

Reversible reactions

Question Paper 1

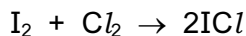
Level	IGCSE
Subject	Chemistry
ExamBoard	CIE
Topic	Chemical Reactions
Sub-Topic	Reversible reactions
Paper	(Extended) Theory
Booklet	Question Paper 1

TimeAllowed: 88 minutes

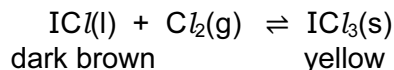
Score: /73

Percentage: /100

1 Iodine reacts with chlorine to form dark brown iodine monochloride.



This reacts with more chlorine to give yellow iodine trichloride.
An equilibrium forms between these iodine chlorides.



(a) What do you understand by the term *equilibrium*?

.....
.....
..... [2]

(b) When the equilibrium mixture is heated, it becomes a darker brown colour.
Suggest if the reverse reaction is endothermic or exothermic. Give a reason for your choice.

.....
.....
..... [1]

(c) The pressure on the equilibrium mixture is decreased.

(i) How would this affect the position of equilibrium? Give a reason for your choice.

It would move to the

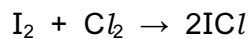
reason

..... [1]

(ii) Describe what you would observe.

.....
..... [1]

- (d) Calculate the overall energy change for the reaction between iodine and chlorine using the bond energy values shown.



Bond	Energy / kJ per mol
I–I	151
Cl–Cl	242
I–Cl	208

Show your working.

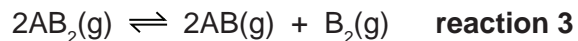
[3]

- (e) Draw a labelled energy level diagram for the reaction between iodine and chlorine using the information in (d).

[2]

[Total: 10]

2 Reversible reactions can come to equilibrium. The following are three examples of types of gaseous equilibria.



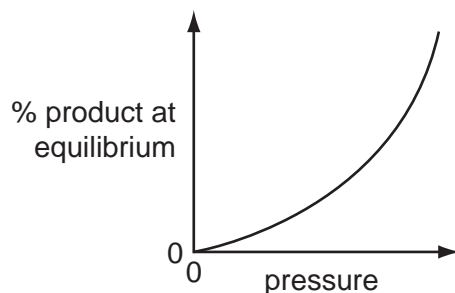
(a) Explain the term *equilibrium*.

.....
 [2]

(b) The following graphs show how the percentage of products of a reversible reaction at equilibrium could vary with pressure.

For each graph, decide whether the percentage of products decreases, increases or stays the same when the pressure is **increased**, then match each graph to one of the above reactions and give a reason for your choice.

(i)



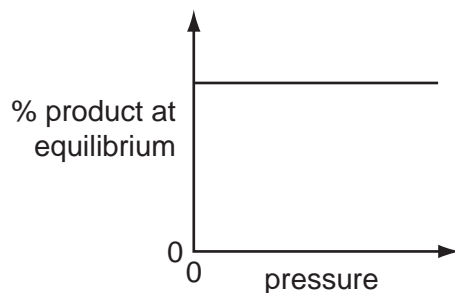
effect on percentage of products

reaction

reason

..... [3]

(ii)



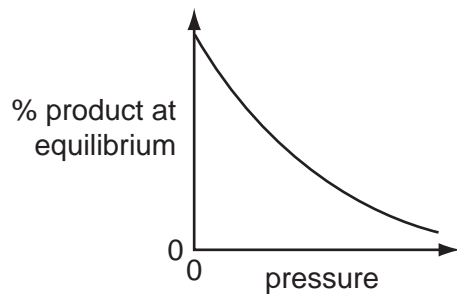
effect on percentage of products

reaction

reason

..... [3]

(iii)



effect on percentage of products

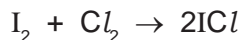
reaction

reason

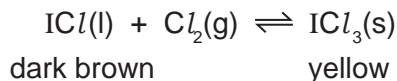
..... [3]

[Total: 11]

3 Iodine reacts with chlorine to form dark brown iodine monochloride.



This reacts with more chlorine to give yellow iodine trichloride.
There is an equilibrium between these iodine chlorides.



(a) Explain what is meant by *equilibrium*.

.....
.....
..... [2]

(b) When the equilibrium mixture is heated it becomes a darker brown colour.
Is the reverse reaction endothermic or exothermic? Give a reason for your choice.

.....
.....
..... [2]

(c) The pressure on the equilibrium mixture is decreased.

(i) How would this affect the position of equilibrium and why?

It would move to the [1]

reason

..... [1]

(ii) Describe what you would observe.

.....
..... [1]

[Total: 7]

4 Nitrogen dioxide is a brown gas. It can be made by heating certain metal nitrates.



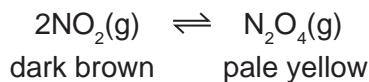
(a) Name another metal whose nitrate decomposes to give the metal oxide, nitrogen dioxide and oxygen.

..... [1]

(ii) Complete the word equation for a metal whose nitrate does not give nitrogen dioxide on decomposition.

metal nitrate → + oxygen [1]

(b) At most temperatures, samples of nitrogen dioxide are equilibrium mixtures.



