Gravitational Fields

Attraction Without Touching

Action at a Distance

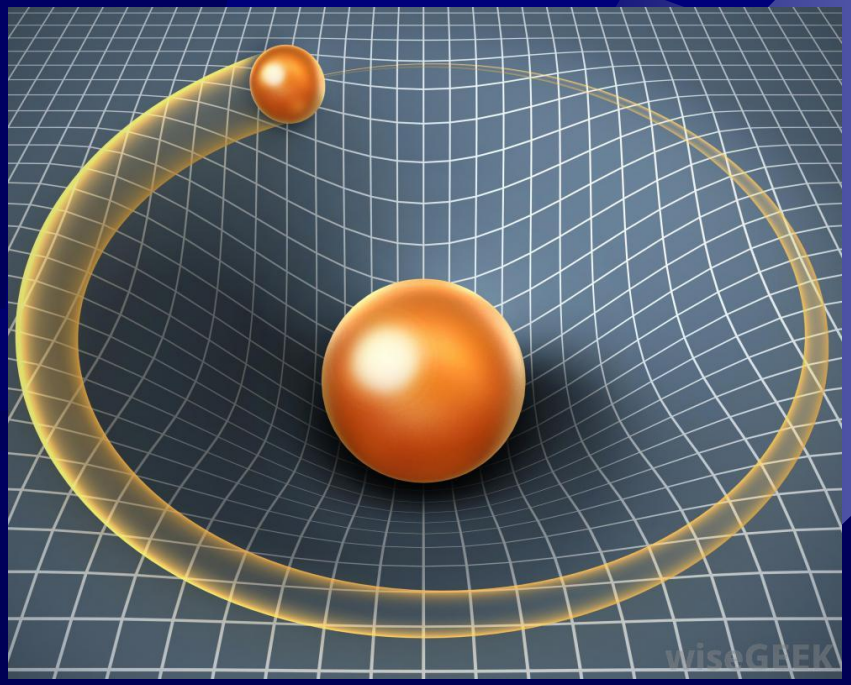
- In Newton's time, there was much discussion about HOW gravity worked - how does the Sun, for instance, reach across empty space, ***with no actual contact at all***, to exert a force on the Earth?
- This spooky notion was called "action at a distance."

The Gravitational Field

- During the 19th century, the notion of the "***field***" entered physics (thank you Michael Faraday).
- Objects with mass create an ***invisible disturbance in the space around them*** that is felt by other massive objects. This is a ***gravitational field***.

The Gravitational Field

- So, since the Sun is very massive, it creates an intense gravitational field around it, and the ***Earth responds to the field***.

