Suggested Answers on Note (Chapter 6S) P.1

Element	R.A.M.	Element	R.A.M.	Element	R.A.M.
Aluminium	**27.0**	**Fluorine**	**19.0**	**Nitrogen**	**14.0**
Argon	40.0	**Helium**	4.0	**Oxygen**	**16.0**
Barium	137.3	**Hydrogen**	**1.0**	**Phosphorus**	**31.0**
Beryllium	9.0	**Iodine**	126.9	**Platinum**	195.1
Boron	10.8	**Iron**	**55.8**	**Potassium**	**39.0**
Bromine	80.0	**Lead**	207.2	**Silicon**	28.1
Calcium	**40.0**	**Lithium**	6.9	**Silver**	107.9
Carbon	**12.0**	**Magnesium**	**24.3**	**Sodium**	**23.0**
Chlorine	**35.5**	**Manganese**	54.9	**Sulphur**	**32.1**
Chromium	52.0	**Mercury**	200.6	**Tin**	118.7
Cobalt	58.9	**Neon**	20.2	**Zinc**	**65.0**
Copper	**63.5**	**Nickel**	58.7		

Formula	Term to describe its Relative Mass	Molecular or Formula mass
H_2O	Molecular / Formula mass	(1) x 2 + (16) x 1 = 18
$Ca(OH)_2$	Formula mass	**(40) x 1 + [(16) + (1)] x 2 = 74**
H_2SO_4	Molecular / Formula mass	**(1) x 2 + (32) x 1 + (16) x 4 = 98**
$Na_2CO_3 \bullet 10H_2O$	Formula mass	**(23) x 2 + (12) x 1 + (16) x 3 + (1 x 2 + 16) x 10 = 286**

Suggested Answers on Note (Chapter 6S) P.2

1.

Formula	Element	R.F.M.	Formula	Element	R.F.M.
KOH	1 K, 1 O and 1 H	39 + 16 + 1 = 56	$C_{12}H_{22}O_{11}$	**12 C, 22 H and 11 O**	**342.0**
HNO_3	**1 H, 1 N and 3 O**	**63.0**	$Al(NO_3)_3$	**1 Al, 3 N and 9 O**	**213.0**
$PbSO_4$	**1 Pb, 1 S and 4 O**	**303.3**	NH_4HSO_4	**1 N, 5 H, 1 S and 4 O**	**115.1**
H_2SO_4	**2 H, 1 S and 4 O**	**98.1**	$H_2S_2O_7$	**2 H, 2 S and 7 O**	**178.2**
Al_2O_3	**2 Al and 3 O**	**102.0**	$CuSO_4.5H_2O$	**1 Cu, 1 S, 9 O and 10 H**	**249.6**
$(NH_4)_3PO_4$	**3 N, 12 H, 1 P and 4 O**	**149.0**	$K_3[Fe(CN)_6]$	**3 K, 1 Fe, 6 C and 6 N**	**329.1**

2.

Name	Formula	R.F.M.	Name	Formula	R.F.M.
Ammonium chloride	NH_4Cl	14 + 4 + 35.5 = 53.5	calcium nitrate	**$Ca(NO_3)_2$**	**164.1**
copper(II) sulphate	**$CuSO_4$**	**159.6**	lead(II) hydroxide	**$Pb(OH)_2$**	**241.2**
barium carbonate	**$BaCO_3$**	**197.3**	magnesium phosphate	**$Mg_3(PO_4)_2$**	**262.9**
aluminium sulphate	**$Al_2(SO_4)_3$**	**342.3**	carbon monoxide	**CO**	**28.0**
nickel(II) chloride	**$NiCl_2$**	**129.7**	nitrogen monoxide	**NO**	**30.0**
cobalt(II) bromide	**$CoBr_2$**	**218.7**	nitrogen dioxide	**NO_2**	**46.0**
Manganese(II) chloride	**$MnCl_2$**	**125.9**	sulphur dioxide	**SO_2**	**64.1**
potassium nitrate	**KNO_3**	**101.0**	sulphur trioxide	**SO_3**	**80.0**
sodium sulphate	**Na_2SO_4**	**142.1**	carbon disulphide	**CS_2**	**76.2**

