

Chemistry questions for the blitz-tour – answers and brief solutions

1. C_4H_9OH – 4 structural isomers, one of them (2-butanol) has two enantiomers, 5 molecules in total.

$CH_3-O-C_3H_7$ – 2 molecules

$C_2H_5-O-C_2H_5$ – 1 molecule

Total – **8** molecules.

2. $C_2H_5CH(OH)CH_3 + 4I_2 + 6NaOH \rightarrow C_2H_5COONa + 5NaI + CHI_3\downarrow + 5H_2O$

$n(C_2H_5CH(OH)CH_3) = 7.4 / 74 = 0.1 \text{ mol}$

$n(NaOH) = 0.6 \text{ mol}$

$m(NaOH) = 0.6 \cdot 40 = 24 \text{ g}$

$m(\text{solution}) = 24 / 0.05 = \mathbf{480 \text{ g}}$.

3. $C(Mg^{2+}) = C(CO_3^{2-})$, $C(Na^+) = C(NO_3^-)$, hence, $C(K^+) = C(Cl^-) = \mathbf{22 \text{ mM}}$.

4. D-galactose – $C_6H_{12}O_6$, sucrose – $C_{12}H_{22}O_{11}$, they are not isomers of any type.

Correct answer – **5**

5. H_2O – bond angle is 104.5° , it is less than the tetrahedral angle (109.5°) because of repulsion of two unshared electron pairs.

NH_3 – angle HNH is closer to the tetrahedral angle than that in H_2O , because in NH_3 molecule there is only one unshared electron pair.

H_2S – the bond angle is close to 90° due to lack of hybridization.

CH_4 – the tetrahedral bond angle, 109.5° .

ICl_4^- – the ion has square form, the bond angle is 90° .

Correct answers – **2, 4**.

6. The initial solution: $C(CH_3COOH) = \frac{[H^+]^2}{K} + [H^+] = 1.0 \text{ M}$.

$C(NaOH) = (2.00/40) / 0.2 = 0.25 \text{ M}$.

After addition of NaOH we get the buffer solution with $C(CH_3COOH) = 0.75 \text{ M}$,

$C(CH_3COONa) = 0.25 \text{ M}$.

$pH = -\lg(1.75 \cdot 10^{-5}) + \lg(0.25/0.75) = 4.28$.

Correct answer – **4**.

7. $XeF_n + (n/2)H_2 = Xe + nHF$

$\Delta P = P(HF) - P(H_{2,\text{reacted}}) = P(H_{2,\text{reacted}}) = 144 - 96 = 48 \text{ Torr}$

$P(H_{2,\text{reacted}}) / P(Xe) = 2$

$n/2 = 2$

$n = \mathbf{4}$.

8. $FeS_2 + 14H^+ + 15NO_3^- = Fe^{3+} + 2SO_4^{2-} + 15NO_2 + 7H_2O$.

The sum of stoichiometric coefficients is **55**.

9. $K = n(I\text{Br})^2 / (n(I_2) \cdot n(\text{Br}_2)) = 0.6^2 / (0.4 \cdot 0.2)^2 = \mathbf{9}$.

10. For the transition $m \rightarrow n$, $\Delta E \sim \left(\frac{1}{m^2} - \frac{1}{n^2} \right)$. The largest wavelength corresponds to the

smallest ΔE , that is $E_6 - E_3$.

Correct answer – **4**.



$$K_{\text{sp}} = [\text{Mg}^{2+}] \cdot [\text{OH}^-]^2 = [\text{OH}^-]^3 / 2$$

$$[\text{OH}^-] = 10^{-3.6}$$

$$K_{\text{sp}} = 10^{-10.8} / 2 = 7.9 \cdot 10^{-12}$$

Correct answer – **7.9** (7.8 is also accepted).

12. We use the Raoult's law.

Let x be the mole fraction of the solute, then

$$x = (2.93 - 2.76) / 2.93 = 0.058.$$

$$0.058 = \frac{\frac{23}{M}}{\frac{23}{M} + \frac{200}{46}}$$

$$M = \mathbf{86} \text{ g/mol.}$$

13. The initial solution: $1 \text{ KOH} + 8\text{H}_2\text{O}$

The final solution: $1\text{KOH} + 28\text{H}_2\text{O}$

The mass ratio: $(56+28 \cdot 18) / (56+8 \cdot 18) = 2.8$

Correct answer – **4**.

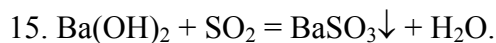
14. $K \sim n(\text{N}_2\text{O}_4) / (n(\text{NO}_2))^2 = 2 / 2^2 = 1/2.$

Fig. 2: $n(\text{N}_2\text{O}_4) / (n(\text{NO}_2))^2 = 1 \neq K$

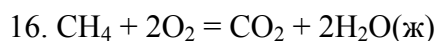
Fig. 3: $n(\text{N}_2\text{O}_4) / (n(\text{NO}_2))^2 = 1/4 \neq K$

Fig. 4: $n(\text{N}_2\text{O}_4) / (n(\text{NO}_2))^2 = 8 / 4^2 = 1/2 = K$ – the mixture is in equilibrium.

Correct answer – **4**.



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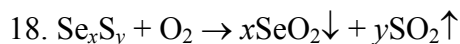
CH_4 and O_2 reacted completely, because there are only two gases in the resulting mixture – CO_2 and Ar.

$$\Delta V = V(\text{O}_2, \text{reacted}) = 20 - 12 = \mathbf{8} \text{ mL.}$$

17. $x = 2.$

$1s^2 2s^2 2p^6 3s^2 3p^6 3d^2 4s^2$ – Ti (8 s -electrons, 12 p -electrons, 2 d -electrons),

the atomic number is **22**.



$$x : y = n(\text{SeO}_2) : n(\text{SO}_2) = (333/111) : (40.3/22.4) = 1.67 = 5 : 3.$$



Correct answer – **53**.



Correct answer – **5101**.

20. Tripeptide is an asymmetric molecule with 6 stereocenters.

The number of stereoisomers = $2^6 = \mathbf{64}$.