1. Connected Particles

When we have multiple connected objects moving in the same straight line, **they can be considered either as two separate particles, or as a single particle**, but **all forces** acting on the particle must be considered.

What assumptions are made?

Example *(EdExcel M1 June 2009 Q6)*

A car of mass 800 kg pulls a trailer of mass 200 kg along a straight horizontal road using a light towbar which is parallel to the road. The horizontal resistances to motion of the car and the trailer have magnitudes 400 N and 200 N respectively. The engine of the car produces a constant horizontal driving force on the car of magnitude 1200 N. Find

(a) the acceleration of the car and trailer,

(3)

(b) the magnitude of the tension in the towbar.

(3)

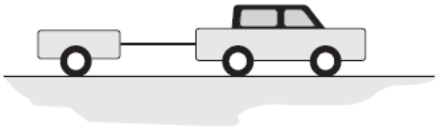
The car is moving along the road when the driver sees a hazard ahead. He reduces the force produced by the engine to zero and applies the brakes. The brakes produce a force on the car of magnitude F newtons and the car and trailer decelerate. Given that the resistances to motion are unchanged and the magnitude of the thrust in the towbar is 100 N,

(c) find the value of F.

(7)

Test Your Understanding

4. A car of mass 900 kg is towing a trailer of mass 100 kg along a horizontal road. There are resistance forces of 60 N and 20 N acting on the car and the trailer respectively.

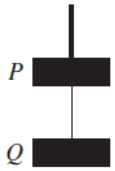


(a) The engine applies a driving force of 480 N. Calculate
(i) the acceleration of the car and trailer
(ii) the tension in the towbar. (4)

(b) The brakes are now applied, bringing the car to a halt from a speed of 10 ms^{-1} in a distance of 50 m. Find
(i) the magnitude of the braking force
(ii) the force in the towbar. (6)

Vertical Example

A brick P of mass 4 kg is suspended by a vertical, light inextensible string. Another brick Q of mass 6 kg is suspended from P by another light inextensible string, as shown in the diagram. The bricks start from rest and are then raised 2 m in 4 seconds. Find the tension in each string.



Example – Using Newton's 3rd Law for Stacked Objects

Newton's 3rd Law: For every action there is an equal and opposite reaction

Therefore when two bodies A and B are in contact, if body A exerts a force on body B, then body B exerts a force on body A that is equal in magnitude and acts in the opposite direction.

[Textbook] A light scale-pan is attached to a vertical light inextensible string. The scale-pan carries two masses A and B. The mass of A is 400g and the mass of B is 600g. A rests on top of B, as shown in the diagram.

The scale-pan is raised vertically, using the string, with acceleration 0.5 ms^{-2}.

(a) Find the tension in the string.
(b) Find the force exerted on mass B by mass A.
(c) Find the force exerted on mass B by the scale-pan.

Test Your Understanding – Motion of a Lift *(EdExcel M1 May 2013 Q2)*

A woman travels in a lift. The mass of the woman is 50 kg and the mass of the lift is 950 kg. The lift is being raised vertically by a vertical cable which is attached to the top of the lift. The lift is moving upwards and has constant deceleration of 2 m s^{-2}. By modelling the cable as being light and inextensible, find

(a) the tension in the cable,

(3)

(b) the magnitude of the force exerted on the woman by the floor of the lift.

(3)

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