HW #01

Roman Senkov

Question 1

0/1 pt 999 998

Which of the following are the possible ways to represent 0.041?

Choices: True or False

$0.41 \cdot 10^{-3}$	Select an answer
$41 \cdot 10^{-1}$	Select an answer
$4.1 \cdot 10^{-2}$	Select an answer
$0.0041 \cdot 10^{1}$	Select an answer
$0.000041 \cdot 10^{3}$	Select an answer
$0.00041 \cdot 10^{2}$	Select an answer

Note: you MUST answer all questions before submitting.

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Question 2

0/1 pt 999 998

If a = 2.3E-14, b = 4.2E-12, and c = 1.7E-18, calculate the following expressions. Note: you can submit your answers in scientific notations, for example, 1234 = 1.234E3 and 0.00123 = 1.23E-3.

$\sqrt[3]{a}$ = _____.

$\frac{a \cdot b}{c}$ = _____.

$\frac{1}{1-b^2} - 1$ = _____.

$\ln\left(\frac{1}{c^2}\right)$ = _____.

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Question 3

0/1 pt 999 998

Calculate the first derivite of $f(x) = x^2 + x^4 - 8 \cdot x^3$.

$f'(x) =$ _____

Find the local extrema of $f(x)$.

The most left extremum, $x_1 =$ _____

The middle extremum, $x_2 =$ _____

The most right extremum, $x_3 =$ _____

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Question 4

0/1 pt 999 998

What is the area of a disk if it's circumference is 19.7 cm?

The area of the disk, A_D = _____ Units Select an answer .

Two short sides of a right triangle are 126.6 cm and 2.7 m. Find the perimeter and area of this triangle.

The perimeter, P_T = _____ Units Select an answer .

The area, A_T = _____ Units Select an answer .

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Question 5

0/1 pt 999 998

A car travels 60 miles with a constant speed of 55 mph and then another 60 miles with 43 mph. How long does it take for the car to travel the first 60 miles?

t_1 = _____ Units Select an answer .

What time is required to travel the second 60 miles?

t_2 = _____ Units Select an answer .

What is the average speed of the car for the entire trip?

The average speed, v = _____ Units Select an answer .

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Question 6

0/1 pt 999 998

Escarpment trail in Catskill mountains is about 24 miles long. LaGuardia Professors Roman and Zach decided to hike this trail together. When they were at the distance x from the trailhead, Prof. Roman decided to turn back to the trailhead, while Prof. Zach continued hiking towards the end of the trail. Find the position x if Prof. Roman arrived to the trailhead 3.7 hours earlier than Prof. Zack to the end of the trail. Both Professors hike at the same average speed of 1.7 mph.

The distance from the trailhead, $x =$ _____ Units Select an answer .

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Question 7

0/1 pt 999 998

Choices: True or False.

If velocity is zero then acceleration must be zero too. Select an answer

If speed is constant then velocity must be constant too. Select an answer

If speed is constant then acceleration is zero. Select an answer

If speed changes then velocity must change too. Select an answer

If velocity is constant then speed must be constant too. Select an answer

Object slows down if it's acceleration is negative. Select an answer

Note: you MUST answer all questions before submitting.

Question Help: Message instructor Post to forum

Question 8

0/1 pt 999 998

A car speeds up from rest to 70 mph over 76 m distance. Assuming motion with constant acceleration, find the time of this speedup process and the acceleration of the car.

The time of the speedup, t = _____ Units Select an answer .

The acceleration of the car, a = _____ Units Select an answer .

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Question 9

0/1 pt 999 998

An object is released from a 250-m height and falls down with the free fall acceleration 9.81 m/s^2. What is the distance traveled by the object during the first 2 sec interval (from $t = 0$ to $t = 2$)?

The distance, H_1 = _____ Units Select an answer .

What is the distance traveled by the object during the second 2 sec interval (from $t = 2$ to $t = 4$)?

The distance, H_2 = _____ Units Select an answer .

How long will it take for the object to reach the ground?

The time of travel, t = _____ Units Select an answer .

What is the speed of the object a moment before it hits the ground?

The speed of the object, v = _____ Units Select an answer .

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Question 10

0/1 pt 999 998

A ball is thrown directly upward, with an initial speed of 29 m/s. Neglecting the air resistance, to what maximum height will the ball rise? Use the free fall acceleration 9.81 m/s^2.

The maximum height, h_{max} = _____ Units Select an answer .

How long will it take for the ball to return back to the ground?

The time of travel, t = _____ Units Select an answer .

At what height the velocity of the ball is the half of it's initial value?

The height, h = _____ Units Select an answer .

What is the magnitude of the ball's acceleration at the highest point?

The acceleration, a = _____ Units Select an answer .

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Question 11

0/1 pt 999 998

A ball is moving perpendicularly to a wall approaching it with an initial speed of 20.6 m/s. After striking the wall it bounces in the opposite direction with a speed of 18.9 m/s. Taking the positive direction towards the wall, find the initial velocity of the ball. Note: pay attention to the sign of the velocity and acceleration.

The initial velocity, $V_{initial}$ = _____ Units Select an answer .

What is the final velocity of the ball after bouncing back?

The final velocity, V_{final} = _____ Units Select an answer .

What is the change in velocity?

The change in the velocity, ΔV = _____ Units Select an answer .

If the contact time between the ball and the wall is 266 msec, what is the average acceleration of the ball during the contact?

The acceleration, a = _____ Units Select an answer .

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Question 12

0/1 pt 999 998

What distance is required to stop a car moving at 74.4 mph? Assume that the driver applies brakes after certain time (the reaction time), before this time the car moves at constant velocity. Take the maximum car's acceleration of `-5` m/s^2 (the acceleration depends on the road condition) and the driver's reaction time of 0.6 sec.

The stopping distance, D_1 = _____ Units Select an answer .

What will be the stopping distance if the maximum acceleration is reduced to `-1` m/s^2?

The stopping distance, D_2 = _____ Units Select an answer .

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Question 13

0/1 pt 999 998

Given the position of an object as a function of time: `x(t) = 18 - 3*t + 1.5*t^2 - 2.4*t^3`, find the object's velocity and acceleration. Assume that time is in seconds and position is in meters.

The velocity, `v(t) =`

The acceleration, `a(t) =`

What is the object's velocity when it's acceleration is zero?

The velocity, `v =` _____ Units Select an answer

At `t = 0` the object is Select an answer .

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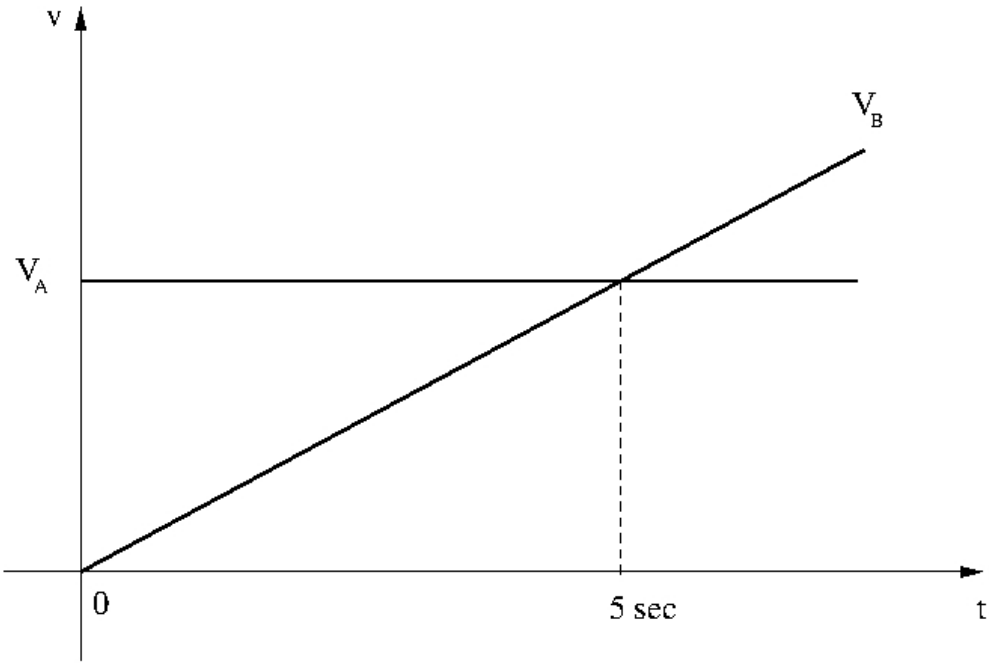
Question 14 0/1 pt 999 998

The motion of cars 'A' and 'B' is described by the figure shown below: car 'A' moves with a constant velocity V_A = 9.4 m/s and car 'B' speeds up from rest with a constant acceleration rate so it reaches the speed of car 'A' at t = 5 seconds.



The acceleration of car 'B', a_B = _____ Units Select an answer .

If initially (at t = 0) the cars were at the same position, at what distance relative to the initial point will the cars meet again?

The distance where the cars meet, D = _____ Units Select an answer .

When will the cars meet?

The time of the meeting, t = _____ Units Select an answer .

At the time of meeting, what will be the speed of car 'B'?

The speed of car 'B', V_B = _____ Units Select an answer .

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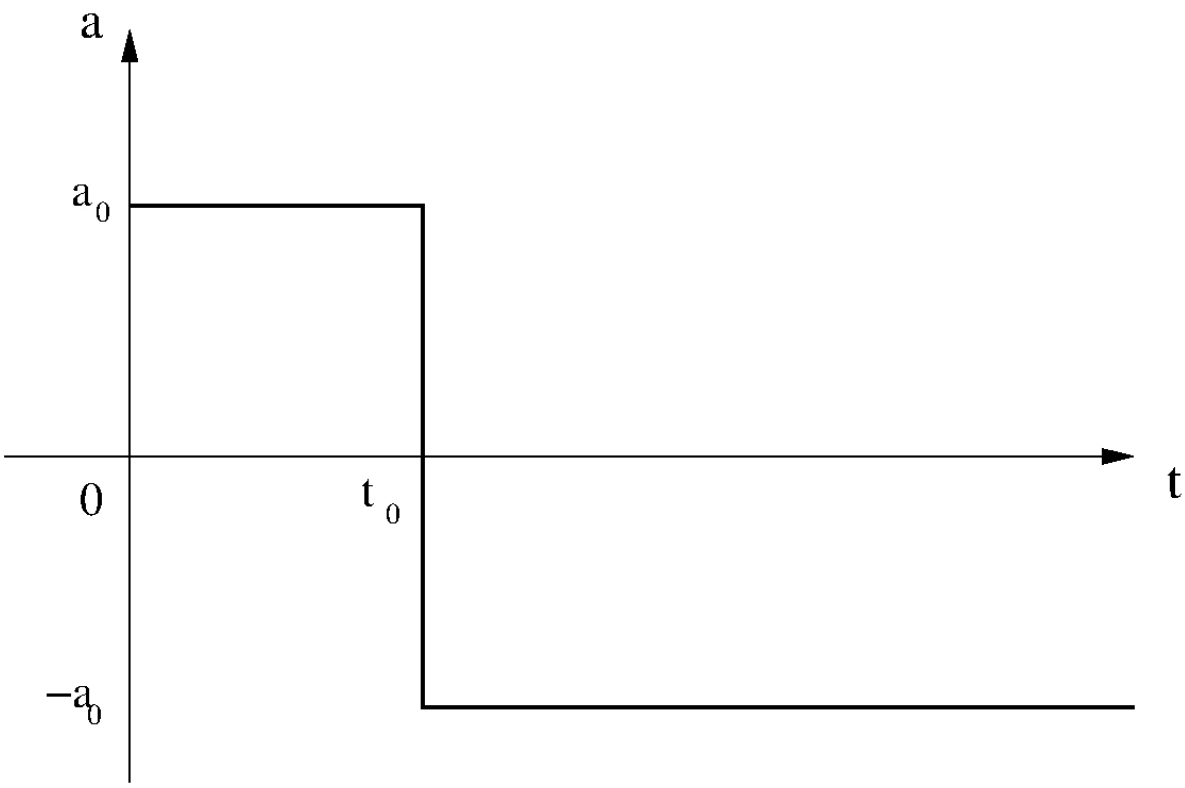
HW #02

Roman Senkov

Question 1

0/1 pt 999 998

A particle starts to move along a straight line with a constant acceleration a_0 = 2 m/s^2. After moving for t_0 = 7.5 seconds the acceleration changes its sign but keeps the same magnitude: - 2 m/s^2 (see the graph below).



At what distance from the initial position will the particle stop (have zero velocity)?

The distance, L = _____ Units Select an answer .

At what time (calculated from the very beginning) will the particle come back to the initial position?

The time, t = _____ Units Select an answer .

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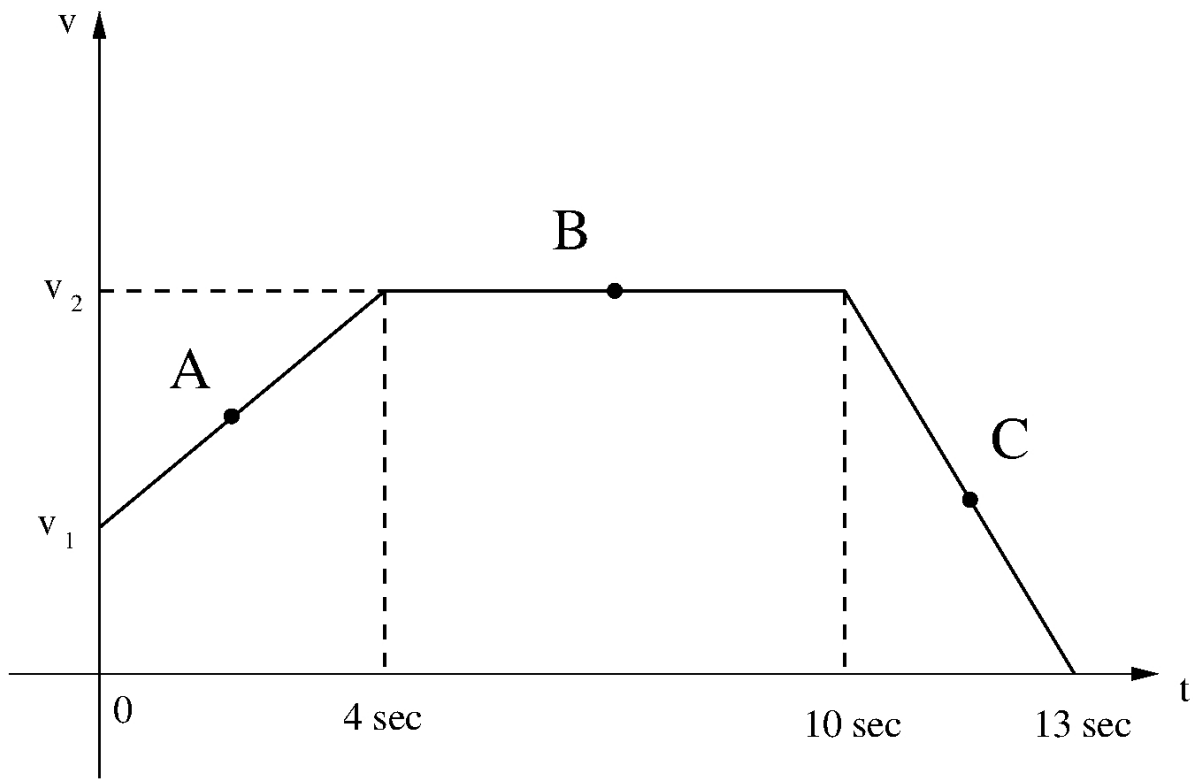
Question 2

0/1 pt 999 998

The velocity of a moving object changes according to the velocity-time graph shown below. Answer the following questions about the motion of the object if v_1 = 6 m/sec and v_2 = 15 m/sec.



How far does the object move from 0 sec to 10 sec?

The change in position, Δx_1 = _____ Units Select an answer .

How far does the odject move from 4 sec to 13 sec?

The change in position, Δx_2 = _____ Units Select an answer .

What is the average velocity of the object for t ∈ [0 sec, 13 sec] time interval?

The average velocity, v_{ave} = _____ Units Select an answer .

What is the acceleration of the object at point A?

The acceleration, a_A = _____ Units Select an answer .

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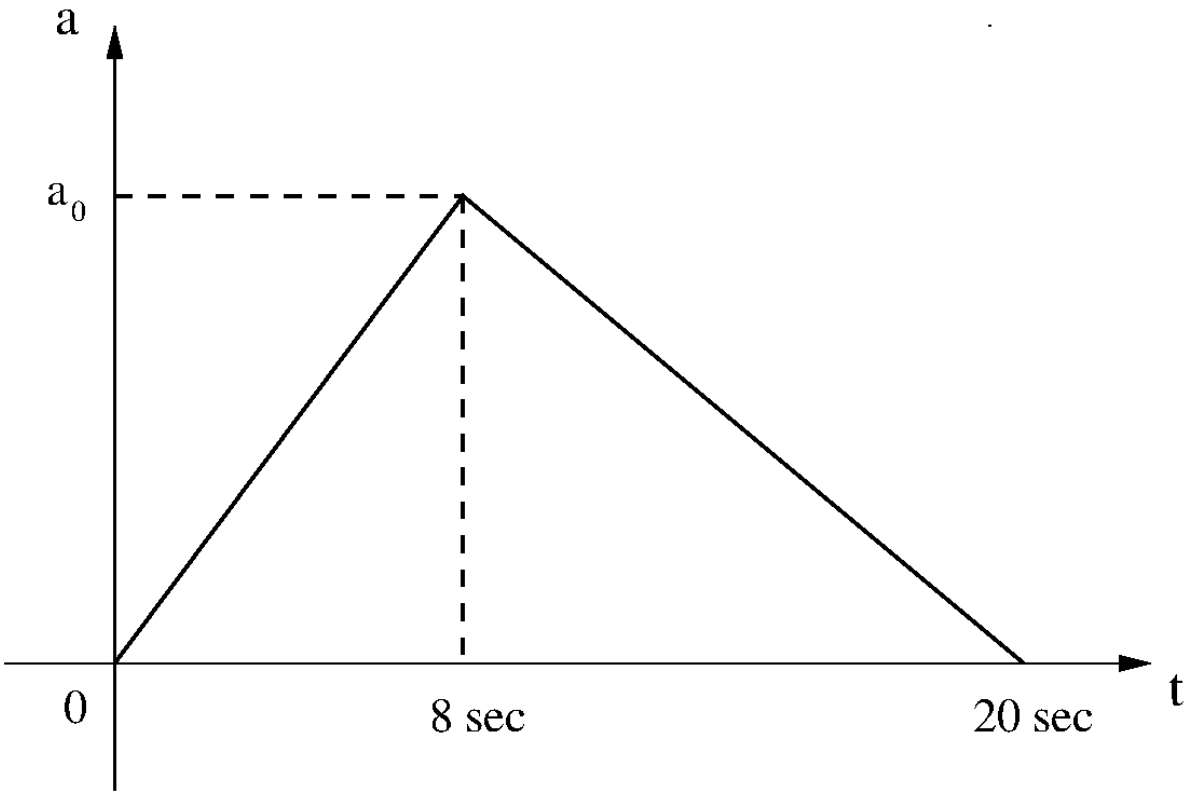
Question 3 0/1 pt 999 998

The acceleration of a car as a function of time is shown on the graph below. If initially (at t = 0) the car was moving at v_0 = 7 m/sec, what is car's velocity at t = 8 sec? Take a_0 = 5.5 m/s^2.



The velocity, v_1 = _____ Units Select an answer .

What is car's velocity at t = 20 sec?

The velocity, v_2 = _____ Units Select an answer .

What is the average acceleration of the car for t ∈ [0 sec, 20 sec] time interval?

The average acceleration, a_{ave} = _____ Units Select an answer .

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Question 4 0/1 pt 999 998

1. A basketball is thrown vertically up from a 1.3-m height with an initial speed v_0 = 23 m/s. At what speed will the ball hit the ground?

The speed of the ball, v_1 = _____ Units Select an answer .

How long will it take for the ball to reach the ground?

The time of flight, t_1 = _____ Units Select an answer .

2. Now the same basketball is thrown vertically down from the same 1.3-m height and with the same initial speed v_0 = 23 m/s. First, check your physical intuition and complete the following twi statements:

If the initial velocity is directed down, the final speed of the ball Select an answer .

If the initial velocity is directed down, the time of the free fall Select an answer .

Now, with the new conditions, what will be the speed of the ball just before it hits the ground?

The speed of the ball, v_2 = _____ Units Select an answer .

How long will it take for the ball to reach the ground?

The time of flight, t_2 = _____ Units Select an answer .

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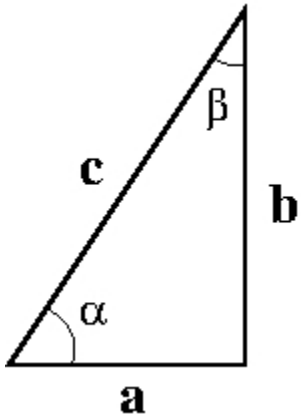
Question 5 0/1 pt 999 998

Consider the right triangle shown below. If the hypotenuse c = 6.3 cm and angle α = 25°, find the short sides of the triangle and the angle β (in degrees).

a = _____ cm.

b = _____ cm.

β = _____ deg.



For a similar triangle (but with different parameters), if a = 2.7 cm and b = 3.6 cm, find the hypotenuse c and angle α (in degrees).

c = _____ cm.

α = _____ deg.

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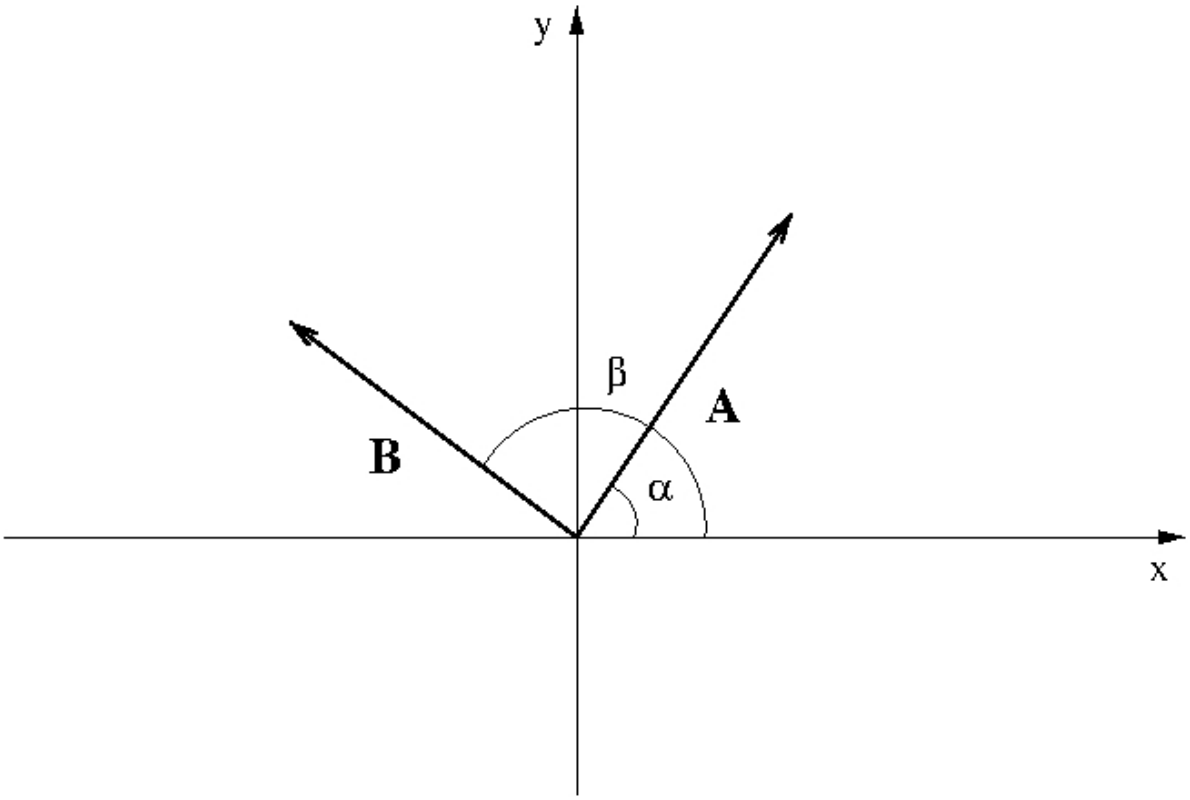
Question 6 0/1 pt 999 998

Consider two vectors shown below. Vector $\vec{A}$ has magnitude 6.5 and makes an angle α = 23° with the positive x-direction, vector $\vec{B}$ has magnitude 4.3 and makes an angle β = 129° with the positive x-direction. Find the x- and y- components of both vectors.



A_x = _____, A_y = _____.

B_x = _____, B_y = _____.

What is the magnitude and direction of $\vec{A} + \vec{B}$?

$\left|\vec{A} + \vec{B}\right|$ = _____, angle = _____.

What is the magnitude and direction of $\vec{A} - \vec{B}$?

$\left|\vec{A} - \vec{B}\right|$ = _____, angle = _____.

Note: For the directions submit the corresponding angles in degrees calculated relative to the positive x-direction from 0° to 360°.

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Question 7 0/1 pt 999 998

How to find pirate treasure (an instruction written on an old map): "Take 70 steps north, then 38 steps west, then 66 steps south, stay still for a while, then take 46 steps east, then 35 steps north and then dig. Heave ho!" If you have followed this instruction and your step is approximately 27 inches, how far will you be from the starting point? Give your answer in feet.

The distance, L = _____ Units Select an answer .

What if the instruction was written for a pirate step and your step is one inch longer? How far from the target will you be? Give your answer in feet.

The dispacement, ΔL = _____ Units Select an answer .

