CHEM1211

Final Exam

1. What is the change in internal energy (ΔE) of a system when 4.50 J of work is done on the system while it releases 12.0 kJ of energy to the surroundings?

A. -7.5 kJ B. -16.5 kJ C. +16.5 kJ
D. +7.5 kJ E. -12.0 kJ

2. Which of the following will always increase the internal energy of a system?

A. The system gains energy and performs work.
B. The system gains energy and work is performed on it.
C. The system loses energy and performs work.
D. The system loses energy and work is performed on it.
E. None of the changes A–D will always increase the internal energy of a system.

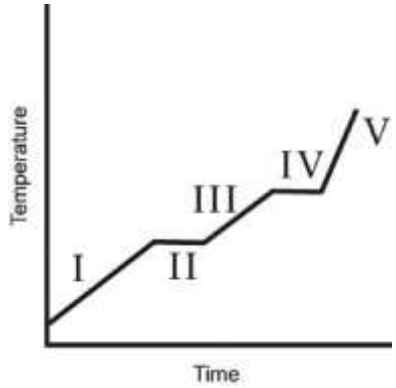
3. When solid NH_4NO_3 is dissolved in water, the temperature of the water and beaker gets noticeably colder. The formation of an aqueous solution of ammonium nitrate is

A. an exothermic process. B. an endothermic process.
C. a combustion reaction. D. a thermodynamic cycle.
E. a redox reaction.

4. How much work does a gas do when it expands against a constant pressure of 0.750 atm from a volume of 40.00 mL to a volume of 275.00 mL? (101.3 J = 1 L×atm)

A. +17.9 J B. 17.9 kJ C, -174 J
D. -17.9 J E. -17.9 kJ

5. The heating curve for a substance is shown below. The substance initially is a solid. It then becomes a liquid and a gas. Which of the line segments (I–V) represents the solid-to-liquid phase transition?



A. I B. II C. III
D. IV E. V

6. Water has a molar heat capacity of 75.38 J/(mol × °C) and its vaporization enthalpy at 100°C is 40.7 kJ/mol. How much energy is needed to boil 54.0 grams of water at 100°C?

A. 22.6 kJ B. 145 kJ C. 179 kJ
D. 122 kJ E. 2.20×10^3 kJ

7. How much energy is needed to change the temperature of 275 grams of lead from 10.0°C to 95.0°C? The specific heat of lead is 0.129 J/g°C.

A. 35.5 kJ B. 113 kJ C. 3.02 kJ
D. 7340 kJ E. 23,400 kJ

8. Given equal masses of the following, which will cool the fastest from the same initial temperature?

A. an aluminum pan [c_p = 0.90 J/(g × °C)]
B. a copper pot [c_p = 0.39 J/(g × °C)]
C. an iron skillet [c_p = 0.45 J/(g × °C)]
D. a container of water [c_p = 4.2 J/(g × °C)]
E. a container of ethanol [c_p = 2.5 J/(g × °C)]

9. A 15 g piece of iron [c_p = 25.09 J/(mol × °C)] is heated to a temperature of 95°C and placed into a bucket containing 4.5 gal of water [c_p = 75.38 J/(mol × °C)], initially at 25°C. Eventually,

A. the water will be warmer than the iron.
B. the iron will be warmer than the water.
C. the iron will be colder than the water.
D. the iron and the water will be at the same temperature.
E. he temperature will be the average of 98°C and 25°C.

10. In an experiment, 2.00×10^2 g of silicon dioxide is heated to 96.7°C and then quickly transferred to 1.25×10^2 g of water at 15.2°C. The final temperature comes to 32.5°C. What is the approximate specific heat capacity of SiO_2? [c_p(water) = 4.18 J/(g × °C)]

A. 10.1 J/(g × °C) B. 0.153 J/(g × °C)
C. 0.313 J/(g × °C) D. 0.878 J/(g × °C)
E. 0.704 J/(g × °C)

11. Suppose the brain needs to metabolizes about 4 g glucose ($C_6H_{12}O_6$, 180 g/mol) per hour. Assuming glucose metabolism can be approximated by the reaction below, about how much energy does the brain use per day?

$$C_6H_{12}O_6(g) + 6\,O_2(g) \rightarrow 6\,CO_2(g) + 6\,H_2O(l) \quad \Delta H_{comb} = -2808\ \text{kJ/mol}$$

A. 700 kJ B. 1500 kJ C. 8400 kJ
D. 11,000 kJ E. 17,000 kJ

12. When 2.28 g of octane (molar mass = 114.23 g/mol) reacts with excess oxygen in a constant volume (bomb) calorimeter, the temperature of the calorimeter increases by 20.0°C. The heat capacity of the calorimeter is 5.09 kJ/°C. Determine the energy flow, q_{rxn}, per mole of octane.

A. +102 kJ B. +5090 kJ C. -102 kJ
D. -5090 kJ E. -2.03 kJ

13. Indicate which of the following is NOT an element in its standard state at 25°C and 1 atm.

A. $O_3(g)$ B. $H_2(g)$ C. Ne(g)
D. $N_2(g)$ E. C(s, graphite)

14. Given the following reactions, what is the overall enthalpy change for the following reaction?

$$NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$$

Reaction	$\Delta H°$ (kJ)
$N_2(g) + 3\,H_2(g) \rightarrow 2\,NH_3(g)$	−92
$H_2(g) + Cl_2(g) \rightarrow 2\,HCl\,(g)$	−185
$N_2(g) + 4\,H_2(g) + Cl_2(g) \rightarrow 2\,NH_4Cl\,(s)$	−629

A. -38 kJ B. -176 kJ C. -352 kJ
D. -445 kJ E. -554 Kj

15. Which of the following does NOT show the reaction associated with the standard heat of formation of a compound?

A. $2\,Cl_2(g) + H_2(g) + 2\,C(s, \text{graphite}) \rightarrow C_2H_2Cl_4(g)$
B. $Ca(s) + Br_2(l) \rightarrow CaBr_2(s)$
C. $\frac{1}{2}\,N_2(g) + O_2(g) \rightarrow NO_2(g)$
D. $Cl_2(g) + H_2(g) \rightarrow 2\,HCl(g)$
E. $2\,Na(s) + C(s, \text{graphite}) + \frac{3}{2}O_2(g) \rightarrow Na_2CO_3(s)$

16. Determine the change in enthalpy for the following reaction from the enthalpies of formation for the reactants and products.
(NH_3, −46 kJ/mol; NO_2, +33 kJ/mol; H_2O, −286 kJ/mol)

$$2\,NO_2(g) + 7\,H_2(g) \rightarrow 2\,NH_3(g) + 4\,H_2O(l)$$

A. -1302 kJ/mole B. -1170 kJ/mole
C. -365 kJ/mole D. +1170 kJ/mole
E. +1302 kJ/mole

17. The reaction

$$4Al\,(s) + 3O_2\,(g) \rightarrow 2\,Al_2O_3\,(s) \qquad \Delta H° = -3351\ kJ$$

is _____, and therefore heat is _____ by the reaction.

A. endothermic, released
B. endothermic, absorbed
C. exothermic, released
D. exothermic, absorbed
E. thermoneutral, neither released nor absorbed

18. The enthalpy change for the following reaction is -483.6 kJ:

$$2H_2\,(g) + O_2\,(g) \rightarrow 2H_2O\,(g)$$

Therefore, the enthalpy change for the following reaction is _____ kJ.

$$4H_2\,(g) + 2O_2\,(g) \rightarrow 4H_2O\,(g)$$

A. -483.6
B -967.2
C. 2.34×10^5
D. 483.6
E. 967.2

19. In a bomb calorimeter, reactions are carried out

A. at 1 atm pressure and 25°C.
B. at 1 atm pressure and 0°C.
C. at a constant pressure and 25°C.
D. at a constant pressure.
E. at a constant volume.

20. The density of a gaseous compound is 2.06 g/L at STP. What is the most likely formula of this gas?

A. F_2
B. HCl
C. O_3
D. NO_2
E. CO_2

21. One compound under investigation for use as a lightweight rocket fuel is dimethylhydrazine (60.10 g/mol). It reacts with dinitrogen tetroxide (92.01 g/mol) according to the following reaction:

$$(CH_3)_2N_2H_2(\ell) + N_2O_4(g) \rightarrow 3\,N_2(g) + 4\,H_2O(g) + 2\,CO_2(g)$$

If 150 g of $(CH_3)_2N_2H_2$ react with excess N_2O_4 at 473 K and 760 torr, what volume of CO_2 gas will form?

