

This print-out should have 30 questions. Multiple-choice questions may continue on the next column or page – find all choices before making your selection. The due time is Central time.

PLEASE remember to bubble in your name, student ID number, and version number on the scantron!

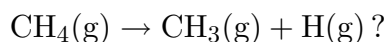
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**Msci 15 0906HS**

15:09, general, multiple choice, < 1 min, fixed.

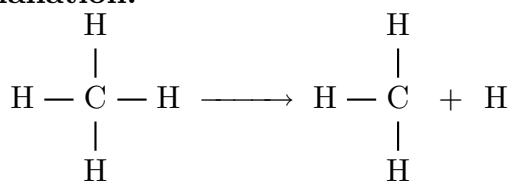
**001**

What would be the signs of  $\Delta H$  and  $\Delta S$ , for the reaction



- Both positive. **correct**
- $\Delta H = +$ ,  $\Delta S = -$
- $\Delta H = -$ ,  $\Delta S = +$
- Both negative.
- $\Delta H = +$ ,  $\Delta S = 0$
- $\Delta H = -$ ,  $\Delta S = 0$
- $\Delta H = 0$ ,  $\Delta S = +$
- $\Delta H = 0$ ,  $\Delta S = -$
- Both 0.
- Impossible to tell from the information given.

**Explanation:**



$$\begin{aligned} \Delta H^0_{\text{rxn}} &= \sum \text{B.E.}_{\text{rct}} - \sum \text{B.E.}_{\text{prod}} \\ &= [4(\text{C} - \text{H})] - [3(\text{C} - \text{H})] \\ &= (\text{C} - \text{H}) \\ &= 414 \text{ kJ/mol} \end{aligned}$$

$\Delta H$  is positive (endothermic, net bond breaking).

$\Delta S$  is also positive because the randomness of the system has increased. (1 mole of gaseous reactants forms 2 moles of gaseous products.)

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**Msci 15 0402**

15:10, general, multiple choice, > 1 min, fixed.

**002**

A 0.10 g piece of chocolate cake is combusted with oxygen in a bomb calorimeter. The temperature of 4000 g of  $\text{H}_2\text{O}$  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.

- 3900 kcal/g
- 460 kcal/g
- 12.8 kcal/g **correct**
- 532 kcal/g
- 13.3 kcal/g

**Explanation:**

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

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

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

$$\frac{-1280 \text{ cal}}{0.10 \text{ g}} \cdot \frac{\text{kcal}}{1000 \text{ cal}} = -12.8 \text{ kcal/g}$$

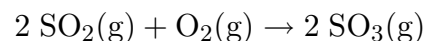
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**Mlib 05 0009**

15:06, basic, multiple choice, > 1 min, fixed.

**003**

Calculate the enthalpy change for the reaction



$$\Delta H_f \text{ for SO}_2(\text{g}) = -16.9 \text{ kJ/mol};$$

$$\Delta H_f \text{ for SO}_3(\text{g}) = -21.9 \text{ kJ/mol}.$$

$$1. -5.0 \text{ kJ/mol rxn}$$

$$2. -10.0 \text{ kJ/mol rxn correct}$$

$$3. +5.0 \text{ kJ/mol rxn}$$

$$4. -77.6 \text{ kJ/mol rxn}$$

$$5. +10.0 \text{ kJ/mol rxn}$$

**Explanation:**

$$\Delta H_f \text{ for O}_2(\text{g}) = 0 \text{ kJ/mol}$$

$$\begin{aligned} \Delta H_{\text{rxn}} &= \sum n \Delta H_f \text{ products} \\ &\quad - \sum n \Delta H_f \text{ reactants} \\ &= (2 \text{ mol})(-21.9 \text{ kJ/mol}) \\ &\quad - (2 \text{ mol})(-16.9 \text{ kJ/mol}) \\ &\quad - (1 \text{ mol})(0 \text{ kJ/mol}) \\ &= -10.0 \text{ kJ/mol rxn} \end{aligned}$$

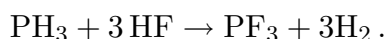
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**Mlib 75 0001**

15:99, basic, multiple choice, &gt; 1 min, fixed.

