C101 Exam #3 **Fall 2002**

Directions:

1. Both your **name** and **identification number** must be included and balloons properly darkened on the scan form. Any errors may result in a point penalty. Only the scan form will be graded.
2. Choose the **best** answer in each of the following questions. Using a #2 pencil, fill in the corresponding balloon on your scan form.
3. **YOU MUST TURN IN THIS BOOKLET WITH YOUR ANSWER SHEET!**

$\Delta G = \Delta H - T\Delta S$ $PV = nRT$ $P_1V_1/T_1 = P_2V_2/T_2$ $K = °C + 273$

Avogadro's number: $N_A = 6.023 \times 10^{23}$ $R = 0.0821$ L·atm/mol·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 = $mC\Delta T$

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s-block		d-block transition metals										p-block					
1 1A																	18 8A
1 H 1.0079	2 2A											13 3A	14 4A	15 5A	16 6A	17 7A	2 He 4.0026
3 Li 6.941	4 Be 9.0122											5 B 10.811	6 C 12.0107	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797
		3 3B	4 4B	5 5B	6 6B	7 7B	8	9 8B	10	11 1B	12 2B						
11 Na 22.990	12 Mg 24.305											13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.4527	18 Ar 39.948
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 websitehttp://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]

For admission informatic send e-mail to:
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317.274.6872

1. A chemical reaction that absorbs heat from the surroundings has a ___________ value of ΔH and is said to be ___________.

   a. negative, exothermic
   b. negative, endothermic
   c. positive, exothermic
   d. positive, endothermic
   e. negative, endotropic

2. Which process would have a negative value for ΔS?

   a. breaking a window
   b. making your bed
   c. dissolving alcohol in water
   d. melting ice to form liquid water
   e. smashing a pumpkin with a baseball bat

3. The value of ΔH for the following reaction is –126 kJ. How much heat will be evolved when 2.0 mol of NaOH is formed in the reaction?

$$2\ Na_2O_2\ (s)\ +\ 2\ H_2O\ (\ell)\ \rightarrow\ 4\ NaOH\ (s)\ +\ O_2\ (g)$$

   a. 252 kJ
   b. 63 kJ
   c. 126 kJ
   d. 31.5 kJ
   e. 3.15 kJ

4. Refer to the reaction in question 3. How much heat would be evolved when 25.0 g of Na_2O_2 reacts with plenty of water?

   a. 20.2 kJ
   b. 28.6 kJ
   c. 40.4 kJ
   d. 67.5 kJ
   e. 80.8 kJ

5. The “spontaneity criterion” for chemical reactions is given by

   a. ΔS positive
   b. ΔS negative
   c. ΔH positive
   d. ΔH negative
   e. ΔG negative

6. The *enthalpy* change for a reaction is positive and the *entropy* change is also positive. In this case,

   a. the free energy change may be negative at high temperatures.

   b. heat is released in the reaction.

   c. chaos decreases in the reaction.

   d. ***a*** and ***b***

   e. ***a*** and ***c***

7. Which of the following will lower the activation energy for a reaction?

   a. increasing the concentrations of the reactants

   b. raising the temperature of the reaction

   c. adding a suitable catalyst

   d. increasing the pressure

   e. ***all of the above***

Use the following reaction for questions 8 – 10.

$$2\ CO_2\ (g) \rightleftharpoons 2\ CO\ (g) + O_2\ (g) \qquad \Delta H = -14\ kJ$$

8. The equilibrium expression for the reaction is

   a. $\dfrac{[CO]^2[O_2]^2}{[2CO]}$

   b. $\dfrac{[CO_2][O_2]}{[CO]}$

   c. $\dfrac{[CO]^2[O_2]}{[CO_2]^2}$

   d. $\dfrac{2[CO]^2[O_2]}{2[CO_2]}$

   e. $\dfrac{[CO]^2[CO_2]}{[O_2]^2}$

9. Decreasing the pressure when this reaction is at equilibrium will

   a. increase the concentration of oxygen gas.

   b. increase the concentration of carbon dioxide gas.

   c. decrease the value of the equilibrium constant.

   d. cause the reaction the shift to the left.

   e. ***not result in any of the effects listed in a - d.***

10. Which of the following would cause more products to form?

   a. removing some carbon dioxide

   b. adding some oxygen

   c. adding some carbon monoxide

   d. increasing the temperature

   e. ***none of the above***

Consider the following energy diagram for questions 11 and 12.

See diagram on last page.

