Tutorial 1

Phys 201 Examples

Examples
PHYS 201 - General Physics
Eastern Oregon University

Chapter 1
Systems of Measurement

Example 1.0:

Unit Conversion

What is the equivalent to 90 km/hr in

a) *m/s?*

b) *mi/hr?*

Solution 1.0:

♣

Example 1.1:

Unit Conversion

Which is longer, a milli-light-second or the diameter of the earth?

Solution 1.1:

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Chapter 2
Motion in 1D

Example 1.2:

Constant Acceleration Motion

You are driving at 30 mph. Seeing a stop sign in front of you, you apply the brakes. If you decelerate at a constant rate and stop at the stop sign in 6 sec.,

a) *What is your rate of deceleration (in $mi/hr \cdot s$)?*

b) *How far in front of you was the stop sign when you started braking (in feet)?*

Solution 1.2:

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Example 1.3:

1D Projectile Motion

A ball is thrown straight up with an initial speed of 30 m/s.

a) How long does it take for the ball to reach its highest point?

b) How high does it go?

Solution 1.3:

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Example 1.4:

1D Projectile Motion

Superman jumps off a 10-m high diving board giving himself a 9.8 m/s initial velocity up.

a) How long does it take for him to reach his maximum height?

b) How high does he go?

c) How long does it take for him to reach the water?

d) What is his velocity when he hits the water?

Solution 1.4:

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Chapter 3
Motion in 2D and 3D

Example 1.5:

Orienteering using Vectors

You walk 3 km east and then 4 km north, what is your resultant displacement?

Solution 1.5:

♣

Example 1.6:

Orienteering using Vectors

You walk 3 km east and then 4 km northwest, then 4 km north, what is your resultant displacement?

Solution 1.6:

♣

Example 1.7:

Orienteering using Vectors

You walk 3 km east and then 4 km headed 60° *north of east. What is your resultant displacement, and angle?*

Solution 1.7:

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Example 1.8:

2D Motion

With respect to some fixed reference point, a sailboat is located at (110, 218) m at t=60 s. Two minutes later it is located at (130, 205) m. What is the magnitude and direction of average velocity? Express in miles/hour.

Solution 1.8:

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Example 1.9:

2D Motion

The previous sailboat then changes position according to

$$x(t) = 100 + \frac{1}{6}t \quad (m)$$

$$y(t) = 200 + \frac{1080}{t} \quad (m)$$

Find the instantaneous velocity for this time interval.

Solution 1.9:

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Example 1.10:

2D Motion

A car is traveling east at 60 km/hr. It rounds a curve, and 5 s later it is traveling north at 60 km/hr. Find the average accelation of the car.

Solution 1.10:

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Example 1.11:

Relative Motion

A pilot wants to fly a plane due north. The speed of the plane relative to the air is 200 km/hr, and the wind is blowing west to east at 90 km/hr.

a) In which direction should the plane head?

b) How fast does the plane travel relative to the ground?

Solution 1.11:

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Example 1.12:

2D Projectile Motion

Another joyful physics graduate throws his cap into the air with an initial velocity of 24.5 m/s at 36.9° *from the horizontal. Neglecting air resistance, find*

a) the total time the cap is in the air.

b) the total horizontal distance traveled.

Example 1.12:

2D Projectile Motion

You hit a golf ball, and it leaves your club with a velocity of 30 m/s at an angle of 30°.

a) How far does the ball go?

b) How high does the ball get?

c) How long does it take the ball to get there?

d) What approximations have we made?

Solution 1.12:

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Example 1.13:

2D Projectile Motion

As a gunnery sergeant in charge of catapults for Hannibal, you are attempting to hurl a projectile to the top of a wall. The front of the wall is 50 m from your catapult. The wall is 10 m high and 20 m wide. If the catapult can only hurl objects at $53°$*, what range of initial speeds will allow the projectile to hit the top of the wall?*

a) How far does the ball go?

b) How high does the ball get?

c) How long does it take the ball to get there?

d) What approximations have we made?

Solution 1.13:

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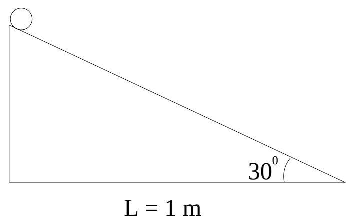
Chapter 4
Newton's Laws

Example 1.14:

Free Body Diagrams

A barrel is let go from rest at the top of an inclined plane, as shown: Determine the speed of the barrel at the bottom of the ramp.



Solution 1.14:

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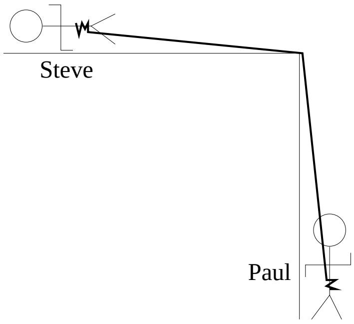
Example 1.15:

Problem with 2 or more objects

Steve is trying to save Paul...



but in the absence of friction, they're both going down.

a) What is their acceleration down?

b) What is the tension in the rope?

Solution 1.15:

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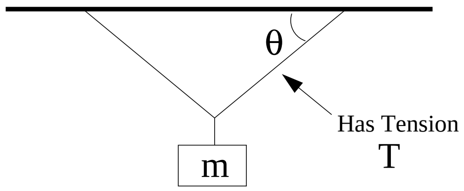
Example 1.16:

Problem with 2 or more objects

For a picture on the wall



a) *Obtain an expression for the tension, T, in terms of the angle θ and the mass of the picture.*

b) *What is the tension if $\theta = 30°$, and the mass is 2 kg?*

Solution 1.16:

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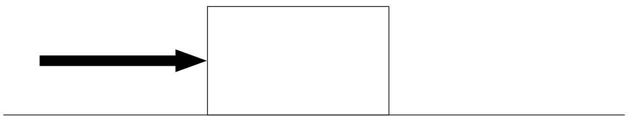
Chapter 5
Applications of Newton's Laws

Example 1.17:

Static Friction

Consider an applied force on an object that is to move over a non-smooth surface.



If the coefficient of static friction is 0.8, how much force must be applied to move a 100 kg object?

Solution 1.17:

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Example 1.18:

Kinetic Friction

If the above object has a kinetic friction of 0.4, and you push it twice as hard as required to get it moving, what is the acceleration of the object?

Solution 1.18:

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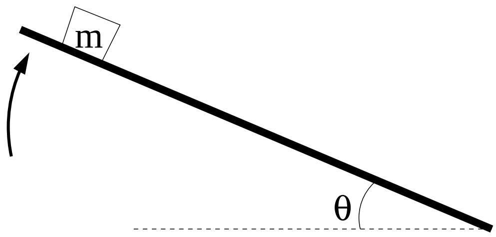
Example 1.19:

Static Friction

If the coefficient of friction between the board and the mass is μ_s, at what angle does the mass begin to move.



Solution 1.19:

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Example 1.20:

Kinetic Friction

You (mass m) are holding a baby buggy (mass M, initial speed v_0), which is a distance D from a large hole in the ice. The coefficient of friction between you and your ice skates is μ_k. Your job is to stop the buggy from going into the hole.

a) *What is the least value of D such that you stop the buggy before it reaches the hole?*

b) *What force do you exert on the buggy?*

Solution 1.20:

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Example 1.21:

Circular Motion

A satellite moves at constant speed in a circular orbit about the center of the earth near the surface of the earth. It its acceleration is g, find

a) its speed

b) its period of revolution

Solution 1.21:

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Example 1.22:

Circular Motion

You swing a pail of water in a vertical circle of radius r. The speed of the pail is v_t at the top of the circle.

a) *Find the normal force of the pail on the water at the top of the circle.*
b) *Find the minimum value of v_t for the water to remain in the pail.*
c) *Find the force exerted by the pail on the water at the bottom of the circle, where the pail's speed is v_b.*

