1. Calculate $\Delta H$ for the reaction: $3\text{O}_2(\text{g}) + 4\text{NH}_3(\text{g}) \rightarrow 2\text{N}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})$, given the following data:

   1. $2\text{NH}_3(\text{g}) \rightarrow \text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \quad \Delta H = 92 \text{ kJ}$
   2. $2\text{H}_2\text{O}(\text{g}) \rightarrow 2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \quad \Delta H = 484 \text{ kJ}$

   a) $-1636 \text{ kJ}$   b) $1636 \text{ kJ}$   c) $-1268 \text{ kJ}$   d) $-1360 \text{ kJ}$   e) $-392 \text{ kJ}$

2. Given the following enthalpies of formation, determine the heat involved when a 2.10 mol sample of methane is reacted with excess chlorine gas at constant pressure according to the following balanced equation:

   $\text{CH}_4(\text{g}) + 4\text{Cl}_2(\text{g}) \rightarrow \text{CCl}_4(\text{l}) + 4\text{HCl}(\text{g})$

   $\Delta H^0_f$ (kJ/mol) $-75$ $-135$ $-92$

   a) $428 \text{ kJ}$ are released   b) $899 \text{ kJ}$ are released   c) $899 \text{ kJ}$ are absorbed   d) $1210 \text{ kJ}$ are released   e) $1210 \text{ kJ}$ are absorbed

3. A 30.0-g sample of a liquid at 15.0°C is mixed with a 55.0-g sample of the same liquid at 80.0°C. Assuming the heat capacity of the liquid is independent of temperature, determine the final temperature.

   a) $37.4^\circ\text{C}$   b) $47.5^\circ\text{C}$   c) $51.3^\circ\text{C}$   d) $57.1^\circ\text{C}$   e) $62.7^\circ\text{C}$

4. Consider the endothermic reaction $\text{A}_2(\text{g}) + \text{B}_2(\text{g}) \rightarrow 2\text{AB}(\text{g})$. Which of the following correctly describes which are more stable and which have higher average bond energies?

<table>
<thead>
<tr>
<th>More stable</th>
<th>Higher average bond energies</th>
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<tbody>
<tr>
<td>a) Reactants</td>
<td>Reactants</td>
</tr>
<tr>
<td>b) Reactants</td>
<td>Products</td>
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<tr>
<td>c) Products</td>
<td>Products</td>
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<tr>
<td>d) Products</td>
<td>Reactants</td>
</tr>
</tbody>
</table>

5. Calculate $\Delta E$ for a system that releases 28 J of heat while 63 J of work is done on it.

   a) $35 \text{ J}$   b) $91 \text{ J}$   c) $-35 \text{ J}$   d) $-91 \text{ J}$   e) $28 \text{ J}$
6. Which of the following has the highest ionization energy?

   a) Mg  b) Mg\(^+\)  c) Mg\(^{2+}\)  d) Mg\(^{3+}\)  e) all the same

7. Which of the following does not correctly match the species with the expected electron configuration?

   a) A ground state calcium atom [Ar] 4s\(^2\)
   b) The most stable ion for bromine [Ar] 4s\(^7\)3d\(^{10}\)4p\(^6\)
   c) An excited state of sulfur [Ne] 3s\(^2\)3p\(^3\)4s\(^1\)
   d) At least two of the above (a-c) are incorrectly matched.
   e) All of the above (a-c) are correctly matched.

8. How many unpaired electrons are expected in the ground state phosphorus atom?

   a) 1  b) 2  c) 3  d) 4  e) 5

9. How many electrons can be described by the quantum numbers \(n = 4, l = 3, m_s = -\frac{1}{2}\)?

   a) 2  b) 7  c) 10  d) 14  e) 32

10. Consider the following orderings.

    I. Al < Si < P < Cl
    II. Be < Mg < Ca < Sr
    III. I < Br < Cl < F
    IV. Na\(^+\) < Mg\(^{2+}\) < Al\(^{3+}\) < Si\(^{4+}\)

    How many of these give(s) a correct trend in ionization energy?

    a) 0  b) 1  c) 2  d) 3  e) 4