Skating

Turn off all electronic devices

Observations about Skating

When you're at rest on a level surface,

- without a push, you remain stationary
- with a push, you start moving in the push's direction

When you're moving on a level surface,

- without a push, you coast steady & straight
- with a push, your speed or direction change in push's direction

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?

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

Question 2

Q: Why does a moving skater tend to continue moving?

A: A body in motion tends to remain in motion

This observed behavior is the second half of inertia

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.

A motionless object obeys this law
as a special case: zero movement!

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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

Two important 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

So a coasting skater moves at constant velocity

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Newton's First Law (Version 2)

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

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

Which brings us to another important 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

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Newton's First Law

An object that is not subject to any outside forces (or is subject to zero net force) moves at a constant velocity.

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Question 4

Q: How does a skater start or stop moving?

A: A non-zero net force causes the skater to accelerate!

Two more important Physical Quantities:

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

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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.

$$\text{acceleration} = \frac{\text{net force}}{\text{mass}}$$

Cause

Effect

Resistance to cause

Traditional form: net force = mass · acceleration

F = ma

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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:

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

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)

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