This print-out should have 18 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

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001 10.0 points

Consider the following statements. Which are true?

I) Vapor pressure is a surface phenomenon.
II) The smaller the IMF, the smaller the vapor pressure.
III) The volume of a liquid does not affect the vapor pressure
IV) Vapor pressure is temperature dependent.

1. I, II, and IV

2. I, and III

3. I, III, and IV **correct**

4. I, II, III, and IV

5. III, and IV

6. II, III, and IV

7. I, II, and III

Explanation:

As vapor particles encounter the surface of a solution and condense, their energy released makes another particle move as a vapor. This is an equilibrium process, and it is temperature dependent. As IMF decreases, the vapor pressure increases, since only weak forces will be holding a substance together as a liquid. Vapor pressure also only occurs at the surface, so it does not matter how deep the liquid phase is.

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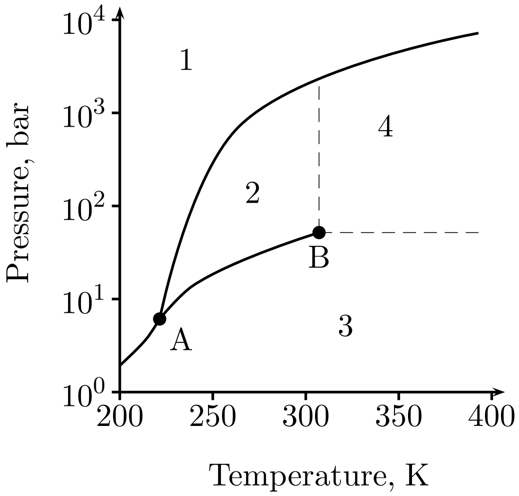
002 10.0 points

According to the given phase diagram for carbon dioxide, what are regions 1, 3 and B respectively?

Carbon Dioxide



1. solid, vapor, critical point **correct**

2. solid, liquid, critical point

3. liquid, vapor, critical point

4. solid, liquid, triple point

5. solid, vapor, triple point

Explanation:

As temperature goes up, gas forms. As temperature decreases, solid forms. As pressure increases, solid forms. As pressure decreases, gas forms. Point A is the triple point, and Point B is the critical point. 1 = solid, 2 = liquid, 3 = vapor, 4 = supercritical region

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003 10.0 points

How much heat is released when 10 g of steam at 115 °C is cooled to ice at −15 °C? Use the approximate values below for your calculation.

$c_{ice} = 2\ \text{J/g} \cdot {}^\circ\text{C}$
$c_{steam} = 2\ \text{J/g} \cdot {}^\circ\text{C}$
$c_{water} = 4\ \text{J/g} \cdot {}^\circ\text{C}$
$\Delta H_{vap} = 2,260\ \text{J/g}$
$\Delta H_{fus} = 340\ \text{J/g}$

1. -26,600 J

2. -4,000 J

3. -8,000 J

4. -30,300 J

5. -30,000 J

6. -30,600 J **correct**

Explanation:

Cooling steam from 115 °C to 100 °C, $\Delta H = m \cdot c_{steam} \cdot \Delta T = 10 \cdot 2 \cdot 15 = 300$ J. Changing steam to water at 100 °C (the boiling point of water), $\Delta H = m \cdot \Delta H_{vap} = 10 \cdot 2,260 = 22,600$ J. Cooling water at 100 °C to water at 0 °C, $\Delta H = m \cdot c_{water} \cdot \Delta T = 10 \cdot 4 \cdot 100 = 4,000$ J. Changing water to ice at 0 °C (the freezing point of water), $\Delta H = m \cdot \Delta H_{fus} = 10 \cdot 340 = 3,400$ J. Finally, cooling ice from 0 °C to -15 °C, $\Delta H = m \cdot c_{ice} \cdot \Delta T = 10 \cdot 2 \cdot 15 = 300$ J. Adding everything together, the ΔH_{sys} for the entire process is -30,600 J.

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004 10.0 points

Rank the following liquids by their miscibility in heptane (C_7H_{16}), from most miscible to least: NH_3, CH_3OH, CH_3CH_2F, CCl_4.

1. $NH_3 > CH_3OH > CH_3CH_2F > CCl_4$

2. $CCl_4 > CH_3CH_2F > CH_3OH > NH_3$ **correct**

3. $CH_3CH_2F > CCl_4 > CH_3OH > NH_3$

4. $CH_3CH_2F > CH_3OH > CCl_4 > NH_3$

5. $CCl_4 > CH_3CH_2F > NH_3 > CH_3OH$

Explanation:

"Like dissolves like." Heptane is hydrocarbon, and thus completely non-polar. Carbon tetrachloride is most soluble since even though the C-Cl bond are polar, there is no net dipole in the molecule, followed by fluoroethane, which is polar. Methanol is small and very polar (exhibiting hydrogen bonding), and ammonia is the most polar of the liquids, and thus least soluble.

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005 10.0 points

Assuming all of the following salts dissolve completely in water, which one would be the best to use if you were trying to raise the boiling point of the solution?

