CSUC Spring Term 2020
Physics 204A sections 6, 7, 8

Reading and Problem Assignment ***Revised Schedule Week 9*** due Friday, March 27.

DEAR CLASS: In our new regimen you are asked to read the chapter and do these problems – but don't write them up for submission. At the end of the week I will post my own (handwritten) solutions. These are the problems you would have done in a regular semester and they exhibit the level of competency you must attain to as a technical person at this stage of education. You will submit **only** the Portfolio Problems which are posted as a separate assignment. I intend to post the Portfolio Problems both on our class site and on Blackboard – but, as it stands now, you are to submit them on Blackboard.

I. Work and Kinetic Energy: Please read chapter **9** in your class text.

II. ★ Please pass the Gasoline!

I'm looking at the butter package as I have my breakfast. It says that a 1 tbsp serving weighs 14 g and has 100 Calories of energy content. You are to estimate the energy content "per gallon of butter" and compare it to another hydrocarbon fuel … namely gasoline. Gas has a combustion energy content of about 10 kWh per liter. Use the common unit of kWh per gallon as your comparison unit. Which is more energy rich ?

III. ★ Feed me or Drive me!

If the "average person" drives about 50 km per day and the average car delivers about 12 km per liter of fuel used, what is the average energy consumption per person per day used up in driving our cars measured in kWh ? Compare this to the "average energy" consumed per day in feeding that "average person" measured in kWh.

IV. ★ Problems for **Mastery**: Chapter **9** pp 227 - **DO NOT SUBMIT !**

1. # 38, **2.** # 39, **3.** # 41, **4.** # 42, **5.** # 53, **6.** # 59, **7.** # 62, **8.** # 64 , **9.** # 65

√ the single most important act in problem solving is drawing a ***good picture!***
√ spread out! - be neat - don't stint on space!
√ **never** insert numerical values until the algebra has been worked through -relationship is *shape*.

Set 8

II. $1\ gal = 256\ Tbsp = 3.78541\ l$

Butter: $1.07 \times 10^8\ J/gal$

Gas. $1.35 \times 10^8\ J/gal$ (10 kWh/liter)

$1\ kWh = 3.6 \times 10^6\ J$

So butter has $\frac{1.07 \times 10^8}{3.6 \times 10^6}\ kWh/gal = 29.72\ kwh/gal$

gas has $\frac{1.35 \times 10^8}{3.6 \times 10^6}\ kwh/gal = 37.5\ kwh/gal$

$\frac{E_{gas}}{E_{butter}} \sim 1.26$

III. Avg. Person $\frac{50\ km}{12\ km/l} = 4.1667\ l$ used

$\Longrightarrow \approx 41.66\ kWh$ used driving each day

$2000\ C \approx 2 \times 10^6 (4.19\ J) = 8.38 \times 10^6\ J$ each day

or $\frac{8.38}{3.6} (3.6 \times 10^6\ J) \approx 2.33\ kWh$

Set #8 Knight Chp. 9

1.) # 38 pg 229

Energy = Power x Time

a) $E_1 = (1.2 \times 10^3\ W) \times (600\ sec) = 7.2 \times 10^5\ J$

b) $E_2 = (10^1\ W) \times (24 \times 3600\ sec) = 8.64 \times 10^5\ J$

comparable!

2.) # 39 pg 229

$$\left(\frac{1 \times 10^3\ W}{m^2}\right) \times (Area) \times (3600\ sec) = 150 \times 10^6\ J$$

$$Area \times \frac{3.6 \times 10^6\ J}{m^2} = 150 \times 10^6\ J$$

$$Area = \frac{150}{3.6}\ m^2 = 41.\overline{6}\ m^2 = (6.45\ m)^2$$

3.) # 41 pg 229

✓ $\Delta E / \Delta t = \frac{1}{2}(70\ kg)(10\ m/s)^2 / 3\ sec = 1.17 \times 10^3\ W$

✓ $\frac{1}{2}(30\ kg)(20\ m/s)^2 / 3\ sec = 2 \times 10^3\ W$

comparable!

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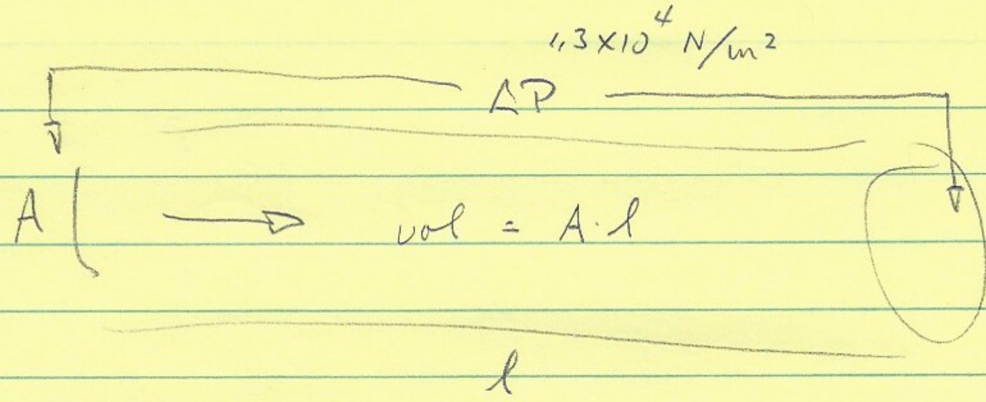
4.) # 42



If the blood filled a tube of area A, & length l

$F = PA$ and $\Delta W = Fl = PAl = P\,vol.$

Then $\Delta W = (1.3 \times 10^4 \frac{N}{m^2})(6\,l)$

$= (1.3 \times 10^4 \frac{N}{m^2})(6\; 10^{-3}\, m^3)$

$= 1.3 \times 6 \times 10^1\ J = 78\ J$

power $= \frac{\Delta W}{\Delta t} = \frac{78\ J}{60\ sec} \approx 1.3\ W$

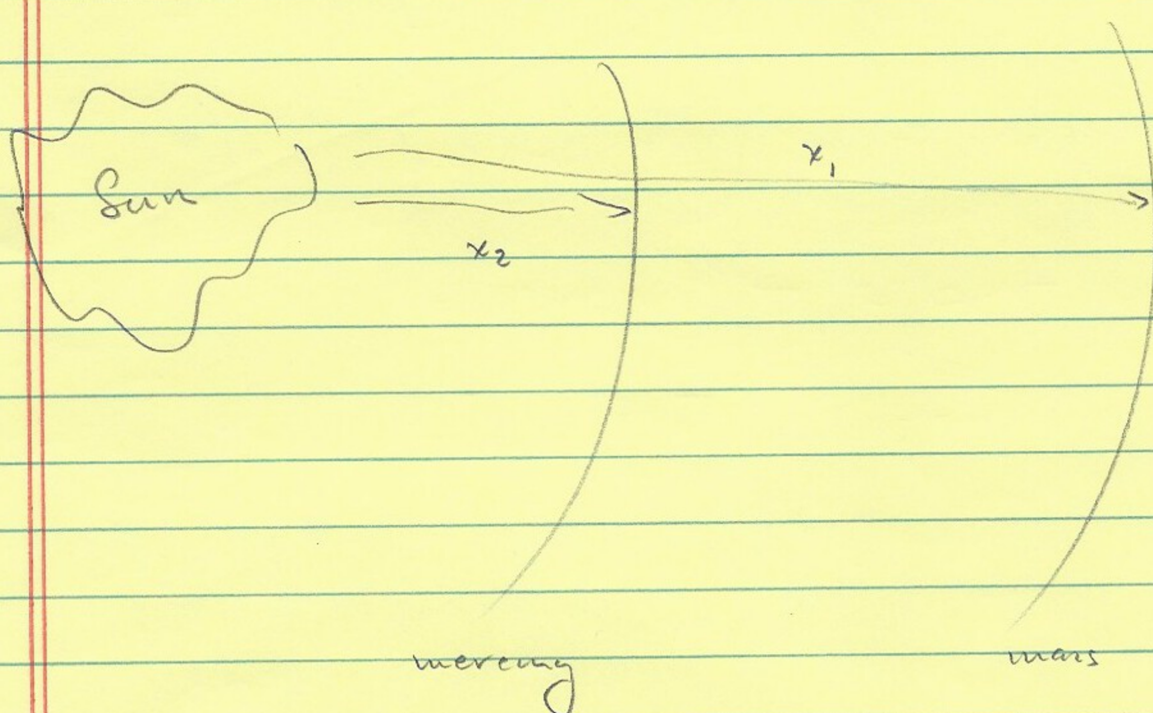
Set #8 Knight Chp. 9

5.) #53

$$F = -\frac{G m_1 m_2}{x^2} \quad \text{\underline{inward} (attractive)}$$

$$\Delta W = \int_{x_1}^{x_2} F\,dx = G m_1 m_2 \int_{x_1}^{x_2} -\frac{dx}{x^2} =$$

