Announcements

- Homework #2 Due Today
  - Written assignment due NOW
  - Write the name of your discussion section leader at the top
  - Online assignment due 10pm tonight

Gravitational Waves Detected!

- What are gravitational waves?
- How were they detected?

Ch 4.3-4
Newton's Second Law

PHYS 1210 - Prof. Jang-Condell

Goals for Chapter 4

- To understand the meaning of force in physics
- To view force as a vector and learn how to combine forces
- To understand the behavior of a body on which the forces balance: Newton's First Law of Motion
- To learn the relationship between mass, acceleration, and force: Newton's Second Law of Motion
- To relate mass and weight
- To see the effect of action-reaction pairs: Newton's Third Law of Motion
- To learn to make free-body diagrams

Recap

- Newton's First law:

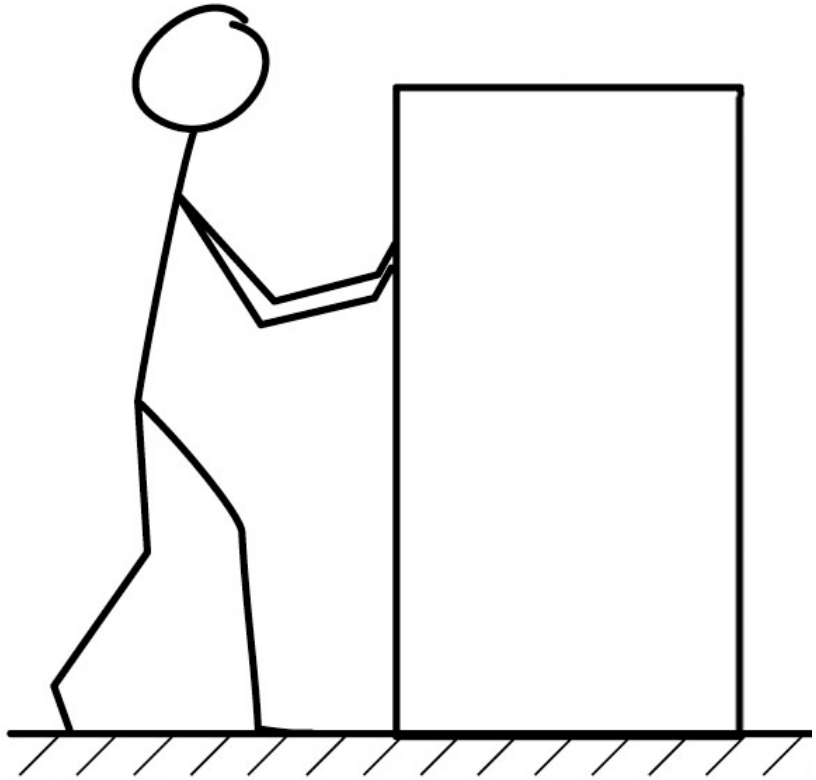
$$\text{If } \sum \vec{F} = 0, \text{ then } \vec{v} = \text{constant or } 0$$

- **Inertia** = the tendency to stay at rest or at constant speed. Related to **mass**
- Newton's Second law:

$$\sum \vec{F} = m\vec{a}$$

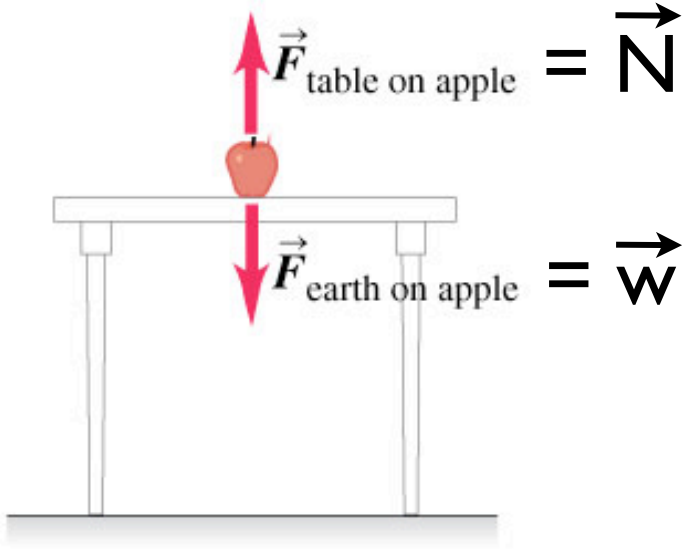
Someone pushes a large box to the right.
There is no friction between the box and floor.
How many forces are acting on the box?

