1) $0 = q_{H_2O} + q_{SK}$

$q_{SK} = -q_{H_2O}$

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

$$C_{SK} = -\frac{m_{H_2O} C_{H_2O} \Delta T_{H_2O}}{m_{SK} \Delta T_{SK}}$$

$$C_{SK} = -\frac{(1000g)(4.184\ J/g^\circ C)(88^\circ C - 100^\circ C)}{(1800g)(88^\circ C - 25^\circ C)}$$

$\boxed{C_{SK} = 0.44\ J/g^\circ C}$

2) A: true (law of conservation of energy)

B: gains heat $\Rightarrow Q > 0$

performs work $\Rightarrow W < 0$

$\Delta E = Q + W$

ΔE: positive or negative

C: False

D: loses heat $\Rightarrow Q < 0$

performs work $\Rightarrow W < 0$

ΔE must be negative $\Delta E = Q + W$

E: if $\Delta E > 0$, then $Q > 0$ and/or $W > 0$

3) $2\,Fe + \frac{3}{2}O_2 \longrightarrow Fe_2O_3$

$0.500\,kg = 500\,g$ $\quad 200\,g$

$\Delta H_f^\circ (Fe_2O_3) = -826.0\,KJ/mol$

$\Delta H_{rxn}^\circ = -826.0\,KJ/mol$

$$500\,g\,Fe \cdot \frac{1\,mol\,Fe}{55.845\,g\,Fe} \cdot \frac{1\,mol\,Fe_2O_3}{2\,mol\,Fe} = 4.477\,mol\,Fe_2O_3$$

$$200\,g\,O_2 \cdot \frac{1\,mol\,O_2}{32\,g\,O_2} \cdot \frac{1\,mol\,Fe_2O_3}{3/2\,mol\,O_2} = 4.167\,mol\,Fe_2O_3$$

$(4.167\,mol\,Fe_2O_3)(826.0\,KJ/mol) = \boxed{3,442\,KJ}$

* positive because question asked how much heat was released

4) $2\,AgNO_3 + CaCl_2 \longrightarrow 2\,AgCl + Ca(NO_3)_2 \quad \Delta H = ?$

$50\,mL$ $\quad 50\,mL$

$0.2\,M$ $\quad 0.1\,M$

① $0 = q_{rxn} + q_{soln}$

$q_{rxn} = -q_{soln}$

③ $\rightarrow \Delta H = \frac{q_{rxn}}{n_{AgCl}}$ ← ① ← ②

$\Delta T = 26°C - 25°C = 1°C$

$m = V \cdot d$, $V = 50mL + 50mL = 100mL$

$d = 1.05\ g/mL$

$m = (100\ mL)(1.05\ g/mL) = 105\ g$

$C = 4.20\ J/g°C$

$$q_{rxn} = -(105g)(4.20\ J/g°C)(1°C)$$

$$q_{rxn} = -441\ J = -0.441\ KJ$$

② $(0.050L)(0.2\ M\ AgNO_3) = 0.01\ mol\ AgNO_3$

$$0.01\ mol\ AgNO_3 \cdot \frac{2\ mol\ AgCl}{2\ mol\ AgNO_3} = 0.01\ mol\ AgCl$$

$(0.05L)(0.1\ M\ CaCl_2) = 0.005\ mol\ CaCl_2$

$$0.005\ mol\ CaCl_2 \cdot \frac{2\ mol\ AgCl}{1\ mol\ CaCl_2} = 0.01\ mol\ AgCl$$

$n_{AgCl} = 0.01\ mol$

③ $$\Delta H_{rxn} = \frac{-0.441\ KJ}{0.01\ mol} = \boxed{-44.1\ KJ/mol}$$

5) $2\,NO_{(g)} + O_{2(g)} \rightarrow 2\,NO_{2(g)}$

$rate = K[NO]^2[O_2]$

I) $rate = K[NO]^2 \neq K[NO]^2[O_2]$

II) $rate = K_2[N_2O_2][O_2]$, $K_{-1}[N_2O_2] = K_1[NO]^2$

$[N_2O_2] = \frac{K_1}{K_{-1}}[NO]^2$

$rate = \underbrace{\frac{K_2 \cdot K_1}{K_{-1}}}_{\text{we'll just call this } K}[NO]^2[O_2]$