A. 97 L
B. 41 L
C. 190 L
D. 82 L
E. 220 L

22. What is the mole fraction of O_2 in a gas mixture with a total pressure of 750 torr when the partial pressure of O_2 is 125 torr?

A.	0.167	B.	6.00	C.	0.200
D.	0.333	e.	0.833		

23. Which of the following statements regarding partial pressures and kinetic molecular theory is NOT correct?

A. The total pressure of a gas mixture will reflect the force with which the gas molecules collide with the container walls, independent of molecular identities.
B. The total pressure of a gas mixture will reflect the frequency with which the gas molecules collide with the container walls, independent of molecular identities.
C. The total pressure of a gas mixture will reflect the average kinetic energy of the gas molecules, independent of molecular identities.
D. Molecules of each gas in a mixture contribute to the total pressure in exact proportion to their relative number in the container.
E. Heavier gases contribute more to the total pressure in a gas mixture because their average kinetic energies are higher.

24. The total pressure of a mixture of gases is

A. obtained by multiplying the individual pressures by the number of moles and averaging.
B. the sum of the partial pressures of the components.
C. dependent only upon the pressure of the gas which is present to the greatest extent.
D. the product of the individual pressures.
E. none of these.

25. A real gas will behave most like an ideal gas under conditions of _____.

A. high temperature and high pressure
B. high temperature and low pressure
C. low temperature and high pressure
D. low temperature and low pressure
E. STP

CONVERSION FACTORS

1 liter = 1000 mL 1 cm^3 = 1 ml 1 Lit●atm = 101.3 J

FORMULAS and CONSTANTS

Avogadro's Number = 6.02 x 10^{23} particles/mole

General Formulas

$$D = \frac{M}{V} \qquad M = \frac{\text{mole}}{\text{L}}$$

$$Mole = \frac{g}{molar\ mass} \qquad \text{mole} = \frac{\text{number of particles}}{6.02 \times 10^{23}}$$

$$\%\ A = \frac{amount\ A}{total\ amount}\ x\ 100$$

gram ---(÷ MW or AW)---> mole ---(x 6.02 x 10^{23})---> molecule ---(x subscript)---> atoms

atoms ---(÷ subscript)---> molecules ---(÷ 6.02 x 10^{23})---> mole ---(x MW or AW)---> grams

Grams A ---(÷ AW or MW)---> mole A ---(coefficients of balanced equation)---> mole B ---(x AW or MW)---> grams B

$$M_I V_I = M_F V_F$$

$$Molarity\ (M) = \frac{mole\ solute}{L\ solution} = \frac{mole}{L} \qquad mole = M\ x\ L \qquad L = \frac{mole}{M}$$

CHAPTER 10 Formulas Gases

PV = nRT $\frac{P_2V_2}{P_1V_1} = \frac{n_2RT_2}{n_1RT_1}$

$$molar\ mass = \frac{gRT}{PV} \qquad D = \frac{PM}{RT} \quad (where\ M\ is\ molar\ mass)$$

$$mole\ Fraction\ A\ (X_a) = \frac{mole\ A}{Total\ mole} = \frac{n_a}{n_{total}} = \frac{P_a}{P_{total}}$$

$$P_a = \chi_a P_{total}$$

Chapter 9 Formulas Thermochemistry

$\Delta E = q + w$ $\quad\quad$ $w = -P\Delta V$

q = (number of grams)(specific heat)(ΔT) $\quad\quad$ q = (heat capacity)(ΔT)

$\Delta H^{o}_{rx} = \sum \Delta H^{o}_{f}(products) - \sum \Delta H^{o}_{f}(reactants)$ $\quad\quad$ $q = (\Delta H_{vap})(Amount)$

Density of water = 1 g/mL or 1 g/cm^3 $\quad\quad$ $q = (\Delta H_{fus})(Amount)$