

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

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

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

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

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

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

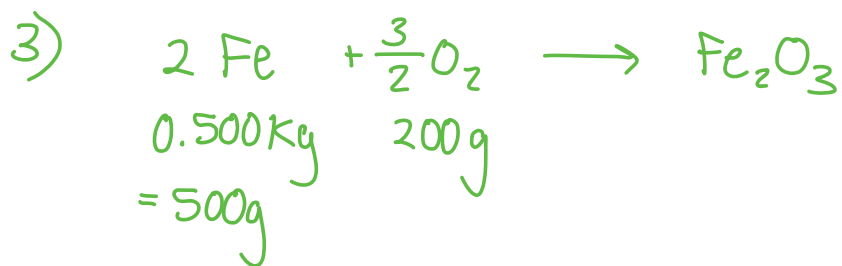
2) A: true (law of conservation of energy)

(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 $W > 0$



$$\Delta H_f^\circ (\text{Fe}_2\text{O}_3) = -826.0 \text{ kJ/mol}$$

↓

$$\Delta H_{\text{rxn}}^\circ = -826.0 \text{ kJ/mol}$$

$$500 \text{ g Fe} \cdot \frac{1 \text{ mol Fe}}{55.845 \text{ g Fe}} \cdot \frac{1 \text{ mol Fe}_2\text{O}_3}{2 \text{ mol Fe}} = 4.477 \text{ mol Fe}_2\text{O}_3$$

$$200 \text{ g O}_2 \cdot \frac{1 \text{ mol O}_2}{32 \text{ g O}_2} \cdot \frac{1 \text{ mol Fe}_2\text{O}_3}{\frac{3}{2} \text{ mol O}_2} = 4.167 \text{ mol Fe}_2\text{O}_3$$

↙

$$(4.167 \text{ mol Fe}_2\text{O}_3) (826.0 \text{ kJ/mol}) = \boxed{3,442 \text{ kJ}}$$

↑
 * positive because question asked how much heat was released



$50 \text{ mL} \quad 50 \text{ mL}$
 $0.2 \text{ M} \quad 0.1 \text{ M}$

①

$$0 = q_{\text{rxn}} + q_{\text{soln}}$$

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

③ → $\Delta H = \frac{q_{\text{rxn}}}{n_{\text{AgCl}}}$

← ①

← ②

$$\Delta T = 26^{\circ}\text{C} - 25^{\circ}\text{C} = 1^{\circ}\text{C}$$

$$m = V \cdot d, \quad V = 50\text{mL} + 50\text{mL} = 100\text{mL}$$

$$d = 1.05\text{g/mL}$$

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

$$C = 4.20\text{J/g}^{\circ}\text{C}$$

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

$$q_{\text{rxn}} = -441\text{J} = -0.441\text{kJ}$$

$$\textcircled{2} \quad (0.050\text{L})(0.2\text{M AgNO}_3) = 0.01\text{mol AgNO}_3$$

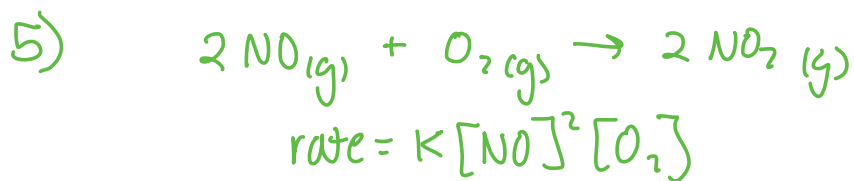
$$0.01\text{mol AgNO}_3 \cdot \frac{2\text{mol AgCl}}{2\text{mol AgNO}_3} = 0.01\text{mol AgCl}$$

$$(0.05\text{L})(0.1\text{M CaCl}_2) = 0.005\text{mol CaCl}_2$$

$$0.005\text{mol CaCl}_2 \cdot \frac{2\text{mol AgCl}}{1\text{mol CaCl}_2} = 0.01\text{mol AgCl}$$

$$n_{\text{AgCl}} = 0.01\text{mol}$$

$$\textcircled{3} \quad \Delta H_{\text{rxn}} = \frac{-0.441\text{kJ}}{0.01\text{mol}} = \boxed{-44.1\text{kJ/mol}}$$



I) $\text{rate} = k [\text{NO}]^2 \neq k [\text{NO}]^2 [\text{O}_2]$

II) $\text{rate} = k_2 [\text{N}_2\text{O}_2] [\text{O}_2]$, $k_{-1} [\text{N}_2\text{O}_2] = k_1 [\text{NO}]^2$
 $[\text{N}_2\text{O}_2] = \frac{k_1}{k_{-1}} [\text{NO}]^2$

$\text{rate} = \frac{k_2 \cdot k_1}{k_{-1}} [\text{NO}]^2 [\text{O}_2]$

we'll just call this k

$\text{rate} = k [\text{NO}]^2 [\text{O}_2] \checkmark$

III) $\text{rate} = k [\text{NO}]^2 [\text{O}_2] \checkmark$

(D)

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

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

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

$0 = q_{\text{Fe}} + q_{\text{H}_2\text{O}}$ $q_{\text{Fe}} = -q_{\text{H}_2\text{O}}$	<table border="1" style="border-collapse: collapse; width: 100%;"> <tr><th style="padding: 5px;">Fe</th></tr> <tr><td style="padding: 5px;">$m = 150\text{g}$</td></tr> <tr><td style="padding: 5px;">$c = 0.450\text{ J/g}^\circ\text{C}$</td></tr> <tr><td style="padding: 5px;">$T_0 = 100^\circ\text{C}$</td></tr> </table>	Fe	$m = 150\text{g}$	$c = 0.450\text{ J/g}^\circ\text{C}$	$T_0 = 100^\circ\text{C}$	<table border="1" style="border-collapse: collapse; width: 100%;"> <tr><th style="padding: 5px;">H₂O</th></tr> <tr><td style="padding: 5px;">$m = 150\text{g}$</td></tr> <tr><td style="padding: 5px;">$c = 4.184\text{ J/g}^\circ\text{C}$</td></tr> <tr><td style="padding: 5px;">$T_0 = 20^\circ\text{C}$</td></tr> </table>	H ₂ O	$m = 150\text{g}$	$c = 4.184\text{ J/g}^\circ\text{C}$	$T_0 = 20^\circ\text{C}$
Fe										
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$T_0 = 20^\circ\text{C}$										

$$T_f = T_f$$

$$m_{\text{Fe}} c_{\text{Fe}} (T_f - T_{\text{Fe}}) = -m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}} (T_f - T_{\text{H}_2\text{O}})$$

$$\begin{array}{ccccccc}
 m_{\text{Fe}} c_{\text{Fe}} T_f & - & m_{\text{Fe}} c_{\text{Fe}} T_{\text{Fe}} & = & - & m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}} T_f & + & m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}} T_{\text{H}_2\text{O}} \\
 \hline
 + m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}} T_f & + & m_{\text{Fe}} c_{\text{Fe}} T_{\text{Fe}} & & + & m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}} T_f & & + & m_{\text{Fe}} c_{\text{Fe}} T_{\text{Fe}} \\
 \hline
 \end{array}$$

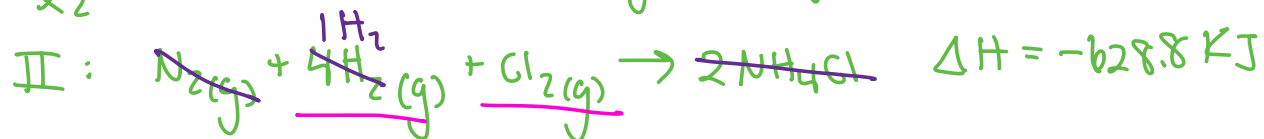
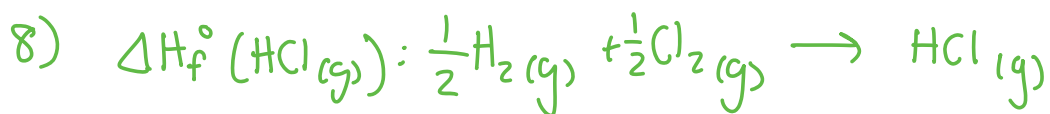
$$m_{\text{Fe}} c_{\text{Fe}} T_f + m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}} T_f = m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}} T_{\text{H}_2\text{O}} + m_{\text{Fe}} c_{\text{Fe}} T_{\text{Fe}}$$

$$T_f (m_{\text{Fe}} c_{\text{Fe}} + m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}}) = m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}} T_{\text{H}_2\text{O}} + m_{\text{Fe}} c_{\text{Fe}} T_{\text{Fe}}$$

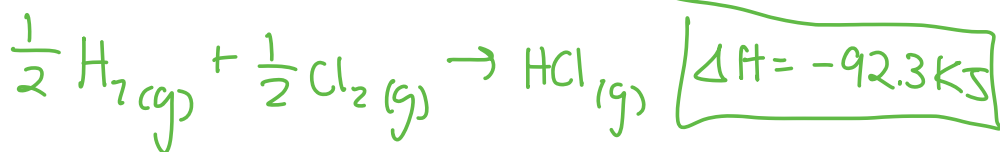
$$T_f = \frac{m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}} T_{\text{H}_2\text{O}} + m_{\text{Fe}} c_{\text{Fe}} T_{\text{Fe}}}{m_{\text{Fe}} c_{\text{Fe}} + m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}}}$$

