This print-out should have 30 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering. V1:1, V2:1, V3:1, V4:1, V5:2.

Please make sure you write your version numbers on your scantron. Good luck!

Mlib 65 7088

14:01, general, multiple choice, > 1 min, fixed.

001 (part 1 of 1) 6 points

The process of steam condensing to form liquid water is

1. an exothermic chemical reaction.

2. an endothermic phase change.

3. neither endothermic nor exothermic.

4. an exothermic phase change. **correct**

5. an endothermic chemical reaction.

Explanation:

Solid → liquid → gas is endothermic because each consecutive phase has more energy/heat. Thus gas → liquid → solid is exothermic because energy is conserved and is a state function. Phase changes are physical changes, not chemical changes.

Mlib 04 2035

14:07, general, multiple choice, > 1 min, fixed.

002 (part 1 of 1) 6 points

Liquids have a higher vapor pressure at a higher temperature because

1. more molecules in the liquid have enough kinetic energy to escape from the surface. **correct**

2. the more rapidly moving molecules in the gas phase exert a higher pressure on the container walls.

3. a higher temperature is required to supply the heat of vaporization of the liquid.

4. the molar enthalpy of vaporization is decreased as the temperature is raised.

5. the higher temperature may exceed the critical temperature of the liquid.

Explanation:

In order to vaporize or evaporate, a molecule must have enough kinetic energy to escape the surface of the liquid.

Mlib 04 4001

16:04, basic, multiple choice, > 1 min, fixed.

003 (part 1 of 1) 6 points

A decrease in temperature usually (decreases, increases, does not change) the solubility of salts in water.

1. decreases **correct**

2. does not change

3. increases

Explanation:

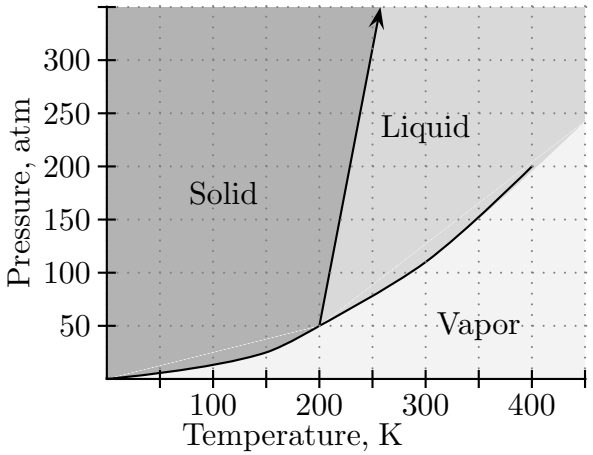
Most salts are less soluble at lower temperature.

ChemPrin3e T08 30

14:10, general, multiple choice, < 1 min, fixed.

004 (part 1 of 1) 6 points

The phase diagram for a pure substance is given below.



What pressure must be applied to liquefy a sample at 425 K?

1. 350 atm

2. The sample cannot be liquefied at 425 K. **correct**

3. 150 atm

4. 50 atm

5. 250 atm

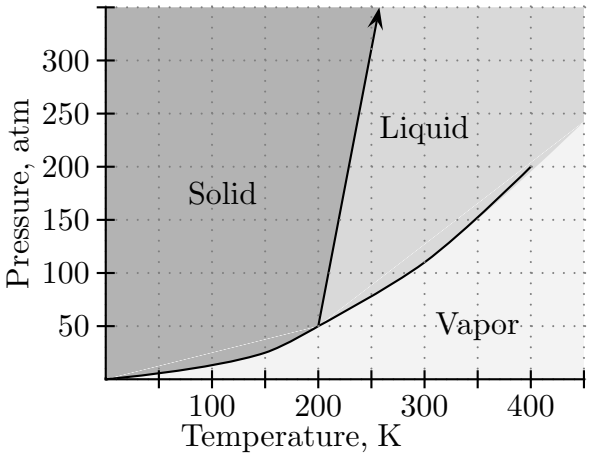
Explanation:

ChemPrin3e T08 26

14:10, general, multiple choice, < 1 min, fixed.

