SUPPORT PAPER TWO

Continued from previous article:

QUESTION 8 (15)

Methane gas, when reacted with oxygen gas can produce poisonous carbon monoxide and hydrogen gas. The following experiment was carried out to investigate this reaction.
Consider the following reversible reaction which has reached equilibrium.

$2CH_{4(g)} + O_{2(g)} \Longleftrightarrow 2CO_{(g)} + 4H_{2(g)}$

8.1. Distinguish between **"reversible"** and **"equilibrium" as related to chemical reactions.** (2)
8.2. Cooling the reaction mixture increases the concentration of the H_2 gas.
8.2.1. Is the forward reaction **exothermic** or **endothermic**? (1)
8.2.2. What effect would raising the temperature have on the rate of production of the hydrogen gas? (3)
8.2.3. What effect would a catalyst have on the ΔH value? (1)
8.3. State what would happen to the **amount of CH_4** if : (simply state **increase**, **decrease**, **no change**)
8.3.1. the pressure is increased (2)
8.3.2. some oxygen gas is removed (2)
8.3.3. a catalyst is added (2)
8.3.4. the temperature is increased (2)

QUESTION 9 (11)

The following equation shows the typical Contact step in the Contact Process.
Consider the reaction done in a sealed container. (All are gases)

$$2SO_2 + O_2 \Longleftrightarrow 2SO_3$$

The **Kc** for the reaction at temperature T is **20**.

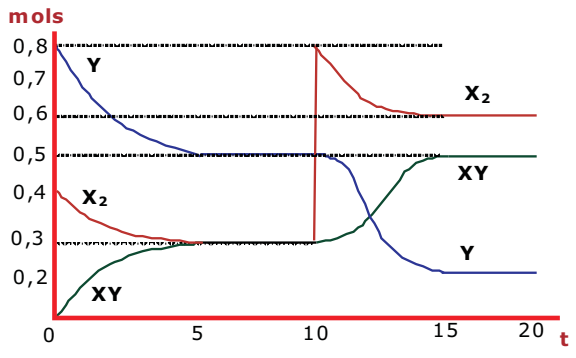
9.1. At some point during the reaction, at temperature T, the concentrations were established to be:

$[SO2] = 0,3 mol.dm^{-3}$ $[O2] = 0,25 mol.dm^{-3}$ $[So3] = 0,3 mol.dm^{-3}$

Show by means of a suitable calculation that the reaction is not in equilibrium. (4)
9.2. In which direction would the reaction have to effectively proceed in order to reach equilibrium? (2)
9.3. Analysis of the concentrations at equilibrium shows that the concentrations of sulphur dioxide gas and oxygen gas are now the same. The sulphur trioxide concentration is twice as much. Calculate the mass of sulphur trioxide that must have been used at the start of the reaction if 3,5 mols of oxygen gas was used at the start. Assume that the temperature remained at T. (5)

QUESTION 10 (15)

The following mols-time graph shows the relationship between various substances according to a hypothetical reaction.



X_2 gas of quantity 0,4mol and twice as many mols of Y gas are allowed to react in a sealed $10dm^3$ container.

The temperature was attempted to be kept constant by means of a water bath until equilibrium was reached.

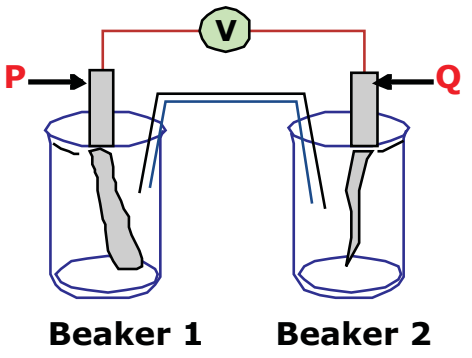
$$X_2 + 2Y \Longleftrightarrow 2XY \quad \Delta H < 0$$

10.1. Calculate the value of the equilibrium constant for the first time that equilibrium was reached. (6)
10.2.1. What happened at t = 10s? (2)
10.2.2. What shift did this cause? Provide evidence from the graph. (3)
10.3. Prove that the temperature had not remained constant throughout the 20s. (2)
10.4 Conclude whether there was an increase or a decrease in the temperature. (2)

QUESTION 11 (33)

Electrochemical cells confirms a remarkable relationship between chemicals and electricity.

The diagram shows an X/Mg cell that has been in operation for a while. The magnesium electrode has been identified as being the anode.

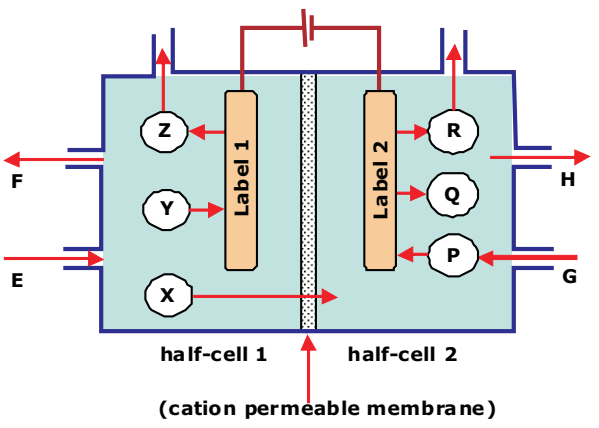


It was set up according the standard conditions, with the initial voltmeter reading being 2,70V.