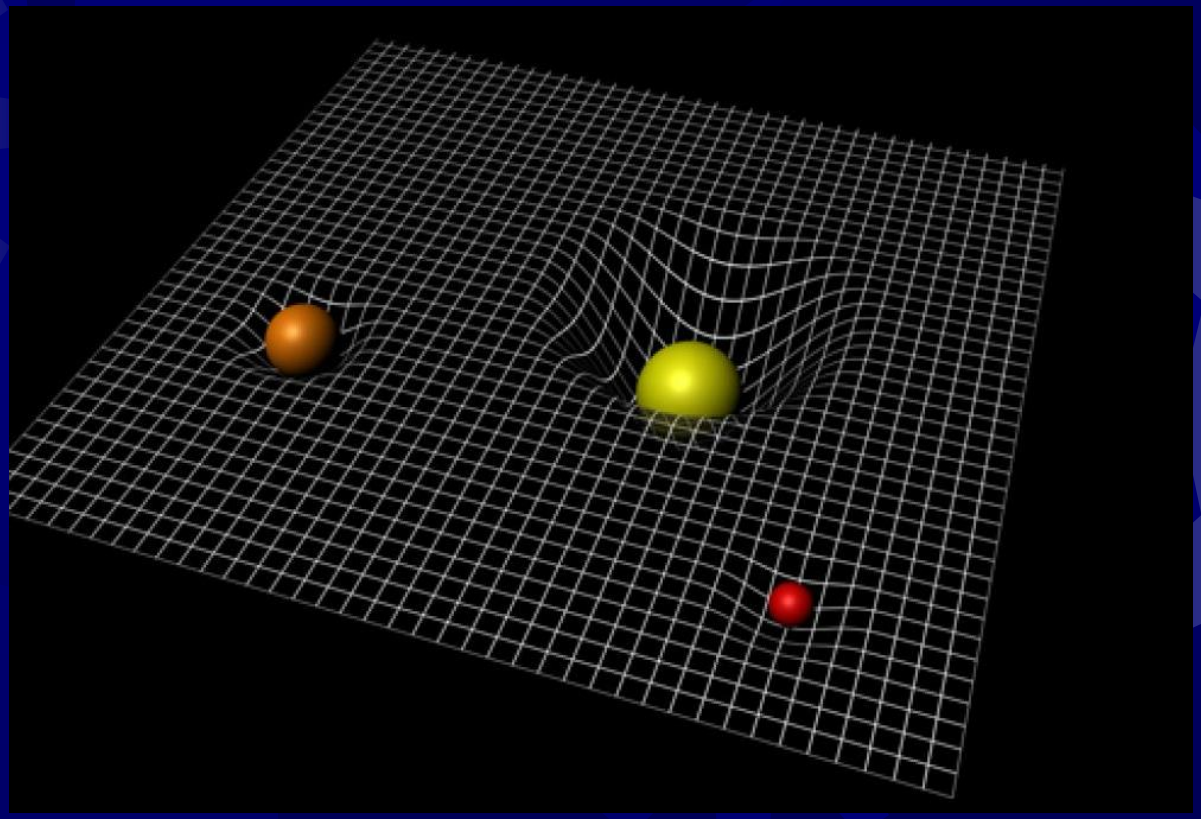


Gravitational Field Strength

- To measure the strength of the gravitational field at any point, measure the gravitational force, F, exerted on any “test mass”, m.
- ***Gravitational Field Strength, g = F/m***

$$\frac{\textit{Force (of gravity)}}{\textit{mass of the object}}$$

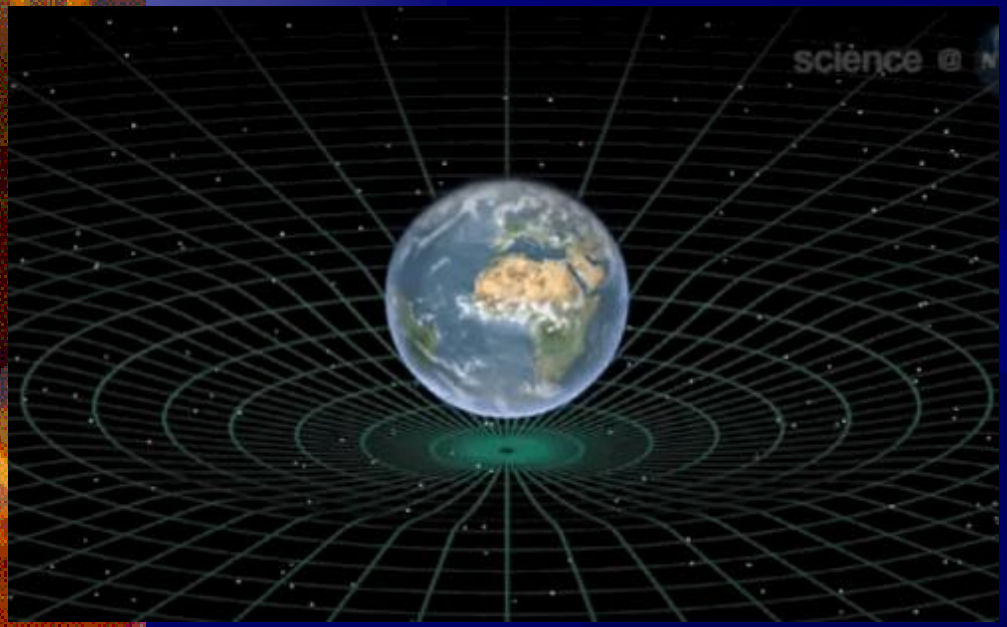
- The key to understanding gravity is that objects with mass warp space and time around them. The bigger they are the more they warp space and time.

