NEWTON'S 2ND LAW OF MOTION 25 FEBRUARY 2014

Lesson Description

In this lesson we:

- Investigate the relationship between force and motion
- Revise how to apply Newton's Laws of motion to different situations

Summary

Acceleration is the rate of change of velocity ($a = \frac{\Delta v}{\Delta t}$).

The SI units of acceleration are $m.s^{-2}$. Acceleration is a vector quantity.

When an object speeds up in the positive direction, acceleration is positive. When an object slows down while moving in the positive direction, the acceleration is negative (opposite to the direction of motion.)

Newton's 2nd Law

The acceleration of an object is in the direction of the **resultant** force acting on the object. The acceleration is directly proportional to the resultant force and inversely proportional to mass of the object.

As an equation: $F_{net} = ma$

Where: F_{net} = resultant force (N)

m = mass (kg)

a = acceleration ($m.s^{-2}$)

Hints

- Draw a sketch diagram of the situation and add in all forces and acceleration
- Select and state which is the positive direction
- Do not change the sign of the direction
- Find the resultant force by adding forces or components of forces together

Test Yourself

Question 1

An object of mass 2kg is pulled across a rough surface at constant velocity. Which of the following statements is true?

A. The object has zero acceleration
B. The applied force causes the object to accelerate
C. The object moves further in the 1st second time interval than in the 5th second time interval
D. The applied force is greater than the frictional force

Question 2

An object experiences a positive uniform acceleration. This means that

A. The displacement in the 1st time interval is greater than the displacement in the 4th time interval
B. The displacement in the 1st time interval is the same as the displacement in the 4th time interval
C. The velocity in the 1st time interval is greater than the velocity in the 4th time interval
D. The velocity in the 1st time interval is less than the velocity in the 4th time interval

Question 3

An object moving at constant velocity experiences a small negative uniform acceleration. This means that

A. The object has changed direction
B. The object continues to move in the same direction until it reaches zero velocity.
C. A net force acts on the object, in the opposite direction to its acceleration
D. The displacement of the object in each time interval remains the same

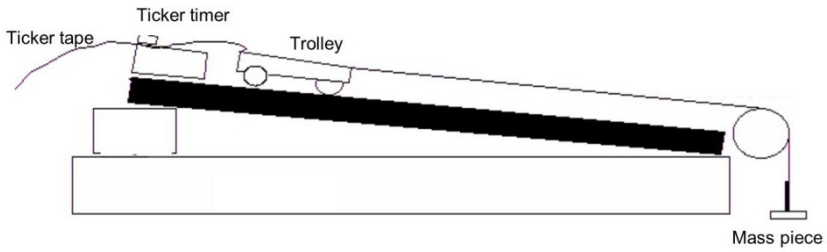
Question 4

Two horizontal forces, F_1 =15N and F_2 =5N, act on a trolley of mass 5kg in opposite directions. What is the magnitude of the acceleration of the trolley?

A. 0 $m.s^{-2}$
B. 1 $m.s^{-2}$
C. 2 $m.s^{-2}$
D. 3 $m.s^{-2}$

Question 5

In an experiment to verify the relationship between acceleration and net force as described in Newton's 2nd Law. The apparatus used is illustrated below:



In the first run, a 5 kg trolley is accelerated down a friction compensated track by a 100g mass piece suspended over the end of the track. For the second run, the mass of the trolley is reduced to 4,8kg. What must the mass of the suspended mass piece be?

A. 0,1kg
B. 0,2kg
C. 0,3kg
D. 0,5kg

Question 6

Give one word or phrase for the following:

a.) The force required to accelerate 1kg object over a frictionless surface with an acceleration of 1 $m.s^{-2}$

b.) An object will remain at rest or in a state of constant velocity unless acted on by a resultant force.

c.) The rate of change of velocity

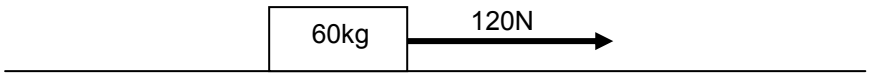
d.) The velocity of an object at a specific time

e.) If body A exerts a force on body B, the body B exerts a force on body A that is equal in magnitude but opposite in direction to the original force.

Improve your Skills

Question 1

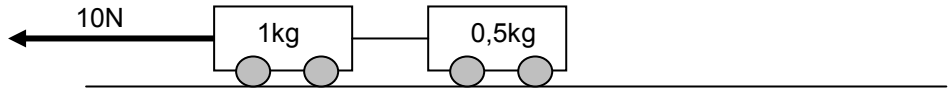
A box with a mass of 60 kg is pulled along a rough floor by a boy exerting a force of 120N.



a.) Draw a force diagram to show all the forces acting on the box. Label the forces
b.) Calculate the magnitude of the frictional force caused by the floor if the acceleration of the box is 1,5 $m.s^{-2}$

Question 2

A 10 N force is used to pull dynamics trolley A along a frictionless horizontal surface. Trolley A is attached by a light, non-elastic string to trolley B. Trolley A has a mass of 1 kg and trolley B has a mass of 500g.



a.) Calculate the acceleration of Trolley A

b.) Calculate the tension (F_T) in the string that joins Trolley A to Trolley B.

Question 3

A helicopter lifts a load vertically off the ground. It accelerates at 4,9 $m.s^{-2}$ vertically upwards.

a.) Draw a labelled free body diagram to show the forces acting on the load
b.) Calculate the lifting force exerted by the rope on the load, if the mass of the load is 120 kg.