KEY

General&Analytical Chemistry I
CHMG-141

Exam 3 (V. Add)

Name_____

R = 0.0821 L. atm/mol . K

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) The first law of thermodynamics 1) _____
A) provides a criterion for the spontaneity of a reaction.
B) defines entropy.
C) defines chemical energy.
D) is a statement of conservation of energy.

2) How much heat is absorbed when 30.00 g of C(*s*) reacts in the presence of excess $SO_2(g)$ to produce $CS_2(l)$ and $CO(g)$ according to the following chemical equation? 2) _____

$$5\ C(s) + 2\ SO_2(g) \rightarrow CS_2(l) + 4\ CO(g) \quad \Delta H^\circ = +239.9\ kJ$$

A) 599.2 kJ B) 119.9 kJ C) 1439 kJ D) 239.9 kJ

3) It takes 11.2 kJ of energy to raise the temperature of 145 g of benzene from 25.0°C to 70.0°C. What is the specific heat capacity of benzene? 3) _____
A) 1.72 J/(g • °C) B) 5.41 J/(g • °C) C) 3.48 J/(g • °C) D) 1.10 J/(g • °C)

4) Water has an unusually high 4) _____
A) electrical conductivity.
B) heat of combustion.
C) specific heat capacity.
D) heat of formation.

5) Acetylene torches utilize the following reaction: 5) _____

$$2\ C_2H_2(g) + 5\ O_2(g) \rightarrow 4\ CO_2(g) + 2\ H_2O(g)$$

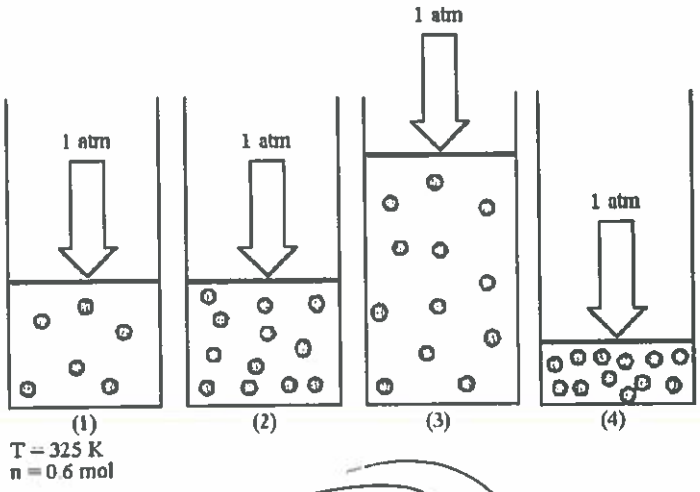
Use the given standard enthalpies of formation to calculate ΔH° for this reaction

Species	ΔH°_f, kJ/mol
$C_2H_2(g)$	+227.4
$CO_2(g)$	-393.5
$H_2O(g)$	-241.8

A) 1256.2 kJ B) -2512.4 kJ C) 2512.4 kJ D) -1256.2 kJ

6) Some assumptions from the kinetic molecular theory are listed below. Which one is most frequently cited to explain compressibility of a gas? 6) _____
A) The average kinetic energy of gas particles is proportional to the Kelvin temperature.
B) Collisions of gas particles are elastic and total kinetic energy of the gas is constant.
C) A gas consist of tiny particles moving in random straight line motion.
D) The volume of the particles is negligible compared to the volume of the gas.

7) Assume that you have a sample of gas in a cylinder with a moveable piston, as shown in diagram (1). The initial pressure, number of moles, and temperature of the gas are noted on the diagram. Which diagram (2)-(4) most closely represents the result of doubling the number of moles of gas while keeping the pressure and temperature constant? 7) _____



A) diagram (2) B) diagram (3) C) diagram (4)

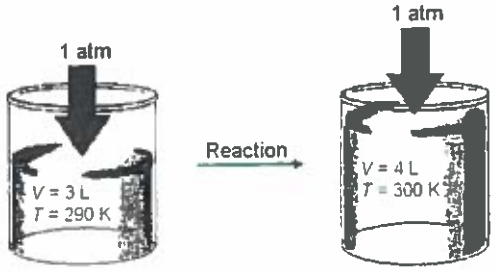
8) One mole of which gas has the greatest density at STP? 8) _____

A) ~~CO~~
B) N_2
C) Ar
D) All three gases have the same density.

9) Ethyl chloride, C_2H_5Cl, is used as a local anesthetic. It works by cooling tissue as it vaporizes. The heat of vaporization is 26.4 kJ/mol. How much heat could be removed by 10.0 g of ethyl chloride? 9) _____

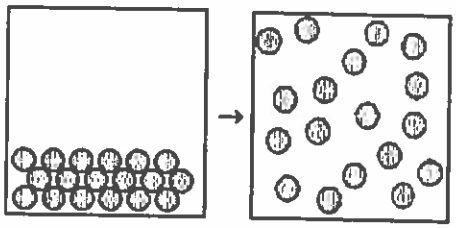
A) 264 kJ B) 4.09 kJ C) 1700 kJ D) 170 kJ

10) Imagine a reaction that results in a change in both volume and temperature, as shown in the diagram below. What is the sign of the work being done and the sign of the enthalpy change involved in this reaction? 10) _____



A) w = + and ΔH = –
B) w = + and ΔH = +
C) w = – and ΔH = –
D) w = – and ΔH = +

11) What are the signs of ΔH, ΔS, and ΔG for the following spontaneous change? 11) _____



A) $\Delta H = -, \Delta S = +, \Delta G = -$
B) $\Delta H = +, \Delta S = -, \Delta G = -$
C) $\Delta H = -, \Delta S = -, \Delta G = -$
D) $\Delta H = +, \Delta S = +, \Delta G = -$

12) When 1.50 g of Ba(*s*) is added to 100.00 g of water in a container open to the atmosphere (calorimeter), the reaction shown below occurs and the temperature of the resulting solution rises from 22.00°C to 33.10°C. If the specific heat of the solution is 4.18 J/(g • °C), calculate ΔH for the reaction, as written (for one mol of Ba). 12) _____

$$Ba(s) + 2\ H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2(g) \qquad \Delta H = ?$$

A) 3.14 kJ B) 431 kJ C) -3.14 kJ D) -431 kJ

13) Use the standard reaction enthalpies given below to determine $\Delta H°_{xn}$ for the following reaction: 13) _____

$$2\ S(s) + 3\ O_2(g) \rightarrow 2SO_3(g) \qquad \Delta H°_{rxn} = ?$$

Given:

$$SO_2(g) \rightarrow S(s) + O_2(g) \qquad \Delta H°_{rxn} = +296.8\ kJ$$

$$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g) \qquad \Delta H°_{rxn} = -197.8\ kJ$$

A) -494.6 kJ B) -692.4 kJ C) -293.0 kJ D) -791.4 kJ E) -98.8 kJ

14) Which of the following phase changes has a positive value for its entropy change? 14) _____
A) boiling water
B) making ice cubes from liquid water
C) formation of raindrops from a cloud
D) making dry ice from gaseous CO_2

15) When a liquid is heated at its boiling point, the 15) _____
A) temperature of the liquid remains the same as long as any liquid is present.
B) temperature of the liquid increases.
C) covalent bonds are broken, allowing vaporization to occur.
D) temperature of the vapor phase increases.

16) If an endothermic reaction is spontaneous at constant temperature and pressure, 16) _____
A) ΔG is positive and ΔS may be positive or negative.
B) ΔG is positive and ΔS is negative.
C) ΔG is negative and ΔS may be positive or negative.
D) ΔG is negative and ΔS is positive.

17) Determine the sign of $\Delta S°$ for each of the following: 17) _____

I. $C_6H_6(s) \rightarrow C_6H_6(l)$

II. $2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$

A) $\Delta S°$ should be negative for I and positive for II.

B) $\Delta S°$ should be positive for I and negative for II.

C) $\Delta S°$ should be negative for I and negative for II.

D) $\Delta S°$ should be positive for I and positive for II.

18) All of the reactions shown are oxidation-reduction reactions **except** 18) _____

A) $K_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s) + 2\ KCl(aq)$.

B) $2\ Zn(s) + 2\ HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$.

