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CAPS

Physical Sciences

Chemical change

This support pack for the **Chemical change** module in the **Physical Sciences Grade 12 CAPS curriculum** provides valuable practice exercises. All questions have the answers provided. Learners can work through these individually at home or these could form the basis of a catch-up class or online lesson. You have permission to print or photocopy this document or distribute it electronically via email or WhatsApp.

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Revision exercises for Chemical change

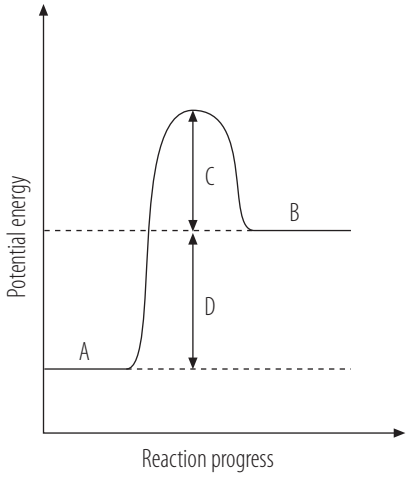
Question 1

Define the rate of a reaction.

Question 2

Consider the potential energy graph below for the reaction:

$$HI(g) \rightarrow \frac{1}{2}H_2(g) + \frac{1}{2}I_2(g) \quad \Delta H = 26 \text{ kJ}$$

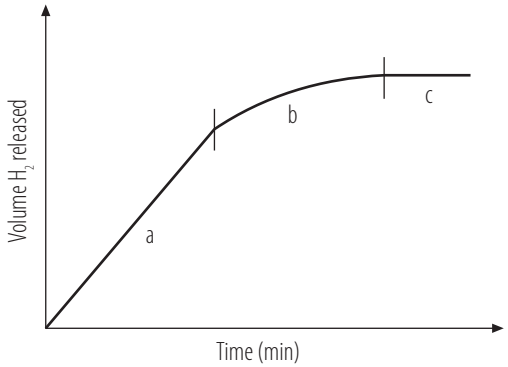


a) Give the chemical compound(s) represented by A.
b) Give the chemical compound(s) represented by B.

The activation energy for the decomposition of 1 mole HI is 183 kJ.
c) Define activation energy.
d) Calculate the energy value for C.
e) Calculate the energy value for D.
f) Calculate ΔH for the reverse reaction.
g) Is the reverse reaction endothermic or exothermic?

Question 3

When Zn reacts with HCl, the rate of gas produced can be graphically represented by the following curve:



Explain the shape of the curve during Stages a, b and c.

Question 4

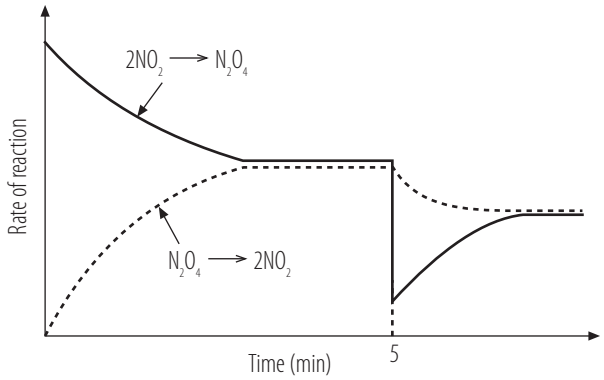
a) State Le Chatelier's Principle.
b) Name the factors that affect the dynamic equilibrium according to Le Chatelier's Principle.

Question 5

When an amount of nitrogen dioxide gas is sealed in a container, the following equilibrium is soon established:

$$2NO_2(g) \rightleftharpoons N_2O_4(g) \quad \Delta H = -58 \text{ kJ}$$

The graph below shows how equilibrium is affected when the conditions are changed at constant temperature.



a) If the change at five minutes were due to a change in pressure, did the pressure decrease or increase? Explain.
b) If the change at five minutes were due to a change in concentration, did the concentration of NO_2 increase or decrease? Explain.

Question 6

A mixture of $CO(g)$, $H_2(g)$ and $CH_3OH(g)$ was allowed to reach equilibrium in a sealed container. At equilibrium, the concentrations were measured: [CO] = 0,105 mol·dm^{-3}, [H_2] = 0,250 mol·dm^{-3} and [CH_3OH] = 0,026 mol·dm^{-3}.

Calculate the K_c for the reaction: $CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$

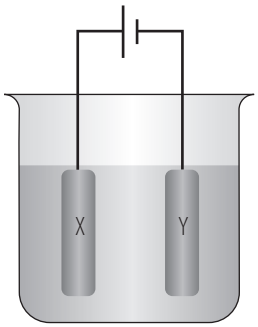
Question 7

a) Name the energy transformation in:
   i) electrolytic cells
   ii) galvanic cells.
b) In which one of the above two cells is the chemical reaction spontaneous?

Question 8

The apparatus on the right is used to electroplate a metal strip with silver. One electrode is made from silver and the other is the metal that must be electroplated.

a) Identify X and Y.
b) Give the half-reaction at the anode.
c) Give the half-reaction at the cathode.
d) In industry, some plastics are electroplated. Why must the plastic be coated with a thin film of graphite before electroplating?



