

Student Name: _____



CHEMISTRY 2021

Unit 3

Key Topic Test 5 – Rates and Reversible Reactions

Recommended writing time*: 45 minutes

Total number of marks available: 50 marks

QUESTION BOOK

* The recommended writing time is a guide to the time students should take to complete this test. Teachers may wish to alter this time and can do so at their own discretion.

Conditions and restrictions

- Students are permitted to bring into the room for this test: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the room for this test: blank sheets of paper and/or white out liquid/tape.
- A calculator is permitted in this test.

Materials supplied

- Question and answer book of 11 pages.

Instructions

- Print your name in the space provided on the top of the front page.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic communication devices into the room for this test.

SECTION A – Multiple-choice questions**Instructions for Section A**

Answer **all** questions.

Choose the response that is **correct** for the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks are **not** deducted for incorrect answers.

If more than one answer is completed for any question, no mark will be given.

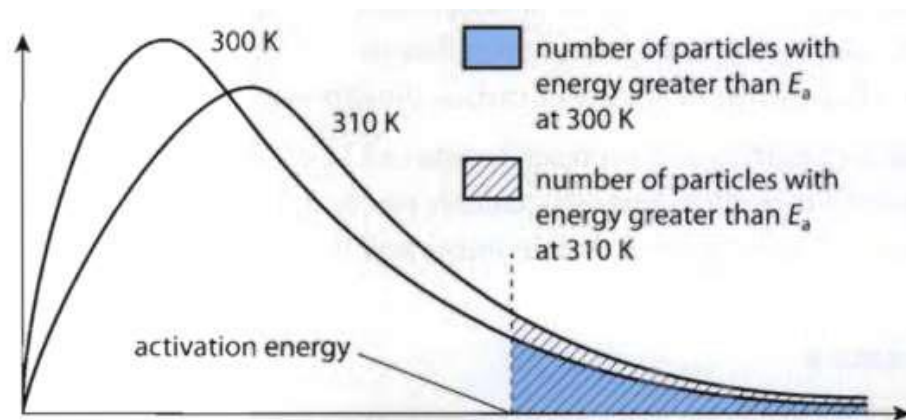
Question 1

A student decides to react pieces of magnesium metal with a 1.0M HNO₃ solution in a test tube. The rate of reaction could NOT be significantly increased by;

- A. Heating the acid
- B. Cutting the magnesium into very small pieces
- C. Sealing the test tube with a rubber stopper
- D. Using 2.0M HNO₃

The following TWO questions refer to the information below;

The graph below is a profile of the average kinetic energies of particles in a gas at two different temperatures.

**Question 2**

The rate of reaction is greater at 310K than 300K because

- A. All of the particles at 310K move faster than all of the particles at 300K
- B. The activation energy is lowered by the increase in temperature
- C. At 310K, more particles are moving with enough energy to overcome the activation energy
- D. At 310K the height of the graph is lower so it is easier for particles to react

Question 3

In order for a chemical reaction to proceed;

- A. All particles need to have enough energy to overcome the activation energy
- B. All of the colliding particles need to be orientated in a way that allows bonds to break and reform
- C. The activation energy needs to be lowered enough to allow bonds in all of the reactants to break
- D. Some particles need to have enough energy to overcome the activation energy and be orientated in a way that allows bonds to break and reform

Question 4

When a hydrogen peroxide solution is heated the rate of oxygen production increases. This occurs because

- A. The activation energy is reduced
- B. The activation energy is increased
- C. The heated solution has particles that have the correct orientation more often
- D. The heated solution has particles that collide more often and with more energy

Question 5

A catalytic converter in cars uses a solid with a honeycomb or sponge like structure. Gases produced in a car engine pass through the catalyst. It could be said that;

