Exam 2
Review
Solutions

1.) $q_{H_2O} + q_{Fe} = 0$

$$m_{H_2O} C_{H_2O} \Delta T_{H_2O} = -m_{Fe} C_{Fe} \Delta T_{Fe}$$

$$1000 (4.184)(88-100) = -1800\, C_{Fe} (88-25)$$

$$\boxed{C_{Fe} = 0.443 \frac{J}{g°C}}$$

2.)

gains heat $\Rightarrow$ (+) q

loses heat $\Rightarrow$ (−) q

Performs work $\Rightarrow$ (−) w

work on it $\Rightarrow$ (+) w

$\Delta E = q + w$

if q & w are (+) $\Rightarrow$ ΔE is (+)

if q & w are (−) $\Rightarrow$ ΔE is (−)

if one is positive and the other is negative, then their quantities nee[d] to be known to determine ΔE

$\Rightarrow$ B is incorrect

3.) $2\,Fe + \frac{3}{2} O_2 \Rightarrow Fe_2O_3$ $\Delta H = -826\ KJ/mol$

Fe: $500_g \times \frac{1\ mol}{55.85_g} \times \frac{1}{2} = 4.476$ mol Fe_2O_3

O_2: $200_g \times \frac{1\ mol}{32_g} \times \frac{1}{3/2} = 4.167$ mol Fe_2O_3

$q = \Delta H\ (mol\ Fe_2O_3)$
$= -3442$ KJ

"released" implies magnitude $\Rightarrow$ $\boxed{|q| = 3442\ KJ}$

4.) $2AgNO_3 + CaCl_2 \rightarrow 2AgCl + Ca(NO_3)_2$

$AgNO_3 : (0.05\ L)(0.2\ \frac{mol}{L}) \times \frac{2}{2} = 0.01\ mol\ AgCl$

$CaCl_2 : (0.05\ L)(0.1\ \frac{mol}{L}) \times \frac{2}{1} = 0.01\ mol\ AgCl$

$q_{rxn} + q_{sol} = 0$

$q_{rxn} = -m_{sol}\, C_{sol}\, \Delta T$

$= -(50+50)(1.05)(4.20)(1°C)$

$= -441\ J$

$\Delta H = \frac{q_{rxn}}{mol\ AgCl} = -44{,}100\ J/mol = \boxed{-44.1\ \frac{kJ}{mol} = \Delta H_{AgCl}}$

5.) x I: $rate = k[NO]^2 \neq k[NO]^2[O_2]$ x

✓ II: $rate = k[N_2O_2][O_2] \Rightarrow rate = k[NO]^2[O_2] = k[NO]^2[O_2]$ ✓

NO INTERMEDIATE

fast: $[NO]^2 = [N_2O_2]$

✓ III: $rate = k[NO]^2[O_2] = k[NO]^2[O_2]$ ✓

6.) Half life: $\frac{\ln(2)}{k} = t$

same as double life

$\Rightarrow \boxed{t = 19.8\ min}$

7.) $q_{H_2O} + q_{Fe} = 0$

$q_{H_2O} = -q_{Fe} \Rightarrow (mC\Delta T)_{H_2O} = -(mC\Delta T)_{Fe}$

$150(4.184)(T_f - 20) = -150(0.45)(T_f - 100)$

$627.6T_f - 12552 = -67.5T_f + 6750 \Rightarrow \boxed{T_f = 27.8°C}$

8.)

$$H_2 + Cl_2 \rightarrow 2HCl$$

III: $\cancel{2NH_4Cl} \rightarrow 2HCl + 2NH_3$ $\quad \Delta H_{III} = (-2)(-176.2)$ kJ

II: $N_2 + 4H_2 + Cl_2 \rightarrow \cancel{2NH_4Cl}$ $\quad \Delta H_{II} = -628.8$ kJ

I: $2NH_3 \rightarrow 3H_2 + N_2$ $\quad \Delta H_I = (-)(-91.8)$ kJ

$\Rightarrow H_2 + Cl_2 \rightarrow 2HCl$ $\quad \Delta H = \Delta H_I + \Delta H_{II} + \Delta H_{III}$

$= -184.6$ kJ

$\div 2$

$\Rightarrow \frac{1}{2}H_2 + \frac{1}{2}Cl_2 \rightarrow HCl$ $\quad \boxed{\Delta H = -92.3 \text{ kJ}}$

