Force, Work, Energy

Crazy for fyziks xd

Review last week? Jk. . . unless. . .

Force. . . and this Newton kid

Newton’s 3 laws of motion (things do be moving)

Inertia: An object in motion will stay in motion and an object at rest will stay at rest unless acted upon by an outside **force**.

Force = **mass** * **acceleration**

Force pairs: For every action, there is an equal and opposite reaction.

Inertia is a property of matter

- If we push a shopping cart it wants to keep going forward (goes whee!!!)
- If we're sliding on a floor, we want to keep sliding
- If we're not moving, we don't suddenly move unless we push ourselves

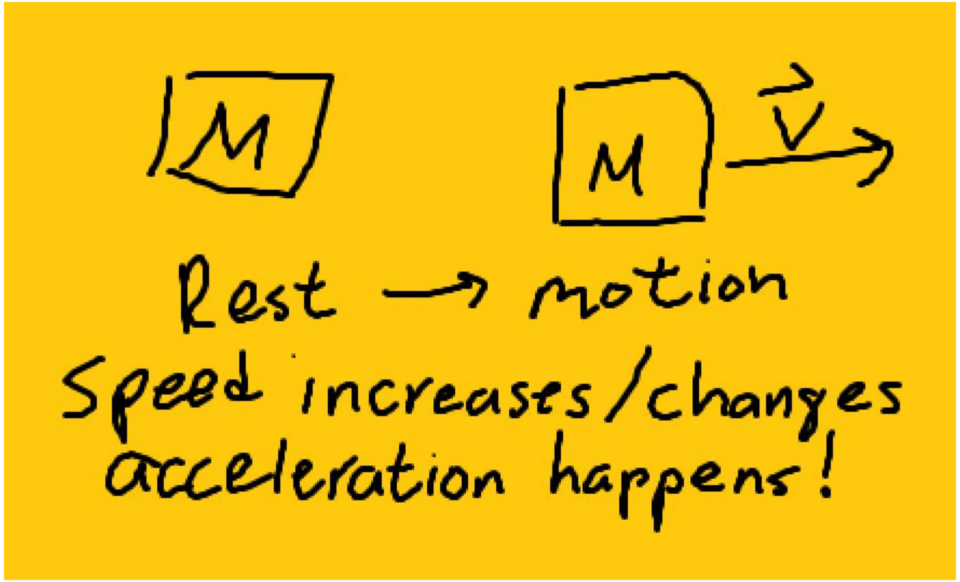
F = ma (this is the important slide)

Forces “push” on objects

Mass is how much matter is in something

Acceleration is change in speed divided by time

Force is dependant on these two things; why?



But why is F = ma?

An object that has more mass is harder to “push”

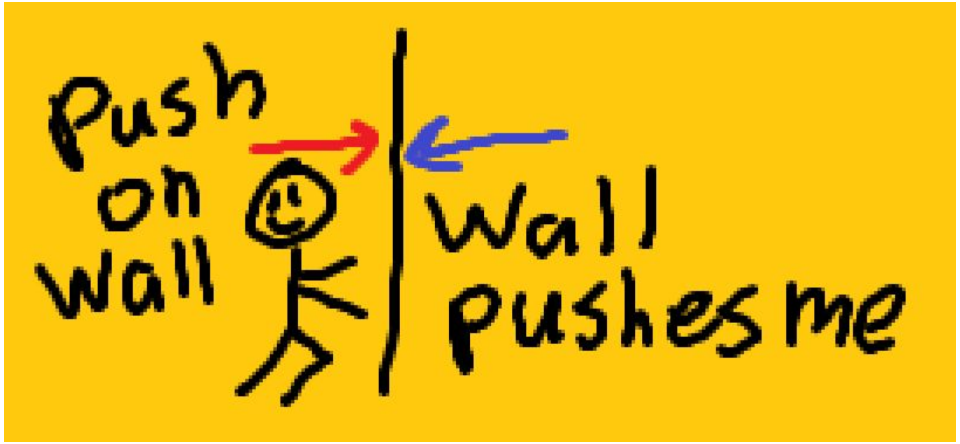
It’s harder to “push” an object faster (change its speed/velocity more), which means it’s harder to accelerate objects more

Thus, if we have more mass and/or acceleration, force is higher!

