Skating 1

Skating

Turn off all electronic devices

Skating 2

Observations about Skating

- When you're at rest on a level surface,
  - without a push, you remain stationary
  - with a push, you start moving that direction
- When you're moving on a level surface,
  - without a push, you coast steady & straight
  - with a push, you change direction or speed

Skating 3

5 Questions about Skating

1. Why does a motionless skater tend to remain motionless?
2. Why does a moving skater tend to continue moving?
3. How can we describe the motion of a coasting skater?
4. How does a skater start, stop, or turn?
5. Why does a skater need ice or wheels in order to skate?

Skating 4

Question 1

Q: Why does a motionless skater tend to remain motionless?
A: A body at rest tends to remain at rest

This observed behavior is known as inertia

Skating 5

Question 2

Q: Why does a moving skater tend to continue moving?
A: A body in motion tends to remain in motion

This behavior is the second half of inertia

Skating 6

Newton's First Law (Version 1)

An object that is free of external influences moves in a straight line and covers equal distances in equal times.

Note that a motionless object obeys this law!

Skating 7

Question 3

Q: How can we describe the motion of a coasting skater?
A: The skater moves at a constant speed in a constant direction

Skating 8

Physical Quantities

1. Position – an object's location
2. Velocity – its change in position with time

- Both are vector quantities:
  - Position is distance and direction from a reference
  - Velocity is speed and direction of motion, relative to a reference

Skating 9

Newton's First Law (Version 2)

An object that is free of external influences moves at a constant velocity.

Note that a motionless object is "moving" at a constant velocity of zero!

Skating 10

Another Physical Quantity

3. Force – a push or a pull

- Force is another vector quantity:
  - the amount and direction of the push or pull
  - Net force is the vector sum of all forces on an object

Skating 11

Newton's First Law

An object that is not subject to any outside forces moves at a constant velocity.

Skating 12

Question 4

Q: How does a skater start or stop moving?
A: A net force causes the skater to accelerate!

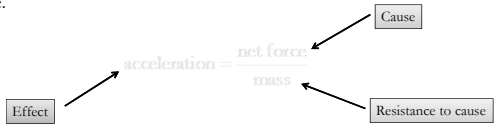
4. Acceleration – change in velocity with time
5. Mass – measure of object's inertia

- Acceleration is yet another vector quantity:
  - the rate and direction of the change in velocity

Skating 13

Newton's Second Law

An object's acceleration is equal to the net force exert on it divided by its mass. That acceleration is in the same direction as the net force.



Traditional form: net force = mass · acceleration

$F = ma$

Skating 14

About Units

- SI or "metric" units:
  - Position → m (meters)
  - Velocity → m/s (meters-per-second)
  - Acceleration → m/s^2 (meters-per-second^2)
  - Force → N (newtons)
  - Mass → kg (kilograms)
- Newton's second law relates the units:

$$1\ \text{m/s}^2\ (\text{acceleration}) = \frac{1\ \text{N}\ (\text{net force})}{1\ \text{kg}\ (\text{mass})}$$

Skating 15

Question 5

Q: Why does a skater need ice or wheels to skate?

A: Real-world complications usually mask inertia

Solution: minimize or overwhelm complications

- To observe inertia, therefore,
  - work on level ground (minimize gravity's effects)
  - use wheels, ice, or air support (minimize friction)
  - work fast (overwhelm friction and air resistance)

Skating 16

Summary about Skating

- Skates can free you from external forces
- When you experience no external forces,
  - You coast – you move at constant velocity
  - If you're at rest, you remain at rest
  - If you're moving, you move steadily and straight
- When you experience external forces
  - You accelerate – you move at a changing velocity
  - Acceleration depends on force and mass