1. There are 140 Calories in the average 12-ounce soft drink. If an individual uses $4.2 \times 10^2$ kJ of energy to run one mile, how far does the athlete need to run to “burn” 140 Calories? (1 Calorie = 4184 J)

A. 1.1 miles  
B. 2.8 miles  
C. 1.4 miles  
D. 27 miles

2. The laws of conservation of energy state that energy can be neither created nor destroyed, but energy changes its form. Which of the following statements is correct concerning this figure?

A. The billiard ball gains potential energy once it is dropped.  
B. The kinetic energy of the billiard ball is converted to potential energy.  
C. The billiard table loses energy once the billiard ball strikes it.  
D. The billiard ball loses potential energy once it is dropped.

3. A gas sample is compressed from an initial volume of 5.55 L to a final volume of 1.22 L by an external pressure of 1.00 atm. During the compression, the gas releases 125 J of heat. What is the change in internal energy ($\Delta E$) of the gas? (1 L·atm = 101.3 J)

A. $-425$ J  
B. $314$ J  
C. $-301$ J  
D. $425$ J
4. A 2.7 kg Pyrex glass casserole dish is placed in an oven and heated from 25° C to 260° C. How much energy did the casserole dish absorb? The specific heat of Pyrex glass is 0.75 J/g·°C.

A. \(2.7 \times 10^4\) J  
B. \(4.8 \times 10^5\) J  
C. \(8.8 \times 10^5\) J  
D. \(6.3 \times 10^7\) J

5. A 376-gram gold nugget at 55 °C is dropped into 190. mL of water at 25 °C. What is the final temperature when the gold and water reach thermal equilibrium?

- Specific heat of gold = 0.128 J/g·°C
- Specific heat of water = 4.18 J/g·°C
- Density of water = 1.00 g/mL

A. 60. °C  
B. 55 °C  
C. 27 °C  
D. 23 °C
6. Heat \((q)\) is absorbed by the **system** in which of the following processes?

I. sweat (the system) evaporating from skin
II. a swollen ankle (the system) wrapped in an ice pack
III. an ice cube tray filled with liquid water (the system) then placed in the freezer

A. I only  
B. II only  
C. I and III  
D. I, II, and III

7. Determine \(\Delta H\) for the reaction

\[
C_2H_4(g) + 6 F_2 (g) \rightarrow 2 CF_4(g) + 4 HF(g)
\]

given the following data:

\[
\begin{align*}
H_2(g) + F_2(g) \rightarrow 2 HF(g) & \quad \Delta H_{\text{rxn}} = -537 \text{ kJ} \\
2 C(s) + 2 H_2(g) \rightarrow C_2H_4(g) & \quad \Delta H_{\text{rxn}} = +52 \text{ kJ} \\
CF_4(g) \rightarrow C(s) + 2 F_2(g) & \quad \Delta H_{\text{rxn}} = +680 \text{ kJ}
\end{align*}
\]

A. \(-2486 \text{ kJ}\)  
B. \(-1066 \text{ kJ}\)  
C. \(222 \text{ kJ}\)  
D. \(486 \text{ kJ}\)
8. The enthalpy change of which reaction is a standard enthalpy of formation, $\Delta H^\circ_f$?

A. $\text{Mg}(s) + \text{C}(s) + \frac{3}{2} \text{O}_2(g) \rightarrow \text{MgCO}_3(s)$
B. $\text{Mg}^{2+}(aq) + \text{CO}_3^{2-}(aq) \rightarrow \text{MgCO}_3(s)$
C. $\text{Na}(s) + 2 \text{H}(g) + 3 \text{O}(g) \rightarrow \text{NaHCO}_3(s)$
D. $\text{C}(s) + \text{H}_4(g) \rightarrow \text{CH}_4(g)$

9. Using the following information, what is the enthalpy, $\Delta H^\circ_{\text{rxn}}$, of the following reaction?

\[ \text{C}(s) + \text{H}_2\text{O}(g) \rightarrow \text{CO}(g) + \text{H}_2(g) \]

<table>
<thead>
<tr>
<th>Substance</th>
<th>$\Delta H^\circ_f$ (kJ/mol)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\text{H}_2\text{O}(g)$</td>
<td>$-241.8$</td>
</tr>
<tr>
<td>$\text{H}_2\text{O}(l)$</td>
<td>$-285.8$</td>
</tr>
<tr>
<td>$\text{CO}(g)$</td>
<td>$-110.5$</td>
</tr>
</tbody>
</table>

