Chemistry 20 – Lesson 4 **Balancing chemical equations**

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I. **Practice problems**

Reaction Type

1. $4 \text{ Al}_{(s)} + 3 \text{ O}_{2,(g)} \rightarrow 2 \text{ Al}_2 \text{O}_{3,(s)}$ formation

2. $2 \text{ HCl}_{(aq)} + \text{ Ca(OH)}_{2 (aq)} \rightarrow 2 \text{ HOH}_{(l)} + \text{ CaC1}_{2 (aq)}$ double replacement

3. $CH_{4 (g)} + 2 O_{2 (g)} \rightarrow CO_{2 (g)} + 2 H_2O_{(g)}$ complete combustion

 $Zn_{(s)} + Pb(CH_3COO)_{2 (aq)} \rightarrow Pb_{(s)} + Zn(CH_3COO)_{2 (aq)}$ 4.

single replacement

5. $SO_{3(g)} + H_2O_{(l)} \rightarrow H_2SO_{4(aq)}$

formation

 $2 \text{ HgO}_{(s)} \rightarrow 2 \text{ Hg}_{(l)} + O_{2(g)}$ 6.

decomposition

7. $CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$ decomposition

 $2 \text{ NaI}_{(aq)} + \text{Pb}(\text{NO}_3)_{2 \text{ (aq)}} \rightarrow \text{PbI}_{2 \text{ (s)}} + 2 \text{ NaNO}_{3 \text{ (aq)}}$ 8.

double replacement

9. $C1_{2 (aq)} + 2 NaI_{(aq)} \rightarrow I_{2 (aq)} + 2 NaCl_{(aq)}$ single replacement

10. $Al_2(SO_4)_{3 \text{ (aq)}} + 3 Ca(OH)_{2 \text{ (aq)}} \rightarrow 2 Al(OH)_{3 \text{ (s)}} + 3 CaSO_{4 \text{ (s)}}$

double replacement

II. **Assignment**

1.
$$N_{2(g)} + 3 H_{2(g)} \rightarrow 2 NH_{3(g)}$$
 (formation)

√ 2.
$$\text{HIO}_{4(s)} + 2 \text{ H}_{2}^{O}_{(l)} \rightarrow \text{ H}_{5}^{IO}_{6(s)}$$
 (formation)

$$\checkmark \checkmark$$
 3. $2 H_2 S_{(g)} + 3 O_{2(g)} \rightarrow 2 SO_{2(g)} + 2 H_2 O_{(g)}$ (complete combustion)

$$\checkmark$$
 5. $C_3H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_2O_{(g)}$ (complete combustion)

$$\checkmark \checkmark 6. \quad 2 \text{ Al(OH)}_{3(s)} + 3 \text{ H}_2 \text{SO}_{4(aq)} \rightarrow \text{Al}_2(\text{SO}_4)_{3aq)} + 6 \text{ HOH}_{(l)} \quad \text{(double replacement)}$$

$$\checkmark$$
 7. iron + sulfur → iron (II) sulfide

$$8\;Fe_{(s)}\;\;+\;\;S_{8\;(s)} \rightarrow\; 8\;FeS_{\;(s)} \quad \mbox{ formation}$$

$$\checkmark$$
 8. aluminum + fluorine \rightarrow aluminum fluoride

$$2 \text{ Al}_{(s)} + 3 \text{ F}_{2 (g)} \rightarrow 2 \text{ AlF}_{3 (s)}$$
 formation

9. copper + silver nitrate \rightarrow silver + copper (II) nitrate

$$Cu_{(s)} + 2 \text{ AgNO}_{3 \text{ (aq)}} \rightarrow 2 \text{ Ag }_{(s)} + Cu(NO_3)_{2 \text{ (s)}}$$
 single replacement

FeCl_{3 (aq)} + 3 NaOH (aq)
$$\rightarrow$$
 3 NaCl (s) + Fe(OH)_{3 (s)} double replacement

