PHYS-320 Energy: Demographics and Heat Engines
Schwartz Problem Set #2

1) Imagine you drive *your* car to San Francisco (if you actually drive an electric car, then imagine you drive someone else's gasoline car) – you may need to look up some information:
   a) How many gallons of gasoline would you use? About how many kg of gasoline is this? About how much energy is this? Put answer in Joules and kWhr.
   b) About how much CO_2 is emitted from your trip?

1) As I remember commuting to [illegible]
on sabbatical in 2007, a fill
lasted me a trip there + part w[illegible]
I'll say 7 gallons

1 gallon = 4 qts ≈ 4 li. Would
but gasoline is less dense than
← 0.78 kg/liter

so mass of 1 gallon of gas[illegible]

because burning adds 2 Oxy[illegible]
(m_{O_2} = 32 g/mole) to the carbon ([illegible]
the CO_2 is more than 3 ti[illegible]

Another way to do this is recogn[illegible]
the carbon intensity of Petrole[illegible]

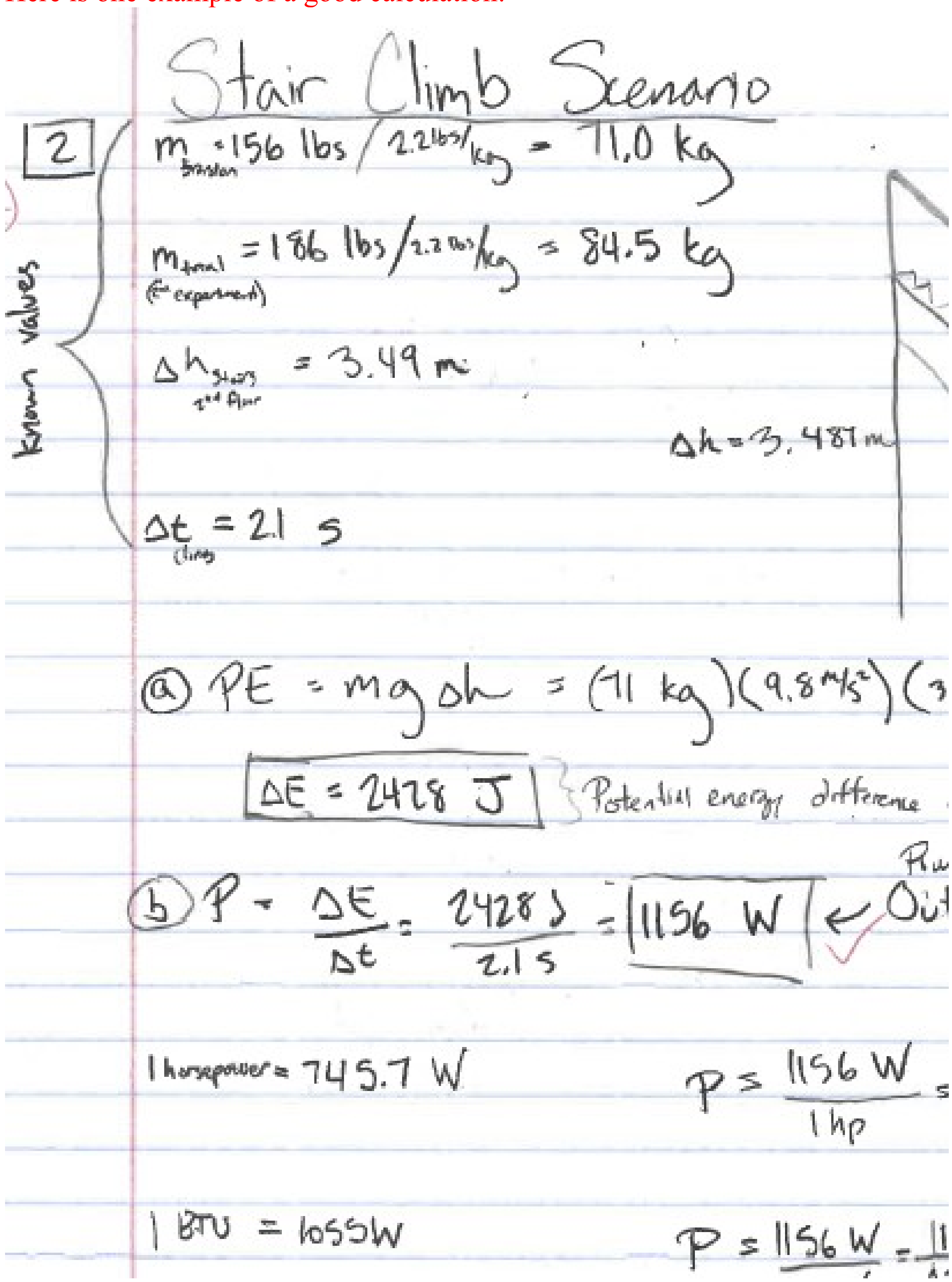
so, CO_2 emissions ≈ $\frac{20g\ (C)}{MJ}$ $\left(\frac{44g(CO_2)}{12g(C)}\right)$

For Activity Section*

2) Measure the power output of your body two different ways. Express it in Watts, horsepower, and BTU/hr:

a) Calculate the total energy you produced and time the process.
b) Calculate the power you put out in Watts, horsepower, and BTU/hr.
c) Calculate how long it would take you to charge a 1 kWh battery (like a car battery) if you could keep up this activity.

Here is one example of a good calculation:



Stair Climb Scenario

2

Known values

$m_{Brandon} = 156$ lbs / 2.2 lbs/kg = 71.0 kg

$m_{total} = 186$ lbs / 2.2 lbs/kg = 84.5 kg
(← experiment)

$\Delta h_{stairs\ 2^{nd}\ floor} = 3.49$ m

$\Delta h = 3.487$ m

$\Delta t_{climb} = 2.1$ s

ⓐ $PE = mg\Delta h = (71\ kg)(9.8\ m/s^2)($

$\Delta E = 2428$ J } Potential energy difference

ⓑ $P = \frac{\Delta E}{\Delta t} = \frac{2428\ J}{2.1\ s} = 1156\ W$ ← Power Out

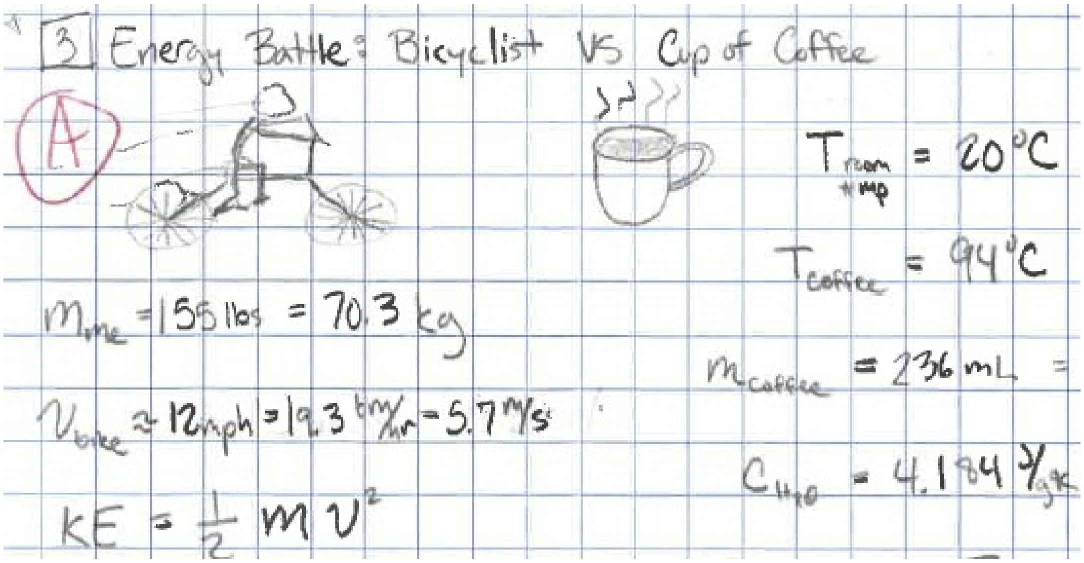
1 horsepower = 745.7 W

$P = \frac{1156\ W}{1\ hp}$

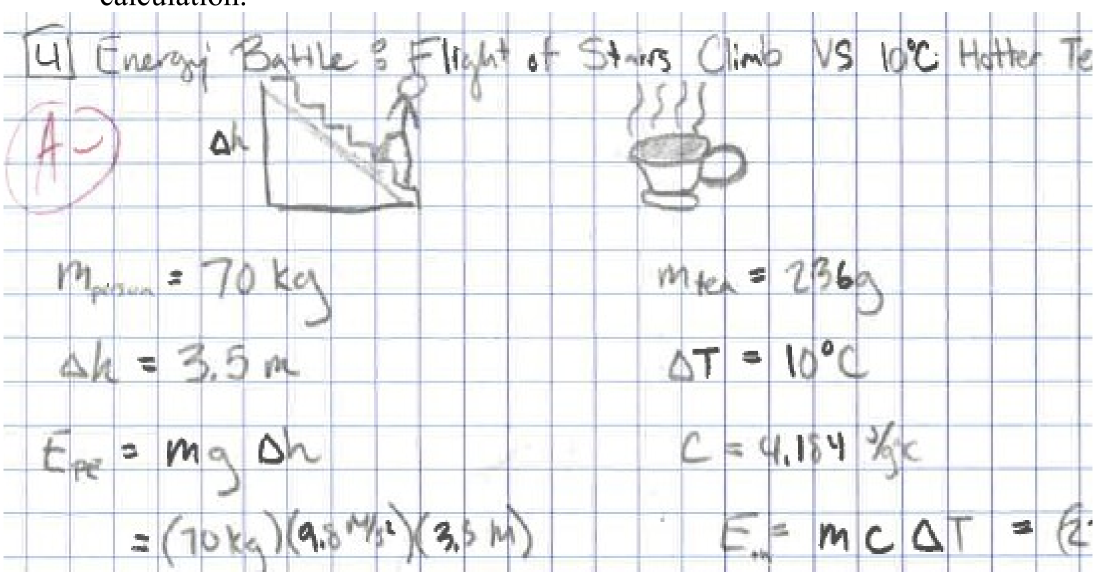
1 BTU = 1055W

$P = 1156\ W =$

2) What do you think has more energy: you riding fast on your bicycle, or a hot cup of coffee? Please do the calculations.



3) What takes more energy: Running up the flight of stairs in Baker or heating your tea (half a liter of water) 10 ºC. Please explain your experience and please show a calculation.

