Name: _____

Chemistry 30

Unit 2: Chemical Kinetics

Assignment 3: 4-1 to 4-3 MAX: 33

1. Explain why the rate of a chemical reaction increases as the concentration of the reactants increases.

   Increasing concentration means there will be more particles are present in a given volume, which will result in more frequent collisions, which means a faster reaction rate.

   2 marks

2. Consider two gases A and B in a container at room temperature. What effect will the following changes have on the reaction rate between these gases (increase, decrease, no effect)?

   1 mark for each, for total value of 3

   a) The pressure is increased. ***Increase rate***

   b) The number of molecules of gas A is doubled ***Increase rate***

   c) The temperature is decreased ***Decrease rate***

3. Which of the following reactions will have the fastest rate? The slowest? **Explain**

   4 marks for this question – 1 for identifying the fastest; 1 for the slowest; 2 marks for the explanation.

   a) $C_{12}H_{26\,(s)} + \frac{37}{2} O_{2\,(g)} \rightarrow 12\ CO_{2\,(g)} + 13\ H_2O_{(g)}$ ***slowest***

   b) $S_2O_8^{2-}{}_{(aq)} + 2\ I^-_{(aq)} \rightarrow 2\ SO_4^{2-}{}_{(aq)} + I_{2(s)}$

   c) $Ba^{2+}{}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$ ***fastest***

   Explanation:

   Reaction A is likely slow for several reasons: it involves the reaction of a solid reactant; covalent bonding is involved, and due to the number of moles of reactants involved. Students must name at least one reason (2 is better)

   Reaction C is the fastest as it involves aqueous ions in solution. (Reaction B also involves ions in solution, but covalent bonds must also be broken which likely causes a slower reaction.)

4. The series of steps by which an overall chemical reaction takes place is called the

   1 mark.

   Reaction mechanism

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5. The slowest step in the series of steps in a chemical reaction is called the

   1 mark.

   Rate determining step

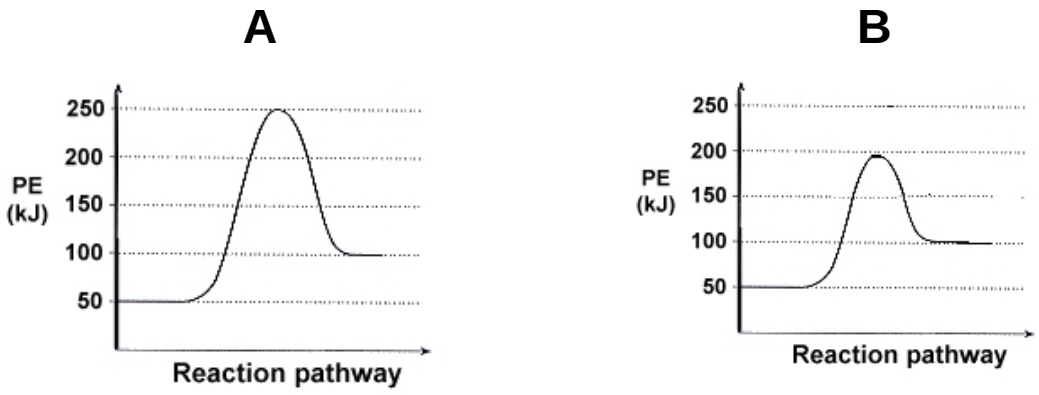
6. Define activation energy.

   1 mark.

   The amount of energy required to reach the activated complex (or to initiate or carry out a reaction)

7. Consider the following potential energy diagrams which represent two chemical reactions. On the basis of these diagrams, which reaction would you expect to occur at a faster rate? Why?

   2 marks – "B" is likely the fastest because it has a lower activation energy.



8. Which will react faster, zinc with 3 M hydrochloric acid or zinc with 1 M hydrochloric acid? Why?

   2 marks

   Zinc with 3 M HCl will react faster because the hydrochloric acid is more concentrated.

9. White phosphorus reacts immediately and rapidly with oxygen when exposed to air. What can you say about the amount of activation energy required for this reaction?

   1 mark

   The activation energy is likely very low

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10. Hydrogen peroxide reacts with hydrogen ions and iodide ions according to the following reaction mechanism:

step 1.	$H^+ + H_2O_2 \rightarrow H_3O_2^+$	fast
step 2.	$H_3O_2^+ + I^- \rightarrow H_2O + HOI$	slow

a) Write the overall reaction described by this mechanism

step 1. $H^+ + H_2O_2 \rightarrow H_3O_2^+$

step 2. $H_3O_2^+ + I^- \rightarrow H_2O + HOI$

overall: ***1 mark*** $\mathbf{H^+ + H_2O_2 + I^- \rightarrow H_2O + HOI}$

NOTE: Be sure students give correct ion charges; otherwise answer is incorrect!

b) If you wanted to increase the rate of the overall reaction, would it be better to increase the concentration of H^+ or I^-. Why?

2 marks. It would be more effective to increase the concentration of I^- because it is involved in the rate determining step.

11. At 20°C, a small strip of magnesium reacts with 3.0 M hydrochloric acid to produce 12 mL of hydrogen gas in 20 s.

a) Calculate the rate of this reaction.

1 mark

$$rate = \frac{12mL}{20\,\text{sec}} = \frac{0.6mL}{\text{sec}}$$

b) What volume of hydrogen might be produced in 20 s at 30°C?

hint – what change in temperature has occurred? What is the general rule for what happens to the rate with this amount of temperature change? At this new rate, how many mL will be produced in 20 seconds?

2 marks. Students typically have trouble with this question (it's good to have some tougher questions). The general rule is that for every increase of 10°C the rate will double. Thus the new rate will be 1.2 mL/s (approximately). Thus, in 20 seconds 24 mL of hydrogen will be produced:

$$20\,\text{sec} \times \frac{1.2mL}{\text{sec}} = 24mL$$

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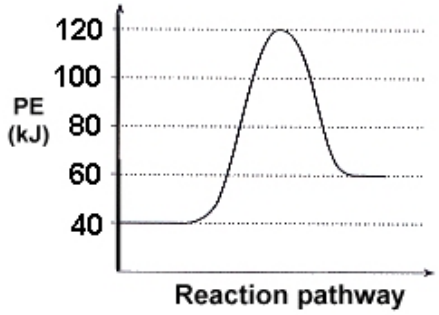
12. Consider the following potential energy diagram:



7 marks

a) Is the forward reaction endothermic or exothermic: ***endothermic***

b) Determine ΔH for the forward reaction: ***+20 kJ***

c) Determine ΔH for the reverse reaction: ***-20 kJ***

d) Determine E_a for the forward reaction: ***+80 kJ***

e) Determine E_a for the reverse reaction: ***+60 kJ***

f) Label the location of the activation complex in the diagram. ***(the highest point)***

g) Add to the diagram a possible pathway for a catalyzed reaction. ***(draw a lower high point)***

13. Sketch a potential energy curve for a reaction based on the information provided below.

Label the parts representing the activated complex, activation energy, and change in enthalpy, ΔH.

$\Delta H_{forward}$ = -30 kJ $E_{a\ reverse}$ = +50 kJ

3 marks. Students must clearly show an EXOTHERMIC reaction and indicate a scale on the y-axis that correctly gives a forward activation energy of +20 and a heat of reaction (*ΔH of -30 kJ). The y-axis and graph do not need to be drawn to scale. A sample: