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.

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_2O 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 ΔE 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:

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

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

SH = 1.0 cal/g·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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19:15, general, multiple choice, > 1 min, fixed.

002

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

$$CaCO_3(s) + 2\,HCl(aq) \longrightarrow CaCl_2(aq) + H_2O(\ell) + CO_2(g)$$

The standard enthalpies of formation are:
for $CaCl_2(aq)$: −877.1 kJ/mol;
for $H_2O(\ell)$: −285.83 kJ/mol;
for $CO_2(g)$: −393.51 kJ/mol;
for $CaCO_3(s)$: −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:

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

Rxn Work 01

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

003

For the reaction

$$CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(\ell)$$

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:

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

$$2\,H_2(g) + O_2(g) \rightarrow 2\,H_2O(g)$$

1. −, −, −, + **correct**

2. −, +, −, +

3. +, −, −, +

4. −, −, −, −

5. −, +, −, −

Explanation:

Rxn Entropy

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

005

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

1. $CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(g)$ **correct**

2. $CH_4(g) + 2\,O_2(g) \rightarrow CO_2(g) + 2\,H_2O(\ell)$

3. $2\,H_2(g) + O_2(g) \rightarrow 2\,H_2O(g)$

4. $2\,H_2(g) + O_2(g) \rightarrow 2\,H_2O(\ell)$

Explanation:

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 effects 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:

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 BCl_2F molecules **correct**

2. two NH_3 molecules

3. eight CCl_4 molecules

4. four CO molecules

5. sixteen O_2 molecules

Explanation:

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: