FIRST MIDTERM - REVIEW PROBLEMS

A solution set is available on the course web page in pdf format. A data sheet is provided at the end. There are no solutions for problems 78-80 and 139-141, 143-144, 173-175.

1. (a) Convert 747 m to feet. ____________
   (b) Convert 345 mi/hr to ft/s. ____________
   (c) Convert 496 m/s to ft/s. ____________
   (d) On a small planet a stone is dropped. It falls 6.0 ft and hits the ground with a velocity of 0.752 m/s. Find g on this planet. ____________
   (e) A stone is dropped on the moon. What is the magnitude of its velocity in m/s after it falls for a time 3.50 s? ____________

2. (a) Convert 48.0 m/s^2 to ft/s^2. ____________
   (b) Convert 152 mi/hr to m/s. ____________
   (c) Given a vector $\vec{A} = 5.00\hat{x} + 7.00\hat{y} + 6.20\hat{z}$, find the magnitude of this vector. ____________
   (d) Given $\vec{A} = 6.20\hat{x} + 3.40\hat{y}$ and $\vec{B} = 7.90\hat{x} - 4.70\hat{y}$, find $\vec{A} + \vec{B}$. ____________
   (e) On a small planet an object dropped from 3.00 m above the surface reaches the surface in 15.2s. Find g on this planet. ____________

3. (a) Convert 528 miles to meters. ____________
   (b) Convert 55.2 miles per hour to meters per second. ____________
   (c) On a small planet an object falls from rest 8.25 m in 7.60 s. Calculate g on this planet. ____________
   (d) On the moon, how long does it take an object dropped from rest to fall 15.0 m? ____________
   (e) Convert 375 meters to feet. ____________

4. Given two vectors $\vec{A}$ and $\vec{B}$ with A = 4.00 $\hat{i}$ + 2.75 $\hat{j}$ and B = -1.00$\hat{i}$ - 7.50$\hat{j}$.

   (a) Calculate $\vec{A} + \vec{B}$ (in $\hat{i}$, $\hat{j}$ notation).
   (b) Calculate $\vec{A} - \vec{B}$ (in $\hat{i}$, $\hat{j}$ notation).
   (c) Calculate of the magnitude of $\vec{A}$.
   (d) Calculate the direction of $\vec{B}$ expressed as an angle measured counterclockwise from the positive x-axis.

5. A parachutist after bailing out falls 50 m without friction. When the parachute opens, he decelerates at 2.0 m/s^2. He reaches the ground with a speed of 30 m/s.

   (a) How long is the parachutist in the air?
   (b) At what height did he bail out?

6. A load of bricks is being lifted by a crane at the steady velocity of 16 ft/s, but 20 ft above the ground one brick falls off.

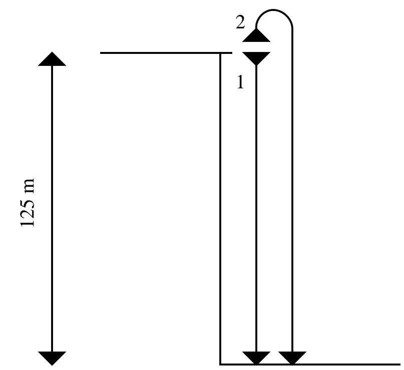
   (a) What is the greatest height the brick reaches above the ground?
   (b) How long does it take to reach the ground?
   (c) What is its speed just before it hits the ground?

7. A ball is thrown down vertically with an initial speed of 20 m/s from a height of 60 m.

   (a) What will be its speed just before it strikes the ground?
   (b) How long will take for the ball to reach the ground?
   (c) What would be the answers to (a) and (b) if the ball were thrown directly up from the same height and with the same initial speed?

8. A rock (#1) is dropped from a window 125 meters above the ground. At the same instant, a second rock (#2) is thrown upward from the same point with an initial velocity of 32.2 m/s.

(a) Find the velocity of each rock when it reaches the ground.
(b) Find the time interval between the instant the first rock strikes the ground, and the instant the second rock strikes the ground.



9. The instant the traffic light turns green, an automobile starts with a constant acceleration a 6.0 ft/s^2. At the same instant a truck, traveling with a constant speed of 30 ft/s, overtakes and passes the automobile.

(a) How far beyond the starting point will the automobile overtake the truck?
(b) How fast will the car be traveling at that instant?

10. On the moon a rock is dropped from the edge of a cliff.

(a) How much time elapses while it falls 75.0 ft?
(b) What is its velocity after falling 75.0 ft?
(c) If it was initially thrown ***down*** with a velocity of 6.75 ft/s, what is its velocity after traveling 75.0 ft?

11. A car skids to a stop with uniform acceleration. The acceleration is -18 ft/s^2, and the skid marks are 150 ft long.

(a) Calculate the speed at the beginning of the skid.
(b) Calculate the time interval between the beginning of the skid and the car stopping.
(c) Calculate the distance from the beginning of the skid to the point where the speed is exactly 1/2 the initial speed.

12. Two rocks are thrown from the roof of a building 120 m tall. Rock 1 is thrown straight down with a speed of 17.5 m/s. Rock 2 is thrown straight up at a speed of 17.5 m/s. Rock 2 misses the building on the way down.

(a) What is the time interval between rock 1 and rock 2 striking the ground?
(b) What is the speed with which rock 1 strikes the ground.
(c) What is the speed with which rock 2 strikes the ground.

13. A flower pot is thrown downwards from the roof of a building 100.00 m high with an initial velocity of 15.00 m/s.

(a) How long does it take the pot to reach the ground?
(b) What velocity does the pot have when it reaches the ground?
(c) The pot passes window 3.00 m high whose top is 80.0 m from the ground. How long does it take the pot to pass the window?

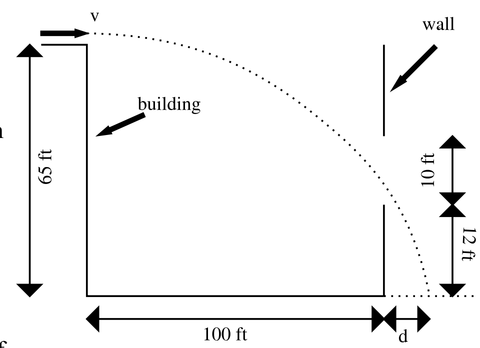
14. A rock is dropped with an initial velocity of zero from the top of a building 150 ft height at t = 0. A second rock is thrown downwards with an initial velocity of 33.0 ft/s. The two rocks arrive at the ground simultaneously.

(a) Calculate the speed of each rock when it reaches the ground.
(b) Calculate the time the second rock was thrown.

15. A ball is thrown straight upwards from the ground. It passes a window on the way up and on the way down. At t = 0 it passes the bottom of the window on its way up. At t = +0.100 s it passes the top of the window on its way up. At t = +3.43 s it passes the ***top*** of the window on its way down. [Reminder: When subtracting two numbers whose values are very similar, it is usually necessary to keep excess significant figures to avoid peculiar results.]

(a) What is the distance from the bottom to the top of the window (in meters)?
(b) What is the distance from the bottom of the window to the top of the ball's path (in meters)?

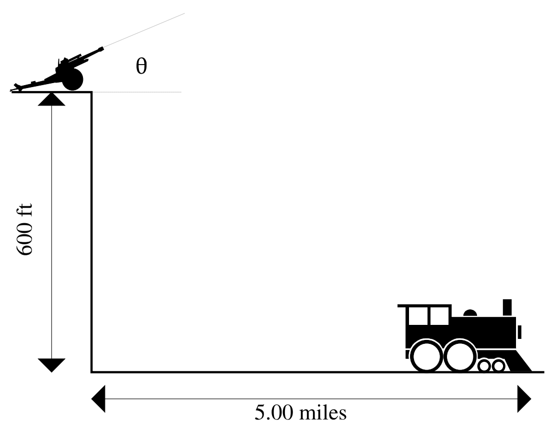
16. A hose is pointed horizontally from the top of a building 65.0 ft tall. 100.0 ft away from the building is a wall with an opening 10.00 ft high whose bottom is 12.00 ft from the ground. The velocity of water leaving the hose can be varied. Calculate the range of positions on the floor on the far side of the wall that can be struck by water from the hose. Express this as distances, d, from the wall. Ignore splashing of the water.



17. A cart moves on a straight horizontal track at a constant speed of 1.75 m/s. A cannon on the cart shoots a ball upward with an initial vertical speed of 6.75 m/s.

(a) What is the maximum height reached by the ball?
(b) How much time elapses before the ball falls back to its original height above the ground?
(c) What horizontal distance is traversed by the car while the ball is in the air?

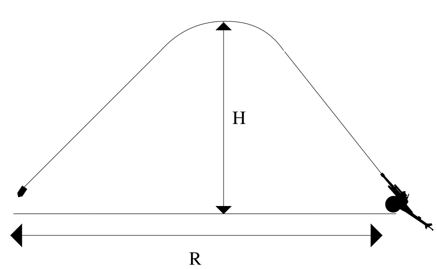
18. A gunner at the top of a 600 ft cliff wishes to hit a train on the plain below. (A train in Spain rolls mainly on the plain?) The muzzle velocity (the speed that the ball leaves the gun) is 1375 ft/s. The train is 5.00 miles from the base of the cliff. Ignore air resistance.



(a) Find an equation which could be solved to find two angles for which the shell will hit the train. (This will be a transcendental equation, don't try to solve it.)
(b) Take one of the angles to be +15.0° (not the solution to part (a)). Find the muzzle velocity needed to hit the train.
(c) Using the solution of (b), find the maximum height of the shell above the plain.
(d) Using the solution of (b), find the time of flight of the shell.

19. A cannon shoots a shell at an angle of 35.0° from the horizontal. The maximum height, H, achieved is 1735 m. Neglect air resistance.

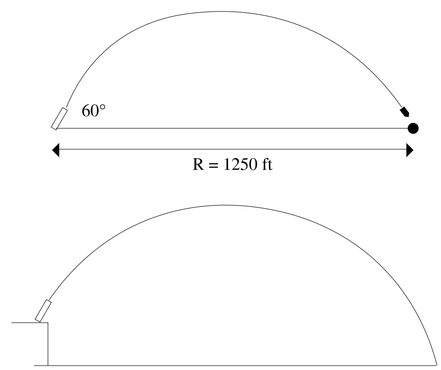
(a) Find the speed with which the shell leaves the gun.
(b) Find the range R. (The initial and final elevation of the shell are the same, as indicated in the drawing.)

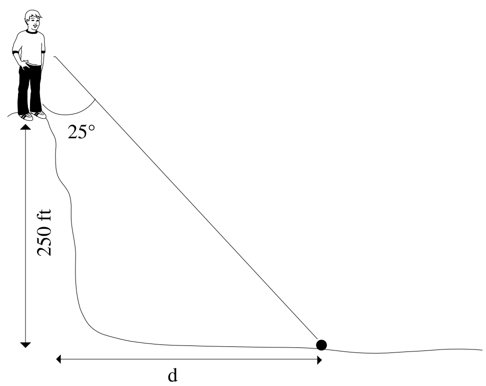


20. A mortar elevated at 60.0° has a range of 1250 ft. The same mortar is placed on a hill, 237 ft above a level plain.

(a) Calculate the new range, measured horizontally from the mortar to the point of impact. (θ is still 60°.)

(b) From the position on the hill calculate the range if the elevation of the gun is changed 30.0°.





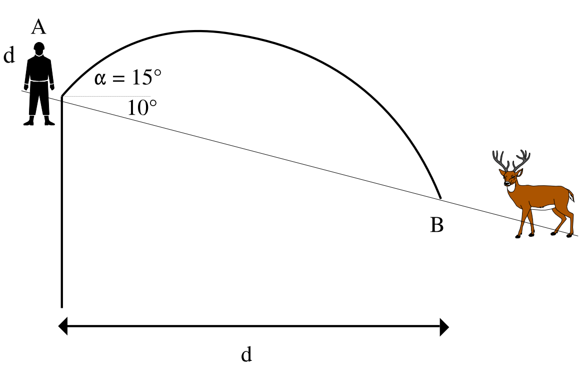
21. A rock is thrown down from the edge of a cliff on earth with an angle as shown, and a velocity of 75 ft/s.

(a) Calculate the distance d away from the base of the cliff where it lands.

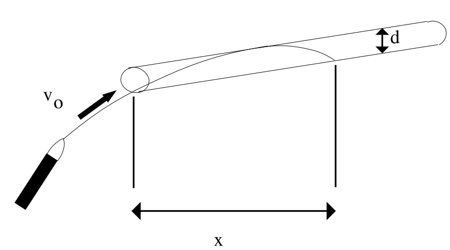
(b) Calculate the velocity (magnitude and direction) when it lands.

(c) Calculate the total time to reach the ground.

22. Standing on the side of a hill, an archer shoots an arrow with an initial velocity of 250 ft/s at an angle $\alpha = 15°$ with the horizontal. Determine the horizontal distance d traveled by the arrow before it strikes the ground at B.



23. A nozzle discharges a stream of water with an initial velocity of v_o of 50 ft/s into the end of horizontal pipe of inside diameter d = 5 ft. Determine the largest distance x that the stream can reach.



24. (a) Convert 375 m/s to mi/hr. ________

(b) Convert 352 miles to meters. ________

(c) On a small planet an object has a velocity of 8.25 m/s after falling 125 m from rest. Find g on this planet. ________

(d) On the moon an object dropped from a cliff lands in 10 seconds. How high is the cliff? ________

(e) A car stops after skidding 150 feet. If its acceleration is $-14.2\ ft/s^2$, calculate its initial speed. ________

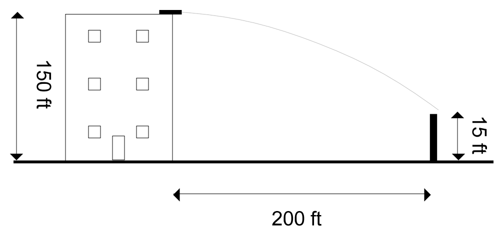
25. Given three vectors A = 3.75 $\hat{i}$ - 4.75$\hat{j}$; B = -5.85$\hat{i}$ + 2.75$\hat{j}$; C = -6.25$\hat{i}$ - 8.75$\hat{j}$.

(a) Calculate $\vec{A} + \vec{C}$ (in $\hat{i}$, $\hat{j}$ notation).
(b) Calculate $\vec{B} - \vec{C}$ (in $\hat{i}$, $\hat{j}$ notation).
(c) Calculate the magnitude of A.
(d) Calculate the direction of $\vec{C}$, expressed as an angle measured counterclockwise from the positive x-axis.

26. On the moon there is a cliff 1500 m high. At t = 0 a rock is dropped from the top of the cliff. At the same time (t = 0) a bullet is shot upwards from the bottom with an initial velocity of 75 m/s (a slow bullet).

(a) Calculate the distance from the top of the cliff to the point where the bullet and rock meet.
(b) Calculate the velocity of the bullet when they meet.
(c) Calculate the time interval between the landing of the rock and the landing of the bullet at the bottom of the cliff. They do not collide.

27. A hose is pointed horizontally from the top of a building 150 feet high. Two hundred feet from the base of building is a wall 15 feet high.



(a) Calculate the minimum initial velocity of the water leaving the hose such that it will just clear the wall.
(b) Calculate the magnitude of the total velocity of the water when it **strikes the ground** (using the initial velocity found in part (a)).
(c) Calculate the time needed for the water to reach the ground.

28. (a) Convert 1652 m to feet. __________
(b) Convert 356 m/s to ft/s. __________
(c) On a small planet a stone is dropped. After falling 13.0 m it has a speed of 9.80 m/s. Find the value of g on this planet. __________
(d) On the moon, how much time elapses for a dropped object to acquire a downward velocity of 33.0 m/s? __________
(e) On the moon an object dropped from a cliff lands in 135 s. How high (in m) is the cliff? __________

29. Given two vectors, $\vec{A}$ and $\vec{B}$, given by $\vec{A} = -2.75\hat{i} + 4.75\hat{j}$ and $\vec{B} = -3.25\hat{i} - 5.65\hat{j}$.

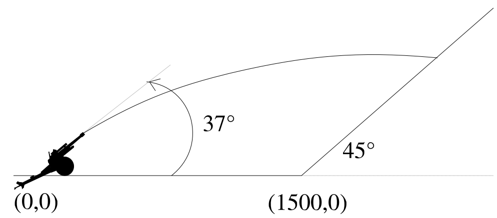
(a) Calculate $\vec{A} + \vec{B}$ (in $\hat{i}$, $\hat{j}$ notation).
(b) Calculate $\vec{B} - \vec{A}$ (in $\hat{i}$, $\hat{j}$ notation).
(d) Calculate the angle between $\vec{A}$ and $\vec{B}$.
(e) Calculate the magnitude of $\vec{B}$.

30. A car skids to a stop with uniform acceleration. The acceleration is -20.0 ft/s^2 and the skid marks are 135 ft long.

(a) Calculate the speed at the beginning of the skid.
(b) Calculate the time interval between the beginning of the skid and stopping.
(c) If under the same circumstances the car hits another car after skidding 42 ft, what is its speed at impact?

31. A cannon is fired at an angle of 37° and a muzzle velocity of 300 m/s. The ground is level for 1500 m, and then rises in a 45° slope. (In this problem it is important to do the work algebraically as far as possible before putting in any numbers.)

(a) Find the x and y coordinates of the point of impact of the shell on the hill.
(b) Find the time of flight of the shell.



32. (a) Convert 725 m to fee. __________
(b) Convert 186 mi/hr to ft/s. __________
(c) On a small planet a dropped from rest rock falls 18.0 ft in 17.0s. What is the magnitude of g on this planet? __________
(d) On the moon an object dropped from rest falls 250 m. What is its velocity after falling 250 m? __________
(e) A ball is thrown straight up on Jupiter ($g = 26.5\ m/s^2$) at a speed of 50.0 m/s (about 100 mi/hr). How high (in meters) does it go? __________

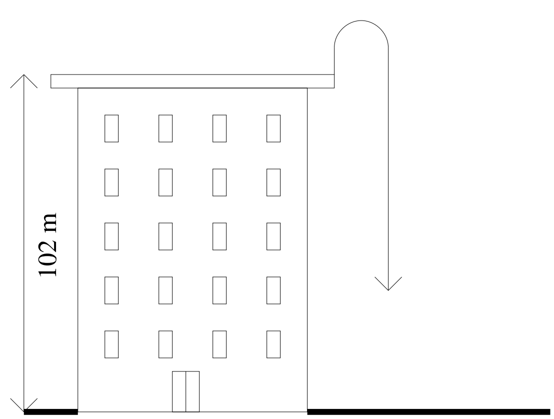
33. Given the following vectors:

$$\vec{A} = 5\hat{i} + 6\hat{j} + 8\hat{k}$$
$$\vec{B} = 3\hat{i} + 8\hat{j} + 8\hat{k}$$
$$\vec{C} = 4\hat{i} + 7\hat{j} - 2\hat{k}$$

(a) Calculate the z component of
$$\vec{A} + \vec{C}$$
(b) Find
$$\vec{A} + \vec{B} \textit{ in } \hat{i}, \hat{j}, \hat{k} \textit{ notation.}$$
(c) Find the magnitude of.
$$\vec{A} - \vec{C}$$
(d) Calculate the direction of
$$\vec{A} - \vec{B}$$
(as an angle measured counterclockwise from the positive x-axis towards the positive y-axis).
(e) Calculate
$$\vec{B} - \vec{A} + \vec{C} \textit{ in } \hat{i}, \hat{j}, \hat{k} \textit{ notation.}$$

34. A ball is thrown up from the edge on top of a building. It is thrown in a way that the ball falls down alongside the building as shown. The building is 102 m high.

(a) If the ball takes 8.00 s to strike the ground, what was its initial velocity (including sign)?
(b) What is the velocity when the ball reaches the ground?
(c) How high above the top of the building does the ball go?



35. A gun fires a large, slow projectile upwards alongside your building. You have a window that is 9.00 ft from top to bottom. You time the arrival of the projectile at the bottom of your window at 4.00 s and the top at 4.10 s (after leaving the ground). Be careful about rounding off too soon in this problem.

(a) Calculate the initial velocity of the projectile when it left the ground.
(b) Calculate how far it is from the ground to the bottom of your window.

36. (a) Convert 3742 feet to meters. ________________
(b) Convert 165 ft/s to m/s. ________________
(c) A ball thrown upward on another planet with an initial upward velocity of 17.0 m/s goes 250 m high. Calculate g on this planet. ________________
(d) On Jupiter ($g = 26.5\ m/s^2$) an object is dropped from rest. How fast is it going after it falls 10.0 m? ____
(e) A drag racer accelerates to 250 mi/hr in a distance of 1/4 mile. Calculate the acceleration, in ft/s^2, assuming that it is uniform. ________________

37. Given the following vectors:

$$\vec{A} = -3\vec{i} + 4\vec{j} - 6\vec{k}$$

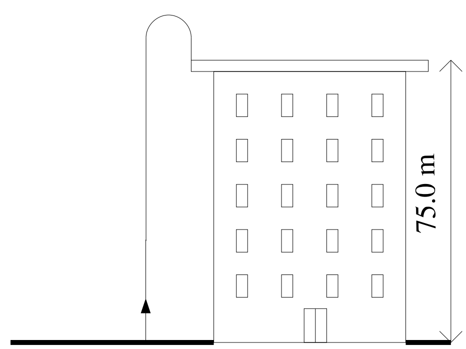
$$\vec{B} = 6\vec{i} - 3\vec{j} + 7\vec{k}$$

$$\vec{C} = -2\vec{i} + 3\vec{j} - 8\vec{k}$$

(a) Calculate the y component of $\vec{A} + \vec{B} - \vec{C}$.
(b) Find $\vec{A} - \vec{C}$ in $\hat{i}, \hat{j}, \hat{k}$ notation.
(c) Calculate the magnitude of $\vec{B} + \vec{C}$.
(d) Calculate the direction of $\vec{A} + \vec{B}$ (as an angle measured counterclockwise from the positive x-axis).
(e) Calculate $\vec{C} - \vec{B} - \vec{A}$ in $\hat{i}, \hat{j}, \hat{k}$ notation.

38. A ball is thrown up from the ground beside a building that is 75.0 m high.

(a) What is the minimum initial velocity needed so that the ball will just reach the top of the building.
(b) If the initial upward velocity is 50.0 m/s, how much time elapses before the ball strikes the roof on its way down?
(c) What is the velocity of the ball when it strikes the roof in part (b)?



39. You start your car [car 1] from rest at point A with an acceleration of $6.00\ ft/s^2$. Four and a half (4.50 s) seconds later a second car [car 2] starts from rest at point A, accelerating in the same direction at $7.50\ ft/s^2$.

(a) How much time elapses after the second car starts before it catches the first?
(b) How fast is each car going when the second catches the first?
(c) How far from the starting point are each of the two cars when the second is 30 feet behind the first?

40. (a) Convert 4320 feet to meters. ______________________

(b) Convert 66.0 mi/hr to m/s. ______________________

(c) On another planet an object falls from rest 10.0 m in 0.230 s. Find the magnitude of g on that planet.

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(d) A drag racer uniformly accelerates to a speed of 250 mi/hr in a distance of 0.25 miles. Calculate his acceleration, in ft/s^2. ______________________

(e) A car moving at 60.0 mi/hr stops in a time of 12.0 s. Assuming the acceleration is constant, calculate the acceleration in ft/s^2. ______________________

41. Given the following vectors:

$$\vec{A} = 4\hat{i} + 5\hat{j} + 7\hat{k}$$
$$\vec{B} = 6\hat{i} - 4\hat{j} - 7\hat{k}$$
$$\vec{C} = -3\hat{i} + 2\hat{j} + 6\hat{k}$$

(a) Calculate the y component of $\vec{A} - \vec{B} + \vec{C}$.

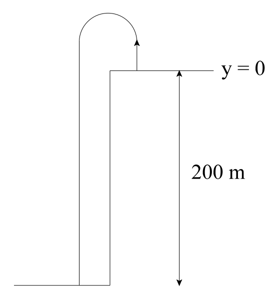
(b) Find $\vec{C} - \vec{B}$ in $\hat{i}$, $\hat{j}$, $\hat{k}$ notation.

(c) Calculate the magnitude of $\vec{C} - \vec{A}$.

(d) Calculate the direction of $\vec{A} + \vec{B}$, expressed as an angle measured counterclockwise from the positive x-axis.

(e) Calculate $\vec{B} + \vec{C} - \vec{A}$ in $\hat{i}$, $\hat{j}$, $\hat{k}$ notation.

42. On the Moon, a rock is thrown upward with an initial velocity of 9.00 m/s. The rock is thrown at the top of a cliff 200 m high, and falls to the bottom of the cliff.



(a) Calculate the maximum height the ball achieves, measured from the top of the cliff.

(b) Calculate the velocity of the ball when it reaches the bottom.

(c) Calculate the time for the ball to reach the bottom.

43. At t = 0 a ball is dropped from rest at the top of a building 110 m high. Exactly two seconds later, a second ball is thrown downwards with an initial speed v_o.

(a) If both balls arrive at the bottom at the same time, calculate v_o.

(b) Calculate the speed of the second ball when it arrives at the ground.

44. (a) Convert 145 mi/hr to m/s. ______________________

(b) Convert 450 m/s to ft/s. ______________________

(c) On a very small planet an object falls 150 m from rest in 20.0 s. Calculate the magnitude of "g" on this planet. ______________________

(d) Calculate the angle between the two vectors

$$\vec{A} = 45.0\,\hat{i} + 37.2\,\hat{j}$$
$$\vec{B} = 27.2\,\hat{i} - 48.0\,\hat{j}$$

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(e) A hot car will accelerate from 0 to 60.0 mi/hr in a distance of 400 ft.. Assume the acceleration is constant (unlikely) and calculate its acceleration in ft/s^2. ______________________

45. Given the following vectors:

$$\vec{A} = 7\hat{i} + 4\hat{j} + 8\hat{k}$$

$$\vec{B} = 3\hat{i} - 7\hat{j} + 2\hat{k}$$

$$\vec{C} = -4\hat{i} + 9\hat{j} - 2\hat{k}$$

$$\vec{D} = -8\hat{i} - 4\hat{j} - 6\hat{k}$$

(a) Calculate the y component of $\vec{A} + \vec{B} + \vec{C}$.

(b) Find $\vec{D} - \vec{C}$ in $\hat{i}, \hat{j}, \hat{k}$ notation.

(c) Determine the magnitude of $\vec{A} - \vec{C} + \vec{D}$.

(d) Calculate the direction of $\vec{B} + \vec{C}$, as an angle from the positive x-axis.

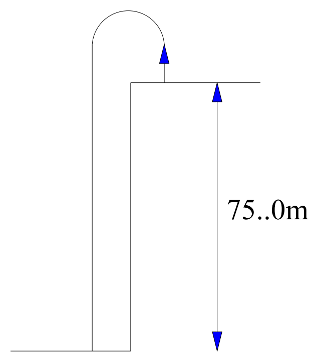
(e) Calculate $2\vec{A} - 3\vec{B} - 4\vec{D}$ in $\hat{i}, \hat{j}, \hat{k}$ notation.

46. A ball is thrown upward at the top of a building that is 75.0 m high building.

(a) If the speed when the ball strikes ground is 44.8 m/s, what is the maximum height of the ball above the top of the building?

(b) If the total time the ball is in the air is 7.00 s [not the same as in (a)], what must the initial velocity be?

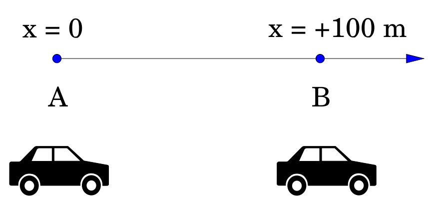
(c) If the initial upward speed is 30.0 m/s, what is the velocity of the ball when it is at the midpoint of the building, 37.5 m above the ground.



47. You start your cat at point A and accelerate to the right at a constant acceleration of $+4.00 \text{ m/s}^2$. At point B, 100 m down the road, a policeman is waiting. He watches you go by, then starts to chase you because he sees you are still accelerating. He starts from rest 3.00 s after you go by.

(a) What must be the uniform acceleration of the policeman's car if he is to catch you 1600 m (nearly one mile) from your starting point?

(b) Calculate the speed of each vehicle in m/s when he catches you? (Yes, your cars are fast enough to do this.)



48. (a) Convert 210 km/hr to ft/s. __________

(b) Convert 125 ft/s to m/s. __________

(c) On a very small planet an object falls 150 m from rest in 145 s. Calculate "g" on this planet. __________

(d) A jet aircraft must accelerate from rest to takeoff speed while traveling 10,000 ft. If the minimum takeoff speed is 135 mi/hr (198 ft/s), calculate the average acceleration needed in ft/s^2. __________

(e) On an icy day the maximum braking acceleration (deceleration) of a car might be as small as 5.00 ft/s^2 in magnitude. Calculate the distance needed to stop a car going at 40 mi/hr with this deceleration. __________

49. Given the following vectors:

$$\vec{A} = 6\hat{i} - 3\hat{j} + 8\hat{k}$$

$$\vec{B} = 7\hat{i} + 4\hat{j} - 8\hat{k}$$

$$\vec{C} = -2\hat{i} - 7\hat{j} + 9\hat{k}$$

$$\vec{D} = 3\hat{i} + 3\hat{j} - 11\hat{k}$$

(a) Calculate $\vec{A} - \vec{B} + \vec{C}$ in $\hat{i}, \hat{j}, \hat{k}$ notation.

