Name: Joseph Specht

Quiz 10 (Total: 30 points; 5 bonus points possible)

Due back on Wed. 19 April, 10 p.m.

- *Save your entire assignment as one PDF document and upload it in the appropriate assignment folder on Canvas.*
- *Assignments will only be graded if the honor code statement, below, is completed and signed.*

Honor Code Statement

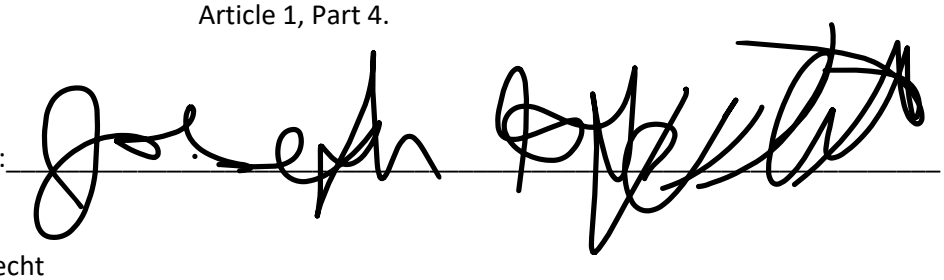
ME 200, Quiz 10

Being a student of high standards, I pledge to embody
the principles of *academic integrity*.

This ME 200 quiz is my own work. I did not seek (or get) outside help or collaboration with any of the questions and their solutions. I also did not offer my solutions to any other student.

I understand that this quiz is "open book" and "open notes" which means that I was permitted to use my prescribed textbook and lecture notes when addressing any of the questions. I have properly cited any other resources, with full cognizance of the regulations pertaining to plagiarism, copyright infringement, academic cheating, etc., as stipulated in the Student Code.

I acknowledge that academic violations will be dealt with according to the UIUC Student Code, Article 1, Part 4.

ME 200 Student's signature: 

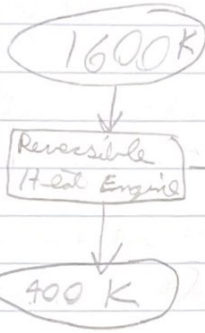
Student's Name: Joseph Specht

Net-ID: jspecht3

Date: 4/17/23

2#10 - Joseph Spechtt

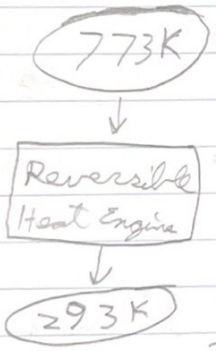
a)



$$\eta_{th} = 1 - \frac{T_c}{T_h} = 1 - \frac{400K}{1600K} = 1 - .25 = .75 = 75\%$$

$$\boxed{\eta_{th} = .75 = 75\%}$$

b)



$$\eta_{th} = 1 - \frac{T_c}{T_h} = \frac{W_{net}}{Q_H} \quad \therefore Q_h = \frac{W_{net}}{1 - \frac{T_c}{T_h}}$$

$$\boxed{Q_h = 1610.42\ kJ}$$

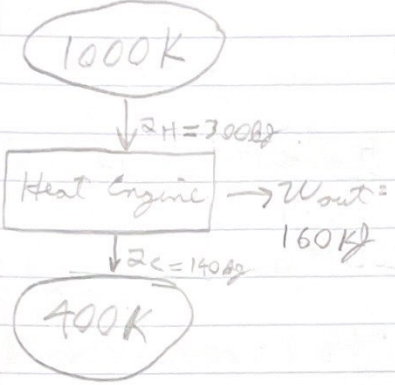
We also know $\eta_{th} = 1 - \frac{T_c}{T_h} = 1 - \frac{Q_c}{Q_h}$

$$\therefore \frac{T_c}{T_h} = \frac{Q_c}{Q_h} \Rightarrow Q_c = Q_h\left(\frac{T_c}{T_h}\right) = 1610.42\ kJ\left(\frac{293K}{773K}\right) = 610.4179$$

$$\boxed{Q_c = 610.42\ kJ}$$

2 #10 - Joseph Specht

2a)



1st law:

$W_{net} = Q_H - Q_C = (300 - 140)kJ = 160kJ$

W_{net} is what it should be!

Also, $\eta_{th} = \frac{W_{net}}{Q_H} = \frac{160kJ}{300kJ} = .533 = 53.3\%$

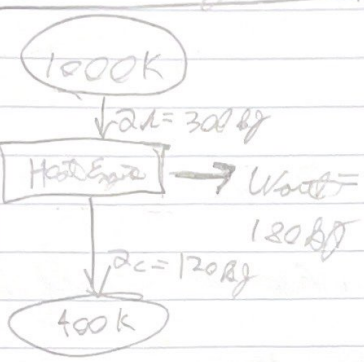
We then need to compare this efficiency to that of a theoretical engine w/ no irreversibilities

2nd law: $\eta_{th} = 1 - \frac{T_C}{T_H} = 1 - \frac{400K}{1000K} = 1 - .4 = .6 = 60\%$

Since the practical efficiency < the theoretical efficiency, this system works & does not need irreversibilities to work!

2#10 - Joseph Lynch

20)



1st law:

$W_{net} = Q_H - Q_C = (300 - 120)\text{kJ} = 180$ kJ

Work matches!

$\eta_{th} = 1 - \frac{Q_C}{Q_H} = 1 - \frac{120\text{kJ}}{300\text{kJ}} = 1 - .4 = .6 = 60\%$

2nd law:

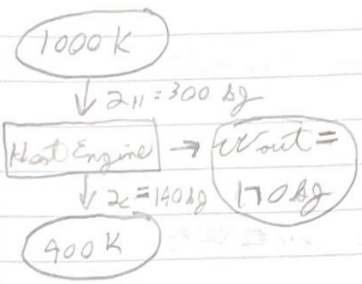
$\eta'_{th} = 1 - \frac{T_C}{T_H} = 1 - \frac{400K}{1000K} = 1 - .4 = .6 = 60\%$

$\eta_{th} = \eta'_{th}$

∴ the process is theoretically possible, but the requirement is no irreversibilities can be present.

2 #10 - Joseph Specht

2c)



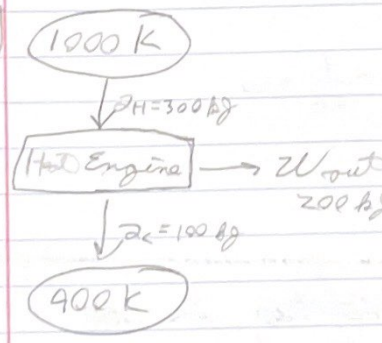
1st law:

$W_{net} = Q_H - Q_C = 160$ kJ

$W_{net} < W_{out}$ ∴ NOT POSSIBLE!

Fails first test, so this process is impossible.

2d)



1st law:

$W_{net} = Q_H - Q_C = (300 - 200)$ kJ $= 100$ kJ

$W_{net} = W_{out}$, so checks out!

$\eta_{th} = \frac{W_{out}}{Q_H} = \frac{200 \text{ kJ}}{300 \text{ kJ}} = .667 = 66.7\%$

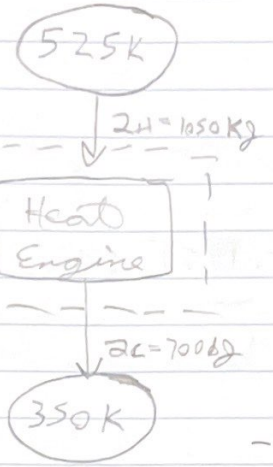
2nd law:

$\eta'_{th} = 1 - \frac{T_C}{T_H} = 1 - \frac{400 K}{1000 K} = 1 - .4 = .6 = 60\%$

$\eta_{th} > \eta'_{th}$ ∴ This process is impossible as the cycle efficiency is greater than the theoretical efficiency

2#10 - Joseph Specht

3)



Using Clausius Equality

$$\oint \left(\frac{\delta Q}{T}\right) \leq 0$$

which can be written

$$\oint \left(\frac{\delta Q}{T}\right) = -\sigma_{cycle}$$

$$-\sigma_{cycle} = \frac{Q_H}{T_H} - \frac{Q_C}{T_C}$$

$$\Rightarrow -\sigma_{cycle} = \frac{1050\ KJ}{525\ K} - \frac{700\ KJ}{350K} = \frac{1}{2K} - \frac{1}{2K} = 0$$

$$\boxed{\sigma_{cycle} = 0}$$

There are no irreversibilities in the cycle meaning it is reversible & almost not possible.