

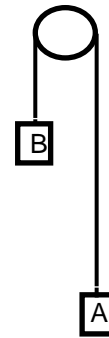
Section 3: Connected objects

Exercise level 1

Take $g = 9.8 \text{ ms}^{-2}$ throughout this exercise.

- A man of mass 72 kg is standing in a lift.
 - Draw a diagram to show the forces acting on the man.
Find the normal reaction of the floor of the lift on the man in the following cases:
 - The lift is moving upwards with a constant speed of 4 m s^{-1} .
 - The lift is moving upwards with an acceleration of 2 m s^{-2} upwards
 - The lift is moving upwards with an acceleration of 3 m s^{-2} downwards
 - The lift is moving upwards and slowing down with a deceleration of 2 m s^{-2}
 - The lift is moving downwards and slowing down with a deceleration of 3 m s^{-2} .

- Masses A of 150 g and B of 250 g are attached to the ends of a light, inextensible string passing over a smooth pulley as shown in this diagram.



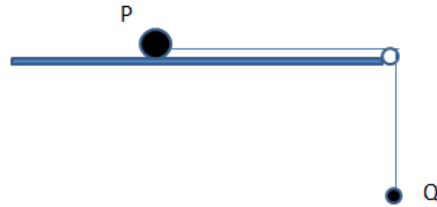
- Initially B is held at rest 1 m above the ground. B is then released.
 - Draw a diagram for each mass showing the forces acting on it and the direction of its acceleration before B hits the ground.
 - Use Newton's second law to find the equation of motion for each mass in the direction it moves.
 - Find the acceleration of each mass.
 - Find the tension in the string.
 - Find the time taken before B hits the ground.
- Two particles, mass 3 kg and 9 kg respectively, are connected by a light inextensible string passing over a smooth pulley. Both masses hang vertically. Find the tension in the string and the acceleration when the system is released from rest.
 - An engine of mass 60000 kg pulls a truck of mass 12000 kg along a horizontal track. The engine experiences a resistance to motion of 80 N per kg and the truck a resistance of 50 N per kg. Given that the train is travelling at a constant speed, find the tractive force of the engine and the tension in the coupling between engine and truck.
 - A particle of mass 4 kg rests on a smooth horizontal table. It is connected by a light inextensible string which passes over a smooth pulley at the edge of the table to a mass of 1.5 kg that hangs freely. The system is released from rest. Find the acceleration and the tension in the string.
 - An engine of mass 50 tonnes pulls a train of mass 200 tonnes along a horizontal track. The resistance to the motion for the engine is 3000 N and the resistance to motion for the train is 7000 N. The engine is exerting a driving force of 60000 N. Find the acceleration of the system and the tension in the coupling between the engine and the train.



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Exercise

7. A cube of mass 7 kg rests on top of a horizontal table. A smaller cube of mass 3 kg is placed on top of the 7 kg cube. Find the reaction between the two cubes and that between the larger cube and the table.
- 8.



Two particles P and Q, of masses 1.9 kg and 0.4 kg respectively, are connected by a light inextensible string. P is held on a smooth horizontal table with the string taut and passing over a small smooth pulley fixed at the edge of the table. Q is at rest vertically below the pulley. P is released. Find the acceleration of the particles and the tension in the string.