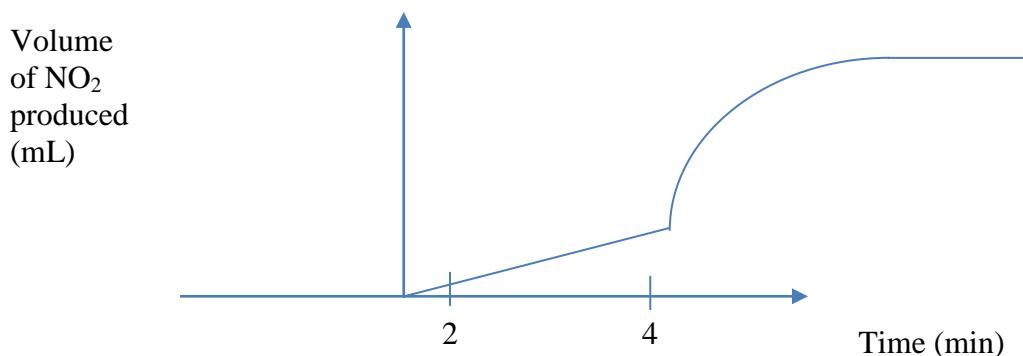
- A. The catalyst is referred to as a heterogeneous catalyst
- B. The catalyst has a honeycomb structure so the molecules can be lined up more effectively
- C. The particles move faster when they are catalysed
- D. The honeycomb structure concentrates the gases

Question 6

A Year 12 student is carrying out a chemical reaction involving 20 mL of 8M nitric acid and excess copper turnings. The equation for the reaction is:



She then measures the volume of NO_2 gas produced over time.



The change in the graph at $t=2$ minutes could be due to;

- A. Adding 20mL of water
- B. Cooling the reaction mixture in an ice bath
- C. Adding a suitable catalyst
- D. Adding some large chunks of copper might allow the reaction to continue for longer but won't increase the rate

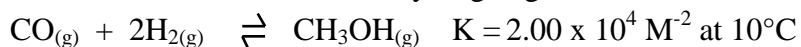
Question 7

A marble chip reacts with hydrochloric acid. The rate of reaction increases when the marble chip is ground into a powder. The reaction rate increases because;

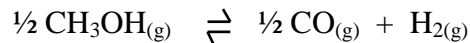
- A. The marble powder can move faster and therefore collide with the HCl molecules with more energy
- B. The activation energy is lowered
- C. The decreased surface area of each marble particle means that there are more collisions between each marble particle and the HCl molecules
- D. There are more collisions between the marble surface and the HCl molecules

Question 8

Carbon monoxide reacts with hydrogen gas as shown below;



The magnitude of the equilibrium constant for the reaction;

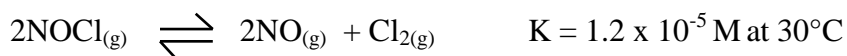


would be;

- A. 0.00707 M
- B. 141 M^{-1}
- C. $5.00 \times 10^{-5} \text{ M}^2$
- D. 100 M^{-2}

The following TWO questions refer to the information below;

NOCl decomposes into NO and Cl₂ according to the equation;

**Question 9**

The equilibrium expression for this reaction is;

- A. $K_c = \frac{[\text{NOCl}]^2}{[\text{NO}]^2 [\text{Cl}_2]}$
- B. $K_c = \frac{[\text{NOCl}]^2}{[\text{NO}]^2 [\text{Cl}_2]}$
- C. $K_c = \frac{[\text{NO}]^2 [\text{Cl}_2]}{[\text{NOCl}]^2}$
- D. $K_c = \frac{[\text{NO}]^2 + [\text{Cl}_2]}{[\text{NOCl}]^2}$

Question 10

A mixture of NOCl, NO and Cl₂ at equilibrium would mainly contain;

- A. NOCl
- B. NO
- C. Cl₂
- D. NO and Cl₂

SECTION B - Short-answer questions

Instructions for Section B

Questions must be answered in the spaces provided in this book.

To obtain full marks for your responses you should:

- Give simplified answers with an appropriate number of significant figures to all numerical questions; unsimplified answers will not be given full marks.
- Show all workings in your answers to numerical questions. No credit will be given for an incorrect answer unless it is accompanied by details of the working.

Make sure chemical equations are balanced and that the formulas for individual substances include an indication of state; for example, $\text{H}_2(\text{g})$; $\text{NaCl}(\text{s})$.

Question 1

Ammonia gas (NH_3) is produced by reacting N_2 and H_2 .

