

Answer on Question #64158 - Chemistry - General Chemistry

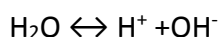
1. If 5.40 kcal of heat is added to 1.00 kg of water at 100°C, how much steam at 100°C is produced? Show all calculations leading to an answer.

Answer

Since the temperatures of water and steam in the task are both equal to 100°C, all heat is used for changing the state (vaporization). The specific latent heat of water vaporization $L = 540 \text{ kcal/kg}$. That means that 1 kg of water requires 540 kcal of heat to boil, $L = Q/m$. Thus, $m = Q/L$ and 5.40 kcal of heat (Q) produces $m = 5.40 \text{ kcal} / 540 \text{ kcal/kg} = 0.01 \text{ kg}$ of steam.

2. The K_w of water varies with temperature. Calculate the pH of water at 46°C with a $K_w = 1.219 \times 10^{-14}$. Show all calculations leading to an answer.

Answer



K_w is a water autoionization constant, $K_w = [\text{H}^+] \cdot [\text{OH}^-]$,

where $[\text{H}^+]$ is the molar concentration of hydrogen (or hydroxonium ion), and $[\text{OH}^-]$ is the concentration of hydroxide ion. At pure water, as it can be seen from the chemical equation above, H^+ and OH^- molar concentrations are equal, $[\text{H}^+] = [\text{OH}^-]$.

So, $K_w = [\text{H}^+]^2$

Thus, $[\text{H}^+] = \sqrt{K_w}$

By definition, $\text{pH} = -\log_{10} [\text{H}^+]$

So, $\text{pH} = -\log_{10} \sqrt{K_w}$

At 46°C $\text{pH} = -\log_{10} \sqrt{1.219 \times 10^{-14}} = 6.957$

3. Calculate the hydroxide ion concentration of a solution with $\text{pH} = 3.25$. Show all calculations leading to an answer.

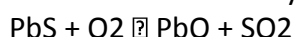
Answer

By definition, $\text{pH} = -\log_{10} [\text{H}^+]$. Thus, hydrogen concentration $[\text{H}^+] = 10^{-\text{pH}} = 10^{-3.25}$

Water autoionization constant $K_w = [\text{H}^+] \cdot [\text{OH}^-] = 1.00 \times 10^{-14}$

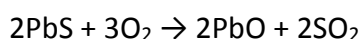
So, $[\text{OH}^-] = K_w / [\text{H}^+] = 1.00 \times 10^{-14} / 10^{-3.25} = 1.78 \times 10^{-11}$

4. The following unbalanced equation describes the reaction that can occur when lead (II) sulfide reacts with oxygen gas to produce lead (II) oxide and sulfur dioxide gas:



Balance the equation and describe in words the electron transfer(s) that takes place.

Answer



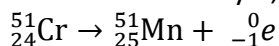
O has an oxidation number of zero in O_2 , but O in compounds has an oxidation number of -2, so each atom of O gets 2 electrons during the reaction. The oxidation number of Pb remains the same (+2). S in compound PbS has an oxidation number of -2, but in compound

SO₂ it has an oxidation number of +4, so each atom of S loses 6 electrons during the reaction.

5. What type of radiation is emitted when chromium-51 decays into manganese-51? Show the nuclear equation that leads you to this answer.

Answer

Using the in periodic table it can be found that we deal with $^{51}_{24}\text{Cr}$ and $^{51}_{25}\text{Mn}$. These isotopes have the same mass number, but different atomic numbers. During the decay, $^{51}_{24}\text{Cr}$ changes atomic number by 1, because 1 neutron converts into 1 proton and 1 electron.



Electron is emitted in the reaction. Such type of decay is called beta-minus decay.

6. A radioactive nucleus alpha decays to yield a sodium-24 nucleus in 14.8 hours. What was the identity of the original nucleus? Show the nuclear equation that leads you to this answer.

Answer

Products of decay are following:

$^{24}_{11}\text{Na}$ – sodium-24

^4_2He – alpha particle (nucleus of a helium-4)

So, $^A_Z\text{X} \rightarrow ^{24}_{11}\text{Na} + ^4_2\text{He}$, where X is an unknown element, A – atomic number, Z – mass number.

$$A = 24 + 4 = 28$$

$$Z = 11 + 2 = 13$$

Mass number 13 in the periodic table has aluminum. Thus, the unknown element is aluminium-28. The final nuclear equation is:

