Redacted

Name: _____

print last   print first

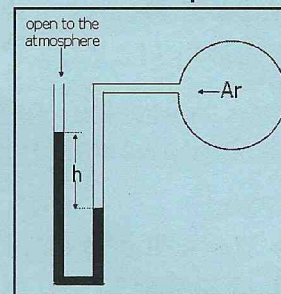Student Number: Redacted   (000#####)

1. The pressure of the atmosphere is 750 mm Hg. What is the pressure in atmospheres of the Argon gas in the bulb if the height difference is 60 mm Hg?

   open to the atmosphere

   ←Ar

   h

   $\dfrac{750+60}{760}$

   A) 1.07 atm

   B) 810 atm

   C) 0.91 atm

   D) 690 atm

2. Early car air bags generated nitrogen by the decomposition of sodium azide (mM = 65.02 g NaN_3/mol), according to the reaction below. How many grams of sodium azide are required to fill a 20.0 liter air bag to 1.00 atmosphere at 25° C?

   $$2NaN_{3\,(s)} \rightarrow 2Na_{(s)} + 3N_{2\,(g)}$$
   sodium azide
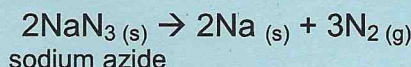
   $PV = nRT$

   $(1)(20) = n(.0831)(298)$

   $n = .817467$

   $n = \dfrac{9}{65.02}$

   A) 53.1 g NaN_3 B) 4.17 g NaN_3 C) 35.4 g NaN_3 D) 266 g NaN_3 E) 6.25 g NaN_3

3. What is the approximate energy in kJ/mol of molecules at 255° C?

   $\Delta E = RT$ 8.314

   A) 43.4 kJ/mol   B) 2120 kJ/mol   C) 2.12 kJ/mol   D) 20.9 kJ/mol   E) 4.39 kJ/mol

4. 4.53 grams of nitrogen are in a container with an initial volume of 7.03 liters at a pressure of 0.563 atmospheres and a temperature of 20°C. Which of the following actions would DECREASE the PRESSURE?

   $PV = nRT$

   I) increasing the moles of nitrogen in the container.
   II) decreasing the volume of the container.
   III) increasing the volume of the container.
   IV) decreasing the temperature.
   V) increasing the temperature.

   A) I, III, & V only   B) I, II, & V only   C) II & IV only   D) III & IV only

5. Which species below has the LOWEST boiling point?

   A   B   C   D   E
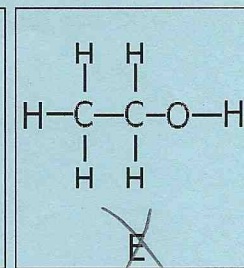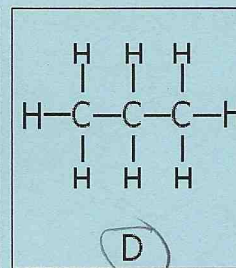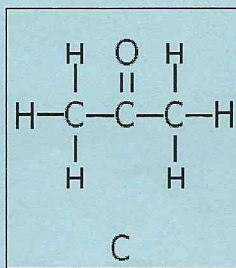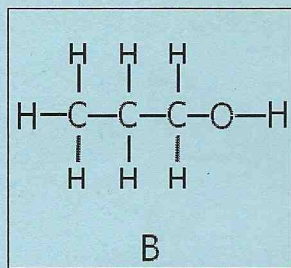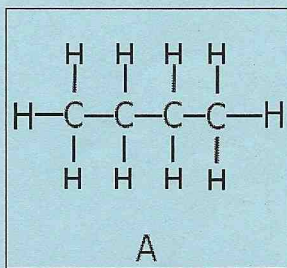
6. Four materials and their boiling points are shown below. Choose the substance in which the interaction energy has the greatest excess over the thermal energy at room temperature and 1 atmosphere of pressure.

   A) C_8H_{18} (125 °C)   **B)** CH_3COOH (118 °C)   **C)** CH_3COH (21 °C)   **D)** CH_4 (-161 °C)

7. Three molecules are shown below. Which one has the HIGHEST boiling point and what is the strongest intermolecular force responsible for the difference?

   H_2S H_2O H_2Se

   A) H_2Se due to dispersion forces.   **B)** H_2O due to H-bonding.
   C) H_2O due to dispersion forces.   **D)** H_2Se due to dipolar forces.
   E) H_2S due to dipolar forces.
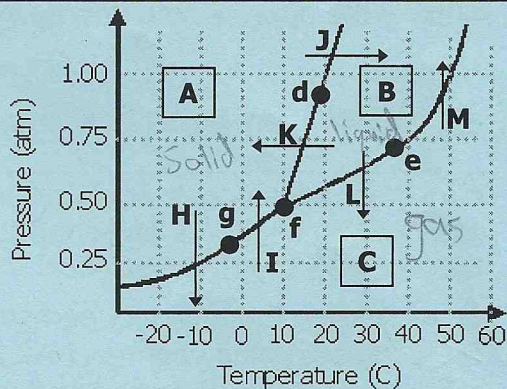
   Hydrogen

8. Three molecules with labeled atoms are shown below. Choose the combinations below in which H-bonding can occur.
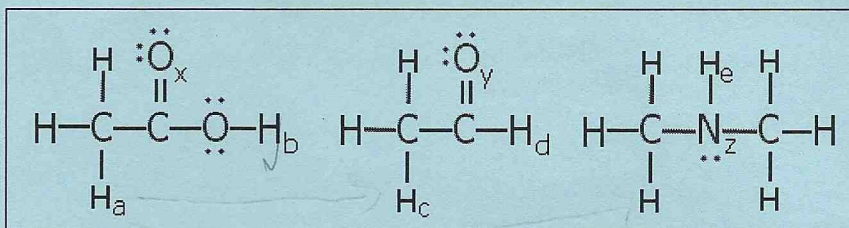
   A) N_z--H_b **B)** O_x--H_c **C)** O_y--H_a **D)** H_b--H_e

9. Select the statement that is FALSE.

   A) Arrow H represents sublimation.
   B) Point d is a melting point.
   C) Arrow K represents freezing.
   D) Arrow L represents condensation.
   E) Region $\boxed{A}$ represents the solid state.

10. The pressure of water vapor in the atmosphere is found to be 12.0 torr when it is 25°C. The vapor pressure of water is 23.8 torr when it is 25°C. What is the relative humidity?

    A) 48.0 %   **B)** 198 %   **C)** 50.4 %   **D)** 95.2 %

11. Choose all the **NON-POLAR** compounds from the choices below.
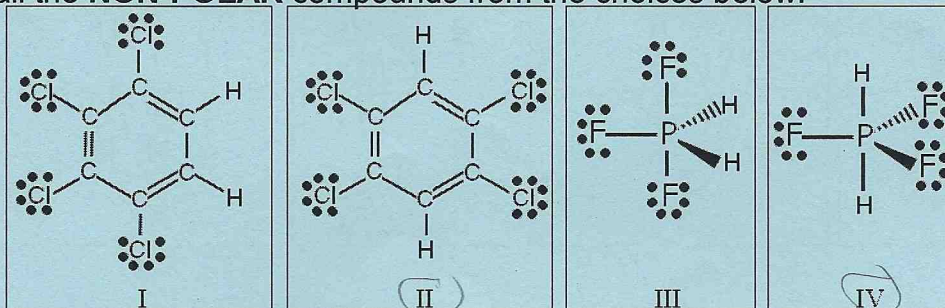
    I   II   III   IV

    A) I only   **B)** I, II & III   **C)** IV only   **D)** I & III   **E)** II & IV

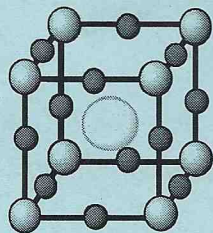12. The unit cell of a magnetic potassium-manganese-fluoride ionic compound is shown below. The potassium occupies the center of the unit cell. The manganese occupies the corners of the unit cell. The fluorine occupies the edge of the unit cell. Choose the correct formula for the compound below.
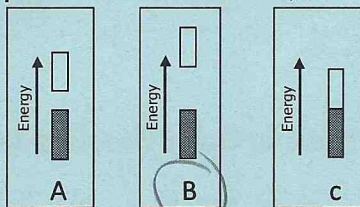
○ K $K=1$
○ Mn $Mn = 8(1/8) = 1$
● F $F = 12(1/4) = 3$
       $K\,Mn\,F_3$

A) KMn_8F_{12}
B) KMn_4F_6
C) KMn_2F_6
D) $KMnF_3$

13. The band diagrams below correspond to a conductor, semiconductor and insulator. Which one is the insulator?

A   B   C

14. Choose the correct set of words to complete the statement below.
$CaCl_2$ is a(n) _____i_____ substance. C_2H_4 is a(n) _____ii_____ substance.
ionic

A) i=ionic, ii=network covalent
B) i=network covalent, ii=molecular
C) i=metallic, ii=molecular
D) i=ionic, ii=molecular

