3.6.2   Chemistry Paper 2 (233/2)

1   (a)   The grid given below represents part of the periodic table. Study it and answer the questions that follow. The letters do not represent the actual symbols of elements.

M			N	P	T		
R							

(i)   Select a letter which represents an element that loses electrons most readily. Give a reason for your answer.   (2 marks)

(ii)   Explain why the atomic radius of P is found to be smaller than that of N.
                                                                                    (2 marks)

(iii)   Element M reacts with water at room temperature to produce 0.2 dm^3 of gas. Determine the mass of M which was reacted with water. (Molar gas volume at room temperature is 24 dm^3, Relative atomic mass of M = 7).   (3 marks)

(b)   Use the information in the table below to answer the questions that follow. (The letters are not the symbols of the elements)

Element	State of oxide at room temperature	Type of oxide	Bonding in oxide
U	Solid	Acidic	Covalent
W	Solid	Basic	Ionic
X	Liquid	Neutral	Covalent
Y	Gas	Neutral	Covalent

Identify a letter which represents an element in the table that could be calcium, carbon or sulphur. Give a reason in each case.

(i)   Calcium: ....(2 marks)

Reason ....

(ii)   Carbon: ....(2 marks)

Reason ....

(iii)   Sulphur: ....(2 marks)

Reason ....

2 (a) (i) What is meant by the term 'Enthalpy of formation'? (1 mark)

(ii) The enthalpies of combustion of carbon, methane and hydrogen are indicated below:

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}; \Delta H = -393 \text{ kJ mol}^{-1}$$

$$H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(l)}; \Delta H = -286 \text{ kJ mol}^{-1}$$
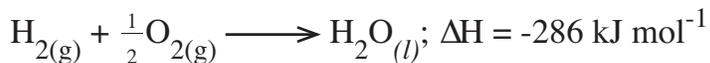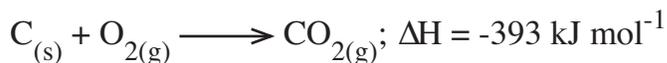
Enthalpy of combustion of CH_4 = -890 kJ mol^{-1}

I Draw an energy cycle diagram that links the enthalpy of formation of methane to enthalpies of combustion of carbon, hydrogen and methane.
(2 marks)

II Determine the enthalpy of formation of methane. (2 marks)

(b) An experiment was carried out where different volumes of dilute hydrochloric acid and aqueous sodium hydroxide both at 25°C were mixed and stirred with a thermometer. The highest temperature reached by each mixture was recorded in the table below:

Volume of hydrochloric acid (cm³)	5	10	15	20	25	30	35	40	45
Volume of sodium hydroxide (cm³)	45	40	35	30	25	20	15	10	5
Highest temperature of mixture (°C)	27.2	29.4	31.6	33.8	33.6	31.8	30.0	28.4	26.6

