

October 23, 2008

NAME _____

(please print clearly)

Instructions: Print your **name** clearly, **NOW**, at the top of **each sheet** of this examination.

Answer all questions and show all work and calculations in the spaces provided on these sheets. You may use the blank page on the back of the previous sheet for all scratch work and calculations.

You must show all work and the reasoning used to solve problems on this examination. Partial credit will be given for any correct reasoning even if the answers are wrong. A problem set up correctly but with no calculations done will receive partial credit. No credit will be given for correct answers without any reasoning or calculations shown.

The examination begins at 9:00 and ends at 10:25 exactly.

Total time: 85 minutes Number of pages: 6 Number of questions: 5 Total points: 125

Data: Use the **periodic table**, provided on a separate sheet, to find **atomic weights**.

Please **do not make any marks** whatever on this periodic table. We want to reuse them.

Numerical values of constants and conversion factors

Avogadro's number $N_A = 6.0221415 \times 10^{23} \text{ mole}^{-1}$

Ideal gas constant $R = 0.08205746 \text{ L-atm/K-mole} = 62.36367 \text{ L-mmHg/K-mole}$

The following conversions are exact:

$T (\text{K}) = t (^\circ\text{C}) + 273.15$ $1 \text{ atm} = 760 \text{ mmHg}$ $1 \text{ mL} = 1 \text{ cm}^3$

The density of mercury at 25°C is 13.6 times that of water.

Constants for Colligative Properties

Solvent	Cryoscopic Constant K_f (deg-kg/mole)	T_{fp} (°C)	Ebullioscopic Constant K_b (deg-kg/mole)	T_{bp} (°C)
Water	1.86	0.00	0.51	100.00
Benzene	5.12	5.5	2.53	80.2
Nitrobenzene	7.0	5.7	5.24	210.8

Credit: Question 1 _____ / 24

Question 4 _____ / 25

Question 2 _____ / 25

Question 5 _____ / 26

Question 3 _____ / 25

TOTAL _____ / 125

Question 1 (24 points)

NAME _____

Write *balanced net ionic equations* describing the predominant reaction(s) that occur when the substances below are mixed in aqueous solution.

Solutions of aluminum nitrate and sodium sulfide are mixed

Sodium iodide solution is mixed with silver nitrate solution

A solution of acetic acid is mixed with lead hydroxide.

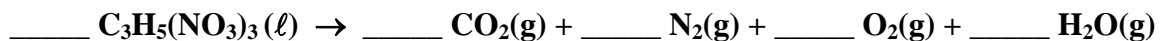
Solutions of sodium nitrite and ammonium chloride are mixed.

Question 2 (25 points)

NAME _____

Nitroglycerine is a shock-sensitive liquid: when disturbed, it explodes violently.
Its molecular weight is 227.09.

a) (4) Balance the chemical equation for the explosion:



b) (8) 28.4 g (one ounce) of nitroglycerin explodes. How many moles of gas are produced?

c) (5) One ounce of nitroglycerin explodes in an empty rigid 3.00 L container. What is the final pressure, if the final temperature is 75°C?

d) (4) What is the mole fraction of CO₂ in the container after the explosion?

e) (4) What is the partial pressure of N₂ in the container after the explosion?

Question 3 (25 points)

NAME _____

THE TWO PARTS OF THIS QUESTION ARE INDEPENDENT OF ONE ANOTHER.

A) (11) Two students are discussing the salt KMnO_4 (formula weight 158.03 g/mole). Sarah argues it dissolves forming ions K^+ , Mn^{7+} , and O^{2-} . Deena thinks it forms K^+ and MnO_4^- . They decide to resolve the issue by experiment. They weigh 1.58 grams of the salt, and dissolve it in 100 g water. Predict the freezing point of the solution, as expected by each student.

B) (14) A 100.0 mL solution of a soluble polysaccharide (a non-electrolyte) was prepared by dissolving 0.0516 g of the substance in water. When the osmotic pressure was measured at 25°C , the solution rose 3.305 cm above the surface of the water. What is the approximate molecular weight of the polysaccharide?

Question 4 (25 points)

NAME _____

Catechol, $C_6H_5O_2$ (molar mass 110.11), is a non-volatile molecular substance present in many plants. It can be extracted by soaking the leaves in the solvent nitrobenzene, $C_6H_5NO_2$ (molar mass 123.11).

a) (10) A sample of leaves is soaked in 80.0 g of nitrobenzene. The resulting solution is filtered, and its freezing point is measured to be $3.4^\circ C$. How many grams of catechol were extracted?

b) (15) 10.0 mL of the same catechol-nitrobenzene solution is found to weigh 12.0 grams. What is the molarity of the solution? (If you were not able to solve part a, assume that 3.2 grams of catechol dissolved in 80 g of nitrobenzene.)

Question 5 (26 points)

NAME _____

At 50°C the vapor pressure of pure ethyl acetate (A) is 280.4 mmHg, while that of pure ethyl iodide (I) is 353.4 mmHg.

- a) (8) Assuming that when mixed they form an ideal solution, draw the P-X diagram for mixtures of ethyl acetate and ethyl iodide at 50°C. Label the axes and all lines, points, or curves.



- b) (10) In a solution which is 63.3 mole % ethyl iodide, the vapor pressure of ethyl iodide is found to be 239.1 mmHg, that of ethyl acetate 122.9 mmHg. Does ethyl acetate obey Raoult's law? Explain.
- c) (5) What is the composition of the vapor in equilibrium with this 63.3% solution?
- d) (3) Is this solution ideal? Explain.