

# Chemistry 222 Sample Final Exam Cover Sheet

Winter XXXX

Name: \_\_\_\_\_

This exam consists of thirty-two (32) multiple-choice questions and five (5) short answer questions.

A periodic table and scratch paper are available for you to use on this exam.

*Before you start:*

- **Turn in the Take Home Lab Final** and the **Final Exam Prep** worksheet *before* starting this exam
- Write your first and last name in the space above
- Sign the integrity statement below. **Failing to sign the integrity statement on this exam imparts an immediate grade of zero.**
- For multiple choice questions: clearly enter your letter answer in the appropriate location. **Circle** the letter which corresponds to your answer.
- For short answer questions: clearly **circle** your final answer, showing all work.

Point values and your exam score will be summarized on the final page.

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*Integrity statement:*

I have neither given nor received aid on this exam.

\_\_\_\_\_  
*Your signature*

1. Atomic number describes the number of \_\_\_\_\_ in an atom.

- a. protons
- b. neutrons
- c. electrons
- d. a and b
- e. all of the above

Letter answer to question #1: \_\_\_\_\_

2. Which of the following symbols represents an alpha particle?

- a.  ${}^4_2\text{He}$
- b.  ${}^2_4\text{He}$
- c.  ${}^0_{+1}\text{e}$
- d.  ${}^0_{-1}\text{e}$
- e.  ${}^1_0\text{n}$

Letter answer to question #2: \_\_\_\_\_

3. The most penetrating type of radiation is a(n)

- a. alpha particle
- b. beta particle
- c. gamma ray
- d. positron
- e. cathode ray

Letter answer to question #3: \_\_\_\_\_

4. If plutonium-244 decays by successive  $\alpha$ ,  $\beta$ ,  $\beta$ ,  $\alpha$  emissions, what nucleus is produced?

- a.  ${}^{236}_{88}\text{Ra}$
- b.  ${}^{236}_{89}\text{Ac}$
- c.  ${}^{236}_{90}\text{Th}$
- d.  ${}^{240}_{90}\text{Th}$
- e.  ${}^{236}_{92}\text{U}$

Letter answer to question #4: \_\_\_\_\_

5. If Ag-106 decays by electron capture, what is the product?

- a.  $^{105}_{46}\text{Pd}$
- b.  $^{106}_{46}\text{Pd}$
- c.  $^{105}_{47}\text{Ag}$
- d.  $^{106}_{48}\text{Cd}$
- e.  $^{107}_{47}\text{Ag}$

Letter answer to question #5: \_\_\_\_\_

6. By what (single step) process does polonium-211 decay to lead-207?

- a.  $\alpha$  particle emission
- b.  $\beta$  particle emission
- c. positron emission
- d. electron capture
- e. neutron capture

Letter answer to question #6: \_\_\_\_\_

7. The decay of radioactive elements is a first-order process. The half-life of carbon-14 is 5730 years. How many years will it take for 5.0 g of carbon-14 to decay to 1.0 mg?

- a. 5730 years
- b. 17,200 years
- c. 24,900 years
- d. 57,300 years
- e. 70,400 years

Letter answer to question #7: \_\_\_\_\_

8. Given the initial rate data for the reaction  $A + B \rightarrow C$ , determine the rate expression for the reaction.

<u>[A], M</u>	<u>[B], M</u>	<u><math>\Delta[C]/\Delta t</math> (initial) M/s</u>
0.334	0.134	$4.11 \times 10^{-9}$
0.334	0.187	$8.00 \times 10^{-9}$
0.668	0.134	$4.11 \times 10^{-9}$

- a.  $\frac{\Delta[C]}{\Delta t} = 2.75 \times 10^{-7} \text{ M}^{-2}\text{s}^{-1}[\text{A}]^2[\text{B}]$
- b.  $\frac{\Delta[C]}{\Delta t} = 3.07 \times 10^{-8} \text{ s}^{-1}[\text{B}]$
- c.  $\frac{\Delta[C]}{\Delta t} = 2.29 \times 10^{-7} \text{ M}^{-1}\text{s}^{-1}[\text{B}]^2$
- d.  $\frac{\Delta[C]}{\Delta t} = 6.85 \times 10^{-7} \text{ M}^{-2}\text{s}^{-1}[\text{A}][\text{B}]^2$
- e.  $\frac{\Delta[C]}{\Delta t} = 1.23 \times 10^{-8} \text{ s}^{-1}[\text{A}]$

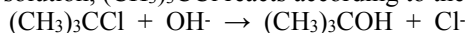
Letter answer to question #8: \_\_\_\_\_

9. For a zero order reaction, which of the following (if plotted versus time) should give a straight line?

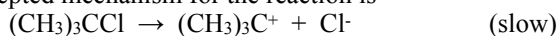
- a.  $\ln [A]$
- b.  $\ln k$
- c.  $\ln [1/A]$
- d.  $1/[A]$
- e.  $[A]$

Letter answer to question #9: \_\_\_\_\_

10. In basic solution,  $(\text{CH}_3)_3\text{CCl}$  reacts according to the equation:



The accepted mechanism for the reaction is

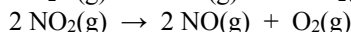
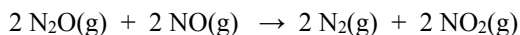


What is a rate law that is consistent with the mechanism for this reaction?

- a.  $\text{rate} = k[(\text{CH}_3)_3\text{CCl}]$
- b.  $\text{rate} = k[(\text{CH}_3)_3\text{CCl}][\text{OH}^-]$
- c.  $\text{rate} = k[(\text{CH}_3)_3\text{C}^+][\text{OH}^-]$
- d.  $\text{rate} = k[(\text{CH}_3)_3\text{CCl}][\text{OH}^-]/[\text{Cl}^-]$
- e.  $\text{rate} = k[(\text{CH}_3)_3\text{CCl}][\text{OH}^-]/[\text{Cl}^-]$

Letter answer to question #10: \_\_\_\_\_

11. The elementary steps for the catalyzed decomposition of dinitrogen monoxide are shown below.



Which of the following statement(s) is/are CORRECT?

- 1. The overall balanced reaction is  $2 \text{N}_2\text{O}(\text{g}) \rightarrow 2 \text{N}_2(\text{g}) + \text{O}_2(\text{g})$ .
- 2.  $\text{NO}(\text{g})$  is a catalyst for the reaction.
- 3.  $\text{N}_2(\text{g})$  is a reaction intermediate.

- a. 1 only
- b. 2 only
- c. 3 only
- d. 1 and 2
- e. 1, 2, and 3

Letter answer to question #11: \_\_\_\_\_

12. What is the half-life for a first-order reaction with a rate constant of  $0.291 \text{ s}^{-1}$ ?

- a. 0.420 s
- b. 1.93 s
- c. 2.38 s
- d. 6.87 s
- e. 13.1 s

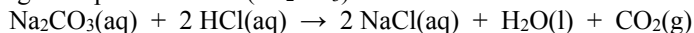
Letter answer to question #12: \_\_\_\_\_

13. The effect of adding a catalyst to a reaction is to

- a. increase the number of collisions between reactants
- b. increase the energy of the products
- c. increase the equilibrium constant of a reaction
- d. lower the activation energy of a reaction
- e. decrease the enthalpy change of a reaction

Letter answer to question #13: \_\_\_\_\_

14. If 0.3000 g of impure soda ash ( $\text{Na}_2\text{CO}_3$ ) is titrated with 17.66 mL of 0.1187 M HCl, what is the percent purity of the soda ash?



- a. 11.11%
- b. 22.22%
- c. 57.91%
- d. 37.03%
- e. 74.06%

Letter answer to question #14: \_\_\_\_\_

15. Which of the following combinations is most likely to produce an ionic bond?

- a. Cl and Br
- b. P and S
- c. N and O
- d. B and O
- e. Li and F

Letter answer to question #15: \_\_\_\_\_

16. Which of the following aqueous solutions would have the highest vapor pressure at 25 °C?

- a. pure water
- b. 1 m glucose ( $\text{C}_6\text{H}_{12}\text{O}_6$ )
- c. 1 m  $\text{NaNO}_3$
- d. 1 m  $\text{MgCl}_2$
- e. 1 M  $(\text{NH}_4)_2\text{SO}_4$

Letter answer to question #16: \_\_\_\_\_

17. When 27.0 g of an unknown metal at 88.4 °C is placed in 115 g  $\text{H}_2\text{O}$  at 21.0 °C, the final temperature of the water is 23.7 °C. What is the specific heat capacity of the metal?

- a. 0.34 J/g·K
- b. 0.51 J/g·K
- c. 0.74 J/g·K
- d. 0.94 J/g·K
- e. 1.4 J/g·K

Letter answer to question #17: \_\_\_\_\_

18. Calculate the amount of heat required to change 50.0 g ice at -20.0 °C to steam at 135 °C. (Heat of fusion = 333 J/g; heat of vaporization = 2260 J/g; specific heat capacities: ice = 2.09 J/g·K, steam = 1.84 J/g·K)

- a. 4.18 kJ
- b. 32.4 kJ
- c. 78.8 kJ
- d. 135 kJ
- e. 156 kJ

Letter answer to question #18: \_\_\_\_\_

19. Hydrazine,  $\text{N}_2\text{H}_4$ , is a liquid used as a rocket fuel. It reacts with oxygen to yield nitrogen gas and water:  $\text{N}_2\text{H}_4(\text{l}) + \text{O}_2(\text{g}) \rightarrow \text{N}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{l})$ . The reaction of 3.80 g  $\text{N}_2\text{H}_4$  evolves 73.7 kJ of heat. Calculate the enthalpy change per mole of hydrazine combusted.
- 8.74 kJ/mol
  - 19.4 kJ/mol
  - $-2.80 \times 10^2$  kJ/mol
  - 622 kJ/mol
  - $-8.98 \times 10^3$  kJ/mol

Letter answer to question #19: \_\_\_\_\_

20. Which of the following chemical equations corresponds to the standard molar enthalpy of formation of  $\text{N}_2\text{O}$ ?
- $\text{NO}(\text{g}) + 1/2 \text{N}_2(\text{g}) \rightarrow \text{N}_2\text{O}(\text{g})$
  - $\text{N}_2(\text{g}) + 1/2 \text{O}_2(\text{g}) \rightarrow \text{N}_2\text{O}(\text{g})$
  - $2\text{N}(\text{g}) + \text{O}(\text{g}) \rightarrow \text{N}_2\text{O}(\text{g})$
  - $\text{N}_2(\text{g}) + \text{O}(\text{g}) \rightarrow \text{N}_2\text{O}(\text{g})$
  - $2 \text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{N}_2\text{O}(\text{g})$

Letter answer to question #20: \_\_\_\_\_

21. Determine  $\Delta H$  for the reaction:  $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightarrow 2 \text{NH}_3(\text{g})$  given the thermochemical equations below.
- |   |                                |
|---|--------------------------------|
| $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}(\text{g})$                                       | $\Delta H = +180.8 \text{ kJ}$ |
| $4 \text{NH}_3(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 4 \text{NO}(\text{g}) + 6 \text{H}_2\text{O}(\text{g})$ | $\Delta H = -906.2 \text{ kJ}$ |
| $2 \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\text{g})$                            | $\Delta H = -483.6 \text{ kJ}$ |
- 1209.0 kJ
  - 1189.0 kJ
  - 756.5 kJ
  - 241.8 kJ
  - 91.5 kJ

Letter answer to question #21: \_\_\_\_\_

22. My reaction 'feels hot', and scientists refer to this reaction as:
- endothermic
  - exothermic
  - enthalpy disfavored
  - enthalpy wannabe
  - lame (*this is not the correct answer! :*)

Letter answer to question #22: \_\_\_\_\_

23. The empirical formula of a certain hydrocarbon is  $\text{CH}_2$ . When 0.120 mole of the hydrocarbon is completely combusted with excess oxygen, 17.7 L  $\text{CO}_2$  gas is produced at 27 °C and 1.00 atm. What is the molecular formula of the hydrocarbon?
- $\text{C}_2\text{H}_2$
  - $\text{C}_2\text{H}_4$
  - $\text{C}_3\text{H}_6$
  - $\text{C}_5\text{H}_{10}$
  - $\text{C}_6\text{H}_{12}$

Letter answer to question #23: \_\_\_\_\_

24. An unknown gaseous hydrocarbon contains 85.63 % C. Its density is 0.426 g/L at 0.465 atm and 373 K. What is the molecular formula of the gas?
- a.  $\text{C}_2\text{H}_4$
  - b.  $\text{C}_3\text{H}_6$
  - c.  $\text{C}_4\text{H}_8$
  - d.  $\text{C}_5\text{H}_{10}$
  - e.  $\text{C}_6\text{H}_{12}$

Letter answer to question #24: \_\_\_\_\_

25. What intermolecular force or bond is primarily responsible for the solubility of  $\text{H}_2\text{S}$  in water?
- a. ion-dipole force
  - b. dipole-dipole force
  - c. ionic bonding
  - d. covalent bonding
  - e. hydrogen bonding

