\text{O}(\text{g})$	1.30

b) Fill in the blanks with appropriate word (s).

[5]

i.	The value of PV for 0.5 moles of gas at standard temperature is _____.
ii.	Alcohol has a great cultural and ceremonial significance in Bhutan. The main ingredient in preparation of alcoholic beverages is _____.
iii.	The metal that can be used as thermometric liquid is _____.
iv.	The empirical formula of $\text{C}_6\text{H}_{12}\text{O}_6$ is _____.
v.	When sodium hydroxide pellets are dissolved in water, the solution becomes warm. The value for heat of solution is _____.

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

i.	When the amount of gas is reduced by half, the number of the gas particles increases by double.		
ii.	The volatility of alcohol is inversely proportional to its boiling point.		
iii.	Fluorine, chlorine, bromine, and iodine are diatomic molecules which are non-polar in nature.		
iv.	When the d-orbital is half filled, the number of electrons in the orbital is 7.		
v.	The volume occupied by 2g of hydrogen is lesser than the volume occupied by 4g of helium at STP.		

d) Match each item under Column A with the item in Column B. Write the correct pairs by writing the letter against the number in the answer column. [5]

Answer	Column A	Column B	
i. _____	i. Pressure-temperature relationship	a. Law of conservation of energy	
ii. _____	ii. Electrolytic reduction	b. Boyle's law	
iii. _____	iii. Treatment of hyperthyroidism and other malignant growth	c. CuO	
iv. _____	iv. 2 moles of gaseous substance	d. Al ₂ O ₃	
v. _____	v. Total energy of the universe remains constant	e. Astatine	
		f. 22.4dm ³	
		g. Gay-Lussac's law	
		h. 44.8dm ³	

SECTION B [60 MARKS]
ATTEMPT ANY SIX QUESTIONS

Question 2

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

Element	Nuclear charge	Total shielding electron(s)	Effective nuclear charge	
Cl	+17		+7	
Na		10	+1	
H	+1	0		

- b) Write down **ONE** difference between the following pairs based on what is given in the bracket.

- i. Roasting and calcination (ore) [1]

Roasting	Calcination	

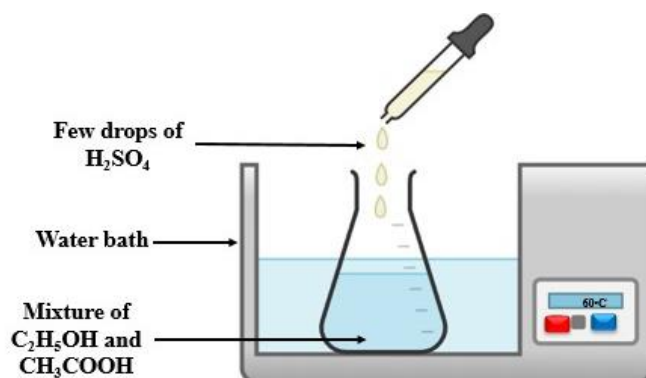
- ii. Pyrometallurgy and aluminothermy (definition) [1]

Pyrometallurgy	Aluminothermy	

- c) The tyre of a car containing 9 moles of air occupies a volume of 36 L. While driving from Thimphu to Paro, the tyre got punctured, and the volume of the air was reduced by half. What would be the amount of air in the deflated tyre assuming temperature and pressure are constant? [2]

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- d) Study the experiment given in the figure below and answer the questions that follow.



- i. What is the aim of the experiment? [1]

- ii. Represent the reaction with a balanced chemical equation. [1]

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- iii. Write down **ONE** safety measure that you need to follow during the experiment. [1]

Question 3

- a) The table below shows the pressure of a sample of a gas with four different volumes at constant temperature.

Volume (L)	Pressure (atm.)
2	12
4	6
6	4
8	3

- i. Based on the data, plot a graph of volume versus pressure. [2]

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ii. Based on the graph draw a conclusion. **[1]**

iii. Use the data given in the table to prove that $PV = \text{Constant}$. **[1]**

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b) Calculate the percentage composition of copper and water of crystallization in blue vitriol ($\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$). [Atomic mass of Cu = 63.5] **[3]**

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- c) Consumption of alcohol is harmful to our health. It has a negative impact on our society and youths. As a responsible citizen of the country, suggest any **THREE** strategies that may help to curb issues related to alcohol consumption. [3]

Question 4

- a) The table below shows the composition of a compound. Study the table and answer the following questions.
- i. Complete the table and determine the empirical formula of the unknown compound. [2]

Element	% composition	Atomic weight	Atomic ratio	Simple ratio
K	47.9	39	_____	2
Be	_____	9	0.6	1
F	46.6	19	2.4	_____
Empirical formula = _____				

- ii. Determine the molecular formula of the compound whose vapour density is 81.5. **[2]**

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- b)** An element X is a 3d-block element and has an atomic number of 26.

- i. Write the electronic configuration of element X in s, p, d, f notation. **[1]**

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- ii. Predict the oxidation states of the element X. **[1]**

- c)** Define the following.

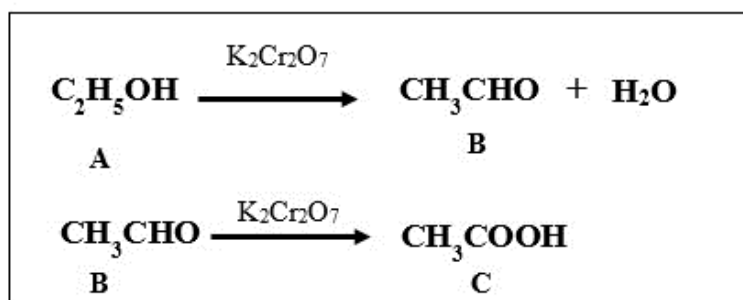
- i. Internal energy **[1]**

ii. Heat of neutralization [1]

d) Why should the glass container for the storage of fluorine be dry? [2]

Question 5

a) Study the chemical reactions below and answer the following questions.



i. What is the function of potassium dichromate in the above reactions? [1]

ii. Give the IUPAC name of substance C. [1]

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- iii. Illustrate a model of a device that works on the principle of the above reaction. [2]

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- b) Pharmaceutical product X has 41.37% of Mg, 55.17% of O and 3.45% of H. [2]
Determine the mass of magnesium and hydrogen, if the mass of X is 58 grams.

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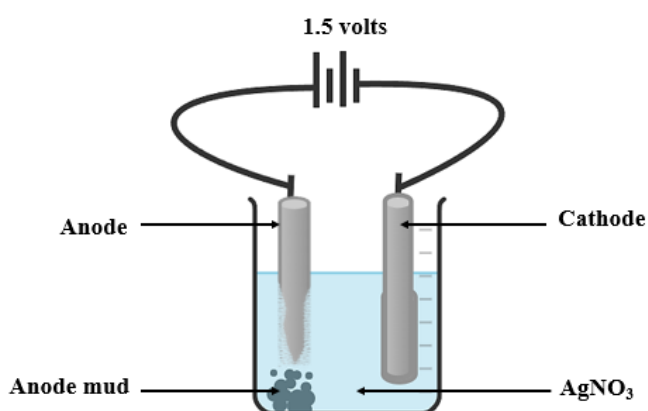
- c) Electron affinity generally decreases down the group. However, chlorine, which is [2]
located below fluorine in the modern periodic table, has more electron affinity than
fluorine. Give reasons.

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- d) Energy change in the system is fundamental for the existence of life on the Earth. [2]
Justify the statement with **TWO** examples.

Question 6

- a) The figure below shows the electrolytic refining of impure silver.



- i. Which electrode is pure silver? Give a reason. [2]

- ii. Classify the reactions below as cathodic or anodic. [1]

1) $\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$ _____	
2) $\text{Ag} \rightarrow \text{Ag}^+ + \text{e}^-$ _____	

- iii. What happens if the electrodes are exchanged? [1]

- b)** Transitioning from fossil fuels to biofuels offers compelling pathway towards a cleaner, greener, and more sustainable energy future. Suggest a practical procedure to formulate biofuel from any source. **[3]**

- c)** A sample of gas occupies a volume of 160 cm^3 at 10 atm and 25°C . What volume does it occupy if the pressure is decreased to 8 atm at constant temperature? **[2]**

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- d)** Why are noble metals such as gold, platinum and silver used in making ornaments? **[1]**

Question 7

- a) The table below shows information related to the industrial preparation of certain substances. Study and complete the table. [3]

Name of the Process	Reactants	Catalyst	Products
_____	$\text{H}_2 + \text{N}_2$	Fe	NH_3
Contact process	$\text{SO}_2 + \text{O}_2$	V_2O_5	_____
Hydrogenation of alkenes	$\text{C}_2\text{H}_4 + \text{H}_2$	_____	C_2H_6

- b) To study the bleaching action of chlorine, a student is provided with a coloured flower and chlorine. With the help of chemical equations, explain the bleaching action of chlorine. [2]

- c) The reaction between calcium carbonate and hydrochloric acid is an example of an acid-base reaction, producing carbon dioxide, water and soluble calcium chloride salt as shown in the equation below.



- i. Calculate the mass of calcium chloride produced from 25 g of calcium carbonate at STP. [2]

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- ii. Find out the volume of carbon dioxide gas evolved at the same time. [2]

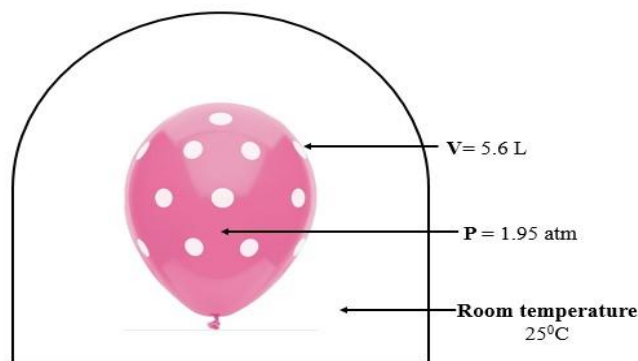
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- d) Halogens are highly soluble in organic solvents. However, they have low solubility in water. Give a reason. [1]

Question 8

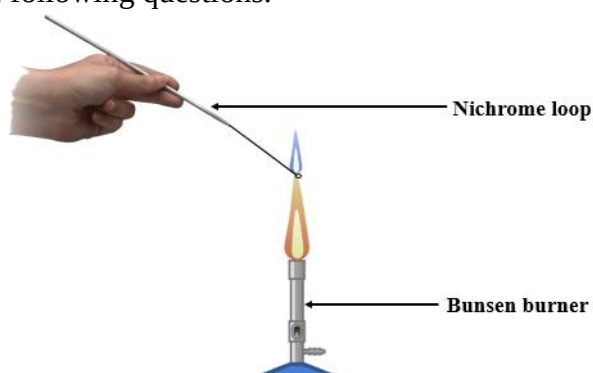
- a) Write down **TWO** advantages of nanoparticles/ alloys over their bulk counterparts. [2]

- b) A balloon filled with a certain amount of helium gas is kept in a room as shown in figure below. Study the figure and determine the mass of helium gas in the balloon. [3]



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- c) The figure below shows a flame test carried out in a chemistry class. Study the figure and answer the following questions.



- i. When the moist sample of salt X is picked with the help of nichrome loop and placed over the flame, it produced blue flame. Identify the salt X. [1]

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ii. Why does X exhibit colour with flame? [2]

iii. Give **ONE** application of the above test. [1]

d) Write down the relationship between internal energy and enthalpy. [1]

Question 9

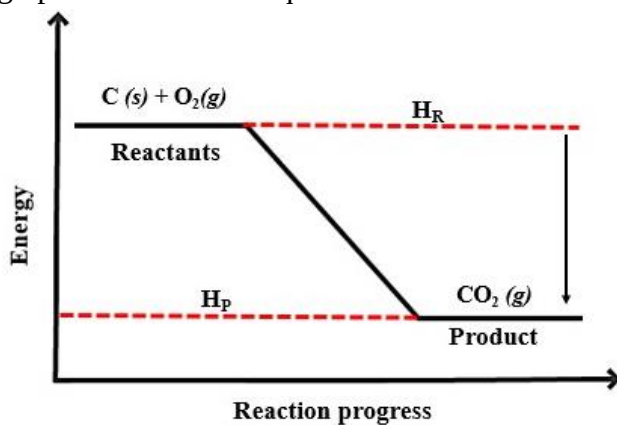
a) Write **TWO** differences between paramagnetic and diamagnetic substances. [2]

Paramagnetic substance	Diamagnetic substance	

- b) Gay-Lussac's law remains an essential principle in the study of gases, helping to predict the relationship between pressure and temperature at constant volume. Derive Gay-Lussac's law equation. [2]

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- c) Study the graph and answer the questions that follow.



- i. What can you say about the energy of the reactants and the product? [1]

ii. How do we calculate the change in enthalpy (ΔH)? [1]

iii. Can the value of enthalpy change (ΔH) in the chemical reaction be zero? Give a reason. [1]

d) Dorji buys a cylinder of oxygen containing 1.076×10^{23} oxygen particles at STP to support a patient with ventilation at Nu.360. How much does Dorji pay for a litre of oxygen? [3]

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