Text 'PHYSJC' and your answer to 22333.



Free-Body diagrams

- A sketch of all the forces acting on a body



Mass and weight

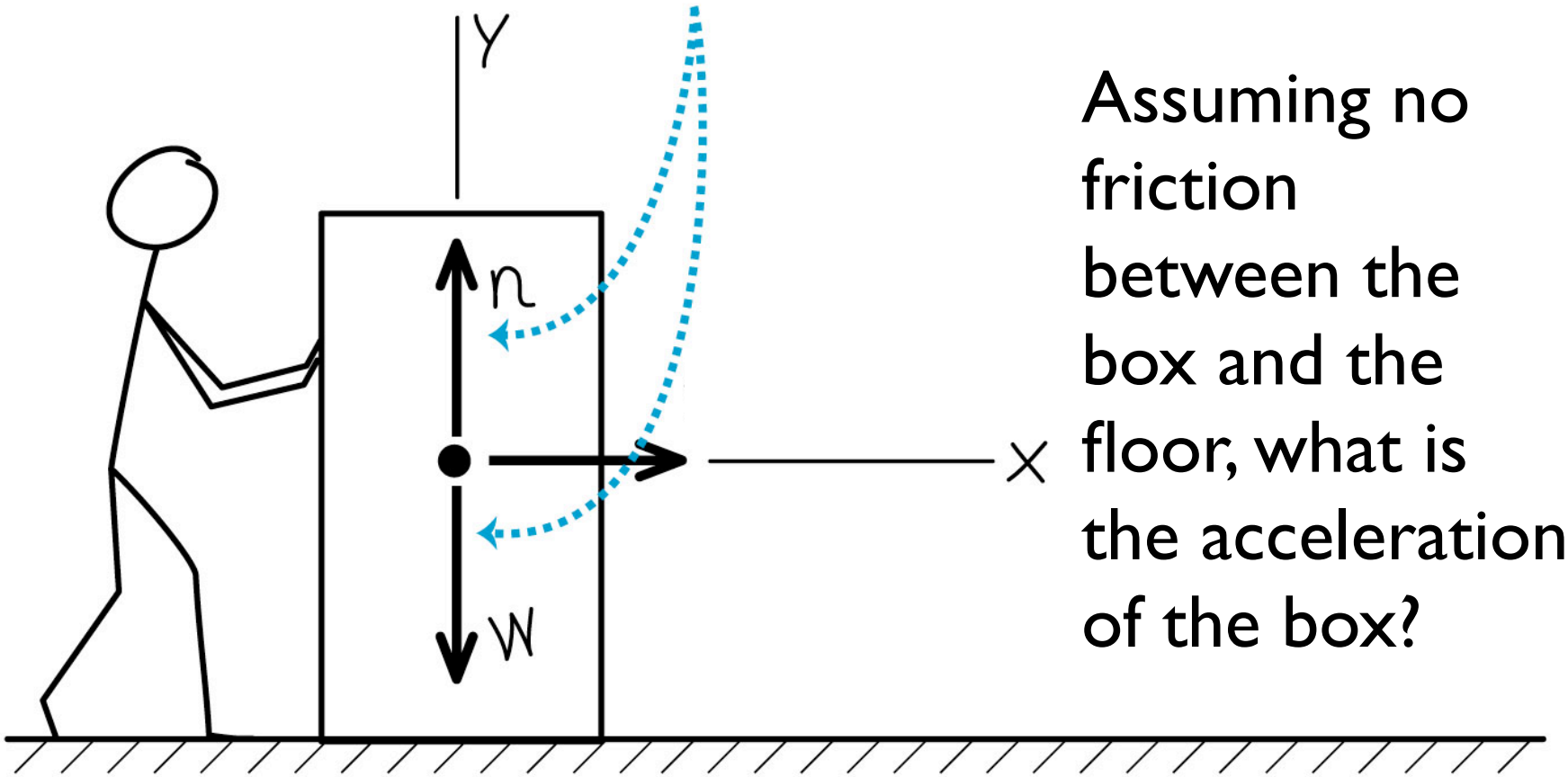
- The *weight* of an object (on the earth) is the gravitational force that the earth exerts on it.
- The weight W of an object of mass m is

$$W = mg$$

- The value of g depends on altitude.
- On other planets, g will have an entirely different value than on the earth.