A. $-125.4$ kJ
B. $-133.4$ kJ
C. $131.3$ kJ
D. $170.3$ kJ

10. An orange laser emits light at a frequency of $4.62 \times 10^{14}$ Hz. What is the wavelength of the emitted light?

A. $649$ nm
B. $677$ nm
C. $550$ nm
D. $498$ nm
11. What is the energy of one mole of photons with a wavelength of 400. nm?
   A. $5.69 \times 10^5$ J
   B. $3.08 \times 10^5$ J
   C. $3.77 \times 10^5$ J
   D. $2.99 \times 10^5$ J

12. Consider this figure of the Bohr model of the atom. Which electronic transition will emit a photon with the **shortest** wavelength?
   A. A
   B. B
   C. C
   D. D

13. What is the de Broglie wavelength of an electron traveling at $1.35 \times 10^5$ m/s? The mass of an electron is $9.11 \times 10^{-31}$ kg.
   A. $3.08 \times 10^{-6}$ m
   B. $8.88 \times 10^{-6}$ m
   C. $5.39 \times 10^{-9}$ m
   D. $7.62 \times 10^{-6}$ m
14. When an electron has the principal quantum number $n = 3$, which of the following statements is correct?

A. The electron can only occupy an $f$ orbital.
B. The electron can only occupy a $d$ orbital.
C. The electron is lower in energy than an electron that has the principal quantum number $n = 2$.
D. The electron is located in an $s$, $p$, $d$, or $f$ orbital.

15. What is the maximum number of electrons that an $n = 2$ shell can hold?

A. 2          C. 8
B. 4          D. 16

16. What are the allowed values of $n$ and $m_l$ for an electron in a 4$d$ orbital?

A. $n = 3; m_l = -3, -2, -1, 0, +1, +2, or +3$
B. $n = 4; m_l = -2, -1, 0, +1, or +2$
C. $n = 3, 2, 1, or 0; m_l = -3, -2, -1, 0, +1, +2, or +3$
D. $n = 4; m_l = -4, -3, -2, -1, 0, +1, +2, +3, or +4$

17. What wavelength of light is emitted when an electron in a hydrogen atom makes a transition from an $n = 5$ to an $n = 3$ shell?

A. 1282 nm     C. 2288 nm
B. 1555 nm     D. 6044 nm
18. Which one of the following orbitals could have the quantum numbers \( n = 4, l = 1 \)?

A. 

B. 

C. 

D. 

19. What is the electronic configuration of carbon?

A. \( 1s^22s^22p^4 \)

B. \( 1s^22s^22p^2 \)

C. \( 1s^22s^22p^6 \)

D. \( 1s^22p^4 \)

20. Which set of four quantum numbers best represents the highest energy electron in a tin atom?

A. \( n = 4, l = 3, m_l = -1, m_s = +\frac{1}{2} \)

B. \( n = 4, l = 1, m_l = -1, m_s = +\frac{1}{2} \)

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

D. \( n = 5, l = 1, m_l = 0, m_s = +\frac{1}{2} \)
21. How many valence electrons are in a neutral sulfur atom?
   A. 2  C. 6
   B. 4  D. 8

22. What is the electronic configuration of chromium?
   A. [Ar]4s²3d⁴  C. [Ar]4s²4d⁴
   B. [Kr]4s²3d⁴  D. [Ar]4s¹3d⁵

23. Which pair of elements has the element with the smaller atomic radius listed first?
   A. In, Al  C. Si, N
   B. Sn, Se  D. F, C

24. Which of the following cations is diamagnetic in the ground state?
   A. Fe²⁺  C. Fe³⁺
   B. Cr⁶⁺  D. Cr³⁺

25. Which pair of elements has the element with the higher first ionization energy listed first?
   A. Br, Bi  C. Rb, Na
   B. Sn, P  D. Si, Cl
Answer Key:

1. C
2. D
3. B
4. B
5. C
6. A
7. A
8. A
9. C
10. A
11. D
12. A
13. C
14. D
15. C
16. B
17. A
18. B
19. B
20. D
21. C
22. D
23. D
24. B
25. A