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Question 8

0/1 pt 999 998

During one of his free kicks, Lionel Messi fires the football with an initial speed V_0 = 27.3 m/s and at an angle θ = 21.9° above the horizontal. Neglecting the air friction, at what distance relative to the initial position will the ball land?

The range, R = _____ Units Select an answer .

For how long the ball will be in the air?

The time of flight, t = _____ Units Select an answer .

What could be the maximum range at this initial speed if the take-off angle was optimal?

The maximum range, R_{max} = _____ Units Select an answer .

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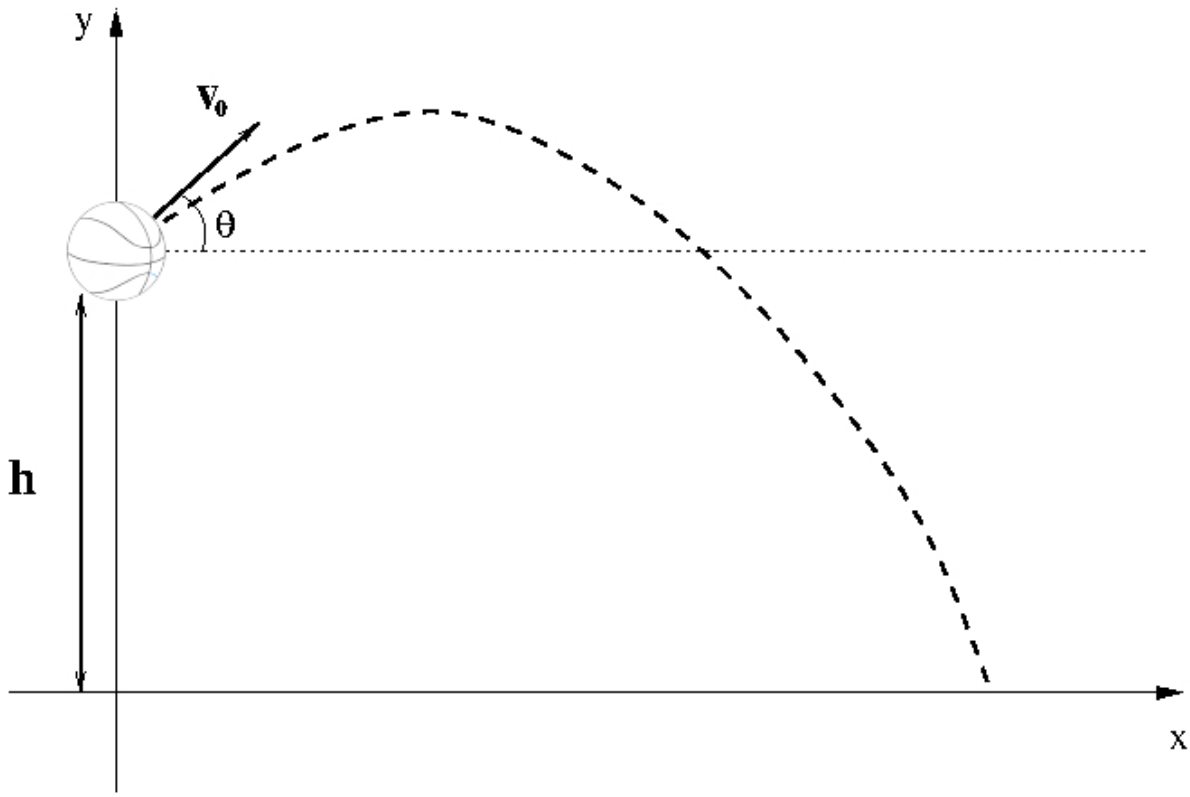
Question 9

0/1 pt 999 998

A basketball is thrown from a height h = 1.3 m with an initial speed v_0 = 5 m/s. The initial velocity of the ball makes an angle θ = 23° with the positive x-direction as shown below. Answer the questions below. Hint: you may find it useful to start by finding the x- and y- components of the ball's initial velocity.



How long will it take for the ball to reach the ground?

The time of flight, t = _____ Units Select an answer .

From the initial position to the landing point, what is the traveled distance in x-direction?

The range, R = _____ Units Select an answer .

What is the speed of the ball just before it hits the ground?

The final speed, v = _____ Units Select an answer .

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Question 10 0/1 pt 999 998

A bullet is fired horizontally with an initial speed v_0. After flying 15 meters in the horizontal direction, the bullet's vertical position decreases by 9.6 cm. What was the initial speed of the bullet?

The initial speed, v_0 = _____ Units Select an answer .

If the bullet with the same initial speed will fly twice as far in the horizontal direction (30 m), by how much will the bullet be lower than it's initial position? Before calculating, check your physical intuition by completing the following statement:

If the horizontal distance is doubled then the decrease in height
Select an answer .

Now calculate the decrease in height for the doubled horizontal distance.

The vertical position will be lower by _____ Units Select an answer .

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Question 11

0/1 pt 999 998

A ball is thrown at an angle of $\theta_0 = 60^\circ$ above the horizontal with an initial speed of $v_0 = 9.5$ m/s. What will be the direction of the ball's velocity after 0.56 sec? Submit the angle between the velocity and the horizontal (in degrees).

The angle, θ = _____ deg.

At what time will the velocity of the ball make an angle 16° relative to the horizontal?

The time, t = _____ Units Select an answer .

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Question 12

0/1 pt 999 998

A ball slides off the edge of a horizontal table with an initial speed of 18 cm/s. The ball hits the floor after it free falls for 69 msec. How far is the landing point from the table's edge (find the distance in cm)? The free fall acceleration is 9.81 m/s^2. Be careful about the units.

The distance from the table's edge to the landing point, d = _____ Units
Select an answer .

What is the ball's speed (in cm/s) and the magnitude of the ball's acceleration at the moment just before landing?

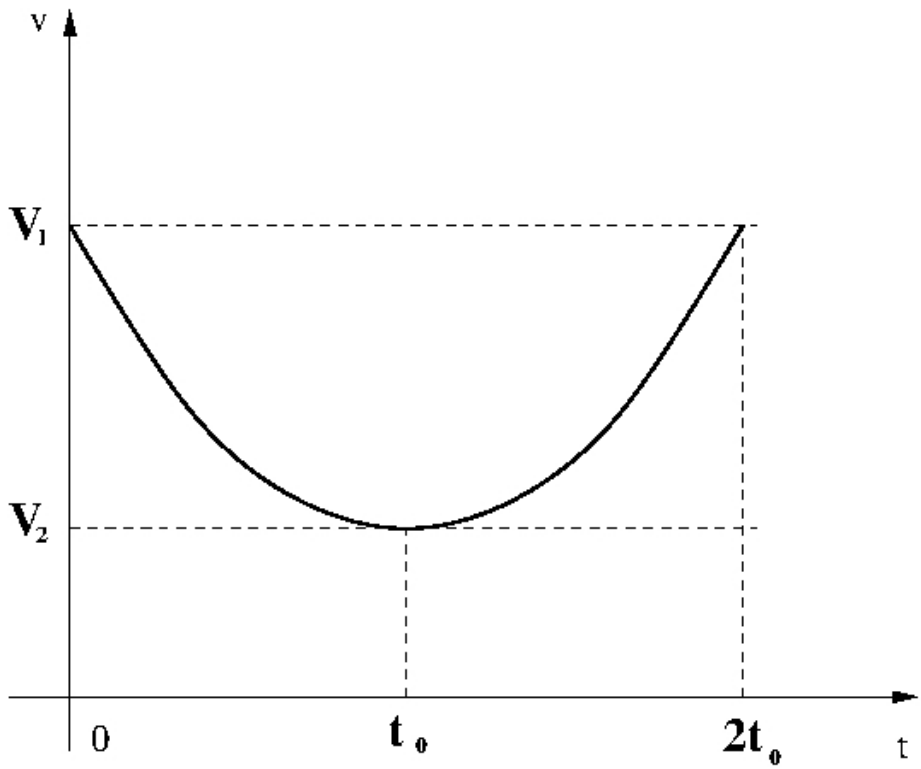
The ball's speed, v = _____ Units Select an answer .

The ball's acceleration, a = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 13 0/1 pt 999 998

A particle is in a projectile ground-to-ground motion. The speed of the particle as a function of time is schematically shown in the figure below. Answer the following questions if the maximum speed of the particle is V_1 = 34.7 m/s and it's minimum speed is V_2 = 24.4 m/s. Neglect the air resistance, the free fall acceleration is g = 9.81 m/s^2.



The particle's acceleration at t = t_0 is zero. Trues or False? Select an answer .

The x-component of the initial velocity, $(V_0)_x$ = _____ Units Select an answer .

The y-component of the initial velocity, $(V_0)_y$ = _____ Units Select an answer .

The time when the speed is minimum, t_0 = _____ Units Select an answer .

The maximum height the particles can reach, h_{max} = _____ Units Select an answer .

The range, R = _____ Units Select an answer .

The take off angle (in degrees), θ = _____ .

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Question 14 0/1 pt 999 998

Blitz problem solving: motion in 2-D

1. The position vector of a moving particle is given as

$$\vec{r}_1 = \left(10 - 3.5 \cdot t + 5 \cdot t^2 - 1.8 \cdot t^3\right)\hat{i} + \left(6 + 2.5 \cdot t - 6 \cdot t^2\right)\hat{j},$$

where position is in meters and time is in seconds. Find the velocity (in m/s) and acceleration (in m/s^2) of the particle.

The velocity, $\vec{v}_1 =$ [ ] $\hat{i} +$ [ ] $\hat{j}$

The acceleration, $\vec{a}_1 =$ [ ] $\hat{i} +$ [ ] $\hat{j}$

2. The velocity of another particle is given as

$$\vec{v}_2 = (7 + 3.6 \cdot t)\hat{i} + \left(10 - 6.3 \cdot t^2\right)\hat{j},$$

where velocity is in m/s and time is in seconds. Find the position vector (up to a constant) and acceleration of the particle.

The position, $\vec{r}_2 =$ [ ] $\hat{i} +$ [ ] $\hat{j}$

The acceleration, $\vec{a}_2 =$ [ ] $\hat{i} +$ [ ] $\hat{j}$

3. Which of the following could correctly present projectile motion of an object near the surface of Earth? Assume that $\hat{i}$ is the unit vector in the horizontal direction and $\hat{j}$ points in the vertical direction up.

- $\vec{r} = \left(6 - 6 \cdot t^2\right)\hat{i} + \left(-9 \cdot t - \frac{9.81 \cdot t^2}{2}\right)\hat{j}$
- $\vec{r} = (6 - 9 \cdot t)\hat{i} + \left(6 + \frac{9.81 \cdot t}{2}\right)\hat{j}$
- $\vec{r} = (6 - 9 \cdot t)\hat{i} + \left(6 - \frac{9.81 \cdot t}{2}\right)\hat{j}$
- $\vec{r} = (9 + 6 \cdot t)\hat{i} + \left(-6 \cdot t - \frac{9.81 \cdot t^2}{2}\right)\hat{j}$
- $\vec{r} = (6 + 6 \cdot t)\hat{i} + \left(-9 \cdot t - \frac{9.81 \cdot t^3}{2}\right)\hat{j}$

- $\vec{r} = (9 + 6 \cdot t)\hat{i} + \left(- 6 \cdot t + \frac{9.81 \cdot t^2}{2} \right)\hat{j}$
- none of the above

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HW #03

Roman Senkov

Question 1

0/1 pt 999 998

An object is in an uniform circular motion, it makes 25 revolutions in 1 min. If the radius of the trajectory is 1.7 m, find the orbital speed of the object.

The orbital speed, v = _____ Units Select an answer .

What are the period and frequency of this motion?

The period, T = _____ Units Select an answer .

The frequency, f = _____ Units Select an answer .

Find is the magnitude of the object's acceleration.

The magnitude of the acceleration, a = _____ Units Select an answer .

Is it a constant acceleration motion? Select an answer .

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Question 2

0/1 pt 999 998

A car goes through a U-turn with a constant speed of 40 mph. What is the magnitude of the car's acceleration if the radius of the turn is 37 m?

The acceleration, a = _____ Units Select an answer .

If the maximum acceleration of the car is restricted by 17.8 m/s^2, what is the maximum speed the car can have (in mph)?

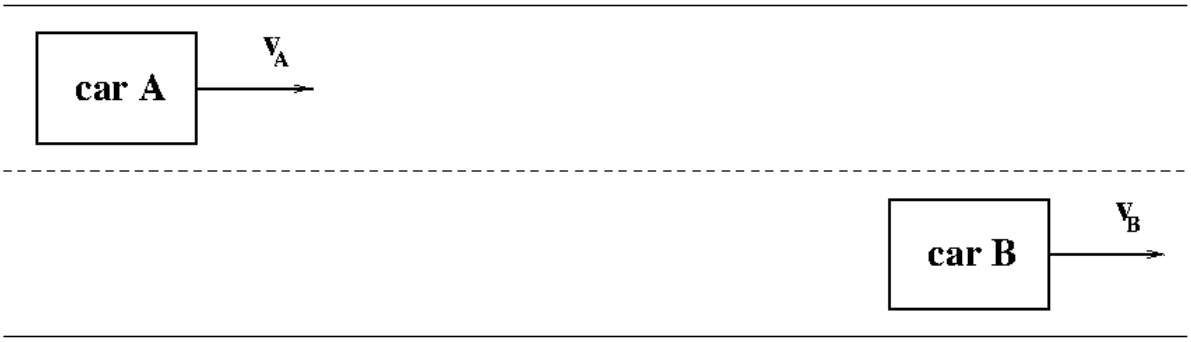
The maximum speed, v_{max} = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 3

0/1 pt 999 998

Cars A and B are moving in the same direction along a straight line with constant speeds v_A = 80 mph and v_B = 60 mph respectively (see the picture below). What is the velocity of car A relative to car B? What is the velocity of car B relative to car A? Take the positive direction to the right. If the initial separation between the cars is L = 0.5 miles, find the time when the cars meet.

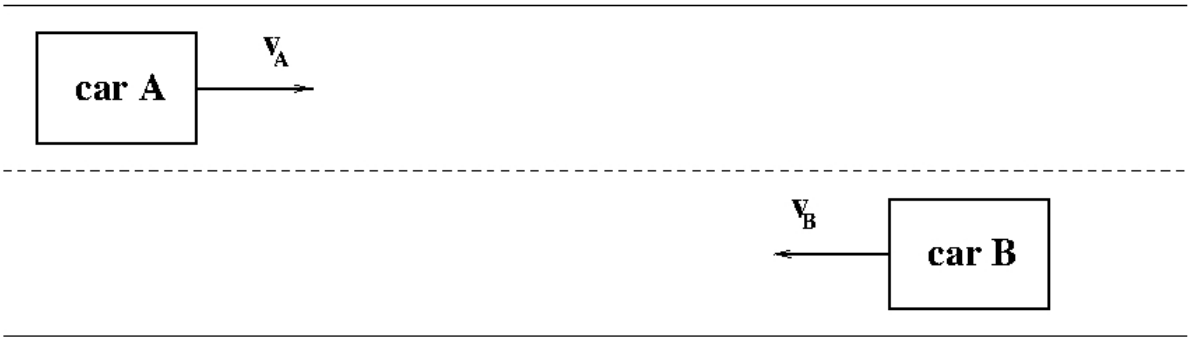


The velocity of car A relative to car B, v_A = _____ Units Select an answer .

The velocity of car B relative to car A, v_B = _____ Units Select an answer .

The time of meeting in minutes, t_1 = _____ Units Select an answer .

Find the relative velocities and the time of meeting with the same initial setup but car B moving towards car A (see the picture below).



The velocity of car A relative to car B, v_A = _____ Units Select an answer .

The velocity of car B relative to car A, v_B = _____ Units Select an answer .

The time of meeting in minutes, t_2 = _____ Units Select an answer .

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Question 4 0/1 pt 999 998

A boat is able to move over still water at 22.5 m/s. If the boat makes a round trip to a town which is 3.4 km upstream and back to the starting point and the river flows at 8.7 m/s, find the time required to complete the round trip.

The time of the round trip with the river current,

t_1 = _____ Units Select an answer .

If the water is still (meaning there is no current) then the time of the round trip would Select an answer .

The time of the round trip if there is no current,

t_2 = _____ Units Select an answer .

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Question 5

0/1 pt 999 998

A 19-kg cart is pushed with a net force of 29 N. Complete the following statements.

If the force and mass are both halved then the acceleration Select an answer .

If force and mass are both doubled then the acceleration Select an answer .

If mass is doubled but force is kept the same then the acceleration Select an answer .

One possible way to double the acceleration is to Select an answer .

The acceleration of the cart is (try not to use calculator) Select an answer .

If force is doubled but mass is kept the same then the acceleration Select an answer .

Note: you MUST complete all sentences before submitting.

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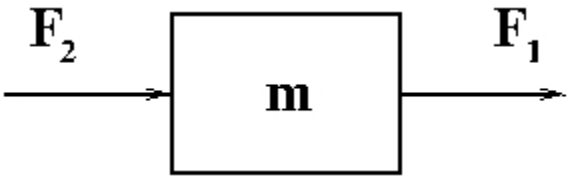
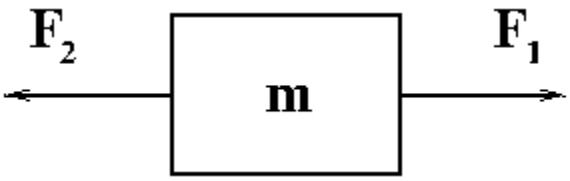
Question 6

0/1 pt 999 998

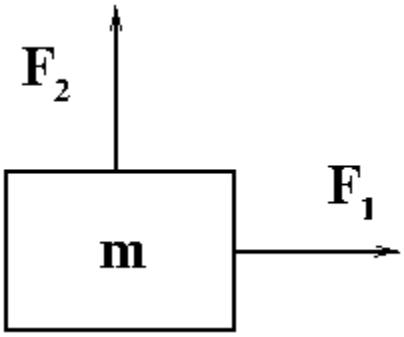
Two forces with the magnitudes F_1 = 26 N and F_2 = 37 N are acting on a 2-kg block. For each situation shown below, find the magnitude of the block's acceleration.



a_1 = _____ Units Select an answer .



a_2 = _____ Units Select an answer .



a_3 = _____ Units Select an answer .

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Question 7

0/1 pt 999 998

A heavy duty 150-lb fishing line is used to pull a 72-lb blue catfish. What is the mass of the catfish?

The mass of the fish, m = _____ Units Select an answer .

At what maximum acceleration the catfish can be pulled out horizontally without breaking the line? Note: the line is rated to a maximum tension of 150 lb.

The maximum acceleration, a_{max} = _____ Units Select an answer .

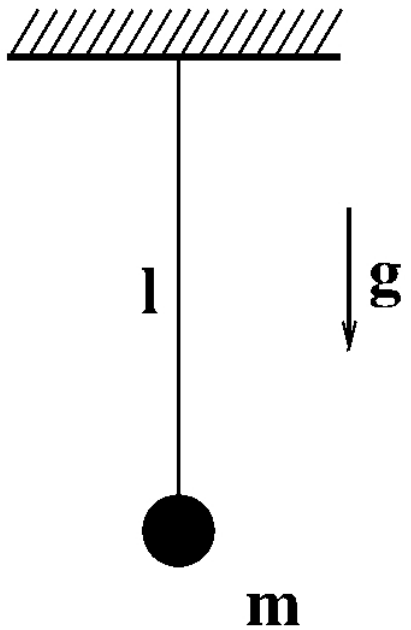
Question Help: Message instructor Post to forum

Question 8

0/1 pt 999 998

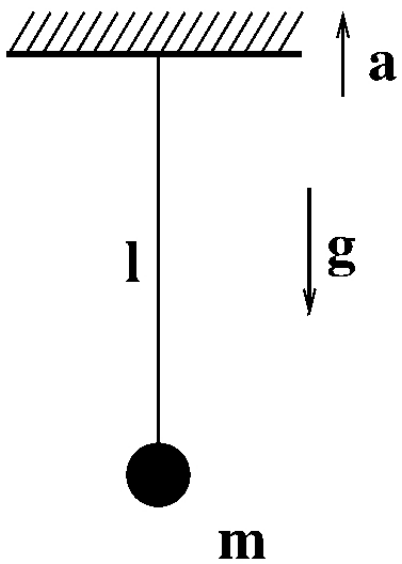
A 300-gram object is attached to ceiling with a 0.74-m rope as shown in the pictures below. Find the tension in the rope for the four different cases described below.

1. The system (the object and ceiling) is not moving, a = 0 m/s^2.



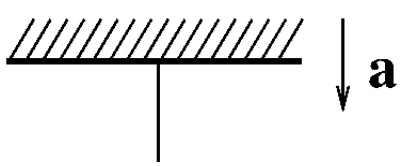
T_1 = _____ Units Select an answer .

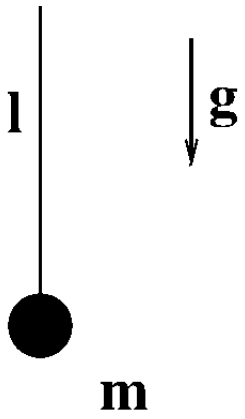
2. The system is accelerating up with a = 7 m/s^2.



T_2 = _____ Units Select an answer .

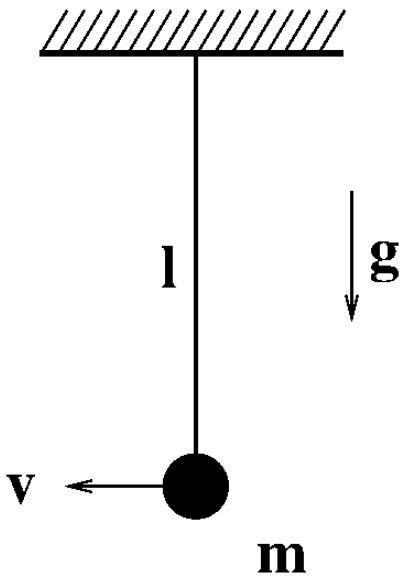
3. The system is accelerating down with a = −7 m/s^2.





T_3 = _____ Units Select an answer .

4. The ceiling is fixed but the object is swinging and has a speed v = 3.1 m/s at the lowest position as shown below.



T_4 = _____ Units Select an answer .

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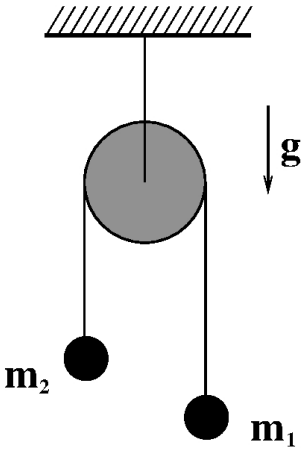
Question 9 0/1 pt 999 998

Find the acceleration of the system shown below. The masses are m_1 = 19 kg, m_2 = 8.5 kg and the pulley is ideal.



The acceleration, a = _____ Units Select an answer .

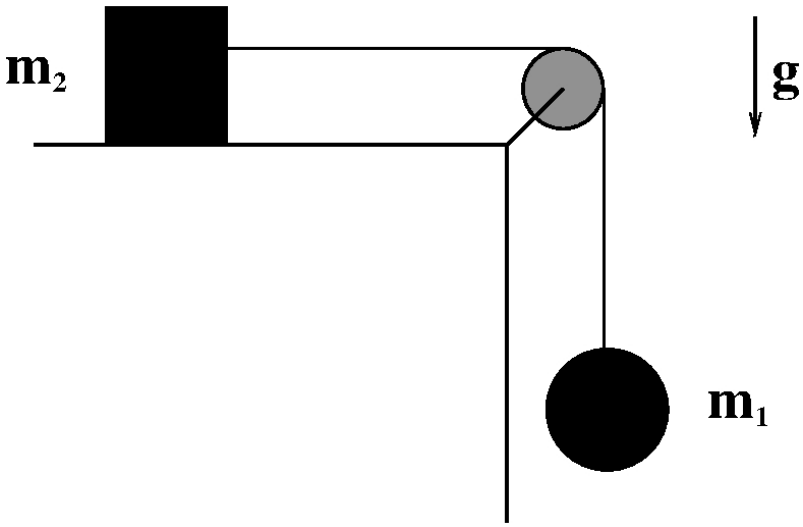
What is the tension in the rope?

The tension, T = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 10 0/1 pt 999 998

The acceleration of the system shown below is 4 m/s^2, find the ratio of the masses m_1/m_2. The system is frictionless and the pulley is ideal.



m_1/m_2 = _____ Units Select an answer .

If m_2 = 9.5 kg, find the mass of the hanging block m_1 and the tension in the rope T.

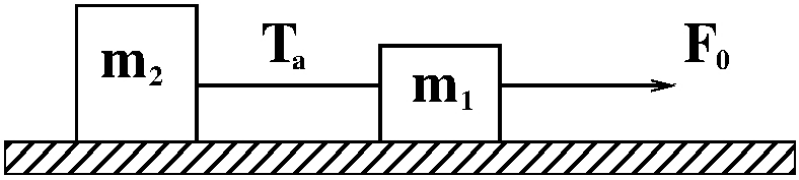
The mass, m_1 = _____ Units Select an answer .

The tension, T = _____ Units Select an answer .

Question Help: Message instructor Post to forum

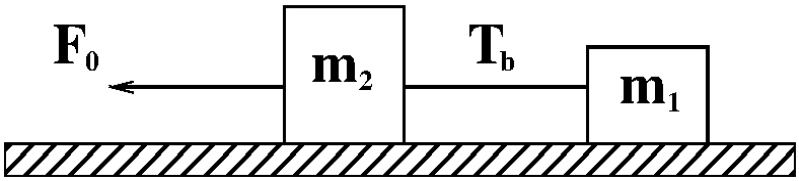
Question 11 0/1 pt 999 998

Two masses m_1 = 4 kg and m_2 = 12 kg are on a frictionless horizontal surface as shown below, they are connected with an unstretchable and massless rope. Find the tension in the rope between the masses for the two situations described below. (a) If an external force F_0 = 14.5 N is applied to m_1:



The tension, T_a = _____ Units Select an answer .

