

# UGFN1000

## In Dialogue with Nature

### 與自然對話

Supplementary lecture on Physics



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[www.cuhk.edu.hk/green/campus](http://www.cuhk.edu.hk/green/campus)



# Velocity (速度) $\neq$ speed (速率)

- Speed is a number.
- Velocity = Speed and its direction.
- Examples:
  - The speed of the car is 70 km/h.
  - The speed of the man is 10 m/s.
  - The velocity of the car is **70 km/h northward**.
  - The velocity of the man is **10 m/s eastward**.



# Question



- John is running around a circle clockwise in a constant speed. Which is **correct**?
  - A. His direction does not change.
  - B. His velocity is always changing because the direction is changing.
  - C. His velocity does not change as long as he keeps running clockwise.



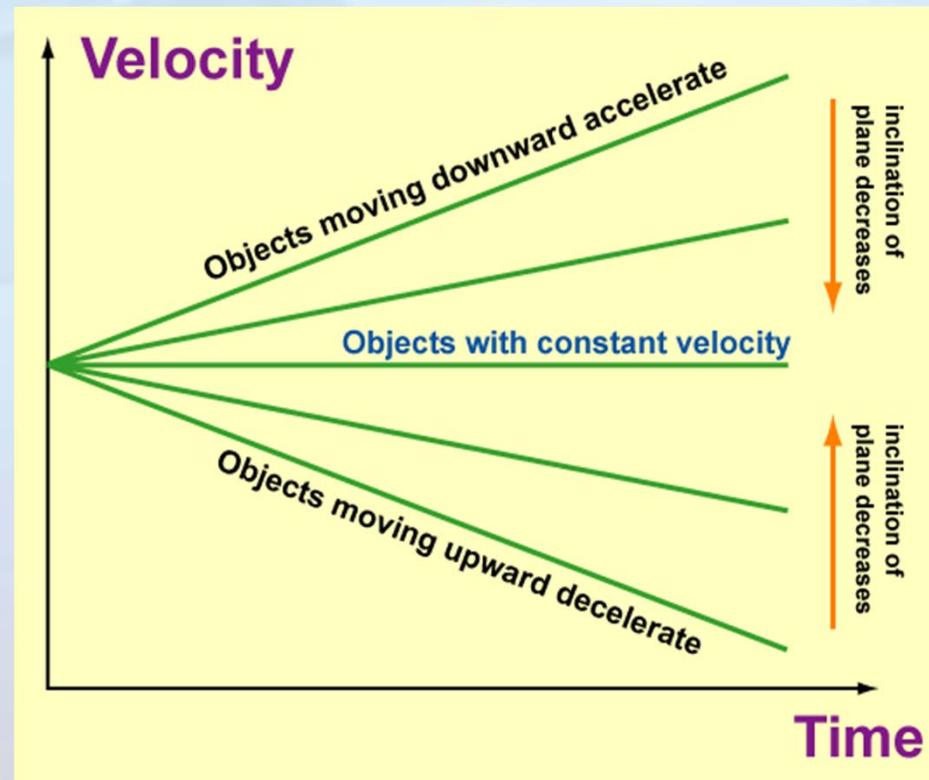
# Acceleration (加速)

- In layman's term: **speeding up.**
- In physics: **change in velocity.**
- Since velocity = speed and its direction,
- **change in velocity** could mean change in speed and/or its direction.



# Negative acceleration?

- Acceleration can be negative.
- This means: deceleration / slowing down.



# Question



- John is running around a circle clockwise in a constant speed. Which is **correct**?
  - A. He is not accelerating.
  - B. He is not accelerating as long as he keeps running clockwise.
  - C. He is accelerating because its velocity is keep changing.



# Mass (質量) $\neq$ Weight (重量)

- Definition 1
  - *Quantity of matter is a measure of matter that arises from its density and volume jointly.*
- Mass = quantity of matter that makes up an object.
  - Example: Your mass is 50 kg. The total amount of substance contained in your body is 50 kg.
  - Your mass is independent of gravity.



# Question

- Your mass is 50 kg. Now you go to the moon. On the moon, your mass will be
  - A. less than 50 kg.
  - B. equal to 50 kg.
  - C. more than 50 kg.



