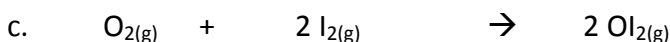
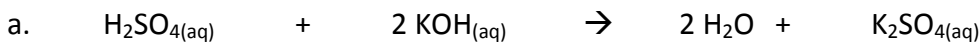


**The ANSWERS FOLLOW the QUESTIONS** Chemistry Pretest 2.2 V 2015

1. Categorize as a fast or slow reaction, and justify your choice.



2. The reaction of oxygen with ethane ( $\text{C}_2\text{H}_6$ ) is very slow at room temperature. How fast, relative to that of ethane, is the reaction of propane( $\text{C}_3\text{H}_8$ ) with oxygen at room temperature? Explain.

3. *Without* using a catalyst and without raising the temperature, how would you increase the rate of reaction 1b? Of 1c?

4. A cube of zinc is cut diagonally from two corners to two opposing corners forming two equal pieces. How much faster will it react with acid compared to the uncut cube?

5. How can you prove that the catalyst in potatoes is not consumed when it catalyses the breakdown of  $\text{H}_2\text{O}_2$ ?

6. Draw an energy-versus-progress-of-reaction profile for the synthesis of cell wall with and without penicillin.



7. a) Draw a distribution of kinetic energies graph for an apple that is naturally browning.

b) On the same graph show what would happen if an inhibitor like  $\text{Cu}^{+2}$  was added. Label the effect.

c) On the same graph, show what would happen if temperature was raised.

8. Use an enthalpy vs. progress of reaction graph and a distribution of kinetic energies graph to show the effect of a catalyst on activation energy.

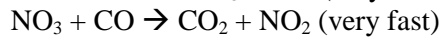
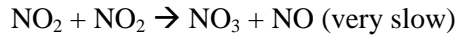
9. What is an activated complex?

10. Peat bogs have been known to preserve dead bodies. Recently scientists discovered that there is very little bacteria in the bogs because bacteria are deprived of essential metal ions, which are retained by the moss. It was already known

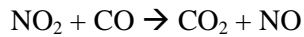


that bog acids, with pH levels similar to vinegar and low oxygen levels, conserve the human bodies in the same way as fruit is preserved by pickling.<sup>[7]</sup> What factors, among the ones we studied, are slowing down the rate of decay?  
Shown: Tollund Man, 2400 years old.

11. The following is a reaction mechanism:



Overall:



- What is the effect of doubling the concentration of CO?
- Of tripling the concentration of nitrogen dioxide?

12. Explain why chlorophyll is considered a catalyst. Mention the two photosystems, the role of water and the role of NADPH.

13. Why are enzymes catalysts? Use the example of sucrase.

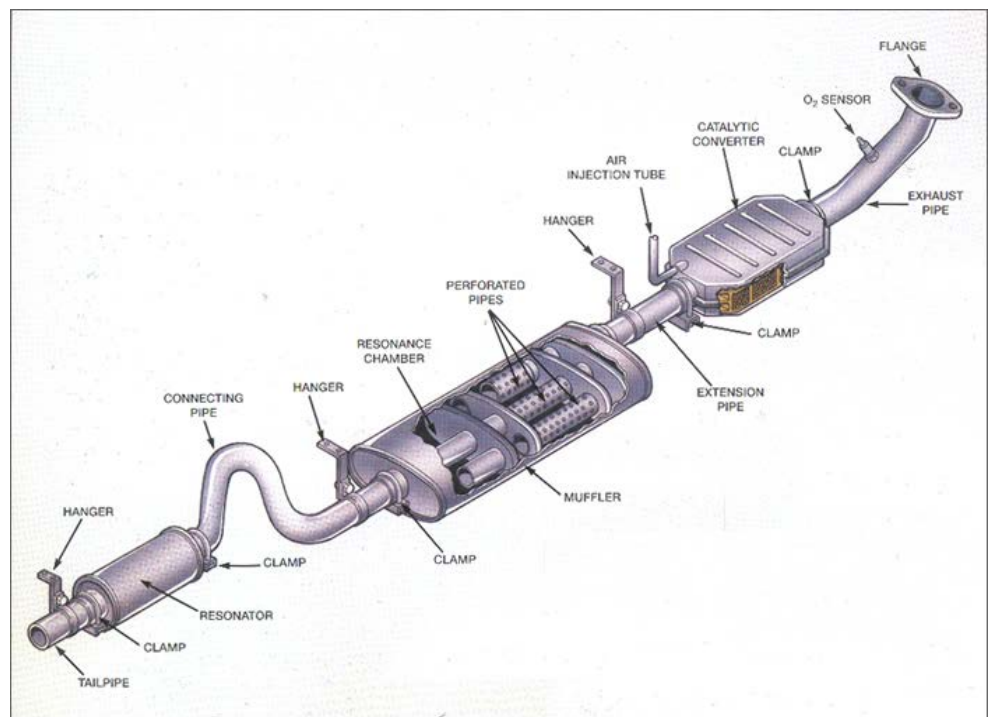
14. a) If a food decomposes at a rate of 1.0 g/h at 30°C and becomes inedible in 5 hours, and only at 0.1g/h in the fridge, for how long can that food be kept in the fridge and still be eaten?

