

## ANSWERS TO UNIT VI : CHEMICAL REACTIONS

- A system that is enclosed by an opaque box. (Light can't get in.)
  - A system that is enclosed by a transparent box. (Material can't get in or out, but light can.)
  - A system that is enclosed by a sound-absorbing box (transparent or opaque).
  - A system that, for example, is surrounded by two boxes, one that is open at the top and one that is open at the bottom, as shown below.



- A system in a container with heat-insulation. (This is not truly "closed"; see exercise 2; below.)
- The only system which might be closed is the universe itself (and astronomers are still arguing about this point). In general approximately closed systems can be made; but even the best heat insulation cannot keep a liquid hot forever. The problem is making a container through which energy cannot pass.
- What is CONSERVED: the composition (the material is still paper); total mass and properties such as colour, volume and density
  - What is NOT CONSERVED: the number of pieces present, shape
  - What is CONSERVED: composition and properties such as colour and density  
What is NOT CONSERVED: total mass; volume, surface area, shape and number of pieces
- Conservation of atoms (primarily) and conservation of mass will also be violated since Fe atoms have a different mass from Cu atoms.
  - Conservation of mass (15 g of reactants cannot make 16 g of products)
  - Conservation of charge: total charge on left = +1; total charge on right = 0.
  - No conservation laws violated.
  - Conservation of atoms (different numbers of Cr's and O's on either side). Conservation of mass will also be violated as a result.
  - No conservation laws violated
- Only (b) is **always** conserved. The others occasionally may be conserved in particular reactions.
- Left hand side contains: 1 C + 4 H + 4 O ; molar mass of reactants = 1 x 16.0 + 2 x 32.0 = 80.0 g  
Right hand side contains: 1 C + 4 O + 4 H ; molar mass of products = 1 x 44.0 + 2 x 18.0 = 80.0 g  
Since left and right sides have the same number and types of atoms and the same mass, atoms and mass are conserved.
  - Left hand side contains: 1 Na + 1 O + 2 H + 1 Cl ; molar mass of reactants = 40.0 + 36.5 = 76.5 g  
Right hand side contains: 1 Na + 1 Cl + 2 H + 1 O ; molar mass of products = 58.5 + 18.0 = 76.5 g  
Since left and right sides have the same number and types of atoms and the same mass, atoms and mass are conserved.
- $2 \text{ Sn} + \text{O}_2 \longrightarrow 2 \text{ SnO}$
- $\text{H}_2 + \text{Cl}_2 \longrightarrow 2 \text{ HCl}$
- $\text{N}_2 + 3 \text{ H}_2 \longrightarrow 2 \text{ NH}_3$
- $2 \text{ Na} + 2 \text{ H}_2\text{O} \longrightarrow 2 \text{ NaOH} + \text{H}_2$
- $4 \text{ NH}_3 + 3 \text{ O}_2 \longrightarrow 2 \text{ N}_2 + 6 \text{ H}_2\text{O}$
- $2 \text{ C}_6\text{H}_{14} + 19 \text{ O}_2 \longrightarrow 12 \text{ CO}_2 + 14 \text{ H}_2\text{O}$
