LESSON 3 - INERTIA

The meaning of inertia

Inertia is the property of an object which resists a change in its motion.
If it is at rest it tends to remain at rest , if it is moving it tends to continue moving.
Or
Inertia is the reluctance of an object to move once it is at rest or the reluctance of an object to stop once it is in uniform velocity.

Explanation of inertia by Newton's First Law of Motion

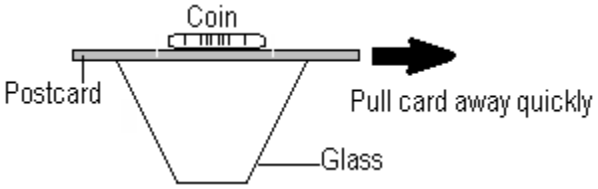
Newton's First Law of Motion states that "an object will remain at rest or continue with a constant speed in a straight line unless acted on by an unbalanced force or if the external force acting on the object is zero"

Relationship between mass and inertia

The mass of a body is a measure of its inertia. If a body has a small mass, it will have a small inertia; if its mass is large, then so is its inersia.

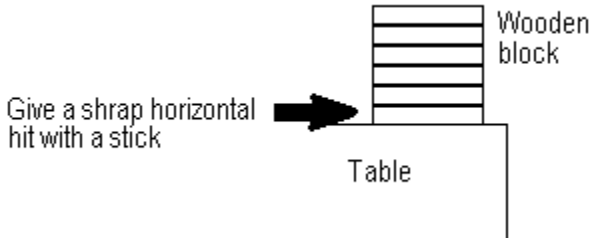
Some examples of situations involving inertia

Example 1



Observation: The coin drops vertically into the glass .
Explaination : The inertia of the coin causes it remain at rest .
The coin drops vertically into the glass due its weight.

Example 2



Obesrvation : The other blocks fall vertically onto the table.
Explaination : The inertia of the wooden blocks causes its remain at rest.
The weight of other blocks makes them fall Vertically onto the table.

Example 3

Observation : If some ketchup is stuck in a bottle, it can be dislodged by turning the bottle upside down , thrusting it downwards and stopping suddenly.
Explanation : The inertia of the ketchup causes it maintain its velocity while the bottle is stopped.

Example 4

Observation: When a driver inside a car applies brake Suddenly , the driver and the passengers are surged forwards.
Similarly ,when the car accelerates , the occupants will move backwards.

Explanation: The inertia of the driver and passengers cause they maintain their original motion (original velocity) or maintain at rest.

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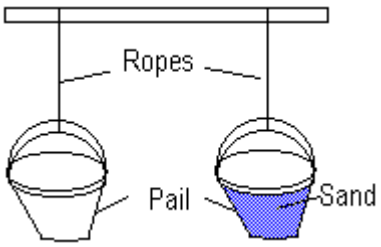
Example 5



Observation : The pail filled with sand feels more reluctant to move and more difficult to stop moving than the empty one.
Explanation: The pail filled sand has a greater inertia or mass than the empty one.

Example 6

Observation : A tanker has to stop its engine 5 km from port.
Explanation : The tanker has so much inertia , so that it can slow down in time to avoid any accident.

Example 7

Observation : An aeroplane need a long runway for landing and take-off
Explanation : The aeroplane has a greater mass and also has so much inertia.

Reducing the negative side effects of inertia.

(i) The seat belts are designed to protect the passengers . If the car is involved in a collision , it will suddenly be brought to a stop. But because of its inertia, their body will continue traveling at a certain velocity until it hits an obstruction , usually the car's windscreen. Without a seat-belt , the passengers can be seriously injury.
The belts exerts a force on the passenger's bodies bringing it to stop without hitting the windscreen or the steering wheel.

(ii) Head restraints are designed to reduce neck injury. There are particularly effective in rear-impact accidents. As the car is shunted forwards , the back of your seat pushes your body towards. If you do not have a head restraint, the inertia of your head means that it stays behind , while your body moves forward. This can cause 'whiplash' injuries.

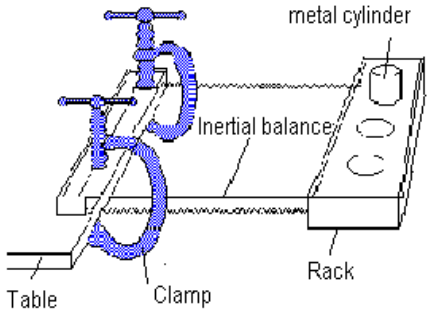
(iii) Timbers carried by a lorry normally are tied up together by a strong iron chain. When the lorry starts to move suddenly , the timbers are more difficult to fall off due to their inertia because their combined mass has increased.

The positive effects of inertia

(i) The motion of a spacecraft in deep space is in a straight line with a constant speed ; since there is no air in space (the external force acting on the object is zero") to slow its motion. For this reason, there is no need to make a space probe aerodynamic in shape .

(ii) A sumo wrestler who has a greater mass also has a greater inertia. He is harder to toppled and normally he is likely to win a championship tournament.

Inertial balance



An inertial balance is used to compare masses or to measure the mass of an object.
When the mass of the metal cylinder is increased by adding a second metal cylinder , the period of vibration become longer.
The square of the period of vibration ,T^2 of a inertial balance is directly proportional to the mass, m of the metal cylinder.

$$T^2 \alpha m$$

Example 1

In an inertial balance experiment , the period of oscillations for loads 0.5 kg is 4.0 s. What is the mass of the load if the period of the oscillations is 9.0 s

Solution

TUTORIAL 2

1 Inertia of an object is

A the friction force exerts to the object
B the friction force exerts to the object
C the force against the motion of the object
D the property of the object which resists a change in its motion.

2 What is the name of the property of a body which resists a change in its state of rest or of uniform motion?

A Acceleration **B** Density
C Inertia **D** Velocity

3 The factor that affect the inertia of an object is

A the acceleration of the object
B the temperature of the object
C the weight of the object
D the mass of the object

4 Which object has the greatest inertia?

A

Mass = 15 kg

B

Mass = 1.2×10^5 kg

C

Mass = 2 000 kg

D

Mass = 1.1×10^8 kg

5 Figure shows a hammer.

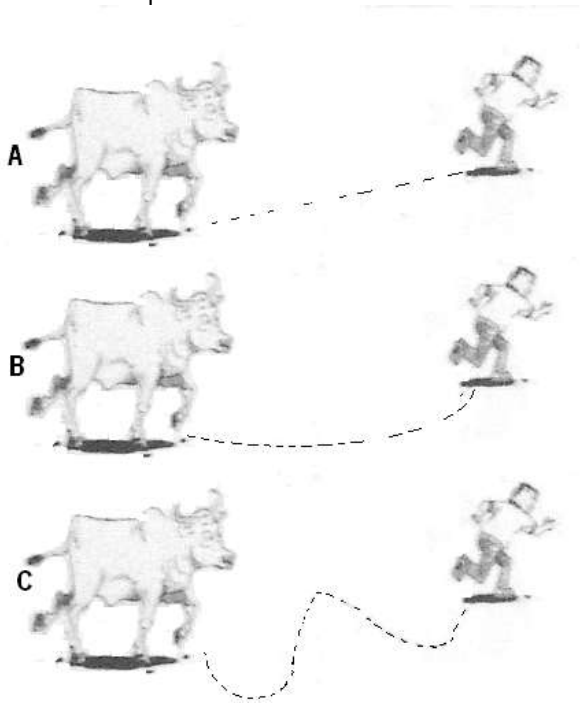
The head of the hammer can be tightened onto the handle by

A pushing the head of the hammer
B rotating the handle of the hammer
C applying a knock on the handle of the hammer

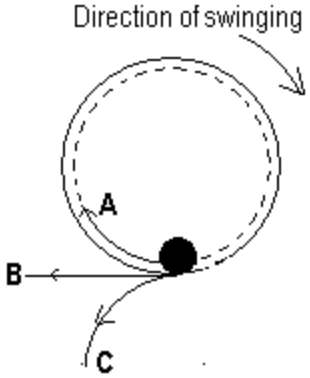
6 How difficult is it to start a heavy lorry moving and to stop it moving ?

	to start	to stop
A	difficult	difficult
B	difficult	easy
C	easy	difficult
D	easy	easy

7 When a boy is chased by a cow, which of the following is the best path to run.



8 The following figure shows a small stone is tied to a piece of string and then swung round and round above the head.



If the string is suddenly released , which path in figure above will the stone follow.

9 Which phenomenon **cannot** be explained by the principle of inertia?

A In a game of carrom , the striker can strike a stake of carrom pieces but only dislodge the bottom piece
B When the lowest coin is struck with a steel ruler, the rest of the stack of coins do not collapse
C A boy on a bicycle does not immediately come to stop although he stops pedalling
D The bubbles formed by a fish expand as they float towards the surface

10 When a bus moves left then the passengers appear to move right, and vice versa. This phenomenon is caused by

A the inertia of the bus
B the reaction of the bus
C the inertia of the passengers
D the reaction of the passengers

11 An inertial balance can be used to compare

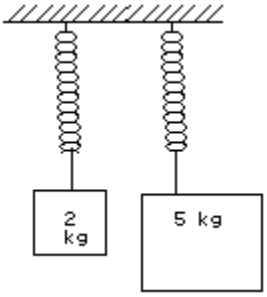
A the acceleration of an object
B the momentum of an object
C the weight of an object
D inertia of an object

12 The period of oscillations of an inertial balance depends on

A The acceleration due to gravity
B The amplitude of the oscillations
C The mass of the metal cylinder
D The force to push the balance

13 In an inertial balance experiment , the period of oscillations for loads 100 g is 4.8 s. What is the mass of the load if the period of the oscillations is 6.8 s.

A 100 g **B** 150 g
C 200 g **D** 250 g
E 300 g



14 Two identical springs hung with two loads 2 kg and 5 kg respectively. The loads is pulled down at the same time and caused the loads bounce up and down.

(a) Compare the period of the oscillations of the springs.

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(b) Give **one** reason for your answer in (a).

.....

.....

(c) What happen to the period of the oscillations of the springs if the experiment is carried out on the surface of the moon.

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15 In Figure 1, shows the driver and the car decorations when the car is accelerating from rests.
In Figure 2, shows the driver and the decorations when the car stops suddenly.

The car accelerates from rest — FIGURE 1

The car stops suddenly — FIGURE 2

(*a*) (i) Define *acceleration*.

[1 *mark*]

(ii) What do you observe about the driver and the decoration in Figure 1 and Figure 2?
Use these observations to explain a physical concept.

[4 *marks*]

(iii) Name the concept.

[1 *mark*]

(*b*) Explain why

(i) a wide safety belt is used rather than a narrow safety belt.

(ii) the belt is designed to extend slightly when the car stops suddenly.

[5 *marks*]

(c) The diagram below shows a typical saloon car.

Ahmad wants to modify the car so that it can be used safely as a racing car. State **one** modification that Ahmad could make and give a suitable concept in physics in **each** of the following aspect:

(i) safety
(ii) shape
(iii) power
(iv) stability
(v) mass

[10 *marks*]

16 The figure shows a man pushes a shopping trolley in two situations. The man experience the empty trolley is easy to start and stop but the fully trolley is hard to start and to stop.

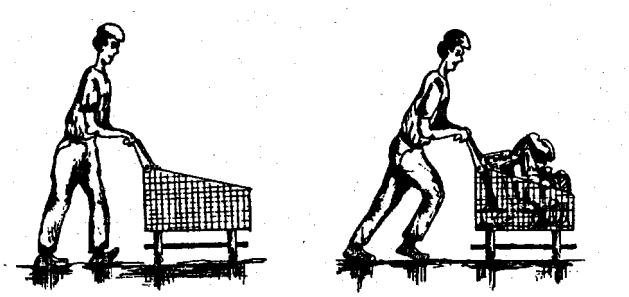

FIGURE 1 — FIGURE 2

Observe the positions of each of the park chute and the appearance of the student when he slides.
Based on the observations:

(a) State **one** suitable inference that can be made.

(b) State **one** appropriate hypothesis for an investigation.

(c) With the use of apparatus such as , jigsaw blade , plasticine ,clamp and other apparatus , describe an experimental framework to test your hypothesis.
In your description , state clearly the following:

(i) Aim of the experiment [1 *mark*]
(ii) Variables in the experiment
(iii) List of apparatus and materials
(iv) Arrangement of the apparatus
(v) The procedure of the experiment which include the method of controlling the manipulated variable and the method of measuring the responding variable. [2 *mark*]
(vi) Way you would tabulate the data
(vii) Way you would analysis the data