b) Explain why in terms of effective collisions.

15. Technically laundry detergent is a lot more than soap. What activation-energy altering substance is in detergent and why? **(SKIP)**

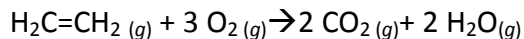
16. Why is BHT, which is added to cereal packaging, technically not a true inhibitor? **(SKIP)**

17. What metallic elements are found in between the muffler and the engine, and what do they do to NO<sub>2</sub> and CO? **(SKIP)**



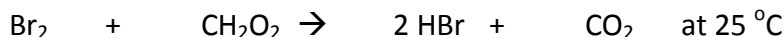
## Flashback

18. a) Estimate the heat of reaction for the following combustion of ethylene using the bond energies given below.



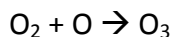
Bond	Bond energy (kJ/mol)
C-H	413
C-C	347
O-H	467
C=C	614
C=O	745
O=O	495

- b) At STP, what is the partial pressure of  $\text{O}_2$  in the above reaction just before we react exactly one mole of ethylene and three moles of oxygen.
- 19 Calculate the average rate of decomposition of  $\text{Br}_2$  in the first 200 seconds.



Time	Total moles HBr produced
0	0.000
50	0.0038
100	0.0048
150	0.0052
200	0.0053

20. At a constant temperature and pressure, oxygen,  $\text{O}_2$ , is converted into ozone ( $\text{O}_3$ ) at a rate of 1.6 g/ minute. At what rate, in *moles/minute*, is ozone formed?



21. You are at the scene of a murder, and your chemical expertise is needed. It takes 3.0 hours for 24 g of poisonous X (molar mass = 50.0) to form. How many grams of  $\text{X}_2\text{Y}_3$  (molar mass = 148) decomposed after 5.0 minutes, which was the time it took for the victim to die?



22. What were some of the rate factors involved in cooking linguini, fries versus potato chips or onions? Why do you cry when you cut an onion?

### Solutions

- very fast: all aqueous ions among reactants; few new bonds needed
  - very fast: all aqueous ions among reactants; few new bonds needed
  - slow: involves covalent bond changes
- Propane will react even more slowly because more bonds have to be broken. Also, if you compare its balanced reaction to that of ethane, you'll notice that propane forms more carbon dioxide and water.
- Increase the pressure (hence the concentration) of oxygen and iodine.

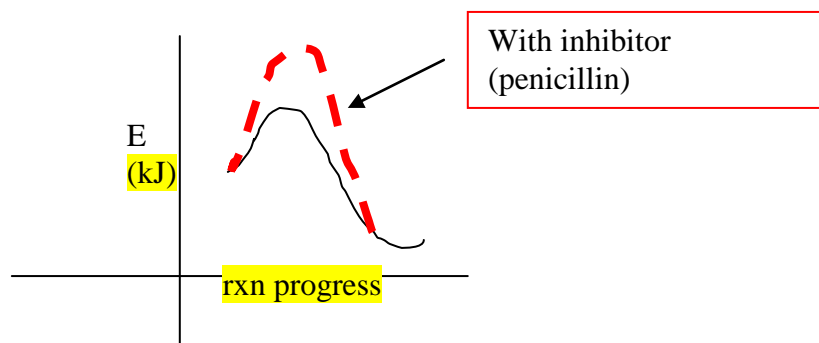
4.

The original surface area of the cube =  $6s^2$ . The diagonal is  $s\sqrt{2}$  long. A diagonal cut will expose two rectangles of area  $s(s\sqrt{2}) = s^2\sqrt{2}$  each. The total area of the cube therefore becomes  $2s^2\sqrt{2} + 6s^2$ . So it will react  $(2s^2\sqrt{2} + 6s^2)/(6s^2)$  faster =  $(2\sqrt{2} + 6)/6 = 1.47$  times faster.