- $2 \text{ KNO}_3 \longrightarrow 2 \text{ KNO}_2 + \text{O}_2$
- $\text{CaC}_2 + 2 \text{ O}_2 \longrightarrow \text{Ca} + 2 \text{ CO}_2$
- $\text{C}_5\text{H}_{12} + 8 \text{ O}_2 \longrightarrow 5 \text{ CO}_2 + 6 \text{ H}_2\text{O}$
- $\text{K}_2\text{SO}_4 + \text{BaCl}_2 \longrightarrow 2 \text{ KCl} + \text{BaSO}_4$
- $2 \text{ KOH} + \text{H}_2\text{SO}_4 \longrightarrow \text{K}_2\text{SO}_4 + 2 \text{ H}_2\text{O}$
- $\text{Ca(OH)}_2 + 2 \text{ NH}_4\text{Cl} \longrightarrow 2 \text{ NH}_3 + \text{CaCl}_2 + 2 \text{ H}_2\text{O}$
- $5 \text{ C} + 2 \text{ SO}_2 \longrightarrow \text{CS}_2 + 4 \text{ CO}$

20.  $\text{Mg}_3\text{N}_2 + 6 \text{H}_2\text{O} \longrightarrow 3 \text{Mg}(\text{OH})_2 + 2 \text{NH}_3$
21.  $\text{V}_2\text{O}_5 + 5 \text{Ca} \longrightarrow 5 \text{CaO} + 2 \text{V}$
22.  $2 \text{Na}_2\text{O}_2 + 2 \text{H}_2\text{O} \longrightarrow 4 \text{NaOH} + \text{O}_2$
23.  $\text{Fe}_3\text{O}_4 + 4 \text{H}_2 \longrightarrow 3 \text{Fe} + 4 \text{H}_2\text{O}$
24.  $\text{Cu} + 2 \text{H}_2\text{SO}_4 \longrightarrow \text{CuSO}_4 + 2 \text{H}_2\text{O} + \text{SO}_2$
25.  $2 \text{Al} + 3 \text{H}_2\text{SO}_4 \longrightarrow 3 \text{H}_2 + \text{Al}_2(\text{SO}_4)_3$
26.  $2 \text{Si}_4\text{H}_{10} + 13 \text{O}_2 \longrightarrow 8 \text{SiO}_2 + 10 \text{H}_2\text{O}$
27.  $4 \text{NH}_3 + \text{O}_2 \longrightarrow 2 \text{N}_2\text{H}_4 + 2 \text{H}_2\text{O}$
28.  $2 \text{C}_{15}\text{H}_{30} + 45 \text{O}_2 \longrightarrow 30 \text{CO}_2 + 30 \text{H}_2\text{O}$
29.  $2 \text{BN} + 3 \text{F}_2 \longrightarrow 2 \text{BF}_3 + \text{N}_2$
30.  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O} + 2 \text{SO}_3 \longrightarrow \text{CaSO}_4 + 2 \text{H}_2\text{SO}_4$
31.  $4 \text{C}_3\text{H}_7\text{N}_2\text{O}_7 + 5 \text{O}_2 \longrightarrow 12 \text{CO}_2 + 14 \text{H}_2\text{O} + 4 \text{N}_2$
32.  $\text{C}_7\text{H}_{16}\text{O}_4\text{S}_2 + 11 \text{O}_2 \longrightarrow 7 \text{CO}_2 + 8 \text{H}_2\text{O} + 2 \text{SO}_2$
33.  $9 \text{Na} + 4 \text{ZnI}_2 \longrightarrow 8 \text{NaI} + \text{NaZn}_4$
34.  $\text{HBrO}_3 + 5 \text{HBr} \longrightarrow 3 \text{H}_2\text{O} + 3 \text{Br}_2$
35.  $\text{Al}_4\text{C}_3 + 12 \text{H}_2\text{O} \longrightarrow 4 \text{Al}(\text{OH})_3 + 3 \text{CH}_4$
36.  $2 \text{Ca}(\text{NO}_3)_2 \cdot 3\text{H}_2\text{O} + 3 \text{LaC}_2 \longrightarrow 2 \text{Ca}(\text{NO}_3)_2 + 3 \text{La}(\text{OH})_2 + 3 \text{C}_2\text{H}_2$
37.  $\text{CH}_3\text{NO}_2 + 3 \text{Cl}_2 \longrightarrow \text{CCl}_3\text{NO}_2 + 3 \text{HCl}$
38.  $\text{Ca}_3(\text{PO}_4)_2 + 3 \text{SiO}_2 + 5 \text{C} \longrightarrow 3 \text{CaSiO}_3 + 5 \text{CO} + 2 \text{P}$
39.  $\text{Al}_2\text{C}_6 + 6 \text{H}_2\text{O} \longrightarrow 2 \text{Al}(\text{OH})_3 + 3 \text{C}_2\text{H}_2$
40.  $2 \text{NaF} + \text{CaO} + \text{H}_2\text{O} \longrightarrow \text{CaF}_2 + 2 \text{NaOH}$
