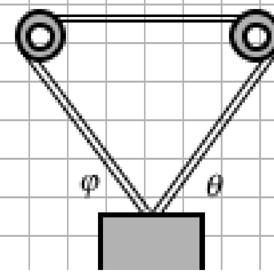
All problems:

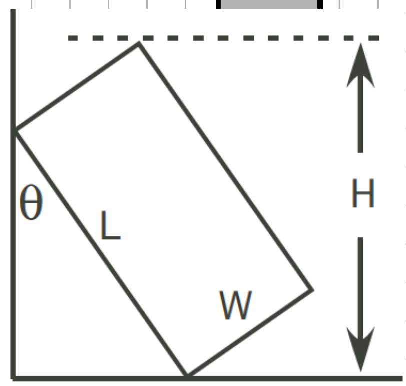
1. The box of mass 6 kg hangs at rest.



a. Prove that $\theta = \varphi$.

b. Determine the tension in the rope, if $\theta = 50°$.

10. A rectangular box of length L and width W rests against a wall, making an angle θ with respect to the wall.

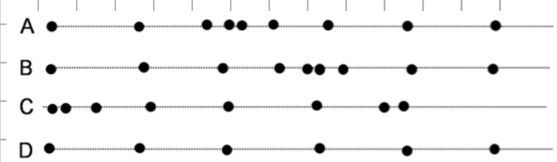


What is the height H of the top edge of the box above the floor?

100. A car starting from rest speeds up to 30 $\frac{m}{s}$ with constant acceleration in 15 seconds. Then, it travels at 30 $\frac{m}{s}$ for 10 seconds. Finally, it brakes to a stop in 30 seconds with constant acceleration.

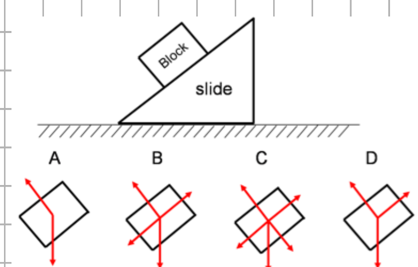
How far does it travel in the 55 second time period?

110. Driving a car in the positive x direction at a speed of 60 mph, Mary tests her brakes by coming to a complete stop in 4 seconds. Then she accelerates to her original speed of 60 mph in 8 seconds. A motion diagram is created by illuminating her car with a strobe at 2 second intervals.



Which of the following best represents the correct diagram? Marys car is represented by a dot.

120. A block sits at rest and stays at rest on a slide with frictional surfaces. Each red arrow represents a force. Observe their number and direction, but ignore their lengths.

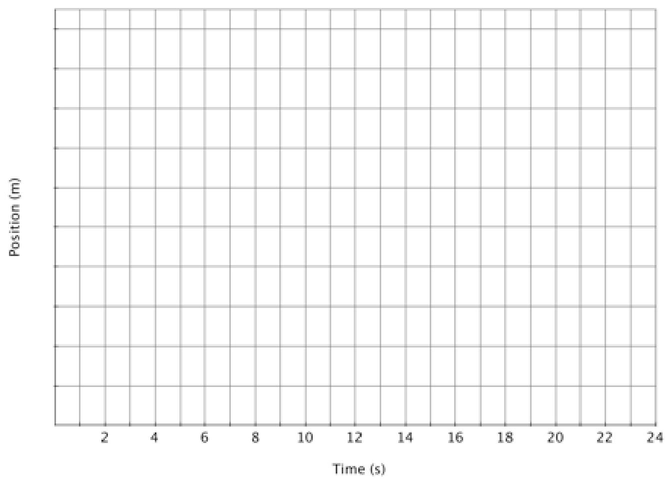


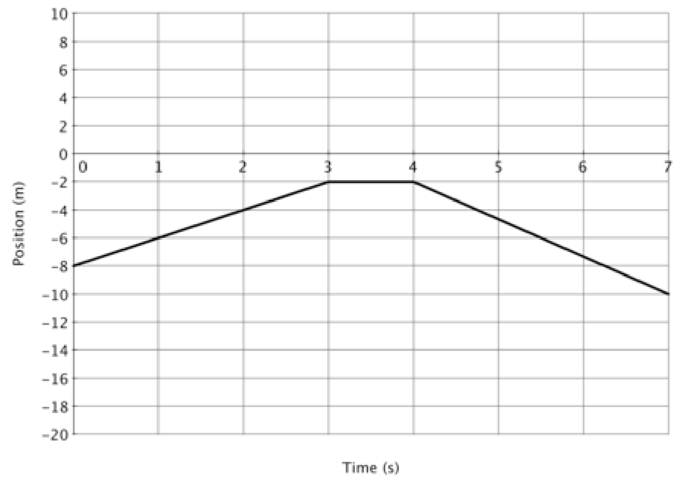
Which of the following sketches most closely resembles the correct free body diagram for all forces acting on the block?

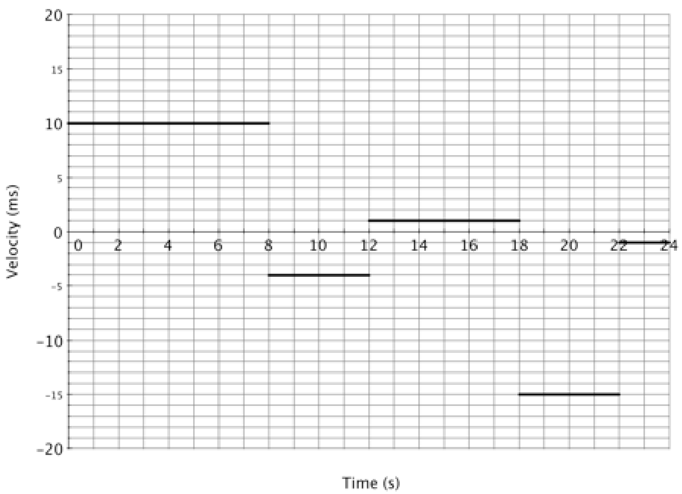
130. Gaeta's Raptor is drifting away from Galactica at a speed of 200 meters per second, while the Galactica drifts away from the Raptor at a speed of 75 meters per second. The two ships are initially 300 km away from each other.

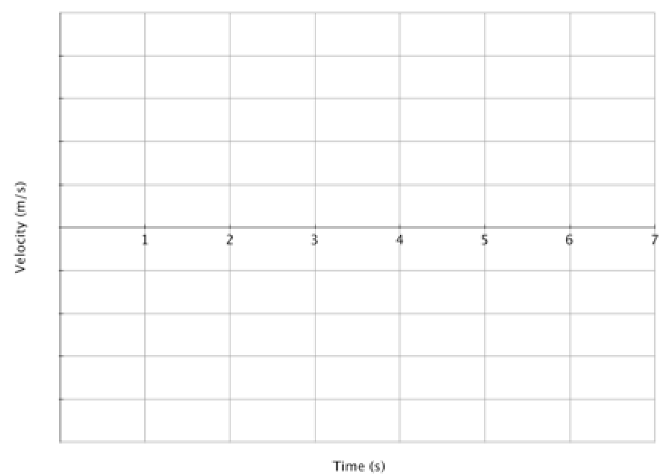
How much time will pass before they are 600 km away from each other, and communication is lost?

140. Draw the missing graphs.









150. Creed and Kevin find some bikes by the loading dock, and devise a competition: they use an 8 meter long rope to tie their bikes together and set up next to each other, facing opposite directions. They begin next to each other, start their pedaling at the same time and ride in opposite directions, trying to see who can ride the furthest before the rope snaps tight. If Creed can pedal his bike at 4 meters per second, and he ends up 5.1 meters away from the starting point, how fast did Kevin pedal? Solve it graphically! Assume that they can get up to speed instantly.

160. As its crew sleeps, the Nostromo glides through space at a brisk clip of 920 $\frac{km}{s}$, relative to a nearby asteroid that it is approaching. The computer uses radar (object detection using radio waves, which travel at the speed of light: 3×10^8 $\frac{m}{s}$) to detect objects in the ship's path. The radio waves are emitted by the ship, bounce off of the asteroid, and return to the ship, where the computer analyzes the results.

Assume that the asteroid begins at the limit of the ship's effective radar range of 2 million km. Once it detects the asteroid, the computer will require 15 minutes to revive the crew.

How much time will the crew have to turn the ship at that point?

170. As its crew sleeps, the Nostromo glides through space at a brisk clip of 920 $\frac{km}{s}$, relative to a nearby asteroid that it is approaching. The computer uses radar (object detection using radio waves, which travel at the speed of light: $3 \times 10^8 \frac{m}{s}$) to detect objects in the ship's path. The radio waves are emitted by the ship, bounce off of the asteroid, and return to the ship, where the computer analyzes the results.