**004**

Based on the bond energies P–H = 321 kJ/mol, H–F = 568 kJ/mol, P–F = 490 kJ/mol, and H–H = 436 kJ/mol, estimate  $\Delta H$  for the gas-phase reaction



$$1. -111 \text{ kJ. correct}$$

$$2. +111 \text{ kJ.}$$

$$3. -37 \text{ kJ.}$$

$$4. +37 \text{ kJ.}$$

**Explanation:**

$$\begin{aligned} \Delta H &= \sum n \text{BE}_{\text{reactants}} \\ &\quad - \sum n \text{BE}_{\text{products}} \\ &= (3 \text{ mol})(321 \text{ kJ/mol}) \end{aligned}$$

$$+ (3 \text{ mol})(568 \text{ kJ/mol})$$

$$- (3 \text{ mol})(490 \text{ kJ/mol})$$

$$- (3 \text{ mol})(436 \text{ kJ/mol})$$

$$= -111 \text{ kJ}$$

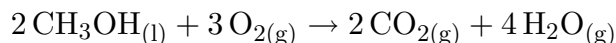
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**DAL 0301 01**

15:10, general, multiple choice, &lt; 1 min, fixed.

**005**

For the methanol combustion reaction



estimate the amount of  $P \Delta V$  work done and tell whether the work was done on or by the system. Assume a temperature of 27°C.

$$1. 2.5 \text{ kJ, work done on the system}$$

$$2. 2.5 \text{ kJ, work done by the system}$$

$$3. 7.5 \text{ kJ, work done on the system}$$

$$4. 7.5 \text{ kJ, work done by the system correct}$$

$$5. \text{ No work is done in this reaction.}$$

**Explanation:**

Considering only moles of gas,

$$\Delta n = n_f - n_i = (2 + 4) - 3 = 3.$$

$$27^\circ\text{C} + 273 = 300 \text{ K}$$

$$w = -\Delta n R T$$

$$= - (3 \text{ mol}) (8.314 \text{ J/mol} \cdot \text{K}) (300 \text{ K})$$

$$= -7500 \text{ J} = -7.5 \text{ kJ}$$

The system expands because  $\Delta n$  is positive, so the system does the work on the surroundings. Also, when  $w$  is negative, work is done by the system.

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**Msci 15 1435**

15:15, general, multiple choice, &gt; 1 min, fixed.

**006**

Which one of the following statements is not correct?

1. When  $\Delta G$  for a reaction is negative the reaction can occur spontaneously.

2. When  $\Delta G$  for a reaction is positive the reaction cannot occur spontaneously.

3. When  $\Delta G$  for a reaction is zero the system is at equilibrium.

4. When  $\Delta H$  for a reaction is negative the reaction can never occur spontaneously. **correct**

5. When  $\Delta H$  for a reaction is very positive the reaction will probably not occur spontaneously at lower temperatures.

### Explanation:

$\Delta G$  determines spontaneity.  $\Delta G$  is dependent on  $\Delta H$ ,  $T$  and  $\Delta S$  by the equation  $\Delta G = \Delta H - T \Delta S$ . If  $\Delta H$  is negative and  $\Delta S$  is positive,  $\Delta G$  will be negative and the process will occur spontaneously.

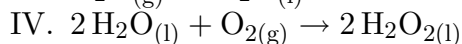
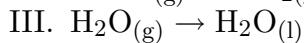
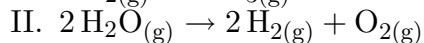
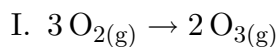
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### DAL 12 001

15:14, general, multiple choice, < 1 min, fixed.

**007**

For the four chemical reactions



which ones are likely to exhibit a positive  $\Delta S$ ?

1. II **correct**

2. I, III and IV

3. I and II

4. III and IV

5. all have a positive  $\Delta S$

### Explanation:

The Third Law of Thermodynamics states that the entropy of a perfect pure crystal at 0 K is 0. As disorder, randomness, and degrees of freedom increase, so does  $S$ . Entropy can increase by changing phase from solid to liquid to gas, and by increasing temperature, volume, or number of particles.

In reaction I, the final state has less gas particles (and thus less entropy) than the initial state. Therefore  $\Delta S$  is negative.

In reaction II, the final state has more gas particles (and thus more entropy) than the initial state. Therefore  $\Delta S$  is positive.

III describes a phase change. Gases have more degrees of freedom, randomness, and disorder (entropy) than liquids. The final state is a liquid and the initial state is a gas. Therefore  $\Delta S$  is negative.

In reaction IV, the final state has 0 gas particles and the initial state has 1 mole of gas particles. Therefore  $\Delta S$  is negative.

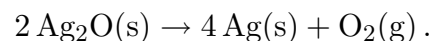
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### Msci 15 1412

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

**008**

Calculate  $\Delta G$  at 298 K for the reaction



Species	$\Delta H_f^\circ$ kJ/mol	$S^\circ$ J/mol·K
Ag(s)	0.0	42.55
Ag <sub>2</sub> O(s)	-30.57	121.7
O <sub>2</sub> (s)	0.0	205.0

1. 21.9 kJ/mol rxn **correct**

2. 38.2 kJ/mol rxn

3. 52.7 kJ/mol rxn

4. -69.85 kJ/mol rxn

5. 81.2 kJ/mol rxn

### Explanation:

$$\begin{aligned} \Delta H_{\text{rxn}}^0 &= \sum n \Delta H_{\text{f prod}}^0 - \sum n \Delta H_{\text{f rct}}^0 \\ &= 0 \text{ kJ/mol} \\ &\quad - 2(-30.57 \text{ kJ/mol}) \\ &= +61.14 \text{ kJ/mol} \end{aligned}$$

$$\Delta S_{\text{rxn}}^0 = \sum n \Delta S_{\text{f prod}}^0 - \sum n \Delta S_{\text{f rct}}^0$$

$$\begin{aligned}
 &= \left[ 4(42.55 \text{ J/mol} \cdot \text{K}) \right. \\
 &\quad \left. + (205.0 \text{ J/mol} \cdot \text{K}) \right] \\
 &\quad - 2(121.7 \text{ J/mol} \cdot \text{K}) \\
 &= 131.8 \text{ J/mol} \cdot \text{K} \cdot \frac{\text{kJ}}{1000 \text{ J}} \\
 &= 0.1318 \text{ kJ/mol} \cdot \text{K}
 \end{aligned}$$

$$\begin{aligned}
 \Delta G &= \Delta H - T \Delta S \\
 &= (+61.14 \text{ kJ/mol}) \\
 &\quad - 298 \text{ K}(0.1318 \text{ kJ/mol} \cdot \text{K}) \\
 &= 21.9 \text{ kJ/mol rxn}
 \end{aligned}$$

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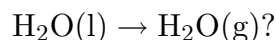
**Msci 15 1437**

15:14, general, multiple choice, &gt; 1 min, fixed.

**009**

At the normal boiling point of water,  $\Delta H_{\text{vap}} = 40 \text{ kJ/mole}$ .

What is the entropy change for



1. 107 J/mol·K **correct**
2. 40 kJ/mol·K
3. -40 kJ/mol·K
4. 10 J/mol·K
5. 400 J/mol·K

**Explanation:**

At standard phase change points  $\Delta G = 0$  because the process is in equilibrium.

$$\begin{aligned}
 \Delta G &= \Delta H - T \Delta S \\
 \Delta S &= \frac{\Delta H}{T} \\
 &= \frac{40 \text{ kJ}}{\text{mol}} \cdot \frac{1}{373 \text{ K}} \\
 &= 0.107 \text{ kJ/mol} \cdot \text{K} \\
 &= 107 \text{ J/mol} \cdot \text{K}
 \end{aligned}$$

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**Mlib 05 3053**

15:12, basic, multiple choice, &gt; 1 min, fixed.

**010**

The normal melting point for ice is 273 K.

Ice melting at atmospheric pressure and 274 K is

1. endothermic and nonspontaneous.
2. exothermic and nonspontaneous.
3. exothermic and spontaneous.
4. endothermic and spontaneous. **correct**

**Explanation:**

Melting requires energy input and is therefore endothermic. Water is liquid at 274 K, so ice will spontaneously melt to form liquid water at 274 K.

