

Examination #3

Directions:

- Both your **name** and **identification number** must be included and balloons properly darkened. Any errors may result in a point penalty.
- Choose the **best** answer in each of the following. Using a #2 pencil, fill in the corresponding balloon on your scoring sheet.
- Print your name and your recitation time and day on the top of this exam booklet. **YOU MUST TURN IN THIS BOOKLET WITH YOUR ANSWER SHEET!**

$$G = H - TS$$

$$PV = nRT$$

$$P_1V_1/T_1 = P_2V_2/T_2$$

$$\text{Avogadro's number: } N_A = 6.023 \times 10^{23}$$

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

1 mole of an ideal gas at STP occupies 22.4 L

1 atm = 760 mm Hg = 760 torr

For water: Heat of fusion is 79.7 cal/g

For water: Spec. heat is 1.0 cal/g°C

Heat of vaporization is 540 cal/g

heat = mC T

s-block		d-block transition metals										p-block							
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1 1A H 1.0079	2 2A											13 3A B 10.811	14 4A C 12.0107	15 5A N 14.0067	16 6A O 15.9994	17 7A F 18.9984	18 8A He 4.0026		
3 Li 6.941	4 Be 9.0122	3 3B	4 4B	5 5B	6 6B	7 7B	8 8B	9 8B	10 8B	11 1B	12 2B	13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.4527	18 Ar 39.948		
11 Na 22.990	12 Mg 24.305	19 K 39.098	20 Ca 40.078	21 Sc 44.956	22 Ti 47.867	23 V 50.9415	24 Cr 51.996	25 Mn 54.938	26 Fe 55.845	27 Co 58.933	28 Ni 58.6934	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80
37 Rb 85.468	38 Sr 87.62	39 Y 88.906	40 Zr 91.224	41 Nb 92.906	42 Mo 95.94	43 Tc [98]	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.760	52 Te 127.60	53 I 126.904	54 Xe 131.29		
55 Cs 132.905	56 Ba 137.327	57 La 138.906	72 Hf 178.49	73 Ta 180.948	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.217	78 Pt 195.078	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po [208.98]	85 At [209.99]	86 Rn [222.0]		
87 Fr [223.0]	88 Ra [226.0]	89 Ac [227.0]	104 Rf [261.1]	105 Db [262.1]	106 Sg [263.1]	107 Bh [264]	108 Hs [265.1]	109 Mt [268]	110 Uun [269]	111 Uuu [272]	112 Uub [277]	Visit our website http://www.chem.iupui.edu							

		f-block transition metals												
Lanthanide series	58 Ce 140.116	59 Pr 140.908	60 Nd 144.24	61 Pm [144.9]	62 Sm 150.36	63 Eu 151.964	64 Gd 157.25	65 Tb 158.93	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.967
Actinide series	90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np [237.0]	94 Pu [244.1]	95 Am [243.1]	96 Cm [247.1]	97 Bk [247.1]	98 Cf [251.1]	99 Es [252.1]	100 Fm [257.1]	101 Md [258.1]	102 No [259.1]	103 Lr [262]

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1. **Exothermic** means
- heat is a product and $H < 0$.
 - heat is a reactant and $H < 0$.
 - heat is a product and $H > 0$.
 - heat is a reactant and $H > 0$.
 - $G > 0$.

2. Which of the following is likely true for the reaction below?



- exothermic and entropy increases
 - endothermic and entropy increases
 - exothermic and entropy decreases
 - endothermic and entropy decreases
 - $H = 0$ and $S = 0$
3. Which of the following conditions will result in a spontaneous reaction regardless of the temperature?
- $H < 0$ and $S < 0$
 - $H > 0$ and $S < 0$
 - $H < 0$ and $S > 0$
 - $H > 0$ and $S > 0$
 - $H > 0$ and $S = 0$
4. When a liquid evaporates
- entropy increases and heat is absorbed.
 - entropy increases and heat is released.
 - entropy decreases and heat is absorbed.
 - entropy decreases and heat is released.
 - S and H are both zero.

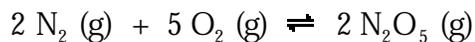
5. A flask contains the following gases:



Arrange the gases in order of increasing average speed.

- $I < II < III < IV$
- $IV < III < II < I$
- $III < I < IV < II$
- $IV < II < I < III$
- $I < III < II < IV$

Use the following reaction for problems 6 – 8.