Letter answer to question #25: \_\_\_\_\_

26. What is the solute mole fraction of 1.98 m  $\text{Fe}(\text{NO}_3)_3(\text{aq})$ ? The molar mass of  $\text{Fe}(\text{NO}_3)_3$  is 241.9 g/mol and the molar mass of water is 18.02 g/mol.
- a. 0.0345
  - b. 0.0641
  - c. 0.324
  - d. 0.479
  - e. 0.863

Letter answer to question #26: \_\_\_\_\_

27. Concentrated hydrofluoric acid is 28.9 M and has a density of 1.18 g/mL. What is the weight percent of concentrated HF?
- a. 24.5%
  - b. 49.0%
  - c. 51.0%
  - d. 68.2%
  - e. 75.5%

Letter answer to question #27: \_\_\_\_\_

28. The Henry's law constant for  $\text{N}_2$  in water at 37 °C is  $8.2 \times 10^{-7}$  M/mm Hg. What is the equilibrium concentration of  $\text{N}_2$  in water when the partial pressure of  $\text{N}_2$  is 634 mm Hg?
- a.  $1.3 \times 10^{-9}$  M
  - b.  $5.2 \times 10^{-4}$  M
  - c.  $1.9 \times 10^{-2}$  M
  - d.  $1.9 \times 10^3$  M
  - e.  $7.7 \times 10^8$  M

Letter answer to question #28: \_\_\_\_\_

29. Which of the following species will have a Lewis structure most like that of a sulfate ion,  $\text{SO}_4^{2-}$ ? Assume that the Lewis structure has no double bonds.
- $\text{NH}_3$
  - $\text{CBr}_4$
  - $\text{SO}_3$
  - $\text{H}_2\text{CO}$
  - $\text{H}_2\text{O}$

Letter answer to question #29: \_\_\_\_\_

30. Which intermolecular force is the strongest?
- induced dipole - induced dipole (ID-ID)
  - ion-dipole
  - hydrogen bonding
  - dipole-dipole
  - ion-ion

Letter answer to question #30: \_\_\_\_\_

31. For  $\text{NH}_4\text{NO}_3(\text{aq})$ , the solvent is
- $\text{NH}_4\text{NO}_3$
  - $\text{NH}_4^+$
  - $\text{NO}_3^{1-}$
  - water
  - Duff beer

Letter answer to question #31: \_\_\_\_\_

32. When making pasta, adding salt to water will \_\_\_\_\_ the boiling point of the water.
- increase
  - decrease
  - have no effect
  - ionize
  - more information is needed to answer this question

Letter answer to question #32: \_\_\_\_\_



**Part II:** Short Answer / Calculation, 20 points total. *Show all work!*

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1. List the following constants and values, and include units. (10 points)

gas constant (R) when used with the ideal gas equation to five sig figs =

gas constant (R) when used with the Arrhenius equation to five sig figs =

Avogadro's number (N) to four sig figs =

the molar mass of ammonia to four sig figs =

the molar mass of water to four sig figs =

2. Convert the following using correct significant figures: (10 points)

370 mL to L

43 m to cm

150 °C to K

128 cm<sup>3</sup> to mL

150 s to minutes

# CH 222 Final Lecture Exam Point Distribution Sheet

*Avoid a point penalty - do **not** write on this page!*

*Multiple choice questions:*

$$\frac{\text{number of multiple choice questions correct}}{\text{X 5 points per question}} = \text{points}$$

*Short answer questions:*

points

*Total points on this exam:*

points

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<i>Grade</i>	<i>Percentage</i>	<i>Points on This Exam</i>
A	90% - 100%	162 - 180
B	80% - 89%	144 - 161
C	67% - 79%	120 - 143
D	57% - 64%	102 - 119
F	0% - 56%	0 - 101

**Part I:** Multiple Choice Questions

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

**Part II:** Short Answer / Calculation.

1. List the following constants, and include units, to four significant figures. (10 points)

**0.082057 L\*atm/mol\*K**

**8.3145 J/mol\*K**

**6.022 x 10<sup>23</sup> /mol**

**17.04 g/mol**

**18.02 g/mol**

2. Convert the following using correct significant figures: (10 points)

**0.37 L**

**4.3 x 10<sup>3</sup> cm**

**420 K**

**128 mL**

**2.5 minutes**