Question 9

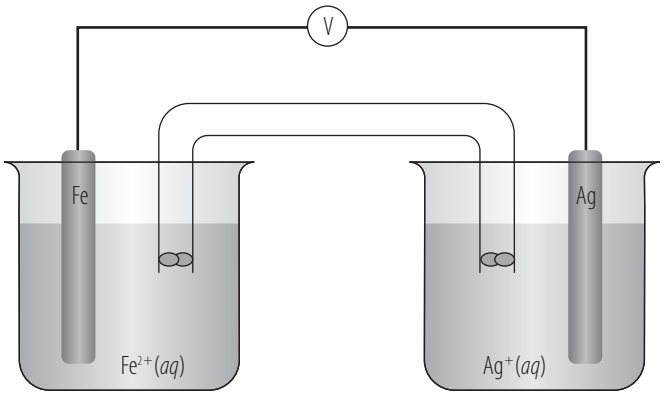
Will the following reactions occur spontaneously?

a) $Ca(s) + Cd^{2+}(aq) \rightarrow Ca^{2+}(aq) + Cd(s)$

b) $2Ag(s) + Ni^{2+}(aq) \rightarrow 2Ag^{+}(aq) + Ni(s)$

Question 10

The following voltaic cell was set up under standard conditions:



a) Give the standard conditions of the cell.

b) Which electrode is the cathode?

c) How will the concentration of the Fe^{2+} ions change while the cell is in operation?

d) Calculate the emf of the cell.

Question 11

The cell notation for a standard galvanic cell is:

$$Fe(s) \mid Fe^{3+}(aq) \mid\mid O_2(g) \mid H_2O(\ell), Pt(s)$$

a) Identify the anode.

b) Identify the cathode.

c) Calculate the emf of the cell.

Question 12

A total of 0,50 mol of oxygen gas and an excess of sulfur powder are sealed in a 2 dm^3 container at a certain temperature. The following equilibrium is established:

$$S(s) + O_2(g) \rightleftharpoons SO_2(g)$$

The value of the equilibrium constant for this reaction is 10 at this temperature. Calculate the concentration of $SO_2(g)$ in the container at equilibrium.

Question 13

For each of the following chemical equations, write down the acid–conjugate base pair.

a) $H_3O^{+}(aq) + OH^{-}(aq) \rightleftharpoons 2H_2O(\ell)$

b) $HSO_4^{-}(aq) + NH_3(aq) \rightleftharpoons SO_4^{2-}(aq) + NH_4^{+}(aq)$

Question 14

At 25 °C, 4,0 g of sodium hydroxide is dissolved in water to make a 250 cm^3 solution. Calculate the pH of the solution.

Question 15

A total of 2,0 g of KOH is dissolved in 50,0 cm^3 of water. All of the KOH solution was neutralised by adding 25,0 cm^3 of an HCl solution. Calculate the concentration of the HCl solution.

Question 16

In a titration, 20 cm^3 of a 0,1 $mol \cdot dm^{-3}$ sodium hydroxide (NaOH) solution neutralises 25 cm^3 of an ethanoic acid (CH_3COOH) solution.

a) Why is CH_3COOH regarded as a weak acid?
b) Write a balanced equation for the neutralisation reaction that takes place.
c) Calculate the number of moles of sodium hydroxide used in this reaction.
d) Using your answer from Question 16 c), calculate the concentration of the ethanoic acid.
e) Name a suitable indicator for use in this titration.

Memorandum for revision exercises

1 The rate of a reaction is a measure of how fast the reactants are used up, or how fast the products are formed.

2 a) HI
b) $\frac{1}{2}H_2(g) + \frac{1}{2}I_2(g)$
c) Activation energy is the minimum amount of energy required to bring about a chemical reaction.
d) 157 kJ
e) 26 kJ
f) –26 kJ
g) exothermic

3 The reaction rate for the reaction is the largest during Stage a because the concentration of the Zn and HCl is the largest during the beginning of the reaction. As the Zn and HCl are used up, the reaction rate decreases as shown in Stage b. Eventually, the reaction rate becomes zero in Stage c when all Zn and/or HCl have been used up and the total volume of released H_2 remains constant.

4 a) Le Chatelier's Principle states that if the conditions (concentration, pressure or temperature) of a system in equilibrium are changed, the equilibrium position shifts in the direction that will oppose the change.
b) Changes in concentration, temperature and pressure.

5 a) The graph shows that the reverse reaction rate decreases while the forward reaction rate increases after five minutes. This implies that the equilibrium has shifted to the right because the forward reaction has a fewer number of moles and a smaller volume. This result would have occurred because of an increase in pressure.
b) Since the equilibrium has shifted to the right as explained above, the concentration of NO_2 would have decreased.

6 3,96

7 a i) electrical energy to chemical energy
ii) chemical energy to electrical energy
b) The reaction is spontaneous in galvanic cells.

8 a) X: silver; Y: metal to be electroplated
b) $Ag \rightarrow Ag^+ + e^-$
c) $Ag^+ + e^- \rightarrow Ag$
d) The graphite serves as an electrical conductor to the external circuit and provides a surface for the reduction to take place.

9 a) Yes, E° is positive.
b) No, E° is negative.

10 a) concentration: 1,00 $mol \cdot dm^{-3}$; temperature: 25 °C (298 K)
b) Ag
c) increase
d) 1,24 V

11 a) Fe
b) Pt
c) 1,27 V

12 0,23 $mol \cdot dm^{-3}$

13 a) $H_3O^+(aq)$ (acid) and $H_2O(\ell)$ (conjugate base)
b) $HSO_4^-(aq)$ (acid) and $SO_4^{2-}(aq)$ (conjugate base)

14 13,6

15 1,42 $mol \cdot dm^{-3}$

16 a) The CH_3COOH ionises partially in water.
b) $CH_3COOH(\ell) + NaOH(aq) \rightarrow CH_3COONa(aq) + H_2O(\ell)$
c) 0,002 mol
d) 0,8 $mol \cdot dm^{-3}$
e) phenolphthalein