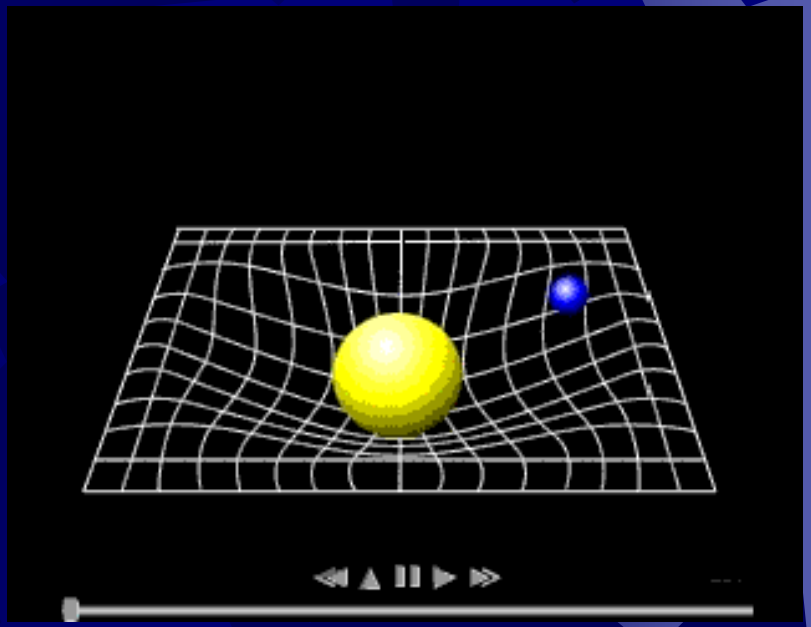


Gravity Visualized

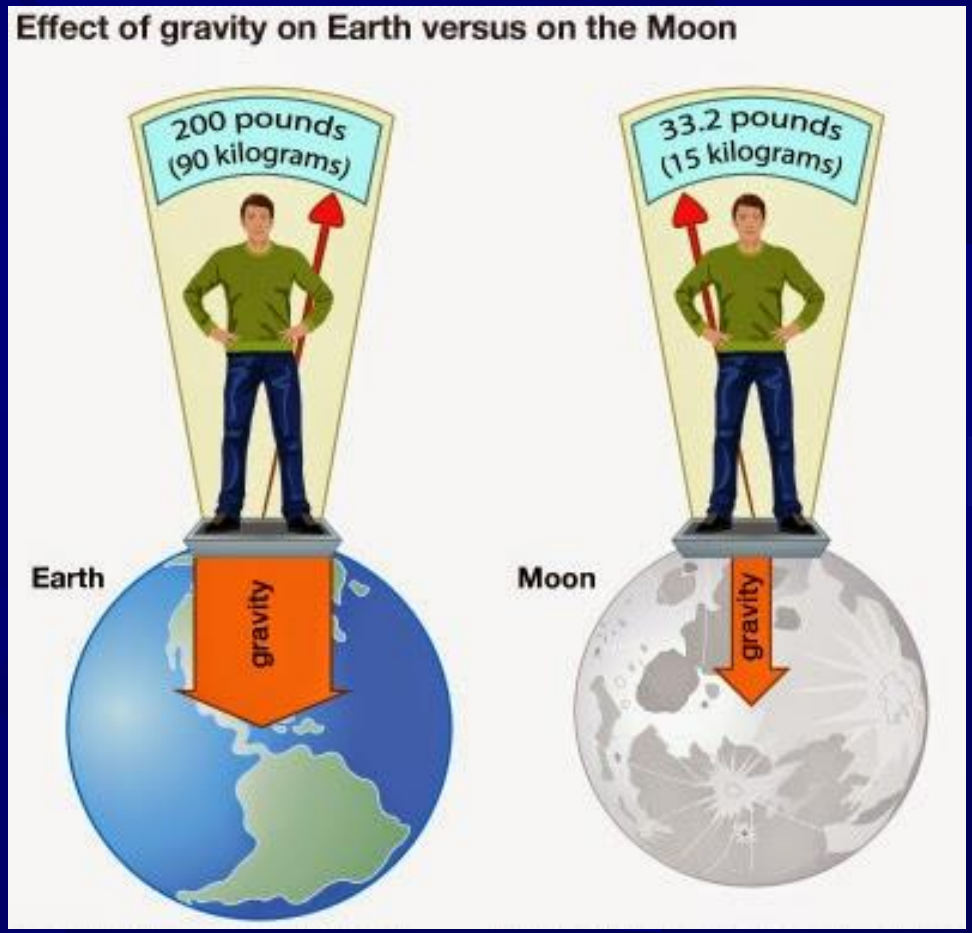
- Gravitational fields are dependent on the distance and mass of the individual objects.
  - The greater the distance, the less the force applied.
  - The closer you are to a gravitational field, the more force is applied.
  - Objects with greater mass also pull with greater force.