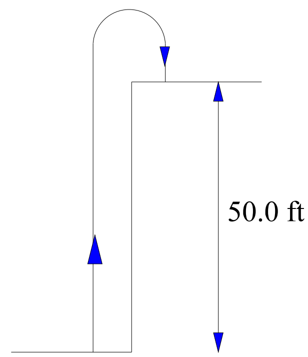
(b) Determine the magnitude of $\vec{B} + \vec{C} - \vec{D}$.

(c) Find the direction of $\vec{A} + \vec{B}$ as an angle from the positive x-direction.

(d) Calculate $4\vec{A} - 3\vec{B} - 2\vec{D}$ in $\hat{i}, \hat{j}, \hat{k}$ notation.

(e) Find the z component of $\vec{A} + \vec{B} + \vec{C} + \vec{D}$.

50. A ball is thrown vertically upward beside a building. The top of the building is exactly 50.0 ft above the point where the ball is released.



(a) If the ball lands on the roof (as shown) with a speed of 19.0 ft/s, what is the initial upward velocity?
(b) Calculate the total length of time the ball travels from its initial point to striking the roof.
(c) What is the *minimum* initial velocity the ball must have to reach the roof?

51. In Japan I observed the following. On the bullet train system the "Kodoma" train stops at all stations. Frequently when it is stopped, a "Hikari" train passes by at 210 km/hr. Exactly one minute later the Kodoma train starts to move. If the design criteria is that trains must be 6.00 minutes apart at full speed (also observed), what is the acceleration in m/s^2 (assumed constant) needed for the Kodoma train? The full speed of the Kodoma is also 210 km/hr. [Note: Put all data in the same units. Be consistent.]

52. (a) Convert 75 mph to km/h. ______________________________
(b) On a certain planet a rock falls 200 m from rest in 11.5 s. Find g on this planet. ______________
(c) Find the mass of a lead sphere with R = 20 cm and $\rho_{(lead)} = 11.3\ g/cm^3$. ______________________
(d) How many atoms are in the sphere in (c)? [$N_A = 6.02 \times 10^{23}$ atoms/mole; atomic mass of lead is 207]

____

(e) A car is traveling at a speed of 55 mph. If the maximum possible deceleration is $a = -8\ ft/s^2$, what is the stopping distance? ______________________________

53. Given the following vectors:

$$\vec{A} = 3\vec{i} + 6\vec{j} - 2\vec{k}$$

$$\vec{B} = \vec{i} - 5j + 3\vec{k}$$

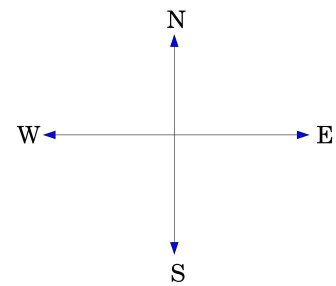
$$\vec{C} = -4i + j$$

(a) Calculate the x component of $\vec{A} + \vec{B}$.

(b) Find $\vec{A} + 2\vec{B} - 3\vec{C}$ in i, j, k notation.

(c) Find the vector in i, j, k notation and magnitude of $\vec{A} - \vec{B} + \vec{C}$.

54. A car travels south for 5 minutes with a speed of v = 50 mph, then turns 45° north of west and travels at a speed of v = 45 mph for 10 minutes and then heads 60° east of north at v = 55 mph for 5 minutes.



(a) Find the total displacement of the car (both magnitude and direction). Illustrate your solution on the graph below.
(b) What is the total distance traveled by the car?
(c) Calculate the average velocity of the car (both magnitude and direction).
(d) Determine the average speed of the car?

55. Two cars (car A and car B) at a distance of 8.00 m apart (the front of car B is 8.00 m behind the back of car A) are both traveling at a speed of v = 20 m/s. The driver of car A (front car) hits a deer on the road and applies his brakes so that the car slows down and stops with $a = -10\ m/s^2$. If the reaction time of the driver of car B is 0.5 s (time interval between seeing the accident and applying his brakes), what must be the minimum acceleration of the car B to barely escape a collision.

56. (a) A rock falls from rest 150 m in 6.00 min on another planet. Calculate g in m/s^2. ____________
(b) If g on a large planet is $100\ m/s^2$, what is this in ft/s^2? ____________
(c) Convert 165 mi/hr to m/sec. ____________
(d) The stopping distance for a car at 30.0 mi/hr is measured to be 50.0 ft. All other things being the same, what is the stopping distance for the car at 50.0 mi/hr? ____________
(e) A rock is thrown upward on the moon with an initial speed of 20.0 m/s. Calculate its maximum height from the point of release. ____________

57. Given the following vectors:

$$\vec{A} = 7\vec{i} + 8\vec{j} + 2\vec{k}$$
$$\vec{B} = -3\vec{i} - 4\vec{j}$$
$$\vec{C} = -6\vec{i} = 4\vec{j} + 4\vec{k}$$

(a) Calculate $\vec{A} + \vec{B}$ in $\vec{i}$, $\vec{j}$ and $\vec{k}$ notation.

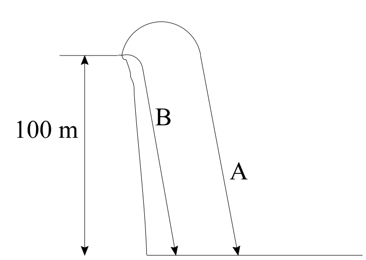
(b) Find the magnitude of $\vec{A} - \vec{C}$.

(c) Determine $\vec{A} - \vec{B} + 2\vec{C}$ in $\vec{i}$, $\vec{j}$ and $\vec{k}$ notation.

(d) What is the z component of $\vec{C} - \vec{A}$.

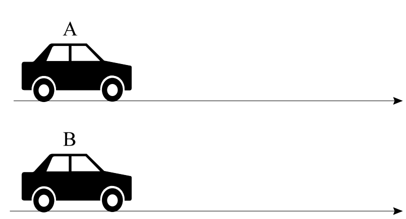
(e) Calculate the magnitude of $\vec{A} + \vec{B} + \vec{C}$.

58. A rock, A, is thrown upward from the edge of a cliff. Rock A has an initial velocity of 20.0 m/s. A second rock, B, is thrown downward at the same speed as rock A. They are both thrown at the same instant of time.



(a) What is the velocity of rock B when it hits the ground?
(b) Calculate the time interval between rock B hitting the ground and rock A hitting the ground. (Note: There is an easy way and hard way to do this problem.)

59. Car A starts at rest and accelerates at $2.50\ ft/s^2$. A second car, Car B, also starts at rest. Car B starts 2.00 s after Car A and catches up with Car A 90.0 s after Car A started.



(a) How far from the starting point does Car B catch Car A?
(b) What is the acceleration of Car B?

60. (a) Convert 75.2 m/s to mi/hr. ______

(b) A rock is dropped on the moon. What is its speed after falling 175 m? ______

(c) On a small planet "g" is measured to be 1.75 m/s^2. Express this in ft/s^2. ______

(d) A drag racer accelerates from 0 to 200 mi/hr in 1/4 miles. Calculate the average acceleration in ft/s^2.

______

(e) A sphere of unknown material has a radius of 3.50 cm. If its mass is 2.40 kg, calculate its density in kg/m^3. ______

61. Given the vectors:

$$\vec{A} = 6\hat{i} - 8\hat{j} - 11\hat{k}$$

$$\vec{B} = -4\hat{i} + 3\hat{j} + 9\hat{k}$$

$$\vec{C} = -7\hat{i} - 9\hat{j} - 3\hat{k}$$

(a) Calculate $\vec{A} + \vec{C}$ in $\hat{i}, \hat{j}, \hat{k}$ notation.

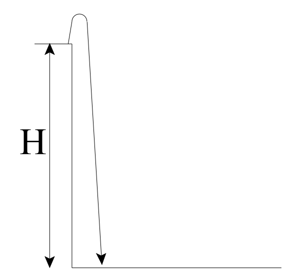
(b) What is the magnitude of $\vec{B} + 3\vec{C}$?

(c) Determine the direction of $\vec{B} + 3\vec{C}$, as an angle measured counterclockwise from the positive x axis.

(d) Find $\vec{A} + \vec{B} - \vec{C}$ in $\hat{i}, \hat{j}, \hat{k}$ notation.

(e) Calculate $\vec{B} - \vec{A}$, in $\hat{i}, \hat{j}, \hat{k}$ notation.

62. A rock is thrown on earth upwards at the edge of a cliff in such a way that it falls to the bottom of the cliff. The initial upward velocity is 37.2 m/s.



(a) If the speed when the rock is half-way down to the bottom of the cliff is 63.2 m/s, how high is the cliff?

(b) Assume the cliff is 150 m high [not the answer to (a)]. What is the total time before the rock hits the bottom?

(c) For the cliff height used in (b), what is the velocity just as the rock hits bottom?

63. A rock is dropped from a building that is 300 ft high. A second rock is thrown down 3.00 sec after the first rock is dropped. Calculate the initial velocity needed for the second rock such that the two rocks arrive at the ground at the same time.

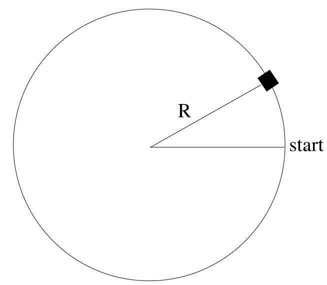
64. The speed of a racing car is increased at a constant rate from 90 km/h to 126 km/h over a distance of 150 m along a curve of 250 m radius. Determine the magnitude of the total acceleration of the car after it has traveled 100 m along the curve.

65. A motorist enters a curve with a 500 ft radius at a speed of 30 mi/h. If he increases his speed at a constant rate of 30 ft/s^2, determine the magnitude of the total acceleration after he has traveled 400 ft along the curve.

66. A car on a circular track of 500 m diameter starts at rest and uniformly accelerates to 60.0 mi/hr. The acceleration from 0 to 60.0 mi/hr takes 18.0 s.

(a) Calculate the inward acceleration (in m/s^2) after the car has traveled 100 m.
(b) Calculate the magnitude of the total acceleration (in m/s^2) when the speed is 50.0 mi/hr.
(c) Calculate the direction of the total acceleration in (b). Express this as an angle measured from the radius direction. Show on a drawing how you define the angle.

67. A car travels a circular track of radius R = 200 m. It starts from rest and travels 350 m along the curve in 17.0 s at constant tangential acceleration.



(a) Calculate the inward (centripetal) acceleration 17.0 s after it starts.
(b) Calculate the magnitude of the ***total*** acceleration 17.0 s after it starts.
(c) Calculate the direction of the total acceleration in (b). Calculate this relative to the inward radial vector at that point.

68. (d) A car goes around a curve whose radius is 305 ft at 55 mi/hr. What is its inward acceleration (in ft/s^2)? ______

(e) On another planet an object falls 150 m from rest and acquires a velocity of 3.25 m/s. What is g on this planet? ______

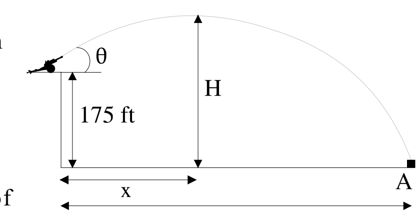
69. (d) A car travels at 55.0 mi/hr around a curve of radius 400 ft. Calculate the inward acceleration in ft/s^2.

______

70. A golfer wants to land a ball on a green a horizontal distance of 145 m away, and 5.50 m down. The golfer chooses an eight iron that he knows will result in the ball leaving the tee at an angle of 60.0°.

(a) With what velocity should the ball leave the tee?
(b) What is the maximum height of the ball above the *green*?

71. A cannoneer wishes to shoot a cannon ball and strike the house at A. He is at the top of a cliff 175 feet high and the house is 5000 feet from the base of the cliff.

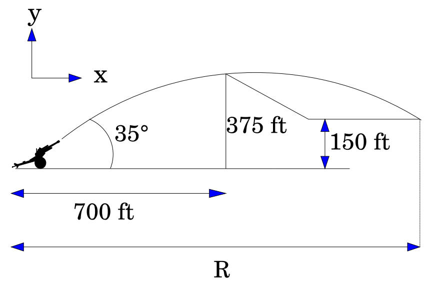


(a) If he sets the angle, θ, of his cannon 35.0° from the horizontal, what must the muzzle velocity of the cannonball be?
(b) What is the maximum height, H, above the level of the house, of this cannon ball?
(c) What is the distance, x, measured from the base of the cliff to the position of maximum height?

72. A car is traveling on a circular track of radius R = 750 m. The initial velocity at point A, v_o, is 15.0 m/s. When the car is at point B the velocity is 35.0 m/s. The tangential acceleration between A and B is constant.

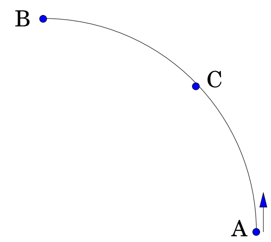
(a) Calculate the magnitude of the inward acceleration at point A.
(b) Determine the magnitude of the total acceleration at point B.
(c) Calculate the magnitude of the ***total*** acceleration at point C, exactly 450 m along the road from point A.
(d) Find the direction of the total acceleration in (c), and show on a ***clear*** diagram how you define the angle.

73. A cannon is set up at 35° elevation. The cannonball just barely clears a 375 foot hill that is 700 feet from the initial spot of the cannon.



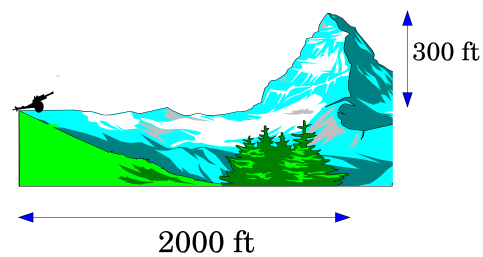
(a) Find the initial velocity of the cannonball.
(b) Calculate the range, R, to a point on the plain behind the hill. The plain is 150 feet higher than where the cannon sits.
(c) Determine the x and y components of the velocity of the cannonball at the point where it lands.

74. 48. A car enters a curve at point A at a speed of 20 m/s. The radius of curvature of the curve is 200 meters. When the car reaches point B his speed is 15.0 m/s. B is exactly 1/4 of the way around a complete circle. Assume the rate of change of the speed of the car is constant between A and B.



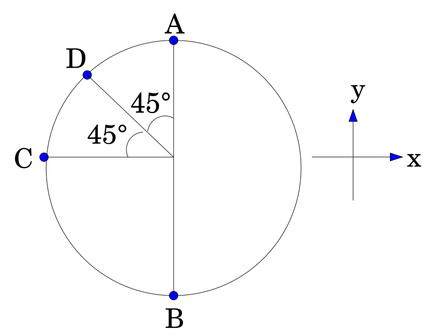
(a) Calculate the inward acceleration at point C, exactly halfway between A and B.
(b) Calculate the magnitude of the TOTAL acceleration at point C.
(c) Draw a clear picture showing the direction of the total acceleration at C and include a numerical value of the angle between the total acceleration and the radius direction.