$$G m_1 m_2 \left(\frac{1}{x_2} - \frac{1}{x_1} \right)$$



$$\frac{1}{2} m v_2^2 - \frac{1}{2} m v_1^2 = \text{Net work done.}$$

$$\frac{1}{2} m v_2^2 = \frac{1}{2} m v_1^2 + G m m_{sun} \left(\frac{1}{x_2} - \frac{1}{x_1} \right)$$

$$v_2^2 = (3.5 \times 10^4 \,m/s)^2 + G m_{sun} 2 \left(\frac{1}{x_{merc}} - \frac{1}{x_{mars}} \right)$$

$r_{merc.} = 5.79 \times 10^{10}$ m

$r_{mars} = 2.28 \times 10^{11}$ m

$G = .667 \times 10^{-10} \frac{N m^2}{kg^2}$

$M_{sun} = 1.99 \times 10^{30}$ kg

$$\frac{G M_{sun}}{r_{merc.}} = \frac{(.667 \times 10^{-10})(1.99 \times 10^{30})}{5.79 \times 10^{10}} = .23 \times 10^{10}$$

$$\frac{r_{merc}}{r_{mars}} = \frac{5.79 \times 10^{10}}{2.28 \times 10^{11}} = .254$$

$$v_2^2 = .1225 \times 10^{10} + .23 \times 10^{10} (.746) \times 2$$

$$= (.1225 + .343)\, 10^{10} \; m^2/s^2$$

$$v_2 = .682 \times 10^5 \; m/s$$

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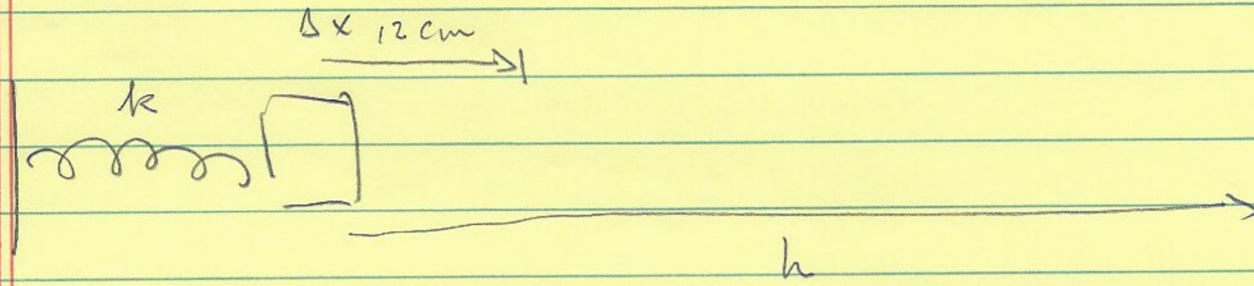
6.) #59 pg 229



$$\frac{1}{2} k \Delta x^2 = F_f h$$

$$\frac{1}{2}\left(250 \frac{N}{m}\right)(.12 m)^2 = (.25 kg)(9.8)(.23)\ h$$

$$\frac{(250)(.12)^2}{2(.25)(9.8)(.23)} = h$$

$$\frac{2.5\ (1.44)}{(.5)(9.8)(.23)} = 3.194 \text{ m}$$

$$(KE + PE)_f - (KE + PE)_i = W^{\text{non con.}}$$

$$\frac{1}{2} m v_\ell^2 - \frac{1}{2} k \Delta x^2 = -F_f \Delta x$$

$$\frac{1}{2}\left(\frac{1}{4} kg\right) v_\ell^2 - \frac{1}{2}\left(250 \frac{N}{m}\right)(.12 m)^2 = -\left(\frac{1}{4} kg\right)(9.8)(.23)(.12)$$

$$v_\ell^2 = 10^3 (.12)^2 - 2(9.8)(.23)(.12)$$

$$14.4 - .541 = 13.859$$

$$v_\ell = 3.7228 \text{ m/s}$$

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7.) #62 pg 230

a) Power = $F \cdot v$

$F = \frac{1}{2} C \rho A v^2$ so $P = \frac{1}{2} C \rho A v^3$

$P = \frac{1}{2}(.9)\left(1.3 \frac{kg}{m^3}\right)(.45 m^2)\left(7.3 \frac{m}{s}\right)^3$