- Massive objects warp space and time around them causing objects to pull towards each other like two masses on a trampoline will roll towards each other.





- Large planets have high gravity. Smaller planets have lower gravity.
- You would experience weight differently on the moon, the Earth, and Neptune.



- **Mass and weight are different.**
  - Mass is the amount of matter in an object.
  - Weight is the pull of gravity on an object's mass.

- **Mass** will ALWAYS be the same on different planets, but **weight** can change depending on each planet's mass (which affects its **gravity**).

Attraction over a Distance

- **Gravitational fields only cause attractive pulls, but other fields exist that can attract OR repel.**
- **Electric and magnetic fields cause attractive pulls or repulsive pushes because of charges and magnetic poles.**

Attraction over a Distance

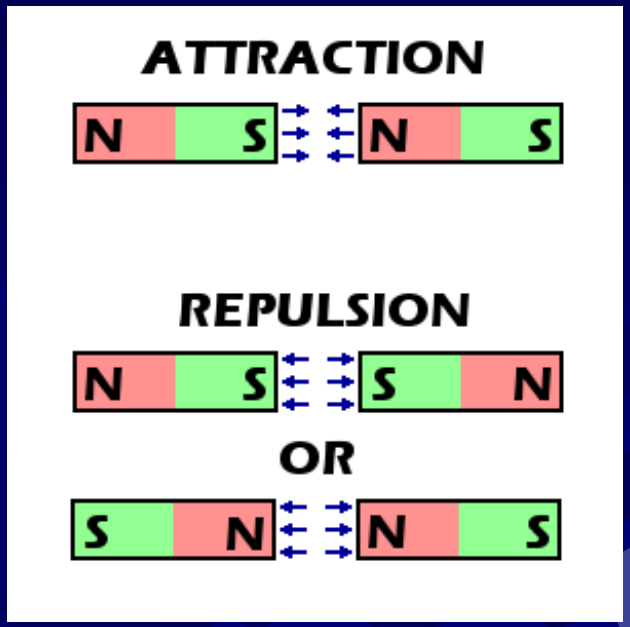
- **In all THREE fields, there is NO DIRECT CONTACT between the two objects as they exert forces on each other!**
- **These attractions and repulsions result from charges that are due to electron alignment.**