Solution 1.22:

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Example 1.23:

Circular Motion

A tetherball of mass m is suspended from a rope of length L and travels at constant speed in a horizontal circle of radius r. The rope makes and angle θ with respect to the verical given by $\sin(\theta) = r/L$.

a) *Find the tension in the rope.*

b) *Find the speed of the ball.*

Solution 1.23:

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Example 1.24:

Circular Motion

In a skid test, a BMW 530i was able to travel in a circle of radius 45.7 m in 15.2 s without skidding.

a) What was the average speed?

b) Assuming v to be constant, what was the centripetal acceleration?

c) Again assuming v to be constant, what was the minimum value of μ_k?

Solution 1.24:

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Chapter 6
Work and Energy

Example 1.25:

Work due to a Constant Force

A truck of mass 3000 kg is to be loaded onto a ship by a crane that exerts an upward force of 31 kN on the truck. This force, which is just strong enough to get the truck started upward, is applied over a distance of 2 m.

a) *Find the work done by the crane.*

b) *Find the work done by gravity.*

c) *Find the upward speed of the truck after 2 m.*

Solution 1.25:

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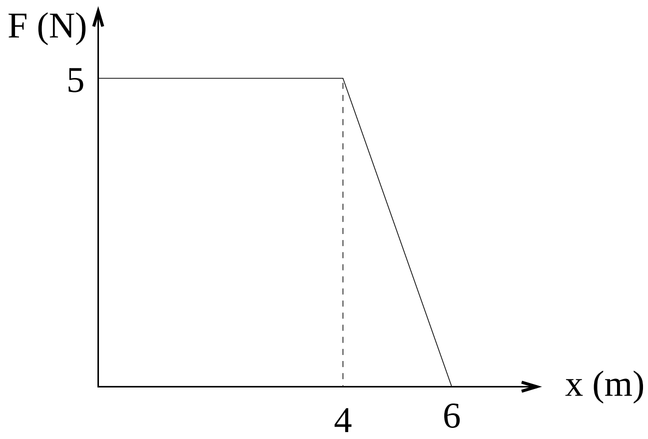
Example 1.26:

Work due to a Variable Force

The following force is applied to a 3 kg mass:



If the initial speed of the mass is zero, how fast is the mass moving at $x = 6$ m?

Solution 1.26:

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Example 1.27:

Work due to a Vector Force

A particle is given by a displacement

$$\mathbf{\Delta} s = 2\mathbf{u_x} - 5\mathbf{u_y} \quad (m)$$

along a straight line. During the displacement, a constant force

$$\mathbf{F} = 3\mathbf{u_x} + 4\mathbf{u_y} \quad (N)$$

acts on the particle.

a) Find the work done by the force.

b) Find the component of the force in the direction of the displacement.

Solution 1.27:

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Example 1.28:

Power

A small motor is used to operate a lift that raises a load of bricks weighing 800 N to a height of 10 m in 20 s. What is the minimum power the motor must produce?

Solution 1.28:

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Example 1.29:

Power

A new Cadillac can accelerate from 0 to 96 km/h in 6.5 s. How quickly would you expect it to be able to accelerate from 80 km/h to 112 km/h? (Hint: assume constant power output).

Solution 1.29:

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Chapter 7
Conservation of Energy

Example 1.30:

Conservation of Energy

Standing near the edge of the roof of a 12 m high building, you kick a ball with an initial speed of $v_i = 16\ m/s$ *at an angle of* $60°$ *above the horizontal. Neglecting air resistance,*

a) *Find how high above the building the ball rises.*

b) *Find its speed just before it hits the ground.*

Solution 1.30:

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Example 1.31:

Pendulums

A pendulum consists of a bob of mass m attached to a string of length L. The bob is pulled aside so that the string makes an angle θ_0 with the vertical and is released from rest.
Find expressions for

a) the speed v at the bottom of the swing.

b) the tension in the string at that time.