(b) If the same external force is applied to m_2:



The tension, T_b = _____ Units Select an answer .

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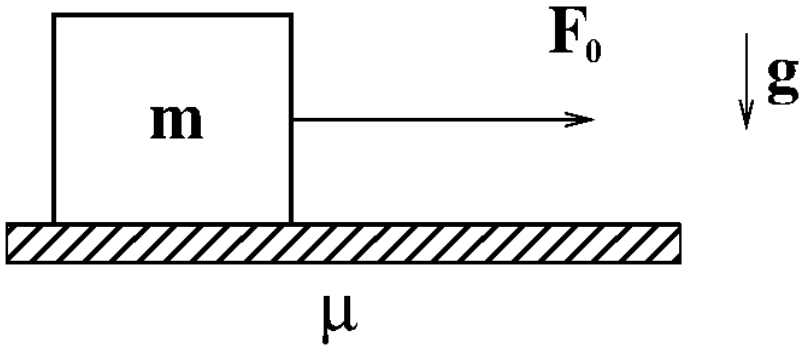
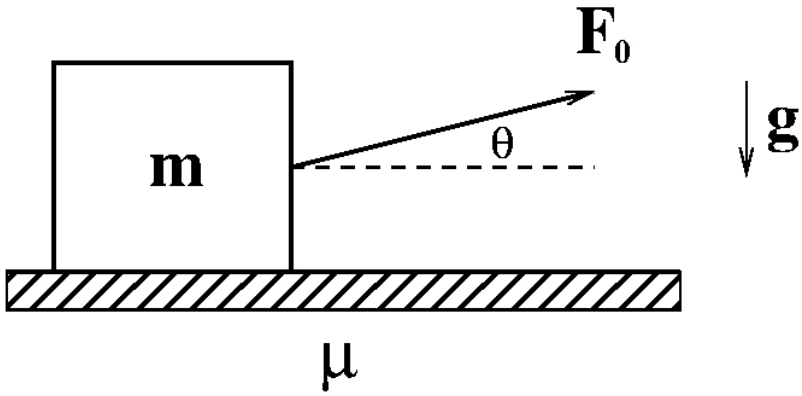
Question 12

0/1 pt 999 998

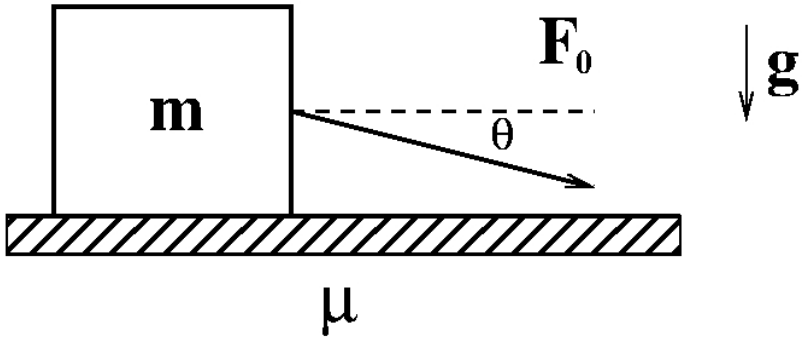
A 1.5-kg box is pulled across a rough horizontal surface with an external force of magnitude F_0 = 23 N. The force is applied (1) horizontally, (2) at an angle of θ = 15° above the horizontal, and (3) at θ = 15° below the horizontal, see the pictures below. For all these cases find the acceleration of the box if the kinetic friction coefficient between the box and surface is μ = 0.59.



The acceleration, a_1 = _____ Units Select an answer .



The acceleration, a_2 = _____ Units Select an answer .



The acceleration, a_3 = _____ Units Select an answer .

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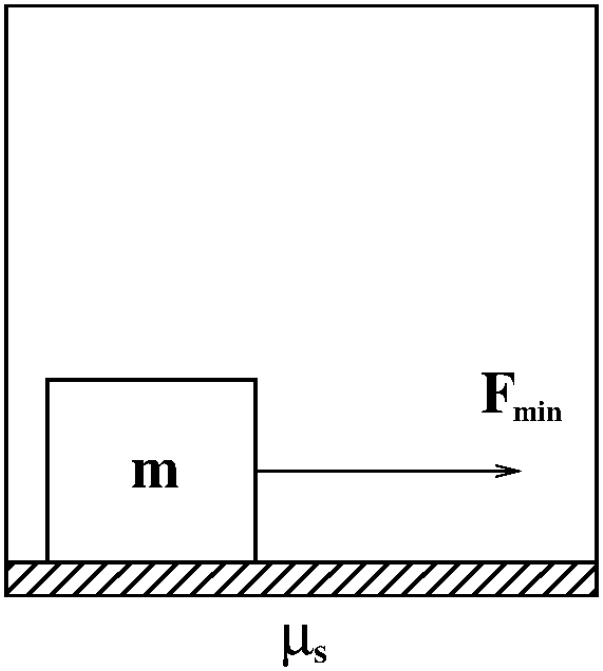
Question 13 0/1 pt 999 998

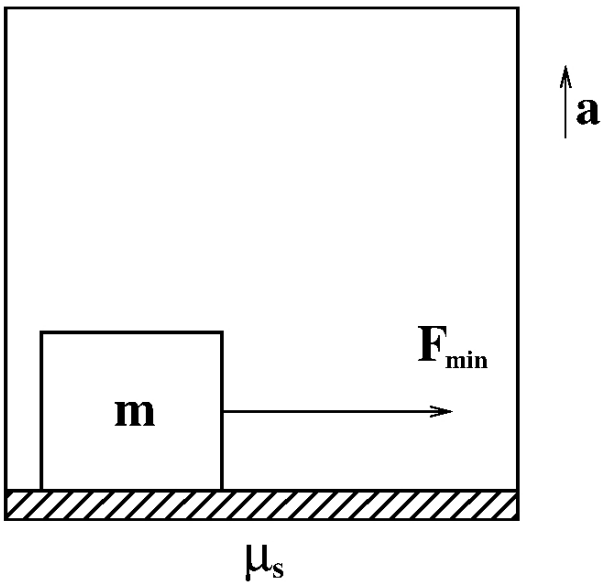
A box of mass m = 4.3 kg is at rest in an elevator on a rough floor, the static friction coefficient between the mass and the floor μ_s = 1.12. What minimum horizontal force is required to set the box on motion? Consider the situations shown below. Note: first find the normal force.

1. The elevator is stationary.



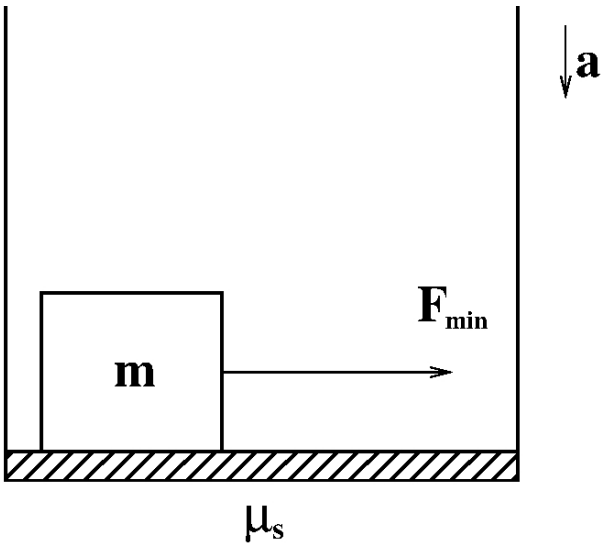
The minimum force, F_{min} = _____ Units Select an answer .

2. The elevator is moving up with an acceleration of a = 4 m/s^2.



The minimu force, F_{min} = _____ Units Select an answer .

3. The elevator is moving down with an acceleration of a = −4 m/s^2.



The minimu force, F_{min} = _____ Units Select an answer .

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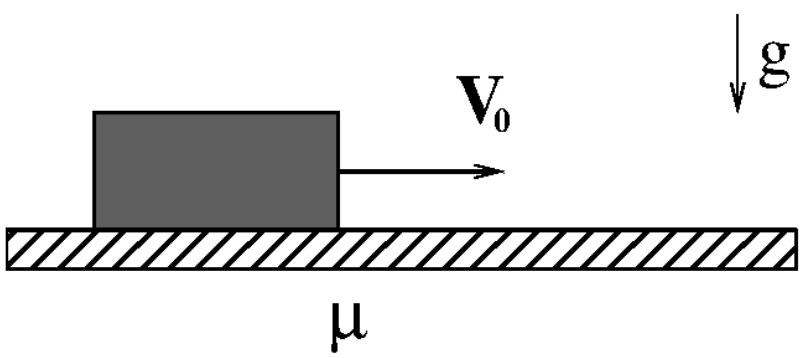
Question 14

0/1 pt 999 998

An ice hockey puck is moving on a horizontal rough surface with the kinetic friction coefficient $\mu = 0.25$. How far will the puck go before coming to a complete stop if it's initial speed is $V_0 = 12.5$ m/s?



The traveled distance, L = _____ Units Select an answer .

How long will it take for the puck to stop?

The time of travel, t = _____ Units Select an answer .

Question Help: Message instructor Post to forum

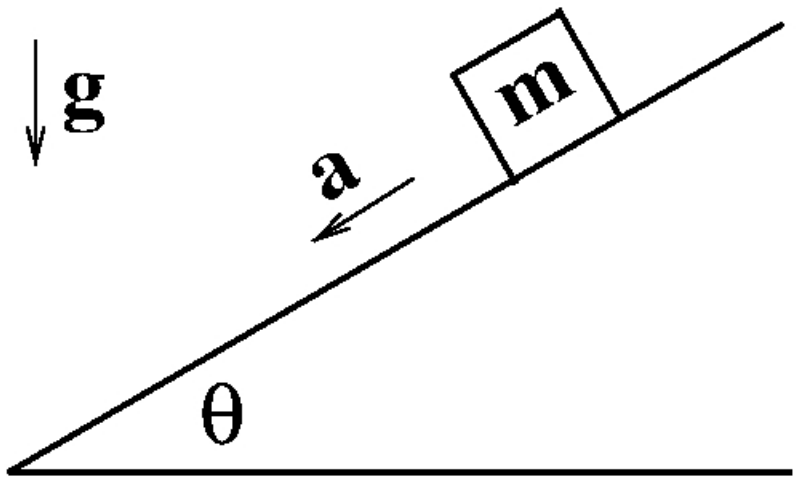
HW #04

Roman Senkov

Question 1

0/1 pt 999 998

A block of mass 0.6 kg slides down an inclined plane as shown below. If the inclination angle θ = 27° and the friction is negligible, find the acceleration of the block.



The acceleration, a = _____ Units Select an answer .

Find the gravity force W, normal force N and net force F_{net} acting on the block.

The gravity force, W = _____ Units Select an answer .

The normal force, N = _____ Units Select an answer .

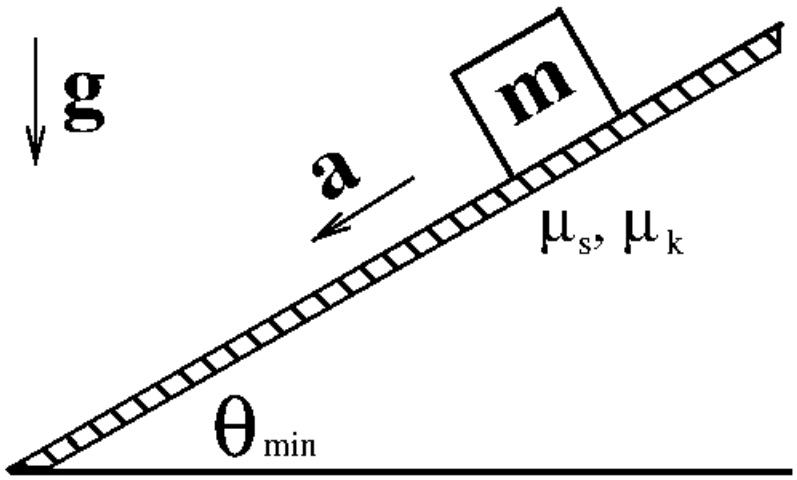
The net force, F_{net} = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 2

0/1 pt 999 998

A block is on an inclined plane with the angle of inclination θ that can vary. The surface of the plane is rough so there are known static friction μ_s = 1.2 and kinetic friction μ_k = 0.85 coefficients between the block and the surface of the plane. At small angles θ the block is stationary, then the angle slowly increases until the block starts to slide down, see the picture below. What is the minimum angle at which the block slides down?



The angle, θ_{min} = _____ Units Select an answer .

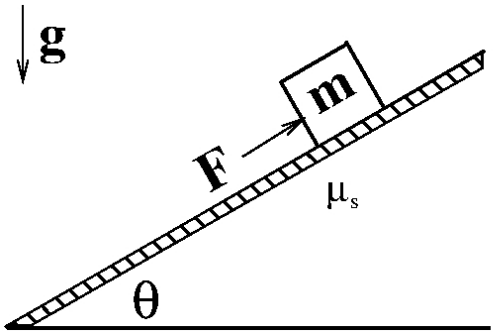
At the angle defined in the previous step and with the block sliding down, what is the acceleration of the block?

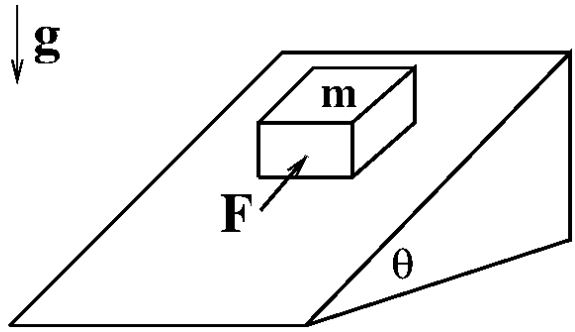
The acceleration, a = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 3 0/1 pt 999 998

A block of mass m = 10 kg is located on a rough inclined plane with an inclination angle of $\theta = 29^\circ$. An external constant force F is applied to the block as shown in the figures below. What minimal external force is required to move the block up? Note that the external force is always parallel to the plane. Take the static friction coefficient between the block and the plane $\mu_s = 0.67$. The free fall acceleration is 9.81 m/s^2.





The minimal external force, F_{min} = _____ Units Select an answer .

If the external force is half of the minimal force from the previous question, $F = F_{min}/2$, then what is the static friction force in this case?

The magnitude of the static friction force, F_{static} = _____ Units Select an answer .

The static friction force is directed Select an answer .

Question Help: Message instructor Post to forum

Question 4

0/1 pt 999 998

A student lifts a 1.7-kg physics book to a height of 44 cm and then puts it down to its original position. Assume that the speed of the book remains constant during the entire process.

The work done by the student while lifting the book up,

W_1 = _____ Units Select an answer .

The work done by the gravity force while lifting the book up,

W_2 = _____ Units Select an answer .

The work done by the student while putting the book down,

W_3 = _____ Units Select an answer .

The work done by the gravity force while putting the book down,

W_4 = _____ Units Select an answer .

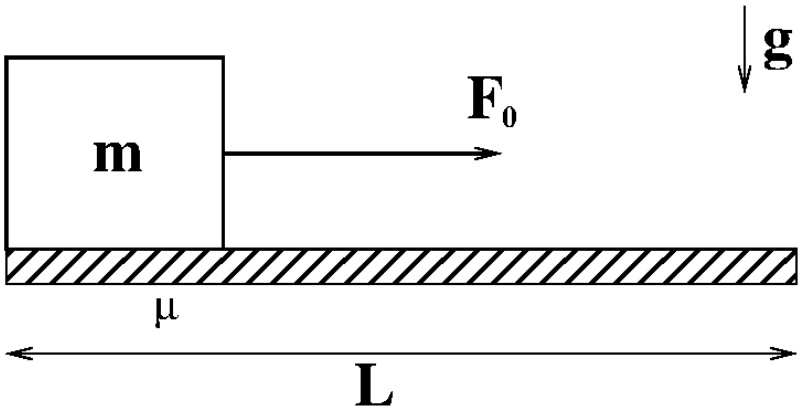
If the book is lifted up in 1.5 seconds, how much power was developed by the student?

P = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 5 0/1 pt 999 998

A heavy cart of mass m = 3.5 kg on a rough horizontal surface is pulled over a distance L = 13.5 meters by applying an external force F_0 = 31.6 N. The friction coefficient between the cart and surface is μ = 0.11. If the applied force is pure horizontal as shown below, find the work done by the following forces.



The work done by F_0, W_1 = _____ Units Select an answer .

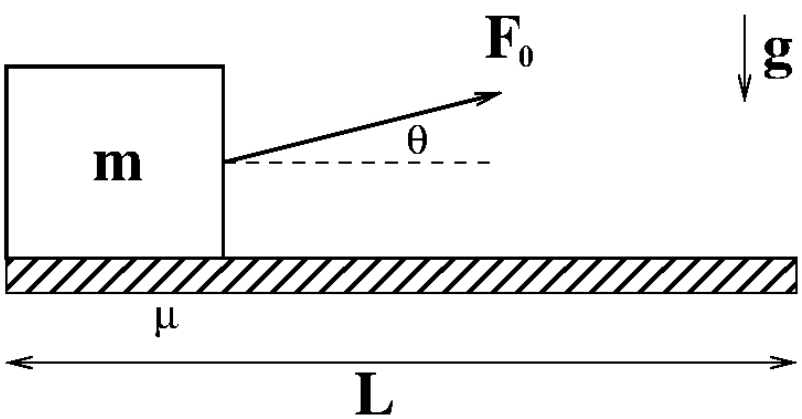
The work done by the gravity force, W_2 = _____ Units Select an answer .

The work done by the normal force, W_3 = _____ Units Select an answer .

The work done by the friction force, W_4 = _____ Units Select an answer .

The work done by the net force, W_5 = _____ Units Select an answer .

Now repeat all these calculations if the same external force is applied at an angle θ = 13° above the horizontal as shown below. Note that the cart is always on the surface.



The work done by F_0, W_6 = _____ Units Select an answer .

The work done by the gravity force, W_7 = _____ Units Select an answer .

The work done by the normal force, W_8 = _____ Units Select an answer .

The work done by the friction force, W_9 = _____ Units Select an answer .

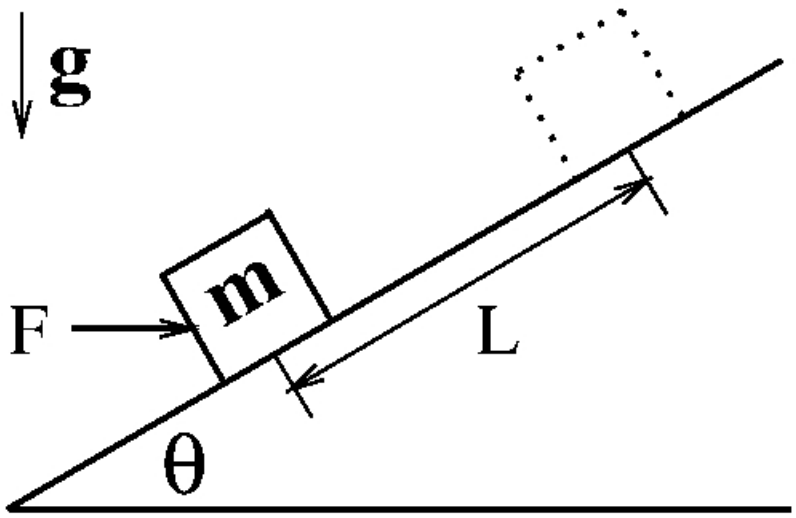
The work done by the net force, W_{10} = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 6

0/1 pt 999 998

An external constant horizontal force F is applied to a block of mass m = 22 kg. The block is located on an inclined plane with the inclination angle of θ = 28° as shown below. What is the minimal external force required to move the block up? Note that the external force is always horizontal and the plane is frictionless.



The minimal external force, F_{min} = _____ Units Select an answer .

If the external force F = 341 N and the block is moved along the plane up a distance L = 1.6 m, what is the work done by the external force?

The work done by F, W_1 = _____ Units Select an answer .

How much work is done by the gravity force?

The work done by mg, W_2 = _____ Units Select an answer .

How much work is done by the net force?

The work by done by F_{net}, W_3 = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 7

0/1 pt 999 998

The work done by an external force to compress an ideal spring can be written as

$$W_{i\to f} = \frac{kx_f^2}{2} - \frac{kx_i^2}{2},$$

where x_i and x_f are the initial and final spring positions to which the spring is stretched and k is the spring constant. Note that the positions x are calculated relative to the equilibrium and they can be positive (the spring is stretched) and negative (the spring is compressed).

How much work is required to stretch a 650-N/m spring from equilibrium to x = 14.3 cm?

The work, W_1 = _____ Units Select an answer .

Consider the spring from the previous question which is initially relaxed. To what position (in cm) the spring can be stretched if 16.3-J work is done on the spring?

The displacement, x = _____ Units Select an answer .

How much work is required to change the position of the same spring from -12.8 cm to 8.9 cm?

The work, W_2 = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 8

0/1 pt 999 998

A non-Hooke's law spring has the following restoring force

$$F_s = -k \cdot x - \alpha \cdot x^3,$$

where x is the deviation from the equilibrium and k = 8 N/cm and α = 0.15 N/cm^3 are the spring constants. How much work is required to stretch this spring from equilibrium to x = 9.5 cm?

The work, W_1 = _____ Units Select an answer .

If the spring is initially relaxed, to what position (in cm) it can be stretched if 17-J work is done on the spring?

The displacement, x = _____ Units Select an answer .

How much work is required to change the position of the same spring from -8.9 cm to 8.8 cm?

The work, W_2 = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 9

0/1 pt 999 998

An Olympic sprinter runs at 9.1 m/s speed. What is the sprinter's kinetic energy if her mass is 57.5 kg?

The kinetic energy of the sprinter, KE = _____ Units Select an answer .

How fast a 60-gram tennis ball should move to have the same kinetic energy as the sprinter from the previous question?

The speed of the ball, v_b = _____ Units Select an answer .

How fast a 650-kg car should move to have the same kinetic energy as the sprinter?

The speed of the car, v_c = _____ Units Select an answer .

If the speed of the car is doubled (but its mass stays the same), then the energy of the car is Select an answer .

If the mass of the car is doubled (but its speed stays the same), then the energy of the car is Select an answer .

Question Help: Message instructor Post to forum

Question 10

0/1 pt 999 998

A 640-kg car speeds up from rest to 41 mph in 3.9 seconds. What is the work done on the car and what is the average power of the car's engine?

The work done on the car, W_1 = _____ Units Select an answer .

The power of the engine, P = _____ Units Select an answer .

Try to answer the following two questions without serious calculations – it is possible!

How much work is required to speed up this car from rest to 82 mph?

The work, W_2 = _____ Units Select an answer .

How much work is required to speed up this car from 41 mph to 82 mph?

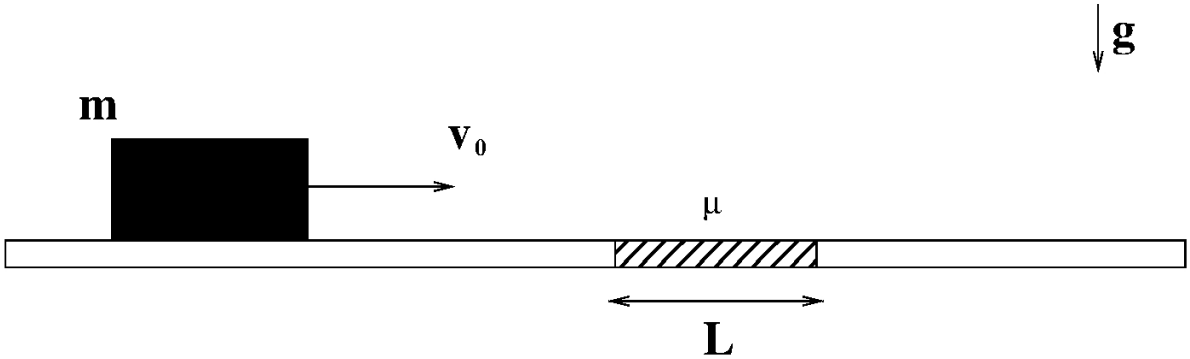
The work, W_3 = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 11

0/1 pt 999 998

An ice hockey puck is sliding over a frictionless horizontal surface with a constant velocity of v_0 = 13.4 m/s. Find the velocity of the puck after it passes a rough area of length L = 8.8 m and with the kinetic friction coefficient μ = 0.39 as shown below. Hint: the mass of the puck is not needed, you can either calculate everything per unit of mass or, if it helps, take m = 160 grams.



The steps to follow: (1) find the initial KE of the puck; (2) find the work done by the friction force (should be negative); (3) find the final kinetic energy as `KE_f = KE_i + W`, meaning that some of the initial kinetic energy is lost due to the work done by friction; (4) from the final KE find the final speed.

The final speed of the puck, v_f = _____ Units Select an answer .

