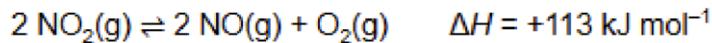


## Question - 01

Nitrogen dioxide decomposes at a high temperature.



(a) A 0.317 mol sample of nitrogen dioxide is placed in a sealed flask and heated at a constant temperature until equilibrium is reached.

At equilibrium, the flask contains 0.120 mol of oxygen.

Calculate the mole fraction of each substance at equilibrium.

Mole fraction of  $\text{NO}_2$  \_\_\_\_\_

Mole fraction of  $\text{NO}$  \_\_\_\_\_

Mole fraction of  $\text{O}_2$  \_\_\_\_\_

(3)

(b) The total pressure in the flask in part (a) is 120 kPa at equilibrium.

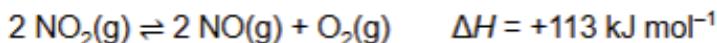
Calculate the partial pressure, in kPa, of  $\text{NO}_2$ .

If you were unable to answer part (a) you should assume that the mole fraction of  $\text{NO}_2$  is 0.380. This is **not** the correct answer.

Partial pressure \_\_\_\_\_ kPa

(1)

(c) The table below shows the mole fractions of the three gases in a different equilibrium mixture.



Gas	Mole fraction
NO <sub>2</sub>	0.310
NO	0.460
O <sub>2</sub>	0.230

For this equilibrium mixture,  $K_p = 59.7 \text{ kPa}$

Give an expression for  $K_p$  for this reaction.

Use your expression and the data in the table to calculate the total pressure, in kPa, in the flask.

$K_p$

Total pressure \_\_\_\_\_ kPa

(3)

(d) The equilibrium mixture in part (c) is compressed into a smaller volume.

Deduce the effect, if any, of this change on the equilibrium yield of oxygen and on the value of  $K_p$

Effect on yield of oxygen \_\_\_\_\_

Effect on  $K_p$  \_\_\_\_\_

(2)

(e) The equilibrium mixture in part (c) is allowed to reach equilibrium at a lower temperature.

Explain why the equilibrium yield of oxygen decreases.

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(2)

(a) M1 0.176

M2 0.549

M3 0.275

*Allow answers to 2 significant figures*

3

(b) 21.1 (kPa)

*Allow answer to question (a) x 120 and answer in kPa**Allow 21.6 (kPa)**Answer using given value of 0.380 mol = 45.6(kPa)*

1

(c) M1 
$$K_p = \frac{p(\text{NO})^2 p(\text{O}_2)}{p(\text{NO}_2)^2}$$

M2 
$$= \frac{K_p \times \text{mol frac } (\text{NO}_2)^2}{\text{mol frac } (\text{NO})^2 \times \text{mol frac } (\text{O}_2)} \text{ OR } \frac{59.7 \times (0.31)^2}{(0.46)^2 \times (0.23)}$$

M3 = 117.9 (kPa) or 118 (kPa)

*Do not allow square brackets**Rearrangement*

3

(d) Decrease

No change

2

(e) M1 Reaction is endothermic OR exothermic in backwards direction

M2 Equilibrium shifts/moves in backwards direction/to the left to raise the temp/oppose the decrease in temp

2