75. A cannon is pointed at a mountain. The top of the mountain is 300 ft above the cannon and is 2000 ft horizontally from it. Take the initial velocity of the cannon ball as 500 ft/s.



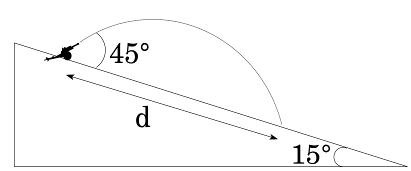
(a) The initial angle is set at 25.0° [not the correct answer to part (c)]. Calculate the time until the cannonball is directly above the top of the mountain.
(b) For the conditions in part (a), find the total velocity, magnitude and direction (as an angle measured from the horizontal), when the cannonball is directly above the mountain.
(c) Determine the angle of the cannon (θ) such that the ball lands on top of the mountain (two answers).

76. A object starts from rest at point A and then uniformly accelerates moving counterclockwise. The velocity at point B is $V_B = 5.00$ m/s and R = 1.50 m.



(a) Calculate the velocity (magnitude and direction) at point D (45° counterclockwise from the vertical).
(b) Find the velocity (both magnitude and direction)) at point C.
(c) Find the total acceleration (magnitude and direction) at point C. Show on a clear drawing the meaning of the angle you calculate.

77. A projectile is fired down an inclined plane with initial speed V_o = 200 m/s at an angle of 45° with respect to the incline. What distance, d, along the incline does the projectile travel.



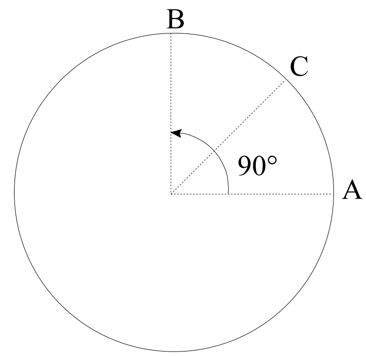
78. (e) Calculate the inward acceleration, in ft/s^2, of a car going 90.0 mi/hr on a curve of radius 250 ft. ______

79. (a) Ignoring air resistance, calculate the minimum initial velocity of a baseball such that it travels in a

trajectory with an 800 ft horizontal range.

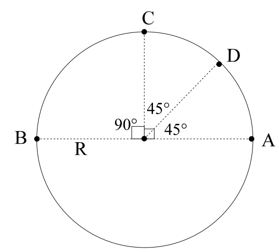
(b) For an initial velocity of magnitude 160 ft/s, calculate the initial angle(s) needed for a baseball to travel 400 ft horizontally ignoring air resistance.

80. A car on a circular track of 200 m radius is traveling at 145 mi/hr at point A. It slows down with uniform acceleration so that at point B its speed is 90 mi/hr. A and B are 90° apart.



(a) Calculate the tangential acceleration of the car along the track between points A and B. (Hint: Use 1-D kinematics along the curved path.)
(b) Find the amplitude of the inward acceleration at point C, which is halfway between points A and B.
(c) Determine the magnitude of the total acceleration at point C.
(d) What is the direction of the total acceleration at point C. Express this as an angle from the radius direction. Show on a drawing how you define this angle.

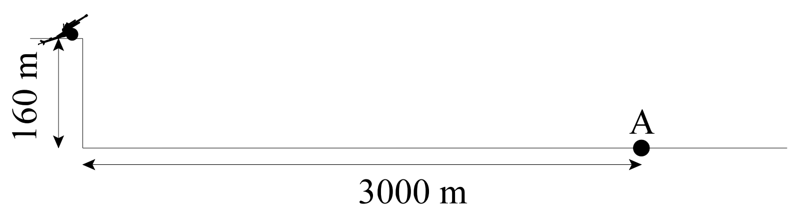
81. A car on a circular racetrack passes point A with a speed of 60 mi/hr. It is uniformly accelerated between A and B and has a speed at B of 100 mi/hr. The radius of the track is 800 feet.



(a) Find the inward acceleration at C which is halfway between A and B.
(b) Calculate the magnitude of the TOTAL acceleration at D.
(c) Determine the direction of the total acceleration at D. Express this as an angle measured from the radius vector, and show clearly on a picture how you define this angle.

82. Given cannon on the cliff as shown.

(a) For an initial angle of 30.0°, calculate the initial velocity for the cannonball to strike point A.
(b) Determine the magnitude of the velocity when the cannon ball in part (a) strikes point A.



83. (a) Convert 341 feet to meters. ____________________
(b) Convert 105 km/hr to mi/hr. ____________________
(c) A ball is dropped from a height of 20.0 m on the moon. A second ball is dropped from the same height (20.0 m) on the earth. What are the speeds of the balls when they hit the surface (i) on the moon and (ii) on earth? ____________________
(d) On a distant planet a rock is dropped from rest and falls 50.0 m in 2.00 s. What is the value of g on the this planet? ____________________
(e) A = 2.00 $\hat{i}$, B = 3.78 $\hat{j}$. Calculate A+ B, A - B and -(A - B) in $\hat{i}$, $\hat{j}$ notation. Calculate the magnitude of A + B. ____________________

84. Native Utahn Wins World 'Extreme' Sky Diver Crown (SL Tribune, 3 Sept. 2001). Johnny Winkelkotter jumped off of the Petronas Twin Towers in Kuala Lumpur, Malaysia. The building was 1480 ft (451 m) tall. Assume he fell without friction for 128 m. At this height the parachute opened and he decelerated at 3.00 m/s^2.

(a) How long did it take him to reach the ground?
(b) With what velocity did he hit the ground?
(c) Why is the answer to part (b) larger than the actual velocity with which Winkelkotter hit the ground?

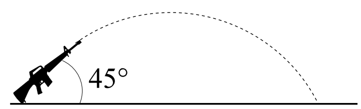
85. Given three vectors $\vec{A} = 4.00\hat{i} + 3.00\hat{j}$, $\vec{B} = 3.00\hat{i} - 4.00\hat{j}$, $\vec{C} = 7.00\hat{i} - 1.00\hat{j}$.

(a) Calculate A + B in $\hat{i}$, $\hat{j}$ notation.
(b) Calculate A + B - C in $\hat{i}$, $\hat{j}$ notation.
(c) Calculate the magnitude of C.
(d) Calculate the direction of C expressed as an angle measured counterclockwise from the positive x-axis.

86. (a) Convert 385 km to feet. ________________

(b) For an initial angle of 45° with respect to the horizontal, calculate the initial velocity for a bullet that travels a distance of 3.50×10^3 m.

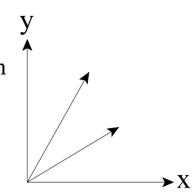
____



(c) A ball is thrown vertically upward on a planet whose acceleration of gravity is $g' = 5.00\ m/s^2$. The ball's initial velocity is 10 m/s. What is the maximum height of the ball above the surface of the planet?

____

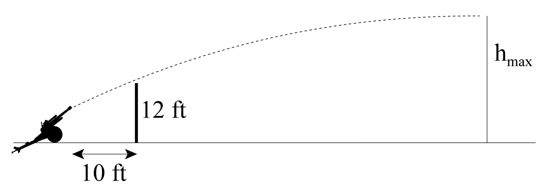
(d) The vector $\vec{A}$ has a magnitude of 2.00 m and makes an angle of 30° with respect to the x-axis. The vector $\vec{B}$ has a magnitude of 3.00 m and makes an angle of 60° with respect to the x-axis. Calculate $\vec{A} - 2\vec{B}$ in $\hat{i}$, $\hat{j}$ notation. See figure.



____

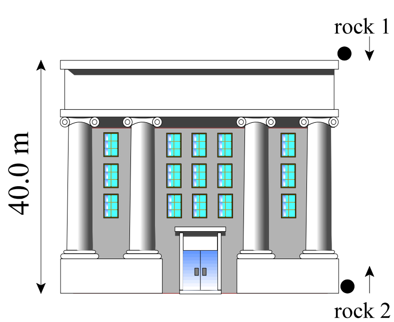
(e) A rock is dropped from a height of 10 m and strikes the ground. Calculate the average velocity of the rock from the time it is dropped to the time it strikes the ground. ________________

87. A cannot shoots a ball just clearing a 12 ft wall which is 10 ft away. What initial velocity is necessary to reach a maximum altitude of 50.0 ft at a distance of 1.00×10^2 ft from the wall? Assume the ground is level.



88. Two cars are in a 50.0 km race on a straight level track. The first car travels the entire distance at constant velocity and finishes the race in 15 min.

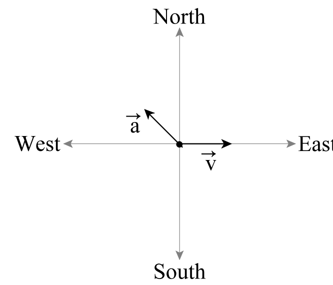
(a) If the second car starts from rest, what constant acceleration must this car have to cross the finish line at the same time as the first car?
(b) For the second car to finish at the same time as the first car, what constant acceleration must the second car have if it runs out of gas after 45 km and coasts through the finish line at constant velocity?



89. Rock 1 with a mass of 3.25 kg is dropped from the top of the Park Building. At the same instant, rock 2 with a mass of 2.75 kg, is projected upward with an initial velocity of $V_o = 21.0$ m/s.

(a) Find the location above the ground of the center of mass of the system when rock 2 reaches its maximum height.
(b) What is the velocity (with sign) of the center of mass the instant rock 1 hits the ground?

90. A. The velocity of a particle is in the eastward direction, while the acceleration is directed toward the northwest as shown in the figure. (Select one of the following answers.)

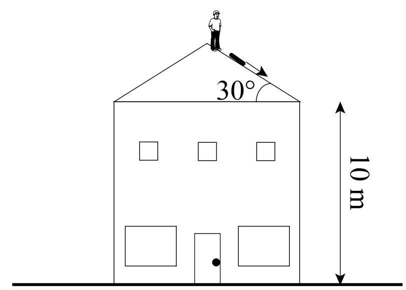


- ○ The particle is speeding up and turning toward the north.
- ○ The particle is speeding up and turning toward the south.
- ○ The particle is slowing down and turning toward the north.
- ○ The particle is slowing down and turning toward the south.
- ○ The particle is maintaining constant speed and turning toward the south.

B. Peter drives 5 miles from the garage of his home to Mario's Pizza. The traffic is heavy and it takes him 20 minutes to arrive at Mario's. On his way back the traffic is light, and he is back at his home in only 10 minutes. What was Peter's average velocity during this trip?

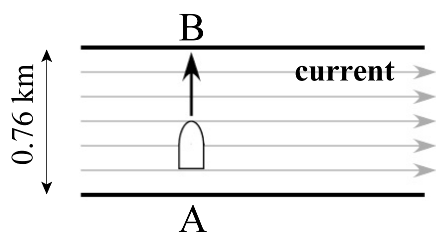
C. Three uniform spheres of masses m_1 = 1 kg, m_2 = 2 kg, m_3 = 3 kg, have their respective centers at positions r_1 = (2 m)î + (1 m)ĵ, r_2 = -(4 m)î + (1 m)ĵ, and r_3 = (6 m)î - (3 m)ĵ, respectively. Find the distance from the center of mass to the center of the heaviest sphere.

91. A worker on the roof of a house drops his hammer, which slides down the roof at a constant speed of 4.0 m/s. The roof makes an angle of 30° with the horizontal, and its lowest point is 10 m from the ground.



(a) Find the time it takes the hammer to hit the ground from the edge of the roof.
(b) What is the horizontal distance traveled by the hammer between the time it leaves the roof of the house and the time it hits the ground?

92. A river is 0.76 km wide. The banks are straight and parallel (see figure). The current is 2.0 km/h and is parallel to the banks as shown. A boat goes on a straight line from A to B, where AB is perpendicular to the banks. The boat has a constant speed of 4.0 km/h with respect to the water.



(a) How many degrees (counterclockwise) from the line AB is the boat driven?
(b) What is the speed of the boat with respect to the ground?
(c) How long does the boat take to cross the river?

93. You start playing a Metallica CD in your CD player, when you realize you did not want the Metallica CD but a Vivaldi CD and you press the stop button. The CD started from rest, going to 57 rad/s in 2.5 s, maintained a steady angular velocity for another 0.80 s, and then slowed down to rest (at a steady rate) in another 5.0 s. The radius of the CD is 62 mm. If you use a convention in which the CD rotates in the $+\theta$ direction, calculate the following for a point on the rim of the CD:

(a) the distance it traveled (in meters) over the full 8.3 s of rotation;
(b) its average tangential speed (in m/s) over the full 8.3 s, and
(c) the magnitude and sign of its average tangential acceleration (in m/s^2) over the first 3.3 s of rotation.

94. (a) State if the following statement is true or false and **explain** your answer: The displacement *always* equals the product of average velocity and the time interval.
(b) If an object is moving toward the west at some instant, in what direction is its acceleration?

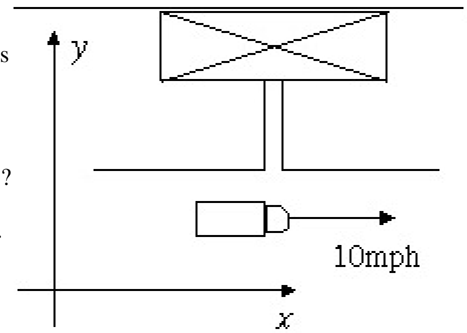
(A) North (B) East (C) West (D) South (E) May be any direction

(c) The position vector of a chicken in a coop is given as a function of time *t* by $\mathbf{r} = 2\mathbf{i} - 6t^3\mathbf{j}$, with position in meters and time in seconds. Write the expression for the instantaneous velocity of the chicken as a function of time.
(d) During one of the many wars between Britain and France, a frustrated Napoleon shoots a cannon across the English Channel. The initial speed of the cannon ball is 23 m/s at an angle of 53˚ from the vertical. What is the instantaneous vertical velocity of the cannon ball when it is furthest from the ground?

95. Two long separated friends, Jill and Bill, spot each other in an airport terminal from a distance of 20.0 m. They start to run toward each other. Bill accelerates at a constant rate of 9.00 cm/s^2 and Jill at a constant rate of 11.0 cm/s^2. They both start from rest.

(a) How far from Jill's initial position do they meet?
(b) What is the average speed of Jill? Of Bill?
(c) If Bill is 1.20 times as heavy as Jill, how far from Jill is their center of mass when they start running?

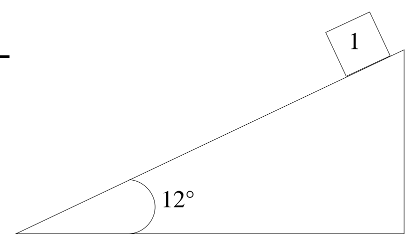
96. The paper delivery boy throws the paper onto your narrow oorstep without slowing down. His pickup truck travels at 10 mph, and he throws the paper at 20 mph relative to the truck just as the truck passes your doorway (see figure).



(a) What is the direction of the paper's velocity relative to the ground? Use the coordinate system in the figure to specify the direction.
(b) In what direction should the delivery boy throw the paper in order for it to land on your doorstep? Express your answer in degrees counterclockwise from the positive *x* axis.
(c) What is the paper's speed relative to the ground?

97. (a) An object weighing 125 pounds on earth is taken to the moon. What is the weight of the object on the moon? ____________
(b) A rock is dropped on a small planet. It falls 3.0 m in 2.0 s. Find g. ____________
(c) An object weighs 345 pounds. Find its weight in Newtons. ____________
(d) An object whose mass is 110 kg is taken to the moon. Find its mass on the moon. ____________
(e) A 100,000 pound coal car on a horizontal track is acted on by a horizontal force of 100 pounds. If there is no friction, find its acceleration. ____________

98. (a) Calculate the weight on the moon of an object that weighs 36.2 pounds on Earth. ____________
(b) Calculate the mass on Earth of an object that weighs 64.2 N on the moon. ____________
(c) Block 1 has a mass of 2.00 kg. The coefficient of static friction is 0.75. The block is not moving. Calculate the frictional force on the block (on Earth).____________



(d) Convert 32.3 N to pounds. ____________
(e) Convert 624 kg to the proper English unit. ____________

99. (a) Convert 645 pounds to Newtons. ____________
(b) Calculate the mass of an object whose weight on Earth is 727 Newtons. ____________
(c) An object weighs 75.2 pounds on Earth. What is the weight of the object on the moon? ____________
(d) An object has a mass of 37.2 slugs on the moon. What is the mass of the object on the Earth? ____________
(e) Calculate the acceleration (in ft/s^2) of a car on a curve of radius 400 ft. The speed of the car is constant at 75.0 mi/hr. ____________

100. An elevator and its load have combined mass of 1600 kg. Find the tension in the supporting cable when the elevator, originally moving downward at 20 m/s, is brought to rest with constant acceleration in a distance of 50 m.

101. An elevator weighing 6000 lb is pulled upward by a cable with an acceleration of 4.0 ft/s^2.

(a) What is the tension in the cable?
(b) What is the tension when the elevator is accelerating downward at 4.0 ft/s^2 but is still moving upward?

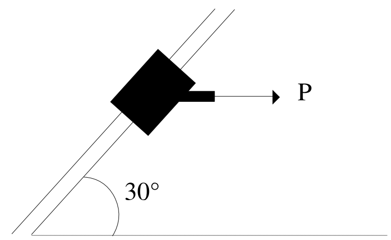
102. A man of mass 80 kg jumps down to a concrete patio from a window ledge only 0.50 m above the ground. He neglects to bend his knees on landing so his motion is arrested in a distance of about 2.0 cm.

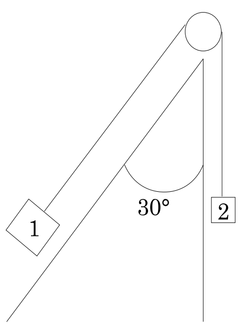
(a) What is the average acceleration of the man from the time his feet first touch the patio to the time he is brought fully to rest?
(b) With what average force does this jump jar his bone structure?

. You weigh 200 pounds. You get on an elevator and stand on a scale. The scale reads 225 pounds for the first 10 seconds, 200 pounds for the next 20 seconds, and 175 pounds for the next 10 seconds.

(a) After this 40 second period, how far has the elevator moved from its original position?
(b) Is it above or below its original position?

104. The 3.0 kg collar is moving down the rod with a velocity of 3.0 m/s when a force P was applied to the horizontal cable. Assuming negligible friction between the collar and the rod, determine the magnitude of the force P if the collar stopped after moving 1.0 m more down the rod.

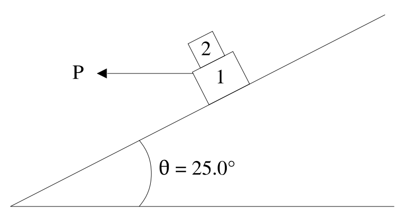




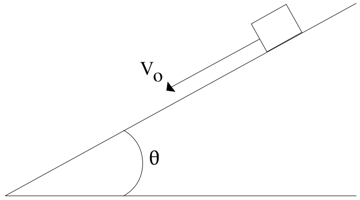
105. Clear free body diagrams and force diagrams are needed for full credit. The right-hand side of the plane is vertical.

(a) If m_1 = 0.375 kg and m_2 = 0.425 kg, calculate the acceleration of the system. Indicate its direction by an arrow on your drawing. The system is frictionless.
(b) If released from rest, how far does "1" travel in 2.50 s?

106. The horizontal force P acts on block 1 of mass m_1. The mass of 2 is m_2. The coefficients of static friction for ***all*** surfaces are 0.60, and of kinetic friction for ***all*** surfaces are 0.50, m_1 = 1.00 kg, m_2 = 0.750 kg. Clear free body diagrams and force diagrams are necessary for full credit.

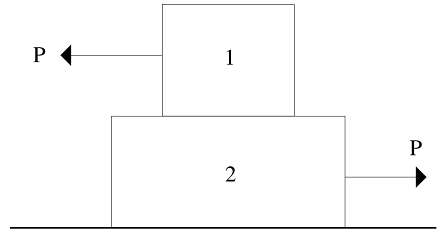


(a) Calculate the maximum acceleration of mass 1 ***parallel*** to the plane such that 2 does not slide with respect to 1.
(b) Calculate the value of P needed to produce the acceleration in (a). If you cannot do (a), do (b) leaving the acceleration as an unknown, a.

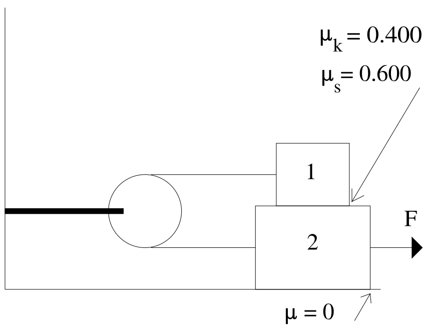


107. A clear free body diagram and force diagram are needed for full credit. Given $\theta = 20.0°$, $\mu_K = 0.50$, $\mu_S = 0.55$. The block is launched down the plane with an initial velocity of 2.75 m/s, and its mass is 1.25 kg. Calculate how far the block slides from its starting point before stopping. The plane (if needed) is infinitely long.

108. Block 1 sits on top of block 2. The coefficients of friction between blocks 1 and 2 are $\mu_S = 0.75$ and $\mu_K = 0.60$. The table is frictionless. A force P is applied on block 1 to the left, and block 2 to the right.



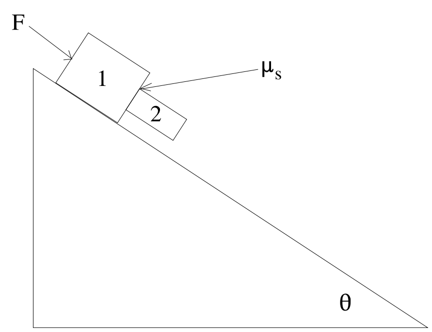
(a) Draw clear free body diagrams for each block.
(b) Find the minimum value of P such that both blocks move.
(c) After they start moving, find the acceleration of each block.



109. In the drawing shown, there is ***no*** friction between the bottom block and the table. The friction coefficients between the two blocks are given. $M_1 = 2.00$ kg and $M_2 = 4.00$ kg. The pulley is frictionless. The string is massless and does not stretch.

(a) Draw clear free body diagrams for each of the blocks. Identify and define any symbols you use.
(b) Find the maximum value of F such that the system does not move.
(c) Find the value of F if the acceleration of block 1 is $0.700\ m/s^2$ to the left.

110. Block 1 is accelerated down the plane such that block 2 does not fall off or slip with respect to 1.

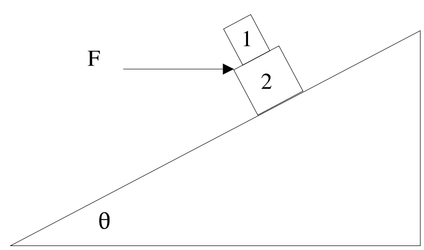


(a) Find an algebraic expression for the minimum value of the acceleration such that this occurs. The answer should be expressed in terms of g, θ, μ_S, m_1 and m_2 (not necessarily all of these are needed).
(b) If $m_1 = 4.00$ kg, $m_2 = 1.00$ kg, $\theta = 30°$ and $\mu_S = 0.65$, find the value of F needed to produce the acceleration in (a). Assume the plane is frictionless. If you did ***not*** get (a), do (b) leaving the acceleration as an unknown.

111. A 10 kg block of steel is at rest on a horizontal table. The coefficient of static friction between block and table is 0.50.

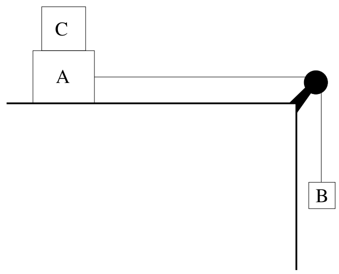
(a) What is the magnitude of the horizontal force that will just start the block moving?
(b) What is the magnitude of a force acting upward 60° from the horizontal that will just start the block moving?
(c) If the force acts down at 60° from the horizontal, how large can it be without causing the block to move?

112. Block 1 is placed on top of block 2. A constant horizontal force F is applied to block 2 as shown. The coefficients of friction are μ_S (static) and μ_K (kinetic) between all surfaces. The mass of 1 is m_1, and the mass of 2 is m_2.



(a) Draw a clear, and distinctly labeled free body diagram for each block. Be sure to define symbols.
(b) Draw a separate, clear, distinctly labeled force diagram for each block.
(c) Set up the complete set of equations necessary to find the maximum force F possible such that 2 accelerates, but 1 does not move with respect to 2. Be sure to include even the "obvious" equations.

113. In the figure shown, A is a 44 N block and B is a 22 N block.

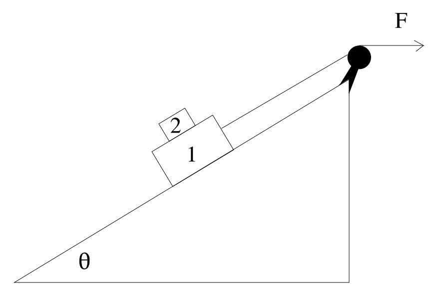


(a) Determine the minimum weight (block C) that must be placed on A to keep it from sliding if μ_S between A and the table is 0.20.

(b) Block C is suddenly lifted off A. What is the acceleration of block A if μ_K is 0.20 between block A and the table?

114. A car comes to a stop leaving skid marks 140 feet long. If the coefficient of friction between the tires and the road is 0.65, how fast was the car going at the beginning of the skid marks? Express your answer in feet per second ***and*** miles per hour.

115. In the drawing to the right, block 1 is pulled by a massless cord which is pulled by a constant force F as shown. The coefficient of static friction between 1 and the plane is $0.70 = \mu_S$, and the coefficient of sliding friction in both places is $0.60 = \mu_K$. The mass of 1 is 2 kg and the mass for 2 is 0.5 kg.

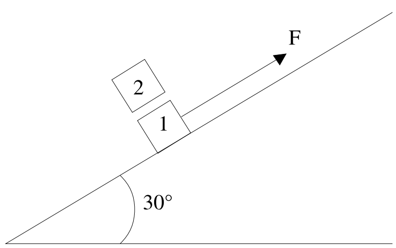


(a) Calculate a general expression for the acceleration of the two blocks up the plane for the case where 2 does not slide.

(b) Calculate the maximum acceleration of the system up the plane such that block 2 does not slide with respect to block 1.

(c) Calculate the maximum force in Newtons for (b).

In each case draw a clear free body diagram appropriate to the problem and on a ***separate*** drawing show the force components in the most useful coordinate system.



116. Assume the coefficients of friction given apply to both the surface between 1 and the plane, and between 1 and 2.

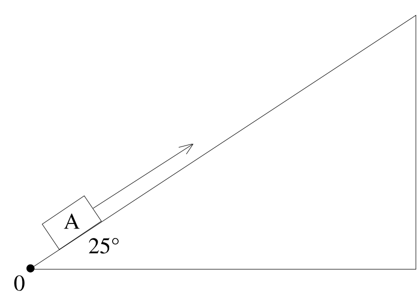
(a) Draw a clear free body diagram for both objects.

(b) Calculate the minimum acceleration up the plane of 1 such that 2 slides with respect to 1.

(c) Calculate the minimum force F needed to produce this acceleration. (Calculate the F to get things started from rest.)

$m_1 = 2.50$ kg, $m_2 = 1.75$ kg, $\mu_K = 0.65$, $\mu_S = 0.75$

117. A block A of mass 2.00 kg is projected up the incline with an initial velocity of 3.00 m/s. The coefficient of friction between the block and plane is 0.05.



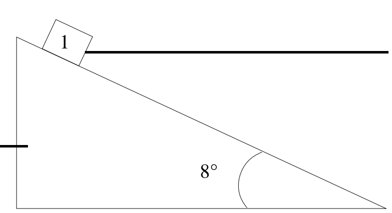
(a) How far up the plane does the block go? The block starts with its rear corner at 0. Measure the distance up from 0 to the rear corner of the block.

(b) When the block slides down and returns to 0, what is its velocity?

118. (a) An object weighs 227 pound on Earth. Find its mass in slugs. ____________________

(b) Calculate the mass on Earth of an object that weighs 325 N on the moon. ____________________

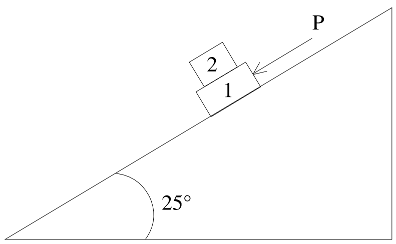
(c) The mass of block 1 is 4.25 kg. The coefficient of static friction is 0.65. Block 1 is not moving. Calculate the frictional force on block 1. ____________________



(d) On a small planet an object of mass 1.75 kg falls from rest a distance of 33.0 m in 15.0 s. What is the weight of that object on that planet? ______________________

(e) Find the mass, in kg, of an object that weighs 25.2 pounds on the moon. ______________________

119. In the drawing shown, the force P cause the blocks to accelerate down the plane.



(a) Draw clear free body and force diagrams for each block. Choose a sensible coordinate system.

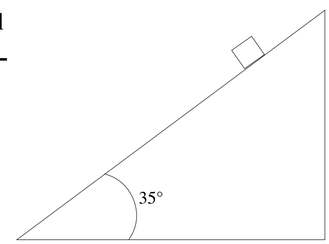
(b) Using the data given, calculate the maximum value of P such that 2 does not slide with respect to 1.

$\mu_S = 0.70$ (all surfaces)
$\mu_K = 0.50$ (all surfaces)
$m_1 = 5.25$ kg
$m_2 = 3.75$ kg

120. (a) An object has a weight of 275 N on the moon. What is its weight on Earth? ______________________

(b) An object has a mass of 343 kg on Earth. What is its mass on the moon? ______________________

(c) When set in motion the block of mass 2.55 kg moves with constant velocity down the plane. If it is at rest on the plane, what is the frictional force acting on it? ______________________



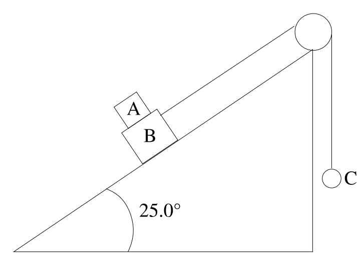
121. An elevator and its load weigh 7500 N. The elevator accelerates upward from rest to a speed of 15.0 m/s in a distance of 22.0 m. Calculate the tension in the cable while the elevator is accelerating.

122. The system shown is initially at rest. The coefficient μ_S and μ_K apply to all surfaces.

(a) Draw clear free body and force diagrams for B and A.

(b) What is the minimum value of m_A such that the system does ***not*** move?

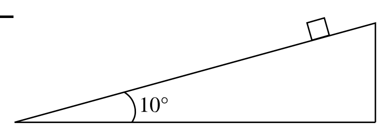
$m_A = ?$ $\mu_S = 0.66$ $m_B = 6.25$ kg $\mu_K = 0.52$ $m_C = 10.0$ kg



123. (a) Convert 375 kg to slugs. ______________________

(b) Find the weight in Newtons of a 256 slug mass. ______________________

(c) The block is at rest on the plane. Its mass is 12.0 kg. The coefficients of friction are $\mu_S = 0.75$ and $\mu_K = 0.60$. Calculate the frictional force on it. ______________________



(e) A 3000 lb car is acted on by a horizontal force of 15.0 lb. If it starts at rest and there is ***no*** friction. Calculate how far it moves in 7.00 s. ______________________

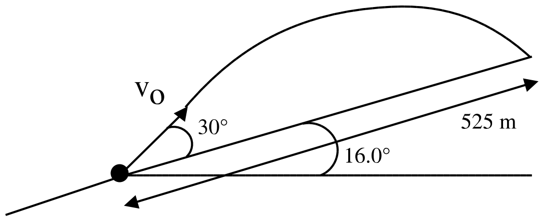
124. A car stops from a speed of 60.0 mi/hr in a distance of 347 ft on a level road.

(a) Calculate the coefficient of friction between tires and road.

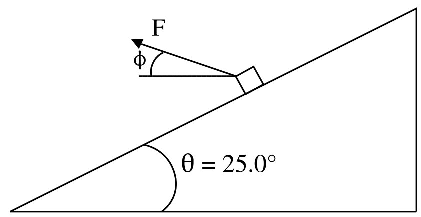
(b) If the car weighs 3750 pounds, calculate the force slowing the car.

125. On the moon, a rock is thrown up a hill that is inclined at 16.0° to the horizontal. The rock lands 525 meters up the hill.

(a) Find the initial velocity.
(b) Calculate the magnitude and direction of the velocity when the rock lands. (Express the angle using a labeled drawing.)

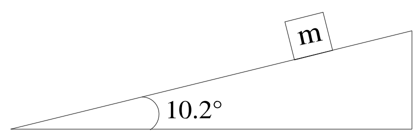


126 A block of mass m = 1.35 kg slides on an inclined plane with friction. The coefficients of friction are $\mu_K = 0.60$ and $\mu_S = 0.70$, between the block and the plane. An external force F is applied at an angle $\phi = 15.0°$ from the horizontal, as shown.



(a) Calculate the minimum value of F such that the block just starts to move. A free body diagram and a force diagram are a necessary part of the problem.
(b) If the force F = 6.00 N (not the same as in (a), calculate the velocity of the block after it has moved 2.50 m down the plane.

127. (a) Calculate the weight (in N) of an object that weighs 556 pounds (on Earth). __________
(b) Determine the weight (in N) on the moon of an object that weighs 789 N on Earth. __________
(c) Find the mass on the moon of an object whose mass is 20.0 slugs on Earth. __________
(d) If the mass shown has m = 14.2 kg, calculate (on Earth) the force of friction on it if it is at rest. __________

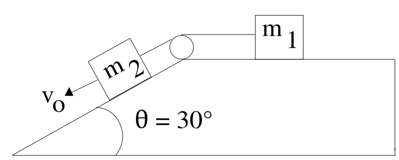


(e) A 4,500 N force is applied horizontally (and parallel to the track) to a railroad car that weighs 100,000 N (on Earth). Find the acceleration that results, if friction is taken to be zero. __________

128. A brick hangs from a string attached to the ceiling. When a horizontal force of 4.00 N is applied to the brick, the string makes an angle of 18.0° with the vertical.

(a) Calculate the mass of the brick.
(b) Determine the tension in the string.

129. Masses $m_1 = 1.0$ kg and $m_2 = 3.0$ kg are connected by a stretched rope. Mass m_2 is just over the edge of the ramp, as shown. The coefficient of kinetic friction of each mass with the surface is 0.21. At t = 0 the system is given an initial velocity of $v_o = 11.0$ m/s which starts m_2 down the ramp. Assume the rope and ramp are long enough that m_1 always stays on the flat, and m_2 always stays on the ramp. The pulley is massless and frictionless.

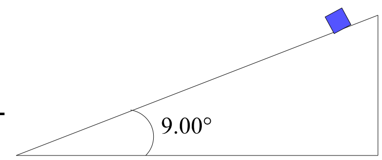


(a) Draw complete free body diagrams and separate force diagrams for each mass.
(b) Calculate the velocity of the system as a function of time.
(c) Find the displacement after 0.50 s.

130. (a) On a small planet a rock falling from rest acquires a velocity of 2.75 m/s after falling 150 m. Calculate g on this planet. ____________________

(b) On the moon an object weighs 75.0 pounds. Calculate its mass on Earth. ____________________

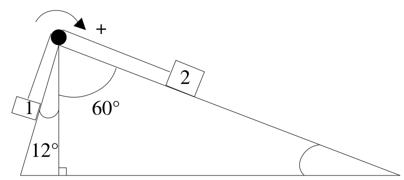
(c) The block on the inclined plane has a mass of 1.50 kg. The coefficient of static friction is 0.80 and of kinetic friction 0.60. The block is not moving. Calculate the magnitude of the force of friction acting on the block (on Earth). ____________________



(d) An object has a mass of 6.00 slugs. Calculate its weight on the moon. ____________________

(e) An object has a mass of 35.0 kg. Calculate its weight (on Earth) in pounds. Use the data given!. ____

131. For the system shown there is no friction between the blocks and the planes. The string is massless and the pulley is massless and frictionless.

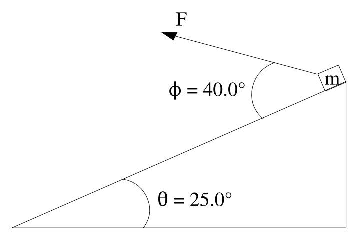


$m_1 = 4.00$ kg $\qquad m_2 = 10.00$ kg

(a) If the positive direction is chosen as shown by the arrow, calculate the acceleration of the system, including sign.

(b) Calculate the tension in the string when the system is accelerated, and moving with a speed of 1.00 m/s.

132. In the drawing shown the block is acted on by a constant force, F.



$\mu_s = 0.80 \qquad \mu_k = 0.60 \qquad m = 3.20$ kg

(a) Show the free body diagram for the block. The angles between the vectors must be clearly shown. Make it big!

(b) Choose a sensible coordinate system, and to the right of the free body diagram show the force diagram for this system. ***Label things clearly!***

(c) Calculate the magnitude of F such that the block moves with a constant acceleration down the plane of 1.25 m/s^2. ***Use the next page with this same problem number for that calculation***.

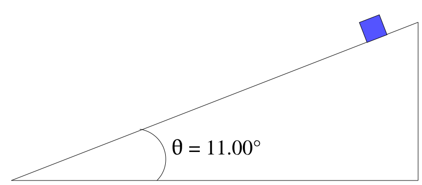
133. (a) A rock is dropped from rest on the moon. Calculate its speed after it has fallen 175 m. ____________________

(b) On a small planet a rock, whose mass is 1.25 kg, falls 27.0 m from rest in 15.0 s. Calculate the weight of this rock on that planet. ____________________

(c) An astronaut weighs 175 pounds on Earth. Calculate the weight of the astronaut on the moon.

(d) In the drawing the mass is 1.35 kg. The coefficients of friction are $\mu_s = 0.55$ and $\mu_k = 0.45$. If the mass is not moving, calculate the frictional force on it.

____



(e) Calculate in kg the mass of an object that weighs 975 pounds (on Earth). ____________________

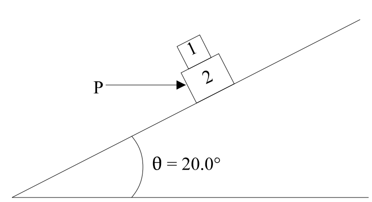
134. In the diagram shown P is applied to block 2 in a ***horizontal*** direction. μ_s and μ_k apply to ALL surfaces.

$m_1 = 2.30$ kg $\mu_s = 0.60$
$m_2 = 4.75$ kg $\mu_k = 0.50$

(a) Draw clear, labeled free body and force diagrams for block 1.

(b) Draw clear, labeled free body and force diagrams for block 2.

(c) Calculate the maximum value of P such that block 1 does not slide with respect to block 2.

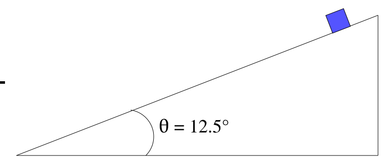


135. (a) Convert 275 N to pounds.

(b) What is the weight, in Newtons, of a mass of 3.75 slugs?

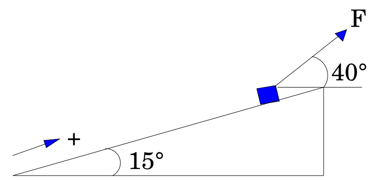
(c) A mass of 367 kg is taken to the moon. What is the weight of the mass on the moon?

(d) In the drawing the mass is 7.25 kg. The coefficients of friction are $\mu_k = 0.50$ and $\mu_s = 0.60$. If the mass is not moving, calculate the frictional force on it.



(e) A mass of 20.0 slugs on earth is taken to the moon. Calculate the mass on the moon in kg.

136. A block is on a inclined plane. The inclined plane has an angle of 15° from the horizontal. An external force, F, is applied to the block at an angle of 40.0° from the horizontal. The coefficients of friction are μ_k = 0.55 and μ_s = 0.65. The mass is 4.27 kg.



(a) Calculate the acceleration of the block in m/s^2 if the force F is 35.0 N. The positive direction is up the plane as shown.

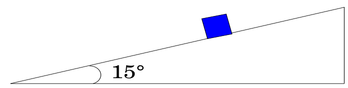
(b) Determine the value of the force (in N) needed to move the block at a constant speed up the incline.

137. (a) A rock with a mass of m = 5.00 kg is on the moon. What is the weight of this object on the moon?

(b) What is the mass of the object in (a) on the moon?

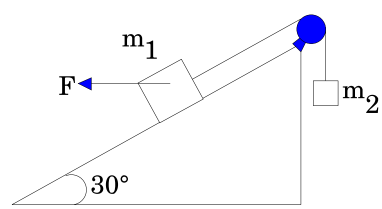
(c) Convert 15.7 N to pounds.

(d) Calculate the acceleration of a car with a constant speed (in ft/s^2) of 6
5 mi/hr on a curve of radius 100 m.



(e) A block of mass 3.62 kg is at rest on an inclined plane. Calculate th
e frictional force on it. (μ_k = 0.4, μ_s = 0.5)

138. The system shown in the drawing rests on an inclined plane with coefficients of friction μ_k = 0.6 and μ_s = 0.7.



(a) Calculate the **minimum** value of F such that the block just starts to move. Clear free body and force diagrams are required for all objects.

(b) Calculate the velocity of the blocks after 3.00 s have elapsed from rest if the force is F = 10.0 N.

(c) Repeat the calculation in (b) for F = 40.0 N.

m_1 = 8.00 kg
m_2 = 3.00 kg

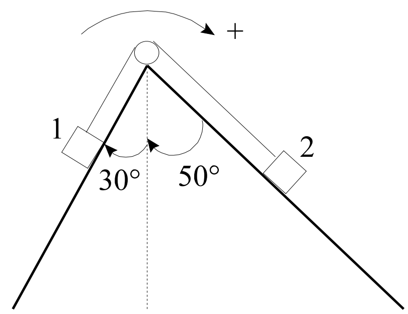
139. (a) An object that weighs 275 pounds on Earth is taken to the Moon. What is the mass of the object on the Moon?

(b) An object which weights 175 N on the Moon is taken to Earth. What is the weight of the object on Earth?

(c) An object on Earth has a mass of 345 kg. What is the weight of this object in pounds?

(d) Your car has a weight of 3220 pounds. If you are capable of exerting a force of 100 pounds and there is absolutely no friction, how far will it move horizontally in 17.0s if you exerted this force?

140. In the drawing shown, block 1 has a mass of 15.0 kg and block 2 has a mass of 18.2 kg. The surfaces are frictionless and the string is massless. The pulley is both massless and frictionless. Using the positive direction as shown by the arrow, calculate:



(a) the acceleration of the system (including sign);
(b) the tension in the string;
(c) the distance traveled by the system 2.00 s after being released from rest.

(Free body and force diagrams are necessary for full credit.)

141. (a) An object whose mass on earth is 365 kg is taken to the moon. Calculate its weight on the moon.

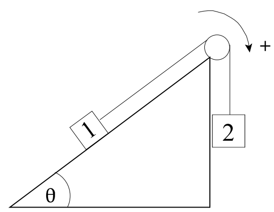
____

(b) An object that weighs 350 N on the earth is taken to the moon. Calculate its weight on the moon.

____

(c) Find the weight on earth, in Newtons, of an object whose mass is 16.7 slugs. ______________
(d) An object of mass 33.2 kg is dropped on the moon. What is its speed after it falls 200 meters? ______
(e) What is the inward acceleration, in m/s^2, of a car rounding a curve at a speed of 50.0 m/s if the radius of the curve is 375 m? ______________________________

142. In the drawing shown the system is frictionless. The string massless. The blocks are released from rest. Clear free body and force diagrams are necessary for full credit.



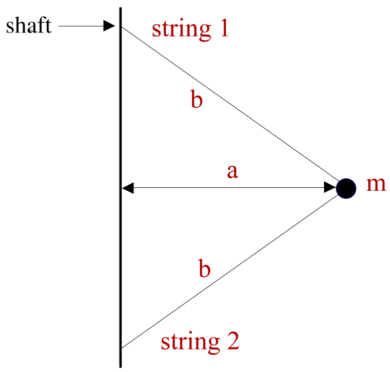
(a) Find the acceleration including signs. Use the sign convention shown.
(b) Calculate the tension in the string after the system is released.

m_1 = 20.0 kg; m_2 = 11.5 kg; θ = 37°

143. (a) Find the weight of a 10.0 kg mass on the earth and on the moon. ______________________
(b) A car accelerates with constant speed of 1.00×10^2 km/hr on a circular curve of radius 50.0 m. Find the acceleration (in m/s^2) and, using a diagram, indicate its direction at a specific point on the curve.

____

(c) Convert 15.5 N to pounds. ______________________________
(d) An object is launched vertically on the surface of the moon with an initial velocity of 5.00 m/s. What is the maximum height above the surface of the moon that is reached by the object? ______________
(e) A spring extends 10.0 cm from its natural length under a force of 5 N. What is the force constant in N/m? ______________________________



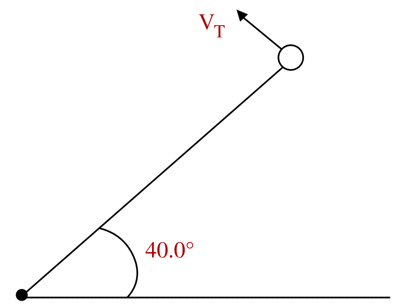
144. A shaft is set up in the vertical direction. Two strings are attached to a mass m as shown. The shaft is rotated so that the tangential velocity of m is 3.10 m/s.

(a) Find the tension in string 1.
(b) Find the tension in string 2.
(c) Calculate the maximum tangential velocity such that the tension in 2 is zero.

a = 1.25 m b = 2.50 m m = 1.75 kg

145. A 1.25 kg mass on the end of a string 0.750 m long is rotated in a circular path in a ***vertical*** plane. The tangential velocity at the point shown in the drawing is 2.71 m/s.

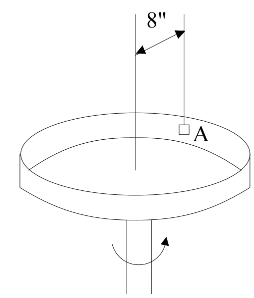
(a) Draw a clear free body diagram for the mass.
(b) Draw a clear force diagram for the mass.
(c) Calculate the tension in the string.



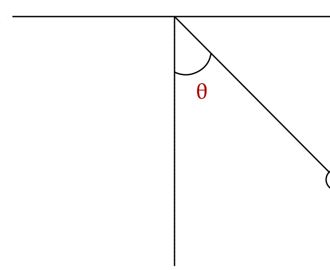
146. A 150 lb student on a steadily rotating ferris wheel has an apparent weight of 125 lb at his highest point.

(a) What is his apparent weight at the lowest point?
(b) What would be his apparent weight at the highest point if the speed of the ferris wheel were doubled?

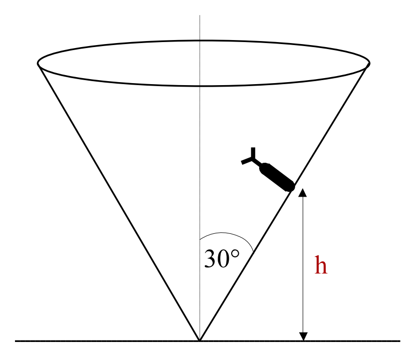
147. The assembly shown rotates about a vertical axis at a constant rate. Knowing that the coefficient of friction between the small block A and the cylindrical wall is 0.20, determine the lowest speed v for which the block will remain in contact with the wall.

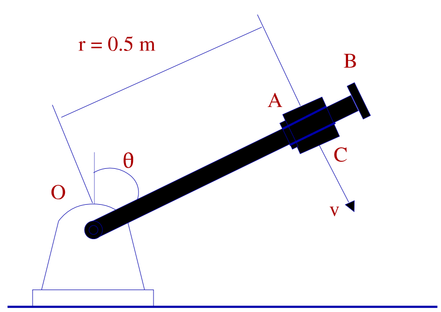


148. A 3 kg ball is swung in a vertical circle at the end of a cord of length $\ell = 0.8$ m. Knowing that when $\theta = 60°$ the tension in the cord is 25 N, determine the instantaneous velocity and acceleration of the ball.



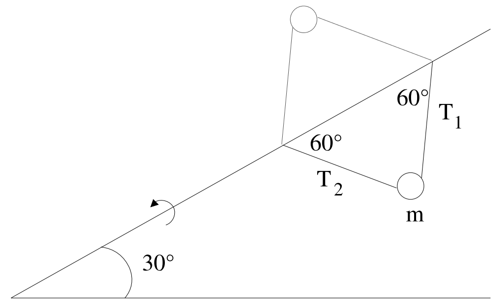
149. A man on motorcycle rides around the inside of a cone. The coefficient of friction between the tires and cone is 0.15 (it is very slippery). If the height h is 30.0 m, find the minimum and maximum possible speed such that the cycle continues in a circle of height h (express these speeds in m/s).





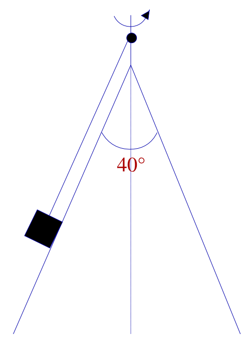
150. The rod OAB rotates in, v, vertical plane at a constant rate such that the speed of collar C is 1.5 m/s. The collar is free to slide on the rod between two stops A and B. Knowing that the distance between the stops is only slightly larger than the collar and neglecting the effect of friction, determine the range of values of θ for which the collar is in contact with stop A.

151. A rod is arranged at an angle of 30° from the horizontal. Attached to the rod with two strings is the mass m, as shown. The rod is rotated, maintaining its direction in space, so that m travels in a circular path. The strings are of equal length, and make angles of 60° with the rod as shown. Take the length of the strings as L.



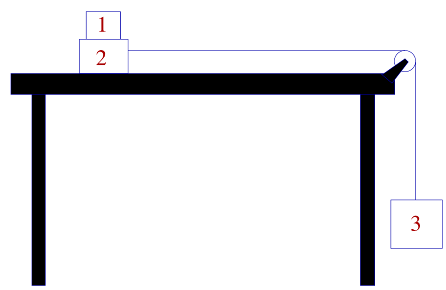
(a) Draw clear free body and force diagrams for the situation where the mass is ***directly above*** the rod (dotted line in the drawing).
(b) Calculate the minimum value of the tangential speed of the mass such that the string with tension T_2 does not become slack when the mass is directly above the rod.
(c) Calculate the value of T_1 for the situation in (b).

152. A frictionless. circular cone is set up with symmetry axis vertical, as shown. The vertex angle of the cone is 40.0°. The cone is rotated about its symmetry axis. A very small mass m (of m = 0.137 kg) is connected by a string to the top of the cone. The string has a length L = 1.25 m. If the mass does not slip with respect to the cone (it rotates with the cone) and its tangential velocity is 0.870 m/s,



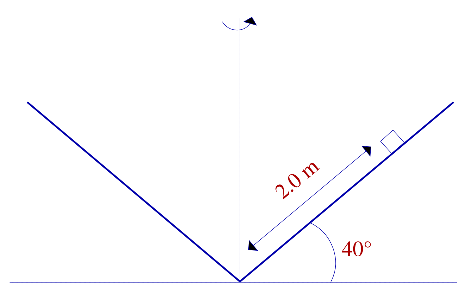
(a) calculate the tension in the string;
(b) calculate the normal force;
(c) calculate the value of the tangential velocity for which the normal force is zero.

153. In this system the table is frictionless. The coefficients of friction between block 1 and block 2 are $\mu_S = 0.67$ and $\mu_K = 0.62$. Calculate the maximum value of m_3 such that 1 does not slide with respect to 2. For full credit you must have free body diagrams for each object.



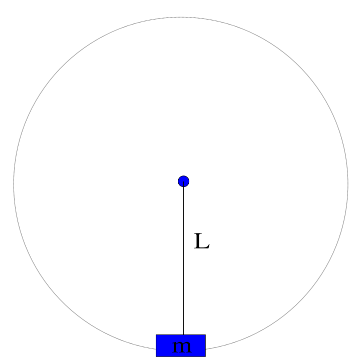
$m_1 = 1.35$ kg
$m_2 = 2.20$ kg
$m_3 = ?$

154. The cone shown rotates about the vertical axis. A block of mass m = 1.25 kg, is at a point 2.00 m up the cone as shown. The coefficients of friction between cone and block are $\mu_K = 0.55$ and $\mu_S = 0.62$.



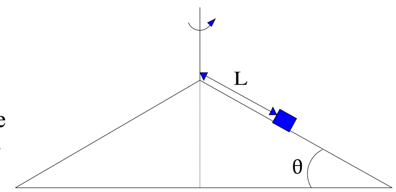
(a) Calculate the <u>minimum</u> value of the tangential velocity of the block such that the block does not slide <u>down</u> the cone.
(b) Calculate the normal force on the block for this velocity.

155. A mass m (m = 3.30 kg) is fastened to a pivot by a massless rod of length L = 0.750 m. The system rotates in the vertical plane at **<u>constant</u>** speed. The tangential speed of the mass is 4.25 m/s.

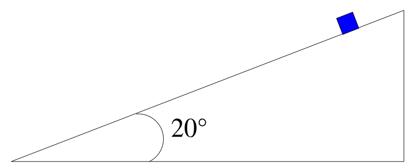


(a) Calculate the tension in the rod at the bottom of the circle.
(b) Calculate the force the rod exerts on the mass at the top. What is the direction of that force (indicate clearly).

156. A block of mass m sits on a conical platform. The angle θ is small enough that the block does not slide when the platform is at rest. The platform is rotated about its vertical axis of symmetry. In terms of θ, m, g, μ_s and L, as needed, calculate the maximum tangential speed of the block such that it does not slide with respect to the platform. An accurate and labeled free body diagram and separate force diagram are needed for full credit. Show clearly the second law equations obtained from the diagrams. BE NEAT.

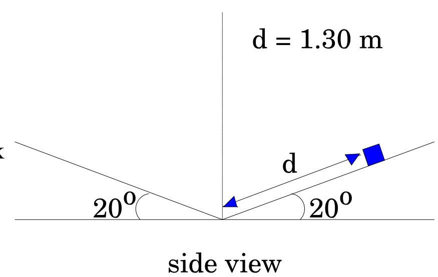


157. The diagram is a cross-section of a banked road. The car is traveling <u>into</u> the paper. The road is very icy, so that the coefficients of friction between tires and road are $\mu_s = 0.20$ and $\mu_k = 0.15$. The road is a curve with radius 400 ft. Take the width of the road as negligible compared to 400 feet.



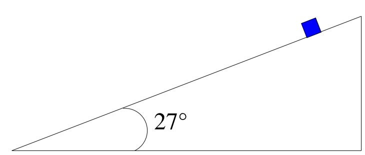
(a) Show a clear, labeled free-body diagram for the car.
(b) Show a clear, labeled force diagram for the car.
(c) Calculate the ***<u>minimum</u>*** speed for this car such that it does not slide off the road.

158. The system shown is a turntable with a conical shape which rotates about the vertical dashed line. A block of mass m is not slipping with respect to the cone. The block has a velocity v directed into the paper. *Clear free body diagrams are necessary for full credit.*



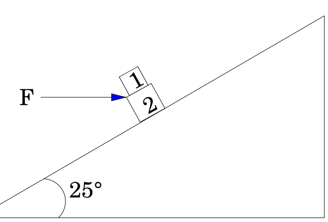
(a) Calculate the maximum possible value of v such that the block does not slide outward. The coefficients of friction are $\mu_k = 0.70$ and $\mu_s = 0.80$.
(b) If the cone is very slippery, find the minimum value of v such that the block does not slide to the inside. The coefficients of friction are $\mu_k = 0.10$ and μ_s 0.15.

159. The diagram is a cross-section of a banked road. The car is traveling <u>into</u> the paper. The road is very icy, so that the coefficients of friction between tires and road are $\mu_s = 0.25$ and $\mu_k = 0.15$. The road is a curve with radius 500 ft. Take the width of the road as negligible compared to 500 feet. Assume the wheels are rolling freely with no braking.



(a) Show a clear, labeled free-body diagram for the car.
(b) Show a clear, labeled force diagram for the car.
(c) Calculate the ***<u>minimum</u>*** speed for this car such that it does not slide off the road.

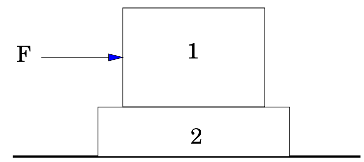
160. In the drawing, force F is horizontal and applied to block 2 only. The coefficients of friction between blocks 1 and 2, and block 2 and plane are $\mu_k = 0.55$ and $\mu_s = 0.65$.



(a) Draw clear, labeled free-body diagrams for each block.
(b) Draw clear, labeled, force diagrams for each block.
(c) Calculate the maximum value of F such that block 1 does NOT slide with respect to block 2.

$m_1 = 4.27$ kg $m_2 = 7.50$ kg

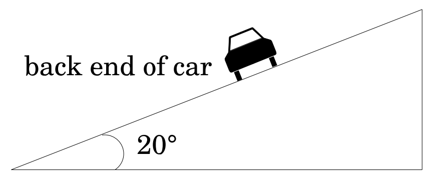
161. In the drawing $\mu_{1s} = 0.83$ and $\mu_{1k} = 0.71$ are the coefficients of friction between block 1 and block 2 and $\mu_{2s} = 0.31$ and $\mu_{2k} = 0.25$ are the coefficients of friction between block 2 and the table. Clearly labeled free body and force diagrams are necessary.



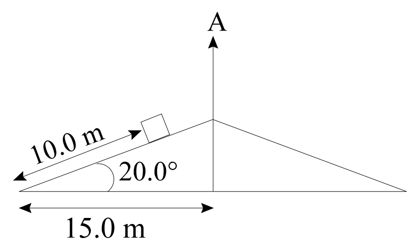
(a) Calculate the maximum force F such that block 1 does not slide with respect to block 2.
(b) What is the acceleration of the blocks for the force determined in (a)?

