Conceptual Physics I
Classical Mechanics

Lesson 3A – Newton's First Law of Motion - Inertia

Lesson 3A – Newton's First Law

Early Thinking about Motion

- Aristotle (4th century BC) – divided motion into two types: natural motion and violent motion. Natural motion was thought to be objects finding their natural resting places, such as boulders rolling downhill or smoke rising in the air.

  Violent motion was considered to be due to imposed pushing or pulling. It had an external cause.

- Copernicus (early 16th century) – reasoned that the Earth moved around the Sun was the simplest explanation for astronomical observations.

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Early Thinking about Motion

- Galileo (early 17th century) – argued that a force is needed to keep an object moving only if friction is present. Otherwise a moving object would need no force to maintain its motion. We call the property of a body to resist a change in its motion "inertia."
- Isaac Newton (late 17th/early 18th century) – developed three laws of motion. The first one was a restatement of Galileo's idea of inertia.

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Newton's First Law of Motion

(also called the Law of Inertia)

Every object continues in a state of rest, or of motion in a straight line at constant speed, unless it is compelled to change that state by forces exerted upon it.

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Newton's First Law of Motion

(also called the Law of Inertia)

Examples:

- Quickly pulling a tablecloth out from under dishes on a table
- Sliding an ice hockey puck along an an ice rink

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Questions:

1) If the force of gravity between the sun and planets suddenly disappeared, what type of path would the planets follow?
   Straight line at constant speed

2) Does the law of inertia pertain to moving objects, objects at rest, or both?
   Both. Moving objects tend to keep moving; objects at rest tend to stay at rest.

3) If you were in a spaceship and launched a cannonball into frictionless space, how much force would have to be exerted on the ball to keep it going? None.

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Questions

4) Suppose you place a ball in the middle of a wagon that is at rest and then abruptly pull the wagon forward. Describe the motion of the ball relative to (a) the ground. Doesn't move (rolls in place)
(b) the wagon. Moves towards the back of the wagon.

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- Inertia is related to the mass of an object (how much matter it is comprised of).
- The greater the mass, the greater the inertia.
- Mass is not volume. Volume is how much space an object takes up.
- Mass is not weight. Weight is the force of gravity on an object. The weight of an object is greater on the earth than on the moon, but the mass of that object is the same.

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Questions:

1) Consider a 1-kg block of iron and a 2-kg block of iron (kilogram is a measure of mass).

Does the 2-kg block have twice as much inertia as the 1-kg block? Yes

Does the 2-kg block have twice as much mass at the 1-kg block? Yes

Does the 2-kg block have twice as much volume as the 1-kg block? Yes

Does the 2-kg block have twice as much weight as the 1-kg block? Yes

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Questions:

2) Consider a 2-kg bunch of bananas and a 1-kg loaf of bread.

Do the bananas have twice as much inertia as the bread? Yes

Do the bananas have twice as much mass as the bread? Yes

Do the bananas have twice as much volume as the bread? No

Do the bananas have twice as much weight as the bread? Yes

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Weight (MKS system) is measured in Newtons.

Length – meters

Mass – kilograms

Time – seconds

Weight – Newtons

Temperature – Kelvin

An object of mass one kilogram weighs 9.8 Newtons on the earth.

1 Newton is about 2.2 pounds.

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Questions:

3) How much does a 1-kg bag of nails weigh at the Earth's surface? 9.8 N

How about 1-kg of yogurt? 9.8 N

How about 2-kg of yogurt? 19.6 N

4) When a junked car is crushed into a compact cube, does its mass change? No Its volume? Yes Its weight? No

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Questions:

5) If an elephant were chasing you, its enormous mass would be very threatening. But if you zigzagged, the elephant's mass would be to your advantage. Why? The elephant has greater inertia and therefore cannot change direction as quickly.

6) If a woman has a mass of 50 kg, calculate her weight in Newtons.
50 kg * 9.8 m/s^2 = 490 N

7) An apple weighs about 1 N. What is its mass in kilograms?
1 N/9.8 m/s^2 = 0.1 kg