

## Atoms, Molecules and Moles

Fluorine has one naturally occurring isotope, so each fluorine atom has mass number 19.

Each atom of F contains 9 electrons around a nucleus containing 9 protons and 10 neutrons.

Each atom of F weighs 19.0 amu (atomic mass unit).

Phosphorus has one naturally occurring isotope, so each phosphorus atom has mass number 31.

Each atom of P contains 15 electrons around a nucleus containing 15 protons and 16 neutrons.

Each atom of P weighs 31.0 amu.

1 mole F has  $6.02 \times 10^{23}$  atoms of F and weighs 19.0 g. So  $19.0 \text{ g F} = 6.02 \times 10^{23}$  atoms F

1 mole P has  $6.02 \times 10^{23}$  atoms of P and weighs 31.0 g. So  $31.0 \text{ g P} = 6.02 \times 10^{23}$  atoms P

The compound phosphorus trifluoride,  $\text{PF}_3$ , is made up of molecules of  $\text{PF}_3$ . Molecules are tiny. Each molecule of  $\text{PF}_3$  contains 1 atom of P and 3 atoms of F (just 4 atoms total).

1 mole  $\text{PF}_3$  has  $6.02 \times 10^{23}$  molecules of  $\text{PF}_3 = 6.022 \times 10^{23}$  P atoms +  $3 \times 6.022 \times 10^{23}$  F atoms.

1 mol  $\text{PF}_3 = 1 \text{ mol P} + 3 \text{ mol F} = 31.0 \text{ g P} + 3 \times 19.0 \text{ g F} = 88.0 \text{ g PF}_3$ .

Fill in the following blanks.

1. One molecule of  $\text{F}_2$  has \_\_\_\_\_ atoms of fluorine and weighs \_\_\_\_\_.
2. 76.0 amu of  $\text{F}_2$  has \_\_\_\_\_ fluorine atoms or \_\_\_\_\_ fluorine molecules.
3. 38.0 g  $\text{F}_2$  has \_\_\_\_\_ fluorine molecules or \_\_\_\_\_ fluorine atoms.
4. One mole of  $\text{P}_4$  has \_\_\_\_\_ atoms of phosphorus and weighs \_\_\_\_\_.
5. 124.0 amu  $\text{P}_4$  has \_\_\_\_\_ phosphorus atoms or \_\_\_\_\_  $\text{P}_4$  \_\_\_\_\_.
6. 31.0 g P has \_\_\_\_\_ mol phosphorus atoms or \_\_\_\_\_ mol phosphorus molecules ( $\text{P}_4$ ).
7. 2 molecules of diphosphorus tetrafluoride,  $\text{P}_2\text{F}_4$ , have \_\_\_\_\_ P atoms and \_\_\_\_\_ F atoms.
8. 69.0 g  $\text{P}_2\text{F}_4$  has \_\_\_\_\_ mol P and \_\_\_\_\_ mol F; or \_\_\_\_\_ mol  $\text{P}_2\text{F}_4$ .
9. 1 molecule  $\text{PF}_5$  contains 31.0 \_\_\_\_\_ P and 5 \_\_\_\_\_ F and weighs \_\_\_\_\_.
10. 1  $\text{PF}_4^+$  ion contains a **total** of \_\_\_\_\_ protons \_\_\_\_\_ neutrons and \_\_\_\_\_ electrons.

Answers: 1. 2, 38.0 amu (not g)      2. 4, 2      3.  $6.02 \times 10^{23}$ , 2 mol ( $2 \times 6.022 \times 10^{23}$ )

4.  $4 \times 6.022 \times 10^{23}$ , 124.0 g      5. 4, 1, molecule      6. 1,  $\frac{1}{4}$       7. 4, 8

8. 1, 2,  $\frac{1}{2}$       9. amu, atoms, 126.0 amu      10. 51, 56, 50