$= 1.024 \times 10^2$ W

b) $P_{metabolic} = 4 \times 10^2$ W

c) $P \times T = (4 \times 10^2 W)(3600 sec)$ J

so ≈ 352 C

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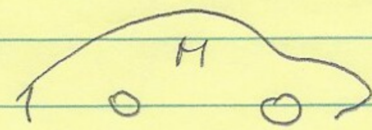
8.) # 64 pp 230



$$F_{max} = \mu_s Mg\left(\frac{2}{3}\right) = M a_{max}$$

a) So! $a_{max} = \mu_s g \frac{2}{3} = 1(9.8)\left(\frac{2}{3}\right) = 6.5\bar{3}\ m/s^2$

b) $P_{max} = F_{max} v_{opt}$ so $\frac{P_{max}}{F_{max}} = v_{opt}$.

$$v_{opt} = \frac{(217\ hp)(.7)}{M a_{max}} = \frac{(217\ hp)(.7)}{(1480\ kg)(6.5\bar{3}\ m/s^2)}$$

$1\ hp = 746\ W$

$$v_{opt} = \frac{(217)(746\ W)(.7)}{(1480)(6.5\bar{3})} \approx 11.7\ m/s$$

c) $11.7\ m/s = a_{max}\Delta t \rightsquigarrow \Delta t = \frac{11.7\ m/s}{6.53\ m/s^2} = 1.79$ se

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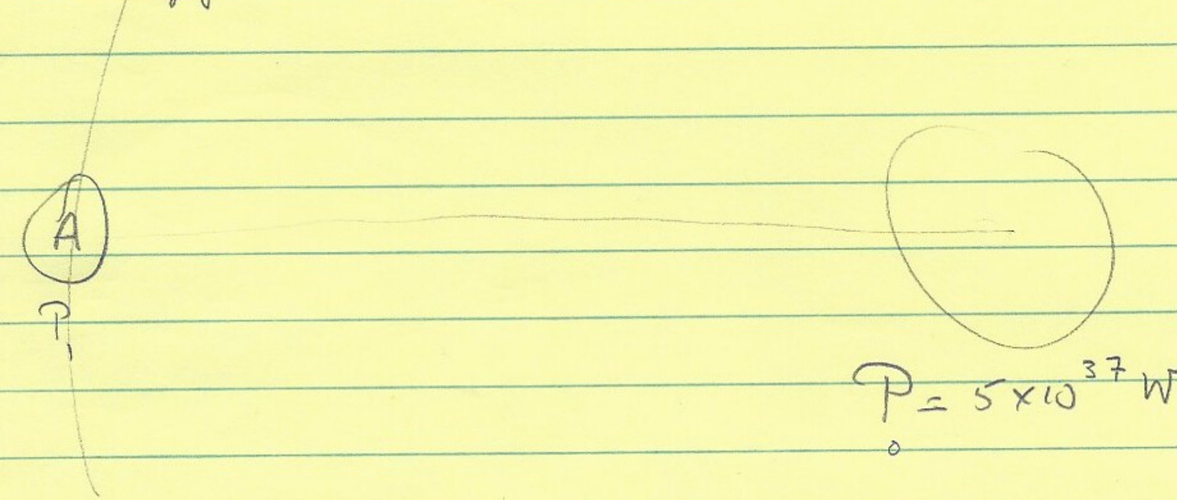
9.) # 65 pg 230



$$\frac{P_1}{A} = \frac{P_0}{4\pi r^2}$$

So $\frac{P_1}{A} \pi (1m)^2 \times 10 \text{ sec} = 9.1 \times 10^{-11} \text{ J}$

or $\frac{P_0}{4\pi r^2} \pi (1m)^2 \times 10 \text{ sec} = 9.1 \times 10^{-11} \text{ J}$

$$\frac{P_0 \; (1m)^2 \times 10 \text{ sec}}{(4) \; 9.1 \times 10^{-11} \text{ J}} = r^2$$

$\rightsquigarrow \frac{5 \times 10^{37} \times 10^1}{4 \times (9.1) \times 10^{-11}} = r^2$

$m^2 \; \frac{5}{4(.91)} \times 10^{48} = r^2 \qquad r = 1.17 \times 10^{24} \text{ m}$

$\frac{r}{(3 \times 10^8)(\pi \times 10^7)} = 1.24 \times 10^8$ light years.