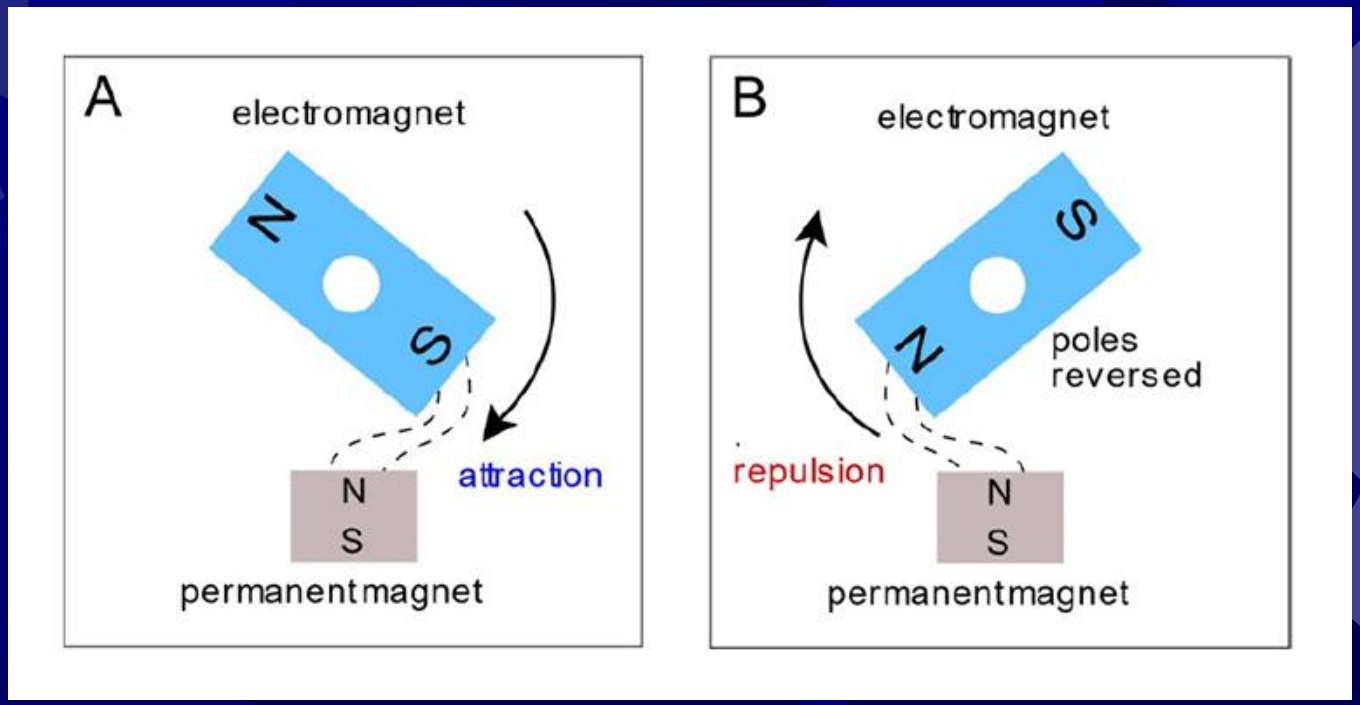
Gravitational Field Strength Depends on Distance

- If the mass of one of the objects is doubled, then the **force of gravity** between them is doubled, and so on.