Suggested Answers on Note (Chapter 6S) P.4

Substance	Symbol / chemical formula	Relative atomic mass(es)	Relative formula mass / Relative molecular mass	Molar mass (mass of 1 mole of substance)
Magnesium	Mg	Mg = 24.3	1 x 24.3 = 24.3	24.3 g mol^{-1}
Nitrogen	**N_2**	N = 14.0	**2 x 14.0 = 28.0**	**28.0 g mol^{-1}**
Sulphur dioxide	**SO_2**	O = 16.0 S = 32.1	**2 x 16.0 = 32.0** **1 x 32.1 = 32.1** **Total =64.1**	**64.1 g mol^{-1}**
Iron(III) sulphate	**$Fe_2(SO_4)_3$**	O = 16.0 S = 32.1 Fe = 55.8	**12 x 16.0 = 192.0** **3 x 32.1 = 96.3** **2 x 55.8 = 111.6** **Total = 399.9**	**399.9 g mol^{-1}**

1. **Molar mass of carbon dioxide = 12 + 16 x 2 = 44 g mol^{-1}**
   Mass of carbon dioxide = 7.5 x 44
   = 330 g

2. **Number of mole of Mg = 4.86 / 24.3 = 0.2**

3. **Molar mass of water = 1 x 2 + 16 x 1 = 18 g mol^{-1}**
   Mass of carbon dioxide = 15.5 x 18
   = 279 g

4. **Molar mass of nitrogen dioxide = 14 + 16 x 2 = 46 g mol^{-1}**
   Mass of nitrogen dioxide = 0.25 x 46
   = 11.5 g

Suggested Answers on Note (Chapter 6S) P.5 – 6

1.

Substance	Chemical formula	Relative formula mass / relative molecular mass	Molar mass (g mol^{-1})
Hydrogen bromide	**HBr**	**81.0**	**81.0**
Propanoic acid	CH_3CH_2COOH	**74.0**	**74.0**
Sodium hydroxide	**NaOH**	**40.0**	**40.0**
Calcium carbonate	**$CaCO_3$**	**100.0**	**100.0**

2. **Molar mass of nitrogen = 14 x 2 = 28 g mol^{-1}**
Number of mole of nitrogen = 15 / 28
= 0.5357

3. **(a) Molar mass of C_xH_{2x} = 140 / 2.5 = 56 g mol^{-1}**
(b) 56 = 12x + 2x
x = 4
Chemical formula = C_4H_8

4. **Number of mole of copper = 12.7 / 63.5 = 0.2**

5. **Molar mass of potassium carbonate (K_2CO_3)**
= 39.1 x 2 + 12 + 16 x 3
= 138.2 g mol^{-1}
Mass of potassium carbonate = 4.5 x 138.2
= 621.9 g

6.

Substance	Chemical formula	Molar mass of substance (g mol^{-1})	Mass of substance present (g)	Number of moles of substance present (mol)
Sulphur dioxide	**SO_2**	**64.1**	**83.33**	1.30
Lead(II) oxide	PbO	**223.0**	44.6	**0.20**
Ammonium carbonate	$(NH_4)_2CO_3$	**96.0**	**24.0**	0.25
Magnesium chloride	**$MgCl_2$**	**95.3**	19.06	**0.20**
Zinc hydroxide	$Zn(OH)_2$	**99.0**	**178.2**	1.80

Suggested Answers on Note (Chapter 6S) P.7

Example 1:

$2H_2(g)$	**+**	***$O_2(g)$***	**⟶**	***$2H_2O(g)$***
2 moles		***1 mole***		***2 moles***
0.5 moles		**0.25** moles		0.5 moles
4 moles		2 moles		**4** moles

Example 2:

$2Cu_2O(s)$	**+**	***$C(s)$***	**⟶**	***$4Cu(s)$***	**+**	***$CO_2(g)$***
2 moles		***1 mole***		***4 moles***		***1 mole***
0.25 moles		**0.125** moles		0.5 moles		**0.125** moles
4 moles		2 moles		**8** moles		**2** moles

Suggested Answers on Note (Chapter 6S) P.8 – 9

1. *Number of moles of H_2 present =* ***0.160 / 2.0 = 0.0800 mol***

   Number of moles of O_2 present = ***0.960 / 32.0 = 0.0300 mol***

   According to the equation,
   Mole ratio of H_2 : O_2 : H_2O = ***2 : 1 : 2***

   During the reaction,
   0.0300 *mole of O_2 reacts with* ***0.0600*** *mole of H_2.*

