

Exam IV – 11, 13, 14, 15, 16, 18

Questions 1 – 20 are multiple-choice worth 2 points each.

Please read each question carefully and circle the best answer or answers.

- If the molecules in a liquid have very weak attractions for each other, which of the following has a relatively high value?
a. surface tension b. viscosity **c. vapor pressure** d. boiling point
- Choose **all** of the following that are true for an endothermic reaction:
a. The energy of the reactants is higher than the energy of the products.
b. The energy of the reactants is lower than the energy of the products.
c. Energy is required for the reaction to occur, so heat can be shown as a reactant.
d. Energy is released when the reaction to occur, so heat can be shown as a product.
- Octane (C_8H_{18}) molecules experience only London dispersion forces whereas ethanol (CH_3CH_2OH) molecules experience hydrogen bonding forces. Chose all of the statements below that are true:
a. Octane's intermolecular forces are stronger than ethanol.
b. Octane has a lower boiling point than ethanol.
c. Octane has a lower viscosity than ethanol.
d. Octane has a lower vapor pressure than ethanol.
- An acid can be both a Brønsted-Lowry acid and an Arrhenius acid.
a. **True** b. False
- Circle **all** of the statements below that are correct:
a. Hydrogen bonds are stronger than ionic or covalent bonds.
b. The H-N bond in a NH_3 molecule is an example of hydrogen bonding forces.
c. Dipole forces are stronger than dispersion forces for molecules of similar size.
d. Water has an unusually high boiling point due to dipole forces.
e. The density of ice is higher than the density of water in the liquid state.
- Choose **all** of the statements below that are true:
a. The solubility of a gas in a liquid increases as the partial pressure of the gas above the liquid increases.
b. The solubility of a solid in a liquid increases as the partial pressure of the gas above the liquid increases.
c. The solubility of a gas in a liquid increases as temperature increases.
d. The solubility of a solid in a liquid increases as temperature increases.
- Putting a few granules of sugar in a glass of iced tea and stirring the solution results in _____ solution.
a. a saturated b. a supersaturated **c. an unsaturated**
- Reaction rate can be increased by which of the following (circle all that apply):
a. Increasing the energy of the molecules by increasing the temperature.
b. Allowing the reaction to sit overnight.
c. Lowering the activation energy by introducing a catalyst.
- A polar solute will completely dissolve in a nonpolar solvent.
a. True b. False
- Predict which liquid has the highest boiling point.
a. $CH_3CH_2CH_3$
b. CH_3CH_2Cl
c. CH_3CH_2OH
d. CH_3CH_2SH
- Predict the physical state of ammonia at $-20^\circ C$ ($Mp = -77^\circ C$, $Bp = -35^\circ C$) and normal atmospheric pressure.
a. solid b. liquid **c. gas**
- Which of the following are examples of a metallic solid?
a. DDT, $C_{14}H_9Cl_5$ b. halite, NaCl c. sulfur, S_8 **d. vanadium, V**

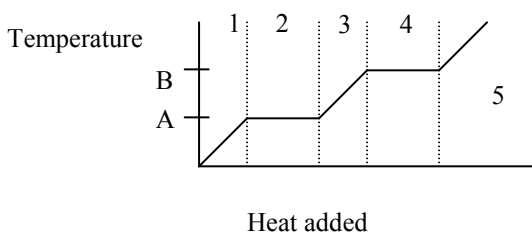
13. Which of the following is true after a reaction reaches chemical equilibrium?
- The amount of reactants is increasing.
 - The amount of the products is decreasing.
 - The rate of the forward reaction equals the rate of the reverse reaction.**
 - All the reactants are completely consumed.
14. Given the following balanced neutralization reaction, please choose all that are correct:
- $$\text{HNO}_2(\text{aq}) + \text{NH}_3(\text{aq}) \rightarrow \text{NO}_2^-(\text{aq}) + \text{NH}_4^+(\text{aq})$$
- $\text{HNO}_2(\text{aq})$ is a Brønsted-Lowry base but not an Arrhenius base.
 - $\text{HNO}_2(\text{aq})$ is an Arrhenius acid and a Brønsted-Lowry acid.**
 - $\text{NH}_3(\text{aq})$ is an Arrhenius acid but not a Brønsted-Lowry acid.
 - $\text{NH}_3(\text{aq})$ is an Arrhenius base but not a Brønsted-Lowry base.
 - $\text{NH}_3(\text{aq})$ is a Brønsted-Lowry base but not an Arrhenius base.**
15. Choose **all** of the following which exhibit dipole forces, but not hydrogen bonds:
- $\text{NH}_3(\text{l})$
 - $\text{H}_2\text{S}(\text{aq})$**
 - $\text{CCl}_4(\text{l})$
 - $\text{Br}_2(\text{l})$
 - $\text{HCl}(\text{l})$**
16. Circle all of the following that are standard temperature and pressure, STP:
- $0^\circ\text{C}, 1 \text{ atm}$**
 - $0 \text{ K}, 760 \text{ atm}$
 - $273 \text{ K}, 760 \text{ torr}$**
 - $25^\circ\text{C}, 760 \text{ torr}$
16. In the ideal gas law, $PV = nRT$, temperature and pressure are inversely related.
- True
 - False**
18. Boyle's Law states that as the volume of a gas increases, the pressure decreases.
- True**
 - False
19. The pressure exerted by a gas above a liquid in a sealed container is called the vapor pressure.
- True**
 - False
20. When uranium-238 undergoes beta and gamma decay, the daughter isotope formed is _____.
- ^{238}U
 - ^{234}Th
 - ^{238}Np**
 - ^{238}Pa
21. (12 pts) Indicate if the substances below are soluble, insoluble, miscible, immiscible with butyl alcohol (a polar solvent).
- | | | | | |
|---------------------------------------|----------------|------------------|-----------------|-------------------|
| a. $\text{NaCl}(\text{s})$ | soluble | insoluble | miscible | immiscible |
| b. $\text{Br}_2(\text{l})$ | soluble | insoluble | miscible | immiscible |
| c. $\text{CH}_3\text{NH}_2(\text{l})$ | soluble | insoluble | miscible | immiscible |
| d. $\text{CCl}_4(\text{l})$ | soluble | insoluble | miscible | immiscible |
| e. $\text{Au}(\text{s})$ | soluble | insoluble | miscible | immiscible |
| f. Water | soluble | insoluble | miscible | immiscible |

