

FORCES, CIRCULAR MOTION, AND GRAVITY

In-Class Example Problems

WEIGHT AND NORMAL FORCE:

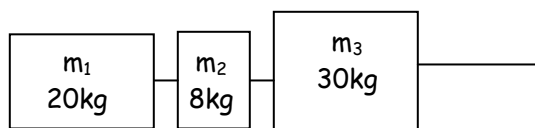
1. a. A 5kg rock is sitting on a scale on the floor of an elevator. Assuming the elevator is at rest, find the weight of the rock, and the normal force exerted on the rock by the scale.

b. Now the elevator accelerates upward at 2.3m/s^2 . Find the weight of the rock and normal force acting on the rock.

2. A fisherman pulls a fish vertically out of the water with an acceleration of 2.5m/s^2 , while using very light fishing line that has a breaking strength of 22N. Unfortunately, the line snaps under these conditions. What do you know about the mass of the fish?

CONNECTED OBJECTS:

3. a. Three objects are connected as shown in the picture, and are moving across a frictionless surface. If a 50N horizontal force pulls the front block to the right, find the acceleration of the whole system.

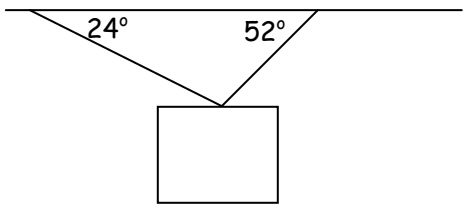


- b. Now find the tension in the cord connecting the front 2 blocks.

4. Two objects are connected by a light string that runs over a lightweight, frictionless pulley. If the two objects have masses of 5kg and 8kg, find the acceleration of the system.

ANGLE STUFF:

5. An object is supported at rest by cables as shown in the picture. If the tension in the right cable is 250N, find the tension in the other cable and the weight of the object.



6. A boy on a train is playing with a yo-yo when the train begins accelerating. If the dangling 32g yo-yo makes an angle of 34° with the vertical as it accelerates horizontally (as part of the train), find the yo-yo's rate of acceleration.

COEFFICIENT OF FRICTION:

7. A certain 350g block of wood on a horizontal countertop requires a 2.5N force to overcome static friction and begin its motion, and a 1.8N force to move at a constant speed. Calculate the coefficient of static friction between the block and countertop.

8. A large steel crate ($m=900\text{kg}$) is being pushed horizontally across a steel floor by an 8000N force directed along the horizontal. Find the acceleration of the crate.

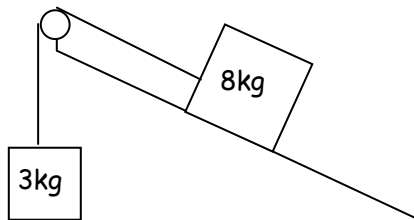
9. A suitcase with a mass of 35kg is pushed at a constant velocity across a horizontal floor, by a 40N force directed at an angle of 15° below the horizontal. Calculate the coefficient of kinetic friction between the suitcase and floor.

OBJECTS ON INCLINES:

10. A 5kg toy is at rest on a 34° incline. Calculate the normal force acting on toy, as well as the force of static friction that is keeping the toy at rest.

11. A 1200kg car is on a 20° frictionless incline. Find the normal force and the acceleration of the car down the ramp.

12. Two boxes are connected by a cable that passes over a frictionless pulley, as shown in the picture. The bigger box, of mass 8kg, is on a 50° frictionless incline, while the smaller 3kg mass hangs over the pulley and dangles in mid-air. Find the acceleration of the 3kg mass.



FRICTION AND INCLINES TOGETHER, OH MY!

13. A 30kg brick sits on a 49° incline. If the coefficient of kinetic friction between the brick and the incline is 0.38, what force would be necessary to pull the brick up the incline at a constant speed? (Assume this force is directed parallel to the incline.)

CENTRIPETAL ACCELERATION AND FORCE:

14. An airplane is flying in a horizontal circle at a speed of 120m/s. The pilot doesn't want her radial (centripetal) acceleration to exceed 6g. What is the minimum radius of the circular path she must follow?
15. A 40kg child takes a ride on a roller coaster. A certain portion of the ride involves vertical loops (that can be approximated as circular), each with a diameter of 18m. If the coaster passes through the loops at a rate of 25m/s, what force does the seat exert on the child at the lowest point of one of the loops?

What force is exerted on the child at the highest point of the ride?

What is the slowest speed at which the coaster can round the top of the curve without 'dropping' the child out of her seat?

16. A speck of dried clay sits at the edge of a potter's wheel of radius 15cm. If the speck slips off when the wheel's rotation rate reaches 40rpm, calculate the coefficient of static friction between the clay and wheel.

GRAVITATION:

17. Use Newton's Law of Universal Gravitation to find the force of gravity acting on a 100kg filing cabinet at sea-level on Earth.

What force of gravitational attraction is that cabinet exerting on the Earth?

GRAVITY CAN CAUSE CENTRIPETAL ACCEL?

18. A 1200kg satellite is set into a circular orbit at 1500km above the surface of the Earth. Find the orbital speed of the satellite.

What is the period of orbit for that same satellite?