   Therefore ***hydrogen*** *is in excess. The amount of* ***oxygen*** *limits the amount of water produced.*

   Number of moles of H_2O produced = ***2 x 0.0300 = 0.0600 mol***

   Molar mass of H_2O = ***2 x 1.0 + 16.0 = 18.0 g mol^{-1}***

   Mass of H_2O produced = ***0.0600 x 18.0 = 1.08 g***

2. *No. of mole of $NaHCO_3$ =* ***3.36 / 84 = 0.04***

   No. of mole of CO_2 ***= 0.04 / 2 = 0.02***

   Molar mass of CO_2 = ***12.0 + 1.0 x 2 = 44.0 g mol^{-1}***

   Maximum mass of CO_2 = ***0.02 x 44.0 = 0.88 g***

3. *No. of mole of HCl =* ***2 x 0.025 = 0.05***

   No. of mole of H_2 = ***0.05 / 2 = 0.025***

   Molar mass of H_2 = ***1.0 x 2 = 2.0 g mol^{-1}***

   Maximum mass of H_2 = ***0.025 x 2.0 = 0.05 g***

4. *(a) No. of mole of Mg =* ***2.43 / 24.3 = 0.1***

   No. of mole of MgO = ***0.1***

   Molar mass of MgO = ***24.3 + 16.0 = 40.3 g mol^{-1}***

   Mass of MgO = ***0.1 x 40.3 = 4.03 g***

   (b) No. of mole of O_2 = ***1.28 / 32 = 0.04***

   No. of mole of Mg = ***0.1***

   Magnesium *is in excess!!!*

   No. of mole of MgO = ***0.04 x 2 = 0.08***

   Mass of MgO = ***0.08 x (24.3 + 16) = 3.224 g***

Suggested Answers on Note (Chapter 6S) P.10 – 13

1. **Number of mole of calcium provided = 1.00 / 40 = 0.025**
   According to the equation, 1 mole of Ca reacts with 2 moles of H_2O.
   Number of mole of H_2O needed = 0.025 x 2 = 0.050
   Mass of H_2O needed = 0.05 x 18 = 0.90 g

   Number of mole of $Ca(OH)_2$ produced = 0.025
   Mass of $Ca(OH)_2$ produced = 0.025 x 74 = 1.85 g

   Number of mole of H_2 produced = 0.025
   Mass of H_2 produced = 0.025 x 2 = 0.05 g

2. **Number of moles of Fe_2O_3 = 15.96 / 159.6 = 0.10**
   Number of moles of Al required = 2 x 0.10 = 0.20
   Mass of Al required = 0.20 x 27.0 = 5.40 g

3. **Number of mole of S = 35.2 / 32.1 = 1.097**
   Number of mole of SO_2 = 1.097
   Mass of SO_2 formed = 1.097 x (32.1 + 16.0 x 2) = 70.29 g

4. **Number of mole of Pb = 7.46 / 207.0 = 0.036**
   Number of mole of Pb_3O_4 required = 0.036 / 3 = 0.012
   Mass of Pb_3O_4 = 0.012 x 685 = 8.229 g

5. **Number of mole of CuO = 15.0 / 79.5 = 0.1887**
   Number of mole of C provided = 1.5 / 12.0 = 0.125

   According to the equation, 2 moles of CuO react with 1 mole of C.
   ∴ 0.125 mole of C needs 0.25 mole of CuO for complete reaction.
   However, there is only 0.189 mole of CuO provided.
   ∴ CuO is the limiting reactant or limiting reagent (or C is in excess).

   Number of moles of Cu formed = 0.1887
   Mass of Cu = 0.1887 x 63.5 = 11.98 g

   Number of moles of CO_2 = ½ x 0.1887 = 0.09435
   Mass of CO_2 formed = 0.09435 x (12 + 16 x 2) = 4.151 g

6. **Number of mole of Mg = 3.5 / 24.3 = 0.144**
   Number of mole of $MgCl_2$ = 0.144
   Mass of $MgCl_2$ formed = 0.144 x (24.3 + 35.5 x 2) = 13.72 g
   Number of mole of $H_2(g)$ = 0.144
   Mass of H_2 formed = 0.144 x (1 x 2) = 0.288 g

