What is the % yield of a reaction in which 42.00g of tungsten(VI)oxide (WO3) reacts with excess hydrogen gas to produce metallic tungsten and 5.40mL of water? (assume the density of water is 1.00g/mL)

Answer

$WO_3 + 3H_2 = W + 3H_2O$

1. Find theoretical mass of metallic tungsten:
   a) Find chemical amount of tungsten(VI)oxide (WO_3):
      n =m/M;
      $m(WO_3) = 42.00$ g;
      $M(WO_3) = 184 + 16 \cdot 3 = 232$ (g/mol),
      $n(WO_3) = 42.00/232 = 0.18$ (mole).
   b) Find chemical amount of metallic tungsten:
      According to equation 1 mole of WO_3 gives 1 mole of metallic tungsten,
      i.e. $n(WO_3)=n(W)$,
      $n(W) = 0.18$ mole.
   c) Find theoretical mass of metallic tungsten:
      $m = M \cdot n$;
      $m(W) = 0.18 \cdot 184 = 33.12$ (g),
      $m(W)_{theretical} = 33.12$ g.

2. Find actual mass of metallic tungsten:
   a) Find chemical amount of water:
      $n = m/M$;
      $m(H_2O) = \rho(H_2O) \cdot V(H_2O)$;
      $m(H_2O) = 1 \cdot 5.40 = 5.40$ (g);
      $M(H_2O) = 1 \cdot 2 + 16 = 18$ (g/mol);
      $n(H_2O) = 5.40/18 = 0.3$ (mole).
   b) Find chemical amount of metallic tungsten:
      According to equating $n(W):n(H_2O) = 1:3$;
      $n(H_2O) = 0.3$ mole,
      $n(W):0.3 = 1:3$,
      $n(W) = 0.1$ mole.
   c) Find actual mass of metallic tungsten:
      $m = M \cdot n$;
      $m(W) = 184 \cdot 0.1 = 18.4$ (g).
3. Find yield:

   $\eta = m_{actual}/m_{theoretical}$;

   $\eta = 18.4/33.12 = 0.5556$ or 55.56%.

Answer: 55,56%.