Materials Chemistry Questions with Solutions

Q1: What is the size range of different materials?

Answer: The size of materials can be as small as the size of the atoms or can be as large as any fundamental unit of any body/ object.

Q2. What are some examples of materials?

Answer: The examples of materials include: metals, ceramics, composite materials, fibres, plastics and glass.

Q3. What are the different fields in which materials are used?

Answer: The application of materials covers vast areas such as transportation, food industry, logistics, cosmetics, construction, metallurgy, design and research.

Q4. The smallest material constituting a crystal structure is _____.

(i) Atoms
(ii) Molecules
(iii) Composite materials
(iv) Unit cell

Answer: (d)

Explanation: A unit cell is the building block of a crystal structure.

Q5. How many atoms and molecules are there in 1 gram of Hydrogen?

Answer: By convention, 1 gram of Hydrogen weighs equal to gram atomic mass of hydrogen. Since 1 mole is equivalent to 6.022×10^{23} units, 1 gram of hydrogen contains 6.022×10^{23} atoms of hydrogen. Now that hydrogen is a diatomic gas, that means its atoms exist in pairs. So, the number of hydrogen molecules in 1 gram of hydrogen is equal to half the number of atoms present in 1 gram of hydrogen. Therefore, 1 gram of hydrogen contains 3.022×10^{23} molecules of hydrogen.

Q6. List each of the following substances as elements, compounds or mixtures.
Milk, sand, wood, iodized salt, water, air, glucose, vitamins, petrol, steam, dry ice, smoke, diamond, mercury, brass, cloud, rain water, benzene, alcohol, amino acids, iron rod.

Answer: The given compounds are listed as elements, compounds and mixtures hereunder:

Elements	Compounds	Mixtures
Diamond	Amino acids	Milk
Mercury	Water	Sand
Iron rod	Glucose	Wood
	Vitamins	Air
	Steam	Petrol
	Dry ice	Smoke
	Benzene	Brass
	Alcohol	Cloud
	Amino acids	Rain Water
		Iodized salt

Explanation: Elements are substances made up of only one kind of particle or atoms. Compounds are substances that are made up of two or more different kinds of atoms combined together in a fixed ratio by mass. Elements and compounds both are considered as pure substances.
Mixtures are made up of different compounds mixed together in indefinite ratios. Mixtures are impure substances.

Q7. Assuming the formula weights of the given compounds as x, y and z respectively, determine the equivalent weight of each of the following.

(a) $MgCl_2$
(b) $Ca_3(PO_4)_2$
(c) $Na_3PO_4.12H_2O$

Answer: The Equivalent weight is said to be the exact amount of substance that reacts with another element or compound. The formula for the calculation of equivalent weight is given hereunder:

Equivalent weight = Molecular weight / Total positive valency

(a) The formula weight or molecular weight is given as x. The total positive valency is 2.
Hence, Equivalent weight = Molecular weight / Total positive valency

Equivalent weight = x / 2

(b) The formula weight or molecular weight is given as y. The total positive valency is 2 x 3 = 6; as the valency of 1 calcium atom is 2 and the given compound has 3 calcium atoms.

Hence, Equivalent weight = Molecular weight / Total positive valency

Equivalent weight = y / 6

(c) The formula weight or molecular weight is given as z. The total positive valency is 3 x 1 = 3.
Hence, Equivalent weight = Molecular weight / Total positive valency

Equivalent weight = z / 3

Q8. Mention three compounds containing the same percentage composition of C, H and O. Also write the formula of all three chemical compounds.

Answer: Percentage Composition of a fraction of the given compound is defined as the part by mass of that fraction in 100 parts by mass of the compound.
Percentage Composition = (No. of parts by mass of the fraction/ Mol. mass of the compound) x 100
The compounds having the same percentage composition of C,H and O must have the same empirical formula. Thus, the compounds having the same empirical formula- CH_2O are HCHO, CH_3COOH and $C_6H_{12}O_6$. In each of these compounds, the percentage composition of H, C and O are 6.67%, 40% and 53.33% respectively.