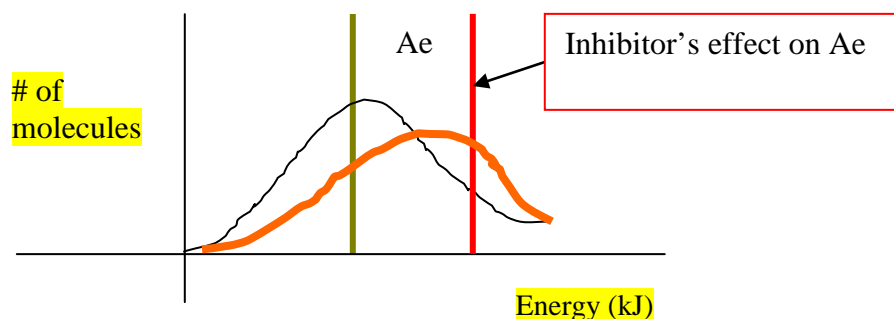
5.

Once the reaction stops fizzing, remove the piece of potato from the solution, and add it to a fresh sample of  $H_2O_2$ . It should cause fizzing again.

6.

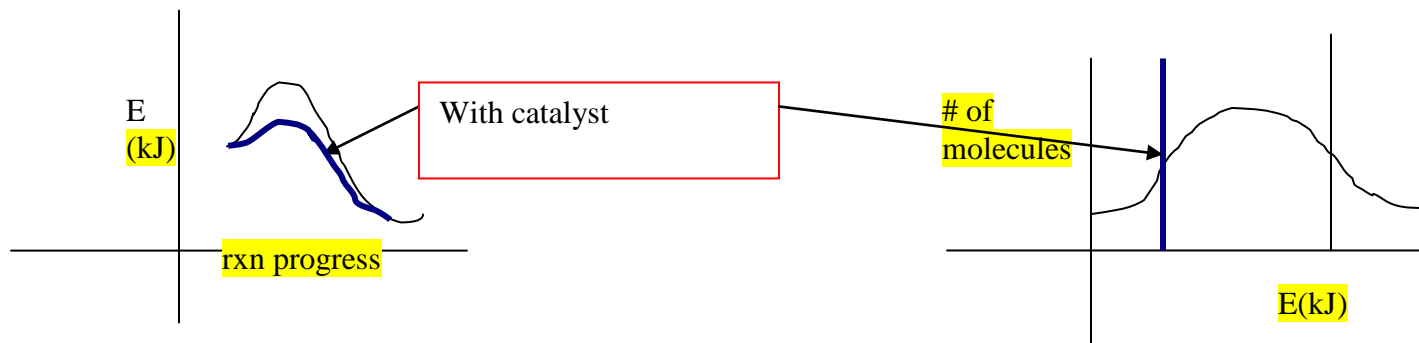


7.



Higher temperature

8.



9. What is an activated complex?

It is an intermediate between the reactants and products. Its enthalpy is the  $H_{\max}$  on the reaction profile.

#### OffBeat Question

10.

**Concentration** of essential ions and oxygen is too low for the bacteria to survive. Acid is acting as an **inhibitor**.

11. a) No effect because the rate determining step is the slow one, so the rate =  $k[\text{NO}_2]^2$ . Note there is no CO involved in that slow step.  
b) It will be nine times faster due to the power of two in the equation ( $3^2$ )
12. Explain why chlorophyll is considered a catalyst. Mention the two photosystems, the role of water and the role of NADPH.

Chlorophyll loses an electron when a photosystem absorbs a photon of light. That electron is picked up eventually by NADP and  $\text{H}^+$  to turn into NADPH, a molecule whose electrons are needed to convert carbon dioxide into sugars.

But that electron is returned when another photosystem's chlorophyll gives up an electron. Ultimately it is water that returns the electron, effectively recycling chlorophyll as  $H_2O$  splits up into voltage-creating  $H^+$ 's and oxygen gas.