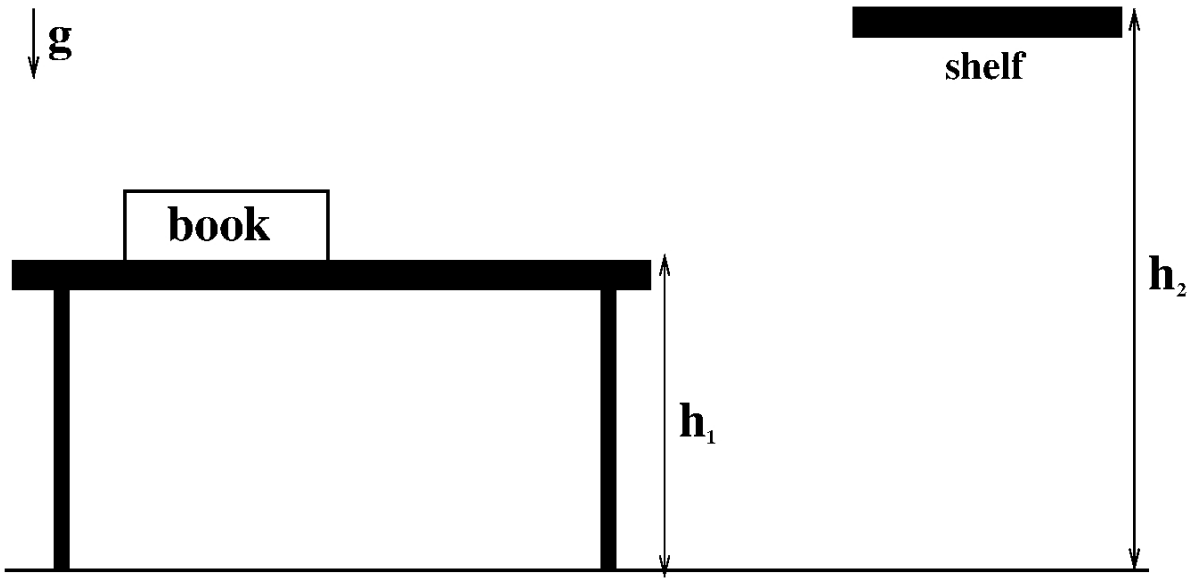
If the initial speed of the puck is not high enough the puck will get stuck in the rough area. At what minimal initial speed should the puck move to barely make it through the rough area?

The minimal initial velocity, v_{min} = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 12 0/1 pt 999 998

A 0.8-kg book is located on a table as shown in the picture below. Find the gravitational potential energy of the book relative to different reference levels. The heights of the table and shelf above the floor are h_1 = 0.8 m and h_2 = 1.6 m correspondingly.

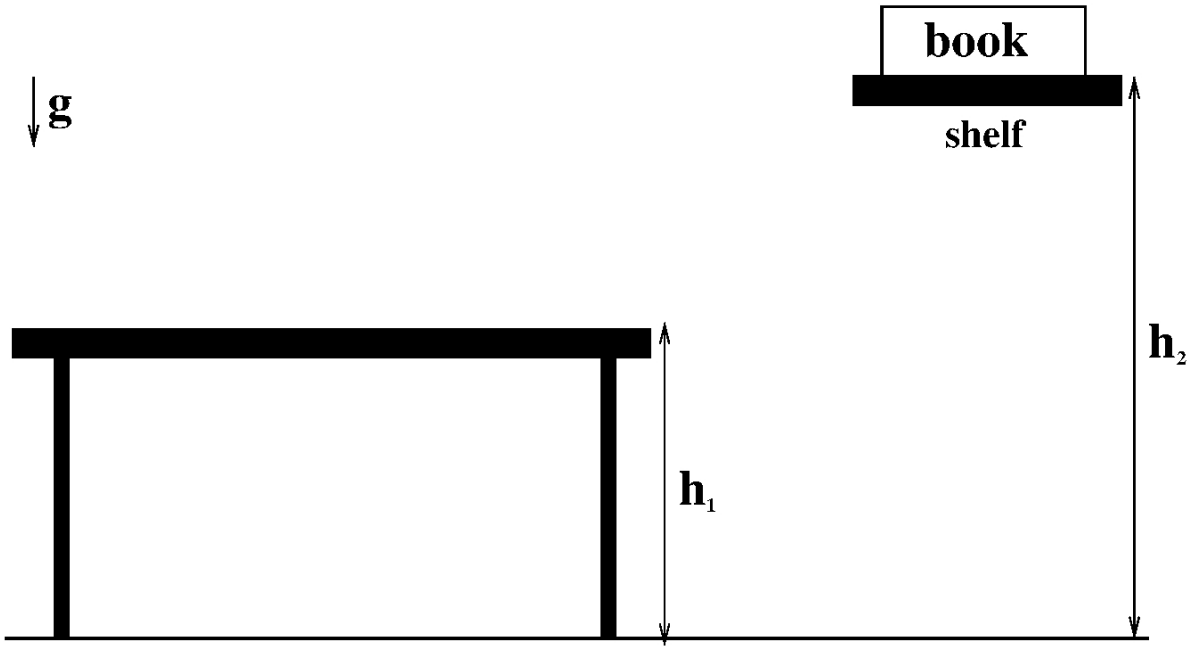


PE_G of the book relative to the floor, PE_1 = _____ Units Select an answer .

PE_G of the book relative to the table, PE_2 = _____ Units Select an answer .

PE_G of the book relative to the shelf, PE_3 = _____ Units Select an answer .

Now the same book is placed on the shelf. Similar to the previous part, find the gravitational potential energy of the book relative to different reference levels.



PE_G of the book relative to the floor, PE_4 = _____ Units Select an answer .

PE_G of the book relative to the table, PE_5 = _____ Units Select an answer .

PE_G of the book relative to the shelf, PE_6 = _____ Units Select an answer .

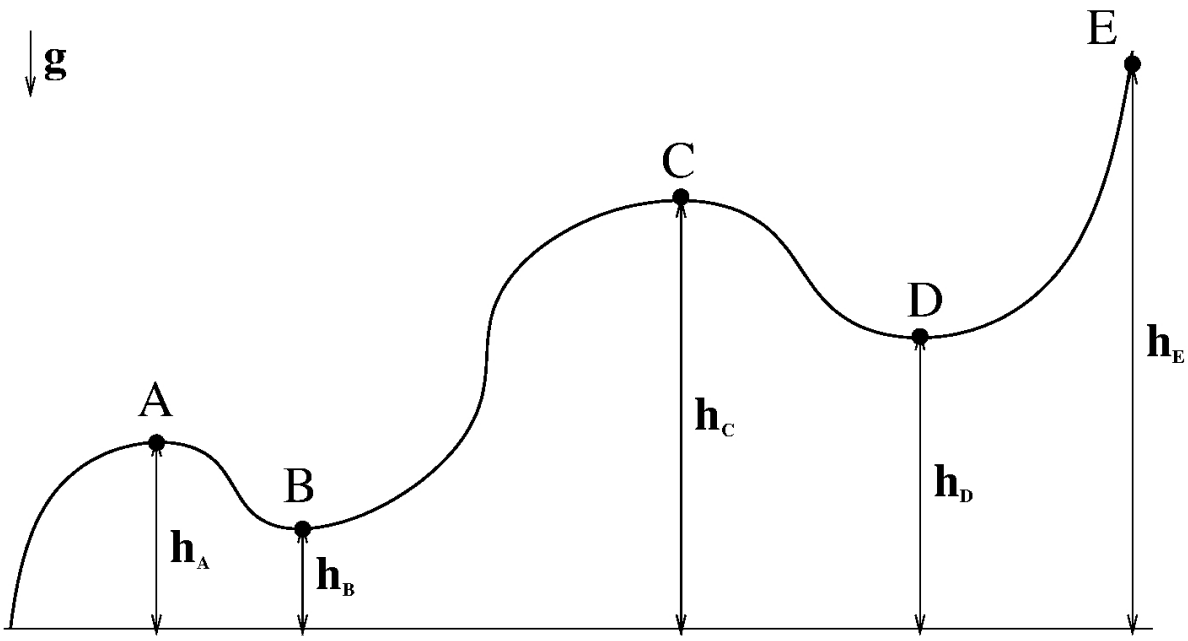
How much work is required to move the book from the table to the shelf?

The work, W = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 13 0/1 pt 999 998

A bead of mass 0.25 kg can freely slide on a frictionless curved wire as shown below. There are five selected points on the wire with the following heights: h_A = 0.95 m, h_B = 0.8 m, h_C = 1.75 m, h_D = 1.4 m, and h_E = 2.4 m. The entire system is in the gravity field of Earth with g = 9.81 m/s^2.



Order these five points based on the gravitational PE of the bead from the lowest to highest: Select an answer .

Pick two points with the maximum difference in the bead's PE: Select an answer .

Find the work required to move the bead from A to E, W_1 = _____ Units Select an answer .

Find the work required to move the bead from A to B, W_2 = _____ Units Select an answer .

Find the work required to move the bead from D to C, W_3 = _____ Units Select an answer .

Hint: when the bead is moved it changes its vertical position and potential energy, which means that some minimal work is required to be done on the bead. This work can be calculated as the change in the potential energy of the bead: `W_(i->f) = PE_f - PE_i`.

Question Help: Message instructor Post to forum

Question 14 0/1 pt 999 998

Find the potential energy of a spring with the spring constant k = 1,300 N/m if the spring is compressed by 0.7 m (x = −0.7 m),

PE_1 = _____ Units Select an answer ,

and if the spring is stretched by 0.44 m (x = 0.44 m),

PE_2 = _____ Units Select an answer .

How much work is required to compress the spring by 0.7 m if initially the spring was relaxed?

W_1 = _____ Units Select an answer .

How much work is required to stretch the spring by 0.44 m if initially the spring was relaxed?

W_2 = _____ Units Select an answer .

How much work is required to stretch the spring by 0.44 m if initially the spring was compressed by 0.7 m?

W_3 = _____ Units Select an answer .

Question Help: Message instructor Post to forum

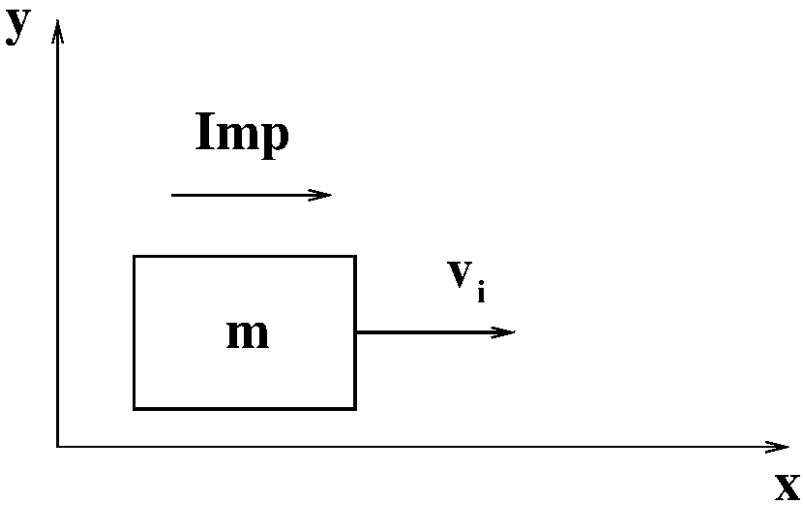
HW #06

Roman Senkov

Question 1

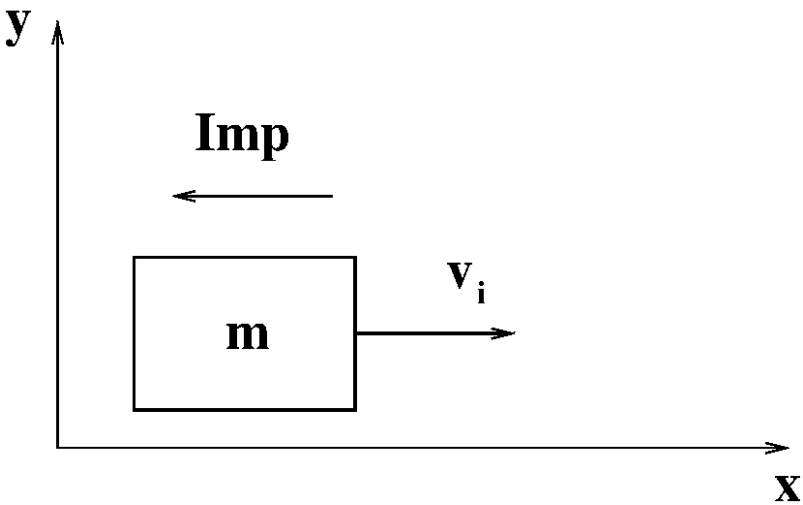
0/1 pt 999 998

An object of 4.2 kg mass is moving in the positive x-direction with an initial velocity of v_i= 0.68 m/s as shown below. Find the final velocity of the object after an impulse of 8 N·s magnitude is exerted on to the object in the positive direction.



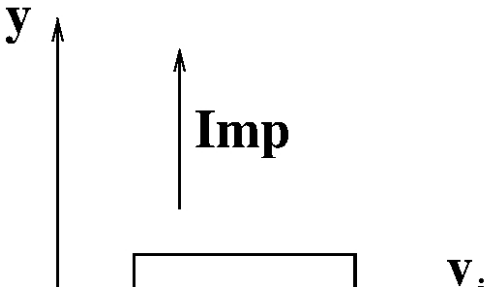
The final velocity of the object, v_1 = _____ Units Select an answer .

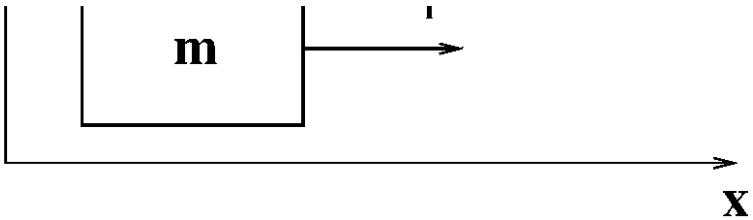
What will be the final velocity of the object if the same impulse is applied in the negative direction?



The final velocity of the object, v_2 = _____ Units Select an answer .

Note that in the previous two questions we were interested only in the x-components of the velocity, the y-components remain zero all the time. Now the same impulse is applied along the positive y-direction as shown below. Find the x- and y-components of the final velocity of the object.





The x-component of the final velocity, v_{3x} = _____ Units Select an answer .

The y-component of the final velocity, v_{3y} = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 2

0/1 pt 999 998

A 400-gram football is moving in the positive x-direction with a speed of 12 m/s. Cristiano Ronaldo hits the ball with his head and sends it in the opposite direction with a speed of 16.5 m/s. Find the change in the ball's linear momentum, consider only the x-component of the momentum.

The change in the ball's momentum, Δp = _____ Units Select an answer .

If the time of contact between the ball and Cristiano's head is 22 msec, find the average force exerted on the ball.

The force on the ball, F_1 = _____ Units Select an answer .

What is the force exerted by the ball on Ronaldo's head?

The force on the head, F_2 = _____ Units Select an answer .

Question Help: Message instructor Post to forum

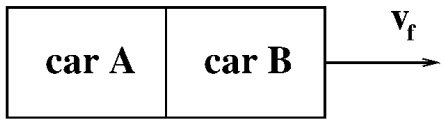
Question 3

0/1 pt 999 998

Two cars A and B are moving to the right as shown below. The cars have the following masses and speeds: m_A = 450 kg, v_A = 33 m/s and m_B = 1150 kg, v_B = 19 m/s. Find the total linear momentum of the cars.

The total momentum of the system, p = _____ Units Select an answer .

The cars experience a perfectly inelastic collision, stick together and move off with a common velocity v_f. Find this final velocity and the energy released during the collision.



The final velocity of the cars after the collision, v_f = _____ Units Select an answer .

The energy released, E = _____ Units Select an answer .

Let's assume that 50% of the energy released in the collision is transferred into the gravitational potential energy of both cars, how high will the cars rise?

The height to which the cars can rise? h = _____ Units Select an answer .

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Question 4 0/1 pt 999 998

A 290-kg cannon is loaded with a 5-kg cannonball, the system is initially at rest. Find the recoil speed of the cannon if it fires the cannonball at a speed of 88 m/s.

The recoil speed of the cannon, v_{cannon} = _____ Units Select an answer .

Find the ratio of the kinetic energies of the cannonball and cannon.

The ratio of energies, KE_{ball}/KE_{cannon} = _____ Units Select an answer .

Assuming that 90% of the explosive energy of the charge went into the kinetic energies of the cannon and cannonball, find this explosive energy.

The explosive energy of the charge, E_{tot} = _____ Units Select an answer .

If we increase the mass of the cannon, but keep the explosive energy of the charge the same, the speed of the cannonball will Select an answer .

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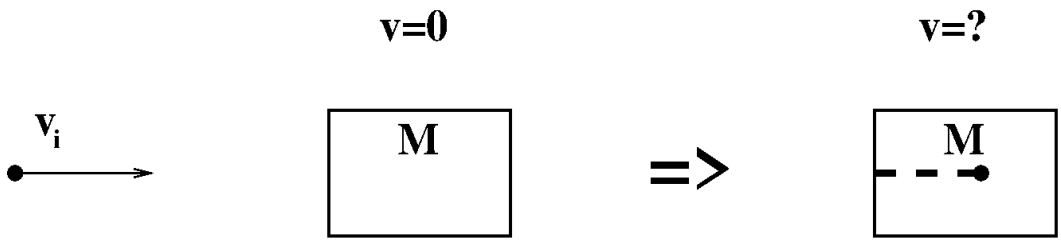
Question 5 0/1 pt 999 998

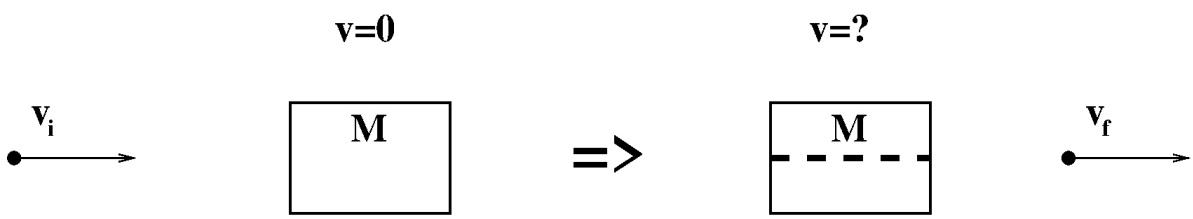
A heavy box of mass M = 2 kg is initially at rest while a 8-gram bullet is moving towards it at a speed of v_i = 90 m/s (see the left side of the picture below). How fast will the box move if the bullet stops inside it? How much energy will be released as heat?



The speed of the box, v_1 = _____ Units Select an answer .

The heat released, Q_1 = _____ Units Select an answer .

With the same initial conditions, if the bullet goes through the box and leaves it with a speed of v_f = 82.8 m/s (see the right side of the picture below). How fast will the box move right after the bullet left it? While the bullet was moving through the box, how much energy was lost into heat?



The speed of the box, v_2 = _____ Units Select an answer .

The energy lost into heat, Q_2 = _____ Units Select an answer .

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Question 6

0/1 pt 999 998

Two masses m_1 = 1.8 kg and m_2 = 7.2 kg are connected with an ideal 660-N/m spring. Initially the system is at rest and the spring is compressed by 13 cm, then the spring is released and the masses start to move freely. What is the speed if each mass after the spring is released?

The speed of the first mass m_1, v_1 = _____ Units Select an answer .

The speed of the second mass m_2, v_2 = _____ Units Select an answer .

Which mass will have a greater speed? Select an answer .

Which mass will have a greater momentum? Select an answer .

Which mass will have a greater kinetic energy? Select an answer .

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Question 7

0/1 pt 999 998

A particle of mass m is moving from infinity towards a stationary mass M along a straight line as shown below. The particles experience a head-on collision and continue to move along the same line after interacting. Find the final velocities of each particle if the repulsive force between the particles is presented as

$$F(t) = \frac{F_0}{1 + t^2/\tau^2},$$

here $F_0 =$ 2,100 N, and $\tau =$ 16 msec. The masses are $m =$ 3.3 kg and $M =$ 4.3 kg. Take the positive direction along the initial velocity of mass m, which is $v_i =$ 22.5 m/s. Hint: when calculating the impulse integrate from minus to plus infinity (τ is very short).

The final velosity of m, $v_{1,f}$ = _____ Units Select an answer .

The final velosity of M, $v_{2,f}$ = _____ Units Select an answer .

What is the magnitude of the impulse exerted on each particles?

The impulse, Imp = _____ Units Select an answer .

What should be the value of constant F_0 so the incoming particles m stops after the collision?

The magnitude, F_0 = _____ Units Select an answer .

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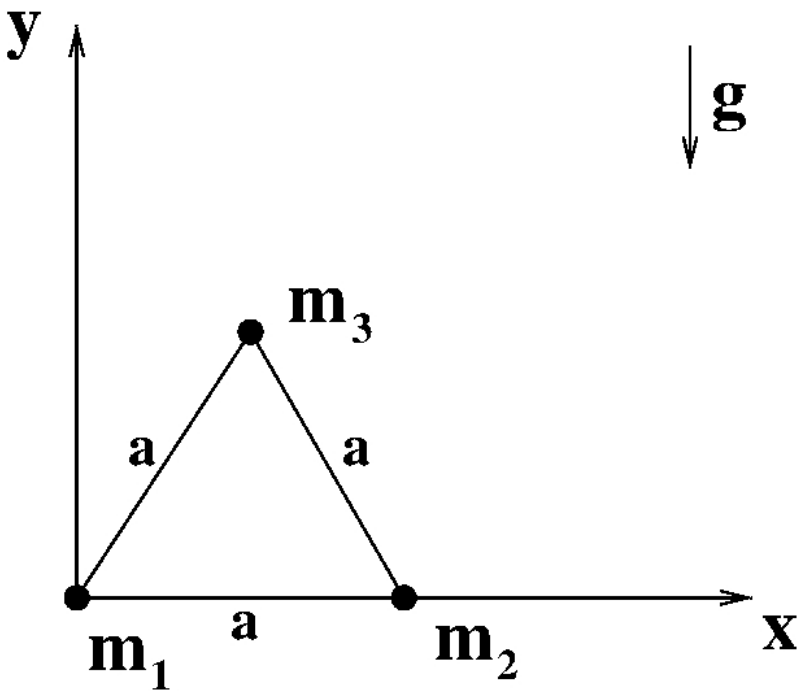
Question 8

0/1 pt 999 998

Three point-like masses are placed in the vertexes of an equilateral triangle with the length of each side a = 29 cm, see the picture below. The masses are m_1 = 6 kg (located at the origin), m_2 = 9.5 kg (located along the positive x-direction), and m_3 = 6.5 kg. Find the position of the center of mass of the system.



The x-component of the CoM position, X_{CoM} = _____ Units Select an answer .

The y-component of the CoM position, Y_{CoM} = _____ Units Select an answer .

Using the CoM position find the gravitational potential energy of the entire system relative to the y = 0 level. Note that $PE_G = m_{tot} \cdot g \cdot Y_{CoM}$, where m_{tot} is the total mass of the system and Y_{CoM} is the y-component of the CoM position.

The potential energy of the system, PE_G = _____ Units Select an answer .

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Question 9 0/1 pt 999 998

There is certain similarity between simple rotation and 1-D linear motion kinematics. Please put in correspondence the following rotational quantities and units with their linear motion analogs by completing the following sentences.

The angular position θ corresponds to Select an answer , the standard units for θ are Select an answer .

The angular velocity ω corresponds to Select an answer , the standard units for ω are Select an answer .

The angular acceleration α corresponds to Select an answer , the standard units for α are Select an answer .

A motor increases its angular velocity from ω_i = 13 rev/sec to ω_f = 21 rev/sec and during this spin up process it makes 40 revolutions. Find the acceleration of the motor and the time of the spin up process. Assume that the motor spins with a constant acceleration rate.

The angular acceleration of the motor, α = _____ Units Select an answer .

The time of this spin up process, t = _____ Units Select an answer .

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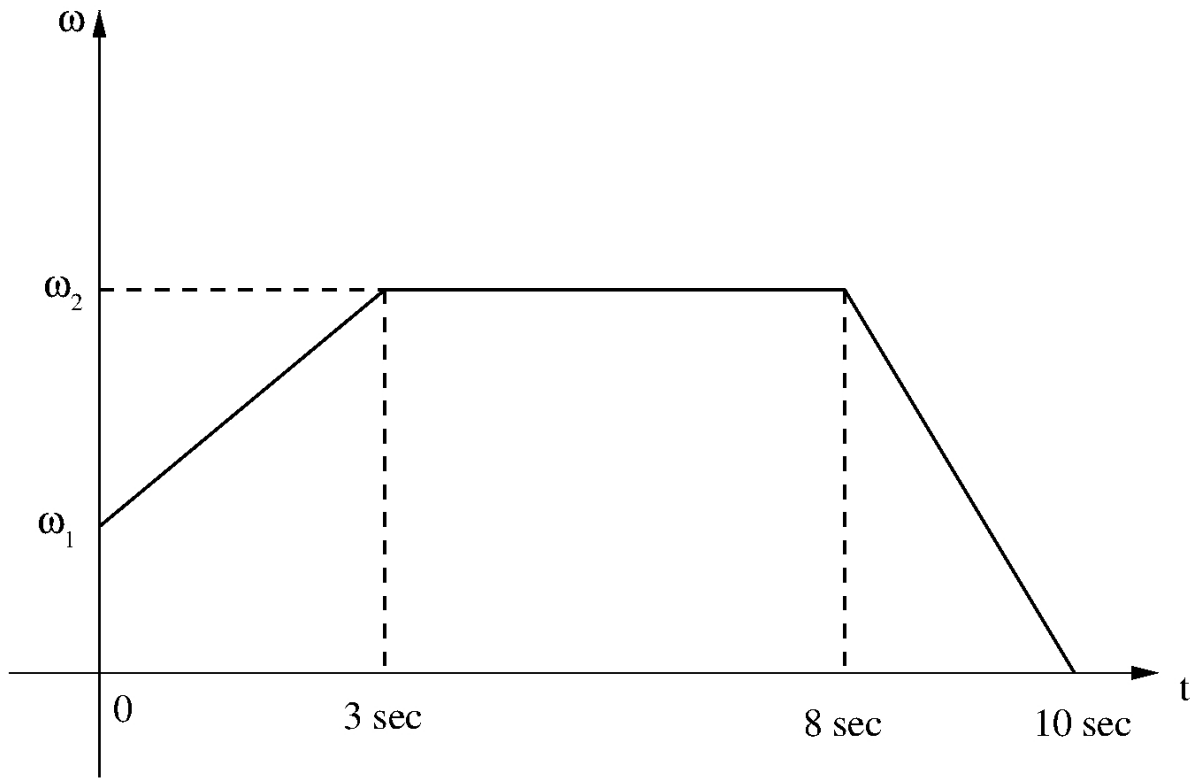
Question 10 0/1 pt 999 998

The angular velocity of a spinning disk changes according to the velocity-time graph shown below. Answer the following questions about the motion of the disk if ω_1 = 6.3 rad/sec and ω_2 = 9.45 rad/sec. Note that 1 rev = 2π rad.