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**Msci 14 0202**

14:02, general, multiple choice, &gt; 1 min, fixed.

**011**

For which of the following ions would the hydration process give off the least heat?

1.  $\text{Al}^{3+}$
2.  $\text{Mg}^{+2}$
3.  $\text{Ba}^{+2}$
4.  $\text{K}^+$  **correct**
5.  $\text{Li}^+$

**Explanation:**

Small charge to radius ratio means that the hydration process will give off a small amount of heat. This term is smallest for  $\text{K}^+$ .

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**Msci 13 1002**

13:99, general, multiple choice, &gt; 1 min, fixed.

**012**

Which of the following is an example of an exothermic phase change?

1. ice melting in a glass of iced tea.
2. a sheet of paper burning.

3. water vapor condensing from the air on a cold window. **correct**

4. generation of electric power by falling water turning a turbine.

5. None of these is correct.

**Explanation:**

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**Mlib 04 1009**

12:09, basic, multiple choice, > 1 min, fixed.

**013**

A 4.40 g piece of solid CO<sub>2</sub> (dry ice) is allowed to vaporize (change to CO<sub>2</sub>(g)) in a balloon. The final volume of the balloon is 1.00 L at 300. K.

What is the pressure of the gas?

1. 2.46 atm **correct**

2. 246 atm

3. 0.122 atm

4. 122 atm

5. none of these

**Explanation:**

$$n = 4.4 \text{ g CO}_2 \cdot \frac{\text{mol CO}_2}{44 \text{ g CO}_2} \quad V = 1.00 \text{ L}$$

$$= 0.1 \text{ mol CO}_2 \quad T = 300 \text{ K}$$

Applying the ideal gas law equation,

$$PV = nRT$$

$$P = \frac{nRT}{V}$$

$$P = \frac{(0.1 \text{ mol})(300 \text{ K})}{1.00 \text{ L}} \cdot \left( \frac{0.08206 \text{ L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \right)$$

$$= 2.46 \text{ atm}$$

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**Msci 12 0918 alg**

12:07, general, multiple choice, < 1 min, wording-variable.

**014**

What volume will 20.0 L of He at 50.0°C and 1201 torr occupy at STP?

1. 26.7 L **correct**

2. 37.4 L

3. 0.0374 L

4. 0.0267 L

5. 20.0 L

6. 12.7 L

**Explanation:**

Using the Combined Gas Law,

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$V_2 = \frac{P_1 V_1 T_2}{T_1 P_2}$$

and converting the temperature to K,

$$50.0^\circ\text{C} + 273 = 323.0\text{K}$$

and recalling that STP implies standard temperature (0°C or 273 K) and pressure (1 atm or 760 torr), we have:

$$V_2 = \frac{(1201 \text{ torr})(20.0 \text{ mL})(273 \text{ K})}{(323.0 \text{ K})(760 \text{ torr})}$$

$$= 26.7 \text{ mL}$$

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**DAL 13 001**

12:13, general, multiple choice, < 1 min, fixed.

**015**

Which of the following statements are both true and explained by the kinetic molecular theory of gas?

- I. Gas molecules typically have velocities of hundreds of meters per second at room temperature.
- II. There is an inverse square root relationship between temperature and gas velocity.
- III. The smaller the molecular weight of a gas, the faster it diffuses.
- IV. Intermolecular attractions between gas molecules reduce the effective pressure of the system.

1. I, III **correct**

2. All statements are correct.

3. I, II, III

4. I, III, IV

5. I

**Explanation:**

The kinetic molecular theory assumes that gas molecules are of discrete size and experience no intermolecular forces.

According to the kinetic molecular theory of gases, the average kinetic energy of gaseous molecules is directly proportional to the absolute temperature of the sample. The average kinetic energies of molecules of different gases are equal at a given temperature.

The average molecular speed is proportional to the square root of the absolute temperature divided by molecular weight.

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**Mlib 04 1009**

12:09, basic, multiple choice, > 1 min, fixed.

**016**

A 4.40 g piece of solid CO<sub>2</sub> (dry ice) is allowed to vaporize (change to CO<sub>2</sub>(g)) in a balloon. The final volume of the balloon is 1.00 L at 300. K.

