YEAR 12 CHEMISTRY   Hello
TEST 1

CHEMICAL EQUILIBRIUM SYSTEMS

This test consists of three sections.

Section One: 20 Multiple-choice questions
Section Two: 3 Short answer questions
Section Three: 1   Extended response question

Recommended time: 50   minutes

QUESTION BOOKLET

PLEASE:

- USE THE ANSWER BOOKLET PROVIDED

- DO NOT TURN THE PAGE UNTIL INSTRUCTED

- DO NOT MARK THIS BOOKLET IN ANY WAY

Section One: Multiple-choice   (20 marks)

**Answer on the multi-choice answer sheet in the Answer Booklet   .**

1. A rise in the temperature of gaseous reactants results in an increase in the rate of the reaction. This is mainly due to an increase in the:

  (a) activation energy of the reaction
  (b)   frequency of collision between reactant molecules
  (c)   proportion of molecules which dissociate into their constituent atoms
  (d)   proportion of molecules with energies greater than the activation energy

2. Measured at constant temperature, the rates of chemical reactions decrease as the reactions proceed because:

  (a) the reactant concentrations decrease with time
  (b)   the forward and reverse reaction rates must approach zero as equilibrium is approached
  (c)   the fraction of reactant molecules with energies in excess of the activation energy decreases as the reaction proceeds
  (d) absorption of heat by the reaction diminishes the reaction rate

3. Which of the following statements best describes a system in dynamic equilibrium?

  (a)   A piece of marble steadily bubbling in excess hydrochloric acid.
  (b)   Liquid bromine and bromine vapour in a sealed tube at 100 ºC
  (c)   Copper crystals growing on a piece of iron in a copper(ll) nitrate solution
  (d)   A supersaturated aqueous solution of Na_2SO_4

4. In a series of experiments, 0.0100g of samples of magnesium were added separately to 20.0 mL volumes of hydrochloric acid.
  The results are shown in the table below:

Experiment No.	Form of Mg used	Concentration of acid	Temperature of acid Before Mg is added
I	Ribbon (strip)	dilute	20 ºC
II	Ribbon (strip)	concentrated	20 ºC
III	Powder	dilute	90 ºC
IV	Powder	concentrated	20 ºC

  In which of the experiments would the magnesium be expected to take the longest time to react completely with the acid?

  (a)   I   (b)   II   (c)   III   (d)   IV

5   Which of the following reactions would be most rapid at room temperature?

  (a) $H_{2(g)} + Br_{2(g)} \rightarrow 2\ HBr_{(g)}$

  (b) $Fe^{3+}_{(aq)} + SCN^-_{(aq)} \rightarrow FeSCN^{2+}_{(aq)}$

  (c) $CH_{4(g)} + 2\ O_{2(g)} \rightarrow CO_{2(g)} + 2\ H_2O_{(g)}$

  (d) $Cu_{(s)} + 2\ Ag^+_{(aq)} \rightarrow Cu^{2+}_{(aq)} + Ag_{(s)}$

2016

6. At 200 °C, nitrogen oxide reacts with oxygen to form nitrogen dioxide as follows:

$$2NO + O_2 \rightleftharpoons NO_2 \qquad K = 3 \times 10^6$$
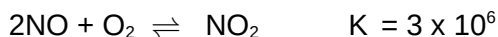
In a mixture of the three species at equilibrium, we can accurately predict that:

(a) The concentrations of both NO and O_2 will be much larger than the concentration of NO_2.

(b) The concentrations of both NO and O_2 will be much smaller than the concentration of NO_2.

(c) The concentrations of either NO or O_2 (and possibly both) will be much smaller than the concentration of NO_2.

(d) The concentration of O_2 will be exactly one half the concentration of NO.

7. Hydrogen peroxide reacts with iodide ions according to the following equation:

$$H_2O_2\,(\ell) + 2H^+{}_{(aq)} + 3\,I^-{}_{(aq)} \rightarrow I_3^-{}_{(aq)} + 2H_2O(\ell)$$
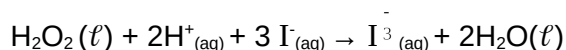
If the rate at which $I^-{}_{(aq)}$ is consumed is 3.0×10^{-4} mol $L^{-1}s^{-1}$, then the rate at which:

(a) $H_2O_2\,(\ell)$ is consumed is 9.0×10^{-4} mol $L^{-1}s^{-1}$

(b) $H^+{}_{(aq)}$ is consumed is 3.0×10^{-4} mol $L^{-1}s^{-1}$

(c) $I_3^-{}_{(aq))}$ is formed is 9.0×10^{-4} mol $L^{-1}s^{-1}$

(d) H_2O is formed is 2.0×10^{-4} mol $L^{-1}s^{-1}$

8. The equation for the decomposition of sulfur trioxide is

$$2\,SO_{3(g)} \rightleftharpoons 2\,SO_{2(g)} + O_{2(g)}$$
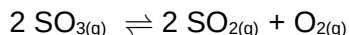
If the system has reached equilibrium, which one of the following statements is FALSE?

(a) Sulfur trioxide is continually decomposing
(b) No sulfur dioxide and oxygen are combining together
(c) The sum of the masses of oxygen and sulfur dioxide remains constant
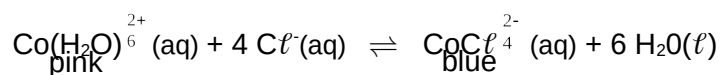(d) If the temperature was altered the proportion of all the components would change

9. The equilibrium expression for a reaction is

$$K \quad = \quad \frac{[H^+]^6}{[Bi^{3+}]^2[H_2S]^3}$$

The reaction could be

(a) $6H^+{}_{(aq)} + BiS_{(s)} \rightleftharpoons 2Bi^{3+}{}_{(aq)} + 3\,H_2S_{(g)}$

(b) $6H^+{}_{(aq)} + Bi_2S_{3(s)} \rightleftharpoons 2Bi^{3+}{}_{(aq)} + 3\,H_2S_{(g)}$

(c) $2Bi^{3+}{}_{(aq)} + 3\,H_2S_{(g)} \rightleftharpoons Bi_2S_{3(s)} + 6H^+{}_{(aq)}$

(d) $2Bi^{3+}{}_{(aq)} + 3\,H_2S_{(g)} \rightleftharpoons Bi_2S_{3(aq)} + 6H^+{}_{(aq)}$

10. Consider the following equilibrium:

$$Co(H_2O)_6^{2+} (aq) + 4\ C\ell^- (aq) \ \rightleftharpoons\ CoC\ell_4^{2-} (aq) + 6\ H_2O(\ell)$$
$$\text{pink} \qquad\qquad\qquad\qquad\qquad \text{blue}$$

When the temperature is increased, the solution turns a dark blue. Based on this observation, the reaction is

(a)   exothermic and the value of K has increased.
(b)   exothermic and the value of K has decreased.
(c)   endothermic and the value of K has increased.
(d)   endothermic and the value of K has decreased.

11. Consider the following equilibrium:

$$2\ IC\ell(g)\ \rightleftharpoons\ I_2(g)\ +\ C\ell_2(g)$$
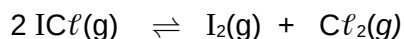
A closed container is initially filled with $IC\ell(g)$. What are the changes in the rate of the forward reaction and the $[I_2(g)]$ as the system approaches equilibrium?

	Rate of forward reaction	$[I_2(g)]$
(a)	decrease	Increase
(b)	decrease	decrease
(c)	increase	Increase
(d)	increase	decrease

12. The following reaction occurs at room temperature in a closed container.

$$NH_4C\ell_{(s)}\ +\ \text{heat}\ \rightleftharpoons\ NH_{3(g)}\ +\ HC\ell_{(g)}$$
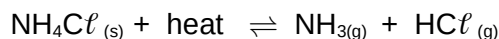
Concerning this system at equilibrium, which one of the following statements is incorrect?

(a)   The reaction can be caused to favour formation of products by increasing the temperature of the system.
(b)   Adding $NH_4Cl_{(s)}$ will increase the amount of $NH_{3(g)}$
(c)   Increasing the pressure by reducing the volume will decrease the amount of gases present at equilibrium
(d)   Adding a catalyst will not affect equilibrium concentrations

13. When KSCN and $FeCl_3$ are mixed, a red solution of $FeSCN^{2+}_{(aq)}$ is produced as shown in the following equation:-

$$Fe^{3+}_{(aq)} + SCN^-_{(aq)} \rightleftharpoons FeSCN^{2+}_{(aq)}$$
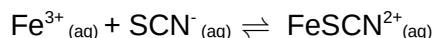
The intensity of the red colour could be increased by the addition of:

(a) $Ag^+_{(aq)}$ions to form insoluble AgSCN
(b) $Sn^{2+}_{(ag)}$ion to reduce $Fe^{3+}_{(aq)}$ to $Fe^{2+}_{(aq)}$
(c)   a small volume of water

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(d)   a small volume of concentrated $Fe^{3+}_{(aq)}$ solution

14.   The equation for the decomposition of hydrogen iodide is:-

$$2\ HI_{(g)}\ \rightleftharpoons\ H_{2(g)} + I_{2(g)} \quad \Delta H\ =\ +\ 51.8\ kJ$$
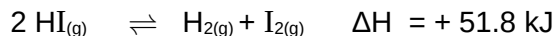
Consider (for the above reaction):

I   Increasing the concentration of H_2
II   Increasing the concentration of HI
III   Increasing the volume of the system without changing the amount of substance present
IV   Increasing the temperature

Which of the above changes would immediately cause the rate of the formation of products to increase?

(a) I, III and IV only   (b) II only   (c) II and III only   (d) II and IV only


15.   If solid calcium carbonate is heated in a sealed container the following equilibrium is established at 500 ºC and 600 kPa pressure.

$$CaCO_{3(s)} \rightleftharpoons\ CaO_{(s)}\ +\ CO_{2(g)} \quad \Delta H = +\ 178\ KJ$$

Which of the following statements about this equilibrium system is TRUE?

(a)   The value of the equilibrium constant for this system is independent of the temperature of the system.
(b)   Increasing the pressure of the equilibrium system to 1000 kPa by the addition of inert nitrogen gas will increase the amount of calcium carbonate present.
(c)   Increasing the temperature to 700ºC will increase the amount of calcium carbonate present.
(d)   The addition of more carbon dioxide to the equilibrium system will reduce the amount of calcium oxide present.

16.   At 300 ºC, gaseous sulfur trioxide decomposes into gaseous sulfur dioxide and oxygen as follows:
$$2\ SO_3 \rightleftharpoons 2\ SO_2 + O_2 \quad K\ =\ 1.6\ x\ 10^{-10}$$
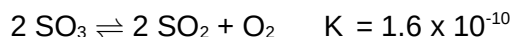
If a mixture of these three gases the partial pressures are 0.10 kPa SO_3, 0.10 kPa SO_2, and 0.01 kPa O_2, then we can accurately predict that the reaction:
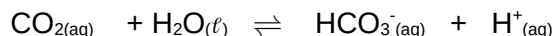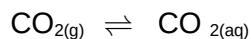(a)   is at equilibrium.
(b)   is not at equilibrium and must proceed from *left to right* to reach equilibrium.
(c)   is not at equilibrium and must proceed from *right to left* to reach equilibrium.
(d)   is not at equilibrium but insufficient information is given to predict which direction the reaction must go to reach equilibrium.

17.   Initially all the species in the following equation are in equilibrium

$$Ag^+(aq) \quad + 2\,NH_3(aq) \;\rightleftharpoons\; [Ag(NH_3)_2]^+(aq)$$
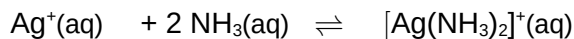
Iodide ions are added and silver iodide precipitates.
After the iodide ions are added, the ammonia:-

(a)   concentration increases
(b)   concentration decreases
(c)   concentration remains the same
(d)   reacts for form ammonium iodide.

18.   The solubility of CO_2 gas in water can be represented by the following equilibria:

$$CO_{2(g)} \;\rightleftharpoons\; CO_{2(aq)}$$

$$CO_{2(aq)} \quad + H_2O_{(\ell)} \;\rightleftharpoons\; HCO_3^-{}_{(aq)} \; + \; H^+{}_{(aq)}$$

The solubility of CO_2 in water may be increased by: -

(a)   adding hydrochloric acid
(b)   adding solid $KHCO_3$
(c)   adding solid NaOH
(d)   decreasing the pressure of CO_2 gas.

19.   Consider the following gas-phase reaction, at equilibrium, at 298 K,

$$2SO_2(g) \quad + O_2(g) \;\rightleftharpoons\; 2SO_3(g) \qquad \Delta H = \text{-196.6 kJ}$$

Which one of the following, when applied to this system initially at equilibrium, would increase the yield of $SO_3(g)$?

(a)   decreasing the pressure by increasing the volume of the reaction   vessel
(b)   increasing the temperature
(c)   increasing the pressure by adding Ar(g)
(d)   decreasing the temperature

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20   The following question refers to the graph below, which represents the partial pressures
     of SO_2 and SO_3 in the reaction shown below.

$$SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g) \quad \Delta H = 142 \text{ kJ}$$
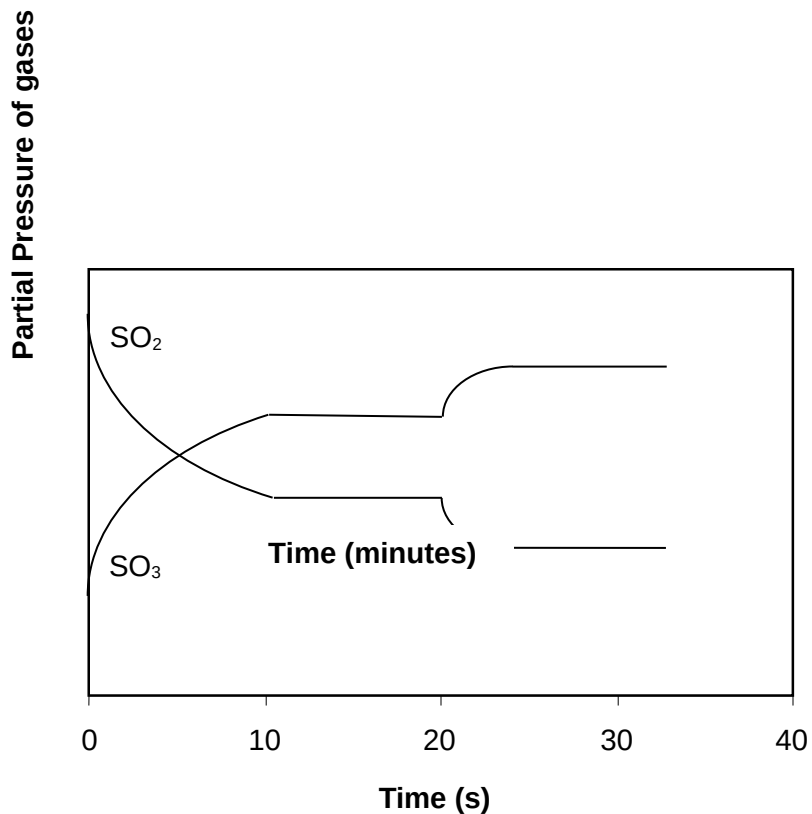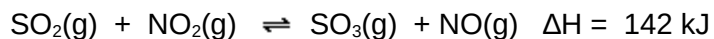
At the 20 minute mark, what changes could have been made to the system to produce the
effects shown by the graph?

(a)   The system temperature is increased or the partial pressure of NO is increased.

(b)   The system temperature is increased or the partial pressure of NO_2 is increased.

(c)   The system temperature is decreased or the partial pressure of NO is decreased.

(d)   The system temperature is decreased or the partial pressure of NO_2 is decreased

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