(i)   On the grid provided, plot a graph of highest temperature (vertical axis) against volume of hydrochloric acid (horizontal axis).   (3 marks)
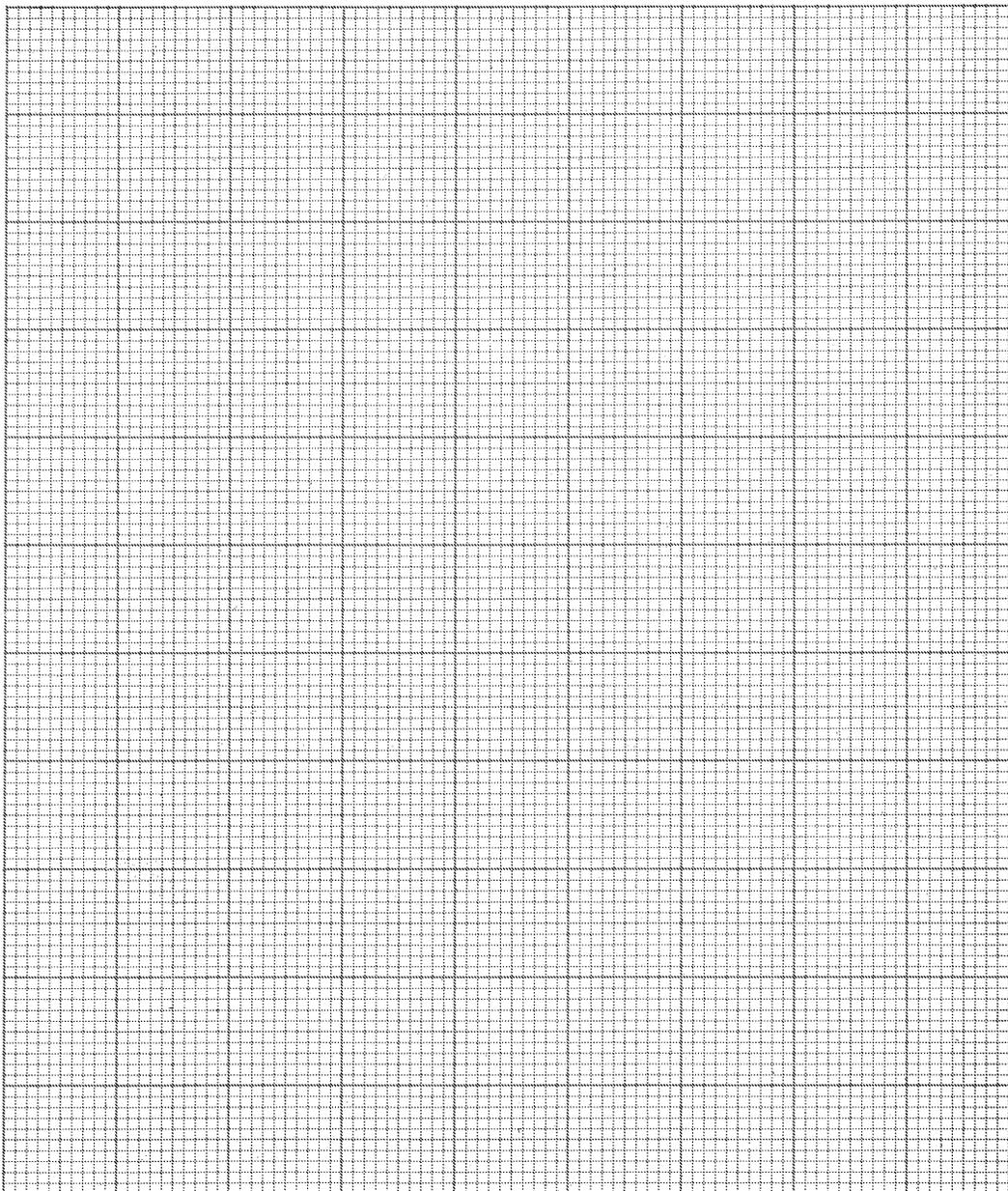
(ii)   Using your graph, determine the:

I   highest temperature reached;   ($\frac{1}{2}$ mark)

II   volume of acid and base reacting when highest temperature is reached;   ($\frac{1}{2}$ mark)

(iii) Calculate the amount of heat liberated during the neutralisation process. (Specific heat capacity is 4.2 J g^{-1}K^{-1} and the density of solutions is 1.0 g cm^{-3}).   (2 marks)

(c)   The molar enthalpy of neutralisation between hydrochloric acid and ammonia solution
       was found to be -52.2 kJ mol⁻¹, while that of hydrochloric acid and sodium hydroxide
       was -57.1 kJ mol⁻¹. Explain the difference in these values.   (2 marks)

3   (a)   The diagram below shows the Frasch process used for extraction of sulphur.
   Use it to answer the questions that follow.
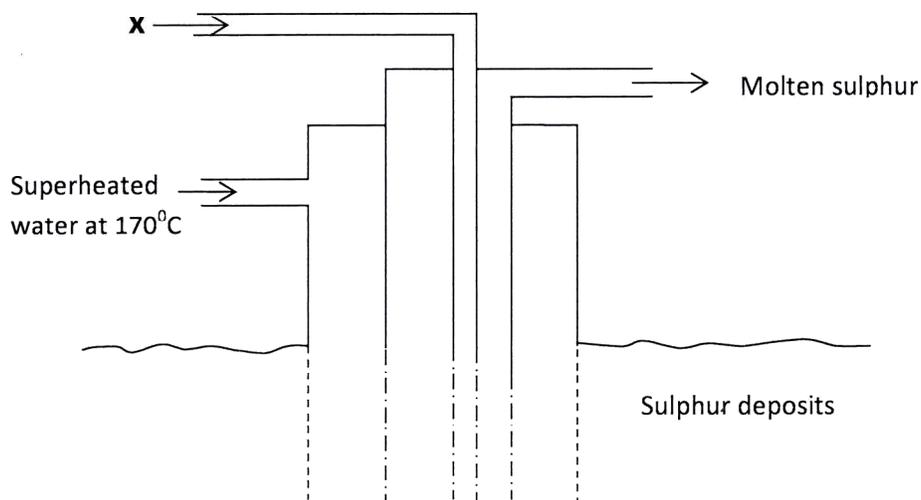
(i)   Identify X.   (1 mark)

