NAME _____
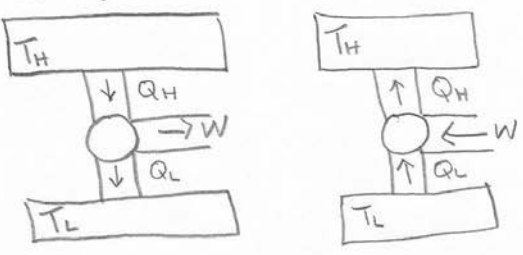
Please do not open until instructed to do so.

Make sure you have filled out your SCAN CARD as instructed.

Heat Engine

T_H → Q_H (down) → W → Q_L (down) → T_L

T_H → Q_H (up) ← W → Q_L (up) → T_L

$$\text{efficiency} = \frac{get}{pay}$$

$$\varepsilon_{carnot}^{\text{Heat Engine}} = 1 - \frac{T_L}{T_H}$$

$$|\vec{F}| = \left| \frac{Kq_1 q_2}{r^2} \right| \qquad K = 8.99 \times 10^9 \ \frac{Nm^2}{C^2} \quad \left(\text{Note: } K = \frac{1}{4\pi\varepsilon_0}\right)$$

$$\left|\vec{E}_{\substack{pt. \\ charge}}\right| = \left| \frac{Kq}{r^2} \right|$$

$$\vec{F} = q\vec{E}$$

$$\Phi = \int \vec{E} \cdot d\vec{A}$$

$$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enclosed}}{\varepsilon_0} \qquad \varepsilon_0 = 8.85 \times 10^{-12} \ \frac{C^2}{Nm^2}$$

$$V_{\substack{pt. \\ charge}} = \frac{Kq}{r}$$

$$\Delta V = V_b - V_a = -\int_a^b \vec{E} \cdot d\vec{l}$$

$$\Delta P.E. = q\Delta V$$

$$\vec{E} = -\nabla V = -\frac{\partial V}{\partial x}\hat{i} - \frac{\partial V}{\partial y}\hat{j} - \frac{\partial V}{\partial z}\hat{k}$$

Q = mc(delta T) and Q = mL.