



MICHIGAN STATE
UNIVERSITY

DEPARTMENT OF CHEMISTRY

ALTERNATE FINAL EXAMINATION

CHEMISTRY 141 FALL 2000

Tuesday December 12th 2000

Name:	
Student number:	

READ THE INSTRUCTIONS AND THE QUESTIONS CAREFULLY

There are forty questions worth 5 points each.

This examination contributes 250 points toward your total of 1000 points for the semester.

Each question has ONLY ONE correct answer.

A Periodic Table and a table of physical constants are attached to this exam paper.

No programmable calculators or computers are permitted.

Mark all your answers on the enclosed answer sheet.

Show your ID when you leave.

You MUST blacken in the Student PID box on the answer sheet correctly.

You must hand in your answer sheet when you leave; you may keep the exam paper.

- What must be true of two isotopes of the same element?
 - they must each contain the same number of protons
 - they must each contain the same number of neutrons
 - they must each contain the same number of electrons
 - they must each contain the same number of subatomic particles (protons, neutrons, and electrons)
 - they must each contain the same number of protons and neutrons in the nucleus.

- Bromine forms polyatomic oxoanions just like chlorine. What is the formula of the hypobromite anion?
 - Br^-
 - BrO^-
 - BrO_2^-
 - BrO_3^-
 - BrO_4^-

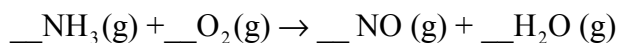
- What is the volume of your room in cubic meters if it is rectangular and has dimensions of 17 ft. by 14 ft. by 8 ft. 6 in.?
 - 2023 m^3
 - 57.28 m^3
 - 4740 m^3
 - 12.04 m^3
 - 1745 m^3

- Which one of the following formulas is incorrect?
 - $\text{Cu}(\text{SO}_4)_2$ copper (I) sulfate
 - $\text{Ca}(\text{PO}_4)_2$ calcium phosphate
 - $\text{Mg}(\text{OH})_2$ magnesium hydroxide
 - $\text{NH}_3 (\text{g})$ ammonia gas
 - $\text{I}_2 (\text{s})$ iodine solid
 - HNO_3 nitric acid

- Examples of an element that exists as a diatomic molecule, a non metal, an element that readily forms a +3 cation and an alkali earth metal are in that order:

	diatomic	nonmetal	+3 cation	alkaline earth metal
a.	helium	oxygen	boron	lithium
b.	chlorine	sulfur	aluminum	sodium
c.	fluorine	aluminum	boron	calcium
d.	bromine	tin	nitrogen	strontium
e.	iodine	carbon	aluminum	calcium
f.	hydrogen	silicon	phosphorous	beryllium

6. What set of coefficients is necessary to balance the equation shown?

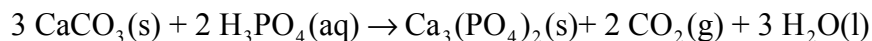


- | | | | | |
|--------|---|-----|---|----|
| a..... | 4 | 5 | 4 | 6 |
| b..... | 2 | 5 | 2 | 3 |
| c..... | 4 | 10 | 6 | 8 |
| d..... | 8 | 10 | 8 | 12 |
| e..... | 2 | 2.5 | 2 | 3 |
| f..... | 1 | 2 | 1 | 3 |

7. What is the percentage by mass of nitrogen in ammonium nitrate, NH_4NO_3 ?

- | | | |
|------------|------------|------------|
| a. 29.16 % | c. 17.50 % | e. 35.00 % |
| b. 28.00 % | d. 77.78 % | |

8. A 50.0 g sample of calcium carbonate is allowed to react with 35.0 g of H_3PO_4 . Calculate the amount of the non-limiting reagent remaining at the end of the reaction.

