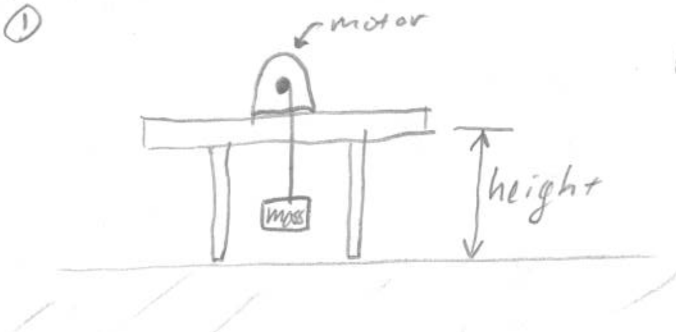
Energy Fundamentals from Physics 101

I Characterize, rather than define, energy

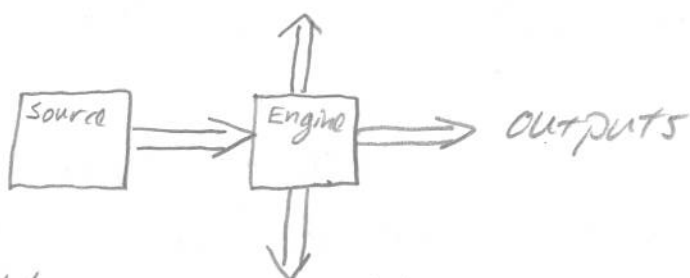
Energy – ① The potential to move mass
– ② A conserved quantity

①



Electricity → Lifting against gravity (work)
→ waste heat (inefficiency)

② Energy is not "lost" – it is conserved



Possible outputs: Electricity
heat
light
work

All outputs are energy. Some are "waste".
But Energy in = Energy Out

II Quantify Energy

Units: Joule (SI)

BTU (Imperial) = 1055 Joules

Calorie = 4.2 Joules

1 Food Calorie = 1,000 Calories

How much energy is a joule?

1) Fluorescent light bulb produces 1 Joule of light in about 0.1 second

2) Stand up. Bend your knees until you have dropped ~1 foot. Now straighten your legs. On lifting yourself up you did about 150 Joules of work

III Power: The rate energy is converted from one form to another. (Remember, energy isn't "consumed")

$$P = \frac{\Delta E}{\Delta t}$$

(deep knee bends ≅ 150 W)

Ex. An incandescent light bulb uses 1000 J in 10 seconds. What's the power?

$$P = \frac{\Delta E}{\Delta t} = \frac{1000\,J}{10\,s} = 100\,\frac{J}{s} = 100 \text{ Watts or W}$$

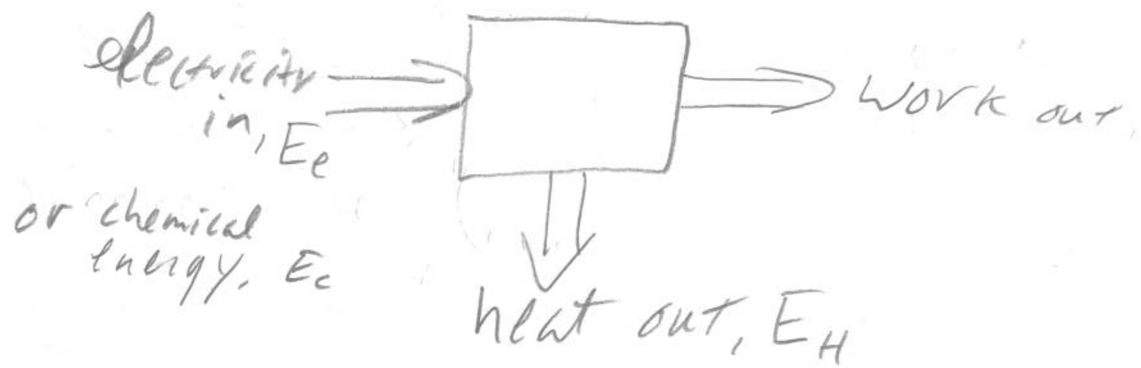
Watt: The number of Joules of energy used each second - Unit of Power

Ex. An electric space Heater is rated at 2,000 W. How many BTU of heat is it producing each second?

$$\Delta E = P \cdot \Delta t = (2000\,W)(1\,s) = 2000\,J$$

$$2000\,J \cdot \frac{1\,BTU}{1055\,J} = 1.9\,BTU$$

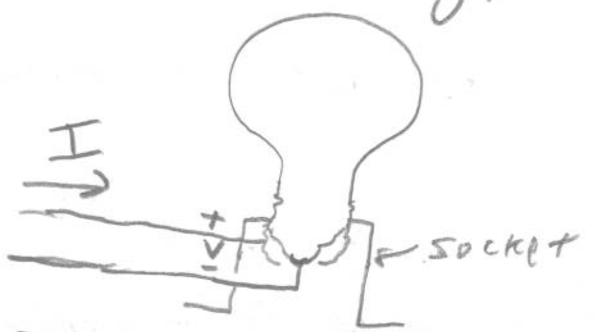
IV efficiency. Electric Heaters convert all the electric energy to Heat. But what about a motor?



$$\text{efficiency} \quad eff = \frac{\text{Desired output}}{\text{input}} = \frac{\text{Work}}{E_e}$$

Ex. A motor draws 100 Watts and does 30 W of Work — eff = 0.30 or 30%

V Electric energy



$I \equiv$ current $\equiv$ charge / time

$V \equiv$ voltage (120 Volts)

$P = IV$

Ex. How much current does a 100W light bulb draw?

$P = IV$

$100W = I \cdot 120V$

$I = 0.83$ Amps

Every electronic device draws power

incandescent bulbs	25W - 200W	
Halogen lamp	300W	
Flourescent bulbs	7W - 40W	
	↑ compact ↑ ceiling	
computer		
Desktop	115W	(active)
	5W	(hibernating)
laptop	25W	(active, running on AC)
		(hibernating)

kilowatt-hour
kW·h = Power · hours → Energy

VI Intensity

$$I = \frac{\text{Power}}{\text{Area}} \qquad \frac{\text{Watts}}{m^2}$$

Also called "Power density"

- Look at wind map & discuss what $\frac{W}{m^2}$ means

Alternately $\frac{\text{Energy}}{\text{time - area}}$ (same thing)

- Look at solar map & discuss what $\frac{kW \cdot h}{m^2 \cdot \text{Day}}$ means

In the 1st week of December we will look at how much energy you get from a chunk of coal and how and for how long it will power some of the appliances listed above.