

Force Problems – Set 1

1

You toss a rock straight up into the air by placing it on the palm of your hand (you're not gripping it) then pushing your hand up very rapidly.

Draw *Free Body Diagrams* for the rock at the following points along its trajectory. Be sure to include a coordinate system on your diagram.

The lengths of the vector arrows should indicate the magnitudes of the applied forces.

a) As you hold the rock at rest on your palm, before moving your hand.

b) As your hand is moving up but before the rock leaves your hand.

c) One-tenth of a second after the rock leaves your hand.

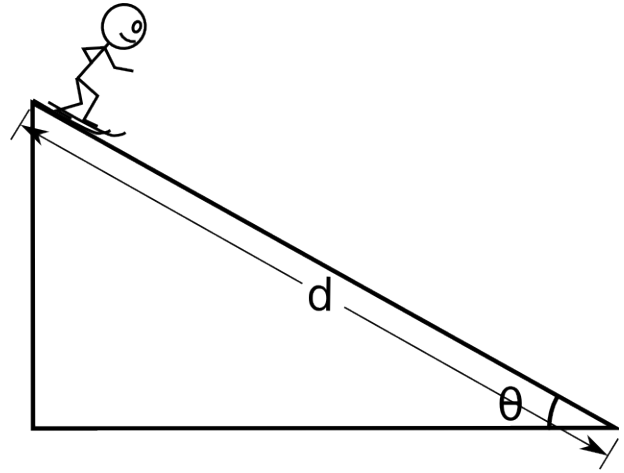
d) At the peak of the rock's trajectory

e) After the rock has reached its highest point and is now falling straight down.

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A very talented stick skier is accelerating down a VERY slippery slope. (there's no friction, that's next period).

- List all of the forces on the skier.
- In what direction will the skier accelerate? Draw the acceleration vector in the picture at the right.
- Draw a *Free Body Diagram* for the skier.
- Choose a coordinate system and superimpose it on your free body diagram.
- Write the x and y versions of Newton's Second Law for the skier based on your coordinate system. Solve these equations for acceleration.
- What's the skier's velocity after accelerating a distance d ?



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For the following situations, draw free-body diagrams to indicate all forces acting on the object(s) in question. *Indicate relative magnitudes of forces by drawing long, short, or equal-length vectors.*

a) An elevator suspended by a cable is descending at a constant velocity.

b) An elevator suspended by a cable is ascending at a constant velocity.

c) A compressed spring is pushing a block across a rough horizontal table (there's friction).

d) A block is resting on a rough incline plane without sliding.

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A 30-kg child is seated in a swing of negligible mass. How much horizontal force is required to pull the child and swing aside so that the support rope makes an angle of 32° with the vertical? (The child is held fixed in that position.)

a) What is the child's acceleration?

b) Draw a free body diagram of the system. Choose a coordinate system.

c) Using the picture from part b, write Newton's Second Law for the x-axis and the y-axis. Solve these equations for the required force.

A terrible earthquake has happened in San Francisco right in the middle of a critical hockey tournament. As a result of the quake, the ice rink is tilted 15° from horizontal. The 80 kg goalie begins to slide down the slope uncontrollably from his net directly into the opposing goalies net. How fast is he when he crosses the opposite goal line 53 m away?

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A block is given an initial velocity of 5 m/s up a frictionless 20° incline. How far up the incline does the block slide before coming to rest?

a) Draw a free body diagram of the block

b) Put a coordinate system on your free body diagram and, from the resulting picture, write Newton's second law for the x axis and for the y axis. Solve these equations for the acceleration of the block.

c) Use the kinematics equations and the acceleration from part b to find the distance.

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A 52 kg circus performer slides down a rope that will break if the tension exceeds 425 N.

- a) What happens if the performer hangs stationary from the rope?
- b) At what acceleration will the performer just avoid breaking the rope?