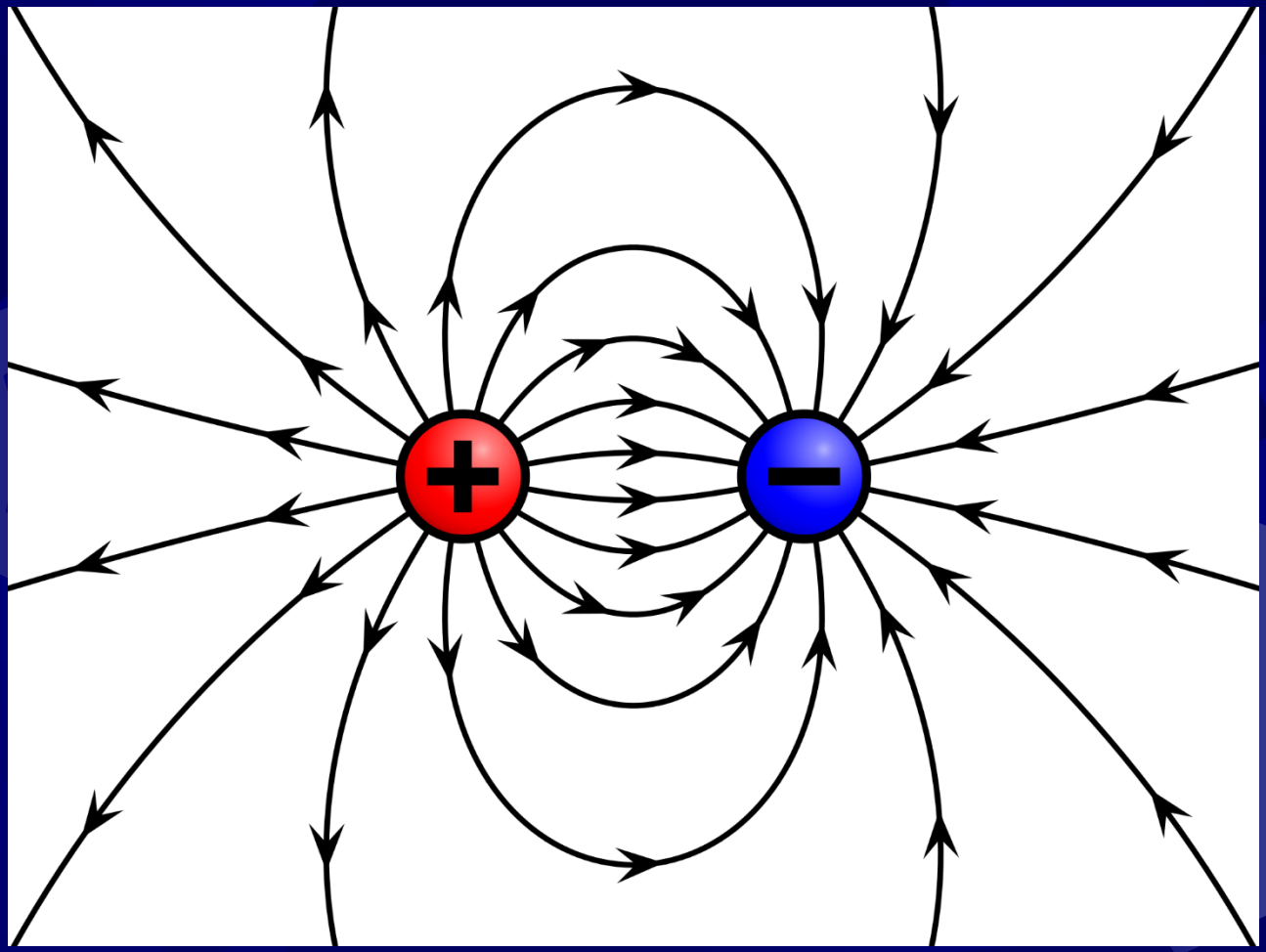
- Since **gravitational force** is inversely proportional to the square of the separation distance between the two interacting objects, more separation distance will result in weaker gravitational forces.

What's going on in these diagrams?