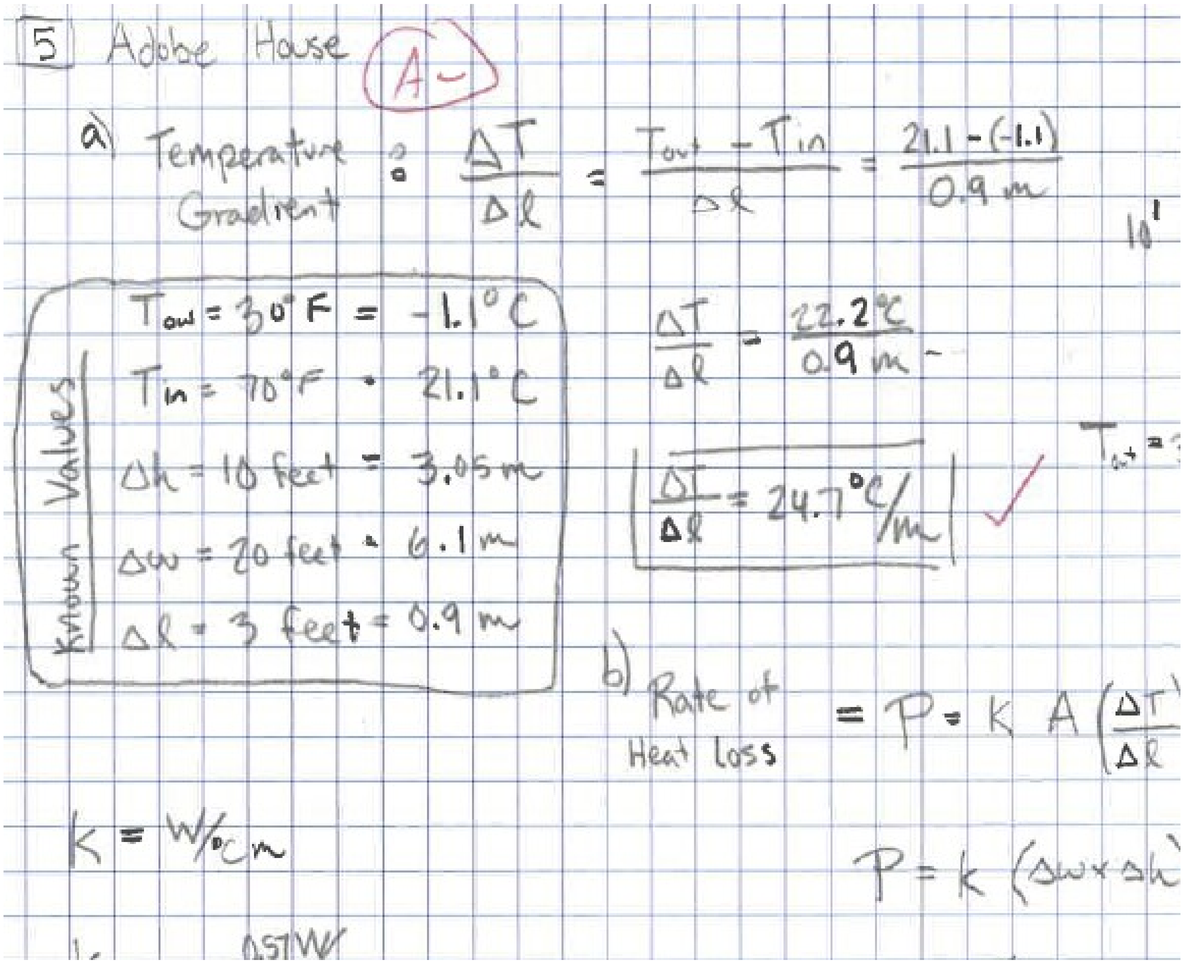


****more questions****

5) I want to make a house out of adobe, (mud, cob, earth whatever you like to call it). If the wall is 10’ x 20’ and is 3’ thick, when it is 70 °F inside and 30 °F outside,

a) Please calculate the temperature gradient

b) please calculate the rate of heat loss in Watts and BTU/hr through the wall.



6) Check out the : [Animated Engines](http://www.animatedengines.com/) (http://www.animatedengines.com/) website and write down an explanation of how the following engines work, which will be testable, so this is just practice for the exams:

a) Reciprocating Engines: What's the difference between a four-stroke engine and a two-stroke engine? When would you use one rather than the other?

b) What's the difference between a diesel and a gasoline engine?

c) How does a Brayton Cycle (gas turbine) work?

d) How does a Rankine Cycle (steam turbine) work? How is it different from a Brayton (gas turbine)?

e) Pick one other kind of heat engine and explain how it works. – You could even look up the new Free Piston Linear Engine and see how it works – do you think this kind of engine will take on? Up to you.

6 Different Engines (A+)

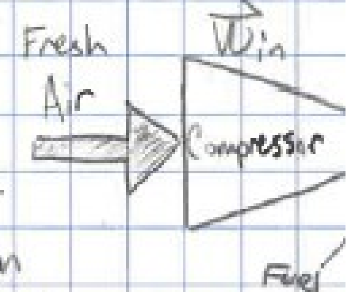
a) Reciprocating Engines

A two stroke engine has all its action in one cylinder completed in two strokes. On the down stroke, the fuel en from the left and fuel leaves out the right. The other stroke re A four-stroke engine has these events take place with more and space used. Two-strokes are more compact and useful mowers, chain saws, etc.

b) Diesel VS Gas Engine

While both the two-stroke and four-stroke engine, l engines help combustion with a spark from a spark s diesel engine combusts purely from the rapid decrease in pressure. The intake/outtake valves open and clos two things against them, pushing at different times.

c) Brayton Cycle (Gas Turbine)



The Brayton Cycle compresses air ($\vec{W}_{in}$) using multiple blades and then injects fuel ($\vec{E}_{chem}$) that gets ignited in the compressed air region. This heat from the fuel raises the temperature of the compressed air, th of the air that is wanting to expand in volume. This lead exhaust which helps propel the plane forward ⇒ thus ge and this process can continue.

e) Stirling Engines

The Stirling Engine works off of a temperature difference between the bottom plate and top plate. For instance, if the displacer is along the bottom plate and that plate gets hot, the air between the displacer and plate gets hot and expand. This pushes the

7) Please see solutions to Assessments on main class website