What is the pressure of the gas?

1. 2.46 atm **correct**

2. 246 atm

3. 0.122 atm

4. 122 atm

5. none of these

**Explanation:**

$$n = 4.4 \text{ g CO}_2 \cdot \frac{\text{mol CO}_2}{44 \text{ g CO}_2} \quad V = 1.00 \text{ L}$$

$$= 0.1 \text{ mol CO}_2 \quad T = 300 \text{ K}$$

Applying the ideal gas law equation,

$$PV = nRT$$

$$P = \frac{nRT}{V}$$

$$P = \frac{(0.1 \text{ mol})(300 \text{ K})}{1.00 \text{ L}} \cdot \left( \frac{0.08206 \text{ L} \cdot \text{atm}}{\text{mol} \cdot \text{K}} \right)$$

$$= 2.46 \text{ atm}$$

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**Msci 12 1401**

12:15, general, multiple choice, > 1 min, fixed.

**017**

Which of the following is most likely to deviate from ideal behavior?

1. A gas at high temperature

2. A noble gas

3. A gas at low density

4. A gas at high pressure **correct**

**Explanation:**

Deviations from ideality occur due to molecular attractions or repulsions. More attractions or repulsions can occur when the molecules are closer together. Low pressure, high volume, and low density all correspond to molecules being far apart. Low temperature often corresponds to molecules being close together. It also corresponds to low kinetic energy which allows molecules to 'stick together' easier. High pressures also correspond to molecules being close together.

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**DAL 0301 07**

12:15, general, multiple choice, < 1 min, fixed.

**018**

Rank the gases H<sub>2</sub>, CH<sub>3</sub>F, N<sub>2</sub>, CF<sub>4</sub>, HF from left to right in terms of the increased non-ideality that results from a reduction in the effective pressure of the gas due to intermolecular forces.

1. H<sub>2</sub>, N<sub>2</sub>, CF<sub>4</sub>, CH<sub>3</sub>F, HF **correct**

2. HF, CH<sub>3</sub>F, CF<sub>4</sub>, N<sub>2</sub>, H<sub>2</sub>

3. H<sub>2</sub>, HF, N<sub>2</sub>, CH<sub>3</sub>F, CF<sub>4</sub>

4.  $\text{CF}_4$ ,  $\text{CH}_3\text{F}$ ,  $\text{N}_2$ ,  $\text{HF}$ ,  $\text{H}_2$

5.  $\text{H}_2$ ,  $\text{CH}_3\text{F}$ ,  $\text{N}_2$ ,  $\text{CF}_4$ ,  $\text{HF}$

**Explanation:**

The stronger the intermolecular forces present, the greater the non-ideality.

Induced Dipole	$\text{H}_2$	smallest, most ideal
	$\text{N}_2$	↓
	$\text{CF}_4$	largest
Dipole – dipole	$\text{CH}_3\text{F}$	
Hydrogen Bonding	$\text{HF}$	least ideal

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**Msci 13 0238**

13:02, general, multiple choice, > 1 min, fixed.

**019**

Which response includes all of the following substances

- I.  $\text{H}_2$
- II.  $\text{CH}_4$
- III.  $\text{NH}_3$
- IV.  $\text{SiH}_4$
- V.  $\text{HF}$

that can exhibit strong hydrogen bonding, and no others?

1. II and V
2. I, II, and III
3. III, IV, and V
4. III and V **correct**
5. I, III, and IV

**Explanation:**

London forces, dispersion forces, van der Waals or induced dipoles all describe the same intermolecular force. London forces are induced, short-lived, and very weak. Molecules and atoms can experience London forces because they have electron clouds. London forces result from the distortion of the electron cloud of an atom or molecule by the presence of nearby atoms or molecules.

Permanent dipole-dipole interactions are stronger than London forces and occur between polar covalent molecules due to charge separation.

H-bonds are a special case of very strong dipole-dipole interactions. They only occur when H is bonded to small, highly electronegative atoms – F, O or N only.

Ion-ion interactions are the strongest due to extreme charge separation and occur between ionic molecules. They can be thought of as both inter- and intramolecular bonding.