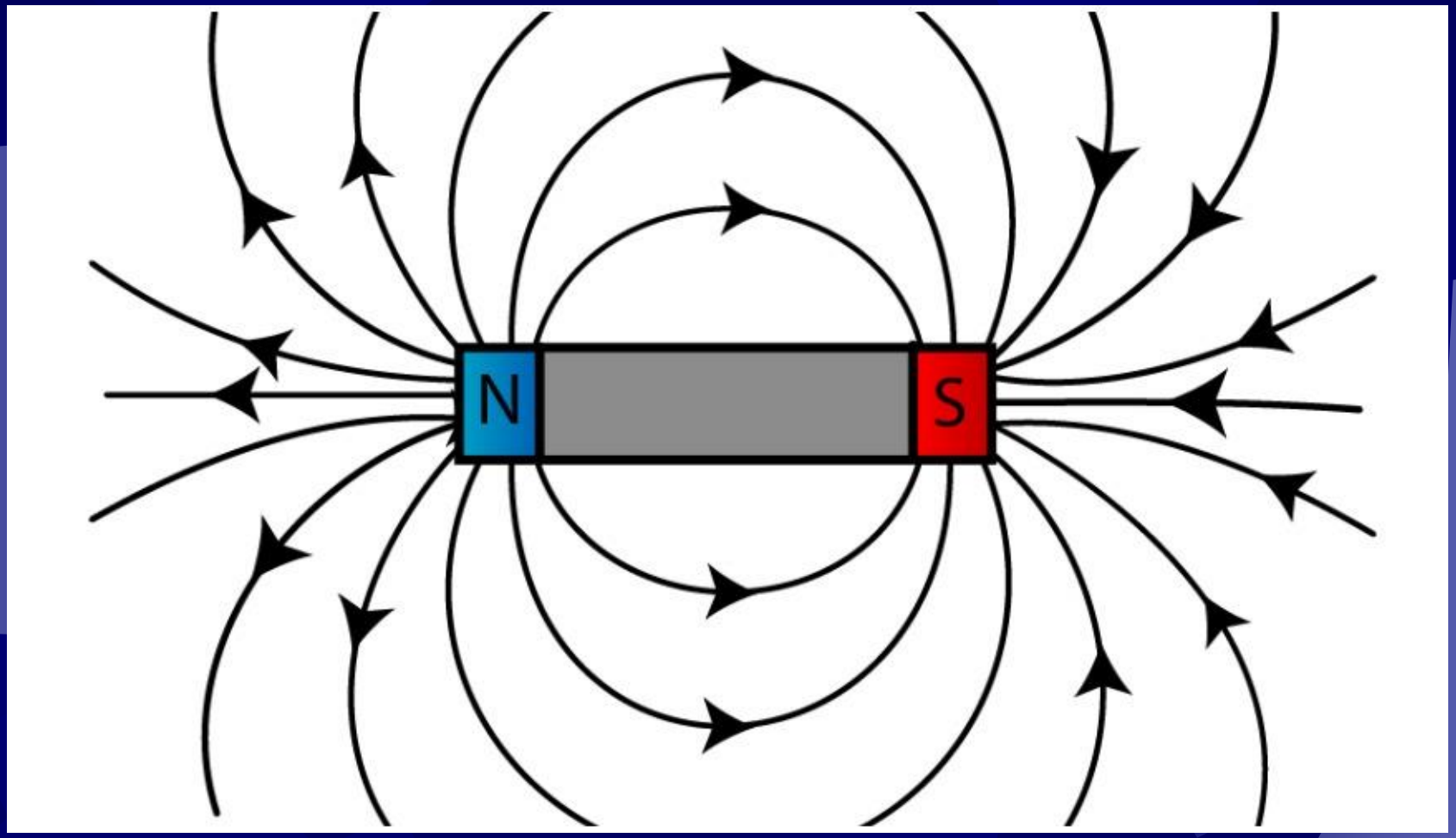


Which Field is This?