Force pairs

If I push on an object, that object pushes back on me with the same force

Question to think about: if my car runs into a fly, and I squash the car, why doesn't the fly break my windshield if it applies the same force? Hint: think 2nd law. . .

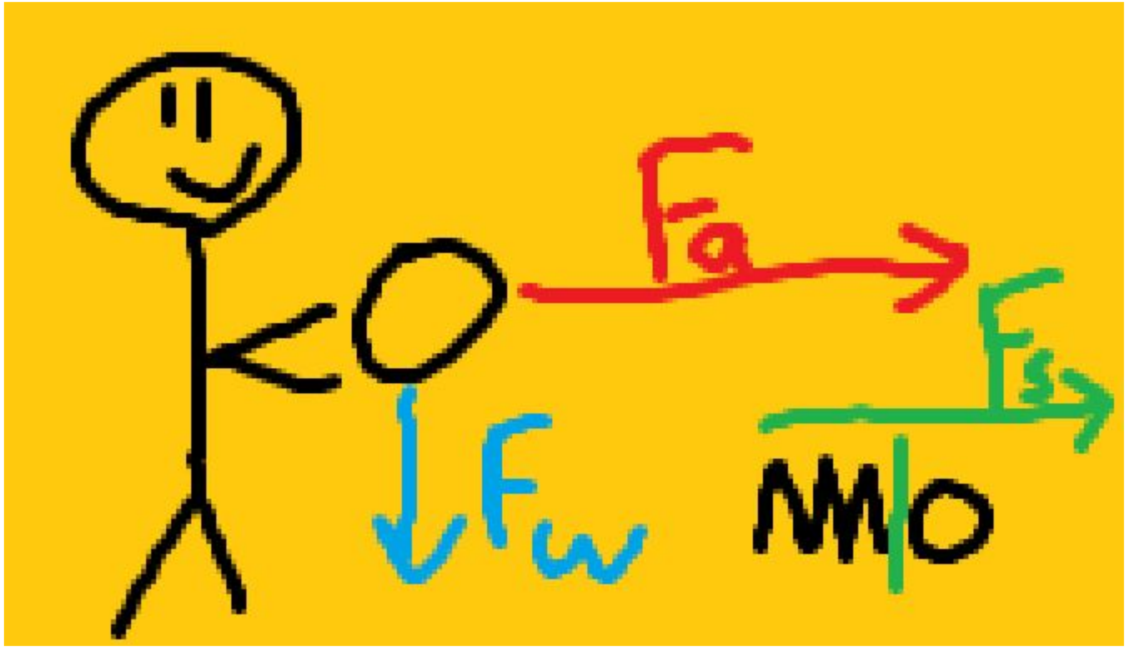


Important forces?

Me pushing a ball to get it to move

Gravity!!!

Springs?



Units/symbols/equations

Force (F): Newtons (N)

Mass (m): kilograms (kg)

Acceleration (a): meters per second squared (m/s^2)

Velocity (v): meters per second (m/s)

Time (t): seconds (s)