[See website diagram](http://www.emsb.qc.ca/laurenhill/science/photosynthesis.pdf) (<http://www.emsb.qc.ca/laurenhill/science/photosynthesis.pdf>)

13. Why are enzymes catalysts? Use the example of sucrase.

They speed up reactions that are normally too slow for life. In the case of sucrase, this enzyme binds specifically to a sugar(sucrose) molecule and water and converts them into two smaller sugar molecules(glucose and fruit sugar(fructose)). This allows the molecules to get out of the intestine and into the blood stream. Glucose gets into cells, where byproducts turn in ATP(an energy-providing molecule) in the mitochondria

14. a) If a food decomposes at a rate of 1.0 g/h at  $30^{\circ}C$  and becomes inedible in 5 hours, and only at 0.1g/h in the fridge, for how long can that food be kept in the fridge and still be eaten?

$$\begin{aligned}r_1 t_1 &= r_2 t_2 \\1(5) &= 0.1 t_2 \\t_2 &= 50 \text{ h}\end{aligned}$$

b) Explain why in terms of effective collisions.

At the lower fridge temperature there will less effective collisions between reacting molecules within bacteria and among the enzymes released by molds. They will grow more slowly, release less toxins, which will keep the food fresh for a longer period of time.

15. Technically laundry detergent is a lot more than soap. What activation-energy altering substance is in detergent and why?

Detergents includes enzymes, which are there to more quickly break down proteins and starches in stains, so they can be washed away by water.

15. Why is BHT, which is added to cereal packaging, technically not a true inhibitor?

It slows down the oxidation of cereal by sacrificing itself to the oxygen in the air. But it turns into other compounds, so it is chemically consumed unlike a true inhibitor.

16. What metallic elements are found in between the muffler and the engine, and what do they do to  $NO_2$  and  $CO$ ?

17. Rhodium and platinum acts as catalysts, speeding up the breakdown of the pollutant NO<sub>2</sub> into air and the conversion of carbon monoxide into carbon dioxide.
- 18.

$\Delta H_{bb}$	$\Delta H_{Bf}$	$\Delta H$
4 C-H + C=C + 3 O=O	2(2) C=O + 2(2) O- H	$\Delta H_{bb} + \Delta H_{Bf}$
4*413 + 614 + 3*495 =	4* 745 + 4* 467 =	-1097 = - 1.10 X 10 <sup>3</sup> <b>kJ/mol</b> H <sub>2</sub> C=CH <sub>2</sub>

19. b)  $P_{O_2} = n_{O_2}/n_T (P_T) = (3/4)(101.3 \text{ kPa}) = 75.98 \text{ kPa}$

20. Avg rate for HBr appearance =  $\Delta n/\Delta t = (0.0053 - 0.000)/(200 - 0) = 0.0000265$   
 moles HBr / s  
 $(0.0000265 \text{ moles HBr / s}) (1 \text{ mole Br}_2 / 2 \text{ moles HBr}) = 0.000013 \text{ moles Br}_2 / \text{s}$   
 $= 0.00001 \text{ moles Br}_2 / \text{s}$

21. Write an equation:



1.6g / (32g/mole) / minute = 0.050 moles of O<sub>2</sub> / minute  
 ratio is 1:1, so we'll get 0.050 moles of O<sub>3</sub> / minute formed

22. 24g X / 3 h = 8 g X / h  
 Convert to moles:  
 0.16 moles X / h  
 Using the ratio from the equation we see that 0.08 moles of X<sub>2</sub>Y<sub>3</sub> will decompose every hour.  
 Converting to grams:  
 $0.08 \text{ moles X}_2\text{Y}_3 / \text{h} (148 \text{ g/mole}) = 11.84 \text{ g/h} = 11.84 \text{ g} / 60 \text{ min} = 0.20 \text{ g X}_2\text{Y}_3 / \text{min}$   
 $5 \text{ min} (0.20 \text{ g X}_2\text{Y}_3 / \text{min}) = 1.0 \text{ g of X}_2\text{Y}_3$

21.

- 1) Linguini cooked quickly due to their high **surface area** to weight ratio.
- 2) Fries don't cook as quickly as potato chips because the former have a lower **surface area** to weight ratio.
- 3) The browning of garlic, onions and fries occurs by high **temperature**-induced Maillard reactions between reducing sugars and amino acids.

4) When you cut an onion, you rupture their cells, releasing their contents. Enzymes (**catalysts**) that were kept separate now are free to mix with the sulfenic acids to produce propanethiol S-oxide, a volatile sulfur compound that translates upward toward your eyes. This gas reacts with the water in your tears to form sulfuric acid. The sulfuric acid burns, stimulating your eyes to release more tears to wash the irritant away. You can keep from crying by refrigerating your onion before cutting it (slows reactions and changes the chemistry inside the onion) or by cutting the onion under water, which dissolves away the lacrymators. You don't have to remember all the names of the chemicals!