How many revolutions does the disk make from 0 sec to 8 sec?

The traveled angle, θ_1 = _____ Units Select an answer .

How many revolutions does the disk make from 3 sec to 10 sec?

The traveled angle, θ_2 = _____ Units Select an answer .

What is the average speed of the disk for t ∈ [0 sec, 10 sec] time interval?

The average angular speed, ω_{ave} = _____ Units Select an answer .

What is the acceleration of the disk at t = 9 sec? α = _____ Units Select an answer .

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Question 11 0/1 pt 999 998

Consider a bicycle on a track rolling without slipping. The radius of the front wheel of the bicycle is R = 0.5 m. How long does it take for that wheel to complete one revolution if the bicycle is moving at v = 11.6 m/s?

The time of one revolution, t = _____ Units Select an answer .

If the wheels of the bicycle uniformly spin up from 200 rpm to 300 rpm in 18.1 seconds, what is the linear acceleration of the bicycle? Note that 1 rpm = 1 rev/min = π/30 rad/sec.

The linear acceleration of the bicycle, a = _____ Units Select an answer .

Calculate the number of revolution each wheel makes if the bicycle traveled a distance of 19 miles.

The number of revolutions, N = _____ Units Select an answer .

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Question 12 0/1 pt 999 998

Blitz problem solving: non-uniform rotation

1. The angle of a rotating object is given as

$$\theta_1 = \left(6 - 3.5 \cdot t + 2 \cdot t^2 - 2 \cdot t^3\right),$$

where the angle is in radians and time is in seconds. Find the angular velocity (in rad/s) and the angular acceleration (in rad/s^2) of the object.

The velocity, $\omega_1 =$ [ ]

The acceleration, $\alpha_1 =$ [ ]

2. The angular velocity of another spinning object is given as

$$\omega_2 = \left(2 + 2.4 \cdot t - 6 \cdot t^2\right),$$

where the velocity is in rad/s and time is in seconds. Find the angle (up to a constant) and the angular acceleration of the object.

The angle, $\theta_2 =$ [ ]

The angular acceleration, $\alpha_2 =$ [ ]

3. At $t = 0$, an object starts to slowly spin down from an initial speed of $\omega_0 = 70$ rad/s and after a long enough time comes to a complete stop as

$$\omega_3 = \omega_0 \cdot e^{-t^2/\tau^2},$$

where the velocity is in rad/s, time is in seconds, and the time constant $\tau = 56$ s. Find the maximum number of revolutions the object can make. Do not round the answer.

The number of revolutions, $N_3 =$ _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 13 0/1 pt 999 998

The core of an electric motor can be considered as a solid cylinder with rotational inertia $I = 1/2 \cdot m \cdot R^2$, where m and R are the core's mass and radius respectively. Calculate the rotational inertia of the motor's core if R = 4.9 cm and m = 360 gram.

The rotational inertia of the core, I = _____ Units Select an answer .

What is the rotational kinetic energy of the core if it spins at 117 rpm?

The kinetic energy of the core, KE_{rot} = _____ Units Select an answer .

How much work is required to spin up the motor from rest to 117 rpm?

The work required, W_1 = _____ Units Select an answer .

How much work is required to spin up the motor from 117 to 468 rpm?

The work required, W_2 = _____ Units Select an answer .

How much power is required to spin up the motor from rest to 468 rpm in 2.6 seconds?

The work required, P = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 14

0/1 pt 999 998

1,500 J of energy was used to spin up a solid object from rest to 1,030 rpm, what is the rotational inertia of that object?

The rotational inertia, I = _____ Units Select an answer .

How much energy is required to double the angular speed of the same object rotated about the same axis of rotation (meaning to spin it up from 1,030 to 2,060 rpm)?

The energy required, E = _____ Units Select an answer .

Find the mass of the object given that the object is a thin uniform rod of 0.7-m length rotated about one of its ends. The rotational inertia of such a rod is $I = \frac{1}{3}mL^2$, where m is the mass of the rod and L is its length.

The mass of the object, m = _____ Units Select an answer .

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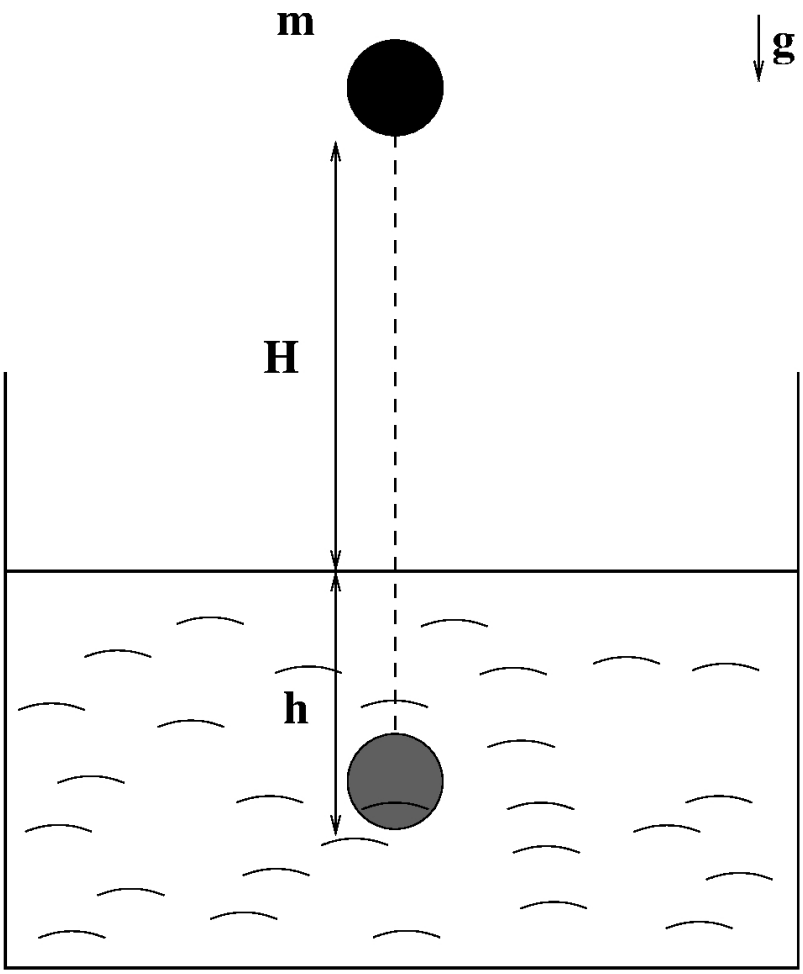
HW #07

Roman Senkov

Question 1

0/1 pt 999 998

A ball of mass 3 kg is released from a height of $H = 0.35$ m above a water surface as shown in the picture below. The ball starts to free fall, then it dives into the water and moves down an additional height of $h = 0.2$ m before coming to a complete stop. Find the net impulse exerted on the ball while it is in the air. Take the positive direction UP and neglect the air resistance.



The net impulse, Imp(in air) = _____ Units Select an answer .

For the motion in the water, what are the impulses exerted on the ball by the net force and by the gravity and water forces separately?

The net impulse, Imp(in water) = _____ Units Select an answer .

The impulse, Imp(due gravity) = _____ Units Select an answer .

The impulse, Imp(due water) = _____ Units Select an answer .

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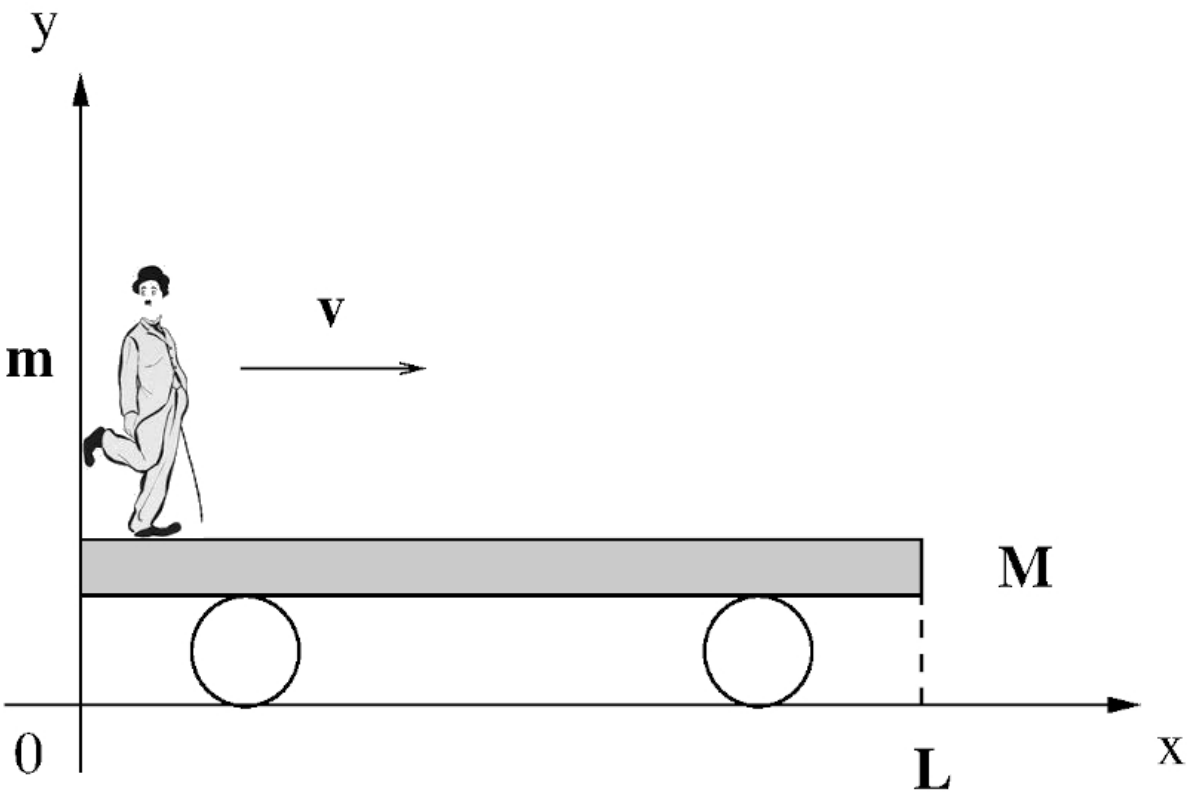
Question 2

0/1 pt 999 998

For a movie scene, Charlie Chaplin needs to walk across the roof of a car. The car has a mass of 160 kg and is of length $L = 2.2$ m. Charlie Chaplin's mass is 75 kg. Charlie Chaplin walks from one end of the car (defined at $x = 0$) towards the other end (at $x = L$), see the picture below. Find the initial position of the Center of Mass (CoM) of the system. Assume that the car has a uniform mass distribution.



The CoM position, $x_{CoM} =$ _____ Units Select an answer .

If the friction force is negligible, when Chaplin starts moving to the right then the car will Select an answer .

Neglecting friction, what will be the position of Charlie Chaplin (relative to the ground) when he reaches the right end of the car?

The Chaplin's position, $x_R =$ _____ Units Select an answer .

Neglecting friction, if Charlie Chaplin is walking at 0.55 m/s relative to the car then at what speed the car will be moving relative to the ground?

The speed of the car, $v_{car} =$ _____ Units Select an answer .

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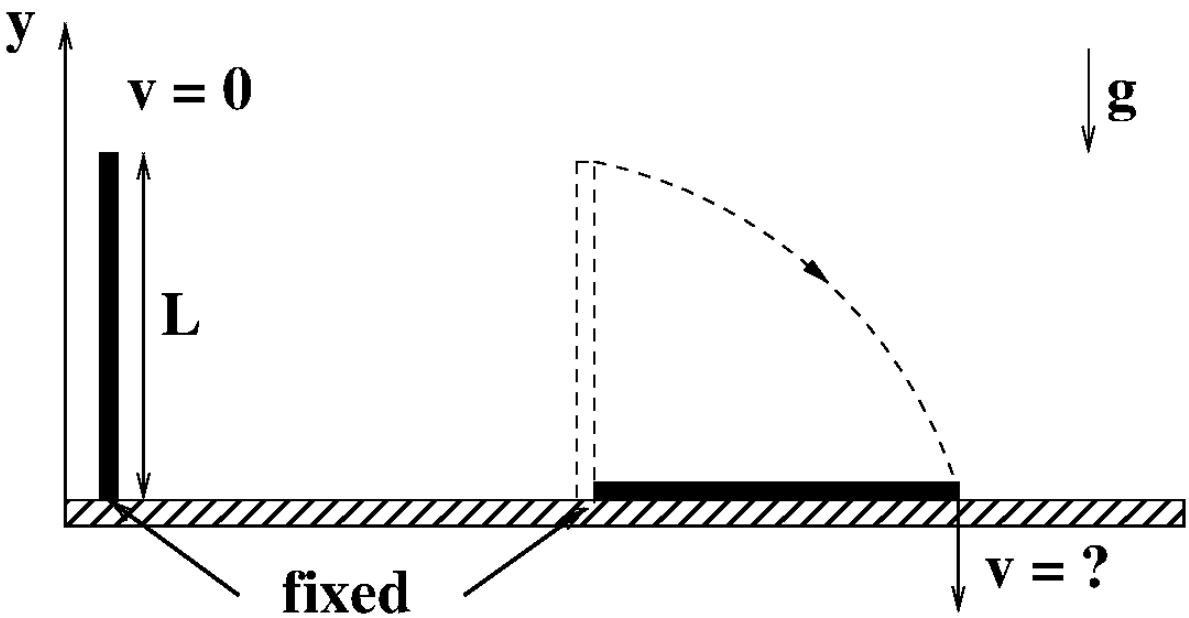
Question 3

0/1 pt 999 998

Part 1 of 2

A 0.9-m stick is standing still on a floor as shown below. At some moment the stick falls down rotating about its lower end (the one which touches the floor), the stick falls without slipping. Find the speed of the upper end of the stick when it hits the floor. Note: this is quite a challenging problem, in order to solve it follow the steps listed below. Although the mass of the stick is not important for this problem - it cancels, for convenience, we can pick m = 1 kg.



Step 1. When the stick is still and vertical find its gravitational potential energy (relative to the floor), kinetic and mechanical energies. Note: to find the potential energy use the position of CoM of the stick and m = 1 kg.

	PE_G, in J	KE, in J	E_{tot}, in J
The stick is vertical	_____	_____	_____

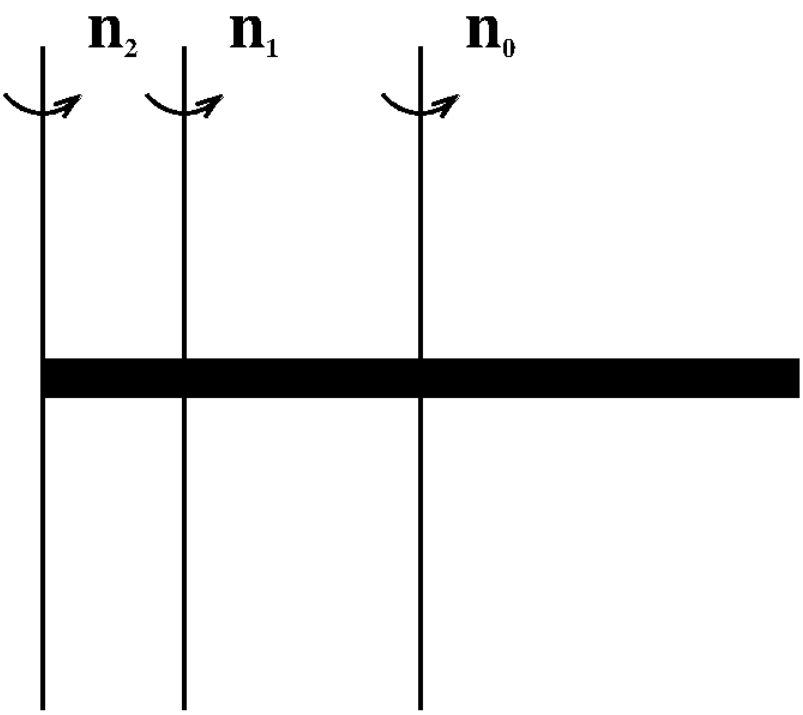
Step 2. When the stick is about to hit the floor find its gravitational potential energy (relative to the floor), kinetic and mechanical energies. Note: assume that mechanical energy is conserved.

	PE_G, in J	KE, in J	E_{tot}, in J
The stick hits the floor	_____	_____	_____

Question Help: Message instructor Post to forum

Question 4 0/1 pt 999 998

A 0.75-kg meter stick is rotated about axis n_0, which is perpendicular to the stick and goes through the 50 cm mark (the stick is one meter long). Find the rotational inertia of the stick about that n_0 axis.



The rotational inertia about n_0 axis, I_0 = _____ Units Select an answer .

Find the rotational inertia of the stick about axes n_2 and n_1, which are parallel to n_0 but go through the end of the stick and through the 32-cm mark respectively (see the picture above).

The rotational inertia about n_1 axis, I_1 = _____ Units Select an answer .

The rotational inertia about n_2 axis, I_2 = _____ Units Select an answer .

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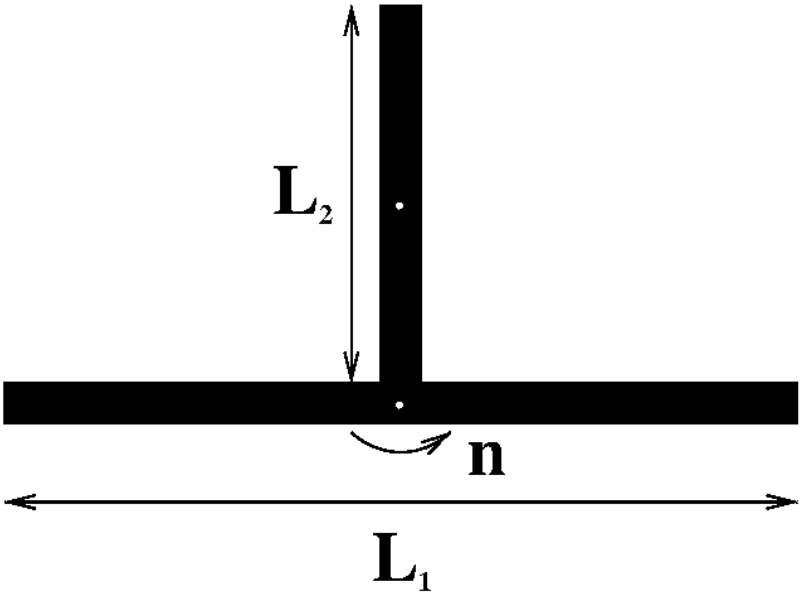
Question 5 0/1 pt 999 998

Part 1 of 2

A T-shaped figure is made from a thin wire with a linear mass density of λ = 2 g/cm. The figure has dimensions of L_1 = 22 cm (the horizontal segment) by L_2 = 17 cm (the vertical segment). First find the mass of each segment.



The mass of the horizontal segment, m_1 = _____ Units Select an answer .

The mass of the vertical segment, m_2 = _____ Units Select an answer .

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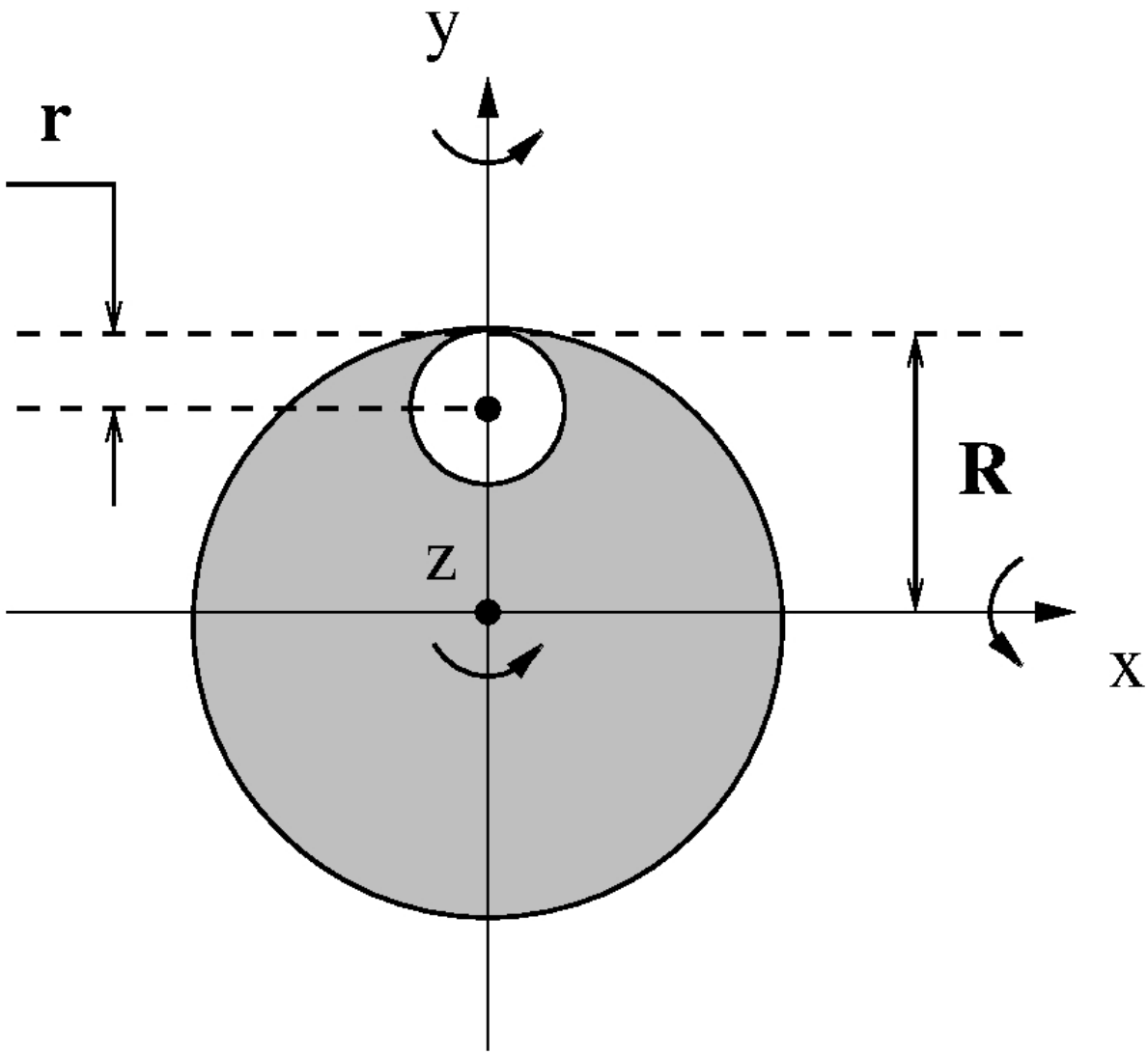
Question 6 0/1 pt 999 998

Consider a flat disk of radius R = 7.5 cm with a hole of radius r = 2 cm that touches the edge of the disk as shown in the picture below. Calculate the rotational inertia of the disk about the x-, y-, and z-axes described below. The disk has uniform distribution with a surface mass density of σ = 0.92 g/cm^2. Submit your answers in g·cm^2.



The x-axis belongs to the plane of the disk, it goes through the center of the disk, and it is perpendicular to the line joining the centers of the disk and the hole.

The rotational inertia, $I_x =$ _____ Units Select an answer .

The y-axis belongs to the plane of the disk, it goes through the centers of the disk and the hole, and it is perpendicular to the x-axis.

The rotational inertia, $I_y =$ _____ Units Select an answer .

The z-axis is perpendicular to the plane of the disk and it goes through the center of the disk.

The rotational inertia, $I_z =$ _____ Units Select an answer .

If you calculate $\left(I_z - I_x - I_y\right)$ then, most likely, you will get zero. What theorem is responsible for

this remarkable fact?