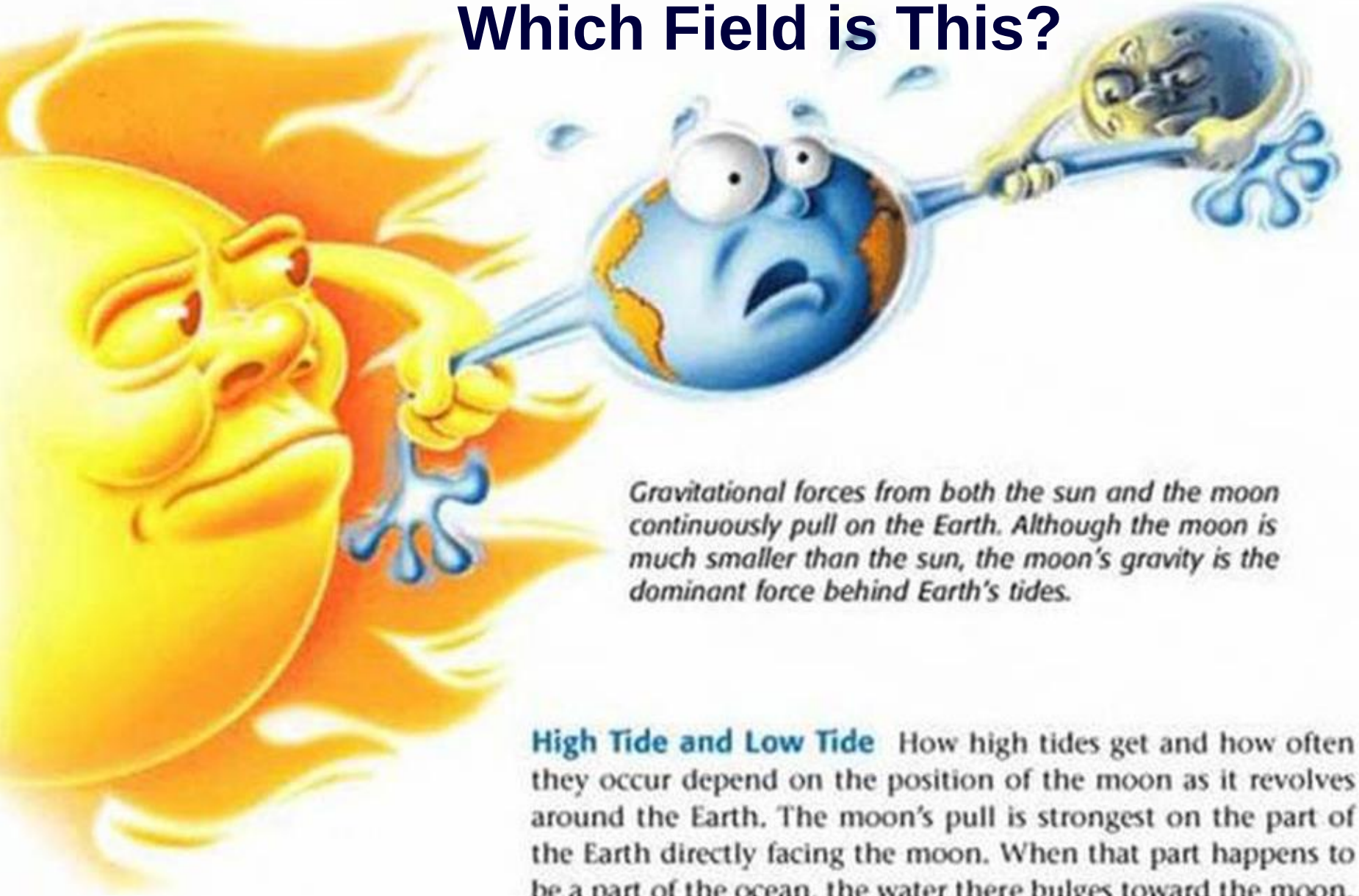
Explain what's happening.

Which Field is This?



Explain what's happening.

Which Field is This?



Gravitational forces from both the sun and the moon continuously pull on the Earth. Although the moon is much smaller than the sun, the moon's gravity is the dominant force behind Earth's tides.

High Tide and Low Tide How high tides get and how often they occur depend on the position of the moon as it revolves around the Earth. The moon's pull is strongest on the part of the Earth directly facing the moon. When that part happens to be a part of the ocean, the water there bulges toward the moon.

Questions:

1. Explain magnetic and electric attraction and repulsion.
2. How are magnetic and electric/magnetic fields alike and different?
3. Give real world examples proving these three fields exist even though we can't SEE them. Draw models!
4. Compare and contrast MASS and WEIGHT.