HOMEWORK 1

A⁻ ⇒ for A⁺ w/out calculator + estimate good work.

1 (a) MOST INTERESTING FIGURE:
U.S. DISPOSABLE INCOME GRAPH

(b) STATISTIC:
NATURAL GAS IS LIKELY TO REMAIN AT \$3 PER MILLION BTU

(c) FUN FACT
MY HOUSE IS IN A 0.2% ANNUAL FLOOD CHANCE AREA

2 FIND: HOW LONG OIL WILL LAST IF USED AT THE CURRENT RATE

X = AMOUNT OF OIL = 110 ZJ = 110 E+21 J

$\frac{dx}{dt}$ = RATE OF USE = 5.0 TW = 5.0E+12 J/s

$$\frac{dx}{dt} = \frac{x}{t} \rightarrow t = \frac{x}{\frac{dx}{dt}}$$

$$t = 110E{+}21\,J \cdot \frac{1\,s}{5.0E{+}12\,J} \cdot \frac{1\,h}{3600\,s} \cdot \frac{1\,day}{24\,h} \cdot \frac{1\,year}{365.25\,day} = 697\,yr$$

OIL WILL LAST FOR 697 YEARS ASSUMING ALL OF IT CAN BE ACCESSED AND USED AT CURRENT RATES

3 FIND RATE OF PETRO CONSUMPTION - CONVERT TO TW

WORLD OIL CONSUMPTION = 85×10^6 BARRELS/DAY
APPLY TIME AND ENERGY CONVERSIONS

$$= 85 \times 10^6 \frac{BARREL}{DAY} \cdot \frac{6.1E{+}9\,J}{1\,BARREL} \cdot \frac{1\,DAY}{24\,HR} \cdot \frac{1\,HR}{3600\,S} \approx 6.0 \times 10^{12}\,J/s$$

↑ Assume 1 bbl = 6.1E+9 J

$= 6.25 \times 10^{12}\,W = 6.0\,TW$ THUS GLOBAL OIL CONSUMPTION IS CLOSE TO 5.0×10 TW

4

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4 Surface area of Earth = 510.1 million km^2

$$SA = 510.1E{+}6\ km^2 \frac{(1000m)^2}{1(km)^2} = 5.101E{+}14 m^2$$

$$P_{EA} = 7.125E{+}9 \text{ people}$$

thus, if the earth was divided evenly among everyone each person would receive

$$\frac{SA}{P} = \frac{5.101E{+}14 m^2}{7.125E{+}9 \text{ people}} = \boxed{71{,}590\ m^2/\text{person}}$$

5

(a) $A = 71{,}590 m^2$ $\eta = \frac{1}{3}$ ← ASSUME EFFICIENCY IS $\frac{1}{3}$ OF FULL SUNLIGHT 24/7 DUE TO DAY/NIGHT CYCLES

$D_E = 1000 W/m^2$ ← ENERGY DENSITY OF LIGHT ON SURFACE

$$P = AD_E\eta = \frac{71{,}590 m^2 \cdot 1000 W/m^2}{3} = \boxed{23.8 MW}$$

the solar heat absorber would capture 23.8 MW, or

$$23.8 \times 10^6 W \frac{1 \text{ Ton}}{3.517 \times 10^3 W} = \boxed{6.77 \times 10^3 \text{ Tons of ice per day}}$$

(b) in a year, the energy absorbed is given by the following conversion:

$$23.8E{+}6 \frac{J}{s} \cdot \frac{3.15569E{+}7 s}{1 yr} = \boxed{751 \times 10^{12} J/yr}$$

This is equivalent to

$$751 \times 10^{12} \frac{J}{yr} \cdot \frac{1 boe}{6.1 \times 10^9 J} = \boxed{123000 \text{ boe}/yr}$$

(c) $\eta = 0.15$, $E = 751 \times 10^{12} J/yr$

The financial value of electricity generated from said solar panels is

$$751 \times 10^{12} J \cdot \frac{\$0.15}{3.6E{+}6 J} \cdot 0.15 = \boxed{\$4.69 \text{ million}}$$

Efficiency

6

total energy ≈ 10^{20} J / USA·yr

OIL USAGE $U = 23.4 \times 10^6$ bbl/Day

POPULATION OF N. AMERICA $P = 528.7 \times 10^6$ PEOPLE

$$\text{OIL PER PERSON} = 23.4E{+}6 \frac{bbl}{Day} \cdot \frac{158.99 L}{1 bbl} \cdot \frac{1 m^3}{1000 L} \cdot \frac{800 kg}{1 m^3} \cdot \frac{2.2 lb}{1 kg} \cdot \frac{1}{528.7 \times 10^6 ppl}$$

$\boxed{= 12.4 \text{ lbs}}$ – THE AVERAGE NORTH AMERICAN WEIGHS 177.9 lbs, THUS USAGE IS $\frac{1}{14}$ THEIR WEIGHT

7 FIND HORSEPOWER

SINCE MY METABOLISM IS ABOUT 1500 kCal/Day, HORSEPOWER IS:

$$1500\frac{kCal}{Day}\cdot\frac{1000cal}{1kcal}\cdot\frac{4.813J}{1cal}\cdot\frac{1Day}{24hrs}\cdot\frac{1hr}{3600s}\cdot\frac{1HP}{745.70J/s}=\boxed{0.112HP}$$

no, go for output.

8 $\frac{d\$}{dt}=i\$$ DIFFERENTIAL EQUATION

$\$(t)=e^{it}$ POSSIBLE SOLUTION
VERIFY BY TAKING DERIVATIVE AND INSERTING INTO ORIGINAL EQUATION

$\frac{d\$}{dt}=ie^{it}$

INSERT $\$(t)$ AND $\frac{d\$}{dt}$ INTO $\frac{d\$}{dt}=i\$$

$\frac{d\$}{dt}=ie^{it}=ie^{it}=i\$$

$ie^{it}=ie^{it}$

TRUE - $\$(t)=e^{it}$ IS A SOLUTION

9 TRIPLING TIME FOR EXPONENTIAL GROWTH IS THE TIME IT TAKES FOR THE GROWING OBJECT TO TRIPLE IN SIZE. THE FORMULA FOR CALCULATING IT IS DERIVED AS FOLLOWS:

BEGIN WITH EXPONENTIAL GROWTH FUNCTION

$\$(t)=Pe^{rt}$

AMOUNT AT TIME t; INITIAL AMOUNT; TIME; CONSTANT - (REPRESENTS PERCENT GROWTH PER TIME)

AT TRIPLING TIME, $\$(t)=3P$, APPLY AND SOLVE FOR t

$3P=Pe^{rt}$

$3=e^{rt}$

$\ln 3=rt$

$\boxed{\frac{\ln 3}{r}=t}$ THUS, TRIPLING TIME IS GIVEN BY THE EQUATION $\boxed{t_{TR}=\frac{\ln 3}{r}}$

nice work.