Theorem's name: Select an answer

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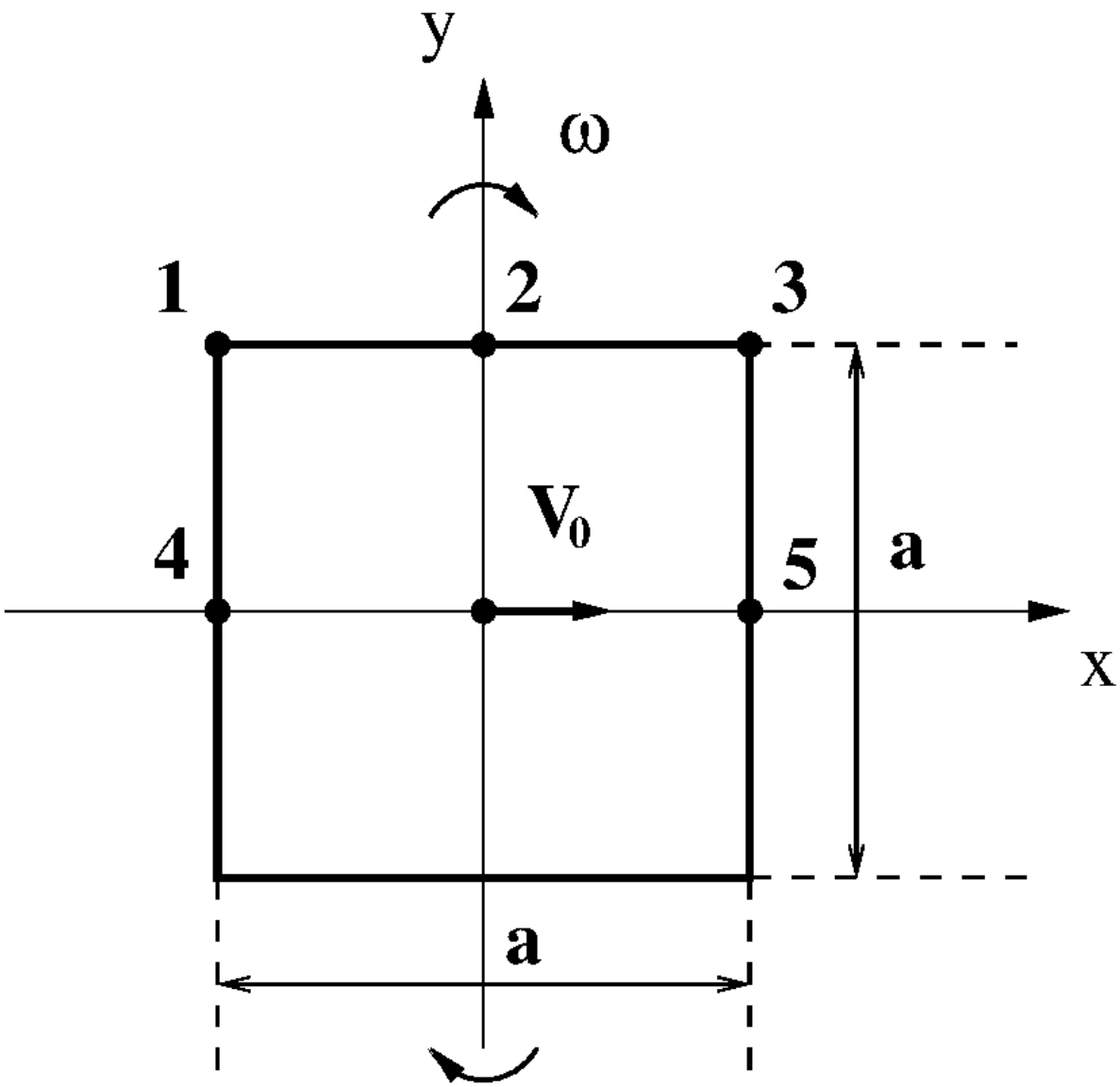
Question 7 0/1 pt 999 998

A perfect square has a length of a = 25 cm. The center of mass of the square moves in the positive x-direction with a constant velocity of V_0 = 35 cm/s and the square spins clockwise about the center of mass with a constant angular velocity of ω = 1.4 rad/s. At some moment the square is oriented as shown below. For this time moment, find the velocities of the five points indicated below. Use unit vector $\hat{i}$ for the positive x-direction and unit vector $\hat{j}$ for the y-direction.



The velocity of point 1:

$\vec{v}_1 =$ _____ $\hat{i} +$ _____ $\hat{j}$ Units Select an answer .

The velocity of point 2:

$\vec{v}_2 =$ _____ $\hat{i} +$ _____ $\hat{j}$ Units Select an answer .

The velocity of point 3:

$\vec{v}_3 =$ _____ $\hat{i} +$ _____ $\hat{j}$ Units Select an answer .

The velocity of point 4:

$\vec{v}_4 =$ _____ $\hat{i} +$ _____ $\hat{j}$ Units Select an answer .

The velocity of point 5:

$\vec{v}_5 =$ _____ $\hat{i} +$ _____ $\hat{j}$ Units Select an answer .

What is the total kinetic energy of the square if its one side has a mass of 65 g?

The total energy, $KE_{\text{tot}} =$ _____ Units Select an answer .

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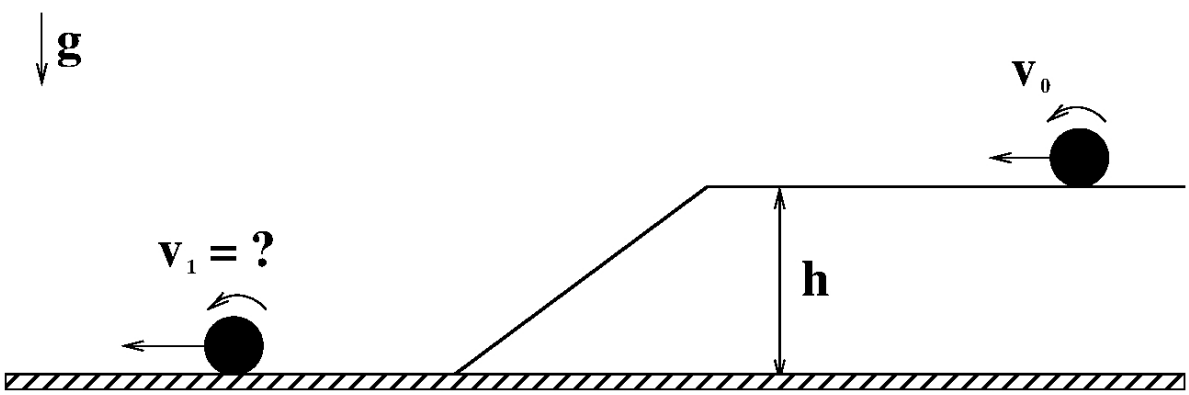
Question 8

0/1 pt 999 998

Part 1 of 2

A solid disk rolls down a ramp of a height of h = 1.4 m as shown below. Find the speed of the disk at the bottom of the ramp if its initial speed is v_0 = 2.5 m/s. The disk rolls without slipping. Note that the mass of the disk is not important, so calculate everything per unit of mass or pick any convenient value, for example, m = 1 kg.



The final speed of the disk, v_1 = _____ Units Select an answer .

Repeat your calculations with the same parameters, but for a rolling ring. Before doing it complete the following sentence: the final speed of the ring will be Select an answer the final speed of the disk.

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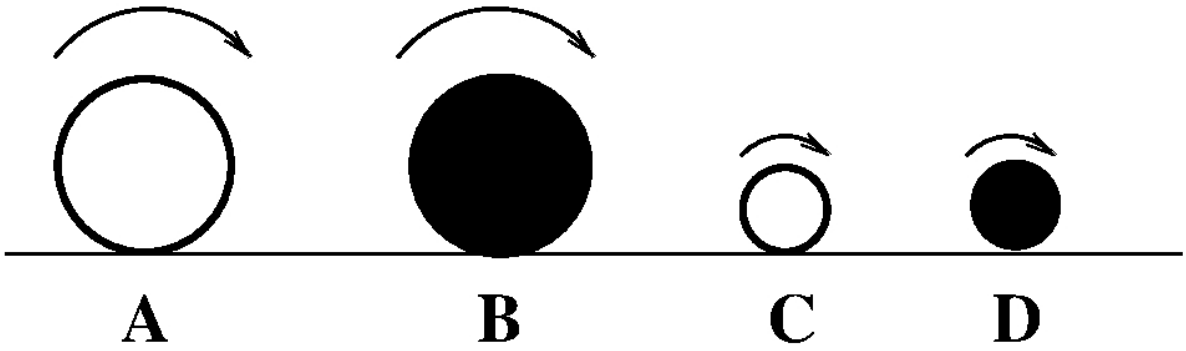
Question 9

0/1 pt 999 998

Consider four different objects shown below: A - big hollow sphere, B - big solid sphere, C - small hollow sphere, and D - small solid sphere. All four objects have the same mass and roll without slipping. Complete the following sentences.



Part I: If all four objects have the same center of mass speed, then...

The total KE of Sphere A is Select an answer the total KE of Sphere B.

The total KE of Sphere B is Select an answer the total KE of Sphere C.

The total KE of Sphere D is Select an answer the total KE of Sphere B.

The total KE of Sphere C is Select an answer the total KE of Sphere D.

The total KE of Sphere A is Select an answer the total KE of Sphere C.

The total KE of Sphere D is Select an answer the total KE of Sphere A.

Part II: If all four objects have the same total kinetic energy, then...

The speed of Sphere A is Select an answer the speed of Sphere B.

The speed of Sphere B is Select an answer the speed of Sphere C.

The speed of Sphere D is Select an answer the speed of Sphere B.

The speed of Sphere C is Select an answer the speed of Sphere D.

The speed of Sphere A is Select an answer the speed of Sphere C.

The speed of Sphere D is Select an answer the speed of Sphere A.

Note: you MUST answer all questions before submitting.

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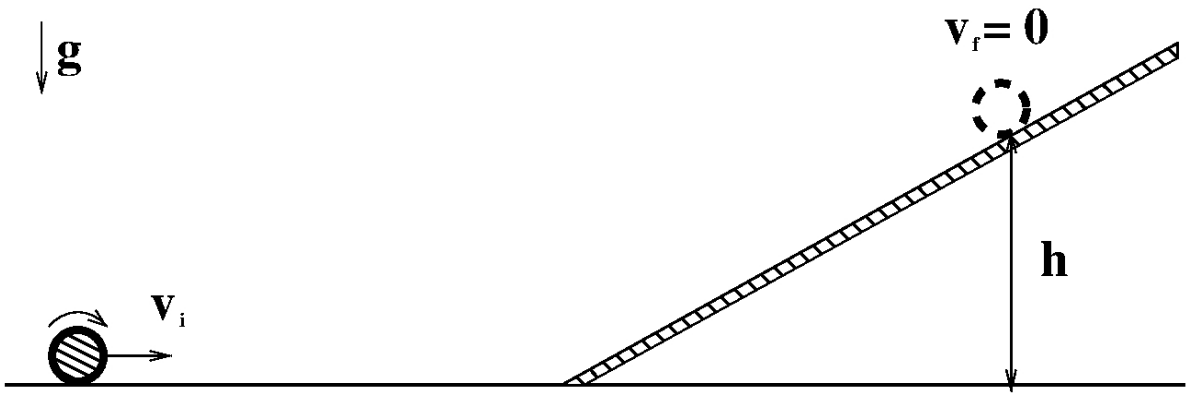
Question 10 0/1 pt 999 998

A 0.6-kg solid sphere starts to roll up a ramp with an initial CoM velocity of v_i = 10.4 m/s and goes up until it stops completely, see the picture below. To what maximum height h will the sphere rise if it rolls without slipping and no energy is lost?



The maximum height, h = _____ Units Select an answer .

At the bottom of the ramp, what are the total, rotational, and translational kinetic energies of the sphere?

The total kinetic energy, KE_{tot} = _____ Units Select an answer .

The rotational kinetic energy, KE_{rot} = _____ Units Select an answer .

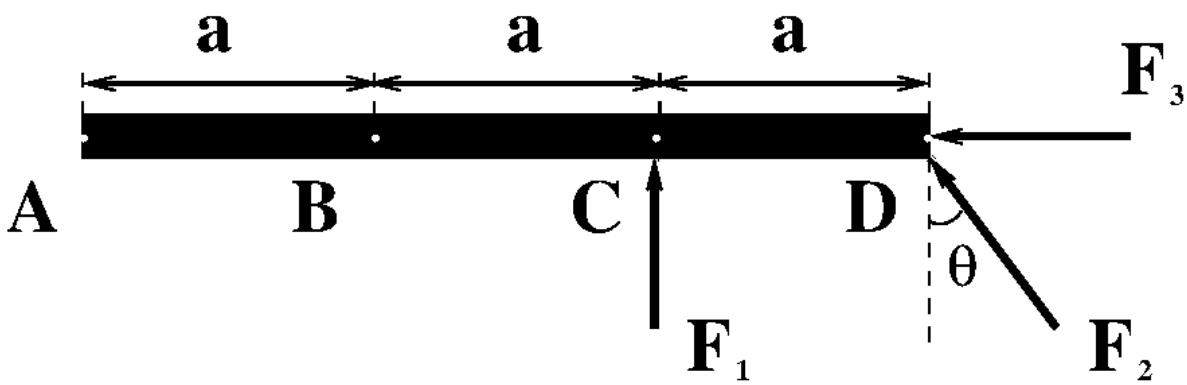
The translational kinetic energy, KE_{com} = _____ Units Select an answer .

If instead of rolling the sphere was sliding onto the ramp with the same initial velocity it would rise to Select an answer maximum height.

Question Help: Message instructor Post to forum

Question 11 0/1 pt 999 998

A 3·a long straight rod (a = 0.55 m) is marked with four equally separated points: A, B, C, and D (points A and D are on the opposite ends of the rod). There are three external forces exerted on the rod: force F_1 = 21.5 N is applied at point C perpendicular to the rod, force F_2 = 16 N is applied at point D at an angle of θ = 33° relative to the rod's normal, and force F_3 = 20.5 N is applied at point D parallel to the rod. Find the magnitude and direction of the torques produced by these forces relative to the points indicated below.



The torque due to F_1 relative to point A, τ_A(due to F_1) = _____ Units Select an answer , direction Select an answer .

The torque due to F_1 relative to point B, τ_B(due to F_1) = _____ Units Select an answer , direction Select an answer .

The torque due to F_1 relative to point C, τ_C(due to F_1) = _____ Units Select an answer , direction Select an answer .

The torque due to F_1 relative to point D, τ_D(due to F_1) = _____ Units Select an answer , direction Select an answer .

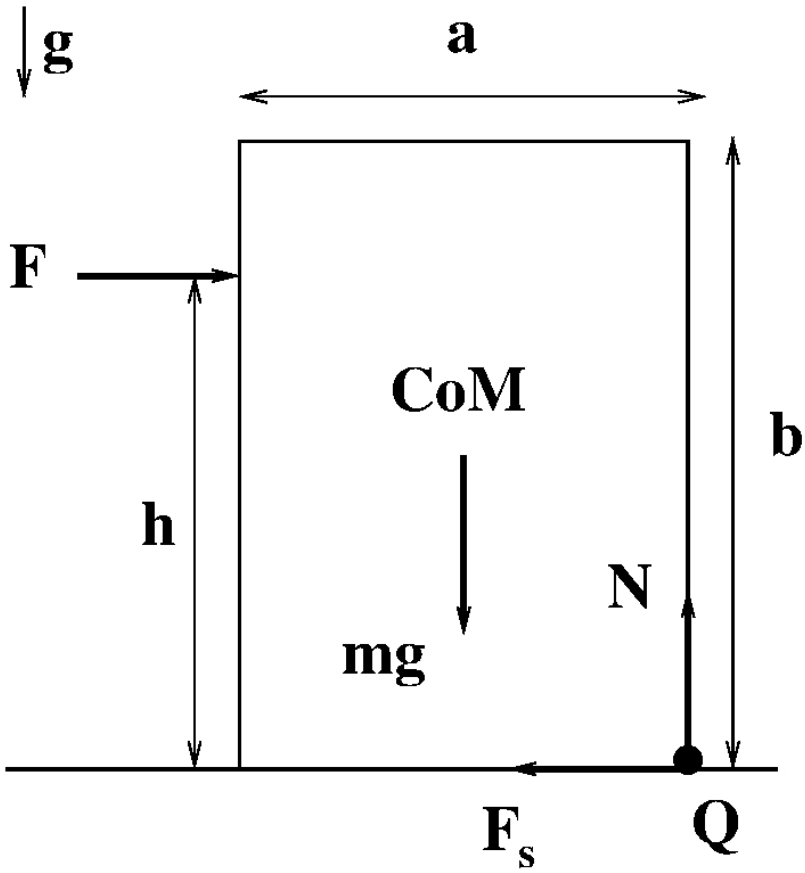
The torque due to F_2 relative to point A, τ_A(due to F_2) = _____ Units Select an answer , direction Select an answer .

The torque due to F_3 relative to point A, τ_A(due to F_3) = _____ Units Select an answer , direction Select an answer .

Question Help: Message instructor Post to forum

Question 12 0/1 pt 999 998

A 35.5-kg box with the dimensions a×b (the width a = 0.7 m and height b = 1.25 m) is standing on a rough horizontal floor (μ_s = 1.3). A LaGuardia Physics Professor wants to tip the box over, she pushes on the right side of the box with a horizontal force F = 120 N at a distance h = 0.875 m above the floor as shown in the picture below. The other forces acting on the box are the gravity force (applied to the CoM of the box), the static friction force F_s and the normal force N (both applied to the lower right corner of the box, point Q).



Calculate the magnitude and direction of the torques produced by the forces acting on the box relative to the lower right corner (point Q). Assume uniform mass distribution.

The torque due to the external force, τ_Q(due to F) = _____ Units Select an answer , direction Select an answer .

The torque due to the weight of the box, τ_Q(due to mg) = _____ Units Select an answer , direction Select an answer .

The torque due to the friction force, τ_Q(due to F_s) = _____ Units Select an answer , direction Select an answer .

The torque due to the normal force, τ_Q(due to N) = _____ Units Select an answer , direction Select an answer .

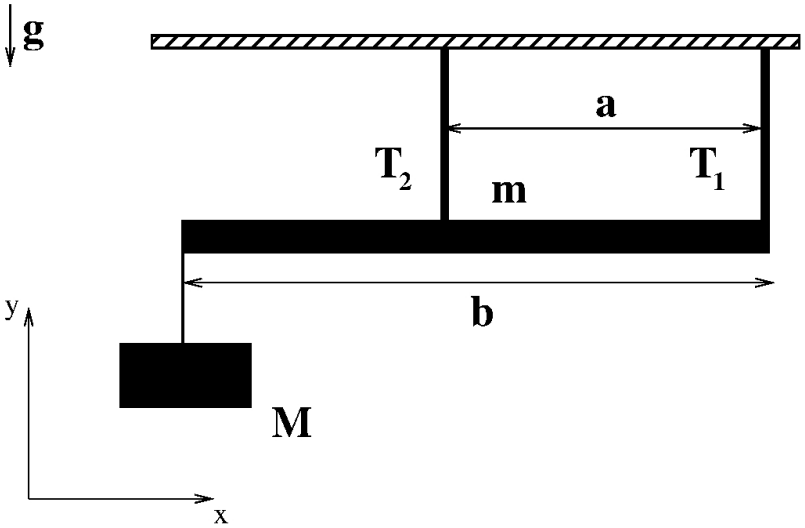
Assuming that the box is not sliding ($F < (F_s)_{max}$), will it tip over? Choose 'Yes' or 'No': ? .

Question Help: Message instructor Post to forum

Question 13

0/1 pt 999 998

A heavy block of a mass of M = 75 kg is attached to the left end of a horizontal beam (beam's mass m = 11.6 kg and length b = 2.2 m). The beam is attached to the ceiling with the help of two vertical rods: the first rod is attached at the right end of the beam, the second one at a distance a = 0.66 m form the right end of the beam, see the picture below. Find the y-component of the tension force in each rod. Note: do not forget to include the weight of the beam.



The tension in the first rod, T_1 = _____ Units Select an answer .

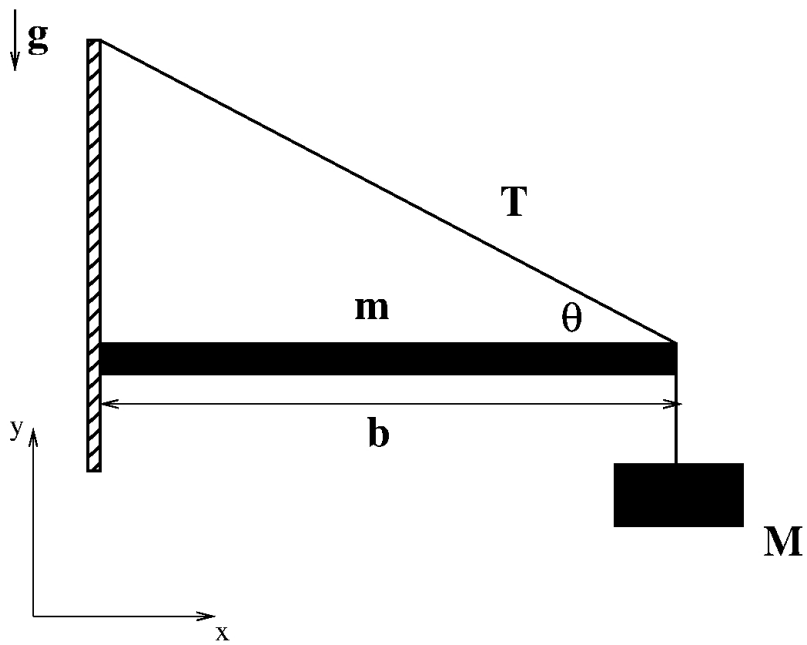
The tension in the second rod, T_2 = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 14

0/1 pt 999 998

A 29.5-kg sing is attached to the right end of a horizontal beam (the beam's mass m = 5.4 kg). The left end of the beam is mounted into a wall and it's right end is supported by a string which makes an angle θ = 34° with the beam, see the picture below. Find the magnitude of the tension in the string.



The tension in the string, T = _____ Units Select an answer .

Find the reaction force exerted by the wall on the beam.

The x component of the wall's reaction force, R_x = _____ Units Select an answer .

The y component of the wall's reaction force, R_y = _____ Units Select an answer .

Question Help: Message instructor Post to forum

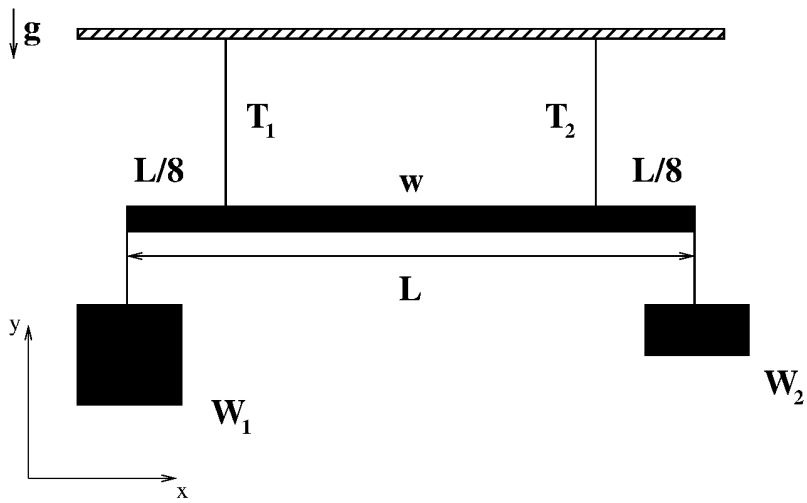
HW #08

Roman Senkov

Question 1

0/1 pt 999 998

Two weights W_1 = 167 lb and W_2 = 149 lb are attached to the ends of a 13-lb horizontal beam. The beam has length L and is suspended by two vertical ropes attached at distances L/8 from the ends of the beam as shown below. Find the tension in each rope.



What is your expectation? The tension in the rope next to the weight W_1 is Select an answer the tension in the rope next to the weight W_2.

The tension in the rope next to W_1, T_1 = _____ Units Select an answer .

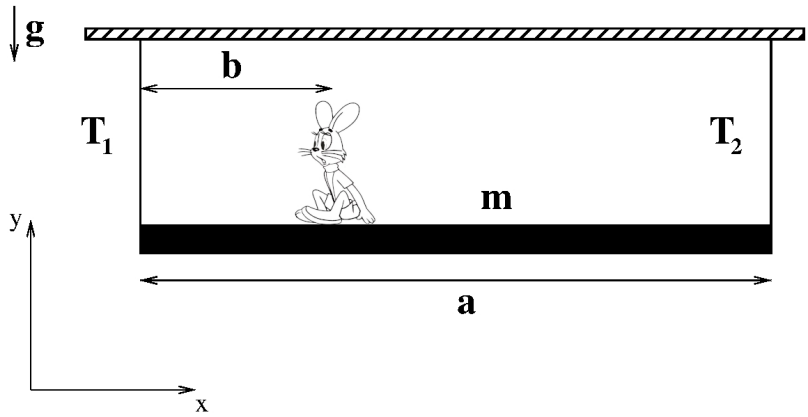
The tension in the rope next to W_2, T_2 = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 2

0/1 pt 999 998

A 4.8-kg brown hare walks on a horizontal beam (the beam's mass m = 2 kg and length a = 1.3 m). The beam is suspended with two ropes attached to the ends of the beam. What should be the distance between the hare and the left end of the beam so that the tension in the left rope is three times as big as the tension in the right rope?



The distance from the left end, b = _____ Units Select an answer .

If the hare is at the distance found in the previous question, calculate the tension in each rope.

The tension in the left rope, T_1 = _____ Units Select an answer .

The tension in the right rope, T_2 = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 3

0/1 pt 999 998

A bike wheel has a radius of R = 0.57 m and a mass of m = 2.6 kg spins at 300 rpm. What is the angular momentum of the wheel? Assume that the wheel has a shape of a ring.

The angular momentum of the wheel, L = _____ Units Select an answer .

A typical bowling ball might have a mass of 8 kg and a radius of 12 cm. How fast the ball should spin to have the same angular momentum as the wheel from the previous question?

The angular speed of the ball, ω = _____ Units Select an answer .

Which of the above objects is harder to stop? Select an answer .

How strong torque is needed to completely stop the wheel in 6 sec time?

The torque needed to stop the wheel, τ = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 4

0/1 pt 999 998

Blitz problem solving: Second Newton's law for rotation.

1. How much torque is required to spin up a disk with an inertia of I_1 = 3.3 kg·m^2 from 12.5 rad/s to 17.5 rad/s in t_1 = 4.3 seconds?

The torque required, τ_1 = _____ Units Select an answer .

