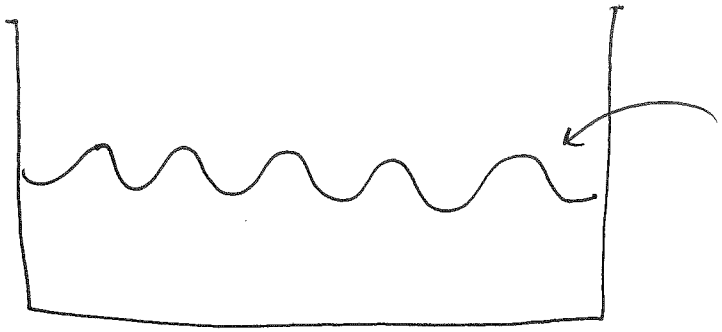
Energy Landscapes

We learned that boundaries (water tank, fixed ends of strings...) play a crucial role in determining the behavior of the waves.

Let's think a little bit more about what we mean by "boundaries"

Why can a wave not propagate (move) through a boundary? What makes a boundary a boundary?

→ the wave does not have enough energy to move over the boundary



What does it mean to have energy?

To answer this question, let's consider a simpler system. Imagine that our wave is just a single ball, and our water tank is a series of hills

Boundaries have something to do with energy. So to understand boundaries (which determine how our waves behave) we have to understand energy.

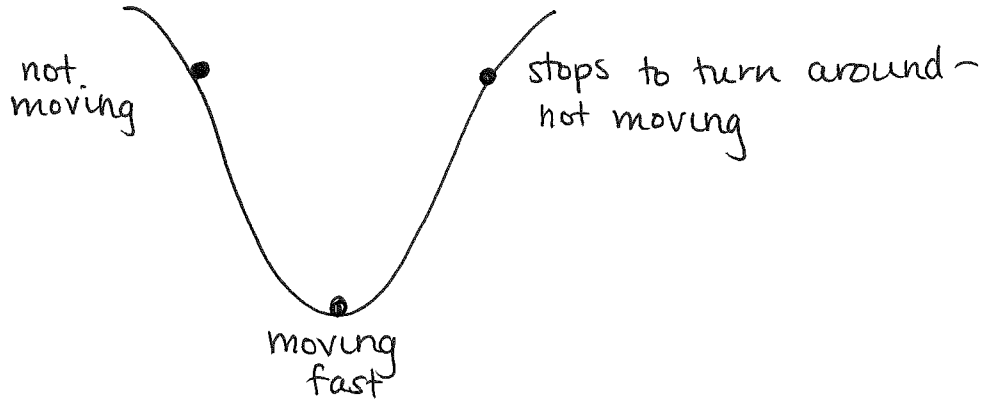
boundaries ←- -?- -→ energy

↓

wave behavior ←- -?- -→

To understand energy, one of the simplest systems to study is a ball rolling on a hill.

What happens if we stand on a hill w/ a ball (not moving) and let go?



Now, there is some energy associated with the motion of the ball. Does anyone know what this is? → kinetic energy

motion ⟷ kinetic energy

(not moving ⟷ no kinetic energy)

In our picture above, we started w/ no kinetic energy, and gained a lot of kinetic energy when we got to the bottom of hill. Where did it come from?

The ball started w/ a different kind of energy, an energy associated w/ its location. Why does the ball want to roll down the hill?

→ force of gravity is pulling it down

→ there is an energy ~~of~~ associated with putting the ball where it doesn't want to be