11. What is the value of ΔG for the forward reaction?

    a. 5 kcal
    b. –5 kcal
    c. 3 kcal
    d. –3 kcal
    e. 2 kcal

12. What is the value of the activation energy for the forward reaction?

    a. 5 kcal
    b. –5 kcal
    c. 3 kcal
    d. –3 kcal
    e. 2 kcal

13. Which description best applies to the following reaction?

$$2\ CH_3CH_2CH_2OH\ (\ell)\ +\ 9\ O_2\ (g)\ \rightarrow\ 6\ CO_2\ (g)\ +\ 8\ H_2O\ (g)$$

    a. It likely has a positive ΔG.
    b. It likely has a negative ΔS.
    c. Heat is a product of the reaction.
    d. It is an example of complete neutralization.
    e. ***All of the above are true.***

14. The following gases are in a flask together. Which has the highest average speed?

    a. Ne
    b. N_2
    c. H_2O
    d. O_2
    e. CH_4

15. A balloon occupies 2 L at 2 atm at 200 K. What is its volume at 1 atm and 100 K?

a. 0.5 L
b. 2 L
c. 4 L
d. 8 L
e. 16 L

16. A balloon occupying 24 L at 0.25 atm in the upper atmosphere will occupy what volume when it returns to earth and the pressure is 1 atm? Assume the temperature remains constant.

a. 6 L
b. 12 L
c. 18 L
d. 0.04 L
e. 96 L

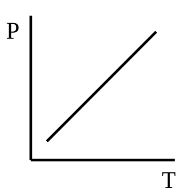
17. A balloon containing 2 moles of He gas is subjected to the following conditions. Which combination would guarantee that the volume of the balloon would increase?

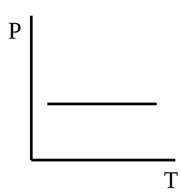
a. decrease pressure and decrease temperature
b. decrease pressure and increase temperature
c. increase pressure and decrease temperature
d. increase pressure and increase temperature
e. both ***a*** and ***b*** above

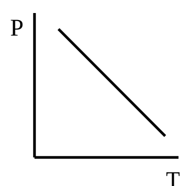
18. The kinetic-molecular theory of gases assumes which of the following?

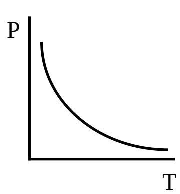
a. lots of space between gas particles
b. average kinetic energy proportional to the Celsius temperature
c. gas particles do not interact with each other or with the container walls
d. ***a*** and ***b***
e. ***a*** and ***c***

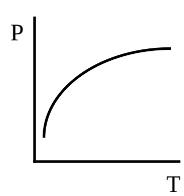
19. Which graph best represents the relationship between P and T for a sample of an ideal gas enclosed in a container with rigid walls?

a.


b.


c.


d.


e.


20. What is the volume of 2 moles of argon gas at 0°C and 2 atm?

a. 33.6 L
b. 44.8 L
c. 67.2 L
d. 22.4 L
e. 11.2 L

21. The boiling point of dimethyl ether (CH_3OCH_3) is –25°C, while the boiling point of ethanol (CH_3CH_2OH) is 78°C. This difference is best explained by

a. the existence of London dispersion forces.
b. the extreme polarity of dimethyl ether.
c. the ability of ethanol to form intermolecular hydrogen bonds.
d. the mass effect.
e. Henry's Law.

22. Heat is required when

a. more than one of the following is correct.
b. a solid sublimes.
c. a liquid freezes.
d. a liquid evaporates.
e. a gas condenses.

23. Which gas has hydrogen bonding as one of its intermolecular forces?

a. H_2S
b. SiH_4
c. HCl
d. CS_2
e. NH_3

24. Compared to methane (CH_4), carbon tetrachloride

a. is a polar molecule, with a significant dipole moment.
b. is more likely to experience hydrogen bonding forces.
c. is more likely to experience dipole-dipole forces.
d. experiences more significant London dispersion forces.
e. ***b*** and ***c***

25. Entropy decreases when

a. gases condense.
b. liquids evaporate.
c. salts dissolve.
d. ***a*** and ***b***
e. ***b*** and ***c***

26. Which one of the following substances has London dispersion forces as its **only** intermolecular force?

a. $CHCl_3$
b. CH_3OH
c. H_2O
d. HCN
e. I_2

Refer to the following equation (at constant temperature) for question 27.

$$N_2\,(g) + 2O_2\,(g) \rightarrow N_2O_4\,(g)$$

27. If 2 L of nitrogen gas and 4 L of oxygen gas are used in the above reaction, how many liters of product gas are formed?

a. 1 L
b. 2 L
c. 4 L
d. 6 L
e. 12 L

28. Since volume and temperature are directly proportional to each other (for a fixed amount of gas at constant pressure) we mathematically say that

a. $V = k(1/T)$
b. $V = kT$
c. $VT = k$
d. $1/k = (V)(T)$
e. $V_1T_1 = V_2T_2$

29. How much heat is needed for 54.0 g of H_2O (ℓ) at 100°C to become steam at 100°C?

a. 29.2 kcal
b. 1.62 kcal
c. 90 cal
d. 4.3 kcal
e. 239 cal

30. Sodium bicarbonate is only somewhat soluble in water, such that a solution of $NaHCO_3$ in water that is 9.6% (w/v) is a saturated solution. Which of the following is (are) true?

a. A solution prepared by combining 10 g of $NaHCO_3$ and 50 mL of water is saturated.
b. A saturated solution always has excess solid present.
c. Adding glucose to a saturated solution of $NaHCO_3$ will cause a further elevation of the boiling point of the solution.
d. ***a*** and ***c***
e. ***b*** and ***c***

31. Which of the following is (are) solutions?

a. the mixture of gases in a SCUBA diving tank
b. gin and tonic
c. a coin made from nickel and copper
d. all of the above: ***a***, ***b***, and ***c***
e. ***none of the above***

32. Which of the following, when placed in water, would likely result in an aqueous solution that readily conducts electricity (a good electrolyte)?

a. CH_3OH
b. $BaSO_4$
c. Na_3PO_4
d. AgCl
e. ***all of the above***

33. Which of the following is likely to be a soluble combination (at least to some significant extent)?

a. CCl_4 and water
b. octane (C_8H_{18}) and water
c. NaCl and hexane (C_6H_{14})
d. $MgSO_4$ and CCl_4
e. hexane (C_6H_{14}) and CCl_4

34. Which would depress the freezing point of 100 mL of water the most?

a. 0.2 mol NaCl
b. 0.4 mol glucose
c. 0.4 mol Na_3PO_4
d. 0.4 mol Na_2CO_3
e. 0.6 mol KI

35. If red blood cells are placed in a liquid and the cells neither swell nor shrink, we can conclude that the liquid is

a. pure water.
b. hypotonic.
c. hypertonic.
d. isotonic.
e. isoelectronic.

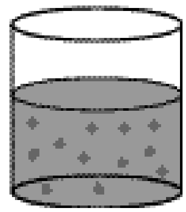
36. If 1.5 L of 1.5 M KF solution were evaporated to dryness, how many grams of the KF salt would we have?

a. 130 g
b. 87 g
c. 25.8 g
d. 8.7 g
e. 58 g

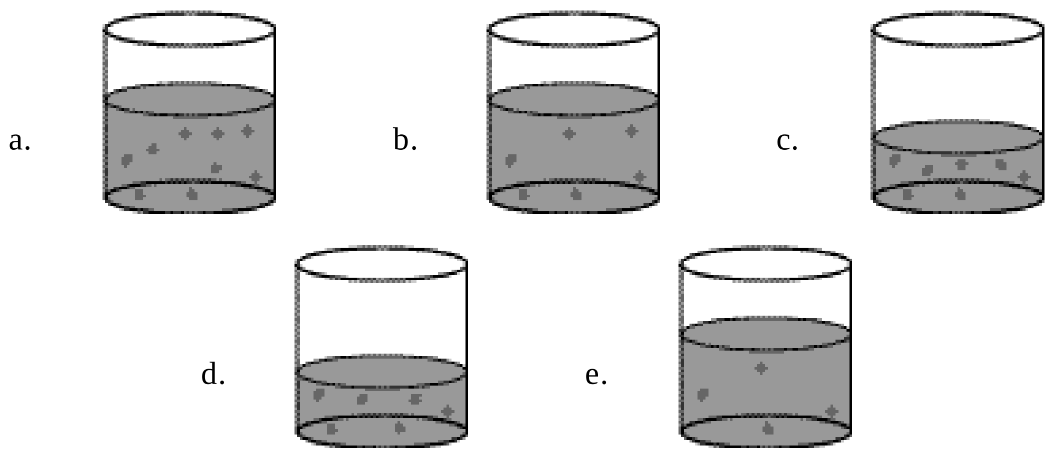
37. If 500 mL of water were added to 500 mL of 0.50 M $Ba(NO_3)_2$, what would be the approximate concentration of the resulting solution?

a. 0.05 M
b. 0.25 M
c. 0.50 M
d. 0.75 M
e. 1.0 M

38. The figure below shows a beaker containing 300 mL of an aqueous solution with solute molecules represented by spheres.



If a 100 mL sample is transferred to an empty beaker, and then 200 mL of pure water is added to the 100 mL that was transferred, which picture below best represents the resulting solution?



39. How many mL of methanol are needed to make 250. mL of a solution that is 10.0% (v/v)?

a. 2.50 mL
b. 10.0 mL
c. 25.0 mL
d. 100. mL
e. 250. mL

40. What is the concentration when 35 mg of lead is present in 10,000 grams of contaminated water?

a. 0.035 ppm
b. 0.70 ppm
c. 3.5 ppm
d. 350 ppm
e. 3.5×10^3 ppm

Diagram for questions 11 and 12.