Chemistry 12
Reaction Rates
version 1

Name:_____

Block:_____

Part 1: Multiple Choice

Outcome 1	Outcome 2	Outcome 3	Review
1. A	9. C	17. D	25. B
2. D	10. D	18. A	26. B
3. D	11. D	19. D	27. ~~B~~ A
4. C	12. C	20. B	28. D
5. A	13. B	21. B	29. D
6. ~~B~~ D	14. B	22. A	30. B
7. D	15. D	23. D	31. D
8. D	16. D	24. B	32. B

Problem Solving (22 marks)

1. Consider the following reaction:

$$2\ O_{3(g)}\ \text{--->}\ 3\ O_{2(g)}$$
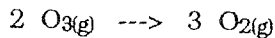
   a. The rate of formation of $O_{2(g)}$ is 0.022 mol/s. Calculate the rate of decomposition of $O_{3(g)}$. (1 mark)

OMIT

   b. Explain how the rate of the reaction can be increased using **two different** methods. (3 marks)

Method 1: (½ mark for method)

If the temperature is increased, more particles will have sufficient KE in order to react and (1 mark for explanation) thus the rate will be increased.

Method 2: If the pressure is increased (volume decreased), the number of collisions will be increased, which would increase the rate.

2. A strip of magnesium was cut into 4 pieces, each of length 1.0 cm and mass of 0.00864 g. Each piece was placed into a test tube containing 5.0 mL of different concentrations of HCl. The time required for each piece of magnesium to be completely consumed was recorded:

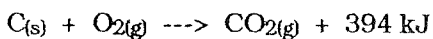| Trial	[HCl]	Time (s)
1	0.50 M	200
2	1.0 M	38
3	3.0 M	12
4	6.0 M	6

   a. Calculate the rate of reaction for magnesium in 3.0 M HCl. (1 mark)

$$\frac{0.00864}{12\ s} = 0.00072\ g/s\ \text{or}\ 7.2\times10^{-4}\ g/s$$

   b. How does the [HCl] affect the reaction rate? (1 mark)

If the [HCl] is increased, the rate increases

3. The combustion of coal, C, produces carbon dioxide gas according to the following equation:

$$C_{(s)} + O_{2(g)} \text{---}> CO_{2(g)} + 394 \text{ kJ}$$

a. What is the value of ΔH for this reaction? (1 mark)

$$\Delta H = -394 \text{ kJ}$$

b. Using the collision theory, explain why a lump of coal does not react with oxygen at room temperature and pressure. (1 mark)

There are not enough particles with sufficient PE, so no rxn

c. Many coal mine disasters have resulted when a spark ignites coal dust in the air. Explain, using the collision theory. (2 marks)

The dust particles have a larger surface area so more particles can react. (1) The spark provides the KE so that the reactants can overcome the activation (1) energy barrier

4. Define the term *activated complex* (2 marks)

An activated complex is a short-lived high energy molecule (1) that forms if the the reactants have sufficient PE to overcome the energy barrier. (1)
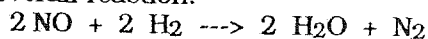
5. Consider the following PE diagram for the uncatalyzed decomposition of hydrogen peroxide:

$$2 \text{ H}_2\text{O}_{2(l)} \text{ ---}> 2 \text{ H}_2\text{O}_{(l)} + \text{O}_{2(g)}$$

Progress of the reaction
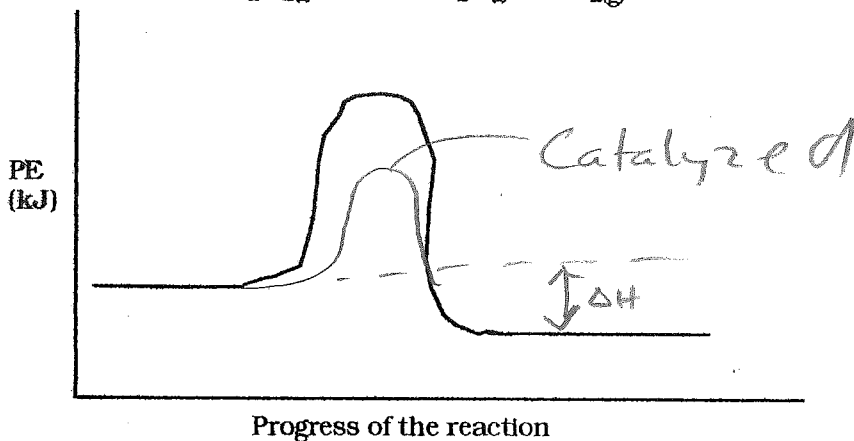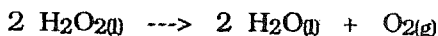
a. On the PE diagram, sketch a curve for the catalyzed decomposition of . (1 mark)
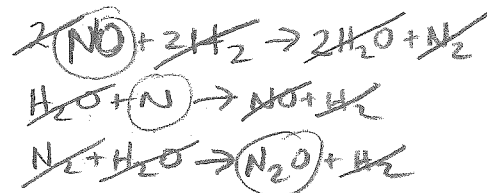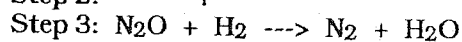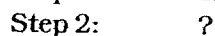b. Compare the ΔH of the catalyzed and uncatalyzed reactions. (1 mark)

Same.

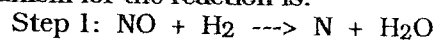6. Consider the following overall reaction:
$$2\,NO + 2\,H_2 \longrightarrow 2\,H_2O + N_2$$

a. Explain why the reaction is likely to involve more than one step. (1 mark)

There are more than two molecules that must collide at one time

b. A proposed mechanism for the reaction is:

Step 1: $NO + H_2 \longrightarrow N + H_2O$
Step 2:   ?
Step 3: $N_2O + H_2 \longrightarrow N_2 + H_2O$

i) Write the equation for step 2. (2 marks)

2 $NO + 2H_2 \rightarrow 2H_2O + N_2$
$H_2O + N \rightarrow NO + H_2$
$N_2 + H_2O \rightarrow N_2O + H_2$

$$NO + N \longrightarrow N_2O$$

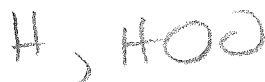ii) Identify all reaction intermediates. (1 mark)

$$N, \; N_2O$$

7. One of the reactions in the production of smog involves the oxidation of nitrogen monoxide. A possible mechanism for this reaction is:

Step 1: $CO + OH \longrightarrow CO_2 + H$
Step 2: $H + O_2 \longrightarrow HOO$
Step 3: $HOO + NO \longrightarrow OH + NO_2$
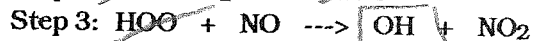
a) Write the balanced equation for the overall reaction. (2 marks)

$$CO + O_2 + NO \longrightarrow CO_2 + NO_2$$

b) Identify all reaction intermediates. (1 mark)

$$H, \; HOO$$

c) Identify the catalyst. (1 mark)

$$OH$$