This is called potential energy, specifically

gravitational potential energy

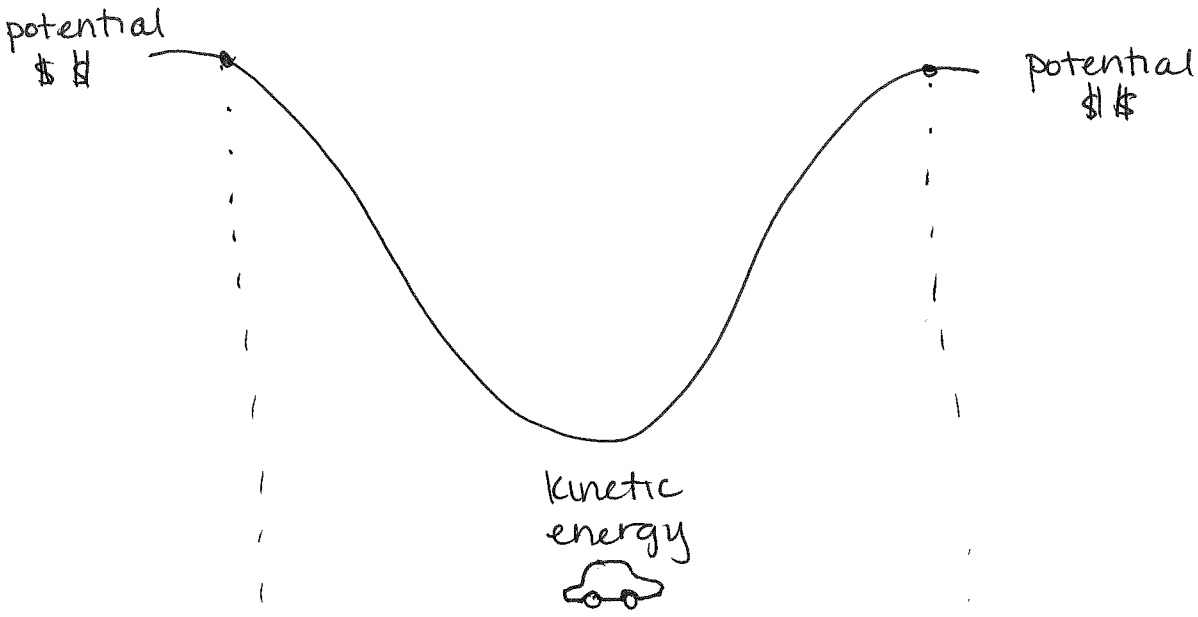
↗ under force of gravity

↑ has potential to move somewhere else (if we let go)

There are many kinds of potential energy - can you think of some?

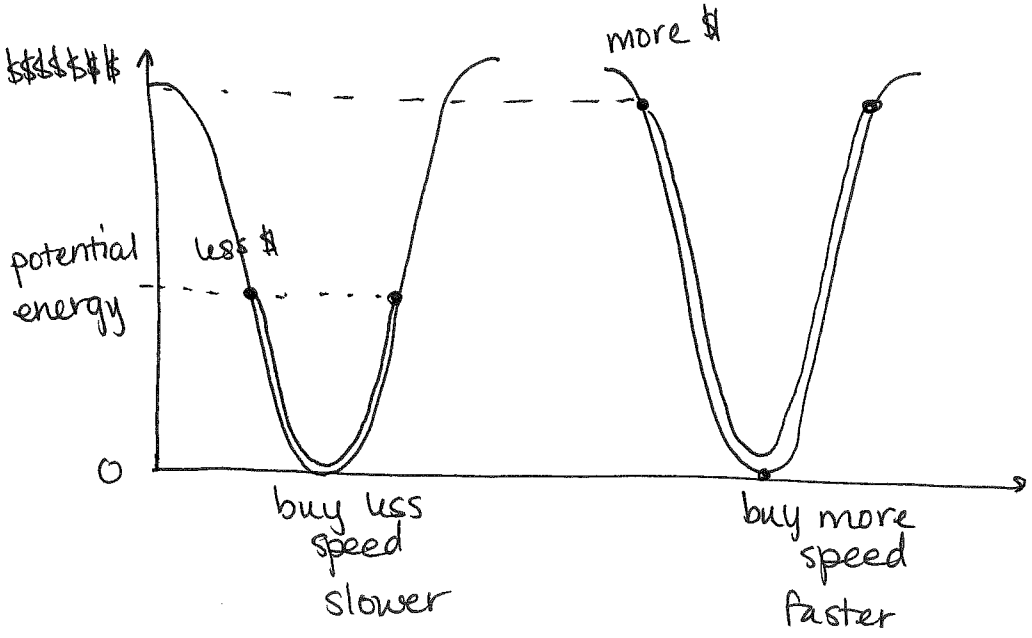
→ magnetic, electric, spring...