005 (part 1 of 1) 6 points

The phase diagram for a pure substance is given below.



The substance is stored in a container at 150 atm at 25°C. Describe what happens if the container is opened at 25°C.

1. The liquid in the container freezes.

2. The solid in the container sublimes.

3. The solid in the container melts.

4. The vapor in the container escapes.

5. The liquid in the container vaporizes. **correct**

Explanation:

Benzene Heat Required

18:11, general, multiple choice, > 1 min, normal.

006 (part 1 of 1) 6 points

The molar heat capacity of $C_6H_6(\ell)$ is 136 J/mol ·°C and of $C_6H_6(g)$ is 81.6 J/mol ·°C. The molar heat of fusion for benzene is 9.92 kJ/mol and its molar heat of vaporization is 30.8 kJ/mol. The melting point of benzene is 5.5°C, its boiling point is 80.1°C, and its molecular weight 78.0 g/mol. How much heat would be required to convert 234 g of solid benzene ($C_6H_6(s)$) at 5.5°C into benzene vapor ($C_6H_6(g)$) at 100.0°C?

1. 157.468 kJ **correct**

2. 4931.72 kJ

3. 60.1968 kJ

4. 97.2715 kJ

5. 152.597 kJ

Explanation:

$m_{benzene} = 234$ g $\qquad T_1 = 5.5°C$

$T_2 = 100.0°C$

$$234\,\text{g} \times \frac{\text{mol}}{78.0\,\text{g}} = 3\,\text{mol}$$

$$\underset{5.5°C}{C_6H_6(s)} \xrightarrow{\text{step 1}} \underset{5.5°C}{C_6H_6(\ell)} \xrightarrow{\text{step 2}}$$

$$\underset{80.1°C}{C_6H_6(\ell)} \xrightarrow{\text{step 3}} \underset{80.1°C}{C_6H_6(g)} \xrightarrow{\text{step 4}} \underset{100.0°C}{C_6H_6(g)}$$

$$\text{Step 1}: \frac{9.92\,\text{kJ}}{\text{mol}} \times 3\,\text{mol} = 29.76\,\text{kJ}$$

$$\text{Step 2}: \frac{136\ \text{J}}{\text{mol} \cdot ^\circ\text{C}} \times (3\ \text{mol}) \times (80.1 - 5.5)^\circ\text{C}$$
$$= 30436.8\ \text{J} = 30.4368\,\text{kJ}$$

$$\text{Step 3}: \frac{30.8\,\text{kJ}}{\text{mol}} \times (3\,\text{mol}) = 92.4\,\text{kJ}$$

$$\text{Step 4}: \frac{81.6\ \text{J}}{\text{mol} \cdot ^\circ\text{C}} \times (3\ \text{mol}) \times (100.0 - 80.1)^\circ\text{C}$$
$$= 4871.52\ \text{J} = 4.87152\,\text{kJ}$$

$$\text{Total} = 29.76\ \text{kJ} + 30.4368\ \text{kJ} + 92.4\ \text{kJ} + 4.87152\ \text{kJ}$$
$$= 157.468\ \text{kJ}$$

Mlib 04 4013

16:05, general, multiple choice, > 1 min, fixed.

007 (part 1 of 1) 6 points

For gases that do not react chemically with water, the solubility of the gas in water generally (decreases, increases) with an increase in the pressure of the gas and (decreases, increases) with increasing temperature.

1. increases; decreases **correct**

2. decreases; increases

3. increases; increases

4. decreases; decreases

Explanation:

An increase in pressure means that you have increased the concentration of gas above the solvent surface, thereby increasing the concentration of the gas in the solvent. Increasing the temperature will decrease the solubility of the gas.

Sparks solubility 001

16:02, general, multiple choice, < 1 min, fixed.

008 (part 1 of 1) 6 points

C_6H_{12} will most likely dissolve in which solvent?