$m_1 = 3.00$ kg; $m_2 = 2.45$ kg

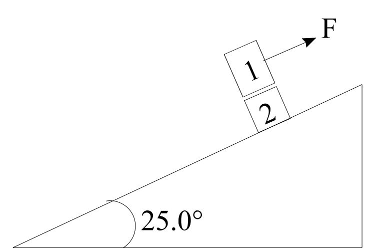
162. The diagram is a cross section of a banked road. The car (you are looking at the back end) shown is ***<u>traveling into the paper</u>***. The road is icy and the coefficients of friction between the tires and road are $\mu_s = 0.25$ and $\mu_k = 0.15$. The road is curved and has a radius of curvature of R = 200 m. Assume the wheels are rolling freely with no braking. Calculate the range of speeds (V_{min}, V_{max}) such that the car doesn't slide off the road. For full credit you must show clear free body and force diagrams for both the V_{min} and V_{max} calculations.



163. The system shown is a cross section of a conical shape that can rotate about the axis A. The block has a mass of 7.75 kg. The coefficients of friction are $\mu_s = 0.75$ and $\mu_k = 0.60$. Calculate the maximum tangential speed due to the rotation of the cone (into the paper in the drawing) of the block when it begins to slide. Proper free body and force diagrams are essential.



164. In the drawing shown the external force F acts on block 1 parallel to the plane. The boundary between block 2 and the plane is frictionless, and the boundary between blocks 1 and 2 has the coefficients given.

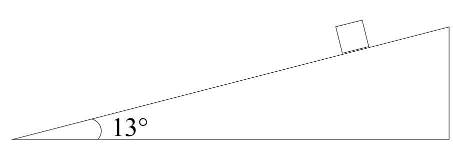


(a) Draw clearly labeled free body and force diagrams for each block.
(b) Calculate the maximum value of F such that block 1 does NOT slide with respect to block 2 when the system slides up the plane.

$m_1 = 11.0$ kg; $m_2 = 7.0$ kg; $\mu_s = 0.70$; $\mu_k = 0.55$

165. (a) The driver of a moving car slams on the brakes and leaves 250 ft of skid marks before stopping. If the friction coefficients are $\mu_s = 0.75$ and $\mu_k = 0.60$, what was the original speed of the car at the beginning of the skid marks?

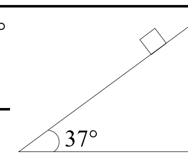
(b) In the drawing shown the block has a mass of 17.5 kg. The friction coefficients are $\mu_s = 0.75$ and $\mu_k = 0.60$. If the block is not moving, calculate the friction force on it.



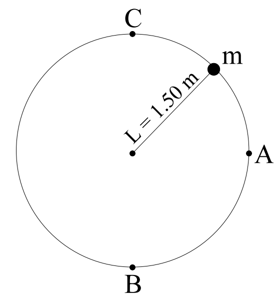
(c) A 100,000 pound railroad car is pushed with a steady horizontal force of 50 pounds. It starts at rest. If there is no friction, what is the speed, in ft/s, of this car after 30.0 seconds?

(d) A car goes around an unbanked curve, which has a radius of 300 m, at a steady speed of 40.0 m/s. A mass is suspended from a string inside the car. What is the angle between the string and the vertical direction?

(e) A block slides down an incline at a constant speed. The incline has an angle of 37.0° from the horizontal. What is the coefficient of kinetic friction?

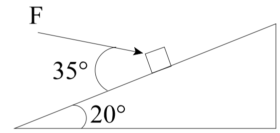


166. A mass m = 1.75 kg is attached to the end of a rigid massless rod of length 1.50 m. The system moves in a vertical plane. The tangential velocity of the mass is constant and is V_{tan} = 1.30 m/s.



(a) Calculate the force, magnitude and direction (inwards or outwards) that the rod exerts on the mass at point A.
(b) Calculate the force, magnitude and direction (inwards or outwards) that the rod exerts on the mass at point B.
(c) Calculate the force, magnitude and direction (inwards or outwards) that the rod exerts on the mass at point C.

167. An external force is applied to the block as shown. The coefficient of kinetic friction is $\mu_k = 0.45$ and the coefficient of static friction is $\mu_s = 0.60$. The mass of the block is 1.25 kg.

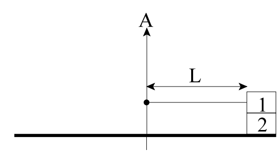


(a) Find the minimum force necessary to start the block moving up the hill. Clear free body and force diagrams are necessary for full credit.
(b) If the plane is extremely slippery with coefficients $\mu_s = 0.10$ and $\mu_k = 0.08$, calculate the value of the force F such that the block moves down the plane at constant speed. [Note: The plane is so slippery that it would accelerate down in the absence of F.]

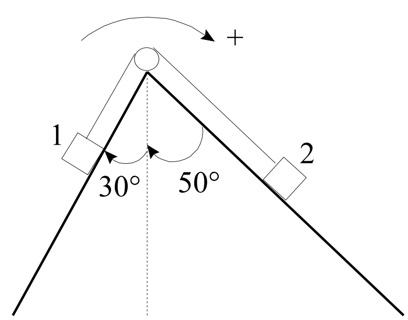
168. Blocks 1 and 2 are on a rotating turntable ("Lazy Susan") as shown. The turntable rotates about the axis A at a constant speed. Block 1 is attached to the axis of rotation with a rope as shown. The coefficients of friction are the same for all surfaces. ***Clear free body diagrams are essential for full credit***.

(a) Find the maximum tangential speed (into the paper) such that block 2 does not slide.
(b) For the conditions in (a), just before block 2 slides, calculate the tension in the rope.

$m_1 = 1.75$ kg
$\mu_k = 0.45$
$m_2 = 3.25$ kg
$\mu_s = 0.55$
L = 1.35 m



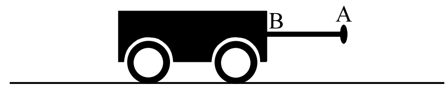
169. Two masses are connected by a massless rope that runs over a frictionless pulley (see figure). Take the positive direction to be to the right. At t = 0 the initial velocity is 11.0 m/s. Mass 1 is 15.0 kg and mass 2 is 18.2 kg. The kinetic coefficient of friction between the blocks and the planes is 0.210. (Assume that the rope and the planes are long enough that each mass stays on its side of the apex.



(a) Draw free body diagrams for each mass.
(b) Calculate the velocity of the system as a function of time. Remember the initial velocity is to the right at t = 0.
(c) Calculate the maximum positive displacement along the plane of the mass 2 (assume displacement is zero at t = 0).
(d) Calculate the coefficient of static friction required to stop the blocks moving at the point of maximum displacement.

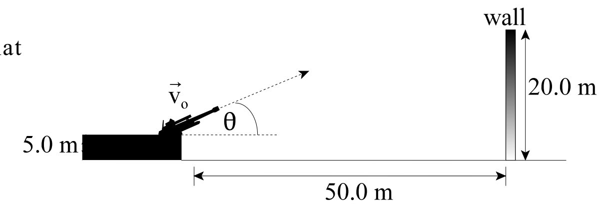
170. (a) Find the weight of a 10.0 kg mass on the earth and on the moon. __________
(b) A car accelerates with constant speed of 1.00×10^2 km/hr on a circular curve of radius 50.0 m. Find the acceleration (in m/s^2) and, using a diagram, indicate its direction at a specific point on the curve.
____
(c) Convert 15.5 N to pounds. __________
(d) An object is launched vertically on the surface of the moon with an initial velocity of 5.00 m/s. What is the maximum height above the surface of the moon that is reached by the object? __________
(e) A spring extends 10.0 cm from its natural length under a force of 5 N. What is the force constant in N/m? __________

171. A child pulls a 10.0 kg wagon on a horizontal surface with a horizontal handle of mass 2.00 kg. The handle starts at point B and ends at point A. The child accelerates the wagon and handle at 3.00 m/s^2.



(a) Calculate the force that the child must apply to the handle and wagon.
(b) Calculate the force on the handle at point A (right-hand side).
(c) Calculate the force on the handle at point B (left-hand side).
(d) Why are the forces in (b) and (c) different?

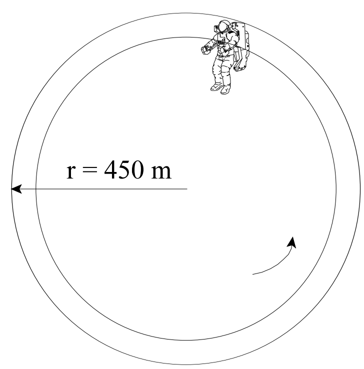
172. A projectile is launched at velocity $\vec{v}_o$ from a platform that is elevated 5.00 m from the horizontal ground. At a distance of 50.0m there is a 20.0 m high vertical wall.



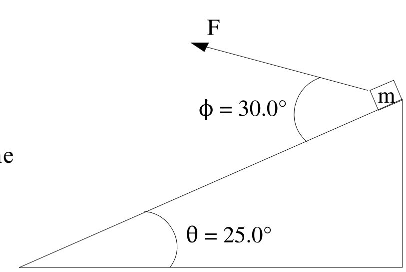
(a) Calculate the horizontal distance traveled by a projectile that just clears the wall when launched at an angle of 30.0° (θ = 30.0 °) with respect to the horizontal.
(b) What happens to a projectile launched at velocity $\vec{v}_o$ and θ = 30.0° if the distance to the wall is 30.0 m (instead of 50.0 m)? **You must give a reason for your answer.**

173. (a) If I can barely lift a 50 kg block on the moon, how massive a block can I lift on Earth? ______
(b) A force of 50 N is applied to a spring which is in equilibrium. The spring constant is 500 N/m. How much does the spring stretch? ______
(c) If the direction of the force in part (b) is reversed and applied to the same spring in equilibrium, how much does the spring compress? ______
(d) A helicopter is accelerating vertically. A block of mass 1 kg is resting on a vertical spring attached to the floor of the helicopter. The spring, whose spring constant is 800 N/m, elongates by 5 cm from its unstretched length. What is the acceleration of the helicopter (magnitude and direction)? ______
(e) A car accelerates with a constant speed of 50.0 km/hr around a circular curve of radius 1.00×10^2 m. Find the acceleration in **m/s^2**. ______

174. A space station is in the shape of a hollow ring, 450 m in radius. At how many revolutions per minute should it rotate in order to simulate Earth's gravity--that is, so that the normal force on an astronaut at the outer edge would be the astronaut's weight on Earth?

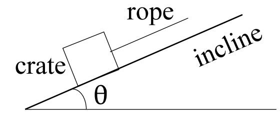


175 In the drawing shown the block is acted on by a constant force, F. The friction between the block and the plane is $\mu_s = 0.80$ or $\mu_k = 0.60$. The mass of the block is m = 6.15 kg.



(a) Show the free body diagram for the block. The angles between the vectors must be clearly shown. Make it big!
(b) Calculate the magnitude of F such that the block moves with a constant acceleration down the plane at 1.00 m/s^2.

176. You are moving into an apartment and plan to drag a heavy crate of mass $m = 62$ kg up a ramp that has been placed over the steps leading to the front door. The ramp is at an angle = 22° to the horizontal and you pull on the crate with a rope which is parallel to the ramp as shown. The coefficient of static friction between the crate and the ramp is $\mu_s = 0.42$, while the coefficient of kinetic friction is $\mu_k = 0.28$. For the purpose of this problem, assume that the rope is massless and does not stretch.



(a) Initially the crate is at rest at the bottom of the ramp. If you now apply a force $F = 480$ N to the rope, will the crate accelerate up the ramp or remain at rest? If it has an acceleration, calculate its magnitude. *Make sure that you draw a force diagram of the crate.*

(b) For *each* of the forces in your force diagram, identify the reaction force prescribed by Newton's *third* law. Give the magnitude and direction of each reaction force, *and* identify the object on which this reaction force acts.

177. The pendulum of a grandfather clock consists of a uniform thin disk of radius R and mass M, whose center is attached at the end of a uniform thin rod of length L and mass m. The other end of the rod is attached to a pivot so that the pendulum rotates in the vertical plane.

(a) Obtain an expression for the moment of inertia I of the pendulum about the pivot in terms of M, R, m, and L.

(b) Compute the total torque on the pendulum about the pivot when the rod is at an angle with the horizontal. Express your result in terms of g, M, m, L, and . Neglect air resistance.

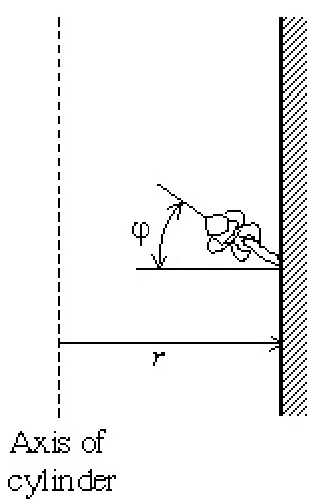
(c) From your results in parts (a) and (b), find the angular acceleration of the pendulum about the pivot when the rod is at an angle with the horizontal.

(d) What is the value of , in rad/s^2, for a pendulum with $R = 0.10$ m, $M = 2.0$ kg, $L = 0.90$ m, $m = 0.45$ kg, and = 20°?

178. A Ferris wheel at an amusement park has a radius $R = 30$ m and makes one complete turn every $T = 75$ s. Calculate the normal force that the seat exerts on a passenger of mass $m = 60$ kg (the seat bottom is always parallel to the ground) when the passenger is

(a) at the bottom of the path, nearest to the ground (*draw a force diagram*), and

(b) at the maximum height of the path (*draw a force diagram*).



179. A trick cyclist rides his bike around a "wall of death" in the form of a vertical cylinder of radius $r = 5.0$ m (see the figure). The coefficient of static friction between the rubber tires and the wall is $_s = 0.60$.

A. What is the direction of the net force acting on the cyclist-bike system when the cyclist rides at constant height?

B. At what minimum speed must the cyclist ride to avoid slipping down?

C. At what angle to the horizontal must he be inclined at this minimum speed? Hint: He should not flip over.

Data: Use these constants (where it states for example, 1 ft, the 1 is exact for significant figure purposes).

1 ft = 12 in (exact)	1 hour = 3600 sec = 60 min (exact)
1 m = 3.28 ft	1 day = 24 hr (exact)
1 mile = 5280 ft (exact)	$g_{earth} = 9.80$ m/s^2 = 32.2 ft/s^2

1 year = 365.25 days

1 kg = 0.0685 slug

1 N = 0.225 pound

1 horsepower = 550 ft·pounds/s (exact)

$M_{earth} = 5.98 \times 10^{24}$ kg

$R_{earth} = 6.38 \times 10^{3}$ km

$M_{sun} = 1.99 \times 10^{30}$ kg

$R_{sun} = 6.96 \times 10^{8}$ m

$M_{moon} = 7.35 \times 10^{22}$ kg

$R_{moon} = 1.74 \times 10^{3}$ km

$G = 6.67 \times 10^{-11}$ N·m^2/kg^2

$k = 9.00 \times 10^{9}$ N·m^2/C^2

$\varepsilon_o = 8.85 \times 10^{-12}$ F/m

$e_{electron\ charge} = -1.60 \times 10^{-19}$ C

$m_{electron} = 9.11 \times 10^{-31}$ kg