

2.00B Lecture 10

3-16-09

Popular mistakes

- concrete vs. cement → cement is just the binder material
- silicone (manmade rubber-like polymer) vs. silicon (element, used to make semiconductor wafers)
- engine (produces kinetic energy from a fuel source) vs. motor (electricity → mechanical motion)
- bolt (threaded fastener, goes into hole, tightened by nut) vs. screw (threaded/tapered shaft, only requires pilot hole)
- nut (threaded fastener used w/ bolt) vs. washer (ring w/ hole for distributing load or spacing)
- inexpensive (low cost) vs. cheap (low quality)
- metal vs. steel (steel is a metal alloy, iron + carbon)
- tap (used to put threads into a hole) vs. die (used to put threads onto a rod).
- strong (material's ability to withstand stress without failure) vs. tough (amount of energy per volume before rupturing) vs. stiff (relates directly to the modulus of elasticity)
- milling (like drilling, also cut in sideways direction) vs. turning (making cylindrical parts on the lathe)
- chamfer (beveled edge), fillet (round on interior edge) vs. round (round on exterior edge)

Energy

- a measure of the potential for change
- never created or destroyed
- converted between different forms

units: Joules ($\text{kg} \cdot \text{m}^2 / \text{s}^2$)

→ work $F \cdot d$ $T \cdot \phi$

* kinetic $\frac{1}{2}mv^2$ $\frac{1}{2}I\omega^2$

* potential mgh $\frac{1}{2}kx^2$

* thermal $mC_p \Delta T$ $C_p \text{H}_2\text{O} = 1 \text{ Calorie} = 4.184 \text{ J/g}^\circ\text{C}$

* pressure $P \cdot V$

* chemical

Energy range:

1 kJ - sup. power

10 kJ - AA cell

100 kJ - D cell

1 MJ - 1,5 ton car

10 MJ - amount consumed/day by 1 person

⋮

- energy for electricity comes mostly from coal
(high energy density) → 30 MJ/kg

Power

- rate → work or energy transfer per unit time

units: Watts or J/s

1 Horsepower = 750 W

forms:

- * mechanical FV (or $T\omega$)
- * fluids $P\dot{V}$
- * electrical VI (or I^2R or V^2/R)
↑ ↑
pushing rates

power ranges:

- 1 W - cell phone
 - 100 W - drill, incandescent bulb
 - 1 kW - milling machine → washer
 - 10 kW - car (sedan)
 - 100 kW - hummer
 - 1 MW - Building 39!
- ⇒ Toys = 1-100 W

sources:

- 100 W - person output
- 1 kW - insolation per m^2
- 10 MW - nuclear power plant

The Grid

chemical → thermal → mechanical → electrical
(30-40% efficient)

- alternating current (AC). 50 or 60 Hz, 120 or 240 volts
- Home circuit breakers · 15A, 20A or 30A
- Current can kill you! @0.26A

Batteries

cells vs. batteries

- primary (Alkaline) and secondary (Lithium ion)

voltage 1.5V

4V

specific energy $\sim 500 \text{ kJ/kg}$ \longrightarrow

cost 1x

45x

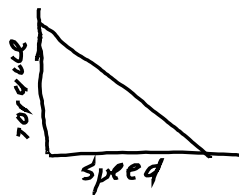
DC Motor

direct current

angular velocity vs. torque

Power = $T\omega$

Max power = $\frac{1}{2} T_{\text{stall}}$



Logistics and Extras

~~My~~ Idea!

Our

* Notebook check in lab

* Thursday EXPO - workbench review, feedback. (and Friday)

→ informal but be prepared

→ mentors = scribes, email feedback

→ NO decisions until after break