(ii)   Why is it necessary to use super heated water in this process?   (1 mark)

(iii)   State **two** physical properties of sulphur that makes it possible for it to be
        extracted by this method.   (2 marks)

(b) The diagram below shows part of the processes in the manufacture of sulphuric (VI) acid. Study it and answer the questions that follow.

Concentrated sulphuric (VI) acid

Air

Sulphur (IV) oxide → PURIFIER →

CHAMBER A

Sulphur (IV) oxide + air

CATALYTIC CHAMBER B

HEAT EXCHANGER

Sulphur (VI) oxide

Concentrated Sulphuric (VI) acid

ABSORPTION TOWER

Oleum
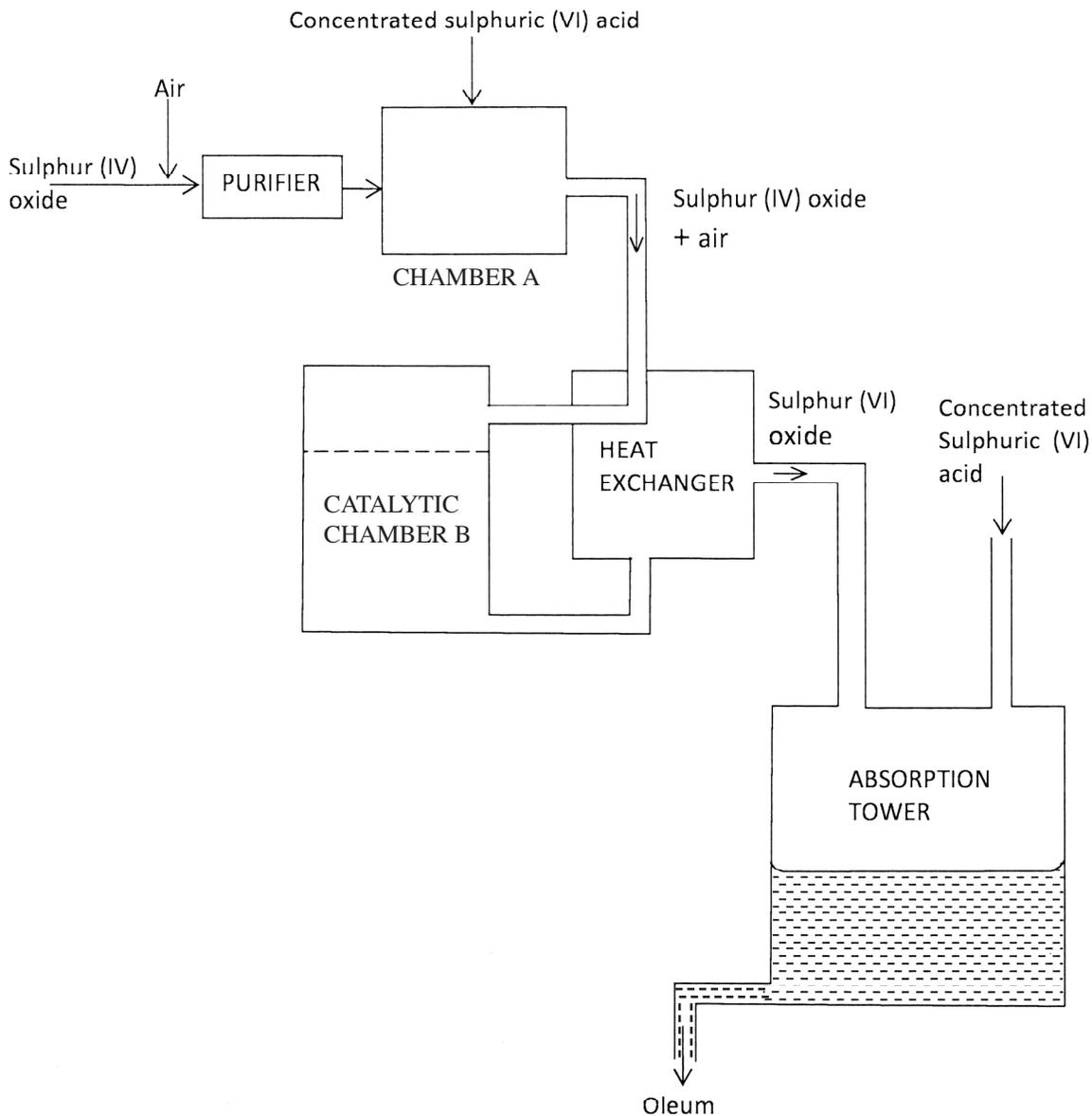
(i) Write an equation for the formation of sulphur (IV) oxide from sulphur.