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

$$T_f = 27.8^\circ\text{C}$$



divide by 2



9)

	$\frac{\text{Au}}{?}$	$\frac{\text{Ag}}{?}$	$\frac{\text{H}_2\text{O}}{(13\text{mL})(1\text{g/mL}) = 13\text{g}}$
m	?	?	
c	0.128 J/g°C	0.235 J/g°C	4.184 J/g°C
ΔT	22.9 - 62.1 = -39.2°C	22.9 - 62.1 = -39.2°C	22.9 - 20.4 = 2°C

$$0 = q_{\text{Au}} + q_{\text{Ag}} + q_{\text{H}_2\text{O}} \quad m_{\text{Au}} + m_{\text{Ag}} = 15.3\text{g}$$

$$-q_{\text{H}_2\text{O}} = q_{\text{Au}} + q_{\text{Ag}}$$

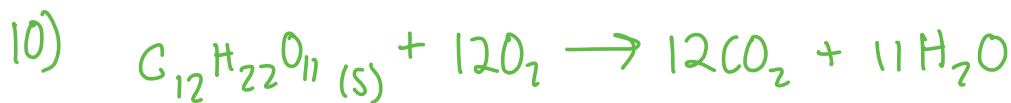
$$\underline{m_{\text{Ag}} = 15.3\text{g} - m_{\text{Au}}}$$

$$-m_{\text{H}_2\text{O}} c_{\text{H}_2\text{O}} \Delta T_{\text{H}_2\text{O}} = m_{\text{Au}} c_{\text{Au}} \Delta T_{\text{Au}} + m_{\text{Ag}} c_{\text{Ag}} \Delta T_{\text{Ag}}$$

$$\begin{aligned}
 - (13\text{g}) (4.184\text{ J/g}\cdot\text{C}) (2\text{C}) &= m_{\text{Au}} (0.128\text{ J/g}\cdot\text{C}) (-39.2\text{C}) + (15.3\text{g} - m_{\text{Au}}) (0.235\text{ J/g}\cdot\text{C}) (-39.2\text{C}) \\
 -108.784\text{ J} &= -m_{\text{Au}} \cdot 5.0176\text{ J/g} - 140.9436\text{ J} + m_{\text{Au}} \cdot 9.212\text{ J/g} \\
 + 140.9436\text{ J} & \qquad \qquad \qquad + 140.9436\text{ J}
 \end{aligned}$$

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

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



10.0g $\Delta H_{\text{rxn}} = \frac{q_{\text{rxn}}}{n_{\text{sucr.}}}$

① $q_{\text{cw}} + q_{\text{rxn}} = 0$

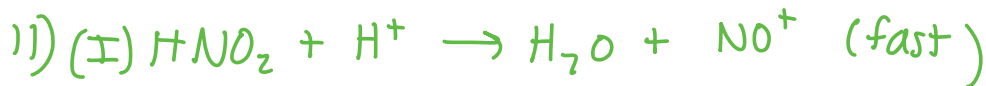
$q_{\text{rxn}} = -q_{\text{cw}}$

$q_{\text{rxn}} = - (7.50\text{ KJ/}^\circ\text{C}) (+22^\circ\text{C})$

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

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

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



$$\text{rate} = k [\text{NO}^+] [\text{NH}_3]$$

$$[\text{NO}^+] [\text{H}_2\text{O}] = [\text{HNO}_2] [\text{H}^+]$$

$$[\text{NO}^+] = \frac{[\text{HNO}_2] [\text{H}^+]}{[\text{H}_2\text{O}]}$$

$$[\text{NH}_3] [\text{H}^+] = [\text{NH}_4^+]$$

$$[\text{NH}_3] = \frac{[\text{NH}_4^+]}{[\text{H}^+]}$$

$$\text{rate} = k \frac{[\text{HNO}_2] [\cancel{\text{H}^+}]}{[\text{H}_2\text{O}]} \cdot \frac{[\text{NH}_4^+]}{\cancel{[\text{H}^+]}}$$

$$\text{rate} = k \frac{[\text{HNO}_2] [\text{NH}_4^+]}{[\text{H}_2\text{O}]}$$

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

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

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

$$0.528 \text{ J/pulse}$$

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

$$13) \quad \text{rate} = k [\text{BrO}_3^-]^x [\text{Br}^-]^y [\text{H}^+]^z$$

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

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

$$x = 1$$

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

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

$$y = 1$$

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

$$1.5^z = 2.25$$

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

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

$$z = 2$$