Units

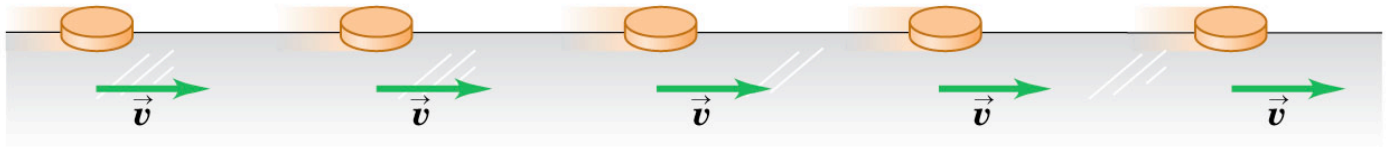
- The SI unit for force is the Newton (N)
- 1 Newton = 1 kg m/s^2
- 1 kg ≠2.2 pounds
- (1 kg)*g = 9.8 Newtons = 2.2 pounds



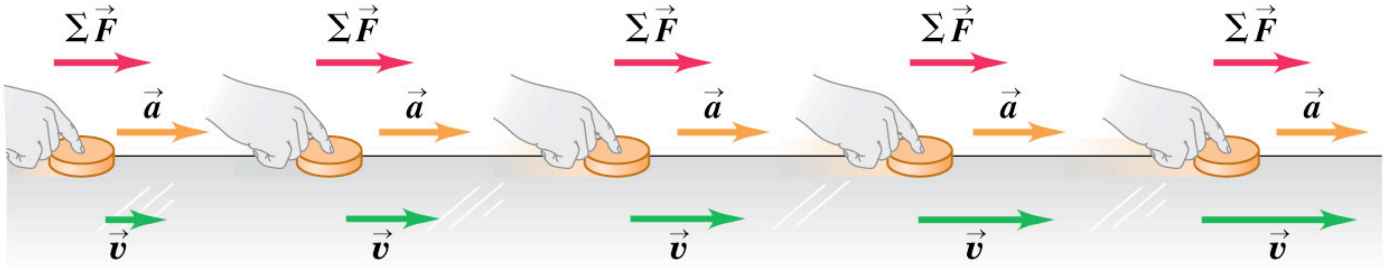
Assuming no friction between the box and the floor, what is the acceleration of the box?

Constant Force

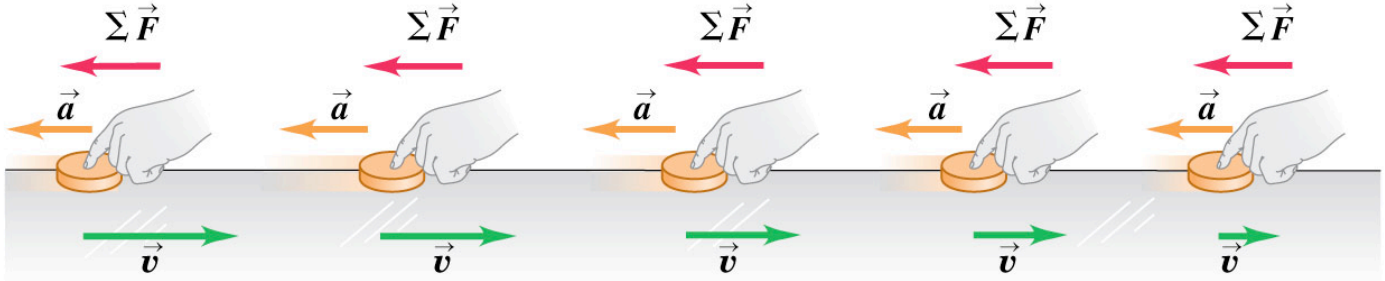
(a) A puck moving with constant velocity (in equilibrium): $\Sigma\vec{F} = 0,\ \vec{a} = 0$