1. $Al_2(SO_4)_3$ **correct**

2. KNO_3

3. Na_3PO_4

4. NaCl

5. $(NH_4)_2Cr_2O_7$

Explanation:

$Al_2(SO_4)_3$ is highly soluble and produces 5 ions upon dissolving, has the largest van't hoff coefficient and is the best choice for attempting raise a solution's boiling point.

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006 10.0 points

Which of the following statements regarding colligative properties is/are true?

I) Pure liquid water exhibits a lower freezing point than a solution of magnesium chloride in water.

II) For completely soluble compounds that do not ionize in solution, the van't Hoff factor, $i = 1$.

III) Osmotic pressure is pressure exerted on a semipermeable membrane between solutions with different concentrations of solutes.

1. I, II, III

2. I, II

3. II only

4. III only

5. I only

6. II, III **correct**

7. I, III

Explanation:

Both II and III are true, but I is false, since salt depresses the freezing point of a solvent.

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007 10.0 points

Nitric oxide, NO, is a toxic chemical produced in automobile engines.

$$O_2(g) + N_2(g) \longleftrightarrow 2\ NO(g)$$

Suppose that at 0 °C, $K = 0.5$ and at 10 °C, $K = 4$. ΔH of this reaction is (positive/negative) and it would be best to run an engine as (hot/cold) as possible to reduce emissions of NO.

1. positive, cold **correct**

2. negative, hot

3. positive, hot

4. negative, cold

Explanation:

The direct proportionality between temperature and K demonstrates that ΔH is positive and to prevent the reaction, the engine should be run as cold as possible.

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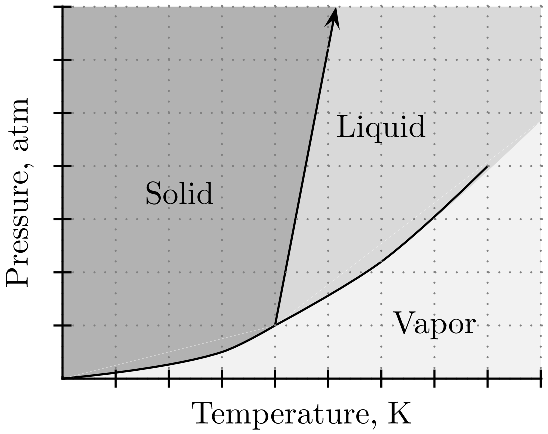
008 10.0 points

The phase diagram for CO_2 is given below.



The triple point is at 5.1 atm and 217 K. What happens if $CO_2(\ell)$ at 25 atm and 350 K is released into a room at 1 atm and 298 K?

1. The liquid and vapor are in equilibrium.

2. The liquid and solid are in equilibrium.

3. The liquid vaporizes. **correct**

4. The liquid freezes.

5. The liquid remains stable.

Explanation:

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009 10.0 points

Based simply on the molecular formula provided, which of the following compounds is least likely to be miscible in cyclohexane (C_6H_{12})?

1. methanol (CH_3OH) **correct**

2. benzene (C_6H_6)

3. Each contains a hydrocarbon unit and should be equally miscible.

4. phenol (C_6H_5OH)

5. naphthalene ($C_{10}H_8$)

Explanation:

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010 10.0 points

Calculate the vapor pressure at 25°C of a mixture of benzene and toluene in which the mole fraction of benzene is 0.650. The vapor pressure at 25°C of benzene is 94.6 torr and that of toluene is 29.1 torr.

1. 71.7 torr **correct**

2. 124 torr

3. 51.3 torr

4. 61.5 torr

5. 84.4 torr

Explanation:

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011 10.0 points

What would be the expression for K_c for the reaction

$$4\,NH_3(g) + 5\,O_2(g) \rightleftharpoons 4\,NO(g) + 6\,H_2O(g)$$

at equilibrium?

1. $\dfrac{[NO]^4\,[H_2O]^6}{[NH_3]^4\,[O_2]^5}$ **correct**

2. $\dfrac{[NH_3]^4\,[O_2]^5}{[NO]^4\,[H_2O]^6}$

3. $[NO]^4\ [H_2O]^6$

4. $[NH_3]^4\ [O_2]^5$

5. $\dfrac{[NO]^4\,[H_2O]}{[NH_3]^4}$

Explanation:

To write K_c for a balanced chemical reaction, multiply the concentrations of the products divided by the same (multiply the concentrations) for the reactants, each raised to its coefficient in the reaction.

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012 10.0 points

Suppose the reaction

$$A \rightleftharpoons B$$

has an equilibrium constant of 1.0 and the initial concentrations of A and B are 0.5 M and 0.0 M, respectively. Which of the following is the correct value for the final concentration of A?