Assume that the asteroid begins at the limit of the ship's effective radar range of 2 million km. Once it detects the asteroid, the computer will require 15 minutes to revive the crew.

How much time will the crew have to turn the ship at that point?

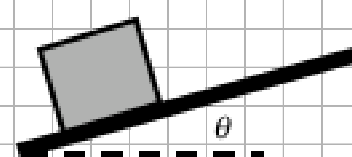
180. A fast RC car (speed: $12 \frac{m}{s}$ and a slower RC car ($8 \frac{m}{s}$) are 40 meters apart. They then drive directly towards each other. Some time after the cars have passed each other, the faster car is 15 meters away from the slower one.

At this moment, how far has the slower one traveled from its starting position?

190. You're driving along the highway at constant speed. When you increase your speed by $7.9 \frac{mi}{hr}$, the time to go one mile decreases by 13 s.

What was your original speed?

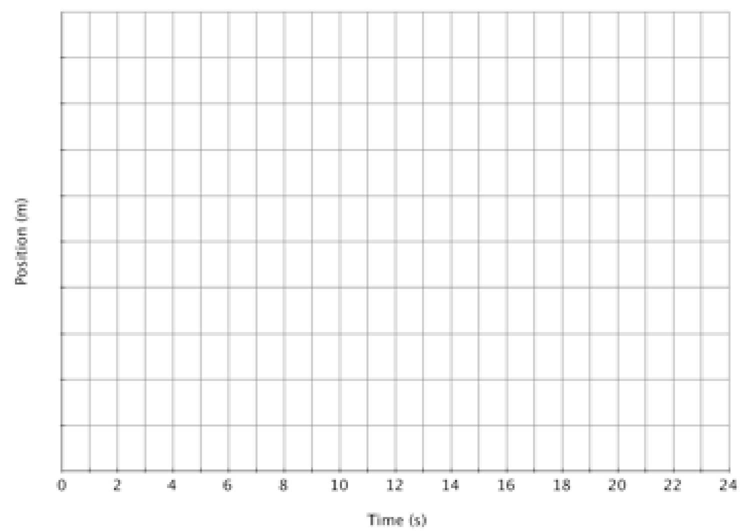
20. A box of mass m slides with an initial velocity of $3 \frac{m}{s}$ down a ramp which is inclined $20°$ from the horizontal. The coefficient of kinetic friction between the ramp and box is .45.

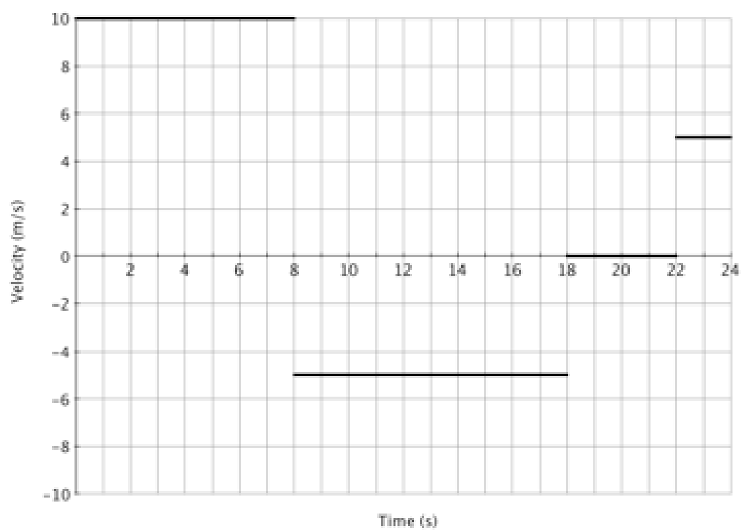


a. Determine the direction and magnitude of the acceleration of the box as it slides down the incline.

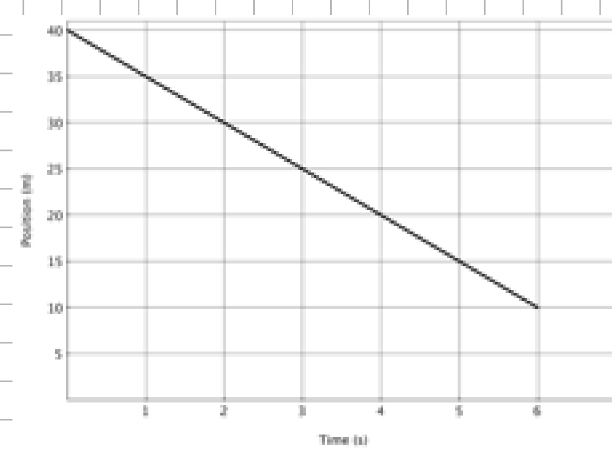
b. Discuss the subsequent motion of the box (qualitatively - no numbers are necessary).

200. Construct a position-vs-time graph for the motion described in the v vs t graph shown below. Assume a position of 10 meters at t = 0. Be sure to number the scale on the position axis..



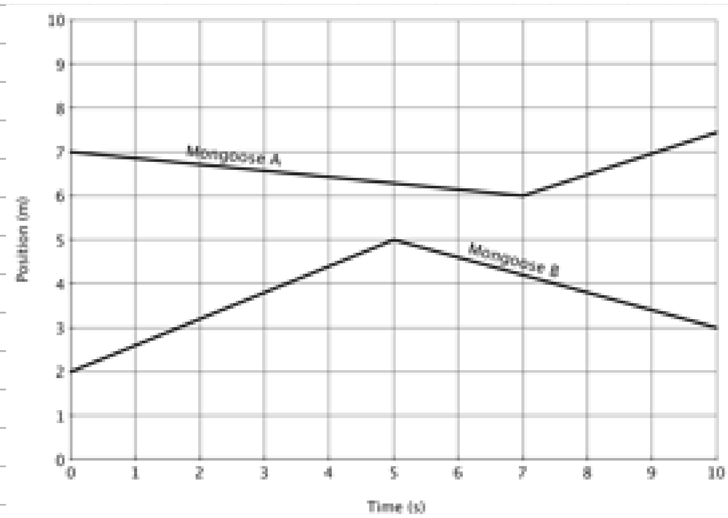


210. Consider an x vs. t graph for Flipper (you know, the dolphin: king of the sea?).



Agebraically determine Flippers position at $t = 10$ s.

220. Two mongooses (mongeese?) walk around on a balance beam:



Describe Mongoose A's motion in words.

Draw a diagram describing Mongoose B's motion.

Which mongoose has the greater average velocity? Defend your answer.

Which mongoose has the greater average speed? Defend your answer.

230. Dori's running at 2 $\frac{m}{s}$ towards Tower Hill's goal line from 20 meters away when Danica lofts a ball over Dori's head. The ball hits the ground 3 meters ahead of Dori and rolls towards the goal line at 4 $\frac{m}{s}$.

It takes 1.5 seconds for Dori to react to the ball; at that point, she begins running faster in order to catch up with the ball before it reaches the goal line.

How fast does she need to run to catch up with the ball before it goes over the goal line? Use graphical problem-solving.

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240. A running back carries the football down the field, running 5.6 $\frac{m}{s}$. The slower safety (running speed: 4.5 $\frac{m}{s}$) runs towards him and tries to tackle him. They begin 22 meters apart and run straight at each other.

How far did the running back go before being tackled, and how much time elapsed before he was tackled? Draw a diagram and use algebraic problem solving.

241. A running back carries the football down the field, running 5.6 $\frac{m}{s}$. The slower safety (running speed: 4.5 $\frac{m}{s}$) runs towards him and tries to tackle him. They begin 22 meters apart and run straight at each other.

How far did the running back go before being tackled, and how much time elapsed before he was tackled? Use graphical problem solving.

250. Two lightcycles (like from Tron - that movie was awesome, and the remake wasn't bad) charge at each other from an initial distance of 112 meters. One lightcyle has a constant speed of 25 $\frac{m}{s}$, and the other a constant speed of 32 $\frac{m}{s}$. They drive at each other, barely missing a head-on collision.

Does CVPM apply? Why or why not?

How long after they begin driving will they pass each other?

260. A ball is thrown vertically into the air. It takes 2.42 seconds for it to reach its peak height of 24.5 meters.

Does CVPM apply? Why or why not?

The ball will take another 2.42 seconds to hit the ground. What is its average velocity over the whole trip?

What was the ball's average speed during the whole trip?