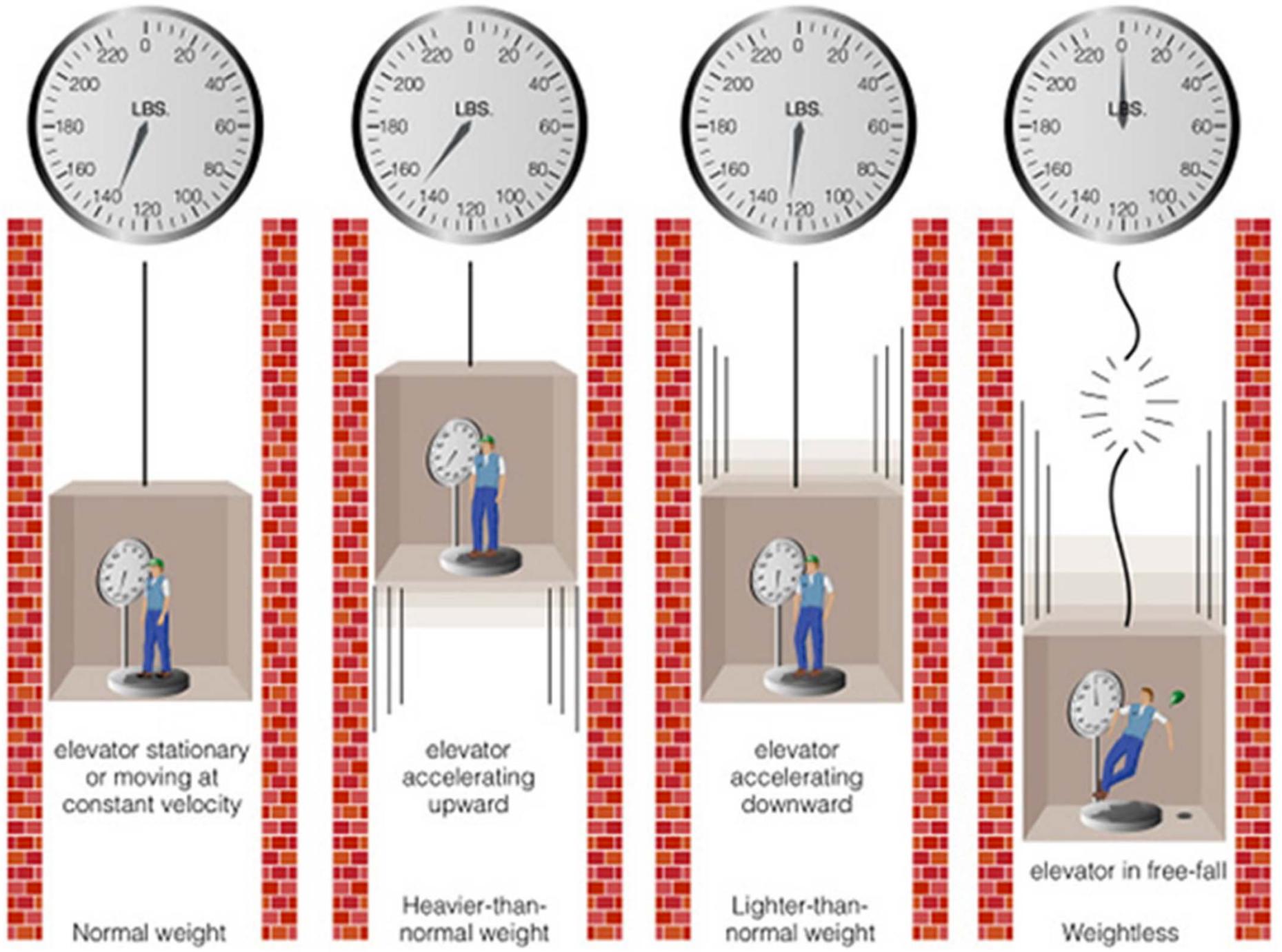
<http://fortheloveofthedogblog.com/news-updates/good-grief-snoopy-is-253-years-old>



# Weight

- Your weight is the gravitational force acting on you by Earth.
- Unit of force: Newton (N).
- On Earth, 1 kg of substance weighs 9.8 N.





# Question

- You weigh 490 N on Earth. Now you go to the moon. On the moon, your weight is
  - A. less than 490 N.
  - B. equal to 490 N.
  - C. more than 490 N.



<http://fortheloveofthedogblog.com/news-updates/good-grief-snoopy-is-253-years-old>



# Momentum

- Definition 2
  - *Quantity of motion is a measure of motion that arises from the velocity and the quantity of matter jointly.*
  - i.e.  $m V$
  - Is a measure of the amount of motion



# Momentum



- When both a ladybird and a tank are moving at the same velocity, the tank obviously has a greater momentum – a greater quantity of motion.



# Inertia

- Definition 3

- *Inherent force of matter is the power of resisting by which every body, so far as it is able, perseveres in its state either of resting or of moving uniformly straight forward.*
- Inertia is a concept of resistance to change in motion.
- It sounds complicated, but mathematically, **inertia is just exactly the same as mass.**



# Newton's three laws of motion



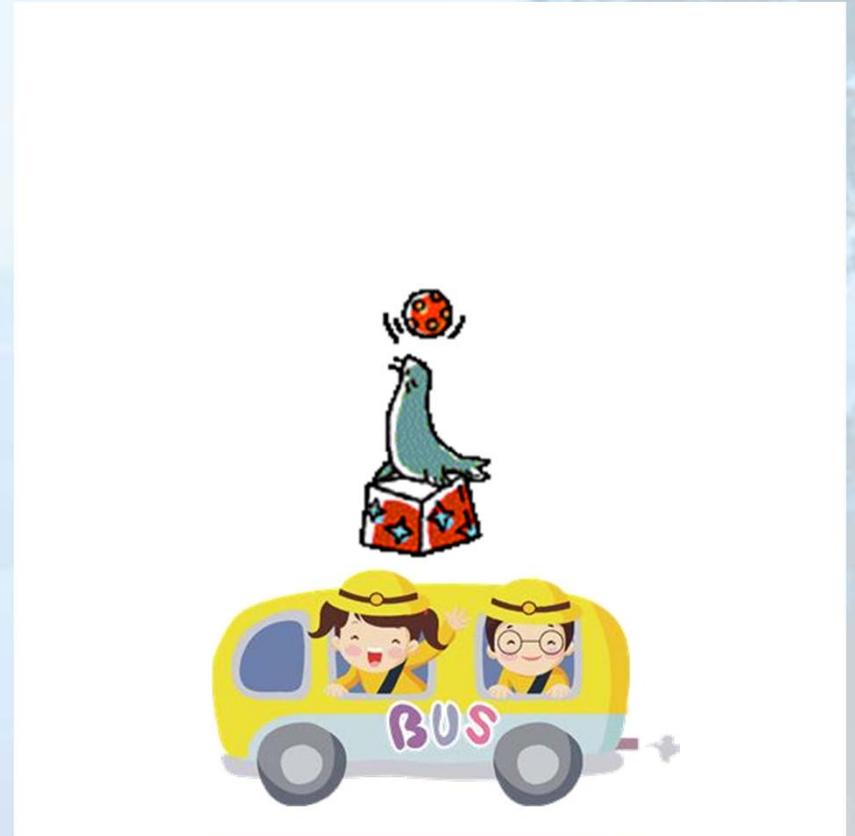
# Law I

- *Every body perseveres in its state of being at rest or of moving uniformly straight forward, except insofar as it is compelled to change its state by forces impressed upon it.*
- Or simply: The law of inertia

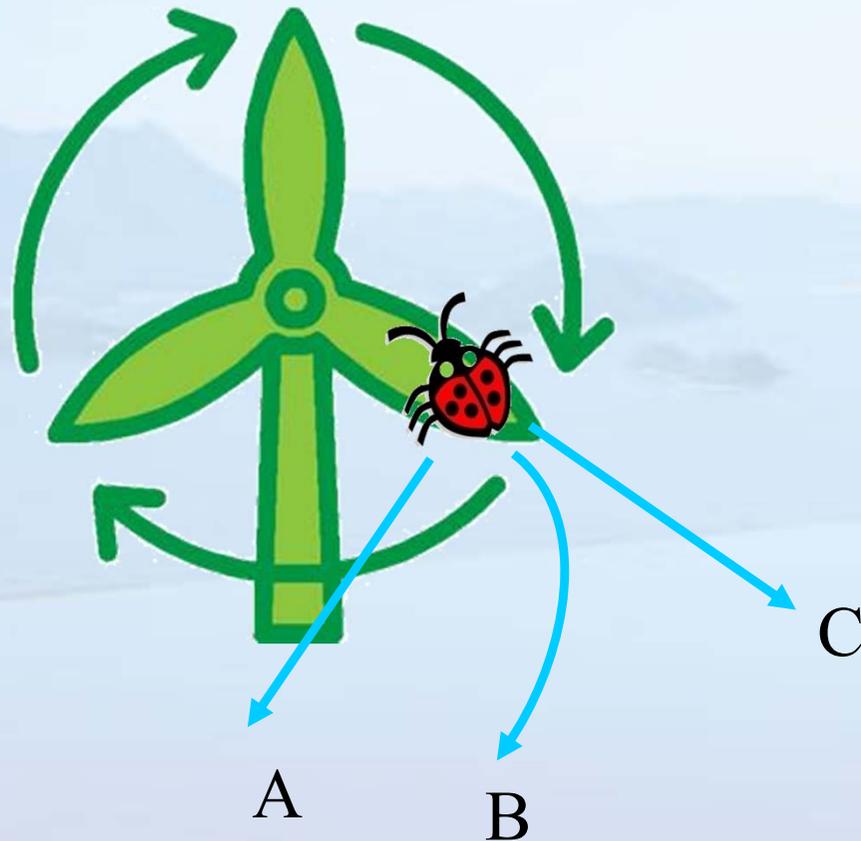


# Question

- Can the sea lion still get the ball back on a moving bus?  
A. Yes  
B. No



# Question



- The ladybird is flung away by the fan. Along which path will it go?



# Law II

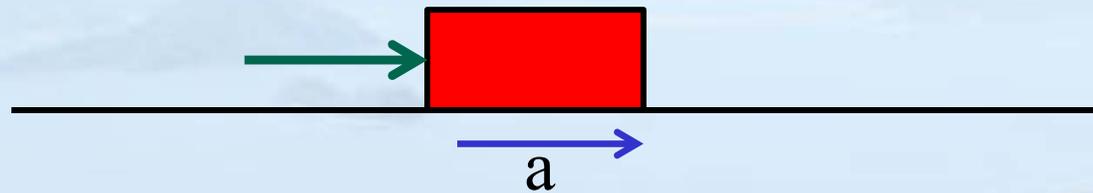
- *A change in motion is proportional to the motive force impressed and takes place along the straight line in which that force is impressed.*
- Or simply:  $\vec{F} = m\vec{a}$



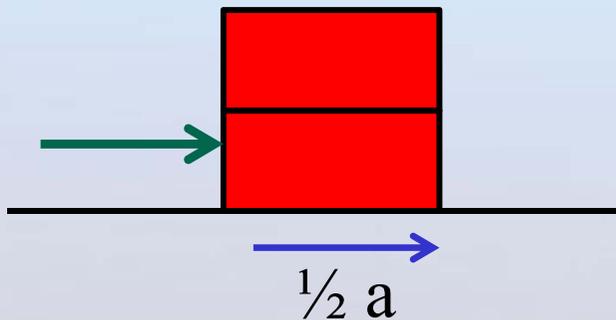
# Law II: $\vec{F} = m\vec{a}$

Focus on the *mathematical relation* between force and acceleration.

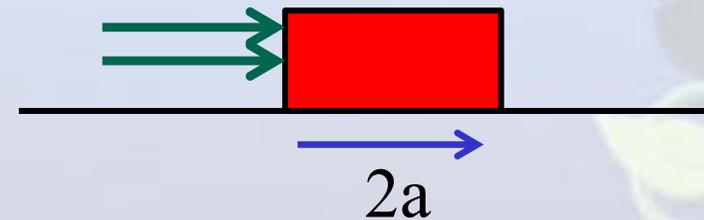
*A brick is accelerated by an applied force*



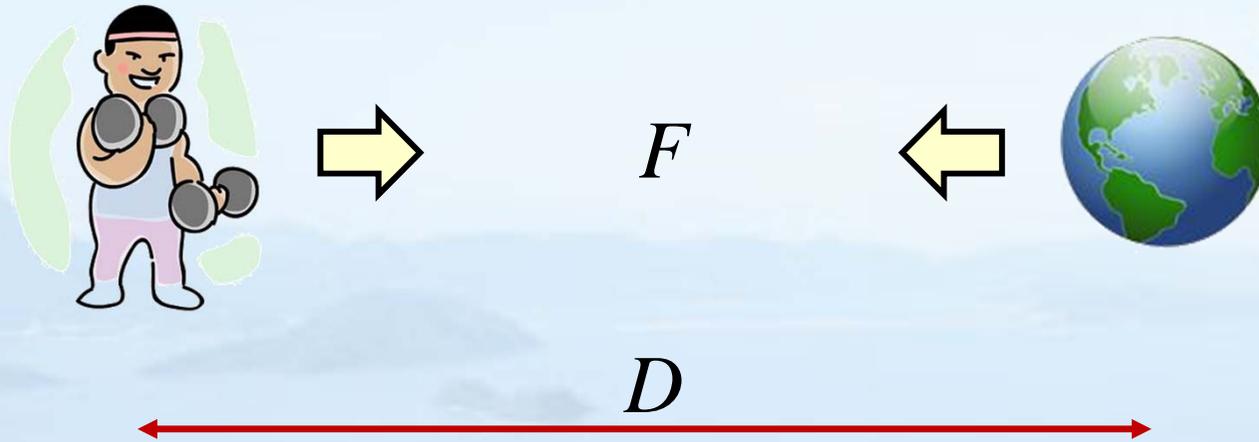
*The same force produces half the acceleration on two bricks*



*Doubling the force produces twice the acceleration on the same brick*



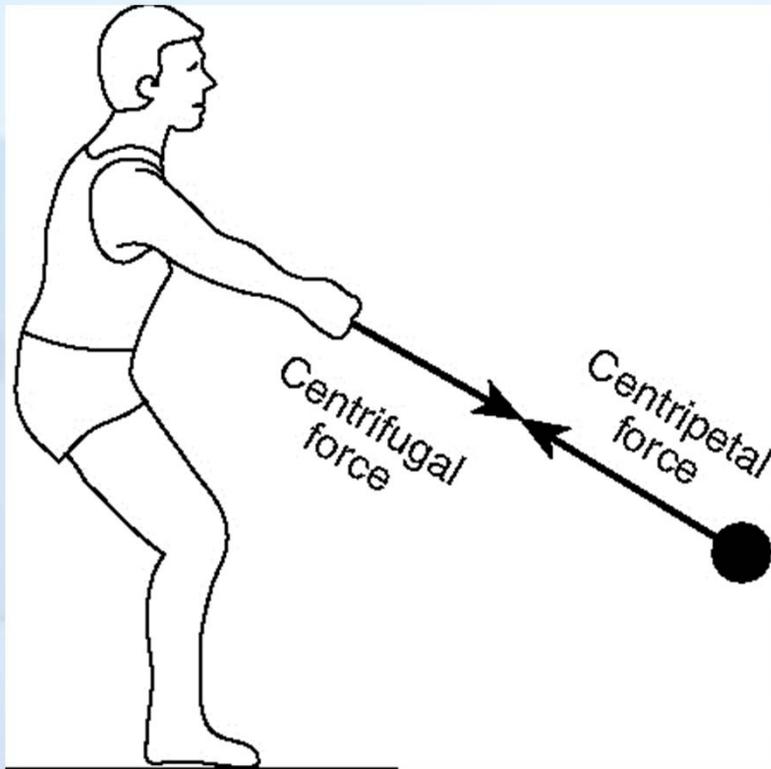
# Gravitation: $F \propto 1/D^2$



- Gravitational force exists between any two objects with the following relationship:

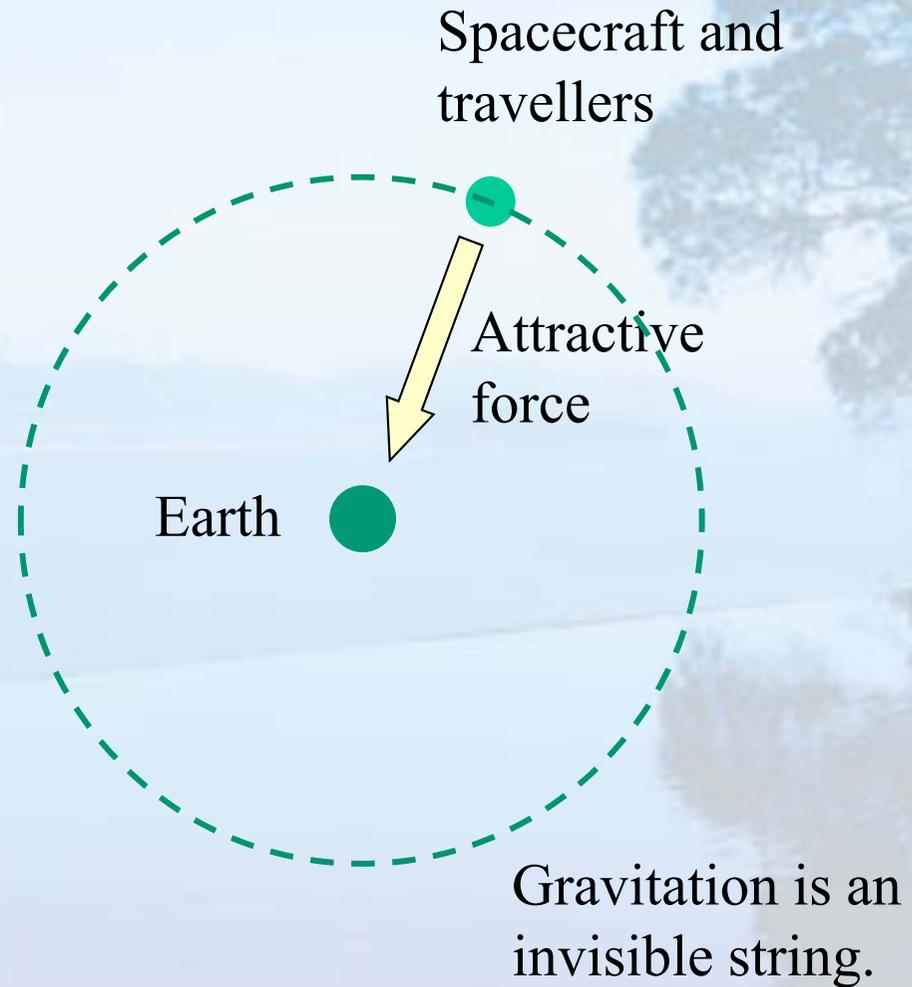
$$F \propto 1/D^2$$





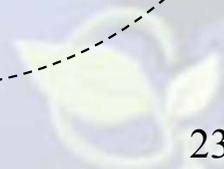
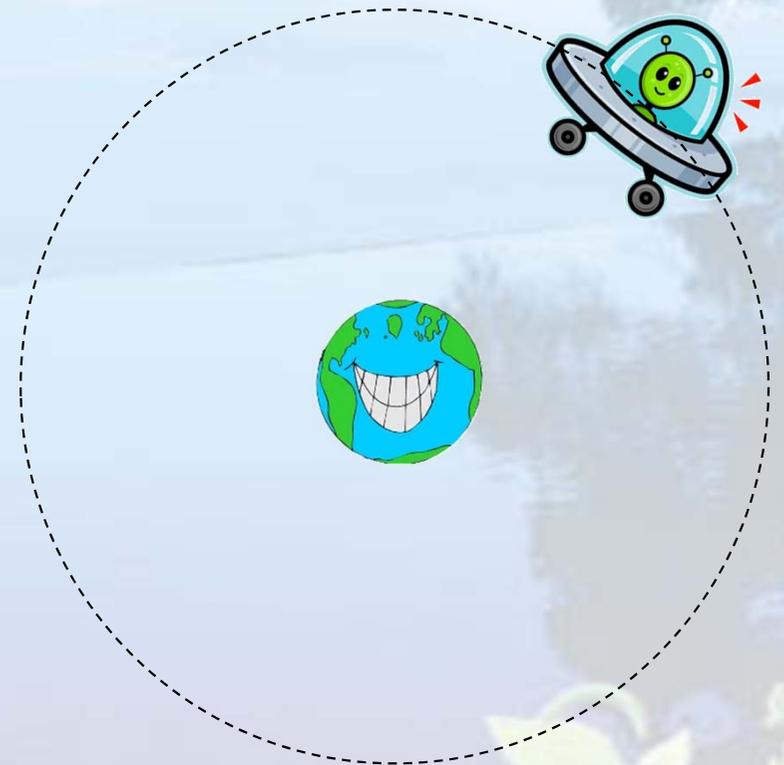
Hammer throw