1. H_2O

2. HF

3. NCl_3

4. CCl_4 **correct**

5. $BaCl_2$

Explanation:

C_6H_{12} is a nonpolar molecule. Like dissolves like, so the solvent most likely to dissolve C_6H_{12} will be nonpolar. CCl_4 is nonpolar.

DAL 0301 09

17:01, general, multiple choice, < 1 min, fixed.

009 (part 1 of 1) 6 points

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.).

Mlib 04 5041y

17:02, general, multiple choice, > 1 min, fixed.

010 (part 1 of 1) 6 points

Consider two liquids A and B. The vapor pressure of pure A (molecular weight = 50 g/mol) is 225 torr at 25°C and the vapor pressure of pure B (molecular weight = 75 g/mol) is 90 torr at the same temperature. What is the total vapor pressure at 25°C of a solution that is 70% A and 30% B by weight?

1. 76 torr

2. 195 torr **correct**

3. 135 torr

4. 203 torr

5. 124 torr

6. 115 torr

7. 335 torr

8. 108 torr

9. 225 torr

Explanation:
For A,
$P^0 = 255$ torr MW = 50 g/mol
For B,
$P^0 = 90$ torr MW = 75 g/mol
The mole fractions are $\frac{7}{9}$ for A and $\frac{2}{9}$ for B.

$$\left(\frac{7}{9}\right)(225) + \left(\frac{2}{9}\right)(90) = 175 + 20 = 195 \text{ torr}$$

ChemPrin3e T08 14
18:06, basic, multiple choice, < 1 min, fixed.
011 (part 1 of 1) 6 points
The vapor pressure of methanol at 25°C is 123 torr and its enthalpy of vaporization is 35.3 kJ·mol^{-1}. Estimate the normal boiling point of methanol. Assume the enthalpy of vaporization is independent of temperature.

1. 450 K

2. 342 K **correct**

3. 315 K

4. 373 K

5. Not enough information is given.

Explanation:

Mlib 04 5009
17:05, general, multiple choice, > 1 min, fixed.
012 (part 1 of 1) 6 points
Consider the solutions

Z1) 0.5 M Na_2SO_4
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_2SO_4 means 0.5 mol of SO_4 ions and 1 mol of Na ions for a total of 1.5 ions. 0.6 mol/L NaCl means 0.6 mol of each Na and Cl ions for a total of 1.2 mol of ions. 1.0 mol/L of sugar means 1 mol of sugar molecules. Therefore, since Na_2SO_4 has the highest concentration of particles or ions, it will have the highest osmotic pressure. NaCl is next, followed by sugar.

ChemPrin3e T08 72
17:05, general, multiple choice, < 1 min, fixed.
013 (part 1 of 1) 6 points
An animal cell assumes its normal volume when it is placed in a solution with a total solute molarity of 0.3 M. If the cell is placed in a solution with a total solute molarity of 0.1 M,

1. water enters the cell, causing expansion. **correct**

2. water leaves the cell, causing contraction.

3. the escaping tendency of water in the cell increases.

4. no movement of water takes place.

Explanation:

Msci 14 1112
17:03, general, multiple choice, > 1 min, fixed.
014 (part 1 of 1) 6 points
If the boiling point elevation constant of water is 0.512°C/m, how many moles of sugar would

you put into 1 kg of water to get a boiling point change of about 2°C?

1. 1 mole

2. 2 moles

3. 3 moles

4. 4 moles **correct**

5. 5 moles

Explanation:
$K_b = 0.512°C/m$ $\quad m_{water} = 1$ kg
$\Delta T_b = 2°C$

The boiling point elevation is

$$\Delta T_b = K_b\, m\,,$$

where ΔT_b is the increase in temperature above the boiling point, K_b is a solvent dependent constant and m is the molality of the solution. The number of moles needed for the BP increase of 2°C is

$$m = \frac{\Delta T_b}{K_b} = \frac{2°C}{0.512°C/m} = 3.9\ m \approx 4\ \frac{\text{mol}}{\text{kg}}$$

ChemPrin3e T09 43

21:02, general, multiple choice, < 1 min, fixed.

015 (part 1 of 1) 6 points

Write the equilibrium constant for
$2\,NaBr(aq) + Pb(ClO_4)_2(aq) \rightarrow PbBr_2(s) + 2\,NaClO_4(aq)\,.$

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

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

3. $K = \dfrac{[NaClO_4]^2}{[NaBr]^2[Pb(ClO_4)_2]}$

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

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

Explanation:

ChemPrin3e T09 31

21:11, basic, multiple choice, < 1 min, fixed.

016 (part 1 of 1) 6 points

Consider the reaction

$$C(s) + CO_2(g) \rightarrow 2\,CO(g)\,.$$

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. 2.00

3. 1.91 **correct**

4. 1.56

5. 0.640

Explanation:

ChemPrin3e T09 48

21:08, general, multiple choice, < 1 min, fixed.

017 (part 1 of 1) 6 points

Consider the reaction

$$Ni(CO)_4(g) \rightarrow Ni(s) + 4\,CO(g)\,.$$

If the initial concentration of $Ni(CO)_4$(g) is 1.0 M, and x is the equilibrium concentration of CO(g), what is the correct equilibrium relation?

1. $K_c = \dfrac{x^4}{1.0 - 4x}$

2. $K_c = \dfrac{x}{1.0 - \dfrac{x}{4}}$

3. $K_c = \dfrac{x^4}{1.0 - \dfrac{x}{4}}$ **correct**

4. $K_c = \dfrac{x^5}{1.0 - \dfrac{x}{4}}$

5. $K_c = \dfrac{4\,x}{1.0 - 4x}$

Explanation:

Lyon E3 05

21:11, general, multiple choice, > 1 min, normal.

018 (part 1 of 1) 6 points

$K_c = 50$ at some temperature for the reaction

$$H_2(g) + I_2(g) \rightleftharpoons 2\,HI(g)\,.$$

If 27.5 mol of HI are introduced into a 10.0 liter vessel, how many moles of I_2 are present at equilibrium?

1. 3.03162 mol **correct**

2. 3.63794 mol

3. 1.51581 mol

4. 30.3162 mol

5. 4.54742 mol

6. 6.06323 mol

Explanation:

$K_c = 50$ $\qquad V_{vessel} = 10.0$ L

$n_{HI} = 27.5$ $\qquad [HI]_{ini} = \dfrac{27.5 \text{ mol}}{10 \text{ L}} = 2.75$ M

	H_2 (g)	+ I_2 (g)	$\rightleftharpoons$ 2 HI (g)
ini, M	0	0	2.75
Δ, M	x	x	$-2x$
eq, M	x	x	$2.75 - 2x$

$$K_c = \frac{[HI]^2}{[H_2]\,[I_2]} = 50$$
$$\frac{(2.75 - 2x)^2}{x^2} = 50$$
$$\frac{2.75 - 2x}{x} = \sqrt{50}$$
$$2.75 - 2\,x = \sqrt{50}\,x$$
$$x = 0.303162$$

$$n_{I_2} = (10.0 \text{ L})\,[I_2]$$
$$= (10.0 \text{ L})\left(0.303162 \frac{\text{mol}}{\text{L}}\right)$$
$$= 3.03162 \text{ mol}$$

DAL 02 0302

21:10, general, multiple choice, < 1 min, fixed.

019 (part 1 of 1) 6 points

Suppose the reaction

$$A + 3\,B \rightarrow 2\,C$$

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. shifts to the right.

2. shifts to the left. **correct**

3. is at equilibrium.

4. shift cannot be determined without the temperature.

Explanation:

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

$$Q = \frac{[C]^2}{[A][B]^3}$$
$$= \frac{\left(\frac{0.5 \text{ mol}}{5 \text{ L}}\right)^2}{\left(\frac{0.5 \text{ mol}}{5 \text{ L}}\right)\left(\frac{0.5 \text{ mol}}{5 \text{ L}}\right)^3}$$
$$= 100 > K = 10.0$$

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

Msci 17 0622

21:15, general, multiple choice, > 1 min, fixed.