$$a = v/t$$

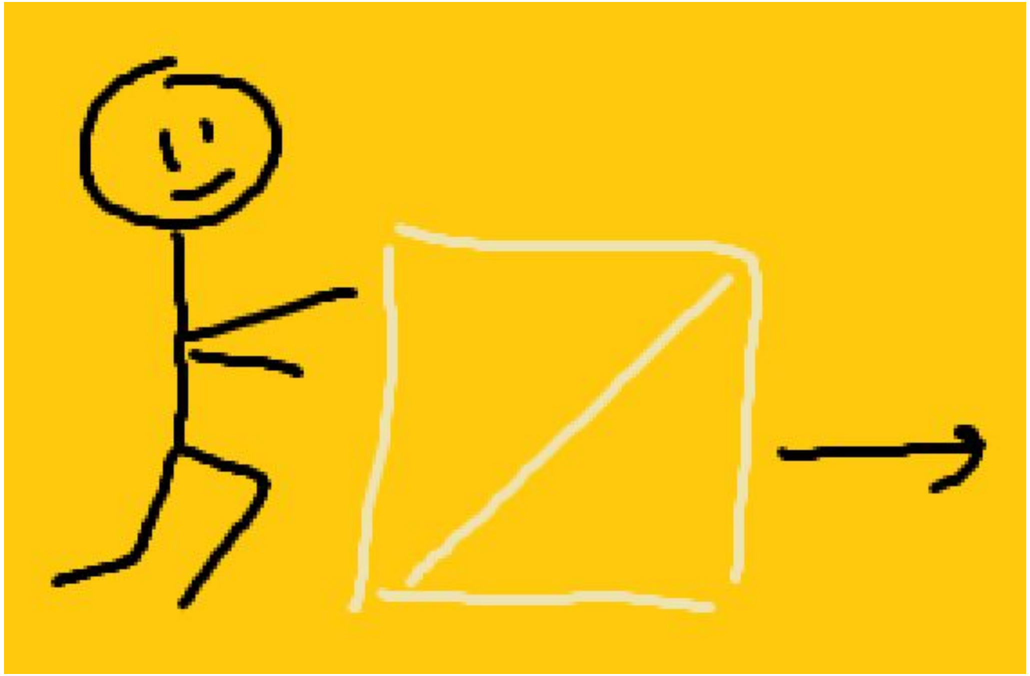
$$F = ma = mv/t$$

What is work?

Times we do work

- Pushing a box
- Lifting a book
- Kicking a ball
- Pushing on a spring

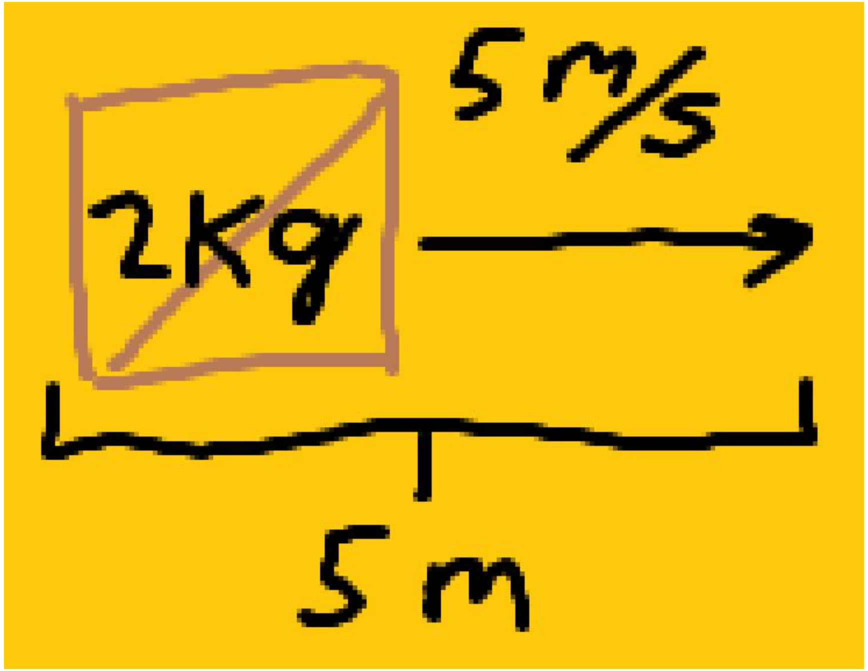
“Pushing” something a certain distance takes work



Work = Force * Distance (W = F * d)

Sample problem lulw:

- What is the acceleration of a 2 kg box if I pushed it from rest to 5 m/s in 1 second?
- What is the force on the box?
- If I pushed it 5 meters, how much work did I do on it?



Energy

What is energy?

