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

1) Calculate the change in internal energy ($\Delta E$) for a system that is giving off 25.0 kJ of heat and is changing from 12.00 L to 6.00 L in volume at 1.50 atm pressure. (Remember that 101.3 J = 1 L·atm)
   
   \[ \Delta E = \text{heat} + \text{volume work} \]
   
   A) $+25.9 \text{kJ}$  
   B) $937 \text{kJ}$  
   C) $-16.0 \text{kJ}$  
   D) $-24.1 \text{kJ}$  
   E) $-25.9 \text{kJ}$

2) Calculate the amount of heat (in kJ) required to raise the temperature of a 79.0 g sample of ethanol from 298 K to 385 K. The specific heat capacity of ethanol is 2.42 J/g°C.
   
   \[ q = m \cdot c \cdot (T_f - T_i) \]
   
   A) 28.4 kJ  
   B) 12.9 kJ  
   C) 16.6 kJ  
   D) 57.0 kJ  
   E) 73.6 kJ

3) Calculate the wavelength (in nm) of a the red light emitted by a neon sign with a frequency of $4.74 \times 10^{14}$ Hz.
   
   \[ \lambda = \frac{c}{f} \]
   
   A) 633 nm  
   B) 466 nm  
   C) 142 nm  
   D) 704 nm  
   E) 158 nm

4) How much energy is evolved during the reaction of 48.7 g of Al, according to the reaction below? Assume that there is excess Fe$_2$O$_3$.
   
   \[ \text{Fe}_2\text{O}_3(s) + 2 \text{Al}(s) \rightarrow \text{Al}_2\text{O}_3(s) + 2 \text{Fe}(s) \quad \Delta H^\circ_{\text{rxn}} = -852 \text{kJ} \]
   
   A) 207 kJ  
   B) 130 kJ  
   C) 415 kJ  
   D) 769 kJ  
   E) 241 kJ

5) Determine the specific heat capacity of an alloy that requires 59.3 kJ to raise the temperature of 150.0 g alloy from 298 K to 398 K.
   
   \[ c = \frac{q}{m \cdot (T_f - T_i)} \]
   
   A) 4.38 J/g°C  
   B) 1.87 J/g°C  
   C) 2.53 J/g°C  
   D) 2.29 J/g°C  
   E) 3.95 J/g°C

6) Use the $\Delta H^\circ_f$ information provided to calculate $\Delta H^\circ_{\text{rxn}}$ for the following:

   \[ \begin{align*}
   \Delta H^\circ_f (\text{kJ/mol}) & \quad \text{SO}_2\text{Cl}_2 (g) + 2 \text{H}_2\text{O}(l) \rightarrow 2 \text{HCl}(g) + \text{H}_2\text{SO}_4(l) \\
   \Delta H^\circ_{\text{rxn}} = \ ? \\
   \text{SO}_2\text{Cl}_2(g) & \quad -364 \\
   \text{H}_2\text{O}(l) & \quad -286 \\
   \text{HCl}(g) & \quad -92 \\
   \text{H}_2\text{SO}_4(l) & \quad -814
   \end{align*} \]

   \[ \Delta H^\circ_{\text{rxn}} = \ ? \]
   
   A) $+161 \text{kJ}$  
   B) $-422 \text{kJ}$  
   C) $+800. \text{kJ}$  
   D) $-62 \text{kJ}$  
   E) $-256 \text{kJ}$
7) How many photons are contained in a burst of yellow light (589 nm) from a sodium lamp that contains 609 kJ of energy?
   A) $3.06 \times 10^{30}$ photons
   B) $1.81 \times 10^{24}$ photons
   C) $4.03 \times 10^{28}$ photons
   D) $3.37 \times 10^{19}$ photons
   E) $2.48 \times 10^{25}$ photons

8) Give the ground state electron configuration for Se.
   A) [Ar]4s$^2$3d$^{10}$
   B) [Ar]3d$^{10}$4p$^4$
   C) [Ar]4s$^2$3d$^{10}$4p$^4$
   D) [Ar]4s$^2$3d$^{10}$4p$^6$
   E) [Ar]4s$^2$4d$^{10}$4p$^4$

9) Use the standard reaction enthalpies given below to determine $\Delta H^{\circ}_{\text{rxn}}$ for the following reaction:
   \[ \text{P}_4(g) + 10 \text{Cl}_2(g) \rightarrow 4\text{PCl}_5(s) \]
   $\Delta H^{\circ}_{\text{rxn}} = ?$

   Given:
   \[ \text{PCl}_5(s) \rightarrow \text{PCl}_3(g) + \text{Cl}_2(g) \]
   $\Delta H^{\circ}_{\text{rxn}} = +157 \text{ kJ}$
   \[ \text{P}_4(g) + 6 \text{Cl}_2(g) \rightarrow 4 \text{PCl}_3(g) \]
   $\Delta H^{\circ}_{\text{rxn}} = -1207 \text{ kJ}$

   A) -1786 kJ  B) -1835 kJ  C) -2100 kJ  D) -1364 kJ  E) -1050 kJ

10) Calculate the energy change associated with the transition from $n=4$ to $n=1$ in the hydrogen atom.
    A) $2.04 \times 10^{-19}$ J
    B) $6.12 \times 10^{-19}$ J
    C) $1.64 \times 10^{-19}$ J
    D) $3.55 \times 10^{-19}$ J
    E) $4.89 \times 10^{-19}$ J
11) Give the set of four quantum numbers that represent the last electron added (using the Aufbau principle) to the Cl atom.

A) \( n = 3, l = 1, m_l = 1, m_s = + \frac{1}{2} \)

B) \( n = 2, l = 1, m_l = 0, m_s = - \frac{1}{2} \)

C) \( n = 3, l = 1, m_l = 0, m_s = - \frac{1}{2} \)

D) \( n = 3, l = 0, m_l = 0, m_s = - \frac{1}{2} \)

E) \( n = 3, l = 2, m_l = 1, m_s = + \frac{1}{2} \)

12) How many valence electrons does an atom of S have?

A) 3  
B) 6  
C) 4  
D) 1  
E) 2

13) Each of the following sets of quantum numbers is supposed to specify an orbital. Which of the following sets of quantum numbers contains an error?

A) \( n = 4, l = 2, m_l = 0 \)

B) \( n = 2, l = 1, m_l = -1 \)

C) \( n = 3, l = 3, m_l = -2 \)

D) \( n = 3, l = 0, m_l = 0 \)

E) \( n = 1, l = 0, m_l = 0 \)

14) How many different values of \( m_l \) are possible in the 3d sublevel?

A) 3  
B) 7  
C) 1  
D) 2  
E) 5

15) Give the ground state electron configuration for the ion of Ba.

A) \([\text{Kr}]5s^25p^6\)

B) \([\text{Kr}]5s^24d^{10}5p^66s^26p^2\)

C) \([\text{Kr}]5s^24d^{10}5p^66s^2\)

D) \([\text{Kr}]5s^24d^{10}5p^6\)

E) \([\text{Kr}]5s^24d^{10}5p^66s^1\)

16) What period 3 element is described by the following ionization energies (all in kJ/mol)?

\[ IE_1 = 1012 \quad IE_2 = 1900 \quad IE_3 = 2910 \quad IE_4 = 4960 \quad IE_5 = 6270 \quad IE_6 = 22,200 \]

A) S  
B) P  
C) Cl  
D) Mg  
E) Si
Answer Key
Testname: TRO E3 REVIEW

1) D
2) C
3) A
4) D
5) E
6) D
7) B
8) C
9) B
10) A
11) C
12) B
13) C
14) E
15) D
16) B