11.1. State the energy conversion in the above cell. (1)
11.2. State one purpose of the salt bridge. (1)
11.3. Does such a cell produce AC or DC? Explain briefly. (3)
11.4. What is the sign of the anode? Motivate your answer. (3)
11.5. If the anode was made twice as large, what would happen to the voltmeter reading? The reading would … (**double, remain unchanged, halve**) (1)
11.6. Which electrode P or Q, would be made of magnesium? Provide an observable reason from the DIAGRAM. (2)
11.7. In which direction will the electrons flow? (from **P to Q** or from **Q to P**?) (1)
11.8. Write down the half reaction occurring in **Beaker 2**, and state whether this reaction is an oxidation or reduction half reaction. (4)
11.9. Write down the reaction occurring at the cathode. (2)
11.10. Write down the net reaction for this cell. (3)
11.11. If the volume of electrolyte in the beakers was $0,2dm^3$, determine the maximum mass loss of the anode. (4)
11.12. Eventually the voltmeter reads zero.
11.12.1. At this time, what can be concluded about the net reaction of the cell? (2)
11.12.2. At this time, what can be concluded about the concentrations of the electrolytes? (2)
11.13. If electrode **P** was replaced by the standard hydrogen electrode:
11.13.1. would the magnesium still be acting as the anode? (2)
11.13.2. what would be the reading on the voltmeter? (2)

QUESTION 12 (30)

The chlor-alkali industry involves the process called **electrolysis**.
The cell shown is used to produce three very important and useful compounds.



The cell includes a **cation permeable membrane**, which is an innovative design that makes the functioning of this cell so unique and environmentally safe.

Study the diagram in totality very carefully and then answer the questions that follow.
The letters **E, F, X, Y, Z, P, Q, R, G and H** represent chemical compounds.
Labels 1 and 2 also represent chemical compounds.

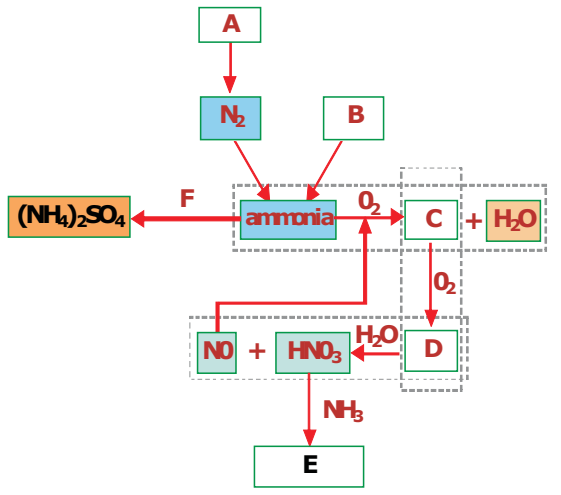
12.1. What is meant by the term **electrolysis**? (2)
12.2. The **cation permeable membrane** allows a certain ion **X** to pass through it. Write down the formula of this cation. (1)
12.3. Write down the formula of the compound from which the cation originates. (1)
12.4. Consider **Label 1**.
12.4.1. Is this the anode or the cathode? (1)
12.4.2. Is the sign positive or negative? (1)

12.5. Write down the formula for compound **Y**. (1)
12.6.1. Write down the reaction that **Y** will undergo when it interacts with the electrode. (3)
12.6.2. Is this reaction an **oxidation** or **reduction ½ reaction**? (2)

12.7. Name the green gas represented by **Z**. (1)
12.8. Write down **1 similarity** and **1 difference** between the compounds represented by **E** and **F**. (4)
12.9. Write down the formula of the compound pumped in at **G**. (1)
12.10. Write down the reaction that this compound undergoes when it interacts with electrode **Label 2**. (3)
12.11. **R** is a gas that is extracted as shown. Write down the formula for **R** and **Q** (2)
12.12. Write down the formula of the compound extracted as **H**. (1)
12.13. Write down **2 uses each** of the compounds **Z**, **R** and **H**. (6)

QUESTION 13 (14)

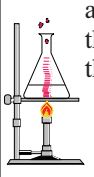
The industrial preparation of fertilizers is crucial to the survival of mankind. Various processes have been developed to manufacture fertilizers on a large scale.



13.1. Explain briefly why it is important that safe and sustainable methods be developed for large scale manufacture of fertilisers. (4)
13.2. Substance **A** is converted by fractional distillation into N_2. Write down the name of substance **A**. (1)
13.3. N_2 and compound **B** react to make ammonia.
13.3.1. Identify compound **B**. (1)
13.3.2. What is the name for the industrial process to make ammonia. (1)
13.4. Ammonia, when reacted with O_2 produces a colourless gas **C**, which when reacted with oxygen again, produces a brown gas **D** commonly causing smog. Identify **C** and **D** (2)
13.5. The process of converting **ammonia** via **three steps** into **nitric acid** is an industrial process. What is the **name** for this process? (1)
13.6. Nitric acid is eventually reacted with NH_3 to produce a fertilizer **E**. Write down the formula for this fertilizer. (2)
13.7. Compound **F** is a strong acid. When ammonia is reacted with **F**, the fertilizer ammonium sulphate is formed. Write down the NAME for **F**. (2)

QUESTION 14 (8)

14.1. What is meant by the N:P:K ratio? (2)
14.2.1. As a lettuce farmer, which ratio is more suitable for your crop: 7:2:1 or 1:2:5 (2)
14.2.2. You locate a 50kg bag of that has only 62% of actual fertiliser, the rest being filler. Calculate the mass of nitrogen fertiliser in the bag. Use the ratio you selected above. (4)



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