



**Gravitation**



**Physics Clicker Quizzes**


*Which is stronger, Earth's pull on the Moon, or the Moon's pull on Earth?*



- A The Earth pulls harder on the Moon
- B The Moon pulls harder on the Earth
- C They pull on each other equally
- D There is no force between the Earth and the Moon
- E It depends on where the Moon is in its orbit at that time

**C They pull equally on each other**

By Newton's 3<sup>rd</sup> Law, the forces are equal and opposite.

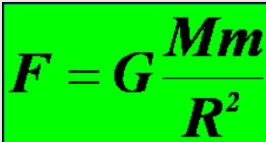


*If the distance to the Moon were doubled, then the force of attraction between Earth and the Moon would be:*

- A one quarter
- B one half
- C the same
- D two times
- E four times

**A one quarter**

The gravitational force depends inversely on the distance squared. So if you **increase** the **distance** by a factor of **2**, the **force** will **decrease** by a factor of **4**.



**Follow-up:**  
What distance would increase the force by a factor of 2?

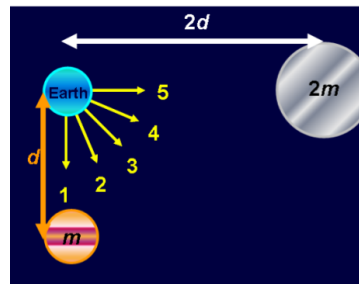
*You weigh yourself on a scale inside an airplane that is flying with constant speed at an altitude of 20,000 feet. How does your measured weight in the airplane compare with your weight as measured on the surface of the Earth?*

- A greater than
- B less than
- C same

**B** less than

At a high altitude, you are farther away from the center of Earth. Therefore, the gravitational force in the airplane will be less than the force that you would experience on the surface of the Earth.

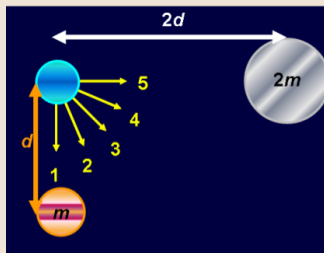
A planet of mass  $m$  is a distance  $d$  from Earth. Another planet of mass  $2m$  is a distance  $2d$  from Earth. Which force vector best represents the direction of the total gravitation force on Earth?



- A 1
- B 2
- C 3
- D 4
- E 5

**B** 2

The force of gravity on the Earth due to  $m$  is **greater** than the force due to  $2m$ , which means that the force component pointing down in the figure is greater than the component pointing to the right.



$$F_{2m} = GM_E (2m) / (2d)^2 = 1/2 GMm / d^2$$

$$F_m = GM_E m / d^2 = GMm / d^2$$

If you weigh yourself at the equator of Earth, would you get a larger, smaller, or similar value than if you weigh yourself at one of the poles?

- A larger value
- B smaller value
- C same value

**B** smaller value

The weight that a scale reads is the **normal force** exerted by the floor (or the scale). At the equator, **you are in circular motion**, so there must be a **net inward force** toward Earth's center. This means that the **normal force must be slightly less than  $mg$** . So the scale would register something less than your actual weight.

The Moon does not crash into Earth because:

- A it's in Earth's gravitational field
- B the net force on it is zero
- C it is beyond the main pull of Earth's gravity
- D it's being pulled by the Sun as well as by Earth
- E none of the above

**E** none of the above

The Moon does not crash into Earth because of its high speed. If it stopped moving, it would, of course, fall directly into Earth. With its high speed, the Moon would fly off into space if it weren't for gravity providing the centripetal force.

*Follow-up:*

What happens to a satellite orbiting Earth as it slows?

Two satellites A and B of the same mass are going around Earth in concentric orbits. The distance of satellite B from Earth's center is twice that of satellite A. What is the ratio of the centripetal force acting on B compared to that acting on A?

- A 1/8
- B 1/4
- C 1/2
- D it's the same
- E 2

**B** 1/4

Using the Law of Gravitation:

$$F = G \frac{Mm}{R^2}$$

Note the  $1/r^2$  factor

we find that the ratio is 1/4.