9.) $q_{Ag} + q_{Au} + q_{H_2O} = 0$ $\quad G + S = 15.3$

$S = 15.3 - G$

$q_{Ag} = -q_{Au} - q_{H_2O}$

$(mC\Delta T)_{Ag} = -(mC\Delta T)_{Au} - (mC\Delta T)_{H_2O}$

$(15.3 - m_{Au})(0.235)(22.9 - 62.1) = -m_{Au}(0.128)(22.9-62.1) - 13.1(4.184)(22.9-20.9)$

$-140.94 + 9.212\, m_{Au} = 5.018\, m_{Au} - 109.621$

$4.194\, m_{Au} = 31.32$

$\boxed{m_{Au} = 7.5 \text{ g}}$

10.) $q_{rxn} + q_{cal} = 0$ $\quad 10\text{ g sucrose} \times \frac{1 \text{ mole}}{342.3 \text{ g}} = 0.02921$ mol

$q_{rxn} = -q_{cal}$

$= -C_{cal}\Delta T$

$= -165$ kJ

$\Delta H_{C_{12}H_{22}O_{11}} = \frac{q_{rxn}}{0.02921} = \boxed{-5648 \frac{\text{kJ}}{\text{mol}}}$

11.) Substitute

$$\text{Rate} = k\,[NO^+][NH_3]$$

Both intermediates

$$\text{II}: \quad [NH_4^+] = [NH_3][H^+]$$

$$[NH_3] = [NH_4][H^+]^{-1}$$

$$\text{I}: \quad [HNO_2][H^+] = [H_2O][NO^+]$$

$$[NO^+] = [HNO_2][H^+][H_2O]^{-1}$$

$$\Rightarrow \text{rate} = k\frac{[NH_4][HNO_2]\cancel{[H^+]}}{[H_2O]\cancel{[H^+]}} = k\frac{[NH_4][HNO_2]}{[H_2O]} = \boxed{k[NH_4][HNO_2][H_2O]}$$

12.) $E = \frac{hc}{\lambda} = 2.93 \times 10^{-19}\ \frac{J}{\text{photon}}$

$h = 6.626 \times 10^{-34}\ J \cdot s$

$c = 3 \times 10^{8}\ m/s$

$\lambda = 679 \times 10^{-9}\ m$

$$\frac{\text{Photons}}{\text{pulse}} = \frac{0.528\ J}{1\ \text{pulse}} \times \frac{1\ \text{photon}}{2.93 \times 10^{-19} J} = \boxed{1.8 \times 10^{18}\ \frac{\text{photon}}{\text{pulse}}}$$

13.) $\text{Rate} = k\,[BrO_3^-]^x[Br^-]^y[H^+]^z$

$\Rightarrow$ Find x: $\frac{\text{Rate}_1}{\text{Rate}_2} = \frac{\cancel{k}[BrO_{3,1}^-]^x\cancel{[Br^-_1]^y}\cancel{[H^+_1]^z}}{\cancel{k}[BrO^-_{3,2}]^x\cancel{[Br^-_2]^y}\cancel{[H^+_2]^z}}$

$$\frac{1.126 \times 10^{-2}}{2.251 \times 10^{-2}} = \left(\frac{0.175}{0.35}\right)^x \Rightarrow 0.5 = 0.5^x \Rightarrow x = 1$$

$\Rightarrow$ Find y: $\frac{\text{Rate}_1}{\text{Rate}_3} = \frac{\cancel{k}\cancel{[BrO^-_{3,1}]^x}[Br^-_1]^y\cancel{[H^+_1]^z}}{\cancel{k}\cancel{[BrO^-_{3,3}]^x}[Br^-_3]^y\cancel{[H^+_3]^z}}$

$$\frac{1.126 \times 10^{-2}}{3.376 \times 10^{-2}} = \left(\frac{0.175}{0.525}\right)^y \Rightarrow 0.333 = 0.333^y \Rightarrow y = 1$$

$\Rightarrow$ Find z:

$$\frac{Rate_2}{Rate_4} = \frac{\cancel{k}\cancel{[BrO_3^-{}_2]^x}[Br^-{}_2]^y[H^+{}_2]^z}{\cancel{k}\cancel{[BrO_3^-{}_4]^x}\cancel{[Br^-{}_4]^y}[H^+{}_4]^z}$$

$$\frac{2.256\times10^{-2}}{5.084\times10^{-2}} = \left(\frac{0.175}{0.263}\right)^z \Rightarrow$$

$$0.4437 = 0.6654^z$$

$$\ln(0.4437) = \ln(0.6654^z)$$

$$\ln(0.4437) = z\ln(0.6654)$$

$$\Rightarrow z = 2$$

$$\boxed{Rate = k[BrO_3^-][Br^-][H^+]^2}$$