(1 mark)

(ii) What is the role of concentrated sulphuric (VI) acid in chamber A? (1 mark)

(iii) Name **two** catalysts that can be used in the catalytic chamber B. (2 marks)

(iv) State **two** roles of the heat exchanger. (2 marks)

(c) Explain **one** way in which sulphur (IV) oxide is a pollutant. (1 mark)

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(d) What observation will be made when a few drops of concentrated sulphuric (VI) acid are added to crystals of sugar? Explain your answer. (1 mark)

**4** (a) The set up below can be used to produce sodium hydroxide by electrolysing brine.
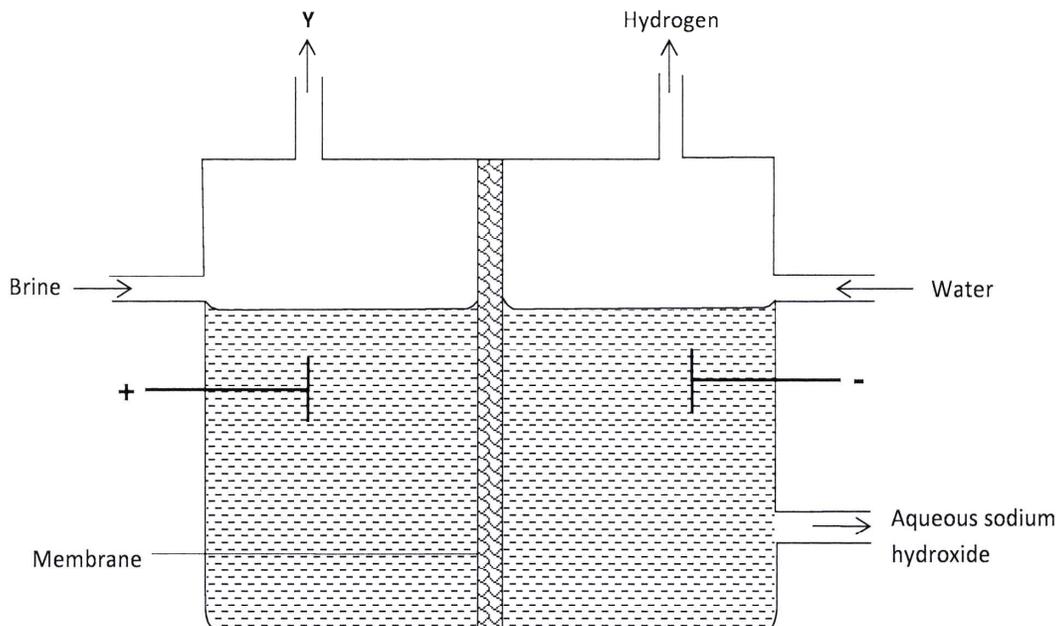
(i) Identify gas Y. (1 mark)

(ii) Describe how aqueous sodium hydroxide is formed in the above set-up. (2 marks)

(iii) One of the uses of sodium hydroxide is in the manufacturing of soaps. State **one** other use of sodium hydroxide. (1 mark)

(b) Study the information given in the table below and answer the questions that follow.

