Limiting Reactants: Problems

1	Silicon carbide, commonly known as carborundum, is very hard and abrasive. The compound is prepared by heating silicon dioxide in the presence of graphitic carbon: $SiO_2 + C \rightarrow SiC + CO_2$ (not balanced) How many grams of silicon carbide can be formed from 50 g of graphite and 50 g of silicon dioxide? SOL: 33.4 g
Atomic weights: Si=28.09; O=16; C=12.01	

2	Elemental phosphorus, P_4, reacts vigorously with oxygen to give P_4O_{10}. How much P_4O_{10} can be prepared from 3.75 g of P_4 and 6.55 g O_2? How much of the excess reactant will remain at the end of the reaction? SOL: 8.60 g P_4O_{10}; 1.70 g O_2 left unreacted
Atomic weights: O=16; P=30.97	

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(1) ↳ The molar masses are

$M(SiO_2) = 28.09 + (2 \times 16) = 60.09$ g/mol

$M(C) = 12.01$ g/mol

$M(SiC) = 28.09 + 12.01 = 40.1$ g/mol

$M(CO_2) = 12.01 + (2 \times 16) = 44.01$ g/mol

↳ This is the adjusted equation and the proportions of the substances:

$$SiO_2 + 2\,C \rightarrow SiC + CO_2$$

1 mol 2 mol 1 mol 1 mol

60.09 g 24.02 g 40.1 g 44.01 g

84.11 g 84.11 g

↳ Determination of the limiting reactant:

$x(SiO_2) = \frac{50\text{ g } SiO_2}{60.09\text{ g } SiO_2} = 0.83$ times the value of the table are involved in the reaction

↳ LIMITING REACTANT

$x(C) = \frac{50\text{ g C}}{24.02\text{ g C}} = 2.08$ times the value of the table are involved in the reaction

↳ REACTANT IN EXCESS

↳ Calculation of the mass of silicon carbide formed in this reaction:

$$m(SiC) = 50\text{ g } SiO_2 \; \frac{40.1\text{ g SiC}}{60.09\text{ g } SiO_2} = \boxed{33.37\text{ g SiC}}$$

2	Elemental phosphorus, P_4, reacts vigorously with oxygen to give P_4O_{10}. How much P_4O_{10} can be prepared from 3.75 g of P_4 and 6.55 g O_2? How much of the excess reactant will remain at the end of the reaction? SOL: 8.60 g P_4O_{10}; 1.70 g O_2 left unreacted
Atomic weights: O=16; P=30.97	

(2) ↳ The molar masses are:

$M(P_4) = 4 \times 30.97 = 123.88$ g/mol

$M(O_2) = 2 \times 16 = 32$ g/mol

$M(P_4O_{10}) = (4 \times 30.97) + (10 \times 16) = 283.88$ g/mol

↳ This is the balanced equation and the proportions in which they react and are formed:

$$P_4 + 5\ O_2 \longrightarrow P_4O_{10}$$

1 mol — 5 mol — 1 mol

123.88 g — 160 g — 283.88 g

283.88 g

↳ Determination of the limiting reactant

$x(P_4) = \frac{3.75\ g\ P_4}{123.88\ g\ P_4} = 0.03$ times the value of the table are involved in the reaction

↳ LIMITING REACTANT

$x(O_2) = \frac{6.55\ g\ O_2}{160\ g\ O_2} = 0.04$ times the value of the table are involved in this reaction

↳ REACTANT IN EXCESS

↳ Mass of P_4O_{10} prepared:

$m(P_4O_{10}) = 3.75\ g\ P_4 \frac{283.88\ g\ P_4O_{10}}{123.88\ g\ P_4} = \boxed{8.59\ g\ P_4O_{10}}$

↳ The excess of reactant

$m(O_2\ \text{consumed}) = 3.75\ g\ P_4 \frac{160\ g\ O_2}{123.88\ g\ P_4} = 4.84\ g\ O_2$

$m(O_2, \text{excess}) = 6.55\ g\ O_2 - 4.84\ g\ O_2 = \boxed{1.71\ g\ O_2 \text{ in excess}}$