READING MATERIAL

CLASS IX CHAPTER 9 FORCE AND LAWS OF MOTION

Inertia and Mass

- First Law
- Inertia and Mass
- State of Motion
- Balanced vs. Unbalanced Forces

Newton's first law of motion states that "An object at rest stays at rest and an object in motion stays in motion with the same speed and in the same direction unless acted upon by an unbalanced force." Objects tend to "keep on doing what they're doing." In fact, it is the natural tendency of objects to resist changes in their state of motion. This tendency to resist changes in their state of motion is described as **inertia**.

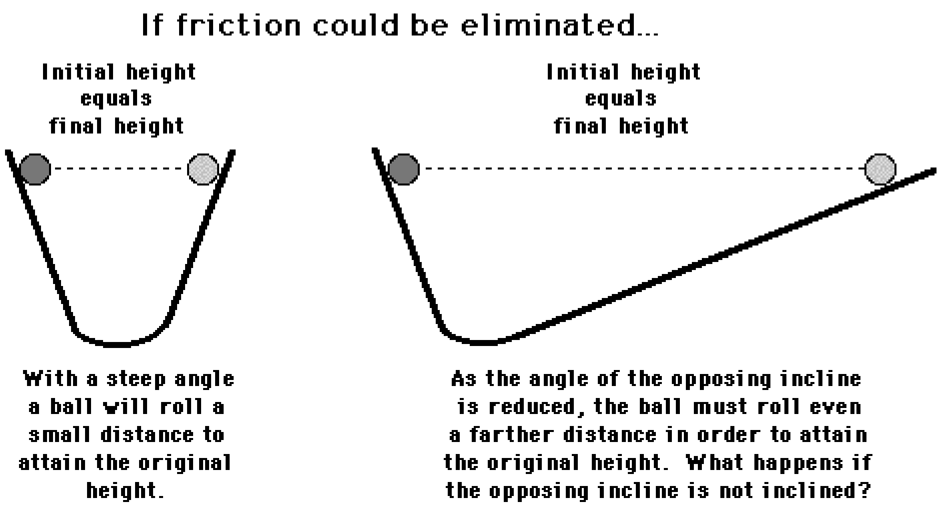
Inertia: the resistance an object has to a change in its state of motion.

Newton's conception of inertia stood in direct opposition to more popular conceptions about motion. The dominant thought prior to Newton's day was that it was the natural tendency of objects to come to a rest position. Moving objects, so it was believed, would eventually stop moving; a force was necessary to keep an object moving. But if left to itself, a moving object would eventually come to rest and an object at rest would stay at rest; thus, the idea that dominated people's thinking for nearly 2000 years prior to Newton was that it was the natural tendency of all objects to assume a rest position.

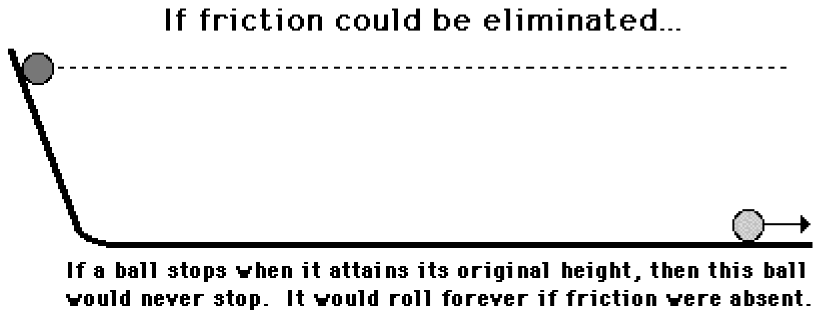
Galileo and the Concept of Inertia

Galileo, a premier scientist in the seventeenth century, developed the concept of inertia. Galileo reasoned that moving objects eventually stop because of a force called friction. In experiments using a pair of inclined planes facing each other, Galileo observed that a ball would roll down one plane and up the opposite plane to approximately the same height. If smoother planes were used, the ball would roll up the opposite plane even closer to the original height. Galileo reasoned that any difference between initial and final heights was due to the presence of friction. Galileo postulated that if friction could be entirely eliminated, then the ball would reach exactly the same height.

Galileo further observed that regardless of the angle at which the planes were oriented, the final height was almost always equal to the initial height. If the slope of the opposite incline were reduced, then the ball would roll a further distance in order to reach that original height.



Galileo's reasoning continued - if the opposite incline were elevated at nearly a 0-degree angle, then the ball would roll almost forever in an effort to reach the original height. And if the opposing incline was not even inclined at all (that is, if it were oriented along the horizontal), then ... an object in motion would continue in motion... .



NUMERICALS

Question 1: Calculate the force needed to speed up a car with a rate of $5ms^{-2}$, if the mass of the car is 1000 kg.

Solution: According to question:

Acceleration (a) =5m/s2=5m/s2 and Mass (m) = 1000 kg, therefore, Force (F) =?
We know that, F=m×aF=m×a
=1000kg×5m/s2=1000kg×5m/s2
=5000kg m/s2=5000kg m/s2
Therefore, required Force =5000m/s2=5000m/s2 or 5000 N

Question 2: If the mass of a moving object is 50 kg, what force will be required to speed up the object at a rate of $2ms^{-2}$?

Solution: According to the question;

Acceleration (a) =2ms−2=2ms-2 and Mass (m) = 50 kg, therefore, Force (F) =?
We know that, F=m×aF=m×a
=50kg×2m/s2=50kg×2m/s2

=100kg m/s2=100kg m/s2
Therefore, required Force =100m/s2=100m/s2 or 100 N

Question 3: To accelerate an object to a rate of 2m/s^2, 10 N force is required. Find the mass of object.

Solution: According to the question:

Acceleration (a) = 2m/s^2, Force (F) = 10N, therefore, Mass (m) = ?
We know that, F=m×aF=m×a
⇒10N=m×2m/s2⇒10N=m×2m/s2
⇒m=102 kg=5 kg⇒m=102 kg=5 kg
Thus, the mass of the object = 5 kg

Question 4: An object gets 50 second to increase the speed from 10m/s to 50m/s. If the mass of the object is 1000 kg, what force will be required to do so?

Solution: According to the question:

Initial velocity (u) = 10m/s, final velocity (v) = 50m/s, time (t) = 50 second, Mass (m) = 1000 kg,
Therefore, force (F)=?
We know that, Force (F) =mv−ut=mv-ut
∴F=1000 kg 50 m/s−10 m/s50 s∴F=1000 kg 50 m/s-10 m/s50 s
⇒F=1000 kg×4050 ms−2⇒F=1000 kg×4050 ms-2
⇒F=20 kg×40ms−2⇒F=20 kg×40ms-2
⇒F=800 kg ms−2=800N⇒F=800 kg ms-2=800N
Thus required force = 800 N

Question 5: A vehicle having mass equal to 1000 kg is running with a speed of 5m/s. After applying the force of 1000N for 10 second what will be the speed of vehicle?

Solution: According to the question:

Mass of (m) = 1000 kg, Force, (F) = 1000 N, time (t) = 10s, Initial velocity (u) = 5m/s

Therefore, Final velocity (v) =?

We know that, Force (F) =mv−ut=mv-ut

∴1000N=1000 kg v−5m/s10s∴1000N=1000 kg v-5m/s10s

⇒ 1000 kg m/s^2 × 10s = 1000 kg (v – 5m/s)

⇒ 10000 kg m/s = 1000 kg × v – 5000 kg m/s

⇒ 10000 kg m/s + 5000kg m/s = 1000kg × v

⇒ 15000 kgm/s = 1000 kg × v

⇒v=15000 kg m/s1000 kg=15 m/s⇒v=15000 kg m/s1000 kg=15 m/s

Thus, the velocity of the vehicle will be 15m/s.