15. Chose the cubic cell below in which each atom has a coordination number of 8.

A   B   C
    $6(1/2)+1+1$
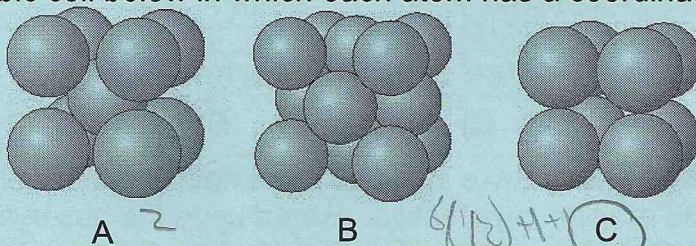
16. Choose the material shown in the picture.
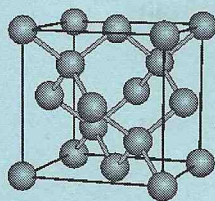
A) diamond
B) bucky ball
C) graphite
D) sodium chloride

17. Calculate ΔE for a system undergoing an <u>exothermic</u> process in which 3.6 kJ of heat flows and where 1.4 kJ of work is done <u>by</u> the system.

by >0

A) +5.0 kJ   B) -5.0 kJ   C) +2.2 kJ   D) -1.2 kJ

18. What is the approximate value of ΔS for the reaction below?

$$CH_{4\,(g)} + 2\,O_{2\,(g)} \rightarrow CO_{2\,(g)} + 2\,H_2O_{\,(l)}$$

A) $\Delta S < 0$ B) $\Delta S > 0$ C) $\Delta S \sim 0$ D) cannot be predicted

19. The combustion reaction of tetranitrocubane is shown below.

$$C_8H_4N_4O_{8\ (s)} + 5O_{2\ (g)} \rightarrow 8\ CO_{2\ (g)} + 2H_2O_{\ (l)} + 2N_{2\ (g)} \qquad \Delta H^\circ = -3700\ kJ/mol$$

What is the value of ΔH° for the reaction shown?

$-2(3700)$

$$16\ CO_{2\ (g)} + 4H_2O_{\ (l)} + 4\ N_{2\ (g)} \rightarrow 2C_8H_4N_4O_{8\ (s)} + 10\ O_{2\ (g)}$$

A) +3700 kJ   **B)** -7,400 kJ   **C)** +7,400 kJ   **D)** +59,200 kJ   **E)** -59,200 kJ

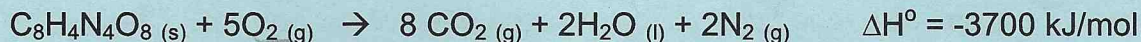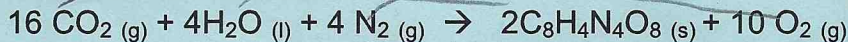**20.** The reaction for the oxidation of formaldehyde to formic acid is shown below. Using bond enthalpies, determine the value of ΔH for the reaction.
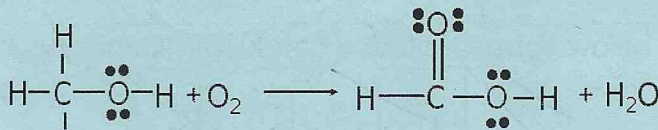
$3(413) + 358 + 463 + 495$ $O=O$ $413 + 358 + 799 + 463 + 2(463)$

Table of Bond Energies (kJ/mol)

C-H	413	N-H	391	O-H	463	H-H	436		
C-F	485	N-F	272	O-F	190	H-F	565	F-F	155
C-Cl	328	N-Cl	200	O-Cl	203	H-Cl	431	Cl-Cl	242
C-Br	276	N-Br	243	O-Br	235	H-Br	366	Br-Br	193
C-I	234			O-I	234	H-I	299	I-I	151

C-C	347	N-N	163	C-N	293	C-O	358	O-O	146
C=C	612	N=N	418	C=N	615	C=O	799	O=O	495
C≡C	820	N≡N	941	C≡N	891	C≡O	1072		

A) +753 kJ/mol   **B)** +59 kJ/mol   **C)** -354 kJ/mol   **D)** -404 kJ/mol   **E)** -753 kJ/mol

21. A spontaneous reaction is taking place in a flask. You notice the formation of gas bubbles intensifies as the reaction progresses. Based upon the observations, choose the correct analysis for each term in the Gibbs Free Energy equation.

A) $\Delta G < 0$, $\Delta S < 0$, ΔH cannot be determined from information given.

B) $\Delta G < 0$, $\Delta S > 0$, $\Delta H < 0$.

$\Delta G = \Delta H - T\Delta S > 0$

C) $\Delta G < 0$, $\Delta S > 0$, ΔH cannot be determined from information given.

D) $\Delta G > 0$, $\Delta S < 0$, $\Delta H > 0$.

22. Choose the correct statement that describes the reaction below.

$$PCl_{5\ (s)} \rightarrow PCl_{3\ (l)} + Cl_{2\ (g)} \qquad \Delta H = +113.5\ kJ/mol$$

A) The reaction is extensive at low temperature.

extensive > 0 > 0

B) The reaction is extensive at high temperature.

C) The reaction is extensive at any temperature.