270. Instead of waiting for a soccer pass to come to you, moving towards the ball can greatly increase your chances of not having the ball stolen. A pass is made to you from 25 meters away, with a speed of 13 $\frac{m}{s}$. After a .4 second pause (your reaction time), you begin running towards the ball at 5 $\frac{m}{s}$.

What issues might make a CVPM model of this situation less than faithful to the real situation?

Where (at what position) will you receive the pass?

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What issues might make a CVPM model of this situation less than faithful to the real situation?

Where (at what position) will you receive the pass? Use graphical problem-solving.

280. A dune buggy takes off down the beach, driving 8.9 $\frac{m}{s}$. It then passes a second dune buggy, which sets off after it at a speed of 12.1 $\frac{m}{s}$, after waiting four seconds to start.

Describe some ways in which a CVPM model of this situation would not match reality.

How far has the first dune buggy traveled when it is caught by the second dune buggy?

281. A dune buggy takes off down the beach, driving 8.9 $\frac{m}{s}$. It then passes a second dune buggy, which sets off after it at a speed of 12.1 $\frac{m}{s}$, after waiting four seconds to start.

Describe some ways in which a CVPM model of this situation would not match reality.

For how long has the first dune buggy traveled when it is caught by the second dune buggy?

290. A squirrel runs back and forth on a fence rail. It runs east 4 meters in 1.2 seconds, then pauses for .8 seconds, then runs west 6 meters in 1.3 seconds, and then east 7 meters in 4 seconds.

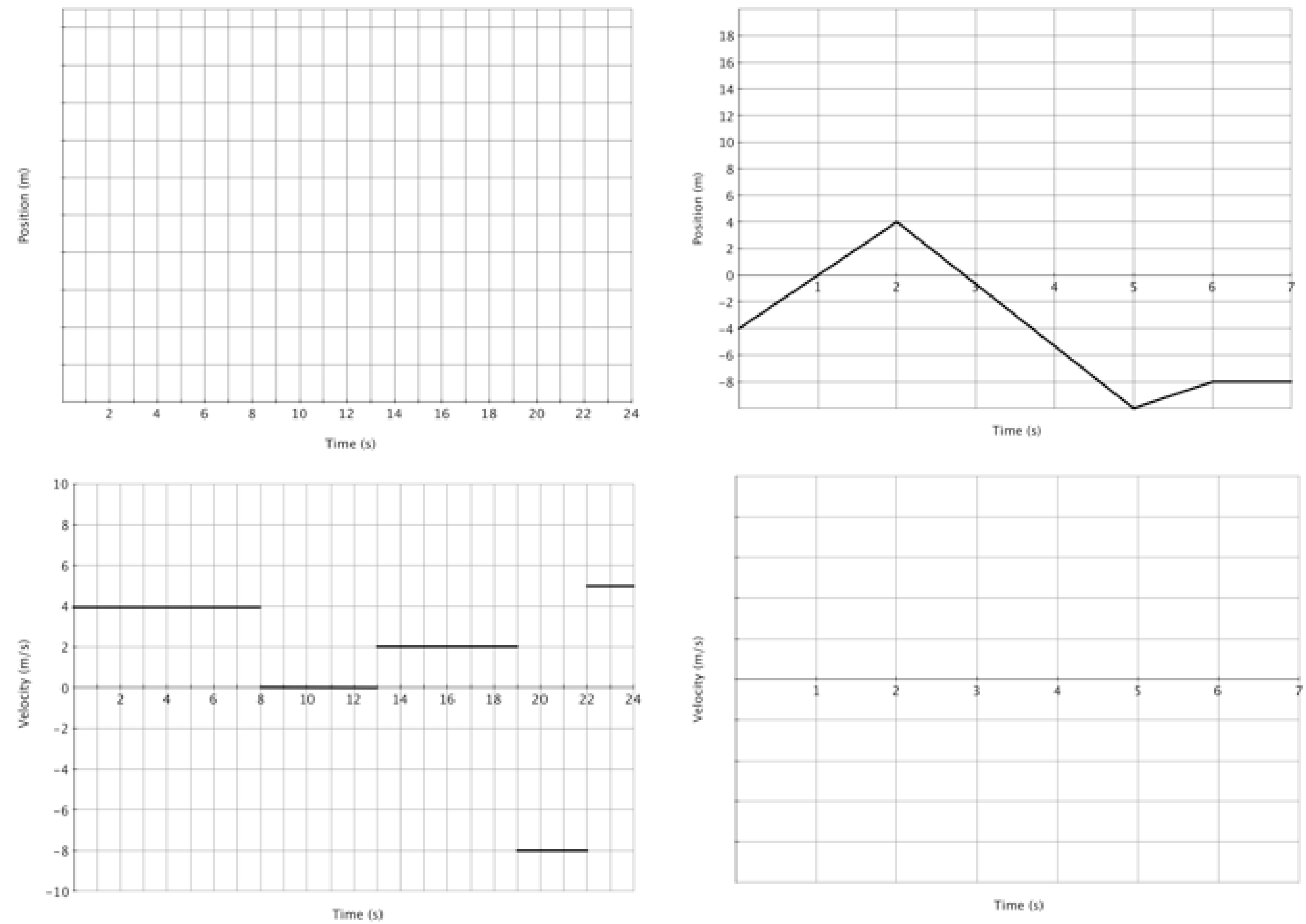
What was the squirrel's maximum speed?

What was the squirrel's displacement during the first 3 seconds?

30. Britney has 25 coins, all nickels (5 cents) and dimes (10 cents). If the nickels were changed to quarters (25 cents) and the dimes changed to nickels, the total value of the coins would remain unchanged.

How many nickels and how many dimes does she have?

300. Draw the corresponding motion graphs.



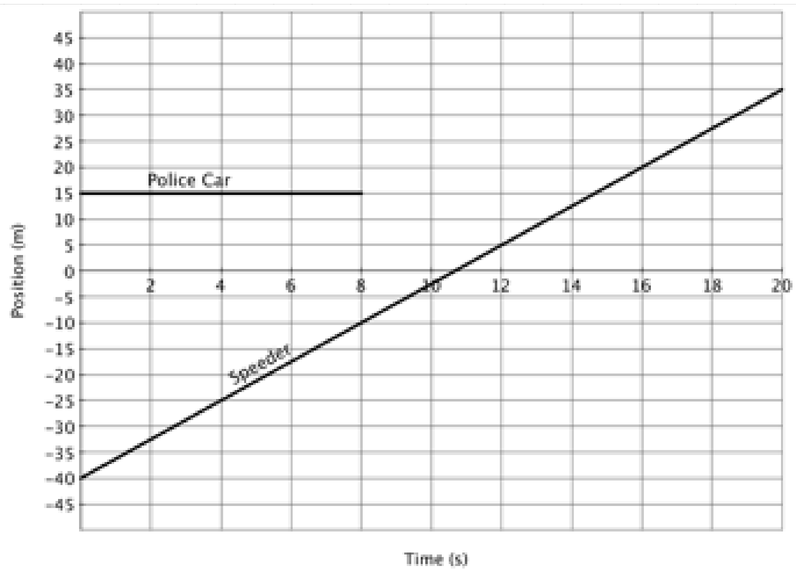
Which motion has the greater (magnitude of) displacement?

Which motion has the greater (magnitude of) average velocity?

Which motion has the greater average speed?

Which motion has the greater distance traveled?

310. An exciting chase has broken out between a toy police car and a toy speeder (running from the police because he foolishly doesnt have any toy insurance).



Describe the segment of the chase shown so far, as accurately as you can (ie: including exact values).

Assuming that the toy police car can get up to speed very quickly, how fast will it need to go in order to catch the speeder before $t = 20$ s?

320. A real police car chases down a stolen sturgeon truck. The police car is sitting by the side of the road when the truck flies by at 35 $\frac{m}{s}$. Assume that the police officer reacts after the truck is 150 meters past her and gets up to speed instantly.

How fast does she need to go in order to catch the truck within 2 minutes? Use graphical problem-solving.

321. A real police car chases down a stolen sturgeon truck. The police car is sitting by the side of the road when the truck flies by at 35 $\frac{m}{s}$. Assume that the police officer reacts after the truck is 150 meters past her and gets up to speed instantly.

How fast does she need to go in order to catch the truck within 2 minutes? Use algebraic problem-solving.

325. A real police car chases down a stolen sturgeon truck. The police car is sitting by the side of the road when the truck flies by at 35 $\frac{m}{s}$. The police officer takes 1.5 seconds to react, but we'll assume that she can get the car up to speed instantly.

how fast will she have to go in order to catch the speeder within 2 km? Use algebraic problem-solving.

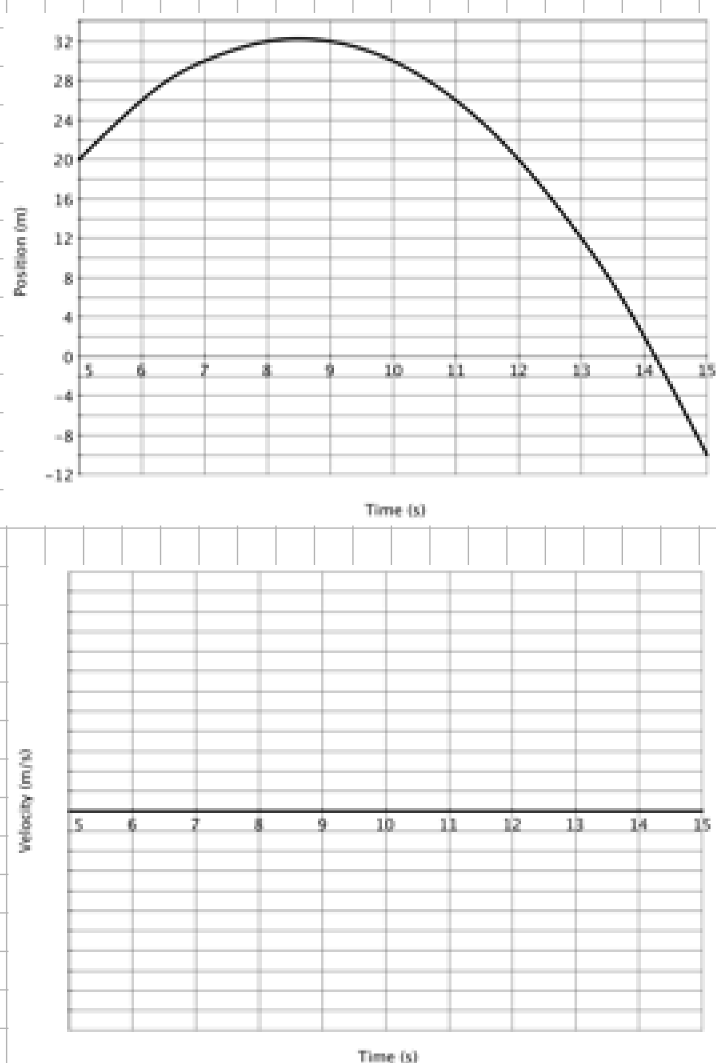
326. A real police car chases down a stolen sturgeon truck. The police car is sitting by the side of the road when the truck flies by at 35 $\frac{m}{s}$. The police officer takes 1.5 seconds to react, but we'll assume that she can get the car up to speed instantly.

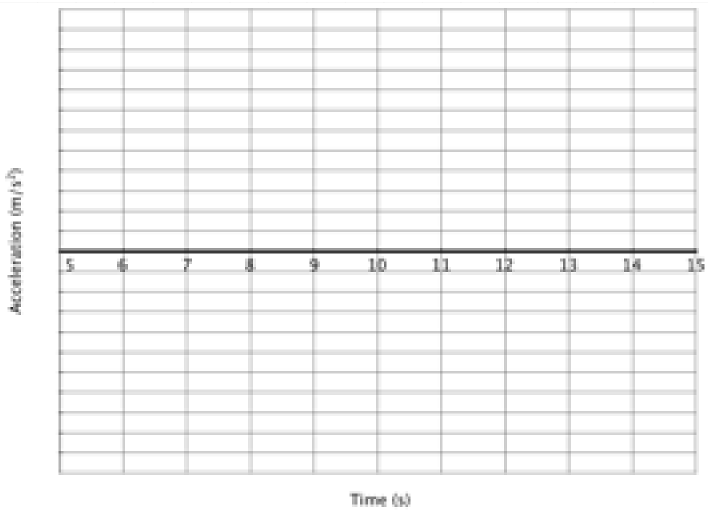
How fast will she have to go in order to catch the speeder within 2 km? Use graphical problem-solving.

Graph (with a dotted line for the police car, but on the same axes as before) a more realistic scenario, where she requires time to get up to full speed.

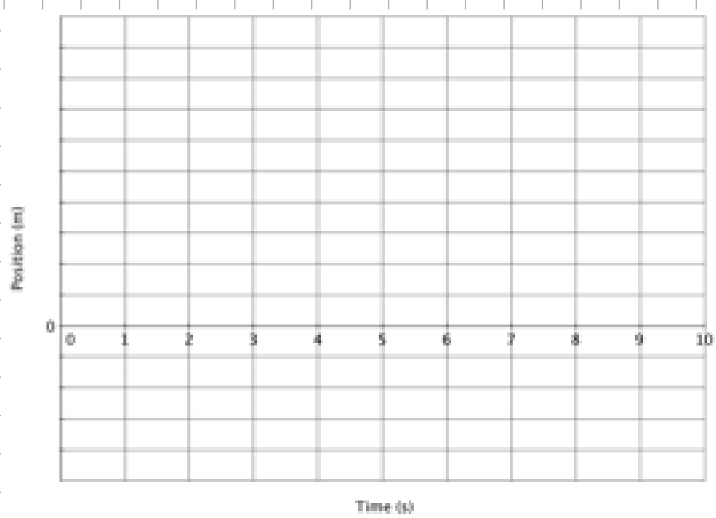
What will this do to the top speed that will be required to catch the truck within 2 km? Make sure that your graph agrees with this!

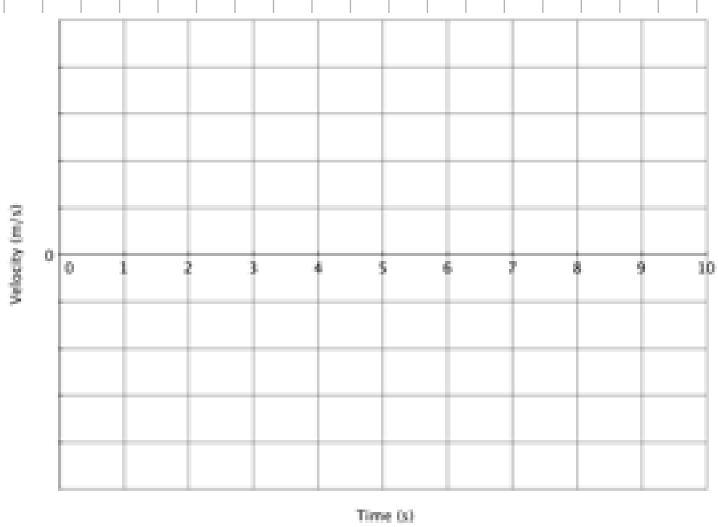
330. Draw the velocity and acceleration graphs that correspond to the given position graph.

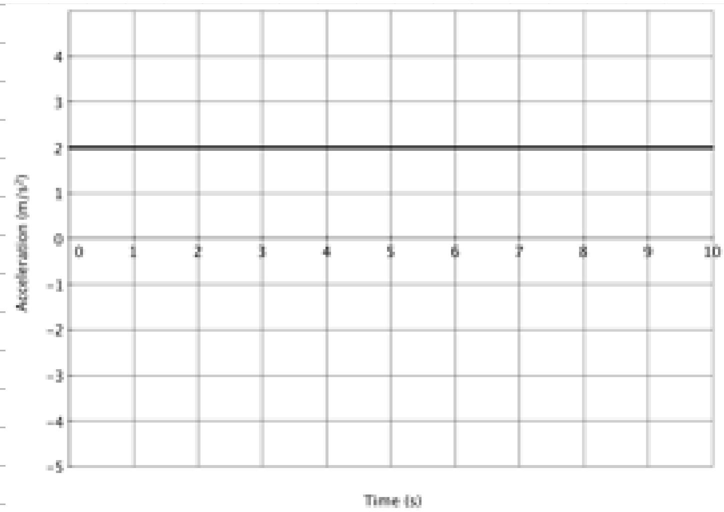




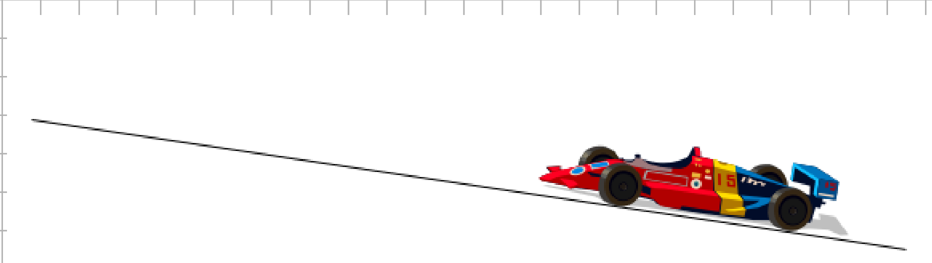
340. Draw the position and velocity graphs that correspond to the given acceleration graph, initial position of -3 meters, and initial velocity of 2 $\frac{m}{s}$.