11. iron (III) oxide \rightarrow iron + oxygen

Fe₂O_{3 (s)}
$$\rightarrow$$
 4 Fe_(s) + 3 O_{2 (g)} decomposition

2 KClO_{3 (s)}
$$\rightarrow$$
 2 KCl_(s) + 3 O_{2 (g)} decomposition

13. barium chloride + sodium phosphate
$$\rightarrow$$
 barium phosphate + sodium chloride

$$VV$$
 $P_{4 (s)} + 5 O_{2 (g)} \rightarrow 2 P_2 O_{5 (s)}$ formation

2 HI_(aq) + Mg_(s)
$$\rightarrow$$
 MgI_{2 (aq)} + H_{2 (g)} single replacement

Balanced reaction:
$$Fe_{(s)} + H_2S_{(aq)} \rightarrow FeS_{(s)} + H_{2(g)}$$

Balanced reaction:
$$2 C_9 H_{6(s)} + 2 O_{2(g)} \rightarrow 18 CO_{2(g)} + 6 H_2 O_{(g)}$$

Balanced reaction:
$$2 \text{ Fe}_{(s)} + 3 \text{ H}_2 \text{SO}_{4 \text{ (aq)}} \rightarrow \text{Fe}_2 (\text{SO}_4)_{3 \text{ (aq)}} + 3 \text{ H}_2 \text{ (g)}$$

20. A precipitate forms when potassium iodide is mixed with lead (II) nitrate.

Balanced reaction:
$$2 \text{ KI}_{(aq)} + \text{Pb(NO}_{3)_{2 (aq)}} \rightarrow 2 \text{ KNO}_{3 (aq)} + \text{PbI}_{2 (s)}$$

21. Joseph Priestly (1733-1804) decomposed cinnabar (mercury (II) sulfide).

Balanced reaction: $8 \text{ HgS}_{(s)} \rightarrow 8 \text{ Hg}_{(l)} + S_{8 (s)}$

Reaction type: **decomposition**

22. A sulfurous acid solution used in the lab neutralises an ammonium hydroxide solution.

Balanced reaction: $H_2SO_{3 (aq)} + 2 NH_4OH_{(aq)} \rightarrow (NH_4)_2SO_{3 (aq)} + 2 HOH_{(l)}$

Reaction type: double replacement

23. Potassium metal may be obtained by decomposing molten potassium chloride.

Balanced reaction: $2 \text{ KCl}_{(l)} \rightarrow 2 \text{ K}_{(l)} + \text{ Cl}_{2 \text{ (g)}}$

Reaction type: **decomposition**

III. Remedial assignment – for extra practice

$$F \underline{\hspace{1cm}} 1. \hspace{1cm} 2 \ Cu_{(s)} + \hspace{1cm} O_{2(g)} \hspace{1cm} \rightarrow \hspace{1cm} 2 \ CuO_{(s)}$$

$$D_{\underline{\hspace{1cm}}} \ \, 2. \qquad 2 \, H_{2}^{} O_{(1)} \qquad \rightarrow \qquad 2 \, H_{2(g)}^{} \, + \qquad O_{2(g)}^{} \,$$

SR_ 3.
$$3 \text{ Fe}_{(s)} + 4 \text{ H}_2 \text{O}_{(g)} \rightarrow 4 \text{ H}_{2(g)} + \text{Fe}_3 \text{O}_{4(s)}$$

DR_ 4.
$$2 \text{ AsCl}_3 + 3 \text{ H}_2 \text{S}_{(aq)} \rightarrow \text{As}_2 \text{S}_{3(s)} + 6 \text{ HCl}_{(aq)}$$

$$SR_6.$$
 $Fe_2O_{3(s)} + 3H_{2(g)} \rightarrow 2Fe_{(s)} + 3H_2O_{(l)}$

D___ 7.
$$CaCO_{3(s)} \rightarrow CaO_{(s)} + CO_{2(g)}$$

$$F_{\underline{}}$$
 8. $8 \operatorname{Fe}_{(s)} + S_{8 (s)} \rightarrow 8 \operatorname{FeS}_{(s)}$

$$DR__ \ 9. \qquad H_2S_{\,(aq)} \ + 2 \ KOH_{\,(aq)} \ \rightarrow \ 2 \ HOH_{\,(l)} \quad + \ K_2S_{\,(aq)}$$

$$D_{\underline{\hspace{1cm}}} 10. \hspace{1cm} 2 \hspace{1cm} NaCl_{(l)} \hspace{1cm} \rightarrow \hspace{1cm} 2 \hspace{1cm} Na_{(l)} \hspace{1cm} + \hspace{1cm} Cl_{2(g)}$$

$$SR_{11}$$
. $2 Al_{(s)} + 3 H_2 SO_{4(aq)} \rightarrow Al_2 (SO_4)_{3 (aq)} + 3 H_{2(g)}$

DR_ 12.
$$H_3PO_{4(aq)}$$
 + $3NH_4OH_{(aq)}$ \rightarrow $3HOH_{(l)}$ + $(NH_4)_3PO_{4(aq)}$

CC_ 13.
$$C_{3}H_{8(g)} + 5O_{2(g)} \rightarrow 3CO_{2(g)} + 4H_{2}O_{(g)}$$

F_ 14.
$$4 \text{ Al}_{(s)} + 3 \text{ O}_{2 (g)} \rightarrow 2 \text{ Al}_2 \text{O}_{3 (s)}$$

F_ 16.
$$2 K_{(l)} + Cl_{2(g)} \rightarrow 2 KCl_{(l)}$$

$$DR__\ 17. \qquad 2\ CuBr\ _{(aq)}\ + K_2S\ _{(aq)}\ \rightarrow\ Cu_2S\ _{(s)}\ +\ 2\ KBr\ _{(aq)}$$

DR_ 18. AlCl_{3 (aq)} + 3 NaOH (aq)
$$\rightarrow$$
 3 NaCl (aq) + Al(OH)_{3 (s)}

DR_ 19.
$$HNO_{3 (aq)} + KOH_{(aq)} \rightarrow KNO_{3 (aq)} + HOH_{(l)}$$

$$SR_{20}$$
 20. 2 $Fe_{(s)}$ + 3 $CuSO_{4 (aq)}$ \rightarrow 3 $Cu_{(s)}$ + $Fe_{2}(SO_{4})_{3 (aq)}$

$$DR__ 21. \qquad H_2SO_{4(aq)} \ + \ Ba(OH)_{2 \, (aq)} \ \rightarrow \ BaSO_{4 \, (s)} + \ 2 \ HOH_{(l)}$$

$$F__ \ \ \, 22. \qquad 2\,Zn_{(s)} \ \, + \ \, O_{2\,(g)} \ \, \to \ \, 2\,ZnO_{(s)}$$

CC_ 23.
$$C_{25}H_{52 (s)} + 38 O_{2 (g)} \rightarrow 25 CO_{2 (g)} + 26 H_2O_{(g)}$$

$$DR__\ \ \, 24. \qquad 3\;H_2SO_4\,{}_{(aq)} \;\; + \;\; 2\;Fe(OH)_3\,{}_{(s)} \;\; \rightarrow \quad Fe_2(SO_4)_3\,{}_{(aq)} + \; 6\;HOH_{(l)}$$

DR_ 25.
$$Na_2CO_{3 (aq)} + CaSO_{4 (s)} \rightarrow CaCO_{3 (s)} + Na_2SO_{4 (aq)}$$

$$F \underline{\hspace{1cm}} 26. \hspace{1cm} 2 \hspace{1cm} Na_{(s)} \hspace{1cm} + \hspace{1cm} Cl_{2 \hspace{1cm} (g)} \hspace{1cm} \rightarrow \hspace{1cm} 2 \hspace{1cm} NaCl_{(s)}$$

$$SR__~27. \hspace{1cm} Zn_{(s)} \hspace{3mm} + \hspace{3mm} Pb(CH_3COO)_{2 \hspace{1mm} (aq)} \hspace{3mm} \rightarrow \hspace{3mm} Pb_{(s)} \hspace{3mm} + \hspace{3mm} Zn(CH_3COO)_{2 \hspace{1mm} (aq)}$$