Quiz (Mole, Avogadro's Number and Molar Mass)

1. A gas jar contains 0.5 mole of oxygen molecules.
   (a) Calculate the number of oxygen molecules in the gas jar.
   (b) Hence, calculate the number of oxygen atoms in the gas jar.

2. Given that a beaker contains 1.204×10^{24} sodium atoms. How many moles of sodium atoms are there in the beaker?

3. What is the molar mass of each of the following substances?
   (a) Silver
   (b) Fluorine
   (c) Ammonia
   (d) Ethanol (C_2H_5OH)
   (e) Iron(III) sulphate
   (Relative atomic masses: H = 1.0, C = 12.0, N = 14.0, O = 16.0, F = 19.0, S = 32.1, Fe = 55.8, Ag = 107.9)

4. What is the mass of each of the following substances?
   (a) 1 mole of sodium sulphate
   (b) 0.5 mole of tetrachloromethane (CCl_4)
   (Relative atomic masses: C = 12.0, O = 16.0, Na = 23.0, S = 32.1, Cl = 35.5)

5. A gas jar contains 1.85 moles of methane (CH_4).
   (a) Calculate the mass of methane in the gas jar.
   (b) Hence, calculate the number of methane molecules in the gas jar.
   (Relative atomic masses: H = 1.0, C = 12.0)

6. A beaker contains 10.21 g of magnesium hydroxide.
   (a) Calculate the number of moles of magnesium hydroxide in the beaker.
   (b) Hence, calculate the number of hydroxide ions in the beaker.
   (Relative atomic masses: H = 1.0, O = 16.0, Mg = 24.3)

7. Calculate the mass of
   (a) 1 Na atom
   (b) 1 H_2O molecule
   (c) 1 formula unit of NaCl
   (Relative atomic masses: H = 1.0, O = 16.0, Na = 23.0, Cl = 35.5)

8. Calculate the mass of
   (a) 1 Mg atom
   (b) 1 I_2 molecule
   (c) 1 formula unit of calcium carbonate
   (Relative atomic masses: C = 12.0, O = 16.0, Mg = 24.3, Ca = 40.1, I = 126.9)

9. Calculate the mass of
   (a) 0.200 mole of chlorine atoms.
   (b) 0.200 mole of chlorine molecules.
   (c) chlorine which contains the same number of molecules as there are in 1.20 mole of water.
   (Relative atomic masses: H = 1.0, O = 16.0, Cl = 35.5)

10. Complete the following table.

	Substance	**Molar mass (g mol^{-1})**	**Mass (g)**	**No. of moles (mol)**	**No. of molecules / formula units**
(a)	Sodium hydroxide			0.250	
(b)	Helium		0.20		
(c)	Sulphur dioxide				3.01×10^{24}
(d)	Compound *X*		23.0		3.01×10^{23}

(Relative atomic masses: H = 1.0, He = 4.0, O = 16.0, Na = 23.0, S = 32.1)

Suggested Answer

1. (a) Number of oxygen molecules
$= 0.5 \times 6.02 \times 10^{23}$
$= 3.01 \times 10^{23}$

(b) As there are two oxygen atoms in each oxygen molecule, number of oxygen atoms
$= 3.01 \times 10^{23} \times 2$
$= 6.02 \times 10^{23}$

2. Number of moles of sodium atoms
$= 1.204 \times 10^{24} / 6.02 \times 10^{23}$
$= 2$ mol

3. (a) Molar mass of Ag
$= 107.9$ g mol^{-1}

(b) Molar mass of F_2
$= 19.0 \times 2$ g mol^{-1}
$= 38.0$ g mol^{-1}

(c) Molar mass of NH_3
$= (14.0 + 1.0 \times 3)$ g mol^{-1}
$= 17.0$ g mol^{-1}

(d) Molar mass of C_2H_5OH
$= (12.0 \times 2 + 1.0 \times 6 + 16.0)$ g mol^{-1}
$= 46.0$ g mol^{-1}

(e) Molar mass of $Fe_2(SO_4)_3$
$= 55.8 \times 2 + 3 \times (32.1 + 16.0 \times 4)$ g mol^{-1}
$= 399.9$ g mol^{-1}

4. (a) Mass of 1 mole of Na_2SO_4
$= (23.0 \times 2 + 32.1 + 16.0 \times 4)$ g
$= 142.1$ g

(b) Mass of 0.5 mol of CCl_4
$= 0.5 \times (12.0 + 35.5 \times 4)$ g
$= 77.0$ g

5. (a) Molar mass of methane
$= (12.0 + 1.0 \times 4)$ g mol^{-1}
$= 16.0$ g mol^{-1}

Mass of methane
$= 1.85$ mol $\times 16.0$ g mol^{-1}
$= 29.6$ g

(b) Number of methane molecules
= 1.85 mol × 6.02×10^{23} mol^{-1}
= 1.11×10^{24}

6. (a) Molar mass of magnesium hydroxide ($Mg(OH)_2$)
= (24.3 + 16.0 × 2 + 1.0 × 2) g mol^{-1}
= 58.3 g mol^{-1}

Number of moles of $Mg(OH)_2$
= 10.21 g / 58.3 g mol^{-1}
= 0.175 mol

(b) Since 1 formula unit of $Mg(OH)_2$ contains $2OH^-$ ions,
number of moles of OH^- ions = 0.175 × 2 mol = 0.350 mol

Number of OH^- ions
= 0.350 mol × 6.02×10^{23} mol^{-1}
= 2.11×10^{23}

7. One mole of a substance corresponds to its molar mass and contains the Avogadro constant of formula units.
∴ mass of 1 formula unit = molar mass / Avogadro constant

(a) Mass of 1 Na atom
= 23.0 g mol^{-1} / 6.02×10^{23} mol^{-1}
= 3.82×10^{-23} g

(b) Mass of 1 H_2O molecule
= (1.0 × 2 + 16.0) g mol^{-1} / 6.02×10^{23} mol^{-1}
= 2.99×10^{-23} g

(c) Mass of 1 formula unit of NaCl
= (23.0 + 35.5) g mol^{-1} / 6.02×10^{23} mol^{-1}
= 9.72×10^{-23} g

8. (a) Mass of 1 Mg atom
= 24.3 g mol^{-1} / 6.02×10^{23} mol^{-1}
= 4.04×10^{-23} g

(b) Mass of 1 I_2 molecule
= 126.9 × 2 g mol^{-1} / 6.02×10^{23} mol^{-1}
= 4.22×10^{-22} g

(c) Mass of 1 formula unit of $CaCO_3$
= (40.1 + 12.0 + 16.0 × 3) g mol^{-1} / 6.02×10^{23} mol^{-1}
= 1.66×10^{-22} g

9. (a) Mass of 0.200 mole of Cl atoms
= 0.200 × 35.5 g
= 7.1 g

(b) Mass of 0.200 mole of Cl_2 molecules
= 0.200 × (35.5 × 2) g
= 14.2 g

(c) Mass of Cl_2
= 1.20 × (35.5 × 2) g
= 85.2 g

10.

	Substance	Molar mass ($g\ mol^{-1}$)	Mass (g)	No. of moles (mol)	No. of molecules / formula units
(a)	Sodium hydroxide	**40.0**	**10**	0.250	**1.51×10^{23}**
(b)	Helium	**4.0**	0.20	**0.05**	**3.01×10^{22}**
(c)	Sulphur dioxide	**64.1**	**320.5**	**5**	3.01×10^{24}
(d)	Compound *X*	**46.0**	23.0	**0.5**	3.01×10^{23}