Name: KEY F 2017 Chem 108 / Dr. Rusay

EXAM 3

Total Possible Points: 127 pts. Answer questions 1-20 (4 pts. each) 21-30 (2 pts. each) on scantron. Answer the remaining questions on the exam, pts. for these questions are indicated on the exam.

1. The Earth is relatively warm due to

   a. Ultraviolet radiation from the sun being absorbed by ozone molecules in the stratosphere.
   b. X-rays and gamma rays exciting nitrogen and oxygen gas molecules in the lower atmosphere.
   c. Infrared radiation being absorbed by certain trace gas molecules such as CO_2, which have certain bond bending and stretching vibrations, that are found in the lower atmosphere.
   d. The very high temperature of the molten inner core of the Earth which is composed mostly of iron.

1 mol 2 mol

2. Compare the respective combustion reactions of 16 grams of methane CH_4 and 116 grams of butane C_4H_{10}, when both are mixed separately with 224 liters (10 moles) of oxygen and then reacted with a spark.

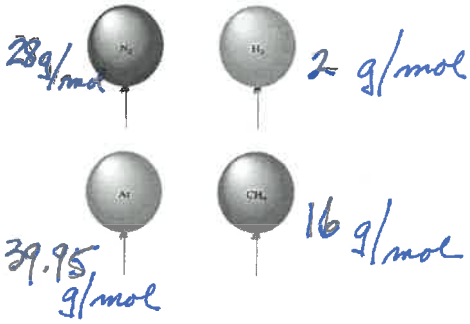
$CH_4\,(g) + 2\,O_2\,(g) \rightarrow CO_2\,(g) + 2\,H_2O\,(g) + 890\ kJ$
$2\,C_4H_{10}\,(g) + 13\,O_2\,(g) \rightarrow 8\,CO_2\,(g) + 10\,H_2O\,(g) + 5{,}748\ kJ$

Select the correct statement :

   a. The carbon footprint is the same for methane and butane since they are both hydrocarbons.
   b. The amount of energy produced is the same in both reactions.
   c. All of the oxygen is consumed in the butane reaction.
   d. The amount of CO_2 produced is greater for methane than butane.
   e. Oxygen is the limiting reagent in the methane reaction.

3. *Consider separate containers of the same size that contain 1 mole of each of 4 different gases at the same temperature and same pressure: nitrogen (N_2), methane (CH_4), argon (Ar), and hydrogen (H_2).* Which of the gases will be moving at the slowest average speed?

   a. nitrogen
   b. methane
   c. argon
   d. hydrogen



$Ar < N_2 < CH_4 < H_2$

4. A gas is cooled from 100°C (373K) to 5°C (278 K) and the pressure remains constant, how does the volume change? *(K = °C +273)*

   a. The volume of the gas increases by 25%.
   b. The volume of the gas decreases by 25%.
   c. The volume of the gas increases by 95%.
   d. The volume of the gas decreases by 95%.
   e. The volume should stay the same.

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ KELVINS

$\frac{1}{373} = \frac{?}{278} = 0.745$

$\frac{1 - 0.745}{1} \times 100 = 25.5\%$

5. A typical total capacity for 100 lb human being's lungs is approximately 5,000 mL. At a temperature of 37°C (average body temperature) and pressure of 1.0 atm, how many moles of air does carry inside her lungs when inflated? (R = 0.08206 L atm/ K mol)

a. 0.16 mol
b. 0.22 mol
c. 1.65 mol
d. 2.20 mol

310 K, 1 atm, 5.0 L $n = \frac{PV}{RT} = 0.196$ mol (GIVEN CREDIT)

6. The following equilibrium is reached in 4 minutes.: **A** $\rightleftharpoons$ **B** When at equiibrium, in every one minute, 20% of reactants A form products B, while during that same period of time, 80% of products B react in the opposite direction to form reactants A. This continues every minute over time. The equilibrium constant, K = [Products] / [Reactants], for this reaction when equilibrium is reached is numerically:

[PRODUCTS] < [REACTANTS]

a. < 1 b. >1 c. 0 d. -1 e. There is no way to estimate the value.

7. A 25.00 mL sample of hydrochloric acid of unknown concentration was titrated with 42.30 mL of 0.2250 M KOH. What is the concentration of the HCl?

a. 0.1329 M
b. 0.1923 M
c. 0.2719 M
d. 0.3030 M
e. 0.3807 M

$\frac{42.30\ mL_{KOH} \times 0.2250\ M_{KOH}}{25.00\ mL_{HCl}} =$

180 g/mol 0.0314 mol

8. In the synthesis of aspirin ($C_9H_8O_3$), Derek obtained 5.65 g. Based on the starting salicylic acid ($C_7H_8O_2$), he calculated that the theoretical number of moles of aspirin formed would be 0.0356 mol. What should be Derek's reported % yield?

a. 11.5%
b. 80.3%
c. 86.9%
d. 88.1%
e. 115%

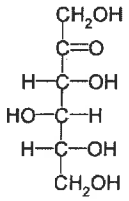
$\frac{0.0314\ mol}{0.0356\ mol} \times 100 =$

9. Of the choices below, which would *not* be found in a photosynthesis reaction?

a. Glucose ($C_6H_{12}O_6$)
b. Water
c. Nitrogen
d. Oxygen
e. Energy

10. The monosaccharide sorbose whose structure is provided below is a _____ and has a(n) _____ function in addition to the alcohols.

Fill in the correct terms.



a. hexose; aldehyde
b. pentose; ketone
c. hexose; ketone
d. triose; ketone
e. pentose; aldehyde

11. Peptide bonds contain which of the following patterns linking the individual amino acids?

a. $(-CH_2-)$
b. $(-COO-)$
c. $(-CONH-)$
d. $(-NH-CH_2-)$
e. $(-CH_2-O-CH_2-)$

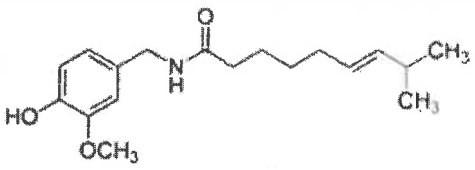
12. Which pure substances will **not** form hydrogen bonds?

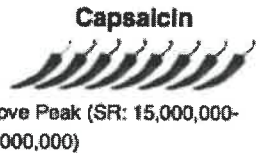
I) CH_3CH_2OH II) CH_3OCH_3

III) CH_3CH_3 IV) $H_3C–NH_2$

a) I and II b) I and III c) II and III d) II and IV

The molecule below is capsaicin, a naturally occuring plant metabolite found in chili peppers. The "hottest" chili pepper is Bhut jolokia, ghost pepper, a hybrid of ***Capsicum chinense*** *and* ***Capsicum frutescens****. It is classified at 1 million scovills (hotness units), habañero peppers are ~ 0.2 million units, jalapeño ~0.01 million units, and pure capsaicin ~16 million units.*



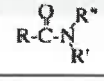


13. What is the correct molecular formula for capsaicin, $C_?H_?N_?O_?$? Its calculated molar mass is 305 g/mol.

a. $C_8H_{13}N_4O_8$
b. $C_{16}H_{21}N_2O_4$
c. $C_{18}H_{32}NO_3$
d. $C_{18}H_{27}NO_3$

14. Which choice best describes capsaicin's functions?

a. alcohol, amine, ketone
b. ether, alcohol, amino acid
c. alcohol, amide, ether
d. amine, aldehyde, ether
e. carboxylic acid, amide, ether

Alcohol	R–OH
Ether	R–O–R'
Amine	$R–NH_2$
Aldehyde	
Ketone	
Carboxylic Acid	
Ester	
Amide	

15. A lightning bolt creates a large quantity of nitrogen monoxide in its path by combining nitrogen gas and oxygen gas.

$$N_2(g) + O_2(g) + 180.5\ kJ \leftrightarrows 2\ NO(g)$$

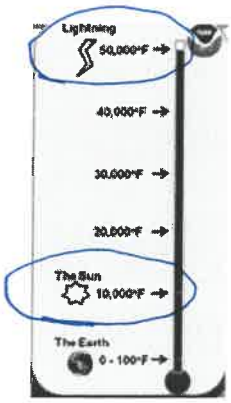
The following table shows the number of moles of OXYGEN, $O_2(g)$ which is present over an elapsed time:

Time (nanoseconds)	0	5 ns	10 ns
moles $O_2(g)$	0.100	0.085	0.070

What is the number of moles of NO(g) formed at 10 ns?

0.100
−0.070
0.030 × 2

a. 0.030 mol
b. 0.060 mol
c. 0.100 mol
d. 0.140 mol
e. 0.200 mol



16. *A lightning bolt can reach temperatures of ~30,000 kelvins. The sun, on the other hand, has a surface temperature of ~6,000 kelvins.* Fill in the blanks in the following statement for a planned equilibrium experiment that is @ 6,000 kelvins with a pressure much less than 1 atm, in comparison to a lightning initiated equilibrium near Oklahoma City @ 1 atm.

$$1\ N_2(g) + 1\ O_2(g) + 180.5\ kJ \leftrightarrows 2\ NO(g)$$

EXOTHERMIC OR ENDOTHERMIC?

The sun-like reaction is expected to produce _____ nitrogen monoxide than lightning, and the difference in pressure will favor the formation of _____ nitrogen monoxide than (as) lightning.

T↑ K↑

a. more, more
b. less, less
c. more, the same amount
d. less, the same amount
e. less, more

PRODUCTS INCREASE
T↓ K↓ DECREASE

$\Sigma n_{PRODUCTS} = \Sigma n_{REACTANTS}$ or $(2) = (1+1=2)$

∴ ΔPRESSURE HAS NO AFFECT

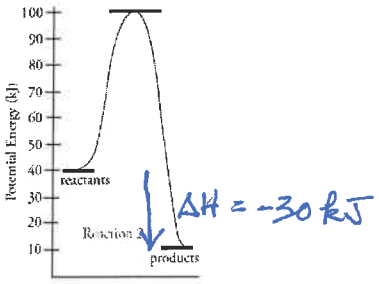
17. Chlorine dioxide (ClO_2) is a disinfectant used in municipal water-treatment plants. It dissolves in basic solution producing ClO_3^- and ClO_2^-:

$$2ClO_2\ (aq) + 2OH^-\ (aq) \rightarrow 1\ ClO_3^-\ (aq) + 1\ ClO_2^-\ (aq) + 1\ H_2O\ (l)$$

Of the following, which would not be a proper expression to relate information about the rate of the reaction?

a. $-\Delta ClO_2/\Delta t = 2\Delta ClO_3^-/\Delta t$
b. $-\Delta ClO_2/\Delta t = \Delta OH^-/\Delta t$
c. $-1/2\ \Delta OH^-/\Delta t = \Delta ClO_3^-/\Delta t$
d. $-\Delta ClO_2/\Delta t = \Delta ClO_2^-/\Delta t$
e. $-\Delta OH^-/\Delta t = 2\Delta ClO_2^-/\Delta t$

18. Which choice is correct for the following energy diagram?



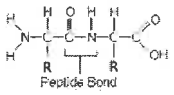
a. The diagram corresponds to an exothermic reaction absorbing 60 kJ of energy.
b. The diagram is for an endergonic reaction releasing 30 kJ of energy.
c. The diagram represents a endothermic reaction absorbing 60 kJ of energy..
d. The diagram represents an exergonic reaction releasing 30 kJ of energy. -30 kJ
e. The diagram is for an exothermic reaction releasing 90 kJ of energy.

Refer to the energy diagram in the previous question.

19. If an active enzyme were added to the reaction, [$C_5H_{10}O_5$ (aq) + 5 O_2 (g) → 5 CO_2 (g) + 5 H_2O (l) + energy] , it would

a. decrease the rate of reaction.
b. increase the Energy of activation E_{act}
c. decrease the Energy of activation E_{act}
d. increase the Potential Energy produced.
e. have no affect.

20. Proteins are made when amino acids form peptide bonds that link them together. Which of the following contains the correct number and type of atoms that are necessary to define a peptide bond, and which molecule forms as the byproduct of each peptide bond formed?



a. One carbon, one oxygen, one nitrogen, plus water
b. Two carbons, one oxygen, one nitrogen, one hydrogen, plus water
c. One carbon, two oxygen, one nitrogen, two hydrogen, plus ammonia
d. One carbon, one oxygen, one nitrogen, one hydrogen, plus water
e. One carbon, one oxygen, one nitrogen, one hydrogen, plus ammonia

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True (A) / False (B) Answer #21-30 on scantron.

T 21. If the temperature and volume of an ideal gas are held constant, the number of particles in a container and the gas pressure are directly proportional.

T 22. The energy from photosynthesis is stored in plants by forming chemical bonds.

T 23. If in a chemical reaction, more energy is released in the formation of new bonds than was necessary to break old bonds the reaction is exergonic.

T 24. Buffers keep human blood and the ocean's pH above 7, and carbon dioxide lowers it.

T 25. Human influenza has a link to ducks, pigs, and genetic mutations due to 2 enzymes, neuraminidase (N_5 or N_1) and hemagglutinin (H_1).

T 26. The secondary structure of proteins consists of helices and sheets resulting from internal hydrogen bonds.

T 27. One of the ways in which catalysts accelerate chemical reactions is by providing an alternative pathway between reactants and products that lowers the activation energy

The following equilibrium reaction is used in the commercial production of acetic acid. Refer to the equilibrium for questions 28-30.

$$CH_3OH(g) + CO(g) + 207.9\ kJ \xrightarrow[\substack{175\ ^\circ C \\ 1\ atm}]{Rh/I_2} CH_3CO_2H(g)$$

T 28. When carbon monoxide is added, methanol (CH_3OH) will decrease to form more acetic acid

F 29. When the temperature is increased the concentration of acetic acid will decrease.

T 30. When the pressure is adjusted to 0.5 atm, the concentration of acetic acid will increase.

Answer on Exam:

31. [4pts] A scuba diver has 4.5 L of air in her lungs 75 ft below the ocean surface, where the pressure is 3.3 atm. What would the volume of this gas be at the surface, where the pressure is 1.0 atm? Show your calculation. Will the difference in volume be a risk factor in how fast she rises to the surface? *Briefly explain.*

YES. ---

$4.5\ L \times 3.3\ atm = V \times 1\ atm$

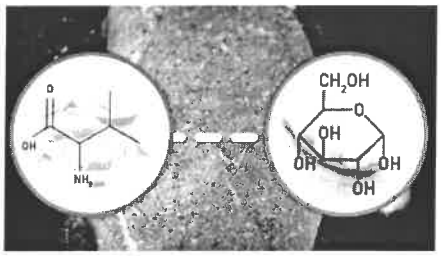
P < @ surface, ΔP (-)

14.85 L

32. [4pts] Complete the following table:

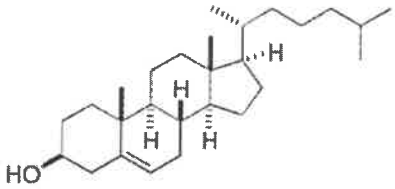
H_3O^+	Estimated pH	Calculated pH
0.0022 M	2-3	2.66
5.0×10^{-9} M	8-9	8.3
0.0100 M	2	2
6.8×10^{-5} M	4-5	4.17

33. [5pts] Fill in the blanks with the best choice on the right.



The structures of two Maillard Reaction molecules are shown above. A(n) G is on the left, and a(n) I is on the right.

The following molecule is a(n) A .



A metabolic reaction that produces energy is a(n) D reaction.

The following molecule is a(n) C .

A. steroid

B. trans fatty acid

C. cis fatty acid

D. catabolic

E. anabolic

F. amine

G. amino acid

H. peptide

I. sugar

J. protein

34. [6pts] The metabolic energy value of dietary lipids (fats and oils) is ~9.0 Cal/g vs ~4.0 Cal/g for proteins and carbohydrates. (a) Calculate the energy that is produced from the fat in 2 ounces of peanuts. [15 g of fat per ounce of peanuts is listed on the package.] Express the value in kilojoules (kJ). (Given: 4.184 kJ = 1 Cal). (b) What percent of the total energy is from fat if 1 ounce of peanuts produces a total of 170 Calories? Show your calculations.

$$\frac{2\,oz}{} \left| \frac{15\,g}{1\,oz} \right| \frac{9.0\,Cal}{1\,g} \left| \frac{4.184\,kJ}{1\,Cal} \right. = 1,130\,kJ$$

$$\% = \frac{135\,Cal}{170\,Cal} \times 100$$

1,130 kJ

79.4 %

35. [8pts] *In antacid medication, if you used enough of them, 1 mole of sodium bicarbonate (MM = 84 g/mol) could neutralize 1 mole of stomach acid. But the stomach, with a volume of 20-100 mL, will have only about 0.001 moles of acid.*

Correctly balance the equation below which represents the neutralization reaction.

$$\_1\_\ HCl\ (aq) + \_1\_\ NaHCO_3\ (s) \rightarrow \_1\_\ CO_2(g) + \_1\_\ H_2O(l) + \_1\_\ NaCl\ (aq)$$

Calculate the number of moles of sodium bicarbonate that are needed to neutralize 0.001 moles of HCl. Show your calculation.

$$\frac{1\ mol\ NaHCO_{3(s)}}{1\ mol\ HCl_{(aq)}} = \frac{?}{0.001\ mol\ HCl} = 0.001\ mol\ NaHCO_3$$

A typical single antacid tablet will have 1,900 mg of sodium bicarbonate as the active ingredient. Will this be enough to neutralize all of the stomach acid? Show a clear calculation for your answer. (*Think of the balloon experiment and limiting reactants.*)

$$\frac{1{,}900\ mg \mid g \mid mol}{1{,}000\ mg \mid 84\ g} = 0.0226\ mol$$

YES, 0.001 mol

Na 23
H 1
C 12
O 48
84 g/mol

BONUS: Calculate 1) the number of moles of CO_2 produced from one tablet of antacid and 2) the respective theoretical volume of CO_2 produced assuming STP (Standard Temperature (0 °C) and Standard Pressure (1 atm). The Ideal Gas Law is PV = nRT, R = 0.082 L atm $mol^{-1}K^{-1}$; one mole of gas occupies 22.4 liters @ STP. Show clear, labeled calculations.

0.001 mol CO_2

0.0224 L = 22.4 mL