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#2) b) $r = -\frac{1[\Delta O_2]}{3\,\Delta t} = \frac{1\,\Delta[O_3]}{2\,\Delta t}$

c) $r = -\frac{1\,\Delta[\Delta H_3]}{4\,\Delta t} = -\frac{1\,\Delta[O_2]}{5\,\Delta t} = \frac{1\,\Delta[NO]}{4\,\Delta t} = \frac{1\,\Delta[H_2O]}{6\,\Delta t}$

#3)

step 1:

$r = \frac{1}{4} r_{NH_3}$

$r = \frac{1}{4}(0.068)$

$r = 0.017\ mol/L\cdot s$

step 2:

$r = \frac{1}{6} r_{H_2O}$

$0.017 = \frac{1}{6} r_{H_2O}$

$0.017(6) = r_{H_2O}$

$r_{H_2O} = 0.102\ mol/L\cdot s$

#5) a) step 1: find # of moles Mg

$n = \frac{m}{M}$

$n = \frac{0.011g}{24.3}$

$n = 0.00045\ moles$

step 2: Find rate of magnesium

$r_{Mg} = -\frac{\Delta\,reactants}{\Delta t}$

$r_{Mg} = -\frac{(0 - 0.00045)}{(1-0)}$

$r_{Mg} = 0.00045\ mol/s$

step 3: Find rate of HCl using the rate of magnesium

$\frac{1}{1} r_{Mg} = \frac{1}{2} r_{HCl}$

$0.00045 = \frac{r_{HCl}}{2}$

$0.00045(2) = r_{HCl}$

$r_{HCl} = 0.0009\ mol/s$

5) b) step 1: Find rate of Hydrogen

$r_{Mg} = r_{H_2}$, since both have the same coefficients in the balanced equation.

$r_{H_2} = 0.00045$ mol/s

step 2: Solve for volume of Hydrogen gas

Known:

n = in 1 sec, 0.00045 moles are produced

T = 20 + 273 = 293 K

P = 101 kPa

$PV = nRT$

$V = \frac{nRT}{P}$

$V = \frac{0.00045(8.31)(293)}{101}$

$V = 0.0108$ L of H_2 produced in 1 sec

6) a) $r_A = \frac{\Delta \text{reactants}}{\Delta t} = \frac{6 \text{ mole}}{45 s} = 0.133 \text{ mol/s}$

b) step 1:
Find rate for gas D

$\frac{1}{1} r_A = \frac{1}{3} r_D$

$0.133 = \frac{r_D}{3}$

$0.133(3) = r_D$

$r_D = 0.399 \text{ mol/s}$

(translation: 0.399 moles of D is produced every 1 sec)

step 2: Determine # of moles of D we have for the given situation:

D = gas

P = 101.2 KPa

T = 25 + 273 = 298 K

V = 150 L

$PV = nRT$

$n = \frac{PV}{RT}$

$n = \frac{(101.2)(150)}{8.31(298)}$

n = 6.13 moles

step 3: Use ratios to determine the time it takes to produce the 6.13 moles of D.
(crossmultiply and solve)

0.399 moles = 1 sec

6.13 moles = x

x = 15.4 seconds

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#4) $r = -\frac{\Delta[\text{base}]}{\Delta t}$ $r = -\frac{(0.0175 - 0.4760)}{960 s}$ $r = 0.00048\ mol/L \cdot s$

$16 min \times 60 = 960 sec$

$r = -\frac{\Delta[\text{base}]}{\Delta t}$ = $r = -\frac{(0.0175 - 0.4760)}{0.267}$ $r = 1.717\ mol/L \cdot h$

$16 min \div 60 = 0.267 hrs$

#10) a) $r = -\frac{\Delta m}{\Delta t}$ $r = -\frac{(0.5g - 0.95g)}{280 sec}$ $r = 0.0016\ g/s$

b) $m = (0.5g - 0.95g)$

$m = 0.45g$

$n = \frac{m}{M}$ $n = \frac{0.45}{24.3}$ $n = 0.0185\ moles$

$r = -\frac{\Delta n}{\Delta t} = \frac{0.0185}{280} = 0.0000661\ mol/s$

c) $r = -\frac{\Delta m}{\Delta t}$ $r = -\frac{(0.5g - 0.95g)}{4.67} = 0.0964\ g/min$

$t = 280 sec = 4.67 min$

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#5) By calculating the appearance of iodine (I_2) since it is a solid. Time its appearance, then weigh its mass.

#7) $1 \text{ ton} = 1000 \text{ kg} = 1000000 \text{ g}$

Find Mass of CO_2 and Volume of CO_2 in 30 min

step 1: find # of moles of Iron (Fe)

$$n = \frac{m}{M} \quad n = \frac{1000\,000}{55.84} = \underline{17907 \text{ mol}}$$

step 2: Find rate of iron production

$$r_{Fe} = \frac{\Delta Fe}{\Delta t} = \frac{17907 \text{ mole}}{30 \text{ min}} = \underline{596.89 \text{ mol/min}}$$

step 3: Find rate of CO_2 using coefficients in the Balanced equation.

$$\frac{1}{2} r_{Fe} = \frac{1}{3} r_{CO_2}$$

$$\frac{596.89}{2} = \frac{r_{CO_2}}{3}$$

$$\underline{r_{CO_2} = 895.33 \text{ mol/min}}$$

step 4: Find # of moles of CO_2 in 30 min

$$\frac{895.33 \text{ mole}}{x} = \frac{1 \text{ min}}{30 \text{ min}}$$

$$\underline{x = 26860.05 \text{ moles}}$$

Step 5: Find Mass of CO_2 for 30min

$$n = \frac{m}{M}$$

$$26860.05 = \frac{m}{44}$$

$m = 1181842.2\,g$ or 1.18 tons

Step 6: Find Volume produced of CO_2 in 30min.

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$V = \frac{(26860.05)(8.31)(298)}{101.2}$$

$V = 657269.7\,L$

#8) step 1: find # of moles of Sodium (Na)

$$n = \frac{3g}{22.99 g/mole} = \underline{0.13 mole}$$

step 2: Find Rate of Sodium (Na)

$$r_{Na} = \frac{\Delta Na}{\Delta t} = \frac{0.13 moles}{1.5 sec} = \underline{0.0867 mol/sec}$$

step 3: Calculate rate of hydrogen using coefficients of Balanced equation,

$$\frac{1}{2} r_{Na} = \frac{1}{1} r_{H_2}$$

$$\frac{0.867}{2} = r_{H_2}$$

$$\underline{r_{H_2} = 0.043 mol/sec}$$

step 4: Calculate volume of hydrogen produced in the 1sec (0.043 moles of H_2 in 1sec)

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$V = \frac{(0.043)(8.31)(273)}{101.3}$$

$$\underline{V = 0.963 L}$$

step 5: calculate rate in mol/L·s for hydrogen.

$r_{H_2} = 0.043 mol/sec$

$$\frac{0.043 mol/sec}{0.963 L} = \underline{0.0446 mol/L \cdot s}$$