For questions 22 – 25, (2 pts each)

- indicate pH, and
 - Determine if it is strongly acidic/basic, weakly acidic/basic, or neutral.
22. $[\text{H}^+] = 0.00001$ pH = **5** basic **acidic** neutral
23. $[\text{H}^+] = 0.00000000001$ pH = **11** **basic** acidic neutral
24. $[\text{H}^+] = 0.0000001$ pH = **7** basic acidic **neutral**
25. $[\text{OH}^-] = 0.000000001$ pH = **$14 - 9 = 5$** basic **acidic** neutral
26. (8 pts) Draw a reaction profile for an exothermic reaction. Please include the proper labels for your axis, E_{act} , ΔH , reactants, products and anything else pertinent.

See text or notes

27. (6 pts) Check all of the correct statements regarding the Heating-Cooling Curve:
- Region 3 contains only gas
 - Region 2 contains solid and gas
 - Region 5 contains only solid
 - Region 4 contains both liquid and gas
 - Region 1 contains only liquid
 - A represents the melting point of the substance.
 - B represents the melting point of the substance.



For problems 28 – 31, show all work and express final answers with the correct units and the correct number of significant figures to receive full credit.

28. (6 pts) What is the molarity, M, of a solution containing 5.54 g of sodium nitrate, NaNO_3 , dissolved in enough water to make a 75.0 mL solution?

$$5.54 \text{ g NaNO}_3 \left(\frac{1 \text{ mol NaNO}_3}{85.00 \text{ g}} \right) = 0.0652 \text{ mol NaNO}_3 \quad M = \text{mol} / \text{L} = 0.0652 \text{ mol} / 0.0750 \text{ L} = 0.869 \text{ M NaNO}_3$$

29. (6 pts) What is the mass/mass percent concentration of a solution containing 8.125 g of potassium sulfide, K_2S , dissolved in 20.087 g of water?

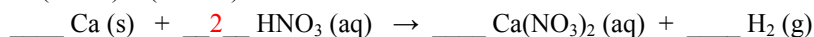
$$\frac{8.125 \text{ g K}_2\text{S}}{(20.087 \text{ g} + 8.125 \text{ g})} \times 100\% = 28.80 \%$$

30. (6 pts) What is the volume, in mL, of 4.50 M NaOH that contains 6.050 g of solute (NaOH)?

$$6.050 \text{ g NaOH} \left(\frac{1 \text{ mol NaOH}}{40.00 \text{ g}} \right) \left(\frac{1 \text{ L}}{4.50 \text{ mol}} \right) (1000 \text{ mL}) = 33.6 \text{ mL}$$

31. (8 pts) When 3.5904 g of solid calcium reacts with nitric acid at 23.2°C and 788 torr, hydrogen gas is evolved according to the following equation. Calculate the volume of hydrogen gas produced.

$$R = 0.0821 \text{ (L atm) / (mol K)}$$



$$788 \text{ torr} \left(\frac{1 \text{ atm}}{760 \text{ torr}} \right) = 1.04 \text{ atm} \quad 3.5904 \text{ g Ca} \left(\frac{1 \text{ mol Ca}}{40.08 \text{ g}} \right) \left(\frac{1 \text{ mol H}_2}{1 \text{ mol Ca}} \right) = 0.08958 \text{ mol H}_2$$

$$V = \frac{nRT}{P} = \frac{(0.08958 \text{ mol H}_2)(0.0821 \text{ (L atm)/(mol K)})(296.2 \text{ K})}{(1.04 \text{ atm})} = 2.09 \text{ L}$$

Extra Credit: (8 pts)

A student performed a titration using 12.65 mL of 2.50 M KOH to reach the end point for 35.0 mL of phosphoric acid (H_3PO_4).

- (3 pts) Write a balanced neutralization reaction.
- (5 pts) Calculate the molarity, M, of the phosphoric acid.