Problem Set #1 PHYS 310 4/6

1. a) Consumption of combustable fuels for electricity generation
b) Coal consumption down 14.5% from 1/14 → 1/15
c) Gas turbine is the cheapest to operate and maintain, but requires 4x in fuel prices than nuclear.

2. According to the chart:

A⁻ for A⁺
don't use calculator + estimate.

- 15TW = .5 Zj/yr
- We use oil for 5TW of our energy
- We have 110 Zj of oil energy in stock

Therefore 5TW = .167 Zj/yr

$$\frac{110 \text{ Zj}}{.167 \frac{\text{Zj}}{\text{yr}}} = \boxed{660 \text{ years}}$$

3. Approximate petroleum use → 90,878,200 $\frac{\text{barrel}}{\text{day}}$

$$\frac{90.9 \times 10^6 \text{ barrel}}{1 \text{ day}} \cdot \frac{5.86 \times 10^9 \text{ j}}{1 \text{ barrel}} \cdot \frac{1 \text{ day}}{86,400 \text{ sec}} = \boxed{6.16 \text{ TW, about } 5\text{TW}}$$

4. $\frac{\text{Circumfrence of Earth}}{4} = \frac{2\pi r}{4} = 10,000 \text{ km}$

$$\therefore \quad r = \frac{40,000 \text{ km}}{2\pi} = 6366 \text{ km}$$

Surface Area $= 4\pi r^2 = 4\pi(6.366 \times 10^6 \text{ m})^2 = 509.26 \times 10^{12} \text{ m}^2$

$$\frac{509.26 \times 10^{12} \text{ m}^2}{7.125 \times 10^9 \text{ people}} = \boxed{71.48 \times 10^3 \text{ m}^2/\text{person}}$$

5. a) According to the energy flow chart:

- 86,000 TW of energy from the sun hits Earth's surface

Assuming exactly half the Earth is lit at a time, this is divided among 3.563 x 10⁹ people

$$\frac{86,000 \text{ TW}}{3.563 \times 10^9 \text{ ppl}} = \boxed{24.2 \frac{\text{MW}}{\text{person}}}$$

$$24.2 \times 10^6 \text{ watt} \cdot \frac{1 \text{ ton of ice}}{3.517 \times 10^3 \text{ watt}} = \boxed{6,880 \frac{\text{ton of ice}}{\text{person}}}$$

b) $24.2\ MW = 24.2 \frac{Mj}{s}$

$$\frac{24.2\ Mj}{1\ sec} \cdot \frac{3600\ sec}{1\ hr} \cdot \underbrace{\frac{12\ hr}{1\ day}}_{\text{Assuming 1/2 the day is sunlight}} \cdot \frac{365\ day}{1\ yr} = .382\ Pj$$

$$= \boxed{381.59 \times 10^{12}\ \text{joules}}$$

$$381.59 \times 10^{12}\ \text{joules} \cdot \frac{1\ boe}{5.862 \times 10^{9}\ j} = \boxed{65{,}095\ boe}$$

$$65{,}095\ boe \cdot \frac{50\ \text{dollar}}{\text{barrel}} = \boxed{\sim \$3{,}255{,}000}$$

c) $24.2\ MW \cdot .15 = 3.63\ MW = 3{,}630\ KW$

oh, you already considered this.

$$3{,}630\ KW \cdot \frac{8760\ hrs}{yr} = 31{,}799{,}800\ kWh$$

~~-1/4~~

$$31.8 \times 10^{6}\ kWh \cdot \frac{15.2\ ¢}{1\ kWh} = \boxed{\$4{,}833{,}600}$$

6. Me → 165 lbs ⇒ Me/.1 = 41.25 lbs
Barrel of Oil → 300 lbs

∴ I am equivalent to $\frac{41.25}{300} = .1375$ barrel of oil

good

$$.1375\ \text{barrel} \cdot \frac{5.862 \times 10^{9}\ j}{1\ \text{barrel}} = \boxed{805{,}959{,}000\ j \quad \text{per day}}$$

According to EIA, US per capital energy use for 2011 → 312.786×10^6 BTU

$$\frac{(312.786 \times 10^{6}\ BTU/yr)(1{,}055.9\ j/BTU)}{365\ \frac{day}{yr}} = \boxed{904{,}851{,}335\ j\ \text{per day}}$$

sig fig?

7. Let's assume 1 rock climb 3 m in 1 minute.

$$E_p = mgh = \left(\frac{165}{2.2} kg\right)(9.81\ m/s^2)(3\ m) = 2207\ j$$

$$\frac{2207\ j}{60\ sec} = 36.79\ watt$$

1 horsepower = 746 watt $\rightarrow$ $\frac{36.79}{746} = \boxed{.0493 \text{ horsepower}}$

8. $Q = e^{it}$

$$\frac{dQ}{dt} = \frac{d(e^{it})}{dt} = \frac{d}{dt}\left[1 + it + \frac{i^2t^2}{2!} + \frac{i^3t^3}{3!} + \ldots\right]$$

$$\Downarrow$$

$$= \left[0 + i + \frac{2i^2t}{2!} + \frac{3i^3t^2}{3!} + \frac{4i^4t^3}{4!} + \ldots\right]$$

$$= i\underbrace{\left[1 + it + \frac{i^2t^2}{2!} + \frac{i^3t^3}{3!} + \ldots\right]}_{e^{it}}$$

$$\therefore \frac{d e^{it}}{dt} = i e^{it}$$

$$\boxed{\frac{dQ}{dt} = iQ}$$

9. $A = A_0 e^t$ $\quad$ $A = 3A_0 \rightarrow$ Triples

$$3A_0 = A_0 e^t$$

$$3 = e^t$$

$$t = \ln(3) = \boxed{1.099 \text{ units of time}}$$