1. 1.00 M

2. None of these is correct.

3. 1.50 M

4. 0.500 M

5. 0.250 M **correct**

Explanation:

$K = 1.0$ $[A]_{\rm ini} = 0.5$ M

$[B]_{\rm ini} = 0$ M

	A	$\rightleftharpoons$	B
ini, M	0.5		0.0
Δ, M	$-x$		x
eq, M	$0.5 - x$		x

$$K = \frac{[B]}{[A]} = 1.0$$

$$\frac{x}{0.5 - x} = 1.0$$

$$x = 0.25\text{ M}$$

$$[A] = 0.5 - x = 0.25\text{ M}$$

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013 10.0 points

The equilibrium constant K_c for the reaction

$$2\,SO_2(g) + O_2(g) \rightarrow 2\,SO_3(g)$$

is 11.7 at 1100 K. A mixture of SO_2, O_2, and SO_3, each with a concentration of 0.015 M, was introduced into a container at 1100 K. Which of the following is true?

1. $SO_2(g)$ and $O_2(g)$ will be formed until equilibrium is reached. **correct**

2. $[SO_3] = [SO_2] = [O_2]$ at equilibrium.

3. $[SO_3] = 0.015$ M at equilibrium.

4. $SO_3(g)$ will be formed until equilibrium is reached.

5. $[SO_3] = 0.045$ M at equilibrium.

Explanation:

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014 10.0 points

Write the equilibrium constant for

$$2\,NaBr(aq) + Pb(ClO_4)_2(aq) \rightarrow PbBr_2(s) + 2\,NaClO_4(aq)\,.$$

1. $K = \dfrac{1}{[Pb^{2+}][Br^-]^2}$ **correct**

2. $K = [Pb^{2+}][Br^-]^2$

3. $K = \dfrac{1}{[Pb(ClO_4)_2][NaBr]^2}$

4. $K = \dfrac{[PbBr_2]}{[Pb^{2+}][Br^-]^2}$

5. $K = \dfrac{[\text{NaClO}_4]^2}{[\text{NaBr}]^2[\text{Pb(ClO}_4)_2]}$

Explanation:

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015 10.0 points

Consider the reaction

$$\text{C(s)} + \text{CO}_2\text{(g)} \rightarrow 2\,\text{CO(g)}\,.$$

At equilibrium at a certain temperature, the partial pressures of CO(g) and CO_2(g) are 1.22 atm and 0.780 atm, respectively. Calculate the value of K for this reaction.

1. 3.13

2. 1.91 **correct**

3. 0.640

4. 1.56

5. 2.00

Explanation:

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016 10.0 points

Suppose the reaction

$$\text{A} + 3\,\text{B} \rightarrow 2\,\text{C}$$

has a value of $K = 10.0$ at a certain temperature. If 0.5 moles of A, 0.5 moles of B and 0.5 moles of C are placed in a 5 L solution, the reaction

1. is at equilibrium.

2. shifts to the right.

3. shift cannot be determined without the temperature.

4. shifts to the left. **correct**

Explanation:

$$K = 10.0 \qquad [\text{A}] = [\text{B}] = [\text{C}] = \frac{0.5\text{ mol}}{5\text{ L}}$$

$$Q = \frac{[\text{C}]^2}{[\text{A}][\text{B}]^3}$$

$$= \frac{\left(\dfrac{0.5\text{ mol}}{5\text{ L}}\right)^2}{\left(\dfrac{0.5\text{ mol}}{5\text{ L}}\right)\left(\dfrac{0.5\text{ mol}}{5\text{ L}}\right)^3}$$

$$= 100 > K = 10.0$$

$Q > K$, therefore the reverse reaction will predominate until equilibrium is established and equilibrium shifts to the left.

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017 10.0 points

The reaction

$$\text{A} + \text{B} \rightleftharpoons \text{C} + \text{D}$$

is at equilibrium. Increasing the temperature of the reaction causes more C and D to be formed. This reaction is

1. neither endothermic nor exothermic.

2. Cannot tell from the information given

3. endothermic. **correct**

4. exothermic.

Explanation:

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018 10.0 points

The equilibrium constant K_p is 5.00×10^{17} at 25°C for the reaction

$$\text{C}_2\text{H}_4\text{(g)} + \text{H}_2\text{(g)} \rightleftharpoons \text{C}_2\text{H}_6\text{(g)}\,.$$

From this information, calculate ΔG^0 at 25°C.

1. insufficient information

2. −101 kJ/mol **correct**

3. −43.9 kJ/mol

4. +43.9 kJ/mol

5. −517 kJ/mol

6. 101 kJ/mol

7. -996 J/mol

Explanation:
$K_\mathrm{p} = 5.00 \times 10^{17} \qquad T = 25^\circ\mathrm{C} + 273 = 298\,\mathrm{K}$

$$\begin{aligned}\Delta G^0 &= -R\,T\,\ln K \\ &= (-8.314\ \mathrm{J/mol\cdot K})(298\ \mathrm{K}) \\ &\quad \times \ln\left(5 \times 10^{17}\right) \\ &= -1.01 \times 10^5\ \mathrm{J/mol} \\ &= -101\,\mathrm{kJ/mol}\end{aligned}$$