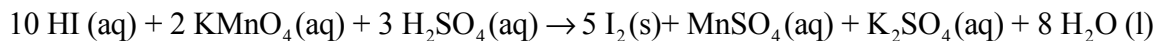


- | | | |
|------------------------------------|------------------------------------|------------------------------------|
| a. 11.67 g H_3PO_4 | c. 32.63 g H_3PO_4 | e. 23.52 g H_3PO_4 |
| b. 11.67 g CaCO_3 | d. 32.63 g CaCO_3 | f. 23.52 g CaCO_3 |

9. If 48.7 g of $\text{Ca}_3(\text{PO}_4)_2$ is actually obtained in question 9, what is the percent yield?

- | | | |
|---------|---------|---------|
| a. 94 % | c. 31 % | e. 50 % |
| b. 47 % | d. 63 % | |

10. How many moles of HI are necessary to produce 0.250 moles of iodine according to the following reaction?



- | | | |
|---------------|---------------|-------------|
| a. 1.25 moles | c. 2.50 moles | e. 10 moles |
| b. 0.50 moles | d. 0.05 moles | |

11. What is the change in the oxidation number of manganese in the equation listed in question 11?

- | | | | | |
|-------|-------|-------|-------|-------|
| a. +3 | c. +5 | e. 0 | g. -2 | i. -4 |
| b. +4 | d. +6 | f. -1 | h. -3 | j. -5 |

12. Which of the following is a strong acid?
- a. H_2SO_3 c. $\text{CH}_3\text{CO}_2\text{H}$ e. HCN
b. H_2CO_3 d. HNO_3 f. HNO_2
13. A compound of nitrogen and sulfur is burned completely in oxygen to form nitrogen dioxide and sulfur dioxide. The number of moles of nitrogen dioxide formed is one-fourth the number of moles of sulfur dioxide formed. What is a possible molecular formula for the nitrogen-sulfur compound?
- a. SN_2 c. S_8N_2 e. S_3N_2
b. SN_3 d. S_8N_8 f. S_2N_3
14. Sufficient magnesium acetate ($\text{Mg}(\text{C}_2\text{H}_3\text{O}_2)_2$; molar mass 142.35 g/mol) was dissolved in water to make 250 mL of a 2.65 M solution of acetate ion. How many moles of magnesium acetate were used?
- a. 2.65 moles c. 5.30 moles e. 0.33 moles
b. 10.60 moles d. 0.66 moles f. 9.43 moles
15. A system absorbs 51 kJ of heat from its surroundings. The system expands and does 15 kJ of work on the surroundings. What is the change in the enthalpy, ΔH , of the system?
- a. -51 kJ c. -15 kJ e. -36 kJ g. -66 kJ
b. +51 kJ d. +15 kJ f. +36 kJ h. +66 kJ
16. What is the net ionic equation representing the reaction between hydrochloric acid and sodium hydroxide?
- a. $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$
b. $\text{H}_3\text{O}^+(\text{aq}) + \text{Cl}^-(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + 2 \text{H}_2\text{O}(\text{l})$
c. $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{H}_2\text{O}(\text{l}) + \text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq})$
d. $\text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow 2 \text{H}_2\text{O}(\text{l})$
e. $\text{HCl}(\text{aq}) + \text{NaOH}(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}^+(\text{aq}) + \text{OH}^-(\text{aq})$
f. $\text{Na}^+(\text{aq}) + \text{Cl}^-(\text{aq}) + \text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{NaCl}(\text{aq}) + \text{H}_2\text{O}(\text{l})$

17. The significance of the four quantum numbers can be described as spin, energy orientation and shape. Which description belongs to which quantum number?

	<i>spin</i>	<i>energy</i>	<i>shape</i>	<i>orientation</i>
a.	n	l	m_l	m_s
b.	l	n	m_l	m_s
c.	m_l	m_s	l	n
d.	m_s	l	m_l	n
e.	m_s	n	l	m_l
f.	m_l	l	n	m_s

18. Which of the following electron configurations is the correct configuration for iron(III) cation?

- | | | | |
|----|--------------------------------------|----|--------------------------------------|
| a. | $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$ | d. | $1s^2 2s^2 2p^6 3s^2 3p^6 3d^5$ |
| b. | $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^4$ | e. | $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^6$ |
| c. | $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^3$ | f. | $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^4$ |

19. Which statement is *correct*?

- The maximum allowed value for m_l is $n-1$
- Red light has a shorter wavelength than blue light.
- The seesaw molecular shape is derived from the octahedral arrangement.
- A triple bond involves two sigma (σ) bonds and a pi (π) bond.
- An ionic bond is between two metals.
- Covalent bonds involve a transfer of electrons.
- The geometry of a set of sp hybrid orbitals is linear.

20. What is the shape of the molecule XeF_4 ?

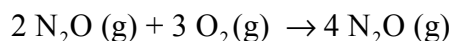
- | | | |
|-----------------------|---------------------|--------------------|
| a. square planar | d. trigonal planar | g. tetrahedral |
| b. trigonal pyramidal | e. square pyramidal | h. octahedral |
| c. T-shaped | f. seesaw | i. V-shaped (bent) |

21. Which statement is correct?

- Polyatomic ions are always polar
- Nonpolar molecules are always linear
- Nonbonding electron pairs in the trigonal bipyramidal arrangement are always placed in the trigonal plane.
- p orbitals can only form π bonds.
- In the ammonia molecule, the hybridization on the central nitrogen atom is sp^2 .
- If there is more than one lone pair of electrons on the central atom in a molecule, then the molecule must be polar.

22. A sample of gas in a rigid container is heated from 100°C to 475°C. Which of the following best describes what will happen to the pressure of the gas?
- The pressure increases by a factor of about 5
 - The pressure decreases by a factor of about 5
 - The pressure increases by a factor of about 2
 - The pressure decreases by a factor of about 2
 - The pressure increases by a factor of about 25
23. If helium diffuses through a porous barrier at the rate of 4.4 mol/min, at what rate would carbon dioxide diffuse?
- 1.33 mol/min
 - 2.66 mol/mol
 - 3.99 mol/min
 - 5.32 mol/min
 - 7 mol/min
24. In the unit cell of an unknown compound of two elements A and B shown on the right below, the black spheres represent A atoms and the shaded spheres represent B atoms. The A atoms all lie on an edge. What is the stoichiometry of the compound?
- AB
 - AB₂
 - AB₃
 - A₂B
 - A₂B₃
 - A₃B
 - A₃B₂
 - A₈B₉

25. Consider the reaction of nitrous oxide, with oxygen O₂ to form nitrogen dioxide, NO₂



Suppose that a 3.0 liter vessel contains N₂O gas at 6.0 atm pressure. Suppose that a second vessel, 4.0 liters in volume contains oxygen at 1.0 atm pressure. A pipe of negligible volume connects the two vessels and the two gases mix and react to produce as much nitrogen dioxide as possible. Assume that the temperature remains constant. How much oxygen is left in the apparatus at the end of the reaction?

- 0 atm
 - 1/21 atm
 - 4/21 atm
 - 8/21 atm
 - 12/21 atm
 - 16/21 atm
 - 46/21 atm
 - 54/21 atm
 - 62/21 atm
 - 2.0 atm
26. What is the total pressure in the apparatus described in question 25 at the end of the reaction?
- 0 atm
 - 1/21 atm
 - 4/21 atm
 - 8/21 atm
 - 12/21 atm
 - 16/21 atm
 - 46/21 atm
 - 54/21 atm
 - 62/21 atm
 - 2.0 atm

27. Which pair of elements is most likely to form a covalent bond?
- Two elements with equally high electronegativities
 - Two elements with high but slightly different electronegativities
 - One element with low electronegativity and one with high electronegativity
 - Two elements with low but not necessarily equal electronegativities
28. Which statement is correct?
- In a sample of a pure gas, all molecules travel at the same speed at a particular temperature
 - The principal reason why gas molecules deviate from ideal behavior is their size
 - All gases at the same temperature have the same average kinetic energy
 - Gases deviate most from ideal behavior at high temperatures and high pressures
 - Larger molecules diffuse more rapidly than smaller molecules at the same temperature
29. When water evaporates from the sidewalk after a shower, what are the signs of ΔH , ΔS , and ΔG for the process?
- | | ΔH | ΔS | ΔG |
|----|------------|------------|------------|
| a. | + | + | + |
| b. | + | + | - |
| c. | + | - | + |
| d. | + | - | - |
| e. | - | + | + |
| f. | - | + | - |
| g. | - | - | + |
| h. | - | - | - |
30. If an ideal solution of two substances A and B contains four times as many molecules of A as B, then the vapor pressure above the solution due to the component A will be equal to
- 20% of the vapor pressure of pure A at the same temperature
 - 25% of the vapor pressure of pure A at the same temperature
 - 75% of the vapor pressure of pure A at the same temperature
 - 80% of the vapor pressure of pure A at the same temperature
 - 4 times higher than the vapor pressure due to component B

31. Which of the following electronic transitions in a hydrogen atom would emit radiation with the longest wavelength?

- a. $n = 3$ to $n = 1$
- b. $n = 4$ to $n = 1$
- c. $n = 4$ to $n = 2$
- d. $n = 4$ to $n = 3$
- e. $n = 5$ to $n = 1$

32. Which statement is *incorrect*?

- a. It is impossible for the concentration of a solute to exceed its solubility
- b. The smaller a molecule is, the faster it moves
- c. Hydrogen bonding is the strongest intermolecular force.
- d. The vapor pressure of a liquid is directly proportional to the temperature.
- e. Ideal gases do not really exist.
- f. The van't Hoff factor depends on the number of particles that result when a solute dissociates.