You can think of potential energy as currency in the energy world. The ball can use potential energy ($$) to buy other kinds of energy (like kinetic energy)

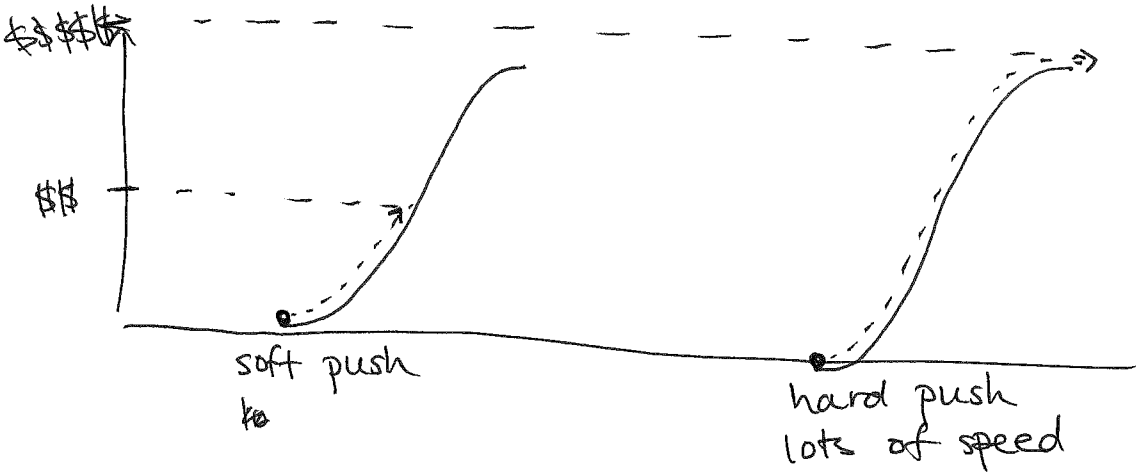


potential $ $	✓	—	✓
kinetic	—	✓	—

Now, there is always a fixed amount of energy in our system (there is only a certain amount of money - if you have $100, you can't buy $100000 worth of speed...)



If we start at the bottom of our hill and push the ball, we are giving it kinetic energy:



We say that the total energy in the system is fixed. You can only <u>exchange</u> one type of energy for another.

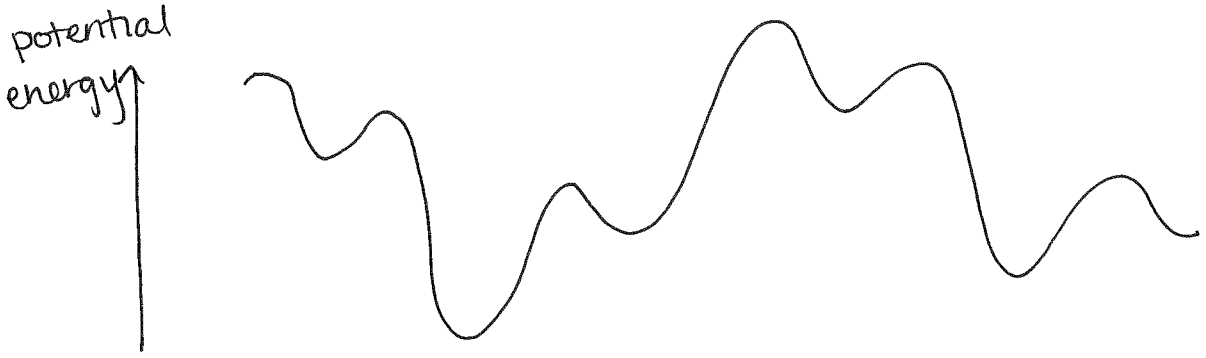
So our hills tell us something about potential energy - what?

~~XXXXXX~~ height of hill ⟷ amount of P.E.

Our system (ball) wants to move to the spots of <u>lowest potential energy</u> - wants to <u>roll down energy hill</u>.

Now in principle, these hills could correspond to any type of potential energy. For gravitational P.E., we build hills ~~XXX/XX~~ by creating variation in height. But there are many other types of energy hills, what we call <u>energy landscapes</u>, and they can be built by interfering lasers, magnetic fields, springs, ...

energy landscape: (in 1D)



higher hill, the higher the potential energy. — as if we're living in an <u>energy</u> world

In 2D, how might we draw an energy landscape?

→ Topo map: