Exercise 1

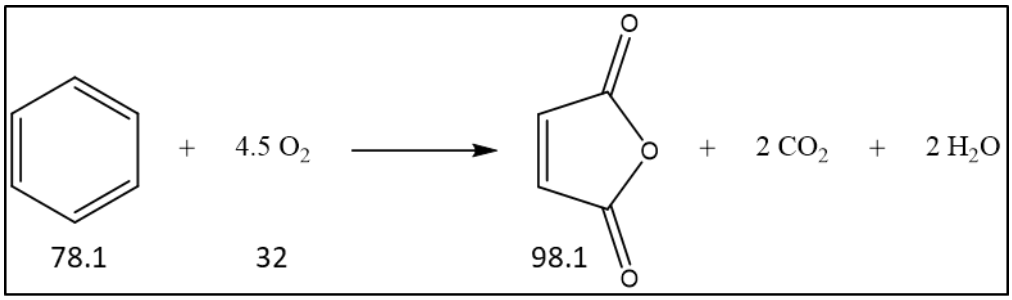
Calculate the atom economy for the following alternative routes to maleic anhydride

Atom economy

Consider: protecting groups, catalysts used in stoichiometric quantities, acids or bases used for hydrolysis, any chemical that is consumed i.e. incorporated into an intermediate or product

Omit: solvents, reagents or materials used in catalytic quantities, workup materials

1. **Benzene oxidation**



Benzene : Reactant → Consider

O_2 : Reactant → Consider

Maleic anhydride : Desired final product → Consider as product

CO_2 and H_2O : Undesired co-products → Do not consider as products

$$AE = \frac{98.1}{78.1 + 4.5 \times 32} = \mathbf{44.1\%}$$

2. **Butane oxidation**

Butane : Reactant → Consider

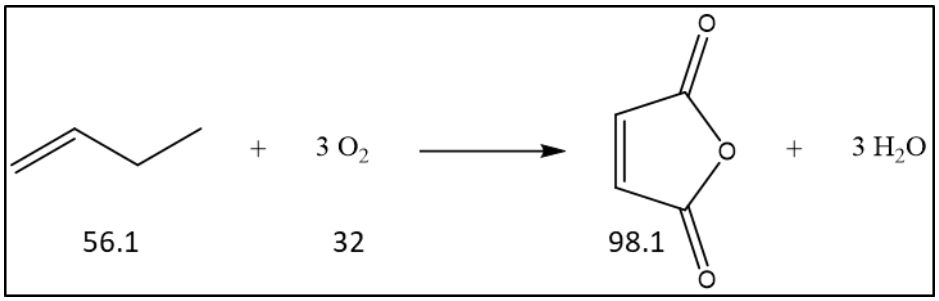
O_2 : Reactant → Consider

Maleic anhydride: Desired final product → Consider as product

H_2O : Undesired co-product → Do not consider as product

$$AE = \frac{98.1}{58.1 + 3.5 \times 32} = 57.7\%$$

3. Butene oxidation:



Butene : Reactant → Consider

O_2 : Reactant in → Consider

Maleic anhydride: Desired final product → Consider as product

H_2O : Undesired co-product → Do not consider as product

$$AE = \frac{98.1}{56.1 + 3 \times 32} = \mathbf{64.5\%}$$