

BROOKLYN COLLEGE.
FINAL EXAMINATION IN CHEMISTRY 1.

Fall, 2008. Paul Cohen, instructor.

Name _____

Formulas: Write the chemical formula for each of the following:

Al₂(SO₄)₃ 1. Aluminum sulfate

Ni(OH)₂ 2. Nickel (II) hydroxide

N₂O₅ 3. Dinitrogen pentoxide

296g 4. Find the mass of 4.00 mole of Ca(OH)₂

2 5. How many moles of Cl⁻ ion are present in 2.00 liters of 0.500 molar BaCl₂ ?

36 6. What is the % H₂O by mass in the hydrate with the formula CuSO₄·5H₂O ?

C₂H₄ 7. What is the molecular formula of a gaseous substance that is 85.7 % carbon and 14.3% hydrogen, if at 273 K and 1.00 atm. the substance has a density of 1.25 g/L ?

E 8. When ΔH° is negative at constant pressure for a given chemical or physical process, it indicates that
A) the process is endothermic B) work is being done on the system
C) work is being done by the system D) heat is flowing into the system
E) the process releases energy in the form of heat

D 9. ΔH° for the reaction 2 HCl(g) + I₂(s) → 2 HI(g) + Cl₂(g) is
A) -66.4 kJ B) +66.4 kJ C) 118.2 kJ D) 236.4 kJ E) -236.4 kJ
(the heats of formation of HCl and HI were given on an accompanying table)

B 10. S(s) + 3 F₂(g) → SF₆(g)

For the reaction above at standard temperature and pressure, the volume of F₂ required to produce 0.500 mole of SF₆ is
A) 67.2 liters B) 33.6 liters C) 22.4 liters D) 11.2 liters
E) 1.5 liters

A 11. C(s) + O₂(g) → CO₂(g) ΔH = -393.5 kJ
2C(s) + O₂(g) → 2 CO(g) ΔH = -221.1 kJ

The heats of combustion of graphite to CO₂ and CO are given above. What is the standard enthalpy change for the reaction CO(g) + ½ O₂ → CO₂(g) ?

A) -283.0 kJ B) -627.1 kJ C) -172.4 kJ D) +172.4 kJ E) +627.1 kJ

- C 12. Under the same conditions, what is the ratio of the rate of effusion of CO₂ (MW=44) to the rate of effusion of SF₆ gas (MW = 146) A) 11 B) 3.32 C) 1.82 D) 0.549 E) 0.301
- B 13. When a sample of an ideal gas in a sealed rigid container is heated from 25°C to 100° C, all of the following quantities change **except** the A) pressure of the gas B) density of the gas C) total kinetic energy of the gas sample D) average speed of the gas molecules E) number of collisions per second of the gas molecules
- A 14. For which chemical equation will the heat of reaction, ΔH° , correspond to the molar heat of formation of liquid water?
A) $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\ell)$ B) $\text{H}(\text{g}) + \text{H}(\text{g}) + \text{O}(\text{g}) \rightarrow \text{H}_2\text{O}(\ell)$
C) $2 \text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow 2 \text{H}_2\text{O}(\ell)$ D) $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightarrow \text{H}_2\text{O}(\ell)$
- D 15. The RMS velocity of a gas varies A) directly with the molar mass of the gas B) inversely with the molar mass of the gas C) directly with the Kelvin temperature of the gas D) directly with the square root of the Kelvin temperature E) inversely with the square root of the Kelvin temperature.
- C 16. Gases will not behave “ideally” when
A) the particles collide elastically with the container walls
B) the particles collide elastically with each other
C) there are significant attractions between the gas particles
D) there is a significant increase in temperature
E) the particles have a total volume that is negligible compared to the volume of the container.
- E 17. A tank contains 32.00 grams of O₂ gas and 16.00 grams of He gas. If the partial pressure of the oxygen gas is 0.400 atm, what is the **total** pressure of the gases in the tank? A) 0.800 atm. B) 0.600 atm C) 1.20 atm D) 1.60 atm E) 2.00 atm
- B 18. How much heat is needed to raise the temperature of 1.00 **mole** of water from 10.0°C to 50.0° C? A) 167 J B) 3.01 kJ C) 9.29 J D) 3760 J E) 40.0 kJ
- A 19. The pressure and kelvin temperature of a gas with a volume of 10.00 L are both doubled. The new volume of the gas is A) 10.00 L B) 2.500 L C) 40.00 L D) 5.000 L E) 20.00 L
- B 20. 20.00 mL of Ne gas is heated from 127° C to 327° C, with the pressure constant. The new volume of the gas would be A) 10.00 mL B) 30.00 mL C) 40.00 mL D) 51.50mL E) 7.77 mL

21 to 23 Indicate whether each of the following values is positive (+) negative (-) or zero. (0)

 0 21. ΔH of formation of $\text{Br}_2(\ell)$

 - 22. ΔH of formation of $\text{Cl}_2(\ell)$

 + 23. The charge on the nucleus of a chloride ion

 A 24. In which compound are the two ions (positive and negative) isoelectronic?