Energy is the “ability to do work,” measured in Joules (J = N * m)

A box I lifted up can do work when gravity pushes down on it

Friction can slow down a stapler I slide across the table

A spring can push on something if I compress it

Types of energy

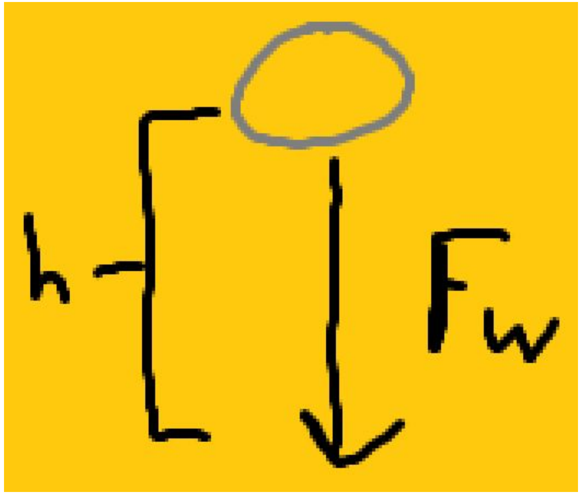
- A box I lifted up can do work when gravity pushes down on it
- Friction can slow down a stapler I slide across the table
- A spring can push on something if I compress it

- Gravitational potential energy
  - U_g
- Kinetic energy
  - E_k
- Spring potential energy
  - U_s

Prepare for the xd

Gravitational potential energy

1. $F_w = mg$
2. $U_g = F_w h = mgh$



1. “Weight” is a force that’s the mass of the object times the acceleration due to gravity (g)
2. Gravitational potential energy is the “ability” for gravity to do work over distance

Kinetic energy, kind of spoopy

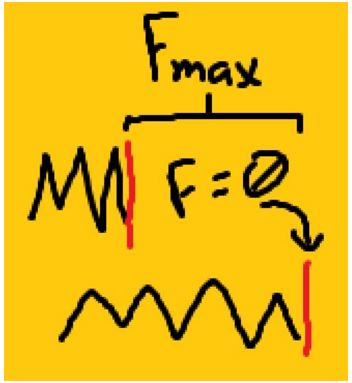
1. $E_k = 1/2\ mv^2$

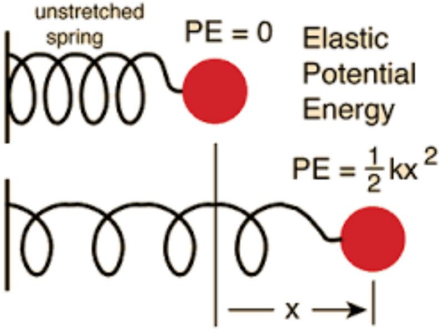
1. Kinetic energy is ½ mass * velocity squared
   a. But why? The proof is hard lulw, but let's look at the units