Half reactions	Electrode potential $E^{\theta} V$
$D^{2+}_{(aq)} + 2e \longrightarrow D_{(s)}$	-0.13
$E^{+}_{(aq)} + e \longrightarrow E_{(s)}$	+0.80
$F^{3+}_{(aq)} + e \longrightarrow F^{2+}_{(aq)}$	+0.68
$G^{2+}_{(aq)} \, 2e \longrightarrow G_{(s)}$	-2.87
$H^{2+}_{(aq)} + 2e \longrightarrow H_{(s)}$	+0.34
$J^{+}_{(aq)} + e \longrightarrow J_{(s)}$	-2.71

(i) Construct an electrochemical cell that will produce the largest emf. (3 marks)

(ii) Calculate the emf of the cell constructed in (i) above. (2 marks)

(iii) Why is it **not** advisable to store a solution containing E^{+} ions in a container made of H? (2 marks)

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5 (a) Describe **one** method that can be used to distinguish between sodium sulphate and sodium hydrogen sulphate. (2 marks)

(b) Describe how a pure sample of lead (II) sulphate can be prepared in the laboratory starting with lead metal. (3 marks)

(c) Study the flow chart below and answer the questions that follow:
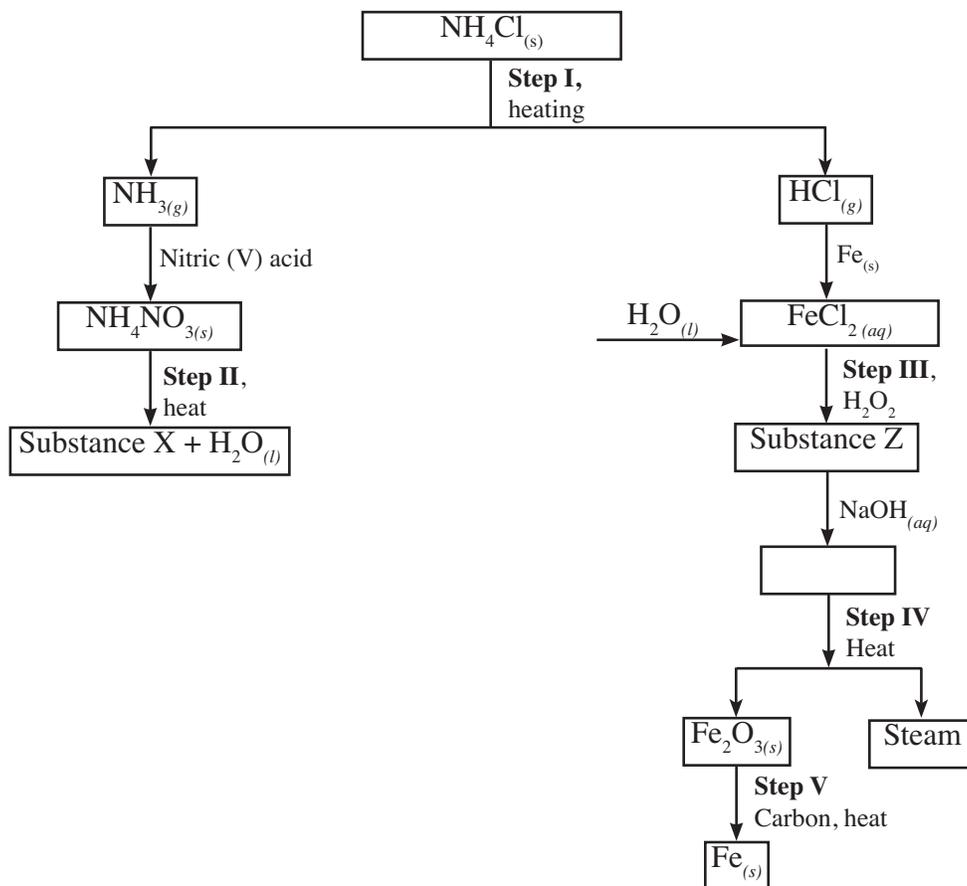
(i) Write an equation for the reaction in:

I   step II; (1 mark)