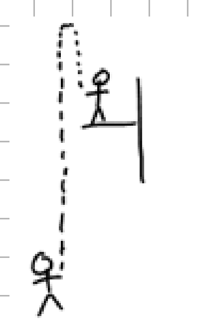


350. A car that is moving 30 $\frac{m}{s}$ runs out of gas while driving up a hill. The car comes to a stop 150 meters further up the hill than the point at which it ran out of gas.

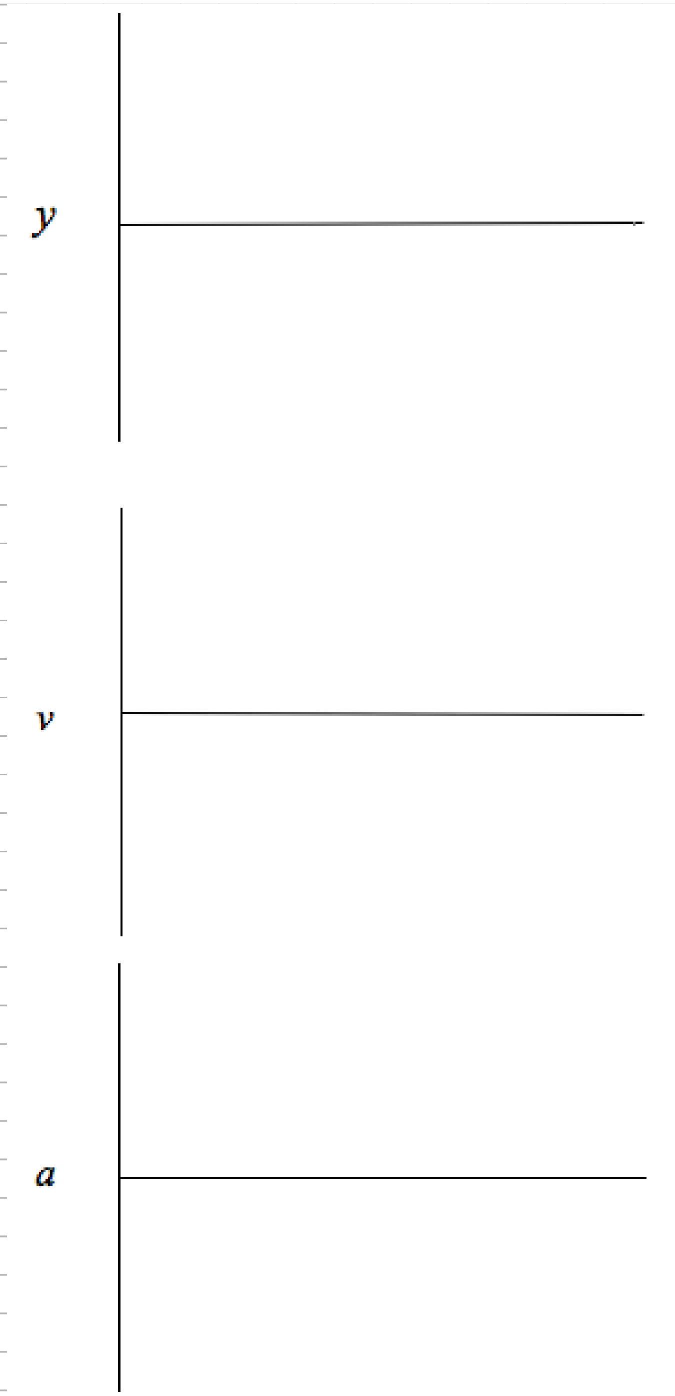


How long, after running out of gas, did it take for the car to come to a stop? Also describe, in words, the direction of the acceleration. Draw a kinematics diagram as part of your solution.

360. A man, on the ground, throws a subway token to his friend on the platform above. The token is thrown essentially straight up; it flies past the friend and falls back to him. Call the lower mans hand $y = 0$ and define up as positive.



Draw graphs of the tokens vertical position, velocity, and acceleration during the trip. No numbers are necessary. Make sure that the time scales of the three graphs line up.



Finally, show on both the position and velocity graphs the *sign* (is it positive, negative, or zero?) of the average velocity for the trip. Be sure that its clear which characteristic of each graph you used to determine the sign of the average velocity!

370. A cannon is shot straight up into the air. The cannonball leaves the cannon moving 45 $\frac{m}{s}$.

After how much time in the air will it have a speed of 20 $\frac{m}{s}$?

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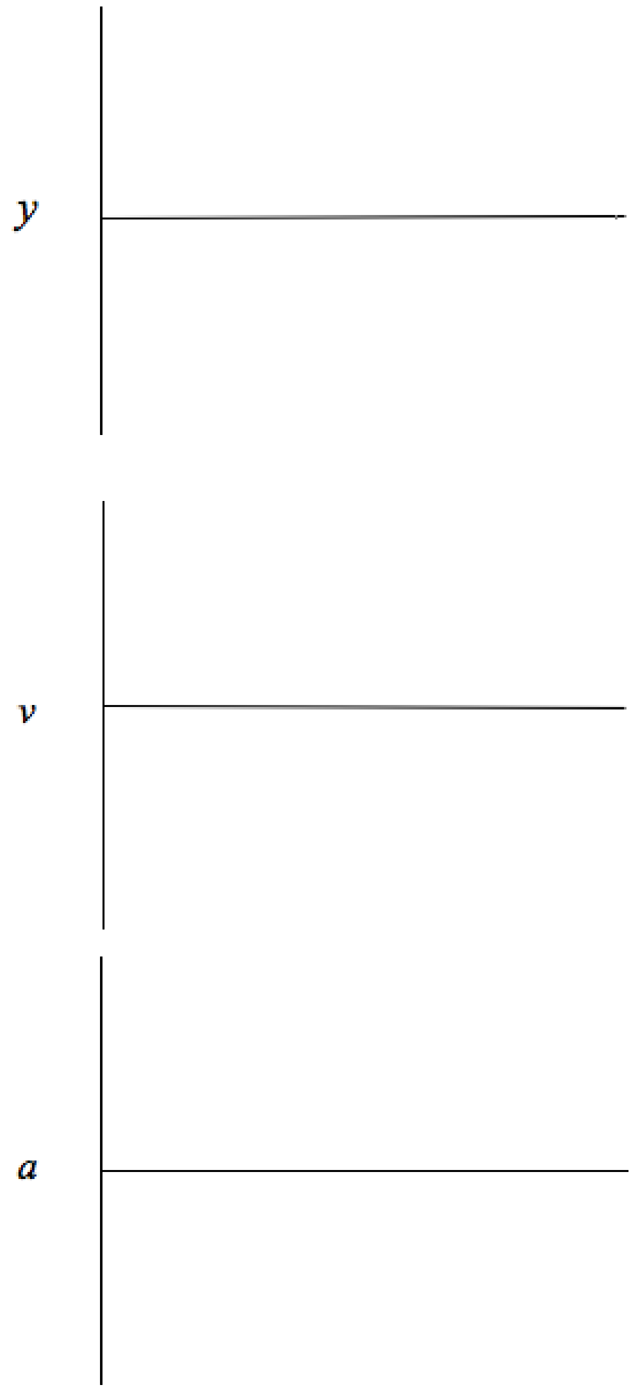
After how much time in the air will it have a speed of 20 $\frac{m}{s}$? Use graphical problem-solving.

372. A cannon is shot straight up into the air. The cannonball leaves the cannon moving 45 $\frac{m}{s}$.

After how much time in the air will it have a speed of 20 $\frac{m}{s}$? Use algebraic problem-solving.

380. A diagram of a crazy skateboarder's stunt is shown below. The skateboarder begins at rest at the top of the ramp, goes down the ramp, up the small ramp, and flies off of the ramp. Do the following:

a. Draw and label acceleration vectors for sections A, B, and C. Thats three vectors to draw.
b. Draw and label initial and final velocity vectors for sections A and B – that's four more vectors to draw. Place the tails of these vectors at the ends of the dotted segments denoting the three sections. Make their lengths proportionate to the speeds.



390. A rock fragment is traveling 640 $\frac{m}{s}$ when it is knocked off of a falling meteor. It has slowed to 590 $\frac{m}{s}$ after .6 seconds. Assume a constant acceleration.

How far will it have gone after 2 seconds?

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How far will it have gone after 2 seconds? Use algebraic problem-solving.

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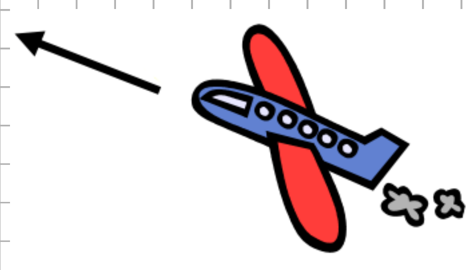
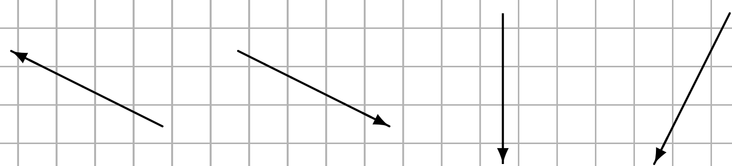
How far will it have gone after 2 seconds? Use graphical problem-solving.

40. Find all possible values of x which solve the equation $x^4 - 20 \cdot x^2 + 64 = 0$.

400. An airplane is gaining height as indicated. The airplane is slowing down.

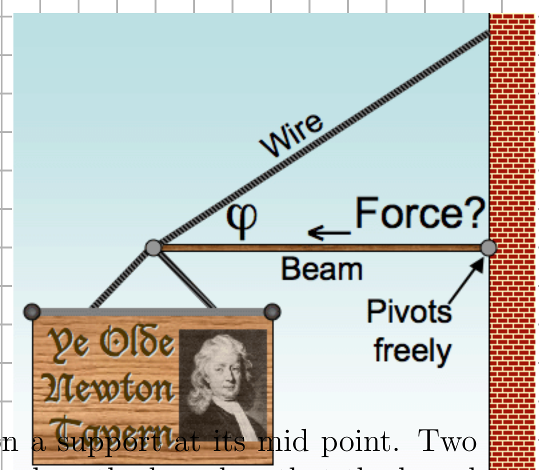


Which of these vectors could be the direction of the net force on a passenger in the plane? Explain!



410. A sign is supported by a horizontal beam and a diagonal wire as shown, both attached to a wall. The sign has a mass m, which is very large compared to the mass of the wire and the beam (i.e., neglect the mass of the wire and the beam). The beam pivots freely around its anchoring point in the wall, so it provides no support in the vertical direction. The angle between the wire and the beam is φ.

Determine the magnitude of the force exerted by the beam.



420. A long uniform board weighs 57.7 N (11.5 lbs) rests on a support at its mid point. Two children weighing 401.0 N (80.2 lbs) and 470.0 N (94.0 lbs) stand on the board so that the board is balanced.

What is the upward force exerted on the board by the support?

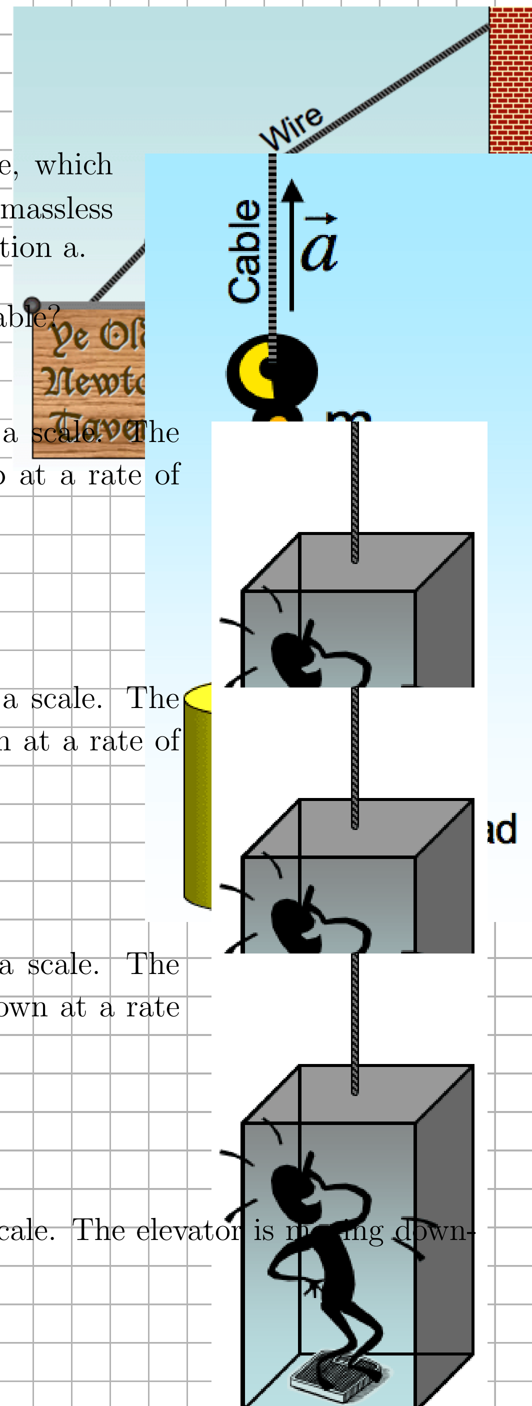
430. Your friend of mass m sits in a hammock that is centered between two vertical posts separated by a distance d. The hammock dips a distance h below the height at which the hammock is secured to the posts.

What is the horizontal force on each post due to your friend?

440. A 2.45 kg mass is suspended from a string which is pulled upward. The mass accelerates upwards with an acceleration of 2.3 $\frac{m}{s^2}$. What is the tension in the string?

450. An 8.4 kg mass is suspended from a spring with spring constant 450 $\frac{N}{m}$. This causesthe spring to have a total length of 0.390 m.

Find the new total length of the spring when a 13.4 kg mass is suspended from it.



460. A barrel (mass m_{Load}) is attached to a massless rope, which is attached to a hook (mass m_{Hook}), which is attached to the massless cable of a crane. The cable is accelerating up with an acceleration a.

What is the tension in the rope? What is the tension in the cable?

470. An elevator contains an 85 kg physicist standing on a scale. The elevator is moving upwards at a rate of 2 $\frac{m}{s}$ and speeding up at a rate of 3 $\frac{m}{s^2}$.

What does the scale read?

471. An elevator contains an 85 kg physicist standing on a scale. The elevator is moving upwards at a rate of 2 $\frac{m}{s}$ and slowing down at a rate of 3 $\frac{m}{s^2}$.

What does the scale read?

472. An elevator contains a 65 kg physicist standing on a scale. The elevator is moving downwards at a rate of 3 $\frac{m}{s}$ and slowing down at a rate of 2.1 $\frac{m}{s^2}$.

What does the scale read?

473. An elevator contains a 72 kg physicist standing on a scale. The elevator is moving downwards at a rate of 2 $\frac{m}{s}$ and speeding up at a rate of 1.5 $\frac{m}{s^2}$.

What does the scale read?

474. An elevator contains a physicist standing on a scale. The scale reads 690 N. The elevator is moving downwards at a rate of 2 $\frac{m}{s}$ and speeding up at a rate of 1.5 $\frac{m}{s^2}$.

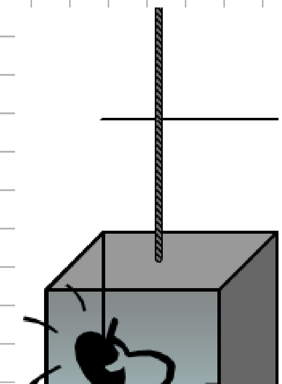
What is the mass of the physicist?

475. An elevator contains a physicist standing on a scale. The scale reads 720 N. The elevator is moving upwards at a rate of 3.1 $\frac{m}{s}$ and speeding up at a rate of 1.5 $\frac{m}{s^2}$.

What is the mass of the physicist?

476. A 2000 kg elevator contains a 72 kg physicist standing on a scale. The elevator is moving upwards at a rate of 3.1 $\frac{m}{s}$ and speeding up at a rate of 1.5 $\frac{m}{s^2}$.

What is the tension in the cable?

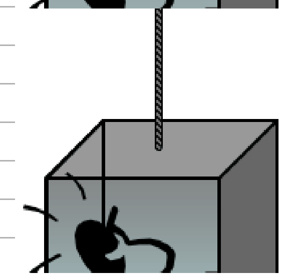


477. A 1500 kg elevator contains a 62 kg physicist standing on a scale. The elevator is moving upwards at a rate of 3.1 $\frac{m}{s}$ and slowing down at a rate of 1.5 $\frac{m}{s^2}$.

What is the tension in the cable?

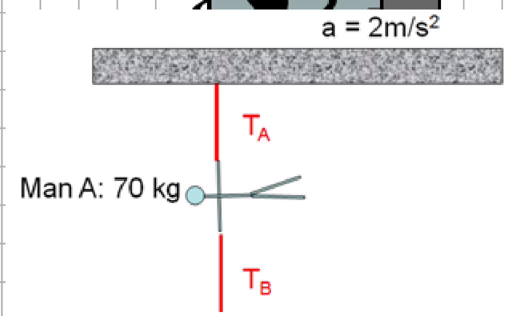
478. A 1700 kg elevator contains a 76 kg physicist standing on a scale. The elevator is moving downwards at a rate of 4.1 $\frac{m}{s}$ and slowing down at a rate of 2.5 $\frac{m}{s^2}$.

What is the tension in the cable?



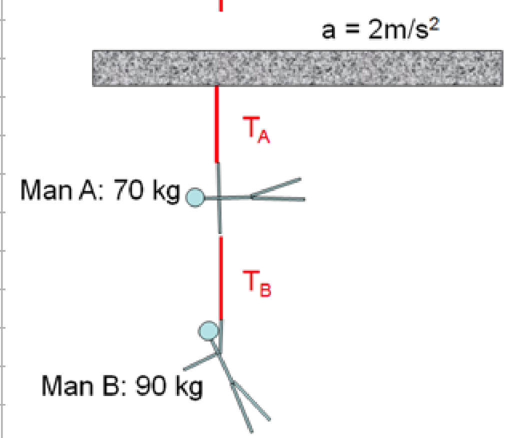
480. Man A (70kg) and Man B (90kg) are hanging from a platform. The platform accelerates upward at a constant rate of 2 $\frac{m}{s^2}$. Assume that the ropes are massless.

What is the tension in the top rope? Make a conceptual argument about why the size of this force makes sense.



481. Man A (70kg) and Man B (90kg) are hanging from a platform. The platform is moving upward and slowing down at a constant rate of 2 $\frac{m}{s^2}$. Assume that the ropes are massless.

What is the tension in the top rope? Make a conceptual argument about why the size of this force makes sense.



Honors Physics Fall Term Recitation Problems

Tips about this packet:

→ Everyone should do every problem!
→ Put your work on the left-hand page. Use the right-right page for notes during presentations
→ Each person will present one problem to the class (approximately 10 minutes) near the end of the term
→ Choosing a problem that looks hard/scary/unfamiliar can allow you to become an expert in that, turning a weakness into a strength

→ The presentations will not be graded, but will be really helpful in preparing for the exam

→ Checking your solutions/answers with me before presentation day is a great idea (you'll only get 10 minutes to present in class, no matter what!)

→ There's no guarantee offered that this covers every piece of every standard from the term, but it's a great place to practice for the exam.

Presented by: ____________________

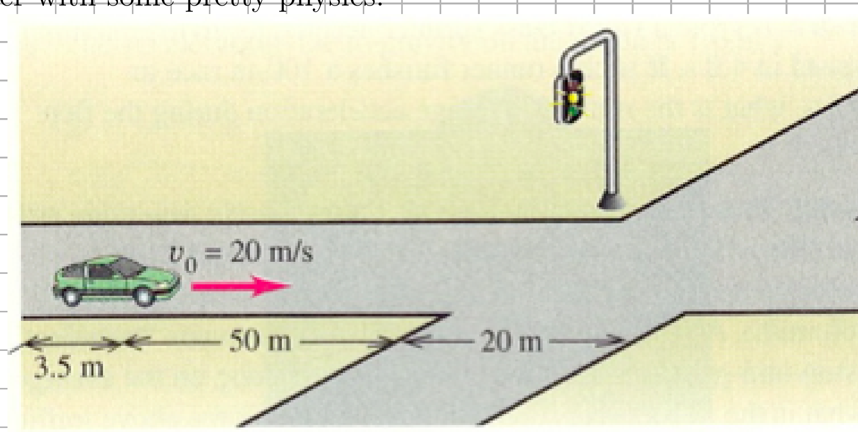
50. $\left(G = 6.67 \times 10^{-11}\ \frac{Nm^2}{kg^2}\right)$ A satellite is said to be in *geosynchronous orbit* if it always stays above the same spot on the body that it is orbiting. It accomplishes this by having the same orbital period as the rotational period of the body that is it orbiting. (How long is that for the Earth?)

a. Determine how far from the surface of the Earth a satellite must be placed in order to be in a geosynchronous orbit. $(R_\oplus = 6,370\ km; M_\oplus = 5.97 \times 10^{24}\ kg)$

b. The space shuttle orbits the Earth with a period of around 90 minutes. Is it closer to the Earth or further from the Earth than geosynchronous satellites? Be convincing!

500. A car 3.5 m in length and traveling at a constant speed of 20 $\frac{m}{s}$ is approaching an intersection. The width of the intersection is 20 m. The light turns yellow when the front of the car is 50 m from the beginning of the intersection. If the driver steps on the brake, the car will slow at a rate of 4.2 $\frac{m}{s}$ per second. If the driver instead steps on the gas pedal, the car will accelerate at 1.5 $\frac{m}{s^2}$. The light will be yellow for 3 seconds. Ignore the reaction time of the driver.

To avoid being in the intersection while the light is red, should the driver hit the brake pedal or the gas pedal? Justify your answer with some pretty physics.

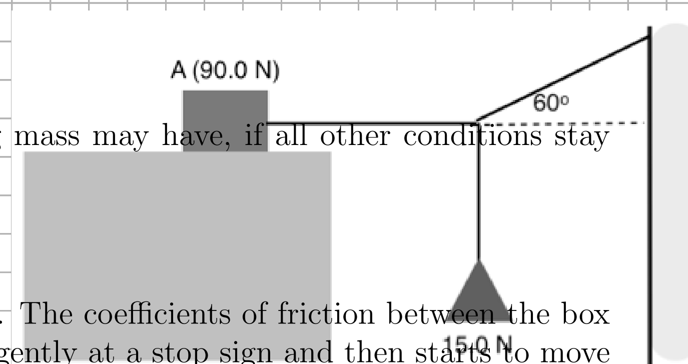


510. The edge of a pool lies 8.0 m (about 26 feet) from the base of a hotel building. The flat roof of the hotel is 25.0 m above the pool (about 82 feet or 5 stories).

Can an average person run off the roof fast enough to clear the edge of the pool? What would that impact be like?

520. In the diagram, there is a block (Block A) with weight 90.0 N resting on the table. The coefficient of static friction between the block and the surface on which it rests is 0.30. Block A is connected to a hanging mass with weight 15.0 N. The hanging mass is also connected to the wall, with the angle of the connecting string being 60 degrees.

Determine the force of friction that must be acting on Block A if the entire system is at rest.



Determine the maximum weight that the hanging mass may have, if all other conditions stay the same.

530. A 20 kg box rests on the flat floor of a truck. The coefficients of friction between the box and floor are $\mu_s = .15$ and $\mu_k = .1$. The truck stops gently at a stop sign and then starts to move with a constant acceleration. The box is 2.2 m from the rear of the truck when the truck starts.

What is the maximum possible acceleration that the truck may have if the box is not to slide?

Suppose that the acceleration of the truck is instead 2.1 $\frac{m}{s^2}$. How much time elapses before the box falls off the rear of the truck?

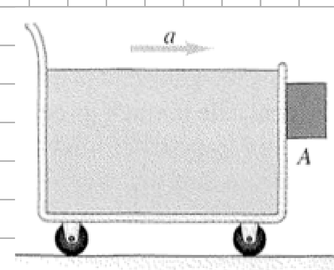
How far does the truck travel in this time?

540. A wagon with two boxes of gold (total mass 300 kg) is cut loose from the horses by an outlaw when the wagon is at rest 50 m up a 6 degree slope. The outlaw plans to have the wagon roll down the slope and across the level ground, and then fall into a canyon where his confederates wait.

Find the speed of the wagon when it reaches the flat ground. Note that it starts from rest at the top of the incline and that the wagon rolls with negligible friction.

If another bandit standing at the end of the slope requires twenty seconds to grab the gold, how far must the edge of the cliff be from the end of the slope, in order to make this double-heist successful?

550. The cart accelerates to the right, keeping block A from sliding down. The coefficient of static friction between the block and the cart is .8, and the coefficient of kinetic friction is .5. The block is 1.2 meters above the ground.



What minimum acceleration must the cart have in order that block A does not fall?

If the acceleration of the cart were only half that value, how long would it take for the block to hit the ground?