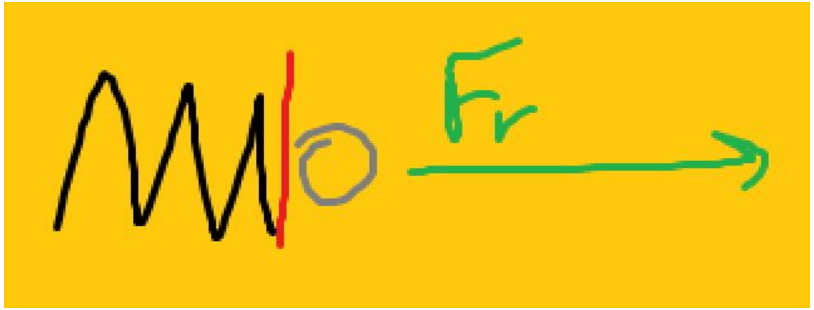
$$W = Fd = Nm = kg * m/s^2 * m =$$

$$kg\ m^2/s^2 = kg\ (m/s)^2$$

Spring potential, the super, super yummy one







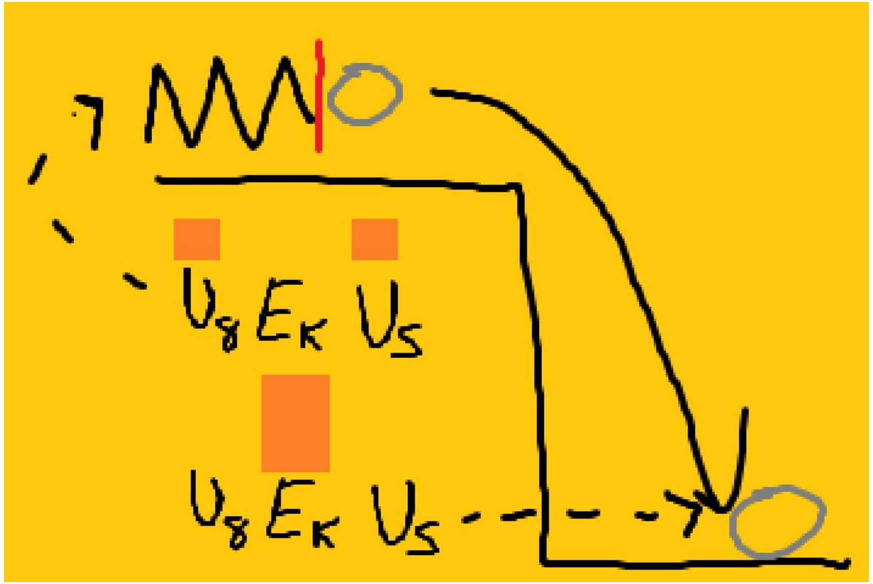
The force changes as the spring decompresses. One can consider the “average” force on the spring, which is half of the force when the spring is totally compressed.

1. $F_s = kd$
2. $U_s = F_s/2 * d = 1/2\, kd^2$

Scary over, now you may perform respiratory actions at a pace you deem acceptable

Energy is conserved

The “Total Mechanical Energy” (TME) is the sum of the three energies we just talked about. This TME never changes.

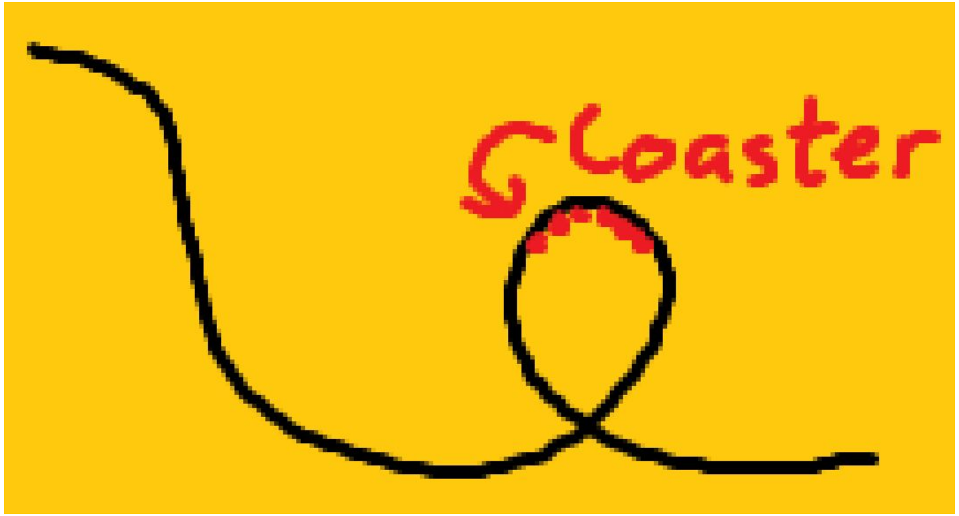


Conservation of energy

Conceptual review (hard)

If I drop a ball that has 20 J of potential energy onto a spring, what energy will the ball have when it fully compresses the spring?

In the picture on the right, what kinds of energies does the roller coaster have?



Math review (very fun)

How much potential energy does a 2 kg book have if I hold it 3 meters up assuming acceleration due to gravity (g) is 10 m/s^2?

If I drop that book, how much kinetic energy will it have when it hits the ground?

What'll be its speed when it hits the ground?