6. The equilibrium expression for the above reaction is

a. $\frac{[\text{N}_2]^2 [\text{O}_2]^5}{[\text{N}_2\text{O}_5]^2}$

d. $\frac{2[\text{N}_2\text{O}_5]^2}{2[\text{N}_2]^2 5[\text{O}_2]^5}$

b. $\frac{[\text{N}_2\text{O}_5]^2 [5\text{O}_2]}{[\text{N}_2]^2}$

e. $\frac{[\text{N}_2]^5 [\text{O}_2]^2}{[\text{N}_2\text{O}_5]^5}$

c. $\frac{[\text{N}_2\text{O}_5]^2}{[\text{N}_2]^2 [\text{O}_2]^5}$

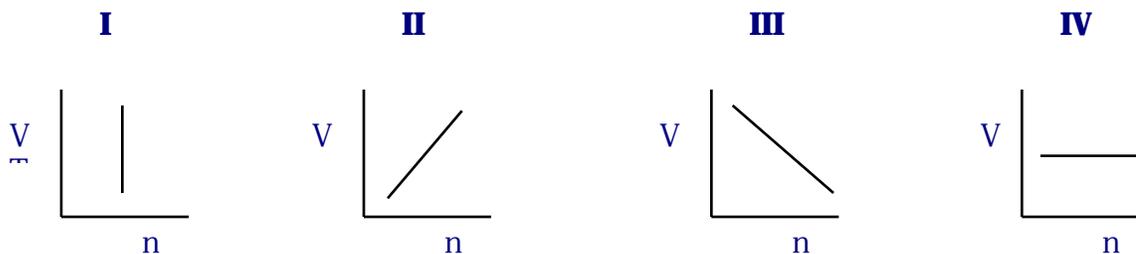
7. In the above equilibrium, increasing the pressure in the reaction vessel has which of the following consequences?

- a. More oxygen will form.
- b. More nitrogen will form.
- c. The equilibrium shifts to the left.
- d. The equilibrium shifts to the right.
- e. The value of the equilibrium constant is increased.

8. In the above equilibrium, removing N_2O_5 from the reaction vessel has which of the following consequences?

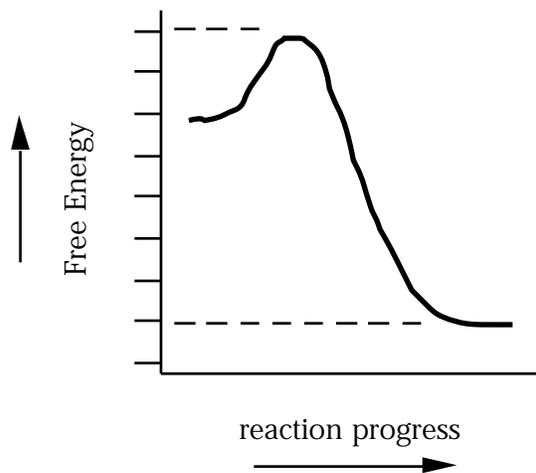
- a. More oxygen will form.
- b. More nitrogen will form.
- c. The equilibrium shifts to the left.
- d. The equilibrium shifts to the right.
- e. The value of the equilibrium constant is increased.

9. Which of the following best represents the behavior of V and n for an ideal gas when both pressure (P) and amount (T) are fixed?



- a. I
- b. II
- c. III
- d. IV
- e. none of the above

Consider the following energy diagram for questions 10 through 12. The units and tick marks on the y-axis are kcal.

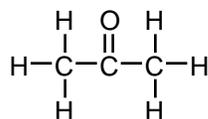


10. The free energy change for this reaction is
- 2 kcal
 - 2 kcal
 - 5 kcal
 - 5 kcal
 - 7 kcal
11. In the forward direction, this reaction is _____ and the activation energy is _____.
- spontaneous, 2 kcal
 - nonspontaneous, -2 kcal
 - spontaneous, 5 kcal
 - nonspontaneous, -5 kcal
 - spontaneous, 7 kcal
12. This reaction would occur more quickly
- at an elevated temperature.
 - at a lower temperature.
 - in the presence of a catalyst.
 - a and c**
 - b and c**
13. What is the volume of 2 moles of neon gas at 0°C and 1 atm?
- 22.4 L
 - 44.8 L
 - 67.2 L
 - 11.2 L
 - 33.6 L

