58. One liter of gaseous (diatomic) oxygen combines completely with two liters of gaseous (diatomic) hydrogen to form a gas of water molecules (steam), when all of the gases are contained at the same temperature and pressure. One concludes from this that a water molecule has twice as many hydrogen atoms as it has oxygen atoms. If one also knows the volume of the steam finally produced (at the same temperature and pressure as the original hydrogen and oxygen), one can also choose the correct formula for water from the chemical formulas, $\text{H}_2\text{O}$, $\text{H}_2\text{O}_2$, and $\text{H}_2\text{O}_3$, etc., all of which have twice as many hydrogen atoms as oxygen atoms in each molecule, as required.

Then suppose that the correct formula for the water molecule were $\text{H}_2\text{O}_3$, and compute the volume (at the same temperature and pressure) of steam finally produced. The final volume in that case would be, most nearly:

$$\text{a. } 6.00 \text{ liters}$$
$$\text{b. } 3.00 \text{ liters}$$
$$\text{c. } 2.00 \text{ liters}$$
$$\text{d. } 1.00 \text{ liter}$$
$$\text{e. } 0.50 \text{ liter}$$
$$\text{f. } 0.33 \text{ liter}$$
$$\text{g. } 0.17 \text{ liter}$$

h. None of the above is within 10% of the correct answer.

59. If 5 g of steam at 100° C are mixed with 45 g of ice at 0° C in a completely insulated container, what is the final equilibrium temperature, most nearly? (Use 80 cal/gm for the latent heat of fusion, 540 cal/gm for the latent heat of vaporization, and 1 cal/gm° C for the specific heat of water.)

$$\text{a. } 10° \text{ C}$$
$$\text{b. } 20° \text{ C}$$
$$\text{c. } 30° \text{ C}$$
$$\text{d. } 40° \text{ C}$$
$$\text{e. } 50° \text{ C}$$
$$\text{f. } 60° \text{ C}$$
$$\text{g. } 70° \text{ C}$$
$$\text{h. } 80° \text{ C}$$
$$\text{i. } 90° \text{ C}$$

j. None of the above is within 5° C of the correct answer. Material cannot give a final temperature >100° C or <0° C. Reconsider the assumption implicit above that all of the ice melted: If only a fraction, $f$, melted, then the final mixture of ice + water has $T_f = 0° \text{ C}$ and only $(f \cdot 45.80) \text{ cal}$ is added from the melting. Then $2700 + 570 - 3600 \cdot f = 50T_f = 50 \cdot 0° \text{ C} = 0$. Then melted fraction is $f = \frac{3200}{6600} = 0.485$ & $T_f = 0° \text{ C}$. Then is correct.