020 (part 1 of 1) 6 points

An acetic acid solution is allowed to come to equilibrium:

$$CH_3COOH + H_2O \rightleftharpoons H_3O^+ + CH_3COO^-$$

If some silver ion (Ag^+) is then added to the solution, solid silver acetate (CH_3COOAg) is formed.

The resulting amount of undissociated acetic acid (CH_3COOH) in the solution would be

1. unchanged from that in the original solution.

2. higher than that in the original solution.

3. lower than that in the original solution. **correct**

4. zero.

Explanation:
Precipitating out CH_3COOAg removes CH_3COO^- from the equilibrium system and shifts the equilibrium to the right, dissociating more CH_3COOH to replace CH_3COO^-.

Sparks equil 006
21:15, general, multiple choice, < 1 min, fixed.
021 (part 1 of 1) 6 points
The reaction

$$A + B \rightleftharpoons C + D$$

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

1. endothermic. **correct**

2. exothermic.

3. neither endothermic nor exothermic.

4. Cannot tell from the information given

Explanation:

Msci 17 1103
21:05, general, multiple choice, > 1 min, fixed.
022 (part 1 of 1) 6 points
The equilibrium constant K_p is 5.00×10^{17} at 25°C for the reaction

$$C_2H_4(g) + H_2(g) \rightleftharpoons C_2H_6(g)\,.$$

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

1. 101 kJ/mol

2. −101 kJ/mol **correct**

3. −43.9 kJ/mol

4. +43.9 kJ/mol

5. insufficient information

6. −996 J/mol

7. −517 kJ/mol

Explanation:
$K_p = 5.00 \times 10^{17} \quad T = 25^\circ C + 273 = 298\,K$

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

Mlib 07 0057
22:04, basic, multiple choice, > 1 min, fixed.
023 (part 1 of 1) 6 points
Choose the pair of concentrations that cannot be in a given aqueous solution at 25°C.

1. $[H^+] = 10^{-3}\,M$: $[OH^-] = 10^{-11}\,M$

2. $[H^+] = 10^{-7}\,M$: $[OH^-] = 10^{-7}\ M$

3. $[H^+] = 10^{-14}\ M$: $[OH^-] = 1\ M$

4. $[H^+] = 10\ M$: $[OH^-] = 10^{-15}\ M$

5. All of these can exist **correct**

Explanation:

DAL 03 0406
22:04, general, multiple choice, < 1 min, fixed.
024 (part 1 of 1) 6 points
While sipping a refreshing glass of ice water, which of the following thoughts about the drink is incorrect?

1. pH = pOH = 7 **correct**

2. pH = pOH

3. pH > 7

4. pOH > 7

Explanation:
ph = pOH =7 for pure water at 25°C.

Mlib 07 1003
22:09, general, multiple choice, > 1 min, fixed.
025 (part 1 of 1) 6 points
A 0.0001 M solution of HCl has a pH of

1. 3.

2. 4. **correct**

3. 11.

4. 10.

Explanation:
[HCl] = 0.0001 M
HCl is a strong acid which means it dissociates completely into $[H^+]$ and $[Cl^-]$. Therefore, we know that the concentration of $[H^+]$ is 0.0001 M.

$$\mathrm{pH} = -\log[H^+] = -\log(0.0001) = 4\,.$$

Lyon q9 01
23:01, general, multiple choice, > 1 min, fixed.
026 (part 1 of 1) 6 points
You have a weak molecular base with $K_b = 6.6 \times 10^{-9}$. What is the pH of a 0.0500 M solution of this weak base?

1. pH = 3.63

2. pH = 4.74

3. pH = 7.12

4. pH = 9.26 **correct**

5. None of these

Explanation:
[base] = 0.05 M
As mentioned, this is a weak base, so use the equation to calculate weak base $[OH^-]$ concentration:

$$\begin{aligned}[OH^-] &= \sqrt{K_b\, C_b} \\ &= \sqrt{(6.6 \times 10^{-9})\,(0.05)} \\ &= 1.81659 \times 10^{-5}\end{aligned}$$

After finding $[OH^-]$, you can find pH using either method below:
A)

$$\mathrm{pOH} = -\log\left(1.81659 \times 10^{-5}\right) = 4.74074$$
$$\mathrm{pH} = 14 - 4.74074 = 9.25926$$

or B)

$$K_w = [H^+][OH^-] = 1 \times 10^{-14}$$
$$[H^+] = \frac{K_w}{[OH^-]} = \frac{1 \times 10^{-14}}{1.81659 \times 10^{-5}} = 5.50482 \times 10^{-10}$$
$$\mathrm{pH} = -\log\left(5.50482 \times 10^{-10}\right) = 9.25926$$

JAH 09 001
23:01, general, multiple choice, < 1 min, fixed.
027 (part 1 of 1) 6 points
A solution of 0.2 M boric acid is prepared as an eye wash. What is the approximate pH of this solution? For boric acid $K_a = 7.2 \times 10^{-10}$.

1. pH = 5 **correct**

2. pH = 3

3. pH = 4

4. pH = 6

5. pH = 7

Explanation:

DAL 04 012
22:07, general, multiple choice, < 1 min, fixed.
028 (part 1 of 1) 6 points
Of the four compounds
HF, $HClO_2$, NaOH, $Ba(OH)_2$
which are either strong acids or strong bases in water?

1. All are either strong acids or strong bases.

2. None are strong acids nor strong bases.

3. $HClO_2$ and NaOH

4. NaOH

5. NaOH and $Ba(OH)_2$ **correct**

Explanation:
Memorize the strong acids and strong bases. All others are weak. Only NaOH and $Ba(OH)_2$ are strong; they are strong bases.

Mlib 07 1091
22:09, general, multiple choice, > 1 min, fixed.

029 (part 1 of 1) 6 points

The pH of a human blood sample was measured to be 7.41. What is the $[OH^-]$ in this blood?

1. 3.89×10^{-8} mol/L

2. 2.57×10^{-7} mol/L **correct**

3. 6.59 mol/L

4. Cannot be determined from the information given.

5. 6.05×10^{-7} mol/L

6. 4.12×10^{-7} mol/L

Explanation:
pH = 7.41

$$\text{pOH} = 14 - \text{pH} = 14 - 7.4 = 6.59$$

$$[OH^-] = 10^{-\text{pOH}} = 2.57 \times 10^{-7}$$

Acid Strength 10 23
23:01, general, multiple choice, > 1 min, wording-variable.

030 (part 1 of 1) 6 points

Arrange the acids

I) hydrogen selenate ion ($HSeO_4^-$), $pK_a = 1.92$;
II) phosphorous acid (H_3PO_3), $pK_{a1} = 2.00$;
III) phosphoric acid (H_3PO_4), $pK_a = 2.12$;
IV) selenous acid (H_2SeO_3), $pK_a = 2.46$;

in *decreasing* order of strengths.

1. I, II, III, IV **correct**

2. IV, III, II, I

3. I, II, IV, III

4. III, IV, II, I

5. I, III, II, IV

6. IV, II, III, I

7. I, III, IV, II

8. II, IV, III, I

9. None of these

10. Cannot be determined

Explanation:
The stronger the acid, the higher the K_a value and the lower the pK_a value:

$$pK_a = -\log(K_a)$$
$$K_a = 10^{-pK_a}$$

I. For the hydrogen selenate ion,

$$K_a = 10^{-1.92} = 0.0120226$$

II. For phosphorous acid,

$$K_a = 10^{-2.00} = 0.01$$

III. For phosphoric acid,

$$K_a = 10^{-2.12} = 0.00758578$$

IV. For selenous acid,

$$K_a = 10^{-2.46} = 0.00346737$$

$$HSeO_4^- > H_3PO_3 > H_3PO_4 > H_2SeO_3$$