14. Based on the reaction shown, which of the following is true?



- a. 43.2 kcal are consumed when 1.00 g of N_2 reacts.
b. 43.2 kcal are consumed when 1.00 g of O_2 reacts.
c. 43.2 kcal are consumed when 1.00 mol of N_2 reacts.
d. 43.2 kcal are consumed when 1.00 mol of NO is produced
e. 43.2 kcal are released when 1.00 mol of NO is produced.
15. What is the total amount of heat needed to boil 10.0 g of water that is initially at 50.0°C ? (Hint: Two separate calculations are necessary! See the front of the exam for useful data.)
- a. 0.50 kcal
b. 1.3 kcal
c. 4.9 kcal
d. 5.4 kcal
e. 5.9 kcal
16. Which of the following intermolecular forces are present in a sample of acetone?



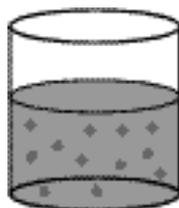
- a. only hydrogen-bonding forces
b. only dipole-dipole forces
c. only London dispersion forces
d. hydrogen-bonding **and** dipole-dipole forces
e. London dispersion **and** dipole-dipole forces
17. Water is rather unique because
- a. of its surprisingly high boiling point.
b. of its high heat of vaporization.
c. of its high specific heat.
d. the density of water in the solid state is less than the density in the liquid state.
e. **all of the above.**
18. A gas (4.0 mol) occupies 3.00 L at 200.0 K. What is the pressure?
- a. 12 atm
b. 22 atm
c. 90 atm
d. 273 atm
e. 4.9×10^{-3} atm

19. A flask contains 0.80 L of helium and 0.20 L of neon at 2.0 atm. What is the partial pressure of helium? *Hint*: Remember the total of the partial pressures equals the total pressure.
- 2.0 atm
 - 1.6 atm
 - 1.2 atm
 - 0.8 atm
 - 0.4 atm
20. Suppose 250 mL of a solution contains 20. g of CaO. What is its w/v %?
- 8% (w/v)
 - 16% (w/v)
 - 24% (w/v)
 - 32% (w/v)
 - 64% (w/v)
21. The addition of a soluble, non-volatile solute, such as KI, to water
- lowers its boiling point.
 - raises its freezing point.
 - decreases its conductivity.
 - increases its vapor pressure.
 - decreases its vapor pressure.
22. A gas in a 2.0 liter container with rigid walls is initially at 300. K and a pressure of 3.0 atm. If the gas is warmed to 400. K, what is the pressure inside the container?
- 0.5 atm
 - 1.0 atm
 - 2.0 atm
 - 4.0 atm
 - 8.0 atm
23. A sample of gas occupies 200 mL at 300 K. What is the temperature if the gas occupies a volume of 500 mL?
- 60.0 K
 120. K
 - 273 K
 - 333 K
 - 750 K
24. If red blood cells are placed in a liquid and the cells neither swell nor shrink, we can conclude that the liquid is
- isotonic.
 - hypotonic.
 - hypertonic.
 - pure water.
 - isoelectronic.

