DAY 4

Summary of Primary Topics Covered

Energy & Power with Math

Kinetic Energy:

$$KE = \frac{1}{2}mv^2$$

SI energy units are kgm^2/s^2, also known as Nm, also known as Joules (J).

Gravitational Potential Energy:

$$PE_{Grav} = mgy$$

g is the *gravitational field strength*. At the surface of the Earth this is

g = 9.8 N/kg = 2.203 lb/kg

meaning that gravity pulls a 1 kg object to the Earth with a force of 9.8 N or 2.203 lb.

Elastic Potential Energy:

$$PE_{Elastic} = \frac{1}{2}kx^2$$

k is the "spring constant" of the elastic object that is storing the energy. k is the force required to deform the object a certain amount. For example, if it takes 6 N of force to stretch a spring 1 cm, then k = 6 N/cm for that spring.

Power

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

SI Power units are J/s, or Watts. English power unit is the Horsepower. 1 Hp = 746 W.

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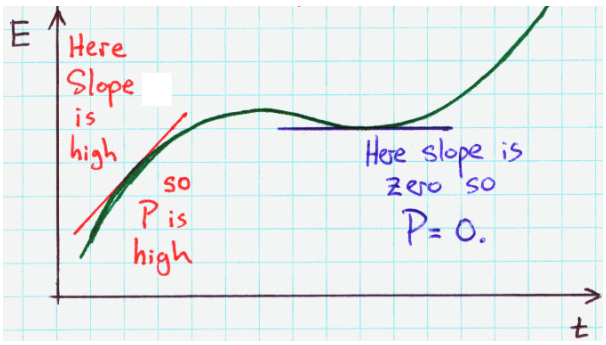
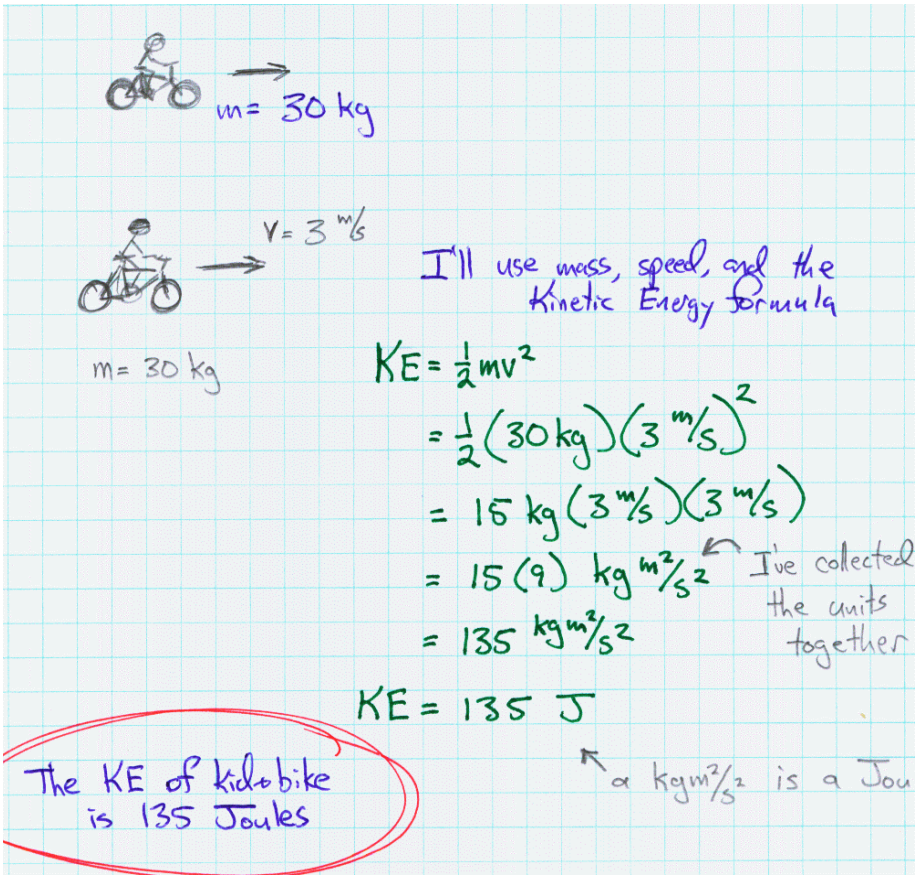
$$P = \frac{dE}{dt}$$

Power is the rate of change of energy - the slope of a tangent line in a plot of Energy vs. Time. On a plot of E vs. t, a steep slope indicates high power because E is increasing rapidly with t.



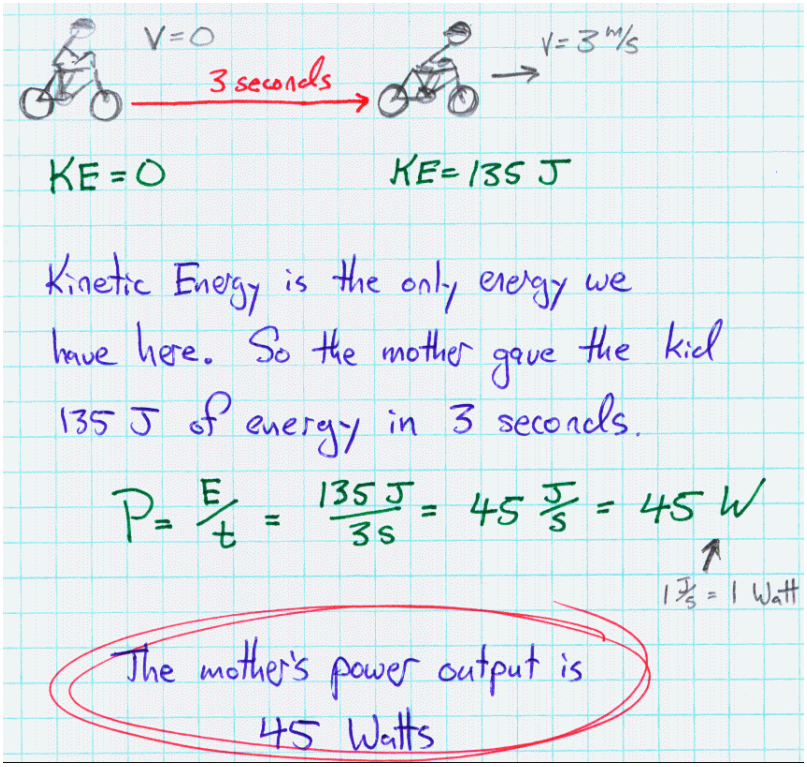
Example Problem #1

A mother who is teaching her child to ride a bike pushes the kid at 3 m/s. If the kid and his bike have a combined mass of 30 kg, what is their kinetic energy?



Example Problem #2

In the above problem, it took the mother 3 seconds to get the kid from rest to moving at 3 m/s. What was her power output?



Example Problem #3

It takes 50 lbs of force to stretch a spring 10 cm. How much energy is stored in the spring when it is stretched this much?

Get stuff into SI units.

$F = 50\ lbs\left(\frac{4.448\ N}{1\ lb}\right) = 222.4\ N$

$x = 10\ cm = .1\ m$

$k = \frac{222.4\ N}{.1\ m} = 2224\ \frac{N}{m}$

Now calculate $PE_{Elastic}$ for $k = 2224\ \frac{N}{m}$ and $x = 0.1\ m$

$PE = \frac{1}{2}kx^2 = \frac{1}{2}\left(2224\ \frac{N}{m}\right)(.1\ m)^2$

$= 1112\ \frac{N}{m}(.01\ m^2) = 11.12\ Nm$

ANSWER: 11.12 J

Example Problem #4

A model rocket has a mass of 0.75 kg. It is launched from the ground. The rocket motor fires for 3 seconds. At the end of those 3 seconds the rocket is moving at 300 mph and is 450 yards up in the air. What was the average power output of the motor in Watts?