41.  $4 \text{LiH} + \text{AlCl}_3 \longrightarrow \text{LiAlH}_4 + 3 \text{LiCl}$
42.  $2 \text{CaF}_2 + 2 \text{H}_2\text{SO}_4 + \text{SiO}_2 \longrightarrow 2 \text{CaSO}_4 + \text{SiF}_4 + 2 \text{H}_2\text{O}$
43.  $3 \text{CaSi}_2 + 2 \text{SbCl}_3 \longrightarrow 6 \text{Si} + 2 \text{Sb} + 3 \text{CaCl}_2$
44.  $2 \text{TiO}_2 + \text{B}_4\text{C} + 3 \text{C} \longrightarrow 2 \text{TiB}_2 + 4 \text{CO}$
45.  $4 \text{NH}_3 + 5 \text{O}_2 \longrightarrow 4 \text{NO} + 6 \text{H}_2\text{O}$
46.  $\text{SiF}_4 + 8 \text{NaOH} \longrightarrow \text{Na}_4\text{SiO}_4 + 4 \text{NaF} + 4 \text{H}_2\text{O}$
47.  $2 \text{NH}_4\text{Cl} + \text{CaO} \longrightarrow 2 \text{NH}_3 + \text{CaCl}_2 + \text{H}_2\text{O}$
48.  $4 \text{NaPb} + 4 \text{C}_2\text{H}_5\text{Cl} \longrightarrow \text{Pb}(\text{C}_2\text{H}_5)_4 + 3 \text{Pb} + 4 \text{NaCl}$
49.  $\text{Be}_2\text{C} + 4 \text{H}_2\text{O} \longrightarrow 2 \text{Be}(\text{OH})_2 + \text{CH}_4$
50.  $4 \text{NpF}_3 + \text{O}_2 + 4 \text{HF} \longrightarrow 4 \text{NpF}_4 + 2 \text{H}_2\text{O}$
51.  $3 \text{NO}_2 + \text{H}_2\text{O} \longrightarrow 2 \text{HNO}_3 + \text{NO}$
52.  $3 \text{LiAlH}_4 + 4 \text{BF}_3 \longrightarrow 3 \text{LiF} + 3 \text{AlF}_3 + 2 \text{B}_2\text{H}_6$
53.  $3 \text{Cu} + 8 \text{HNO}_3 \longrightarrow 3 \text{Cu}(\text{NO}_3)_2 + 2 \text{NO} + 4 \text{H}_2\text{O}$
54.  $3 \text{FeCl}_2 + \text{KNO}_3 + 4 \text{HCl} \longrightarrow 3 \text{FeCl}_3 + \text{NO} + 2 \text{H}_2\text{O} + \text{KCl}$
55.  $2 \text{KMnO}_4 + 16 \text{HBr} \longrightarrow 2 \text{MnBr}_2 + 5 \text{Br}_2 + 2 \text{KBr} + 8 \text{H}_2\text{O}$
56.  $\text{K}_2\text{Cr}_2\text{O}_7 + 14 \text{HCl} \longrightarrow 2 \text{KCl} + 2 \text{CrCl}_3 + 7 \text{H}_2\text{O} + 3 \text{Cl}_2$
57. (a)  $2 \text{K} + 2 \text{H}_2\text{O} \longrightarrow 2 \text{KOH} + \text{H}_2$                       (d)  $2 \text{Cu}_2\text{O} + \text{C} \longrightarrow 4 \text{Cu} + \text{CO}_2$   
 (b)  $\text{Sr} + 2 \text{H}_2\text{O} \longrightarrow \text{Sr}(\text{OH})_2 + \text{H}_2$                       (e)  $2 \text{NH}_3 + \text{H}_2\text{SO}_4 \longrightarrow (\text{NH}_4)_2\text{SO}_4$   
 (c)  $2 \text{Al} + 3 \text{Cl}_2 \longrightarrow 2 \text{AlCl}_3$
58.  $2 \text{H}_3\text{PO}_4(\text{l}) + 3 \text{Ba}(\text{OH})_2(\text{aq}) \longrightarrow \text{Ba}_3(\text{PO}_4)_2(\text{s}) + 6 \text{H}_2\text{O}(\text{l})$
59.  $\text{Al}_2\text{O}_3(\text{s}) + 3 \text{H}_2\text{SO}_4(\text{aq}) \longrightarrow 3 \text{H}_2\text{O}(\text{l}) + \text{Al}_2(\text{SO}_4)_3(\text{aq})$
60.  $2 \text{NF}_3(\text{g}) + 3 \text{H}_2(\text{g}) \longrightarrow \text{N}_2(\text{g}) + 6 \text{HF}(\text{g})$
61.  $\text{Na}_2\text{CO}_3(\text{s}) + 2 \text{HBr}(\text{aq}) \longrightarrow \text{CO}_2(\text{g}) + 2 \text{NaBr}(\text{aq}) + \text{H}_2\text{O}(\text{l})$