- a. List 3 ways of increasing the rate of formation of NH_3

3 marks

- b. 5.50 mol of H_2 is present with 2.20 mol of N_2 in a 2.00 litre container at equilibrium. If the value of K_c is 0.052M^{-2} , determine the concentration of NH_3 present at equilibrium.

5 marks

- c. When the system is at equilibrium, the forward reaction continues to occur. How is this possible?

2 marks

Total 10 marks

Question 2

By referring to collision theory, give reasons for the following;

- a.** Fine particles in a coal mine can ignite and cause an explosion.

2 marks

- b.** Food will keep longer if stored in a refrigerator

2 marks

- c.** FeCl_3 will increase the rate of decomposition of hydrogen peroxide (H_2O_2)

2 marks

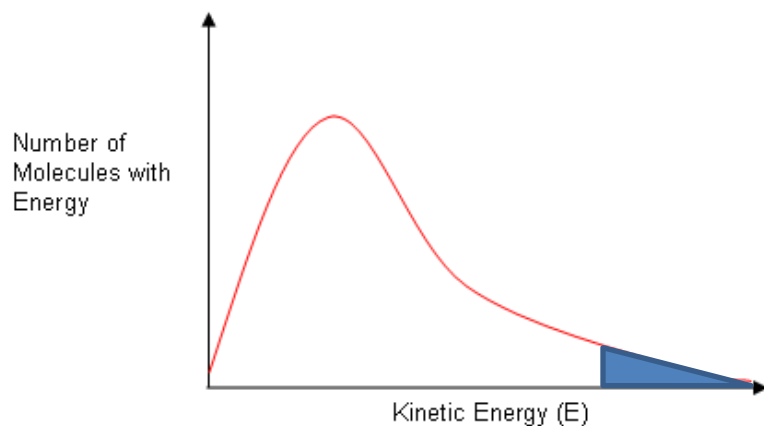
- d.** A shirt on the washing line will dry more quickly on a windy day.

2 marks

Total 8 marks

Question 3

The kinetic energy of the particles involved in the reaction can be represented by the diagram below:



The particles in the shaded area have enough energy to overcome the activation energy.

- a.** A catalyst is added to the reaction mixture. Explain what happens to;
- The activation energy

ii. The shaded area.

iii. The shape and position of the graph

1 + 1 + 1 = 3 marks

- b.** The temperature of the reaction mixture is increased. Explain what happens to;
- The activation energy

ii. The shaded area.

iii. The shape and position of the graph

1 + 1 + 1 = 3 marks

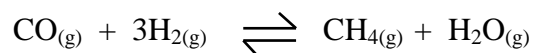
- c. A student claims that when the temperature of a reaction mixture is increased, that all of the particles have more energy and move more quickly. What is correct and what is incorrect about this statement?

2 marks

Total 8 marks

Question 4

Methane can be formed using the reaction;



If 0.20mol of CO is mixed with 0.50mol of H₂ in a 1.0L container, it is found that 0.10mol of CO remains once the system is at equilibrium. Determine the equilibrium constant for the reaction.

4 marks

Question 5

The preparation of sulphur trioxide from sulphur dioxide and oxygen is shown by the equation below:



The reaction can be carried out at 200°C and the activation energy is 100 kJ mol⁻¹.

- a. Determine the energy required;
- i. To break the bonds within the SO₂ and O₂ molecules.

- ii. To begin the reverse reaction. i.e. to break the bonds within the SO_3 molecules.

1 + 1 = 2 marks

- b. The reaction is an equilibrium reaction where $K_c = 1.0 \times 10^6 \text{ M}^{-1}$ at 200°C .

- i. Comment on the extent of the reaction at this temperature.

- ii. A reaction mixture at this temperature has the following composition;

Species	Concentration
SO_2	0.0020 M
O_2	0.0040 M
SO_3	0.30 M

Show that this mixture is not at equilibrium and indicate which direction the equilibrium must shift to reach equilibrium.

1 + 4 = 5 marks

- c. If the reaction is reversed at 200°C , what would be the value of;

- i. ΔH ?

-
- ii. K_c ?

1 + 2 = 3 marks
Total 10 marks

END OF KEY TOPIC TEST