7. **Number of mole of Al = 16.2 / 27.0 = 0.60**
   Number of mole of Al_2O_3 reacted = 0.60 / 4 x 2 = 0.30
   Mass of Al_2O_3 reacted = 0.30 x (27.0 x 2 + 16.0 x 3) = 30.6 g
   Number of mole of O_2 formed = 0.60 / 4 x 3 = 0.45
   Mass of O_2 formed = 0.45 x (16.0 x 2) = 14.4 g

8. **Number of mole of sodium carbonate = 5.30 / (23.0 x 2 + 12.0 + 16.0 x 3) = 0.05**
   Number of mole of HCl = 0.08
   Sodium carbonate is in excess!!!
   Number of mole of carbon dioxide = 0.08 / 2 = 0.04
   Mass of carbon dioxide = 0.04 x (12.0 + 16.0 x 2) = 1.76 g

9. **Number of mole of copper(II) oxide = 15.9 / 79.5 = 0.20**
   Number of mole of hydrogen = 0.20
   Mass of copper = 0.20 x 63.5 = 12.7 g

10. **Number of mole of N_2 = 24.0 / 28.0 = 0.8571**
    Number of mole of NaN_3 = 0.8571 / 3 x 2 = 0.5714
    Mass of NaN_3 = 0.5714 x (23.0 + 14.0 x 3) = 37.14 g

11. (a) Number of mole of LiOH = 100.0 / (7.0 + 16.0 + 1.0) = 4.167
Number of mole of CO_2 absorbed = 4.167 / 2 = 2.083
Mass of CO_2 absorbed = 2.083 x (12.0 + 16.0 x 2) = 91.67 g

(b) Number of mole of CO_2 = 200.0 / (12.0 + 16.0 x 2) = 4.545
Number of mole of Li_2CO_3 = 4.545
Mass of Li_2CO_3 = 4.545 x (7.0 x 2 + 12.0 + 16.0 x 3) = 418.2 g

12. Number of moles of Hg present = 21.5 / 200.6 = 0.107 mol
Number of moles of Br_2 present = 15.6 / 160.0 = 0.0975 mol
Hg was in excess. The amount of Br_2 limited the amount of $HgBr_2$ produced.
Number of moles of $HgBr_2$ produced = 0.0975 mol
Molar mass of $HgBr_2$ = 200.6 + 2 x 80.0 = 360.6 g mol^{-1}

(a) Mass of $HgBr_2$ produced = 0.0975 x 360.6 = 35.16 g
(b) Mass of Hg reacted = 0.0975 x 200.6 = 19.56 g
Mass of Hg left = (21.5 – 19.56) g = 1.94 g

Suggested Answers on Note (Chapter 6S) P.14 – 15

1. The formula of aluminium oxide is Al_2O_3.
Formula mass of Al_2O_3 = 2 x 27.0 + 3 x 16.0 = 102.0.
Mass of Al_2O_3 = 102.0 x 2.3 = 234.6 g

2. The formula of metal sulphate is M_2SO_4.
71.05 / (2m + 32.0 + 16.0 x 4) = 0.50
m = 23.05

3. 2.0 = mass / (35.5 x 2)
Mass of chlorine molecules = 2.0 x 71.0 = 142.0 g

4. Formula mass of $FeSO_4 \bullet 7H_2O$
= 55.8 + 32.0 + 16.0 x 4 + 7 x (1.0 x 2 + 16.0)
= 277.8

5. Number of moles of sodium hydroxide
= 160.0 / (23.0 + 16.0 + 1.0)
= 4

6. Number of mole of lead = 20.7 / 207.0 = 0.10
Number of mole of lead(II) oxide = 0.10
Mass of lead(II) oxide = 0.10 x (207.0 + 16.0) = 22.3 g

7. $2ZnO(s) + C(s) \longrightarrow 2Zn(s) + CO_2(g)$
Number of mole of zinc = 0.80
Number of mole of ZnO = 0.80
Mass of ZnO = 0.80 x (65.4 + 16.0) = 65.12 g

8. **Number of mole of potassium = 3.90 / 39.0 = 0.10**
   Number of mole of hydrogen = 0.10 / 2 = 0.05
   Mass of hydrogen = 0.05 x (1.0 x 2) = 0.10 g

9. **Number of mole of oxygen = 4.80 / (16.0 x 2) = 0.15**
   Number of mole of M = 0.15 x 4 = 0.60
   Relative atomic mass of M = 19.20 / 0.60 = 32.0