$\text{H}_2$ ,  $\text{CH}_4$ ,  $\text{SiH}_4$  – Dispersion  
 $\text{NH}_3$ ,  $\text{HF}$  – H-bonding

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**Msci 13 0303**

13:02, general, multiple choice, > 1 min, fixed.

**020**

On a relative basis, the weaker the intermolecular forces in a substance,

1. the larger is its heat of vaporization.
2. the more it deviates from the ideal gas law.
3. the greater is its vapor pressure at a particular temperature. **correct**
4. the larger is its heat of fusion.
5. the higher is its melting point.

**Explanation:**

Weak intermolecular forces allow molecules to break away from one another; therefore, vapor pressure will be larger.

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**Sparks10 RDmod**

13:99, general, multiple choice, < 1 min, fixed.

**021**

Based on the types and strengths of intermolecular forces present, place the compounds

$\text{C}_2\text{H}_6$ ,  $\text{CH}_4$ ,  $\text{H}_2\text{O}$ ,  $\text{SO}_2$ ,  $\text{MgO}$

in order from lowest to highest boiling point:

1.  $\text{C}_2\text{H}_6$ ,  $\text{CH}_4$ ,  $\text{H}_2\text{O}$ ,  $\text{SO}_2$ ,  $\text{MgO}$

2. CH<sub>4</sub>, C<sub>2</sub>H<sub>6</sub>, H<sub>2</sub>O, SO<sub>2</sub>, MgO
3. CH<sub>4</sub>, C<sub>2</sub>H<sub>6</sub>, SO<sub>2</sub>, H<sub>2</sub>O, MgO **correct**
4. MgO, H<sub>2</sub>O, SO<sub>2</sub>, C<sub>2</sub>H<sub>6</sub>, CH<sub>4</sub>
5. CH<sub>4</sub>, H<sub>2</sub>O, C<sub>2</sub>H<sub>6</sub>, SO<sub>2</sub>, MgO
6. MgO, SO<sub>2</sub>, C<sub>2</sub>H<sub>6</sub>, H<sub>2</sub>O, CH<sub>4</sub>

**Explanation:**

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**Mlib 65 7087**

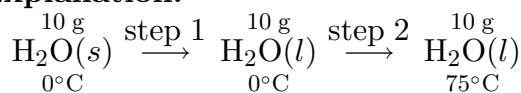
13:09, basic, multiple choice, &gt; 1 min, fixed.

**022**

The specific heat of water is 1.00 cal/g·°C, the heat of vaporization of water is 540 cal/g, and the heat of fusion of water is 80 cal/g.

How much heat would be required to convert 10 grams of ice at 0°C to 10 grams of water at 75°C?

1. 1.55 Kcal **correct**
2. 155 cal
3. 15.5 cal
4. 61.5 Kcal
5. 6150 cal

**Explanation:**

$$\text{Step 1: } \frac{80\text{ cal}}{\text{g}}(10\text{ g}) = 800\text{ cal}$$

$$\text{Step 2: } \frac{1\text{ cal}}{\text{g}\cdot^\circ\text{C}}(10\text{ g})(75 - 0)^\circ\text{C} = 750\text{ cal}$$

$$\begin{aligned} \text{Total} &= 800\text{ cal} + 750\text{ cal} \\ &= 1550\text{ cal} \\ &= 1.55\text{ kcal} \end{aligned}$$

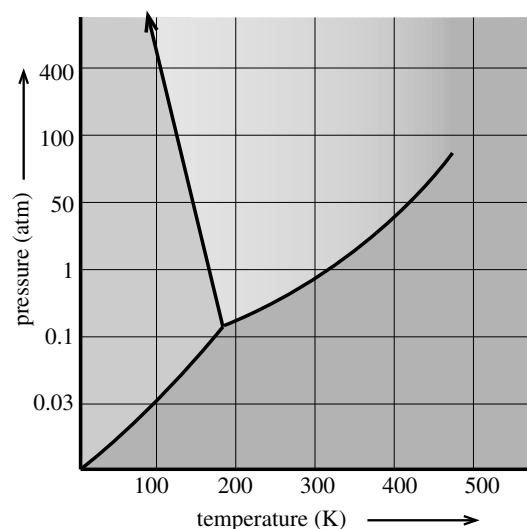
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**DAL 0301 12**

13:13, general, multiple choice, &lt; 1 min, fixed.