A) MgF_2 B) KBr C) NaCl D) LiF E) RbCl

C

 25. Which could be a correct set of quantum numbers for the valence electrons of an alkaline earth metal in the ground state?

| | n | l | m_l | m_s (spin) |
|-----|---|---|-------|--------------|
| (A) | 4 | 1 | 0 | -1/2 |
| (B) | 1 | 0 | 0 | +1/2 |
| (C) | 3 | 0 | 0 | -1/2 |
| (D) | 2 | 0 | 1 | +1/2 |
| (E) | 4 | 2 | 1 | -1/2 |

 C 26. How many unpaired electrons are there on an Ni^{3+} ion?

A) 0 B) 2 C) 3 D) 5 E) 7

 B 27. In a hydrogen atom, which of the following electron drops would produce the highest frequency of light? A) from $n=6$ to $n=3$ B) from $n=2$ to $n=1$

C) from $n=4$ to $n=2$ D) from $n=6$ to $n=5$ E) from $n=7$ to $n=3$

 C 28. In the Stern-Gerlach experiment, silver atoms were shot through a powerful magnetic field. The stream of atoms divided into two separate paths. This division would **not** be observed with atoms of A) Cu B) Cr C) Mg D) K E) Al

 D 29. The Pauli exclusion principle states that A) the velocity of all electromagnetic radiation equals the speed of light B) all particles with mass also have a wave length C) the velocity of an electron and its exact position cannot be known at the same instant D) each electron in an atom has its own unique set of four quantum numbers E) as many electrons as possible remain unpaired within one atomic subshell

 D 30. Which group on the periodic table contains only diamagnetic* elements?

A) group 1 B) group 4 C) group 10 D) group 12 E) group 16

* diamagnetic means **not** paramagnetic

___6.18___31. What is the molality of a solution of acetone in water if the mole fraction of the acetone in the solution is 0.100 ?

_102.08°___32. What is the boiling point of an aqueous solution of sucrose of molality 4.00 ? (the boiling point elevation constant of water is 0.52/m)

___B___33. As sugar is dissolved in water, the vapor pressure of the water
A) decreases, while the freezing point increases
B) decreases, and the freezing point decreases
C) increases, and the freezing point increases
D) increases, while the freezing point decreases

___C___34. At standard pressure solid carbon dioxide will sublime to form gaseous carbon dioxide. No liquid state is observed. This observation indicates that
A) the melting point of carbon dioxide occurs at a temperature above room temperature
B) the triple point of carbon dioxide occurs at a temperature above room temperature
C) the triple point of carbon dioxide occurs at a pressure above standard pressure
D) the triple point of carbon dioxide occurs at a pressure below standard pressure

Choices for questions 35 - 40

A. Molecule is a dipole, and there is resonance B. Dipole, **no** resonance
C. Non-dipole, and there is resonance D. Non-dipole, **no** resonance

___B___35. NH₃

___D___36. CO₂

___B___37. SF₄

___C___38. SO₃

___A___39. SO₂

___B___40. HCN

___A___41. Which ionic substance has the greatest lattice energy?
A) MgO B) Na₂O C) NaCl D) MgF₂ E) KBr

___C___42. In which molecule would the oxygen side of the molecule have a slight **positive** charge? A) H₂O B) H₂SO₄ C) OF₂ D) P₂O₅

___A___43. Which ion has the same geometry as an ammonia molecule?
A) ClO₃⁻ B) NO₃⁻ C) CO₃²⁻ D) PF₄⁻ E) NO₂⁻

Choices for questions 44 - 50:

- A. T shaped B. Linear C. Trigonal planar D. Bent, approx 120 bond angle
E. Bent, approx. 109 bond angle F. see-saw G. tetrahedral H. square planar.