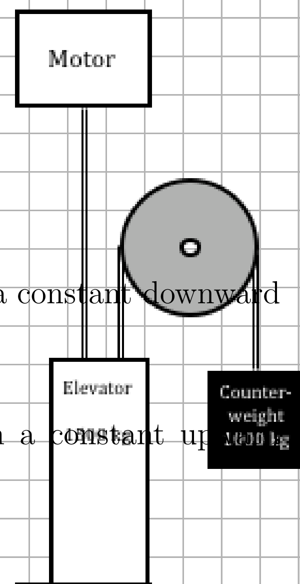
560. The human body can survive a negative acceleration trauma incident (sudden stop) if the magnitude of the acceleration is less than 250 $\frac{m}{s^2}$ (approximately 25g), as a rule of thumb. Suppose that you are in an automobile accident with an initial speed of 105 $\frac{km}{hr}$ (65 mph) and are stopped by an airbag that inflates from the dashboard.

Over what distance must the airbag stop you for you to survive the crash?

How much time will it take for the airbag to stop you?

What average force will be exerted on you by the airbag?

570. An elevator (1500 kg mass, with passengers) is attached to a 1000 kg counterweight by a cable that is wrapped over a pulley, as shown. It is also attached (by a second cable) to a motor. The elevator is moving down at a constant speed of 5 meters per second.

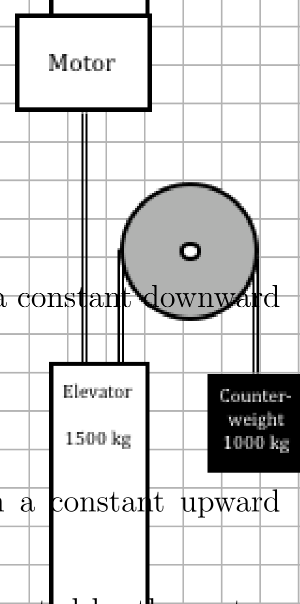


Determine the force that the motor must apply to the second cable.

Determine the force that the motor must exert to lower the elevator with a constant downward acceleration of 1 $\frac{m}{s^2}$.

Determine the force that the motor must exert to lower the elevator with a constant upward acceleration of 1 $\frac{m}{s^2}$.

571. An elevator (1500 kg mass, with passengers) is attached to a 1000 kg counterweight by a cable that is wrapped over a pulley, as shown. It is also attached (by a second cable) to a motor. The elevator is moving down at a constant speed of 5 meters per second.



Determine the force that the motor must apply to the second cable.

Determine the force that the motor must exert to lower the elevator with a constant downward acceleration of 1 $\frac{m}{s^2}$.

Determine the force that the motor must exert to lower the elevator with a constant upward acceleration of 1 $\frac{m}{s^2}$.

Draw a graph of the acceleration of the elevator as a function of the force exerted by the motor. Fill in important numbers on each axis.

580. An Atwood machine is constructed from a 3 kg mass and a 1 kg mass. The 3 kg mass is released from rest 180 cm off of the floor, while the 1 kg mass is 40 cm above the floor.

Determine the speed of the 3 kg mass as it hits the floor.

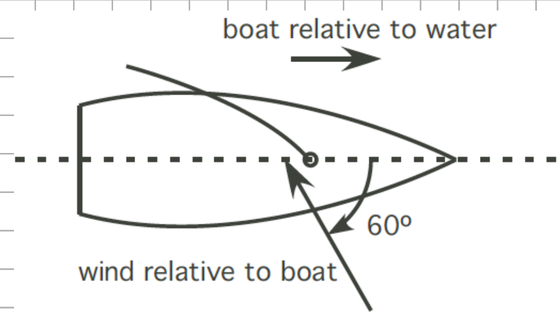
After the 3 kg mass hits the floor, the 1 kg mass will continue to move upwards for a short time. Determine how high above the floor the 1 kg mass will rise. Draw quantitatively correct acceleration and velocity graphs for the 1 kg mass.

590. A glider is given a quick push to start it moving up a 7° inlined air track. The glider travels to a maximum distance of 112 cm up the track.

Determine the initial speed of the glider.

Draw a velocity graph for the glider; use the graph to determine how long the glider takes to get to that 112 cm point. Use your velocity graph to determine where the glider will be 2 seconds after it was launched.

60. A sailboat is moving forward at a speed of 5 knots relative to the water. A gauge attached to its mast indicates a wind speed of 10 knots at an angle of 60 degrees, both relative to the boat.



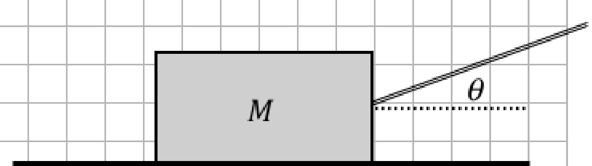
What is the wind speed relative to the water?

600. A police car is driving towards a parked pair of criminals eating Zagnuts after pulling off a heist. The police car is moving 40 $\frac{m}{s}$ and is initially .4 km away from the criminals. The criminals are going to drive away from the police car in an attempt to escape. Assume that the crimemobile moves with a constant acceleration of 1.8 $\frac{m}{s^2}$.

Where will the police catch them?

Draw a velocity graph for the criminals. Use it to determine how far down they road they are when the police car passes their starting point.

610. A 10 kg box is pulled across the floor by a rope inclined 21° from the horizontal. The coefficient of static friction between the floor and the box is .7 and the coefficient of kinetic friction is .4.

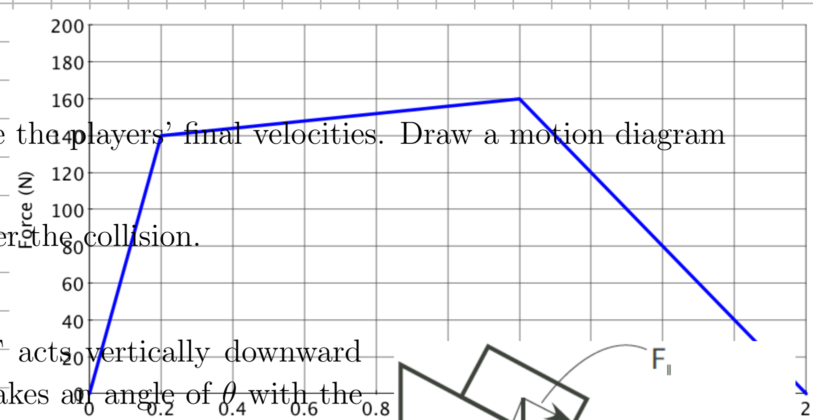


How hard will the rope need to be pulled in order to set the box in motion?

If the angle is changed, the necessary force to make the box slide changes. Determine the angle at which the tension required to move the box is at a minimum. You may need to get creative to find that minimum point!

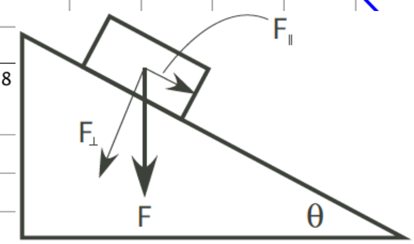
620. A 50 kg peewee football player runs into a stationary 40 kg player at an initial speed of 4 meters per second. The magnitude of the force exerted by the football players on each other is shown as a function of time.

Draw quantitatively accurate acceleration graphs for each player.



Use your acceleration graphs to determine the players' final velocities. Draw a motion diagram showing the players' motions before and after the collision.

70. A gravitational force of magnitude F acts vertically downward on a block resting on a plane. The plane makes an angle of θ with the horizontal.

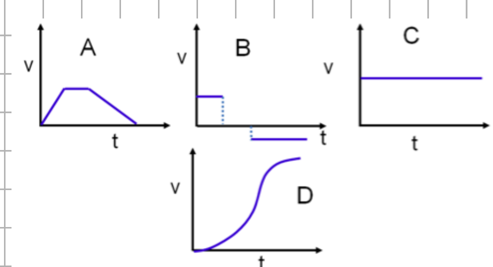


What is the magnitude of the component of the gravitational force acting parallel to the plane?

80. A party of fishermen rented a boat for 240 dollars. Two of the fishermen had to withdraw from the party and, as a result, the share of each of the others was increased by 10 dollars.

How many were in the original party?

90. A car starting from rest speeds up to 30 $\frac{m}{s}$ with constant acceleration in 10 seconds. Then, it travels at 30 $\frac{m}{s}$ for 10 seconds. Finally, it brakes to a stop in 20 seconds with constant acceleration.



Which of the following graphs represents the speed of the car versus time?