$\Delta H\ +$ $-$ any

D) The reaction is not extensive at any temperature.

never

$+$ $+$ high

$-$ $-$ low

$\Delta G = \Delta H - T\Delta S$

$> 0 =$

23. The Mond process, shown below, is used to purify nickel. What is the K_{eq} expression for this reaction?

$$Ni_{(s)} + 4 CO_{(g)} \rightleftharpoons Ni(CO)_{4\,(g)}$$
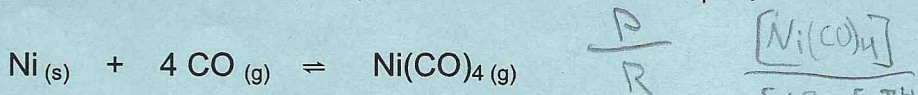
$\frac{P}{R}$ $\frac{[Ni(CO)_4]}{[Ni] \times [CO]^4}$

A) $K_{eq} = [Ni(CO)_4] / [CO]^4$

B) $K_{eq} = [Ni(CO)_4] / ([CO]^4 \times [Ni])$

C) $K_{eq} = [Ni(CO)_4] / (4 \times [CO])$

D) $K_{eq} = [CO]^4 \times [Ni] / [Ni(CO)_4]$

Use the reaction coordinate diagram below to answer the next two questions regarding the reaction: **X-Y + Z $\rightleftharpoons$ X + Y-Z** .
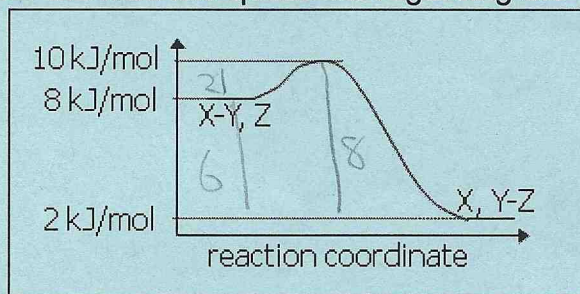
**24.** Choose the value of ΔG and E_{act}(forward).

A) $\Delta G = +2$ kJ, $E_{act} = +10$ kJ   **B)** $\Delta G = +2$ kJ, $E_{act} = +8$ kJ   **C)** $\Delta G = -6$ kJ, $E_{act} = +10$ kJ

D) $\Delta G = -6$ kJ, $E_{act} = +2$ kJ   **E)** $\Delta G = -6$ kJ, $E_{act} = -2$ kJ

25. Select the **FALSE** statement for the diagram above.

A) The forward reaction is preferred because $k_{forward} > k_{reverse}$.

B) The diagram represents a reaction for which K > 1.

C) Bond X-Y is stronger than bond Y-Z.

D) Heating the reaction will result in the formation of more X-Y.

Use the reaction for the formation of stalagmites and stalactites for the next two questions. The reaction is at equilibrium.

$$Ca^{2+}_{(aq)} + 2HCO_3^{1-}_{(aq)} \rightleftharpoons CaCO_3_{(s)} + CO_2_{(g)} + H_2O_{(l)} \quad \Delta H > 0$$
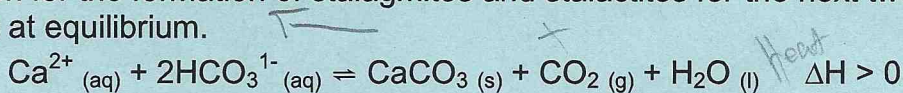
heat

26. What is the effect on Ca^{2+} concentration when the reaction is heated?

A) increases   **B)** decreases   **C)** stays the same

27. What is the effect on Ca^{2+} concentration when $CO_{2\,(g)}$ is added?

A) increases   **B)** decreases   **C)** stays the same

28. Choose the sample with the LEAST mass.

A) 6×10^{23} S atoms   **B)** 3×10^{23} Na atoms   **C)** 0.75 mol Cu atoms   **D)** 1.5 mol N atoms

32.07

$\frac{22.99}{2}$

$\frac{3}{4}(63.55)$

1.5(14.01)

11.495

47.66

21.015

I pledge that I have neither given nor received aid on this exam.

Signature: _Mdrand Bunfard_

		Campus	Spec	Misc	Total	Score by Part					
Name		Number	Code	Data	Score	1	2	3	4	5	Pct
======	======	========	======	======	=======	===	===	===	===	===	=====
Redacted				./ . . .	19	19	.	.	.	.	67.9

```
  1-A          2-A (C)         3-E            4-D              5-D
  6-A          7-B             8-A            9-D             10-C
 11-E         12-D            13-B           14-D             15-C (A)
 16-A         17-A (B)        18-C (A)       19-C             20-D
 21-C         22-A (B)        23-B (A)       24-D             25-C
 26-A (B)     27-B (A)        28-C (D) (B)
```