Newton’s Third Law

Yet another law!

“To every action there is always an equal and opposite reaction”

More precisely:

• The interaction of two objects always occurs by way of two forces
  • A force of the first object acting on the second, and
  • An equal-magnitude and oppositely directed force of the second object acting on the first

Standing still

• Her weight is an external force acting on her.
  The Earth pulls on her and she pulls on the Earth - this is an action-reaction pair.

• Her weight causes her feet to push on the ground and so the ground pushes back on her - another action-reaction pair.

• The forces on her are the weight and the reaction of the floor - they are in balance (if the floor is strong enough!)

• By pushing back on a fixed block, the runner causes the block to push forward and up on her. It is the horizontal component of this force that initially accelerates the athlete in the forward direction.

Pushing off to change direction:

• The basketballer pushes on the floor
  • The floor pushes up and to the right on the basketball player with a force \( F_R \), allowing him to change direction.
  • It has components \( F_f \) (a friction force keeping his foot from sliding) and \( F_N \) (the normal force equal to his weight).

Forces on a slope

• The component of weight acting down the slope drives the skier downhill.

• The component of weight perpendicular to the slope is matched by the normal force.
Walking and Running

- With every stride, we push off the back foot to maintain speed. Why?
- We push on the ground and the ground pushes back on us (using the frictional force). That force on us propels us forward.
- Then why don’t we accelerate with every step?

Jumping

- Use Newton’s third law
  - if you push down on the floor it will push up on you
  - Push hard enough and the upward force will exceed your weight.

Only two forces act on the jumper - $F_w$ down and $F_u$ up
The harder you push down - the bigger net upward force on the jumper - the bigger net upward acceleration of the jumper

Summary

- To every action there is always an equal and opposite reaction.
- It is only the forces acting on an object that determine what an object will do in response.
- A balance of forces on an object (no net force) implies no acceleration - i.e. the object remains stationary or continues moving with constant velocity.

- NEXT: ........more on gravity