C) $N_2(g) + O_2(g) \rightarrow 2\ NO(g)$.

D) $2\ NaI(aq) + Cl_2(g) \rightarrow 2\ NaCl(aq) + I_2$.

E) $2\ Fe_2O_3(s) \rightarrow 4\ Fe(s) + 3\ O_2(g)$.

19) The oxidation number of sulfur in calcium sulfate, $CaSO_4$, is _____. 19) _____

A) +4 B) -2 C) +6 D) 0 E) +2

20) When a substance loses electrons it is _____; the substance itself is acting as a(an) _____ agent. 20) _____

A) oxidized, oxidizing

B) reduced, reducing

C) oxidized, reducing

D) dissolved, neutralizing

E) reduced, oxidizing

21) Determine the oxidation state of P in PO_3^{3-}. 21) _____

A) 0 B) +6 C) +2 D) +3 E) -3

22) What mass of NO_2 is contained in a 13.0 L tank at 4.58 atm and 385 K? 22) _____

A) 53.1 g B) 69.2 g C) 86.7 g D) 18.8 g E) 24.4 g

23) Which of the following is TRUE if $\Delta E_{sys} = -95$ J? 23) _____

A) The system is gaining 95 J, while the surroundings are losing 95 J.

B) The system is losing 95 J, while the surroundings are gaining 95 J.

C) Both the system and the surroundings are gaining 95 J.

D) Both the system and the surroundings are losing 95 J.

E) None of the above are true.

24. Many homes are heated using natural gas. The combustion of natural gas converts

a) Thermal energy to mechanical energy.
b) Mechanical energy to thermal energy.
c) Electrostatic energy to mechanical energy.
d) Chemical potential energy to thermal energy.
e) Thermal energy to acoustic energy.

25. Heat capacity is defined as

a) The amount of heat energy required to raise the temperature of 1 gram of substance by 1 K.
b) The amount of heat required to raise a body's (object's) temperature by 1K (or °C).
c) The amount of heat energy required to vaporize a solid or liquid.
d) The maximum amount of heat energy that a substance may absorb without decomposing.
e) 4.18 cal/g·K.

26. (Bonus 3 points): For the following reaction

$MnO_2(s) + H_3AsO_3(aq) \rightarrow Mn^{2+}(aq) + H_3AsO_4(aq)$

+4 -2 +1 +3 -2 +2 +1 +5 -2

H_3AsO_3

$3(+1) + x + 3(-2) = 0$

$x = +3$

1. (0.5 point) Assign the oxidation numbers to all of the atoms in the reaction

$Mn O_2 \rightarrow Mn^{2+}$

2. (0.5 point) Split the reaction into two half-reactions; identify the atom that is oxidized and the atom that is reduced

$\underset{+4}{Mn}O_2 \rightarrow \underset{+2}{Mn}^{2+}$ (GER) Mn Reduced

$H_3\underset{+3}{As}O_3 \rightarrow H_3\underset{+5}{As}O_4$ (LEO) As oxidized

3. (0.5 point) Identify oxidizing agent and the reducing agent.

MnO_2 – oxidizing agent

H_3AsO_3 – reducing agent

4. (1 point) Balance the given redox reaction by the Half-Reaction Method in acidic solution

$$H_3AsO_3(aq) + H_2O(\ell) \rightarrow H_3AsO_4(aq) + 2H^+ + 2e^-$$

$$MnO_2(s) + 4H^+(aq) + 2e \rightarrow Mn^{2+}(aq) + 2H_2O(\ell)$$

$$H_3AsO_3(aq) + H_2O(\ell) + MnO_2(s) + 4H^+ + 2e^- \rightarrow$$

$$Mn^{2+}(aq) + 2H_2O(\ell) + H_3AsO_4(aq) + 2H^+ + 2e^-$$

5. (0.5 point) How many electrons are transferred in the reaction from the reducing agent to the oxidizing agent?

$$H_3AsO_3(aq) + MnO_2(s) + 2H^+(aq) \rightarrow Mn^{2+}(aq) + H_2O(\ell) + H_3AsO_4(aq)$$

$2e^-$ are transferred