Exam 3 **Duration: 50 minutes**

Directions: *Mark your answer on the Scantron Sheet. Find the periodic table in the last page of the exam.*

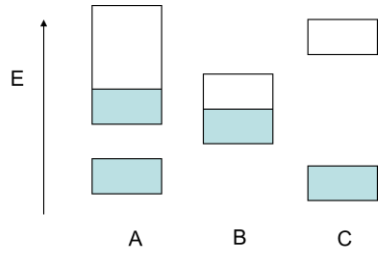
(1) Calculate the total volume occupied by atoms in a fcc (face-centered cubic) unit cell?
a) 24 л r^3
b) 8/3 л r^3
c) 16/3 л r^3
d) 22.63 r^3
e) 26.23 r^3

(2) In the sea of the electron model for **Calcium**, what is the charge of the cores?
a) +8
b) +20
c) +2
d) +3
e) +18

(3) If silver atoms follow a face-centered cubic unit cell pattern, what is the edge length of this unit cell if the atomic radius is 104.4 pm?
a) 104.4 pm
b) 408.3 pm
c) 179.6 pm
d) 295.2 pm
e) 345.6 pm

(4) Doping pure silicon with **Arsenic** results in a(n) _____ material.
a) p-type
b) n-type
c) s-type
d) d-type
e) f-type

(5) Which of these band diagram/s is consistent with graphite being an insulator?



a) A only
b) B only
c) C only
d) A and C only
e) A and B only

(6) Which of the following statements is true of dipole–dipole interactions?

a) They are based on transient dipoles
b) They are also referred to as instantaneous dipole–induced dipole forces
c) They are stronger than dispersion forces
d) They are the weakest intermolecular forces
e) They are also referred to as London forces

(7) In which of the following molecules are you likely to observe hydrogen bonding?

a) NaF
b) $C_2H_4F_2$
c) CH_3CH_2OH
d) Na_2O
e) $C_8H_{17}Br$

(8) An engineering student reaches for his favorite granola bar while working on an OWL homework assignment. If the granola bar contains 185 calories, how much energy (in joules) will the student receive from the bar?

a) 1004 J
b) 774 J
c) 4200 J
d) 873 J
e) 572 J

(9) What is the kinetic energy of a single He atom traveling at 2.8×10^4 m/s?

a) 1.3×10^{-18} J
b) 6.4×10^{-18} J
c) 2.6×10^{-18} J
d) 7.7×10^{-18} J
e) 6.4×10^{-18} J

(10) Calculate the work energy, w, gained or lost by the system when a gas expands from 15 L to 55 L against a constant external pressure of 1.5 atm. [1 L · atm = 101 J]

a) -5.3 kJ
b) -3.0 kJ
c) +3.0 kJ
d) +6.1 kJ
e) - 6.1 kJ

(11) How much heat is absorbed/released when 20.00 g of $NH_3(g)$ reacts in the presence of excess $O_2(g)$ to produce $NO(g)$ and $H_2O(l)$ according to the following chemical equation?

$4\ NH_3(g) + 5\ O_2(g) \rightarrow 4\ NO(g) + 6\ H_2O(l) \quad \Delta H° = +1168$ kJ

a) 342.9 kJ of heat are absorbed.
b) 342.9 kJ of heat are released.
c) 1372 kJ of heat are absorbed.
d) 1372 kJ of heat are released.

(12) Given: $S(s) + O_2(g) \rightarrow SO_2(g)$ $\Delta H° = -396.1$ kJ

$2\ SO_3(g) \rightarrow 2\ SO_2(g) + O_2(g)$ $\Delta H° = 298.2$ kJ

Find $\Delta H°$ for : $2\ S(s) + 3\ O_2(g) \rightarrow 2\ SO_3(g)$

a) -790.4 kJ
b) -1090.4 kJ
c) -970.9 kJ
d) +970.9 kJ
e) +1090.4 kJ

(13) What is the standard molar enthalpy change ΔH_{rxn} for the following reactions using the standard molar enthalpies of formations provided?

$SiCl_4(\ell) + 2\ H_2O(\ell) \rightarrow SiO_2(s) + 4\ HCl(g)$ $\Delta H_{rxn} = ???$

$\Delta H°_f(SiCl_4) = -540.1$ kJ/mol
$\Delta H°_f(SiO_2) = -810.9$ kJ/mol
$\Delta H°_f(H_2O) = -285.8$ kJ/mol
$\Delta H°_f(HCl) = -192.3$ kJ/mol

a) -1091.8 kJ
b) -1929.1 kJ
c) -468.4 kJ
d) -68.4 kJ
e) None of these

(14) Given the following thermochemical equations and their corresponding enthalpies:

$2\ C_2H_2(g) + 5\ O_2(g) \rightarrow 4\ CO_2(g) + 2\ H_2O(\ell)$ $\Delta H = -2601$ kJ
$C_8H_8(\ell) + 10\ O_2(g) \rightarrow 8\ CO_2(g) + 4\ H_2O(\ell)$ $\Delta H = -4393$ kJ

What is the enthalpy change for the following reaction?

$4\ C_2H_2(g) \rightarrow C_8H_8(\ell)$ $\Delta H = ?$

a) -1792 kJ
b) -809 kJ
c) -6994 kJ
d) -9595 kJ
e) None of these

(15) During melting of a molecular compound, there is no temperature increase because the heat energy is used to,

a) increase the velocity of the molecules
b) break covalent bonds within the molecules
c) rearrange atoms within the molecules

d) break intermolecular forces between molecules
e) decrease the velocity of the atoms

(16) Which species functions as the reducing agent in the following reduction-oxidation reaction:

$Zn(s) + Cu^{2+}(aq) \rightarrow Cu(s) + Zn^{2+}(aq)$.

a) $Cu(s)$
b) $Cu^{2+}(aq)$
c) $Zn(s)$
d) $Zn^{2+}(aq)$
e) None of these

(17) Identify the balanced chemical equation for the following cell:

$$Al(s)\,|\,Al^{3+}\,\|\,Hg^{2+}\,|\,Hg(l)$$

a. $Al(s) + Hg^{2+}(aq) \rightarrow 2\ Al^{3+}(aq) + Hg(l)$
b. $2\ Al(s) + 3\ Hg^{2+}(aq) \rightarrow 2\ Al^{3+}(aq) + 3\ Hg(l)$
c. $Al(s) + 3\ Hg^{2+}(aq) \rightarrow Al^{3+}(aq) + 3\ Hg(l)$
d. $2\ Al(s) + Hg^{2+}(aq) \rightarrow 2\ Al^{3+}(aq) + Hg(l)$

(18) What is the cell potential (E^0) for a galvanic cell formed from the following two half-reactions?

$Cu^{2+}(aq) + 2\ e^- \rightleftarrows Cu(s)$ $\quad E^0 = 0.307$ V
$Al^{3+}(aq) + 3\ e^- \rightleftarrows Al(s)$ $\quad E^0 = -1.76$ V

a) +2.31 V
b) +2.07 V
c) -1.32 V
d) -2.00 V
e) +3.31V

(19) Which change is likely to be accompanied by an increase in entropy?

a) $N_2(g) + 3H_2(g) \longrightarrow 2NH_3(g)$
b) $Br_2(l) + H_2(g) \longrightarrow 2HBr(g)$
c) $Ag^+(aq) + Cl^-(aq) \longrightarrow AgCl(s)$
d) $H_2O(g) \longrightarrow H_2O(l)$
e) $NaCl(l) \longrightarrow NaCl(s)$

(20) The dissolution of calcium chloride is an exothermic process.

$$CaCl_2(s) \longrightarrow Ca^{2+}(aq) + 2Cl^-(aq)$$

When a sample of $CaCl_2$ dissolves in water,

a) the value of ΔH is negative and the temperature of the water will decrease
b) the value of ΔH is negative and the temperature of the water will increase
c) the value of ΔH is positive and the temperature of the water will decrease
d) the value of ΔH is positive and the temperature of the water will increase

(21) Identify the spontaneous process,

a) Oxygen molecules dissociate to form oxygen atoms
b) A warm cup of coffee cooling to room temperature
c) A tray of water is placed in the sun on a warm day and freezes
d) A group of cheerleaders builds a human pyramid
e) Sulfuric acid sitting in a beaker turns into water by giving off gaseous SO_3

(22) If a 5.0 L flask holds 0.125 moles of nitrogen at STP, what happens to the entropy of the system upon cooling the gas to -75 °C?

a) The entropy increases
b) The entropy remains the same
c) The entropy decreases
d) The given information is not enough to assess the change
e) The entropy change is negligible

(23) Calculate ΔS° for the following reaction:

$$SO_3(g) + CaO(s) \rightarrow CaSO_4(s).$$

ΔS° in J/moles K for $CaO(s)$ is 60, for $SO_3(g)$ is 256.6, and for $CaSO_4(s)$ is 207.

a) +404 J/K
b) -323 J/K
c) -110 J/K
d) +98 J/K
e) +218 J/K

(24) Which of the following is the strongest of all intermolecular interactions?

a) London forces
b) Covalent bonding
c) Instantaneous dipole-induced dipole forces
d) Hydrogen bonding
e) Dipole-dipole interactions

(25) A salt bridge between half-reactions maintains the electrical balance of a galvanic cell. This bridge is filled with:

a) a weak electrolyte
b) inert carbon
c) inert helium
d) a strong electrolyte
e) a biodegradable polymer