Q9. What is the vapour Density of 1 L of a gas that weighs 2.05 g at STP?

Answer: Since we know that the mass of 22.4 L of any gas at STP is equal to its molecular weight.
Hence, 22.4 L of the given gas weighs: 22.4 x 2.05 = 45.92 g at STP.
So, the molecular mass of the given gas is 45.92 g.
Now, Vapour Density = Mol. mass/ 2
Vapour Density of the given gas = 45.92 / 2 = 22.96

Q10. Why is the atomic mass an average mass?

Answer: Since most of the elements exist in different isotropic forms. The different isotopes differ in masses and their relative abundance in nature. Hence, an average value of masses is taken.

Q11. Calculate the volume occupied by 1 molecule of water.

Answer: The density of water is 1 g/cm^3. Hence, the volume occupied by 1 mole of water i,e. 18 g of water is 18 cm^3. This means that 6.022×10^{23} molecules of water occupy 18 cm^3.
Hence, 1 molecule of water will occupy 18 / 6.022×10^{23} cm^3 i,e. 2.989×10^{-23} cm^3.

Q12. Name any 5 methods used in the synthesis of nanoparticles.

Answer: The 5 methods used in the synthesis of nanoparticles are:

1. Vapour Deposition method
2. Hydrothermal synthesis

3. Thermal Decomposition method
4. Sol-gel method
5. Microwave synthesis

Q13. How many kinds of nanoparticles are there? Name them.

Answer: Based on the kinds of constituting substances, the nanoparticles can be categorised into 2 groups namely Inorganic and Organic nanoparticles.

Q14. Which void has the largest size among the following?

(a) Triangular void
(b) Octahedral void
(c) Tetrahedral void
(d) Cubic void

Answer: (d)
Explanation: Cubic voids are formed when each spherical unit is placed on the edge of a cube in the 3D space.

Q15. Why are the atomic masses of most of the elements fractional?

Answer: This is because the atomic masses of elements are relative values to that of the mass of carbon-12.

Practise Questions on Materials

Q1. Calculate the amount of carbon dioxide gas that can be produced when 2 moles of carbon are burnt in air.

Answer: The balanced chemical equation for the reaction that occurs when carbon is burned in air is given below:

$$C(s) + O_2(g) \rightarrow CO_2\ (g)$$

Hence, it can be seen that 1 mole of carbon produces 1 mol of carbon dioxide and hence, 2 moles of carbon will produce 2 moles of carbon dioxide. Hence, the mass of 2 moles of CO_2 is 2 x 44 g = 88 g.

Q2. How much of Sodium can be obtained from 100 g of Na_2SO_4?

Answer: The molar mass of Na_2SO_4 is 142 g/mol.
142 g of Na_2SO_4 contains 46 g of sodium.

Hence, 100 g of Na_2SO_4 contains 46 / 142 x 100 g of sodium. So, 100 g of Na_2SO_4 contains 32.39 g of Na.

Q3. One mole of Nitrogen gas at STP is equal to_____.

(a) 6.022 x 10^{23} moles of Nitrogen
(b) 6.022 x 10^{23} atoms of Nitrogen
(c) 6.022 x 10^{23} molecules of Nitrogen
(d) 22.4 g of Nitrogen

Answer: (c)

Explanation: Nitrogen gas is diatomic in nature. Hence, 1 mole of nitrogen gas is equivalent to 6.022 x 10^{23} molecules of Nitrogen.

Q4. What is the difference between vapours and gases?

Answer: The vapour is the gaseous form of any substance which is a liquid at normal room temperature. However, gases exist in gaseous state at normal room temperature conditions as well.

Q5. How are 0.50 mol and 0.50 M $NaHCO_3$ different?

Answer: The molar mass of $NaHCO_3$ is 84 g/mol.
0.50 mol of $NaHCO_3$ means 0.50 x 84 = 42 g of $NaHCO_3$.
While, 0.50 M $NaHCO_3$ would mean that 0.50 moles of $NaHCO_3$ are present in 1 L of solution.