**023**

Consider the phase diagram for water below.



How is the  $P, T$  phase diagram for water different from  $P, T$  phase diagrams of other common chemicals?

1. The slope of the phase transition line between solid and liquid is negative. **correct**
2. The triple point occurs near the boiling point of water.
3. It is not possible to produce supercritical H<sub>2</sub>O.
4. Sublimation does not occur.
5. Water as a liquid is less dense than water as a solid.

**Explanation:**

Water is unique in that the slope of the phase transition line between solid and liquid is negative. Solid water is less dense than liquid water, where most other solids are more dense than their liquids.

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**Mlib 04 3057**

13:16, basic, multiple choice, &gt; 1 min, fixed.

**024**

Which one of the following substances is incorrectly matched with the kind of solid that it forms?

1. sulfur dioxide / molecular
2. graphite / covalent



3. calcium bromide / ionic
4. lithium / covalent **correct**
5. methane / molecular

**Explanation:**

Molecular solids consist of molecules held together by weak intermolecular forces. Ionic solids are held together by electrostatic attraction between metal cations and non-metal anions. Metallic solids are composed only of metals held together by metallic bonds. Covalent solids are like huge molecules held together by covalent bonds. Carbon in diamond is the most known example. Group IV B elements can form tetrahedral electronic geometries. Lithium will form metal solids.

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**Msci 14 0211**

14:02, general, multiple choice, &gt; 1 min, fixed.

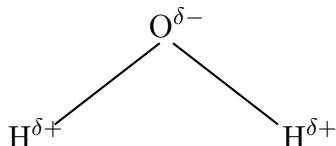
**025**

Consider an aqueous solution of  $\text{CaCl}_2$  and the following statements:

- Z1) Hydration is a special case of solvation in which the solvent is water.
- Z2) The oxygen ends of water molecules are attracted toward  $\text{Ca}^{2+}$  ions.
- Z3) The hydrogen ends of water molecules are attracted toward  $\text{Cl}^-$  ions.

Which response contains *all* the statements that are true and no false statements?

1. Z1
2. Z2
3. Z3
4. Z1 and Z2
5. Z1, Z2, and Z3 **correct**

**Explanation:**

Z1 is true; "hydration" cannot happen with

any other solvent than water.

Z2 and Z3 are also true since oxygen ( $\delta^-$ ) will be attracted to the positive  $\text{Ca}^+$  and the hydrogen ( $\delta^+$ ) will be attracted to the negative  $\text{Cl}^-$  ions.

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**Msci 14 5001**

14:04, general, multiple choice, &gt; 1 min, fixed.

**026**

Which one of the following statements is false?

1. Carbon tetrachloride ( $\text{CCl}_4$ ) is more miscible with hexane ( $\text{C}_6\text{H}_{14}$ ) than it is with a polar solvent such as methanol ( $\text{CH}_3\text{OH}$ ).
2. Gases are generally more soluble in water under high pressures than under low pressures.
3. As temperature increases, the solubilities of some solids in liquids increase and the solubilities of other solids in liquids decrease.
4. Gases are generally more soluble in water at high temperatures than at low temperatures. **correct**
5. Water dissolves many ionic solutes because of its ability to hydrate ions in solution.

**Explanation:**

The polarity of water allows it to hydrate the individual ions in the ionic solute.

$\text{CCl}_4$  is non-polar and will be miscible with another non-polar liquid and not with a polar one.

Increasing temperature makes salts with exothermic  $\Delta H_{\text{sol}}$  more soluble, but salts with endothermic  $\Delta H_{\text{sol}}$  less soluble.

Gases are generally more soluble in water under high pressures than under low pressures because of Henry's Law; as the pressure of a gas above a liquid increases, the concentration of the gas in the solution increases.

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**Mlib 04 5009**

14:99, basic, multiple choice, &gt; 1 min, fixed.