Solution 1.31:

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Example 1.32:

Spring Potential Energy

A 2 kg block is pushed against a spring that has a spring constant of 500 N/m, compressing the spring 20 cm. The block is then released and the spring projects is along a frictionless horizontal surface and then up a frictionless incline of angle $45°$*. How far up the incline does the block travel before momentarily coming to rest?*

Solution 1.32:

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Example 1.33:

Energy Dissipation

A child of mass m *goes down a rough slide inclined at* $30°$*. If* $\mu_k = 0.2$*, and the height of the slide is 4 m,*

a) *how fast is the child traveling at the bottom of the slide?*

b) *How much energy has been dissipated?*

c) *Where did it go?*

Solution 1.33:

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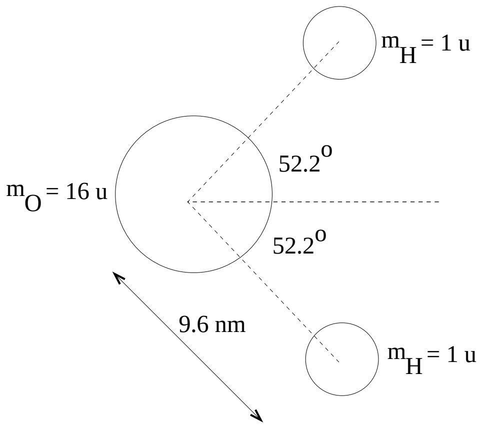
Chapter 8
Systems of Particles
&
Conservation of Momentum

Example 1.34:

Center of Mass

Find the center of mass of a water molecule:



Solution 1.34:

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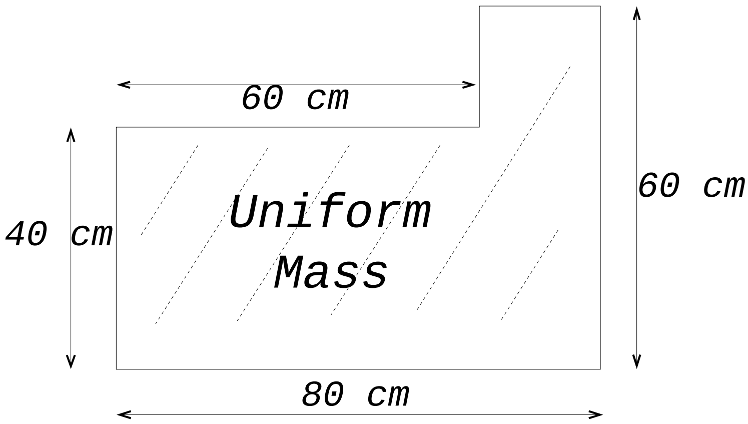
Example 1.35:

Center of Mass

Find the center of mass of the following irregular object with uniform mass:



Solution 1.35:

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Example 1.36:

Exploding Projectiles

A projectile is fired into the air over level ground with an initial velocity of v_0 at and angle θ_0 to the horizontal. At its highest point, it explodes into two fragments of equal mass. One fragment falls straight down to the ground. Where does the other fragment land?

Solution 1.36:

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Example 1.37:

Motion in a Frictionless Environment

You (mass 80 kg) and Bubba (mass 120 kg) are in a rowboat (mass 60 kg) on a calm lake. You are at the center, rowing, and he is at the back, 2 m away. You get tired and stop rowing. Bubba offers to row, and after the boat comes to a rest, you change places. How far does the boat move?

Solution 1.37:

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Example 1.38:

Conservation of Momentum

During a spacewalk, astronaut Ripley (80 kg) throws a wrench (1 kg) at a velocity of 2 m/s. What is her velocity?

Solution 1.38:

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Example 1.39:

Impulse

You shatter a concrete block with your open hand. If the mass of your fist is 0.7 kg, and velocity of your open hand is 5 m/s, and the stopping distance is 6 mm,

a) *What is the impulse?*

b) *What is the collision time?*

c) *What is the average force?*

Solution 1.39:

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