Match the molecule or ion with its **molecular** geometry, (not the electron geometry)

- A 44. ICl_3 E 45. SF_6 C 46. NO_3^- F 47. SiF_4^{2-}
H 48. ICl_4^- B 49. XeF_2 G 50. PO_4^{3-}

PROBLEMS:

I. Chlorous acid has the formula HClO_2 .

A. Draw two dot structures - one with the H bonded to the O, and the other with the H bonded to the Cl. (2 pts)

B. Find the formal charges on each of the atoms in both of your structures. (3 pts)

On the structure with the H-O bond, the H and the O bonded to it are zero, the Cl is +1, and the remaining O is -1. If the H is bonded to the Cl, the H is zero the Cl is +2, and both O are -1.

C. Which structure do you believe to be correct? Explain your answer. (2 pts)

The first one, because it has less formal charge.

D. What is the electron geometry around the chlorine atom? (1 pt)

tetrahedral.

II. Draw dot structures for each of the following molecules. In each case, indicate whether the molecule is a dipole. If there is resonance, indicate this by drawing all of the contributing structures. (2 pts each part)

A. HNO_3 B. ICl_5 C. BCl_3 D. CH_2Cl_2 E. PCl_5

only the HNO_3 has resonance. A, B, and D are dipoles

F. Provide a drawing that illustrates the difference in molecular geometry between ICl_5 and PCl_5 . In this drawing there is no need to show the lone pairs on the chlorine atoms.

Show that ICl_5 is a square based pyramid, while PCl_5 is a trigonal bipyramid

III. A. What is the vapor pressure of water at a temperature of 100 C? (2 pts. each part)
1 atmosphere

B. A solution of sugar ($\text{C}_{12}\text{H}_{22}\text{O}_{11}$, MM = 342) is prepared by dissolving 171 grams of sucrose in 500 grams of water. The solution has a density of 1.28 g/mL

1. Find the mole fraction of sucrose, and the mole fraction of water in the solution

0.0177 and .982

2. Find the molality of sucrose in the solution.

1.00

3. Find the molarity of sucrose in the solution. .954 M

4. Find the vapor pressure of the water in this solution. (any pressure unit you wish)
.982 atm

IV. The diagram to the right represents the phase diagram for a pure substance. (8 pts)

A. Find the approximate normal boiling points and normal freezing points of this substance.
about 240 and 110 Celsius

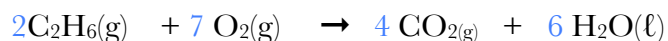
B. Which interval on the diagram represents equilibrium between the solid and gas phases?
I-II

C. Would the solid float or sink in the liquid? Explain.

It would sink. The slope of line II-III indicates that the solid is denser than the liquid

D. What phase change would occur if at 200°C the pressure was increased from 0.25 atm to 1.00 atm?
condensation

V. The combustion of ethane, C₂H₆ is the subject of this problem:



A. Balance the equation.

B. Find ΔH for the reaction, as balanced in part A.
-3119.44 kJ

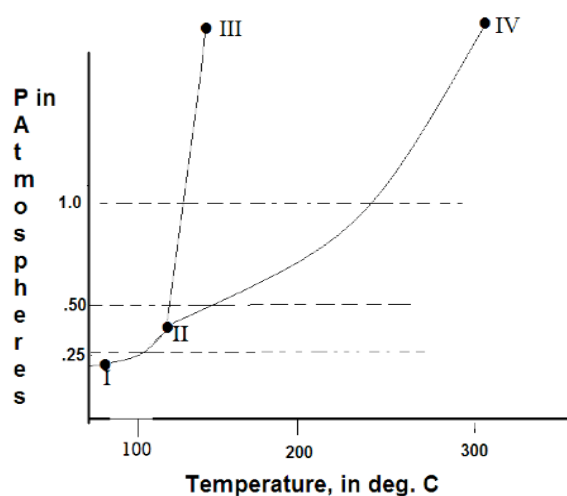
C. How much heat is produced in the combustion of 10.00 gram of ethane? 520.0 kJ

D. Assume that the 10.00 gram of ethane was originally placed in a 10.00 liter container at a temperature of 300.0 K.

1. What is the pressure of the ethane, in atmospheres? 0.821

2. Sufficient oxygen is pumped into the tank to bring the total pressure in the tank to 4.00 atm. What is the partial pressure of the oxygen, assuming that no reaction occurs? (12 pts) 3.18 atm

3. What is the partial pressure of the oxygen remaining in the tank after the reaction occurs, using up all of the ethane? Assume that the temperature is brought back to 300.0 K. 0.31 atm



Extra Credit: (4 pts) What is the molar mass of a nonelectrolyte, given that when 10.0 grams of this non-electrolyte dissolve in 50.0 grams of water, the resulting mixture freezes at a temperature of -2.00 C ?