<http://sportminor.blogspot.hk/>



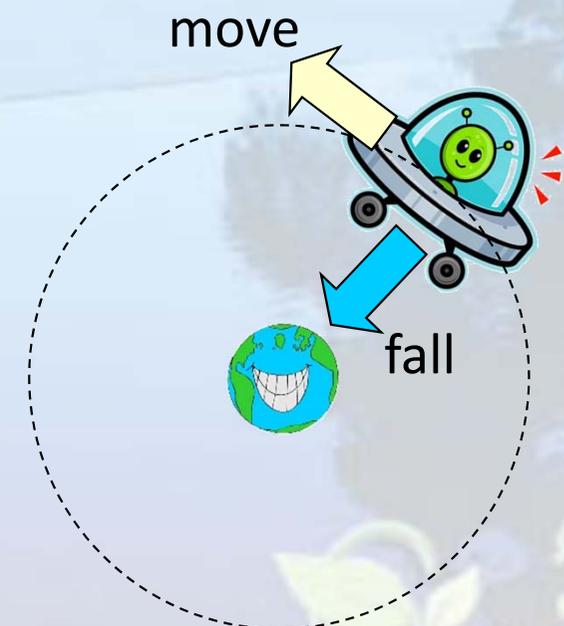
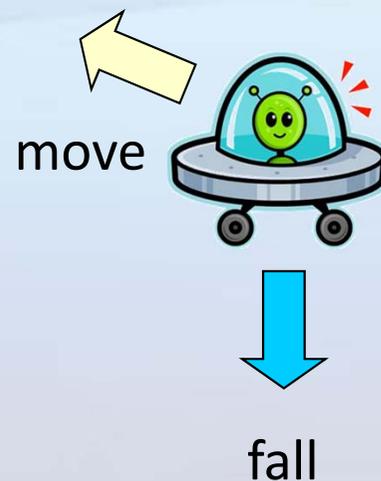
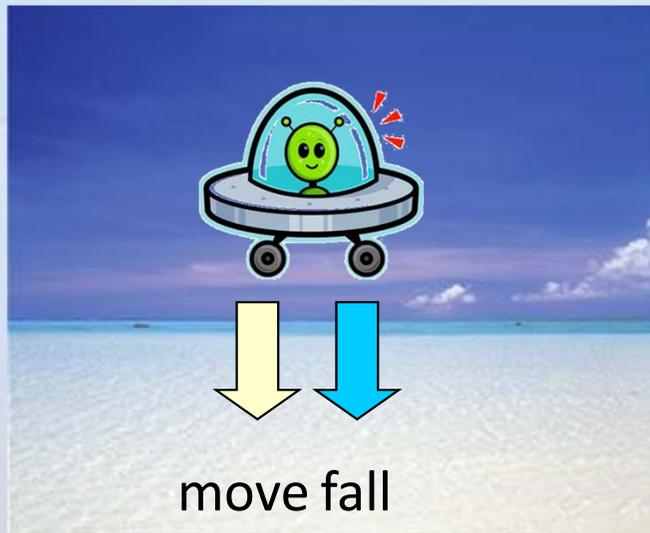
# Question

- The spacecraft (and the travellers) are revolving around the Earth. Is there gravitation acting on the spacecraft? (i.e., is it falling?)
  - A. No
  - B. Yes



# Falling together

- The spacecraft and the travellers are falling together towards the Earth.
- But in an unusual way.



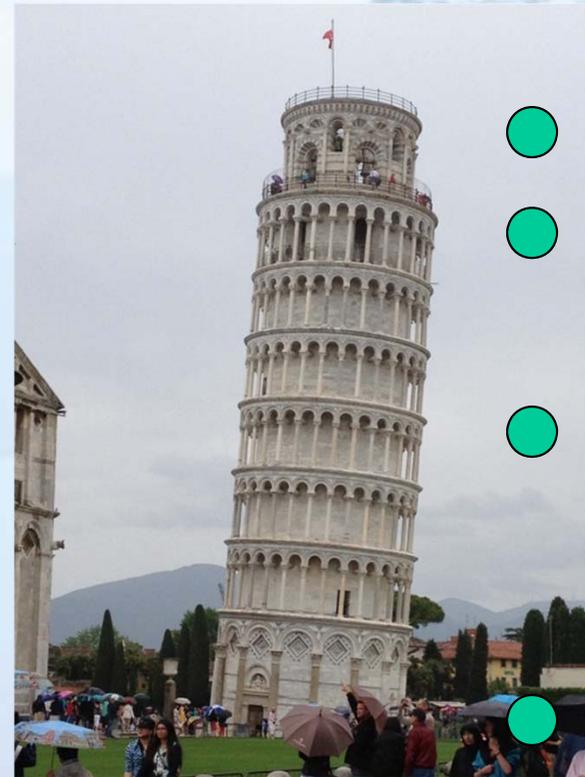
# Gravitational acceleration

- Since we are almost always the same distance away from the Earth's centre, the gravitational acceleration on Earth is almost a constant:  $g = 9.8 \text{ m/s}^2$
- i.e., in free fall, the speed increases by 9.8 m/s every 1 second.



# Question

- Two balls of different weight are dropped from the rooftop. Which statement is correct?
  - A. The heavier ball will reach the ground first.
  - B. Both reach at the same time.

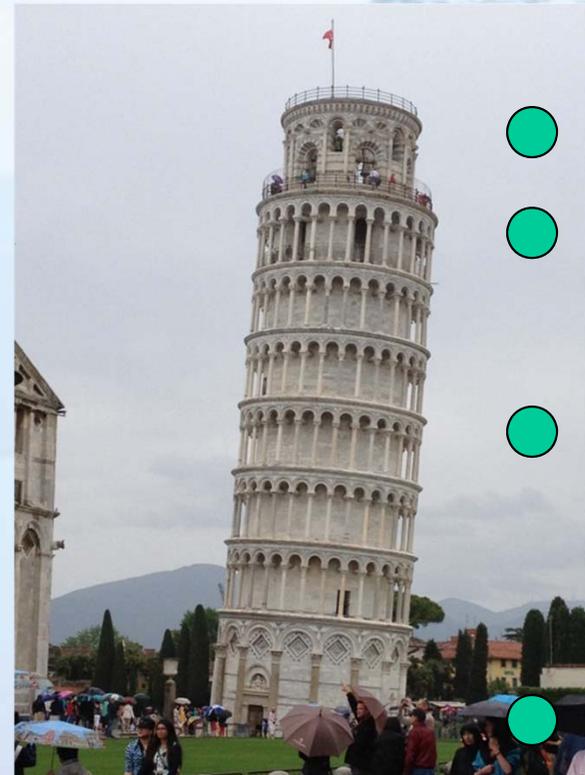


- 0 sec
- 1 sec
- 2 sec
- 3 sec



# Question

- The gravitational forces on them have the same strength. True or false?  
A. True.  
B. False.



- 0 sec
- 1 sec
- 2 sec
- 3 sec



$$F=ma$$

- Gravitational force is greater with a heavier mass, even the acceleration is the same.



# Law III

- *To any action there is always an opposite and equal reaction; in other words, the actions of two bodies upon each other are always equal and always opposite in direction.*
- Or simply: Equal and opposite reaction exist
- This law is not important in text 3's discussion.



# Question



- A police car crashes into a moving tank.  
Which exerts a greater force to the other?  
A. Tank.  
B. Car.  
C. Neither.



# Question

- You jump. Which is correct?
  - A. The ground pushes you up.
  - B. Your muscles push you up.
  - C. Gravity is lost when your feet leave the ground.