$rate = K[NO]^2[O_2]$ ✓

III) $rate = K[NO]^2[O_2]$ ✓

(D)

6) first order $\rightarrow t_{1/2} = \frac{\ln(2)}{K}$, $K = 0.035\ min^{-1}$

$t_{1/2} = \frac{\ln(2)}{0.035\ min^{-1}}$

$\boxed{t_{1/2} = 19.8\ min}$

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

$q_{Fe} = -q_{H_2O}$

Fe	H_2O
$m = 150g$	$m = 150g$
$c = 0.450\ J/g^\circ C$	$c = 4.184\ J/g^\circ C$
$T_0 = 100^\circ C$	$T_0 = 20^\circ C$

$T_f = T_f$

$$m_{Fe} c_{Fe} (T_f - T_{Fe}) = -m_{H_2O} c_{H_2O} (T_f - T_{H_2O})$$

$$m_{Fe} c_{Fe} T_f - m_{Fe} c_{Fe} T_{Fe} = -m_{H_2O} c_{H_2O} T_f + m_{H_2O} c_{H_2O} T_{H_2O}$$

$$+ m_{H_2O} c_{H_2O} T_f \quad + m_{Fe} c_{Fe} T_{Fe} \quad + m_{H_2O} c_{H_2O} T_f \quad + m_{Fe} c_{Fe} T_{Fe}$$

$$m_{Fe} c_{Fe} T_f + m_{H_2O} c_{H_2O} T_f = m_{H_2O} c_{H_2O} T_{H_2O} + m_{Fe} c_{Fe} T_{Fe}$$

$$T_f (m_{Fe} c_{Fe} + m_{H_2O} c_{H_2O}) = m_{H_2O} c_{H_2O} T_{H_2O} + m_{Fe} c_{Fe} T_{Fe}$$

$$T_f = \frac{m_{H_2O} c_{H_2O} T_{H_2O} + m_{Fe} c_{Fe} T_{Fe}}{m_{Fe} c_{Fe} + m_{H_2O} c_{H_2O}}$$

$$T_f = \frac{(150g)(4.184\ J/g^\circ C)(20^\circ C) + (150g)(0.45\ J/g^\circ C)(100^\circ C)}{(150g)(0.453/g^\circ C) + (150g)(4.184\ J/g^\circ C)}$$

$T_f = 27.8^\circ C$

8) $\Delta H_f^\circ (HCl_{(g)})$: $\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \rightarrow HCl_{(g)}$

III flipped: $2NH_4Cl_{(s)} \rightarrow 2NH_{3(g)} + 2HCl_{(g)}$ $\Delta H = +352.4\ KJ$

×2

II: $N_{2(g)} + 4H_{2(g)} + Cl_{2(g)} \rightarrow 2NH_4Cl$ $\Delta H = -628.8\ KJ$

(1 H_2)

I flipped: $2NH_{3(g)} \rightarrow N_{2(g)} + 3H_{2(g)}$ $\Delta H = +91.8\ KJ$

$H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl$ $\Delta H = -184.6\ KJ$

divide by 2

$\frac{1}{2}H_{2(g)} + \frac{1}{2}Cl_{2(g)} \rightarrow HCl_{(g)}$ $\boxed{\Delta H = -92.3\ KJ}$

9)

	Au	Ag	H_2O
m	?	?	$(13mL)(1g/mL) = 13g$
c	$0.128\ J/g^\circ C$	$0.235\ J/g^\circ C$	$4.184\ J/g^\circ C$
ΔT	$22.9 - 62.1 = -39.2^\circ C$	$22.9 - 62.1 = -39.2^\circ C$	$22.9 - 20.9 = 2^\circ C$

$0 = q_{Au} + q_{Ag} + q_{H_2O}$ $\quad m_{Au} + m_{Ag} = 15.3g$

$-q_{H_2O} = q_{Au} + q_{Ag}$ $\quad m_{Ag} = 15.3g - m_{Au}$

$-m_{H_2O} c_{H_2O} \Delta T_{H_2O} = m_{Au} c_{Au} \Delta T_{Au} + m_{Ag} c_{Ag} \Delta T_{Ag}$

$-(13g)(4.184\,J/g°C)(2°C) = m_{Au}(0.128\,J/g°C)(-39.2°C) + (15.3g - m_{Au})(0.235\,J/g°C)(-39.2°C)$

$-108.784\,J = -m_{Au}\cdot 5.0176\,J/g - 140.9436\,J + m_{Au}\cdot 9.212\,J/g + 140.9436\,J$

$32.1596\,J = m_{Au}\cdot 4.1944\,J/g$

$\boxed{m_{Au} = 7.67g}$

10) $C_{12}H_{22}O_{11\,(s)} + 12O_2 \rightarrow 12CO_2 + 11H_2O$

10.0g

③ $\Delta H_{rxn} = \frac{q_{rxn}\ ①}{n_{sucr.}\ ②}$

① $q_{cw} + q_{rxn} = 0$

$q_{rxn} = -q_{cw}$

$q_{rxn} = -(7.50\,KJ/°C)(+22°C)$

$q_{rxn} = -165\,KJ$

② $10.0g\ sucrose \cdot \frac{1\,mol\ sucrose}{342.3g} = 0.0292\,mol$

③ $\Delta H = \frac{-165\,KJ}{0.0292\,mol} = -5,648\,KJ/mol$

11) (I) $HNO_2 + H^+ \rightarrow H_2O + NO^+$ (fast)

(II) $NH_4^+ \rightarrow NH_3 + H^+$ (fast)

(III) $NO^+ + NH_3 \rightarrow NH_3NO^+$ (slow)

(IV) $NH_3NO^+ \rightarrow H_2O + H^+ + N_2$ (fast)

Overall: $HNO_2 + NH_4^+ \rightarrow H^+ + 2H_2O + N_2$

$$\text{rate} = K[NO^+][NH_3]$$

$$[NO^+][H_2O] = [HNO_2][H^+]$$

$$[NO^+] = \frac{[HNO_2][H^+]}{[H_2O]}$$

$$[NH_3][H^+] = [NH_4^+]$$

$$[NH_3] = \frac{[NH_4^+]}{[H^+]}$$

$$\text{rate} = K \frac{[HNO_2]\cancel{[H^+]}}{[H_2O]} \cdot \frac{[NH_4^+]}{\cancel{[H^+]}}$$

$$\boxed{\text{rate} = K \frac{[HNO_2][NH_4^+]}{[H_2O]}}$$

12) $E = h \cdot f \qquad c = f \cdot \lambda \Rightarrow f = \frac{c}{\lambda}$

$$E = \frac{hc}{\lambda} = \frac{(6.626 \times 10^{-34}\ J \cdot s)(3 \times 10^{8}\ m/s)}{679 \times 10^{-9}\ m}$$

$$E = 2.928 \times 10^{-19}\ J/\text{photon}$$

$0.528\ J/\text{pulse}$

$$\frac{0.528\ \cancel{J}}{1\ \text{pulse}} \cdot \frac{1\ \text{photon}}{2.928 \times 10^{-19}\ \cancel{J}} = \boxed{1.80 \times 10^{18}\ \text{photons/pulse}}$$

13) $\text{rate} = K[BrO_3^-]^x[Br^-]^y[H^+]^z$

$$\frac{Exp2}{Exp1}: \left(\frac{0.350}{0.175}\right)^x = \frac{2.251 \times 10^{-2}}{1.126 \times 10^{-2}}$$

$$2^x = 1.999 \approx 2$$

$$x = 1$$

$$\frac{Exp3}{Exp1}: \left(\frac{0.525}{0.175}\right)^y = \frac{3.376 \times 10^{-2}}{1.126 \times 10^{-2}}$$

$$3^y = 2.998 \sim 3$$

$$y = 1$$

$$\frac{\text{Exp 4}}{\text{Exp 2}}: \quad \left(\frac{0.263}{0.175}\right)^z = \frac{5.084 \times 10^{-2}}{2.251 \times 10^{-2}}$$

$$1.5^z = 2.25$$

$$\log_{10}\left(1.5^z\right) = \log_{10}(2.25)$$

$$z = \frac{\log(2.25)}{\log(1.5)}$$

$$z = 2$$

$$\boxed{\text{rate} = k[BrO_3^-][Br^-][H^+]^2} \quad (4)$$