**027**

Consider the solutions

Z1) 0.5 M Na<sub>2</sub>SO<sub>4</sub>

Z2) 0.6 M NaCl

Z3) 1.0 M sugar

What answer gives the expected order of increasing osmotic pressure?

1. lowest Z1 < Z2 < Z3 highest
2. lowest Z2 < Z1 < Z3 highest
3. lowest Z3 < Z2 < Z1 highest **correct**
4. lowest Z3 < Z1 < Z2 highest
5. lowest Z2 < Z3 < Z1 highest

**Explanation:**

The osmotic pressure of a liquid increases as the number of moles of solute particles or ions increases. 0.5 mol/L Na<sub>2</sub>SO<sub>4</sub> means 0.5 moles of SO<sub>4</sub> ions and 1 mole of Na ions for a total of 1.5 ions. 0.6 mol/L NaCl means 0.6 moles of each Na and Cl ions for a total of 1.2 moles of ions. 1.0 mol/L of sugar means 1 mole of sugar molecules. Therefore, since Na<sub>2</sub>SO<sub>4</sub> has the highest concentration of particles or ions, it will have the highest osmotic pressure. NaCl is next, followed by sugar.

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**DAL 0301 09**

14:99, general, multiple choice, < 1 min, fixed.

**028**

Several interesting observations from the world around you are listed below.

Which of these is NOT explained by a colligative property?

1. At high altitude it takes longer to cook spaghetti. **correct**
2. The freezing point of water is lowered when salt is added.
3. Antifreeze is added to a car radiator to keep the car from overheating.
4. Water boils at a higher temperature when salt is added.
5. A lobster will die when placed in fresh

water.

**Explanation:**

Colligative properties of a solution depend on the number of solute particles in solution, not the type. Boiling point variations due to pressure changes have nothing to do with solutions and colligative properties (boiling point variations due to particles in solution, etc...).

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**Msci 14 1207**

14:13, general, multiple choice, > 1 min, fixed.

**029**

When 20.0 grams of an unknown nonelectrolyte compound are dissolved in 500 grams of benzene, the freezing point of the resulting solution is 3.77°C. The freezing point of pure benzene is 5.48°C, and its freezing point depression constant is  $K_f = 5.12^\circ\text{C}/\text{molality}$ .

What is the molecular weight of the unknown compound?

1. 120 grams/mole **correct**
2. 80.0 grams/mole
3. 100 grams/mole
4. 140 grams/mole
5. 160 grams/mole
6. 0.334 grams/mole
7. 240 grams/mole
8. 54 grams/mole

**Explanation:**

$$\begin{aligned}\Delta T_f &= T_f^\circ - T_f \\ &= 5.48^\circ\text{C} - 3.77^\circ\text{C} = 1.71^\circ\text{C} \\ \Delta T_f &= k_f \cdot m \\ m &= \frac{\Delta T_f}{k_f} \\ &= \frac{1.71^\circ\text{C}}{5.12^\circ\text{C}/m} = 0.334 m\end{aligned}$$

$$m = \frac{\text{mol compound}}{\text{kg benzene}} \times \frac{\text{g}_{\text{compound}}}{\text{MW}_{\text{compound}}} = \frac{\text{MW}_{\text{compound}}}{\text{kg benzene}}$$

$$\begin{aligned} \text{MW}_{\text{compound}} &= \frac{\text{g}_{\text{compound}}}{\text{kg benzene}} \times m \\ &= \frac{20.0 \text{ g compound}}{0.500 \text{ kg benzene}} \\ &\quad \times \frac{1 \text{ kg benzene}}{0.334 \text{ mol compound}} \\ &= 120 \text{ g/mol} \end{aligned}$$

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**Mlib 04 4055**

14:03, basic, multiple choice, > 1 min, fixed.

**030**

Which of the following alcohols would be the least miscible with water?

1. hexanol,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$   
**correct**

2. pentanol,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$

3. propanol,  $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

4. ethanol,  $\text{CH}_3\text{CH}_2\text{OH}$

5. methanol,  $\text{CH}_3\text{OH}$

**Explanation:**

The polar OH group is miscible with water but as the nonpolar hydrocarbon chain lengthens, solubility decreases.