2. A solid cylinder has an inertia of I_2 = 196 kg·m^2. How long will it take to spin up the cylinder from rest to 14.9 rad/s if a torque of τ_2 = 2.5 N·m is applied to the cylinder?

The time of the spin up, t_2 = _____ Units Select an answer .

3. A ring rotates with a constant angular acceleration of α_3 = 3.8 rad/s^2 when a torque of τ_3 = 22 N·m is applied to the ring. What is the rotational inertia of the ring?

The rotational inertia of the ring, I_3 = _____ Units Select an answer .

4. A torque of τ_4 = 0.32 N·m is applied to a hollow sphere with an inertia of I_4 = 0.055 kg·m^2. Find the angular acceleration of the sphere.

The angular acceleration of the sphere, α_4 = _____ Units Select an answer .

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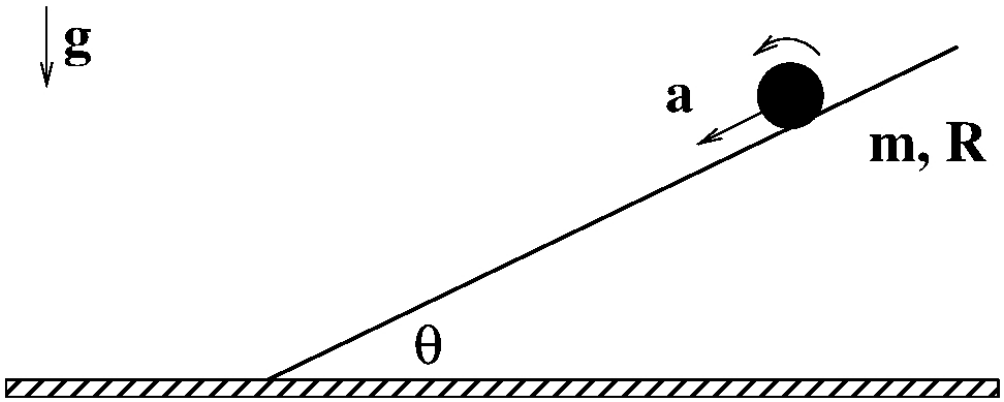
Question 5 0/1 pt 999 998

Various objects roll down an inclined plane with an inclination angle of $\theta = 21^\circ$, see the picture below. The objects have uniform mass distribution and roll without slipping. Which of the objects listed below is the fastest and which one is the slowest?



The fastest object is Select an answer and the slowest one is Select an answer .

Find the linear accelerations for the following objects.

If the object is a solid cylinder, it's acceleration, a_1 = _____ Units Select an answer .

If the object is a hollow cylinder, it's acceleration, a_2 = _____ Units Select an answer .

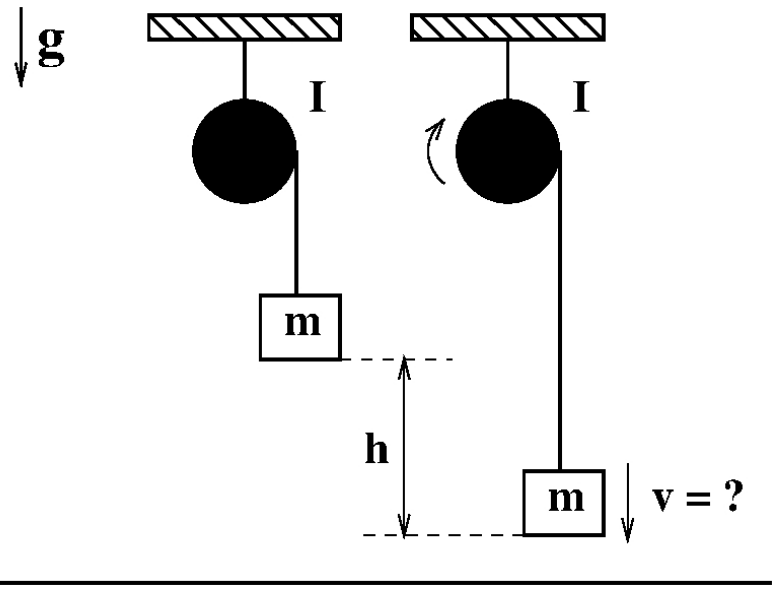
If the object is a solid sphere, it's acceleration, a_3 = _____ Units Select an answer .

If the object is a hollow sphere, it's acceleration, a_4 = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 6 0/1 pt 999 998

A box of mass m = 0.6 kg is attached to a rope which is wrapped around a physical pulley with a radius of R = 14.4 cm and a rotational inertia of I = 0.079 kg·m^2. When the box is released it starts to fall down with a constant acceleration and, at the same time, the pulley starts to spin up, see the picture below. Assuming that the pulley is frictionless, what is the magnitude of the box's acceleration and what is the tension in the rope?



The acceleration of the box, a = _____ Units Select an answer .

The tension in the rope, T = _____ Units Select an answer .

If the box starts from rest and traveled downwards a distance of h = 29.5 cm, what is the speed of the box and what is the angular velocity of the pulley?

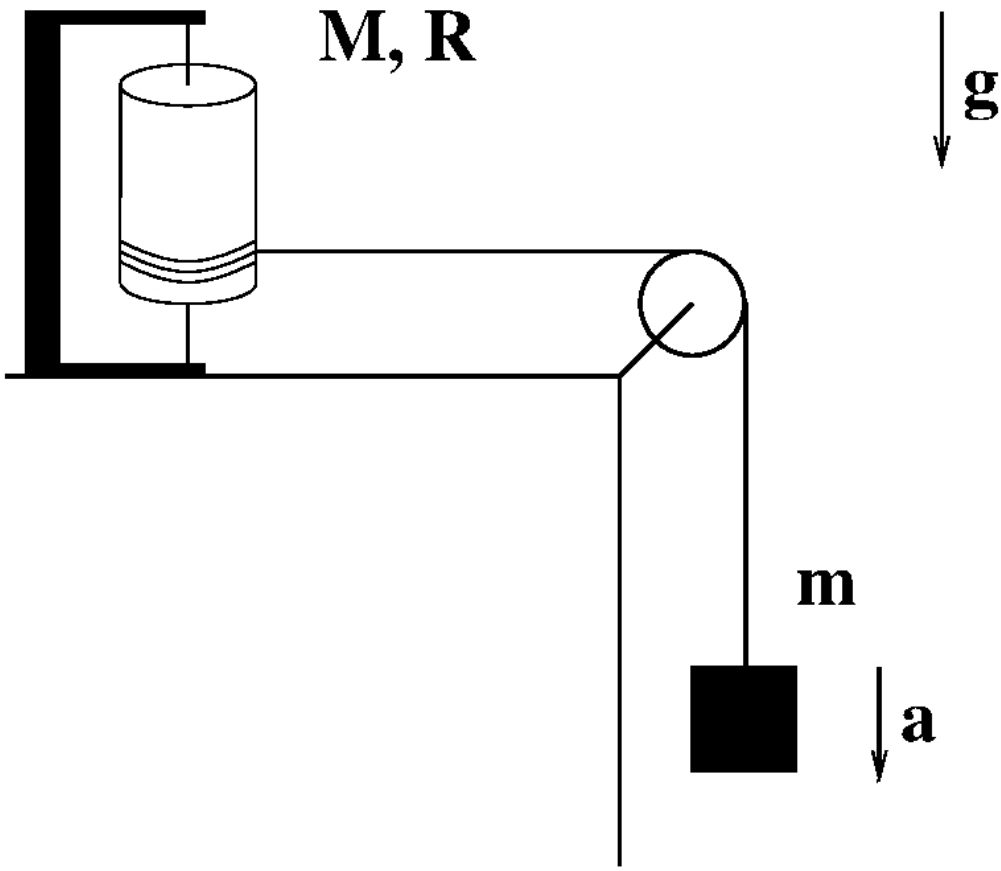
The speed of the box, v = _____ Units Select an answer .

The angular velocity of the pulley, ω = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 7 0/1 pt 999 998

A block of mass m = 170 gram is attached to a solid cylinder of mass M = 720 gram and radius R = 25 cm with the help of a massless and frictionless pulley as shown below. The rope connecting the objects is tightly wrapped around the cylinder and unwinds without slipping as the block falls down. Find the linear acceleration of the block *m* and the angular acceleration of the cylinder *M* if the rope is massless and unstretchable.



The linear acceleration of the block, a = _____ Units Select an answer .

The angular acceleration of the cylinder, α = _____ Units Select an answer .

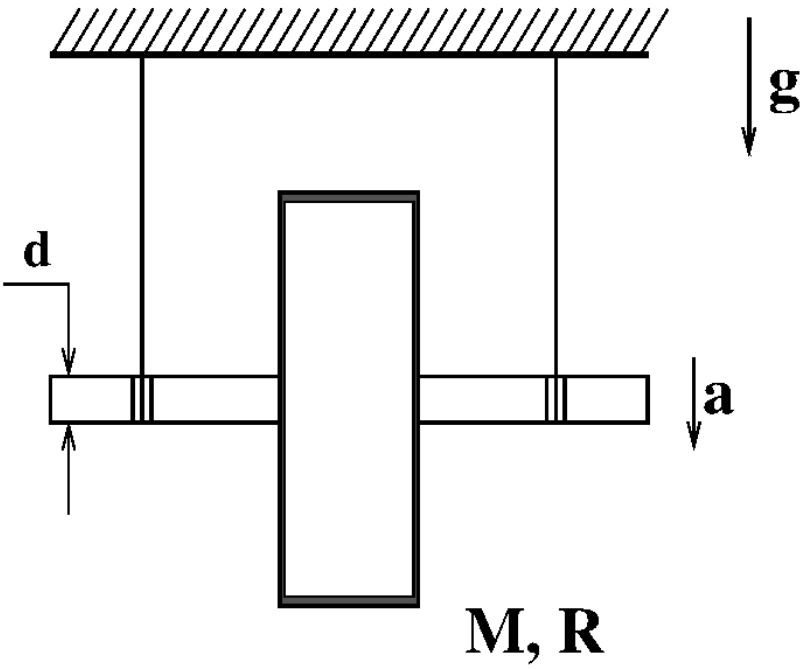
What is the tension in the rope?

The tension, T = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 8 0/1 pt 999 998

How Maxwell's wheel works. A hollow cylinder of mass *M* and radius R = 80 cm is suspended with the help of two ideal strings which are tightly wrapped around the axis of the cylinder and they unwind without slipping as the cylinder moves down. See the picture below. Find the linear acceleration of the cylinder if the axis has a diameter of d = 5.4 cm and its mass is negligible. You should get a relatively small value for the acceleration, why do you think it is so?



The linear acceleration of the cylinder, a = _____ Units Select an answer .

As the cylinder moves down, by how many times its rotational kinetic energy is greater than its translational kinetic energy? What is your expectation for this ratio?

The ratio, KE_{rot}/KE_{CoM} = _____ Units Select an answer .

If the cylinder started to move from rest and traveled 8 cm down, what are its linear and angular speeds? Submit your answers in cm/s and rev/s respectively.

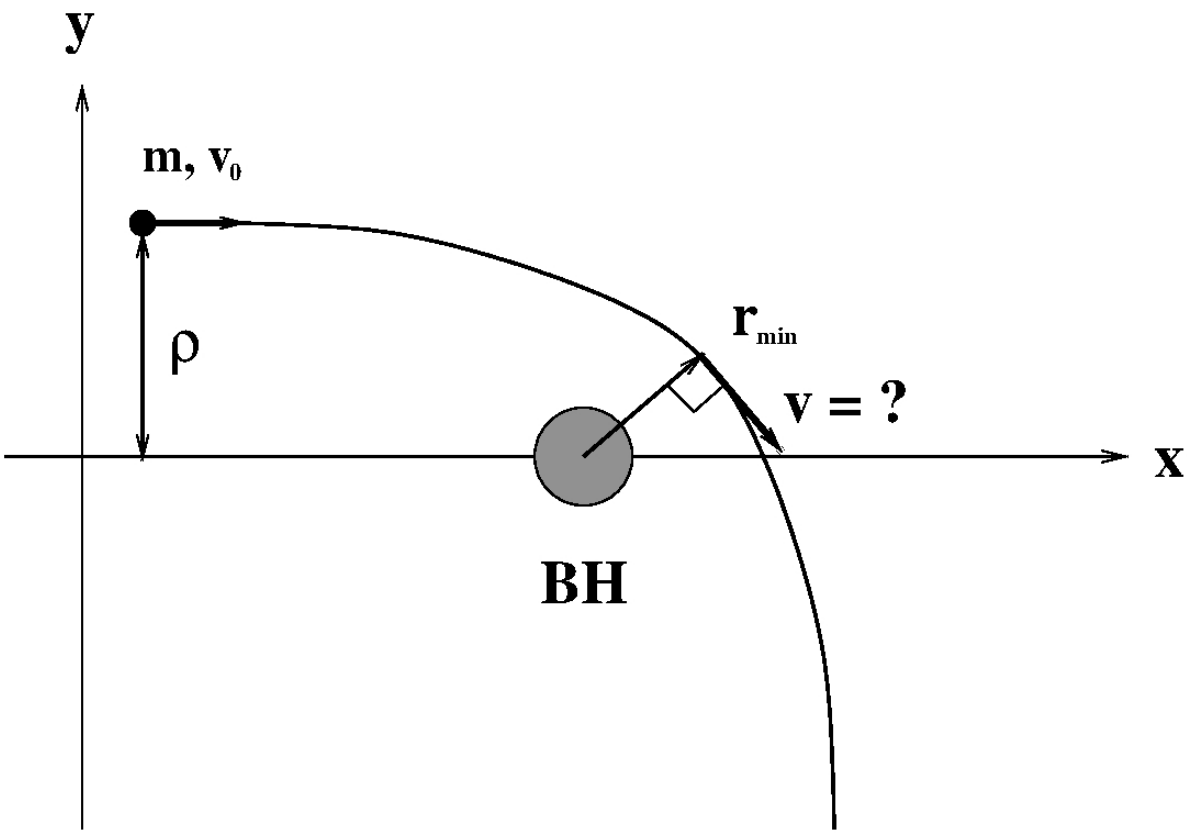
The linear speed, v = _____ Units Select an answer .

The angular speed, ω = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 9 0/1 pt 999 998

A small celestial body, let's say an asteroid, with a mass of m = 190 kg is moving from infinity with an initial velocity of v_0 = 20 km/s along the positive x-direction, see the figure below. What is the magnitude of the asteroid's angular momentum calculated relative to the center of a heavy Black Hole (BH) located somewhere on the x-axis (y = 0), if the initial y-position of the asteroid is ρ = 16,500 km?



The angular momentum, L = _____ Units Select an answer .

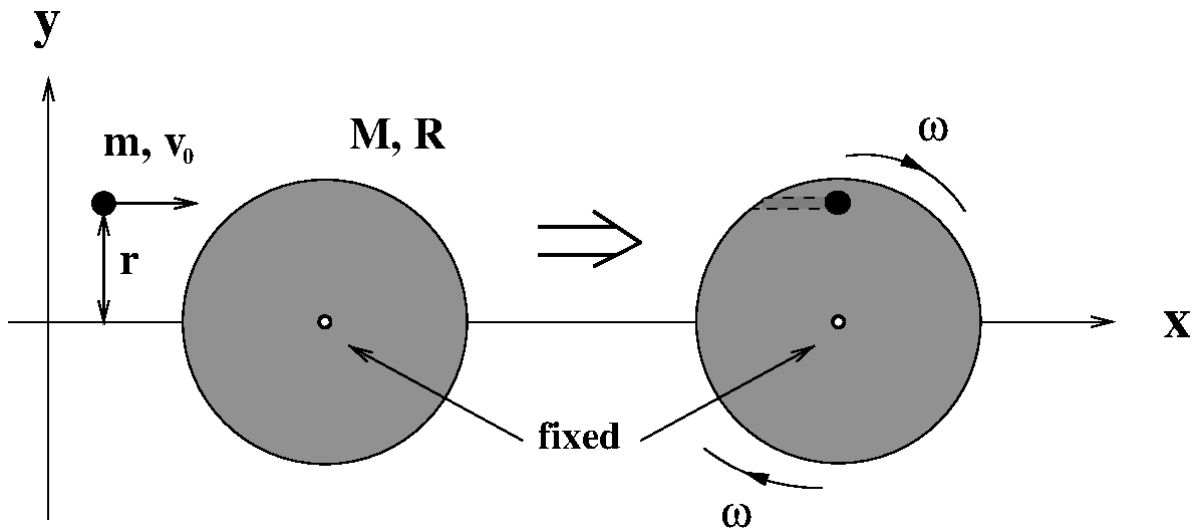
The asteroid is attracted by the BH with a Newtonian gravitational force that conserves the angular momentum of the asteroid. Use this fact to find the speed of the asteroid at its closest approach to the BH at r_{min} = 70 km.

The speed, v = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 10 0/1 pt 999 998

A solid cylinder of mass M = 2 kg and radius R = 80 cm can freely spin about its symmetry axis which is fixed. The cylinder is initially at rest while a 12-gram small bullet is moving towards it at a speed of v_0 = 190 m/s along the positive x-direction (see the left side of the picture below). How fast will the cylinder spin if the bullet stops inside it? To find the final angular velocity follow the steps outlined below.



Find the initial angular momentum of the system calculated relative to the center of the cylinder if initially the bullet was moving at a vertical position of r = 30 cm.

The angular momentum, L = _____ Units Select an answer .

What is the rotational inertia of the cylinder and the bullet inside it, if the bullet stuck at the distance 30 cm from the center of the cylinder (see the right side of the picture above)?

The rotational inertia, I = _____ Units Select an answer .

Use the angular momentum conservation law to find the final angular velocity of the system. How much heat was released during the collision?

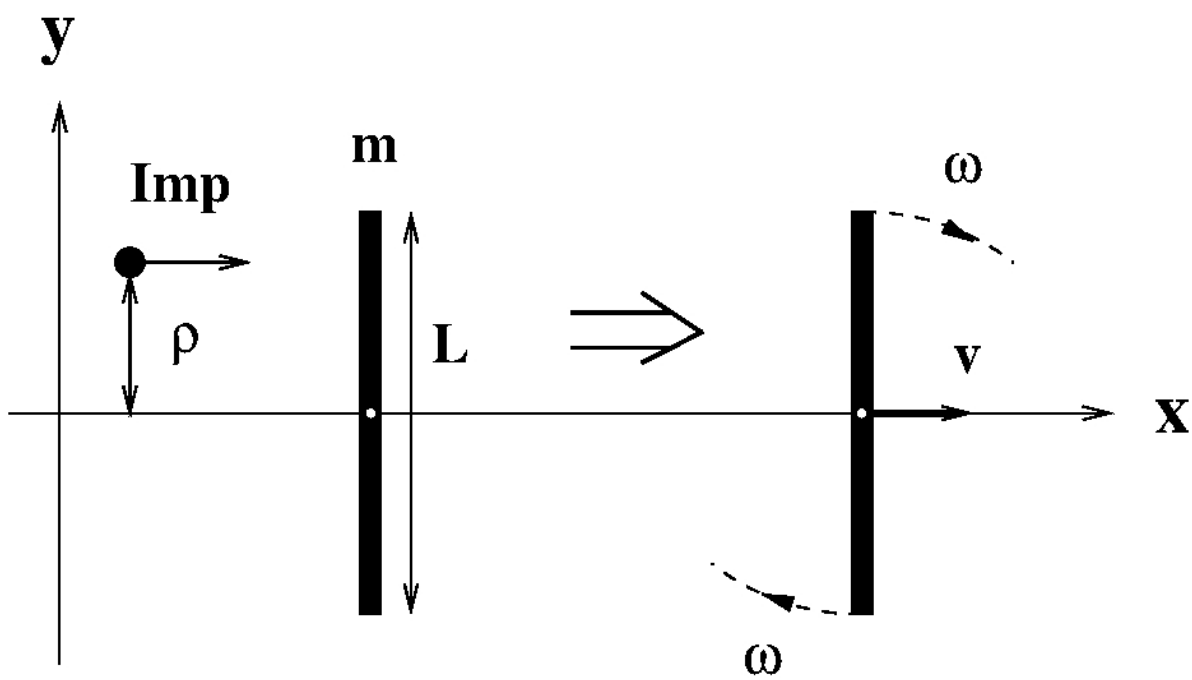
The angular velocity, ω = _____ Units Select an answer .

The heat, Q = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 11 0/1 pt 999 998

A 0.5-kg thin rod of a length L = 75 cm is initially at rest and is not restricted from moving by any forces. An impulse with a magnitude of Imp = 2.3 N·s is applied to the rod at a distance ρ = 35 cm from the center of the rod in the direction perpendicular to the rod. Due to the impact the rod starts to move and spin as shown in the figure below. Find the velocity of the CoM of the rod after the impact.



The speed of the CoM, v = _____ Units Select an answer .

What is the magnitude of the rotational impulse, $\vec{R} = \left[\vec{r} \times \overrightarrow{Imp}\right]$, applied to the rod and calculated relative to the center of the rod?

The rotational impulse, R = _____ Units Select an answer .

What are the angular velocity and the total kinetic energy of the rod after the impact?

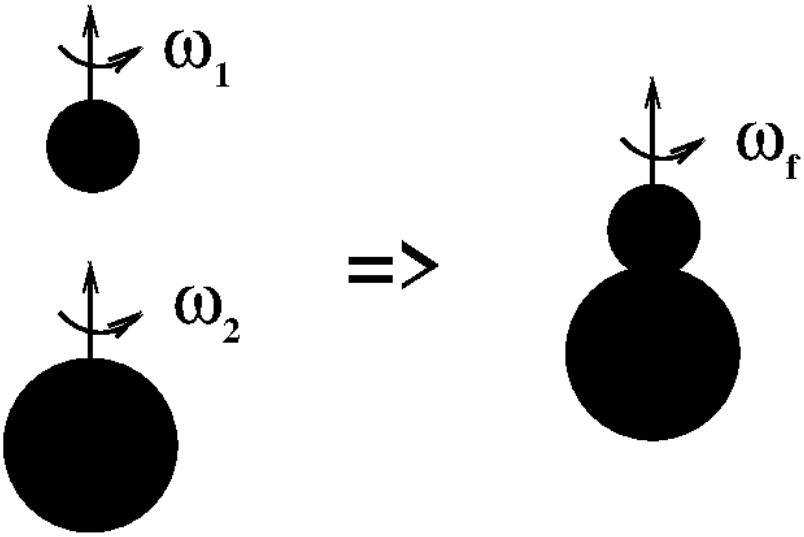
The angular velocity, ω = _____ Units Select an answer .

The total kinetic energy, KE_{tot} = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 12 0/1 pt 999 998

Consider two solid spheres with uniform mass distribution each: a small one with a radius R_1 and a large one with a radius of $2 \cdot R_1$. Initially the spheres are separated and rotate in the same direction about the same axis of rotation as shown below, the smaller sphere rotates with ω_1 = 22.7 rad/sec and the larger one with ω_2 = 2.9 rad/sec, then the spheres are brought together. Friction acts between the spheres until both are eventually rotating at the same speed. Assuming that the spheres are made of the same material, what is the final angular velocity of the system?



The final angular velocity of the system, ω_f = _____ Units Select an answer .

How much energy is released as heat due to the friction if the mass of the small sphere is m_1 = 2.1 kg and it's radius is R_1 = 0.65 m?

The heat released, Q = _____ Units Select an answer .

Question Help: Message instructor Post to forum

Question 13 0/1 pt 999 998

A Merry Go Round carousel has a radius of R = 3 m and a rotational inertia of I = 640 kg·m^2. A 78.5-kg LsGuardia student is on the carousel at the midpoint between the carousel's center and the rim (at R/2 distance from the center). Initially the system rotates about a vertical axis that goes through the center of the carousel at 3.2 rad/sec.

If the student walks to the rim of the carousel, the system will Select an answer . What is the new angular velocity of the system in this case?

The new angular velocity, ω_1 = _____ Units Select an answer .

If the student walks to the very center of the carousel, the system will Select an answer . What will be the new angular velocity of the system?

The new angular velocity, ω_2 = _____ Units Select an answer .

If the student started from the midpoint, how much work should be done by him in order to reach the center of the carousel?

The work done by the student, W = _____ Units Select an answer .

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Question 14

0/1 pt 999 998

When a star collapses it significantly shrinks in size and spins up. Consider a star with a mass of M = 2.5×10^{30} kg and an initial radius of R_i = 7.1×10^6 km. If the initial period of rotation of the star is T_i = 33.5 days, find the new rotational period after it collapses to a final radius of R_f = 7.1×10^3 km. Treat the star before and after the collapse as a solid sphere with uniform mass distribution (which is not true, of course, but good enough for an estimation).

The new rotational period of the star, T_f = _____ Units Select an answer .

Find the ratio between the final and initial rotational kinetic energies of the star.

The factor by which the kinetic energy of the star increases, KE_f/KE_i = _____ Units Select an answer .

The increase in the rotational kinetic energy of the star comes from gravity. How much work is done by the gravity force while collapsing the star?

The work done by gravity, W = _____ Units Select an answer .