(i) At 25 °C, the mixture contains 20 % of nitrogen dioxide. At 100 °C this has risen to 90 %. Is the forward reaction exothermic or endothermic? Give a reason for your choice.

.....
.....
..... [2]

(ii) Explain why the colour of the equilibrium mixture becomes lighter when the pressure on the mixture is increased.

.....
.....
..... [2]

- (c) A 5.00g sample of impure lead(II) nitrate was heated. The volume of oxygen formed was 0.16 dm³ measured at r.t.p. The impurities did not decompose. Calculate the percentage of lead(II) nitrate in the sample.



Number of moles of O₂ formed =

Number of moles of Pb(NO₃)₂ in the sample =

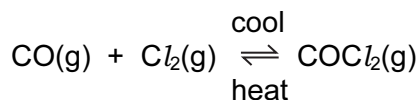
Mass of one mole of Pb(NO₃)₂ = 331 g

Mass of lead(II) nitrate in the sample = g

Percentage of lead(II) nitrate in sample = [4]

[Total: 10]

5 Carbonyl chloride, COCl_2 , is a colourless gas. It is made by the following reaction.



(a) When the pressure on the equilibrium mixture is decreased, the position of equilibrium moves to left.

(i) How does the concentration of each of the three chemicals change?

.....
 [2]

(ii) Explain why the position of equilibrium moves to left.

.....
 [2]

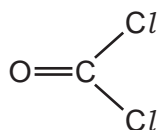
(b) Using the information given with the equation, is the forward reaction exothermic or endothermic? Give a reason for your choice.

.....
 [2]

(c) Carbonyl chloride reacts with water to form two acidic compounds. Suggest which acidic compounds are formed.

1.
 2. [2]

(d) The structural formula of carbonyl chloride is given below.



Draw a diagram that shows the arrangement of the valency electrons in one molecule of this covalent compound.

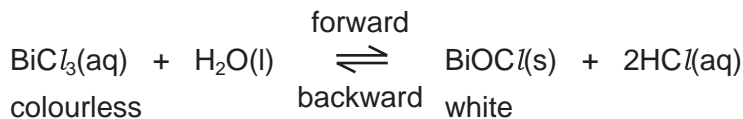
Use x for an electron from a chlorine atom.

Use o for an electron from a carbon atom.

Use • for an electron from an oxygen atom.

6 Reversible reactions can come to equilibrium. They have both a forward and a backward reaction.

(a) When water is added to an acidic solution of bismuth(III) chloride, a white precipitate forms and the mixture slowly goes cloudy.



(i) Explain why the rate of the forward reaction decreases with time.

.....
..... [2]

(ii) Why does the rate of the backward reaction increase with time?

.....
..... [1]

(iii) After some time why does the appearance of the mixture remain unchanged?

.....
..... [2]

(iv) When a few drops of concentrated hydrochloric acid are added to the cloudy mixture, it changes to a colourless solution. Suggest an explanation.

.....
..... [2]

(b) Both of the following reactions are reversible.



(i) Suggest a reason why an increase in pressure does not affect the position of equilibrium for reaction 1.

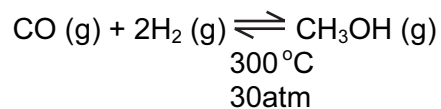
..... [1]

(ii) What effect would an increase in pressure have on the position of equilibrium for reaction 2? Give a reason for your answer.

.....
..... [2]

7 The simplest alcohol is methanol.

(a) It is manufactured by the following reversible reaction.



(i) Reversible reactions can come to equilibrium. Explain the term *equilibrium*.

[1]

(ii) At 400 °C, the percentage of methanol in the equilibrium mixture is lower than at 300 °C. Suggest an explanation.

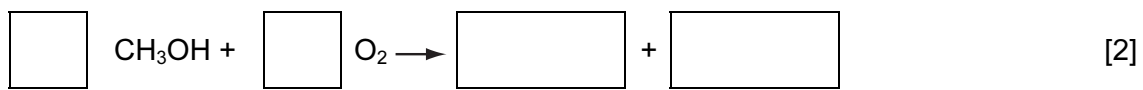
[2]

(iii) Suggest two advantages of using high pressure for this reaction. Give a reason for each advantage.

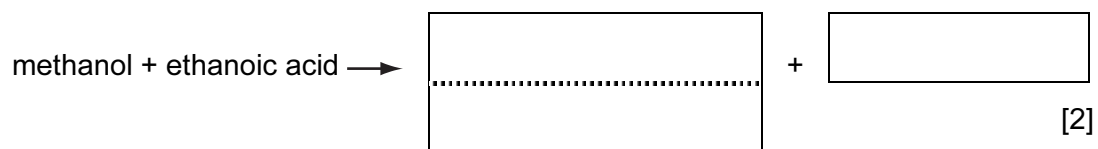
advantage	
reason	

advantage	
reason	
[5]	

(b) () Complete the equation for the combustion of methanol in an excess of oxygen.



(ii) Complete the word equation.



(iii) Methanol can be oxidised to an acid. Name this acid.

[1]