

This print-out should have 8 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. The due time is Central time.

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**Msci 15 0402**

19:09, general, multiple choice, > 1 min, fixed.

**001**

A 0.10 g piece of chocolate cake is combusted with oxygen in a bomb calorimeter. The temperature of 4000 g of H<sub>2</sub>O in the calorimeter is raised by 0.32 K. (The specific heat of the water is 1.0 cal/g·K and the heat of vaporization of water is 540 cal/g.) What is  $\Delta E$  for the combustion of chocolate cake? Assume no heat is absorbed by the calorimeter.

1. -3900 kcal/g
2. -460 kcal/g
3. -12.8 kcal/g **correct**
4. -532 kcal/g
5. -13.3 kcal/g

**Explanation:**

$$m_{\text{water}} = 4000 \text{ g} \qquad m_{\text{cake}} = 0.10 \text{ g}$$

$$T = 0.32 \text{ K} \qquad \Delta H_{\text{vap}} = 540 \text{ cal/g}$$

$$\text{SH} = 1.0 \text{ cal/g}\cdot\text{K}$$

The amount of heat responsible for the increase in water temperature for 4000 g of water is

$$q = \left(\frac{1 \text{ cal}}{\text{g}\cdot\text{K}}\right)(4000 \text{ g})(0.32 \text{ K}) = 1280 \text{ cal}$$

The amount of heat released by the reaction is thus 1280 cal. There were 0.10 g of cake, so

$$\left(\frac{-1280 \text{ cal}}{0.10 \text{ g}}\right)\left(\frac{\text{kcal}}{1000 \text{ cal}}\right) = -12.8 \text{ kcal/g}$$

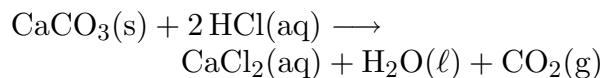
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**ChemPrin3e 06 58**

19:15, general, multiple choice, > 1 min, fixed.

**002**

Calculate the standard reaction enthalpy for the reaction of calcite with hydrochloric acid



The standard enthalpies of formation are:

- for CaCl<sub>2</sub>(aq) : -877.1 kJ/mol;
- for H<sub>2</sub>O(ℓ) : -285.83 kJ/mol;
- for CO<sub>2</sub>(g) : -393.51 kJ/mol;
- for CaCO<sub>3</sub>(s) : -1206.9 kJ/mol;
- and for HCl(aq) : -167.16 kJ/mol.

1. -165 kJ/mol
2. -116 kJ/mol
3. -215 kJ/mol
4. -15.2 kJ/mol **correct**
5. -38.2 kJ/mol
6. -72.7 kJ/mol
7. -98.8 kJ/mol

**Explanation:**

We use Hess' Law:

$$\begin{aligned} \Delta H^\circ &= \sum n \Delta H_{\text{j,prod}}^\circ - \sum n \Delta H_{\text{j,react}}^\circ \\ &= \Delta H_{\text{f,CaCl}_2(\text{aq})}^\circ + \Delta H_{\text{f,H}_2\text{O}(\ell)}^\circ \\ &\quad + \Delta H_{\text{f,CO}_2(\text{g})}^\circ - \left[ \Delta H_{\text{f,CaCO}_3(\text{s})}^\circ \right. \\ &\quad \left. + 2 \left( \Delta H_{\text{f,HCl}(\text{aq})}^\circ \right) \right] \\ &= -877.1 \text{ kJ/mol} + (-285.83 \text{ kJ/mol}) \\ &\quad + (-393.51 \text{ kJ/mol}) \\ &\quad - \left[ -1206.9 \text{ kJ/mol} \right. \\ &\quad \left. + 2(-167.16 \text{ kJ/mol}) \right] \\ &= -15.22 \text{ kJ/mol}. \end{aligned}$$

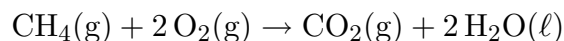
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**Rxn Work 01**

20:99, general, multiple choice, > 1 min, .

**003**

For the reaction



what is the approximate value of the work at 300 K?

1. +5 kJ **correct**
2. +2.5 kJ
3. +7.5 kJ
4. -5 kJ
5. -2.5 kJ
6. -7.5 kJ
7. No work is done.

**Explanation:**

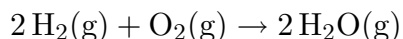
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### Balloon Explosion

20:50, general, multiple choice, < 1 min, .

**004**

What are signs, respectively, for free energy, enthalpy, entropy and work in the explosion of a hydrogen balloon according to the equation



1. -, -, -, + **correct**
2. -, +, -, +
3. +, -, -, +
4. -, -, -, -
5. -, +, -, -

**Explanation:**

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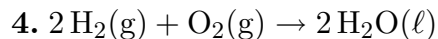
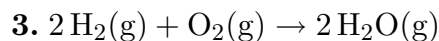
### Rxn Entropy

20:03, general, multiple choice, < 1 min, .

**005**

Which chemical reaction is most likely to have the smallest thermal entropy?

1.  $\text{CH}_4(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$  **correct**
2.  $\text{CH}_4(\text{g}) + 2 \text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\ell)$



**Explanation:**

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### Free Energy and Temp

20:05, general, multiple choice, < 1 min, .

**006**

Six moles of gas react exothermically to yield seven moles of gas products. What can be said about how the temperature of the reaction affects the free energy of the reaction?

1. The reaction occurs at any temperature. **correct**
2. The reaction cannot occur at any temperature.
3. The reaction will be more likely to occur at lower temperatures.
4. The reaction will be more likely to occur at higher temperatures.
5. Not enough information is given.

**Explanation:**

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### Positional Entropy 01

20:02, general, multiple choice, > 1 min, .

**007**

Which of the following has the largest positional entropy at 0 K?

1. three  $\text{BCl}_2\text{F}$  molecules **correct**
2. two  $\text{NH}_3$  molecules
3. eight  $\text{CCl}_4$  molecules
4. four  $\text{CO}$  molecules
5. sixteen  $\text{O}_2$  molecules

**Explanation:**

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### Translational Energy

19:19, general, multiple choice, > 1 min, .

**008**

What is the internal energy associated with the translation of six water molecules?

1. 9 kT **correct**

2. 6 kT

3. 9 RT

4. 3 RT

5. 18 kT

**Explanation:**