II   step IV. (1 mark)

(ii) State the observation made in step III. Explain. (2 marks)

(iii) Name another substance that can be used in step V. (1 mark)

6 (a) Distinguish between a neutron and a proton. (1 mark)

(b) What is meant by a radioactive substance? (1 mark)

(c) State **two** dangers associated with radioactive substances in the environment. (2 marks)

(d) The two isotopes of hydrogen, deuterium ($_1^2D$) and tritium ($_1^3T$) react to form element Y and neutron particles, according to the equation below:

$$_1^2D + _1^3T \longrightarrow _b^aY + _0^1n$$

    (i) What is the atomic:

        (I) mass of Y;   (1 mark)

        (II) number of Y.   (1 mark)

    (ii) What name is given to the type of reaction undergone by the isotopes of hydrogen?   (1 mark)

(e) (i) What is meant by half-life of a radioactive substance?   (1 mark)

    (ii) 288g of a radioactive substance decayed to 9g in 40 days. Determine the half-life of the radioactive substance.   (2 marks)

7 (a) Give the systematic names for the following compounds:

    (i) CH_3CH_2COOH;   (1 mark)

    (ii) $CH_3CH_2CH_2CHCH_2$;   (1 mark)

    (iii) $CH\ C\ CH_2CH_3$.   (1 mark)

(b) Study the flow chart below and use it to answer the questions that follow:
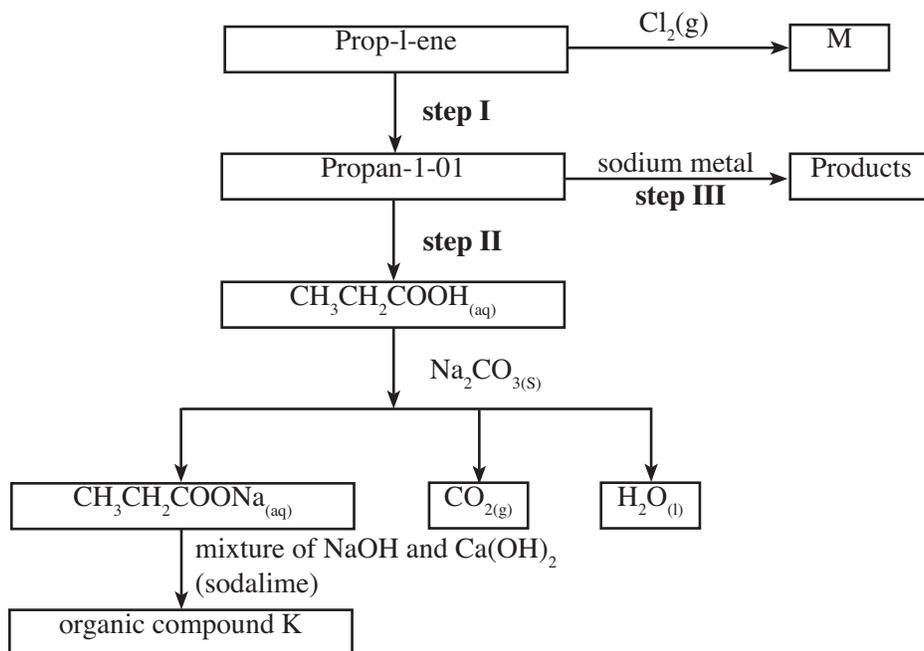
    (i) Identify the organic compound K.   (1 mark)

(ii)   Write the formula of M.   (1 mark)

    (iii)   Give one reagent that can be used in:

    (I)   step I;   (1 mark)

    (II)   step II.   (1 mark)

(iv)   Write the equation of the reaction in step III.   (1 mark)

(c)   The structure below represents a type of a cleansing agent.

R —⟨ ◯ ⟩— $SO_3^- Na^+$
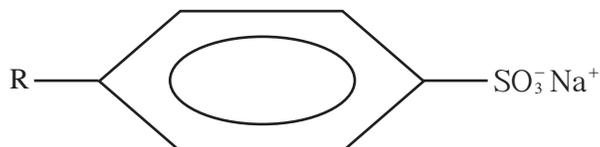
Describe how the cleansing agent removes grease from a piece of cloth.   (3 marks)