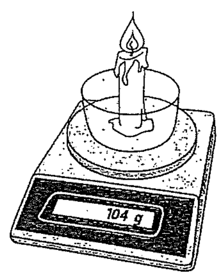
A paraffin candle ($C_{28}H_{58}$) is placed in a petri dish on an electronic balance and combusted for a period of 15.0 min. The accompanying data is collected.



Time (min)	Mass (g)
0	180.00
3.0	178.00
6.0	175.98
9.0	173.99
12.0	172.00
15.0	170.01

(a) Calculate the average rate of combustion of the paraffin over the entire 15 min period.
(b) Calculate the average rate of formation of water vapour for the same period.
(c) Note the mass loss in each 3.0 min time increment. Comment on the rate of combustion of the candle during the entire trial. Suggest a reason why the rate of this reaction isn't greatest at the beginning, with a steady decrease as time passes.
(d) Why don't the mass values drop in a completely constant fashion?

A piece of zinc metal is placed into a beaker containing an aqueous solution of hydrochloric acid. The volume of hydrogen gas formed is measured by water displacement in a eudiometer every 30.0 s. The volume is converted to STP conditions and recorded.
(a) Determine the average rate of consumption of zinc metal over the entire 150.0 s in units of g/min.

Volume H_2 (STP) (mL)	0	15.0	21.0	24.0	25.0	25.0
Time (seconds)	0	30.0	60.0	90.0	120.0	150.0

(b) When is the reaction rate the greatest?

(c) What is the rate from 120.0 to 150.0 s?

(d) Assuming there is still a small bit of zinc left in the beaker, how would you explain the rate at this point?

A 3.45 g piece of marble ($CaCO_3$) is weighed and dropped into a beaker containing 1.00 L of hydrochloric acid. The marble is completely gone 4.50 min later. Calculate the average rate of reaction of HCl in mol/L/s. Note that the volume of the system remains at 1.00 L through the entire reaction.

Propane gas combusts in camp stoves to produce energy to heat your dinner. How long would it take to produce 6.75 L of CO_2 gas measured at STP? Assume the gas is combusted at a rate of 1.10 g C_3H_8/min. Begin by writing a balanced equation for the combustion of C_3H_8.

A 2.65 g sample of calcium metal is placed into water. The metal is completely consumed in 25.0 s. Assuming the density of water is 1.00 g/mL at the reaction temperature, how long would it take to consume 5.00 mL of water as it converts into calcium hydroxide and hydrogen gas?

Key

CHEMISTRY 12: UNIT 1 – REACTION KINETICS
Calculating Average Rate & Using Rate as a Conversion Factor

$2C_{28}H_{58} + 85O_2 \rightarrow 56CO_2 + 58H_2O$

STATION 1
(a) $\frac{\Delta \text{Amount}}{\Delta \text{time}} = \frac{180.00\,g - 170.01\,g}{15.0\,min} = \frac{9.99\,g\ C_{28}H_{58}}{15.0\,min} = 0.666\,g/min$
(b) $\frac{0.666\,g\ C_{28}H_{58}}{min} \times \frac{1\,mol}{394.0\,g} \times \frac{58\,mol\ H_2O}{2\,mol\ C_{28}H_{58}} = 0.0490\,mol\ H_2O/min = (0.882\,g/min)$
~~(c)~~ $\sim\frac{2.00\,g}{3.0\,min}$ b/c $[O_2]$ in air remains relatively constant.
~~(d)~~

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

STATION 2
(a) $\frac{25.0\,mL\ H_2}{150.0\,s} \times \frac{1\,L}{1000\,mL} \times \frac{1\,mol}{22.4\,L} \times \frac{1\,mol\ Zn}{1\,mol\ H_2} \times \frac{65.4\,g}{1\,mol} \times \frac{60\,s}{1\,min} = \boxed{0.0292\,g/min}$
~~(b)~~ $\boxed{0-30\,s}$ b/c [HCl] is greatest @ start of rxn.
~~(c)~~ $\boxed{\frac{0\,mL\ H_2}{s}}$ Rate $= \frac{\Delta \text{Amount}}{\Delta \text{time}} = \frac{25.0\,mL - 25.0\,mL}{150.0\,s - 120.0\,s} =$
~~(d)~~ All of the acid is consumed ↖ limiting reactant (HCl)

$CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

STATION 3
$\frac{3.45\text{ g } CaCO_3}{4.50\text{ min}} \times \frac{1\text{ mol}}{100.1\text{ g}} \times \frac{2\text{ mol } HCl}{1\text{ mol } CaCO_3} \div 1.00\text{ L} \times \frac{1\text{ min}}{60\text{ s}}$ $= \boxed{\frac{2.55\times10^{-4}\text{ M } HCl}{s}}$

$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$

STATION 4
$\frac{1.10\text{ g } C_3H_8}{\text{min}} \times \frac{1\text{ mol}}{44.0\text{ g}} \times \frac{3\text{ mol } CO_2}{1\text{ mol } C_3H_8} \times \frac{22.4\text{ L}}{1\text{ mol}} = \frac{1.68\text{ L}}{\text{min}}$ $6.75\text{ L } CO_2 \times \frac{\text{min}}{1.68\text{ L}} = \boxed{4.02\text{ min}}$

CO_2

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

STATION 5
$\frac{2.65\text{ g } Ca}{25.0\text{ s}} \times \frac{1\text{ mol}}{40.1\text{ g}} \times \frac{2\text{ mol } H_2O}{1\text{ mol } Ca} \times \frac{18.0\text{ g } H_2O}{1\text{ mol}} \times \frac{1.0\text{ mL}}{1.0\text{ g}} = \frac{0.0952\text{ mL } H_2O}{s}$ $5.00\text{ mL } H_2O \times \frac{1\text{ s}}{0.0952\text{ mL } H_2O} = \boxed{52.5\text{ s}}$