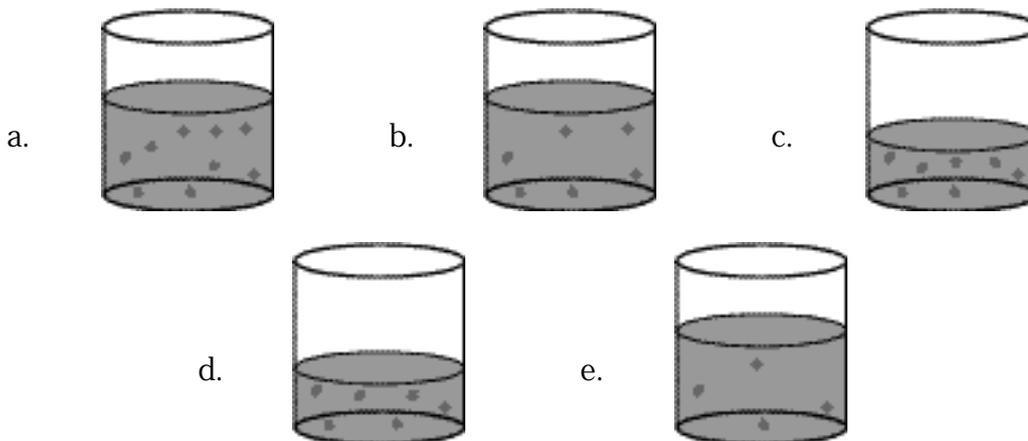
25. The volume of solute in mL, divided by the volume of solution in mL, expressed as a percent, is the concentration unit that is abbreviated
- M
 - w/v %
 - v/v %
 - w/w %
 - ppm
26. Which of the following, when placed in water, is a strong electrolyte?
- CH₃OH
 - BaSO₄
 - Na₃PO₄
 - PbCl₂
 - sugar
27. Since pressure and temperature are directly proportional to each other (for a fixed amount of gas at constant volume) we mathematically say that
- $P = k(1/T)$
 - $P = kT$
 - $PT = k$
 - $1/k = (P)(T)$
 - $P_1T_1 = P_2T_2$
28. Which of the following is likely to be a soluble combination (at least to some significant extent)?
- CCl₄ and water
 - CaCl₂ and CCl₄
 - KCl and octane (C₈H₁₈)
 - K₂SO₄ and CCl₄
 - CBr₄ and CCl₄
29. Sodium bicarbonate is only somewhat soluble in water, such that a solution of NaHCO₃ in water that is 9.6% (w/v) is a saturated solution. Which of the following is (are) true?
- A solution prepared by combining 5 g of NaHCO₃ and 100 mL of water is saturated.
 - Adding sodium chloride to a NaHCO₃ solution will increase the Na⁺ concentration in the solution.
 - Adding additional sodium bicarbonate to an already saturated solution will cause a further reduction in the vapor pressure of the solution.
 - A saturated solution always has excess solid present.
 - all of the above**
30. If 500 mL of 2.5 M KF solution were evaporated to dryness, how many grams of the KF salt would be recovered?
- 2.5 g
 - 7.3 g
 - 11.6 g
 - 73 g
 - 130 g

31. If 100 mL of 1.0 M CaCl_2 and 300 mL of water are combined, what is the approximate **chloride ion** concentration in the resulting solution?
- 0.33 M
 - 0.25 M
 - 0.50 M
 - 3.0 M
 - 4.0 M
32. If 500 mL of water were added to 500 mL of 0.50 M silver nitrate, what would be the approximate concentration of the resulting solution?
- 0.05 M
 - 0.25 M
 - 0.50 M
 - 0.75 M
 - 1.0 M
33. Which one of the following, when prepared as a 0.1M solution in water, would have its freezing point depressed the most relative to pure water?
- NaCl
 - glucose
 - CaCl_2
 - KI
 - CsI
34. How many grams of salt are needed to make 300. mL of a solution that is 3.0% (w/v)?
- 0.18 g
 - 0.90 g
 - 3.0 g
 - 9.0 g
 - 15 g
35. Place the following in order of increasing boiling point.
- | | | | |
|---------------|----------------------|------------|-----------|
| NH_3 | H_2O | Ne | NO |
| I | II | III | IV |
- $\text{I} < \text{II} < \text{III} < \text{IV}$
 - $\text{IV} < \text{III} < \text{II} < \text{I}$
 - $\text{III} < \text{II} < \text{I} < \text{IV}$
 - $\text{III} < \text{IV} < \text{I} < \text{II}$
 - $\text{II} < \text{I} < \text{III} < \text{IV}$
36. Which of the following is capable of hydrogen-bonding?
- CBr_4
 - CH_3OH
 - CHCl_3
 - HCN
 - H_2

37. What is the molarity of a solution prepared by dissolving 80.0 g of NaOH in water and diluting until the total volume is 1.0 L?
- 0.5 M
 - 1 M
 - 2 M
 - 4 M
 - 8 M
38. A reaction is **certainly** spontaneous if
- S is positive.
 - S is negative.
 - H is positive.
 - G is positive.
 - G is negative.
39. The figure below shows a beaker containing 600 mL of an aqueous solution with solute molecules represented by spheres.



If a 200 mL sample is transferred to an empty beaker, and then 400 mL of pure water is added to the 200 mL that was transferred, which picture below best represents the resulting solution?



40. Relative to pure solvent, a solution containing a non-volatile solute has a _____ vapor pressure and a _____ boiling point.
- lower, higher
 - lower, lower
 - higher, lower
 - higher, higher
 - none of the above