33. Which statement is *incorrect*?

- a. The kinetics of a reaction is dependent upon the temperature.
- b. At equilibrium the rates of the reactions in both directions (forward and reverse) become zero.
- c. Liquids and solids are not included in the equilibrium constant expression for gas phase equilibrium.
- d. Only concentrations at equilibrium can be used to compute equilibrium constants.
- e. If Q is larger than K , then the equilibrium will shift to the left.
- f. At dynamic equilibrium, the rate of the reaction in the forward direction and rate of the reaction in the reverse direction are equal.

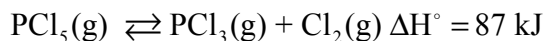
34. Which of the following solutions will cause the largest deviation in boiling point?

- a. 1.2 m of sugar
- b. 1.5 m of calcium phosphate
- c. 0.2 m of sodium nitrate
- d. 1.8 m of sodium acetate
- g. 1.6 m of glycerol
- h. 1.6 m of ethanol

35. What is the pOH of a 0.001M solution of nitric acid?

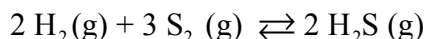
- | | | | |
|--------|--------|---------|---------|
| a. 1.0 | c. 3.0 | e. 7.0 | g. 13.0 |
| b. 2.0 | d. 7.0 | f. 11.0 | h. 14.0 |

36. Given the following equilibrium, which one of the following is correct?



- If chlorine gas is added the equilibrium is shifted to the right.
- When the temperature is raised, the equilibrium is shifted to the left.
- If the volume of the system is increased, the equilibrium is shifted to the right.
- If a catalyst is added to the reaction mixture, there is shift in the equilibrium to the right.
- If PCl_3 is removed, the equilibrium is shifted to the left.

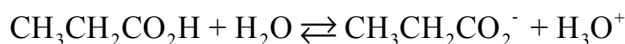
37. Calculate the equilibrium constant for the following equilibrium 973 K.



Analysis of the contents of a 5.0L flask reveals that there are 2.5 moles of H_2 , 1.00×10^{-5} moles of S_2 and 8.3 moles of H_2S in the flask at equilibrium. Calculate the equilibrium constant K_c .

- | | | | |
|--------------------------|--------------------------|--------------------------|--------------------------|
| a. 5.52×10^6 | c. 6.83×10^2 | e. 2.53×10^8 | g. 1.38×10^8 |
| b. 5.52×10^{-6} | d. 6.83×10^{-2} | f. 2.53×10^{-8} | h. 1.38×10^{-8} |

38. Propanoic acid, $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$, ionizes in water according to the following equation:



If you dissolve 1.56 g of the acid in enough water to make 1.145L of solution, what is the equilibrium concentration of the hydronium ion? The ionization constant for propanoic acid is $K_a = 1.30 \times 10^{-5}$.

- | | | |
|--------------------------|---------------------------|--------------------------|
| a. 1.84×10^{-2} | c. 4.89×10^{-4} | e. 1.41×10^{-6} |
| b. 1.30×10^{-5} | d. 5.26×10^{-12} | |

39. What is the pH of the solution at equilibrium in question 38?

- | | | |
|---------|----------|---------|
| a. 3.31 | c. 4.89 | e. 5.85 |
| b. 2.28 | d. 11.27 | |

40. What is the energy of a photon with a wavelength (λ) of 355 nm?

- | | | |
|-------------------------------------|-------------------------------------|------------------------------------|
| a. $5.09 \times 10^{38} \text{ J}$ | c. $5.60 \times 10^{-28} \text{ J}$ | e. $1.41 \times 10^{-6} \text{ J}$ |
| b. $5.60 \times 10^{-17} \text{ J}$ | d. $5.60 \times 10^{-19} \text{ J}$ | |