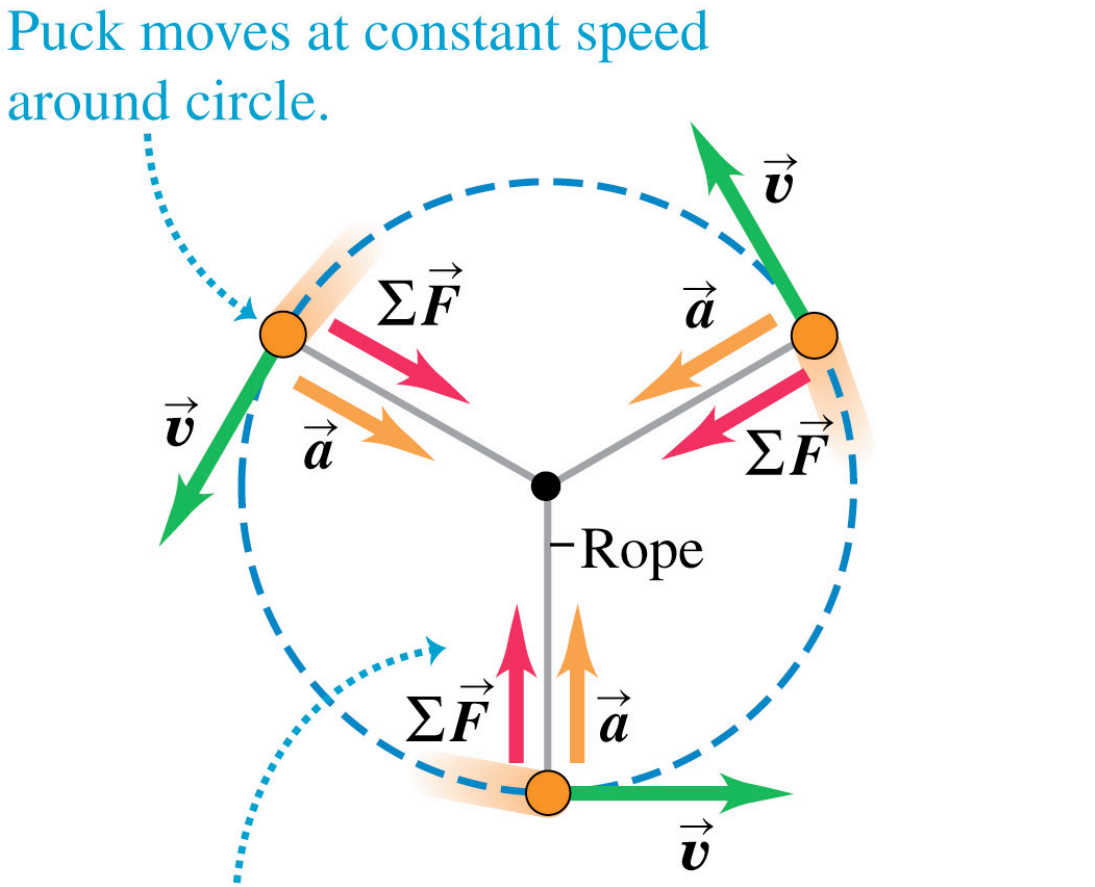
(b) A constant net force in the direction of motion causes a constant acceleration in the same direction as the net force.



(c) A constant net force opposite the direction of motion causes a constant acceleration in the same direction as the net force.

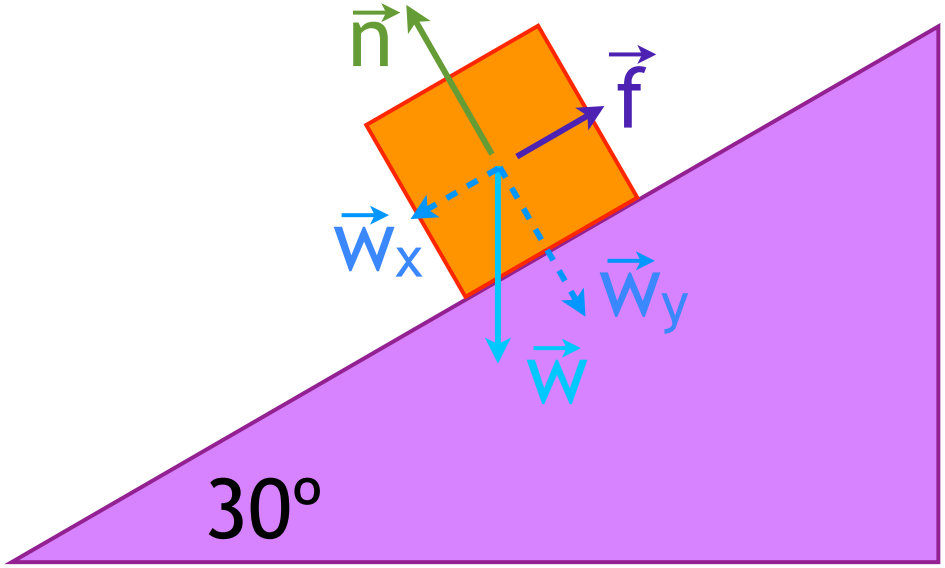


Uniform Circular Motion



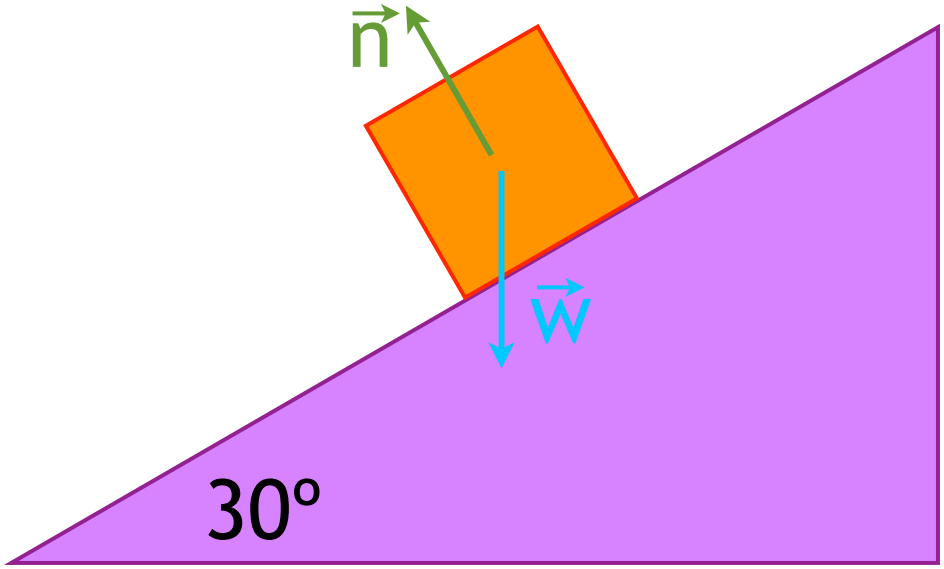
What is the magnitude of w_y?

Assume the block is at rest



A. w sin 30°
B. w cos 30°
C. w cos 60°
D. w sin 45°
E. none of the above

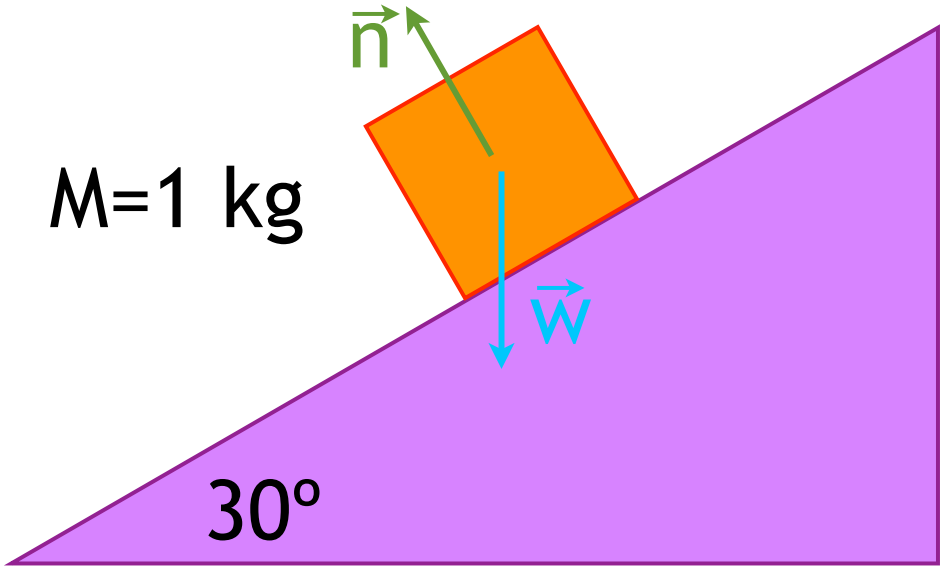
Assuming no friction, in what direction does the net force point?



F. Straight down
G. Straight left
H. Left and downward, 30° from horizontal
I. Left and downward, direction depends on mass
J. None of the above

Text your answer to 22333

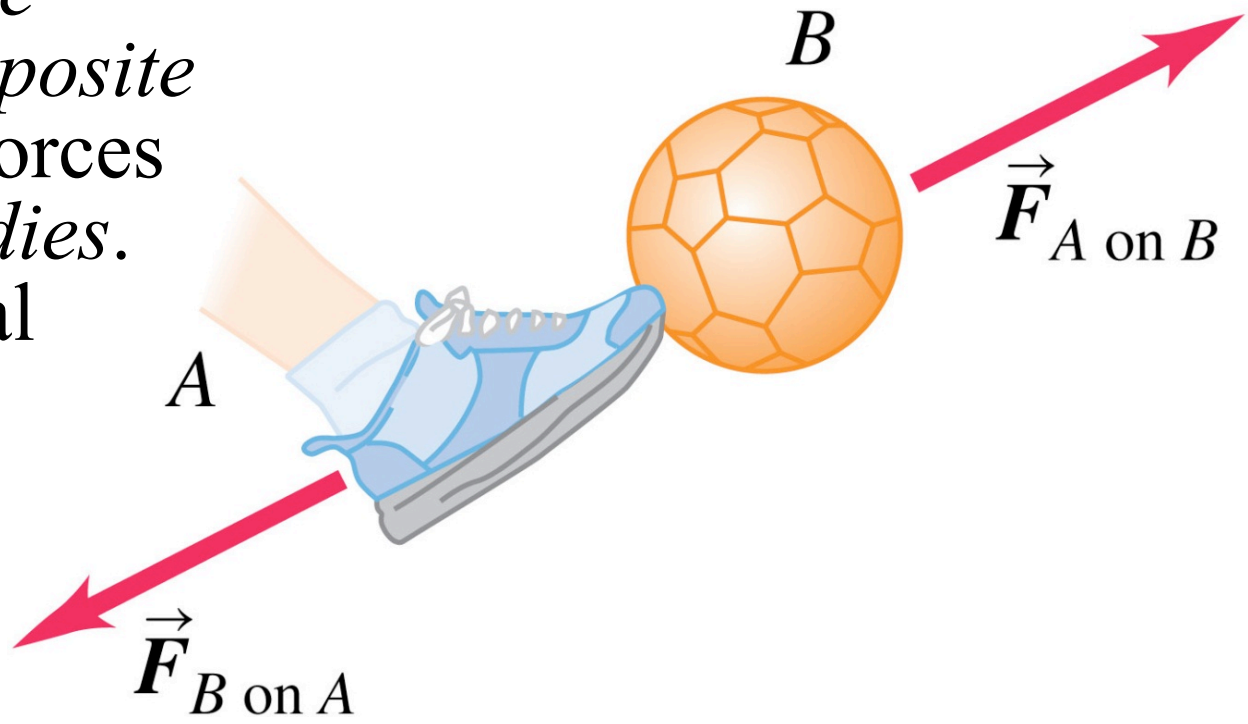
No Friction
What is acceleration?



Newton's Third Law

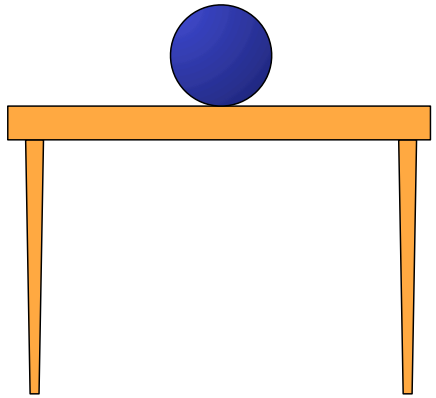
- If you exert a force on a body, the body always exerts a force (the "reaction") back upon you.
- Figure 4.25 shows "an action-reaction pair."

- A force and its reaction force have the *same magnitude but opposite directions*. These forces act on *different bodies*. [Follow Conceptual Example 4.8]



Q4.10

A ball sits at rest on a horizontal table top.



The gravitational force on the ball (its weight) is one half of an action–reaction pair. Which force is the other half?

K. the force of the earth's gravity on the ball

L. the upward force that the table top exerts on the ball

M. the upward force that the ball exerts on earth

N. the downward force that the ball exerts on the table top

O. the frictional force between the ball and the table top

Action-Reaction pairs act on **different** bodies

A thought experiment

- Suppose everyone on the planet gathered in one spot and jumped all at once. What would happen to the Earth?
- Text your answer to 22333

A thought experiment

- Suppose everyone on the planet gathered in one spot and jumped all at once. What would happen to the Earth?
- See http://what-if.xkcd.com/8/