Question Help: Message instructor Post to forum

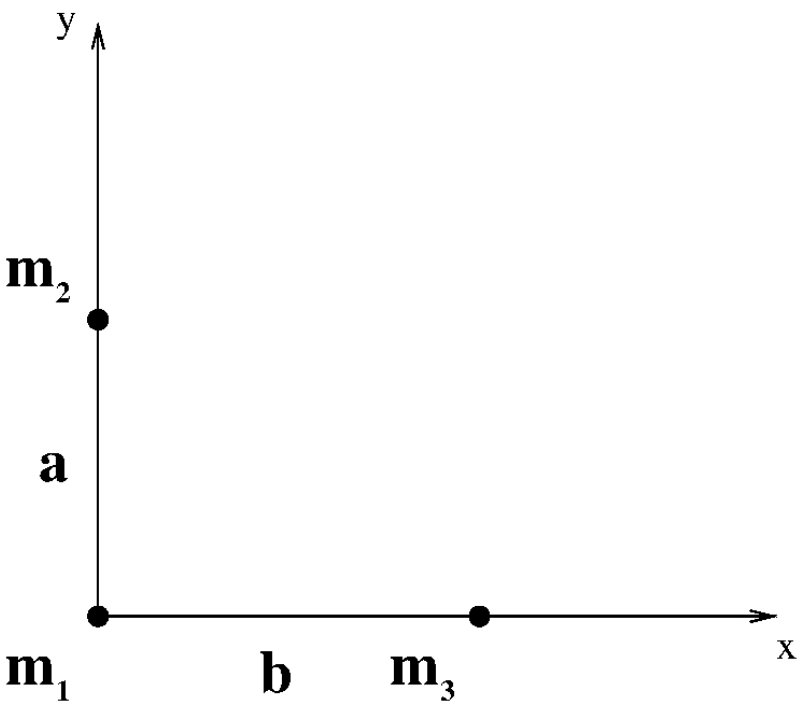
HW #09

Roman Senkov

Question 1

0/1 pt 999 998

Three point-like masses are arranged on a (x,y)-plane as follows: m_1 = 3.6 kg is placed at (0,0), m_2 = 4 kg is placed at (0,24 cm), and m_3 = 6 kg is placed at (26 cm,0), see the picture below. Find the gravitational forces exerted on each mass.



The magnitude of the gravitational force on m_1 due to m_2,

F_{12} = _____ Units Select an answer .

The direction of F_{12} is best described as Select an answer .

The magnitude of the gravitational force on m_1 due to m_3,

F_{13} = _____ Units Select an answer .

The direction of F_{13} is best described as Select an answer .

The magnitude of the gravitational force on m_2 due to m_1,

F_{21} = _____ Units Select an answer .

The direction of F_{21} is best described as Select an answer .

The magnitude of the gravitational force on m_2 due to m_3,

F_{23} = _____ Units Select an answer .

The direction of F_{23} is best described as Select an answer .

The magnitude of the gravitational force on m_3 due to m_1,

F_{31} = _____ Units Select an answer .

The direction of F_{31} is best described as Select an answer .

The magnitude of the gravitational force on m_3 due to m_2,

F_{32} = _____ Units Select an answer .

The direction of F_{32} is best described as Select an answer .

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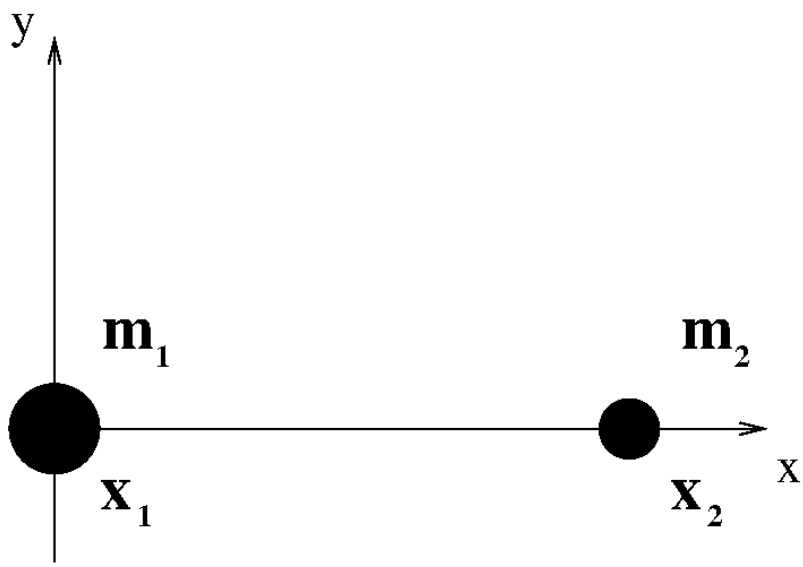
Question 2

0/1 pt 999 998

Two masses are placed on the x-axis. The first mass m_1 = 5 kg is at the origin and the second mass m_2 = 16 kg is at x_2 = 11 m, see the picture below. At what position should be a third mass of m_3 = 7 kg placed so it experiences zero net gravitational force?



The position of m_3 with no net force on it, x_3 = _____ Units Select an answer .

If instead of x_3 the third mass is placed at the midpoint between m_1 and m_2, what will be the magnitude of the net gravitational force on m_3?

The magnitude of the net force, $F_{3,Net}$ = _____ Units Select an answer .

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Question 3

0/1 pt 999 998

Find the free fall acceleration at the surface of a Neutron Star with a mass of M_{NS} = 3×10^{30} kg and a radius of R_{NS} = 10.4 km.

The free fall acceleration near the NS, g_{NS} = _____ Units Select an answer .

What is the free fall acceleration at the surface of the Moon? The Moon is about 81 times less massive and 3.7 times smaller than the Earth. Note: try to answer this question using only the knowledge of the Earth's free fall acceleration, g_{Earth} = 9.81 m/s^2.

The free fall acceleration near on the Moon, g_{Moon} = _____ Units Select an answer .

What is the weight of a 151-lb student at the surface of that Neutron Star and at the Moon's surface?

The weight of the student at the NS, W_1 = _____ Units Select an answer .

The weight of the student as the Moon, W_2 = _____ Units Select an answer .

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Question 4

0/1 pt 999 998

To find the change in the free fall acceleration calculated at the surface of a planet (or a star/moon/etc) and at a height h above the planet's surface one can use the following approximate expression

$$\Delta g = GM\left(\frac{1}{R^2} - \frac{1}{(R+h)^2}\right) \approx GM\frac{2h}{R^3} = g\,\frac{2h}{R},$$

where $G = 6.67 \times 10^{-11} Nm^2/kg^2$ is the universal gravitational constant, g is the free fall acceleration near the surface, M and R are the mass and the radius of the planet, and h is the height above the surface (we assumed that $h \ll R$).

Use the above formula to calculate the difference in the free fall acceleration between the feet and head of a 1.7-m tall person standing at the surface of Earth (M_{Earth} = 5.97×10^{24} kg, R_{Earth} = 6,371 km, g_{Earth} = 9.81 m/s^2).

The difference in g near Earth, Δg_1 = _____ Units Select an answer .

Repeat the calculation for the same person near the surface of a White Dwarf (M_{WD} = 0.98×10^{30} kg, R_{WD} = 11,414 km).

The difference in g near the star, Δg_2 = _____ Units Select an answer .

Find the decrease in the weight of a 167-lb person standing on the roof of a 180-m tall tower located at the Earth's surface.

The decrease in the weight, ΔW = _____ Units Select an answer .

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Question 5

0/1 pt 999 998

Based on the information provided below calculate the periods, orbital sizes and orbital speeds of the planets in our Solar system. Complete the following table.

	Period in Years	Orbital Size in AU	Orbital Speed in km/s
Mercury	_____	0.387	47.862
Venus	_____	0.723	35.04
Earth	1.000	1.000	29.806
Mars	1.881	1.524	_____
Jupiter	11.858	5.2	_____
Saturn	29.424	9.531	_____
Uranus	83.75	_____	6.812
Neptune	163.72	_____	5.449
Pluto	247.94	_____	4.745

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Question 6

0/1 pt 999 998

A satellite is in a circular orbit 370 km above the Earth's surface. Find the orbital period and the speed of the satellite. Take $M_{Earth} = 5.97\times10^{24}$ kg, $R_{Earth} = 6{,}371$ km.

The orbital period, T = _____ Units Select an answer .

The orbital speed, v = _____ Units Select an answer .

How high above the Earth's surface should be the orbit of a satellite so it's orbital period equals to the period of the Earth's spin (24 hrs)?

The elevation above the surface, h = _____ Units Select an answer .

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Question 7

0/1 pt 999 998

The U.S.S. Enterprise (NCC-1701-A) approaches an unknown system with a Black Hole at the center. One of the planets in this system is observed to have an orbit with a radius of R_1 = 4 AU and a period of T_1 = 0.5 years. What is the mass of the Black Hole compared to the mass of the Sun?

The mass of the Black Hole, M_{BH} = _____ Units Select an answer .

Another planet in the system is observed to have an orbital radius of R_2 = 6.2 AU, how long does it take for this planet to complete one orbit around the Black Hole?

The orbital period, T_2 = _____ Units Select an answer .

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HW #10

Roman Senkov

Question 1

0/1 pt 999 998

Electrical AWG 10 copper wire has a cross section diameter of 2.54 mm. Find the linear mass density of the wire (the mass per unit of length), the copper volume mass density is 8.96 g/cm^3.

The linear mass density of the wire, λ = _____ Units Select an answer .

What is the mass of a 7-m segment of AWG 10 wire?

The mass of the segment, m = _____ Units Select an answer .

A wire spool is marked to have 15 kg of AWG 10 wire. What is the length of the wire in the spool?

The length of the wire, L = _____ Units Select an answer .

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Question 2

0/1 pt 999 998

At high altitudes the air pressure can drop quite noticeably. What is the net force on a 9.8×12.4 inch airplane window if at certain altitude the outside-cabin air pressure is P_{out} = 36 kPa and the inside-cabin pressure is supported at a level of P_{in} = 78.5 kPa?

The net force on the window, F_{net} = _____ Units Select an answer .

If the same airplane window can withstand a twice as strong force as determined above, to what maximum value the inside-cabin pressure can be increased without breaking the windows (assume the same outside pressure as in the previous problem)? Compare your results to the standard atmospheric pressure: 1 atm = 101.33 kPa = 14.7 psi.

The maximum inside pressure, P_{max} = _____ Units Select an answer .

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Question 3

0/1 pt 999 998

Estimate the average pressure exerted on the ground by a red kangaroo when it jumps straight up to a 1.5 m height. Use the following parameters: the kangaroo's mass m = 48.8 kg, the time of the contact between the kangaroo's feet and the ground during the jump t = 0.14 sec, and the kangaroo's foot area A = 29.9 cm^2. Assume that the kangaroo jumps by pushing with it's both feet.

The pressure produced by the jumping kangaroo,

P_1 = _____ Units Select an answer .

Just for comparison, calculate the pressure exerted on the ground by a 8,200-lb elephant standing on one foot with an area of 220 in^2.

The pressure produced by the elephant,

P_2 = _____ Units Select an answer .

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Question 4

0/1 pt 999 998

What is the pressure due to the sea water at a 10 m distance below the surface? Take 1.035 g/cm^3 density for the sea water and 1 atm = 101.33 kPa.

The pressure due the sea water, p_1 = _____ Units Select an answer .

What is the pressure due to the sea water at a depth of 100 m?

The pressure due the sea water, p_2 = _____ Units Select an answer .

At what distance below the surface the pressure due to the water is 130 atm?

The distance below the surface, d = _____ Units Select an answer .

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Question 5

0/1 pt 999 998

A cylinder vase is 79 cm tall and has a diameter of 21 cm, the vase stands vertically and is half filled with pure water (ρ_{water} = 1 g/cm^3). Find the gauge pressure (only due to the fluid) near the bottom of the vase. What is the force on the vase's bottom due to the water?

The gauge pressure at the bottom of the vase, P_1 = _____ Units Select an answer .

The force on the bottom of the vase, F_1 = _____ Units Select an answer .

Now, some oil with ρ_{oil} = 0.65 g/cm^3 is poured on top of the water so that the total level of two fluids together is h_2 = 69.5 cm (the fluids do not mix and do not get compressed). What is the gauge pressure and the force on the bottom of the vase in this case?

The gauge pressure near the bottom of the vase, P_2 = _____ Units Select an answer .

The force on the bottom of the vase, F_2 = _____ Units Select an answer .

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Question 6

0/1 pt 999 998

Blitz problem solving: Pascal's Principle.

For the questions below the master cylinder is the smaller ones, it accepts the input force, while the second or controlled cylinder (the larger one) produces the output force.

1. What force must be exerted on the master cylinder of a hydraulic lift to support the weight of a 2,000-kg car resting on a second cylinder? The master cylinder has a 1.6-cm diameter and the second cylinder has a 25-cm diameter. The free fall acceleration is g = 9.81 m/s^2.

The input force, F_{input} = _____ Units Select an answer .

2. A certain hydraulic system is designed to exert a force 91 times as large as the one put into it. What must be the ratio of the diameter of the cylinder that is being controlled to the diameter of the master cylinder?

The ratio of the diameters, $d_{controlled}/d_{master}$ = _____ Units Select an answer .

3. For previous question (#2), by what factor is the distance through which the output force moves reduced relative to the distance through which the input force moves? Assume no losses due to friction.

The ration of the distances, $L_{controlled}/L_{master}$ = _____ Units Select an answer .

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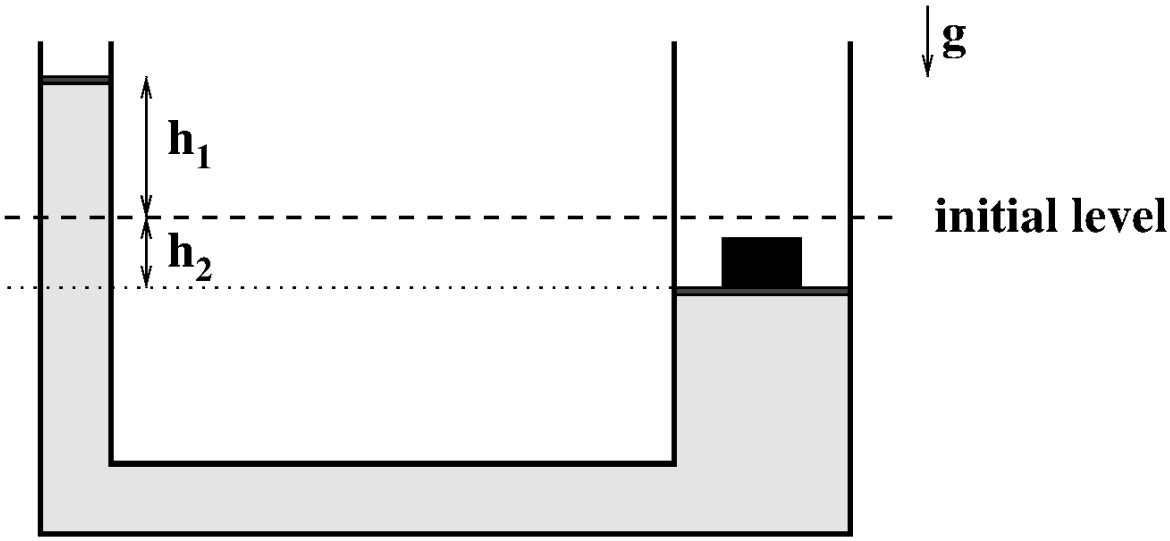
Question 7

0/1 pt 999 998

A simple hydraulic press is filled with pure water (ρ_{water} = 1 g/cm^3) and has the pistons of 328 cm^2 and 49 cm^2 areas each. Initially the pistons are balanced out, then a 90-kg load is placed on the larger piston so it moves down until new equilibrium is reached. Assuming that the fluid is incompressible and the pistons are massless, to what height relative to *it's initial level* the small piston will rise?



The height of the small piston, h_1 = _____ Units Select an answer .

What mass should be placed on the small piston so it moves back to the initial level?

The mass on the small piston, m = _____ Units Select an answer .

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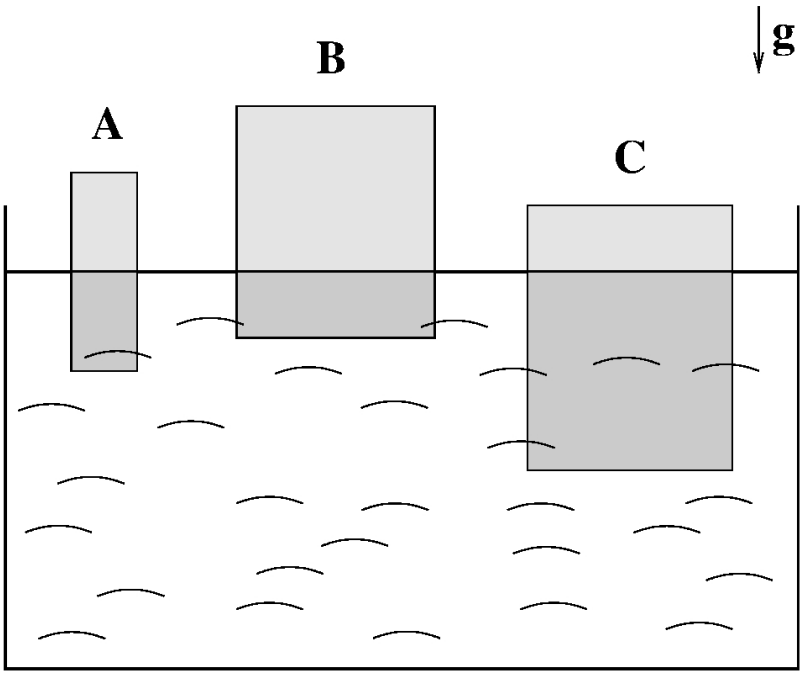
Question 8 0/1 pt 999 998

Consider two situations described below and complete the corresponding statements. (1) Three boxes are floating in a fluid as shown in the picture below. The boxes are different in masses, volumes, densities, but have the same thickness (in the direction perpendicular to the screen).

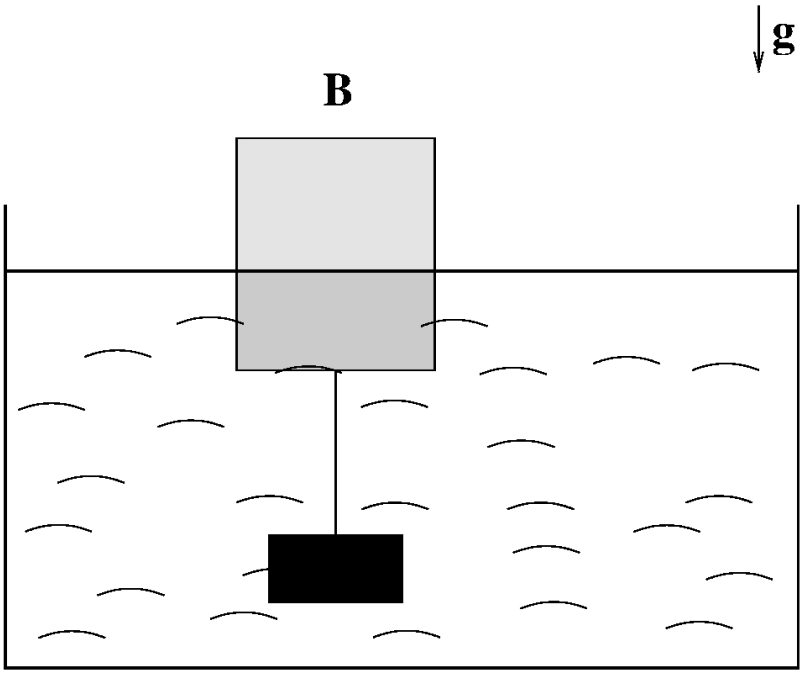


Rank the objects according to the buoyant force on them (largest first): ? .

Rank the objects according to their density (largest first): ? .

Rank the objects according to their mass (largest first): ? .

(2) Box B floats in the same fluid with a heavy brick attached to it, see the picture below. If the string holding the brick is cut and the brick falls to the bottom, complete the following statements.



The position of the box relative to the water level Select an answer .

The water level in the tank Select an answer .

The buoyant force on the brick Select an answer .

Note: you MUST answer all questions before submitting.

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Question 9

0/1 pt 999 998

The weight of a brick in air is $W_{in\ air}$ = 21.5 lb, while the weight of the same brick when it is completely submerged in water (ρ_{water} = 1 g/cm^3) is $W_{in\ water}$ = 18.3 lb (it is called apparent weight). What is the density of the brick?

The density of the brick, ρ_{brick} = _____ Units Select an answer .

What are the mass and volume of the brick?

The mass of the brick, M_{brick} = _____ Units Select an answer .

The volume of the brick, V_{brick} = _____ Units Select an answer .

What is the apparent weight of the same brick if 90% of it is submerged into a fluid with 1.54 g/cm^3 density and the rest of the brick is in air?

The apparent weight of the brick, $W_{in\ fluid}$ = _____ Units Select an answer .

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Question 10

0/1 pt 999 998

A ball floats in a tank filled with pure water (ρ_{water} = 1 g/cm^3). The ball has a mass of 0.74 kg and a radius of 10.65 cm. What is the buoyant force on the ball?

The buoyant force on the ball, F_B = _____ Units Select an answer .

Find the volume of the water displaced by the ball.

The volume of the displaced water, V = _____ Units Select an answer .

How much force is needed to apply to the ball to completely submerged it under the water? What is the mass of the displaced water in this case?

The force on the ball, F = _____ Units Select an answer .

The mass of the displaced water, m = _____ Units Select an answer .

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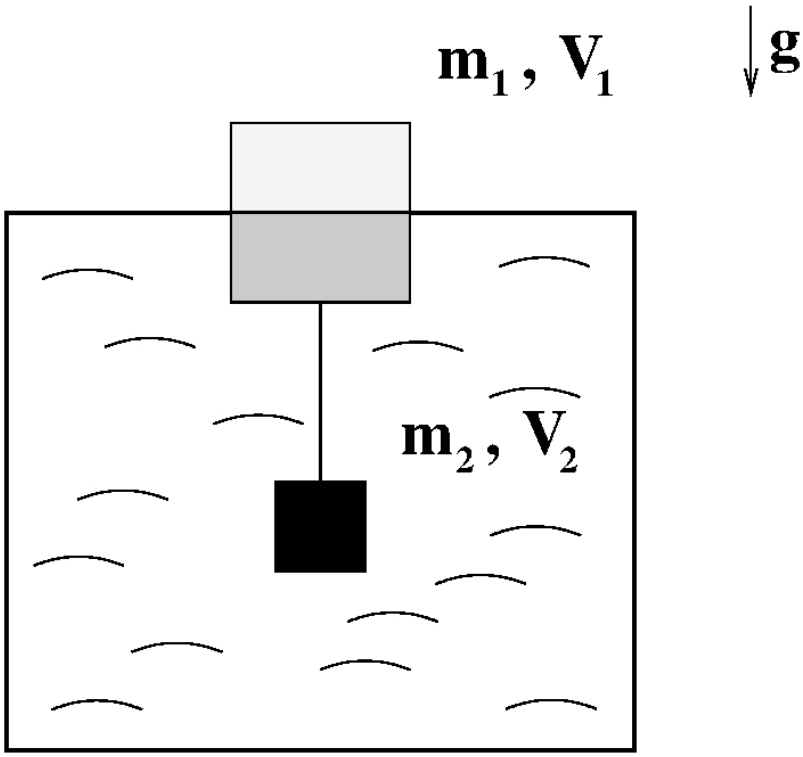
Question 11 0/1 pt 999 998

Consider a system of two masses m_1 and m_2 connected by a massless thin rod, the volumes of the first and second masses are V_1 = 810 cm^3 and V_2 = 330 cm^3 correspondingly. The system floats in a fluid in such a way that a half of the first mass and the entire second mass are below the surface of the fluid, see the picture below. Find the sum of the masses if the density of the fluid is ρ_{fluid} = 1.22 g/cm^3.



The total mass of the system, $m_{tot} = m_1+m_2$ = _____ Units Select an answer .

Find the each mass if the second mass is 5 times greater than the first mass. What is the tension in the rod?

The first mass, m_1 = _____ Units Select an answer .

The second mass, m_2 = _____ Units Select an answer .

The tension in the rod, T = _____ Units Select an answer .

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Question 12 0/1 pt 999 998

Water flows out of a garden hose that lays on the ground. The water stream makes an angle of 35° with the horizontal and has a speed of 9.5 m/s. Find the mass of the water which is in the air. The cross section area of the hose pipe 3 cm^2, the density of water is 1 g/cm^3 and the free fall acceleration is g = 9.81 m/s^2.

The mass of the water, m = _____ Units Select an answer .

Assuming the same angle between the pipe and the horizontal, if the cross section area of the hose pipe is reduced by 2.5 times, then by how many times will the range increase? Find this range.

The range will increase by a factor of _____.

The range, R = _____ Units Select an answer .

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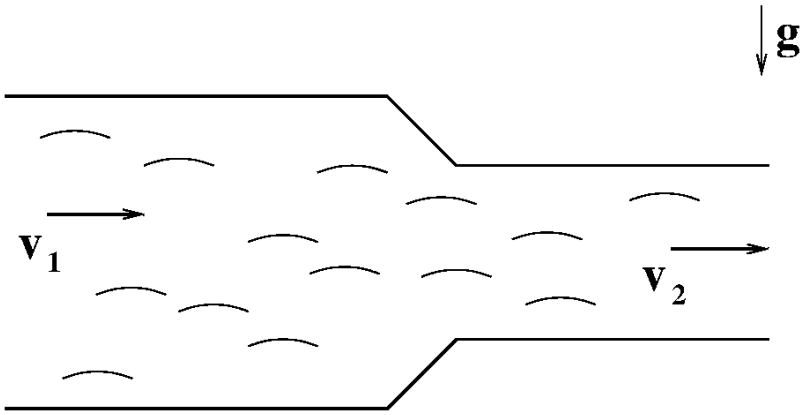
Question 13 0/1 pt 999 998

An incompressible oil of 760 kg/m^3 density is flowing in a horizontal pipe of variable cross section as shown below. The oil is pumped through the pipe at a constant volume flow rate of 2.9 l/s (liter per second). How long will it take to pump 1200 kg of oil through the pipe?



The time to pump the oil, t = _____ Units Select an answer .

The left-end cross section of the pipe has a radius of 5.6 cm, what is the speed of the oil at which it flows trough this cross section?

The speed of the oil, v_1 = _____ Units Select an answer .

How fast does the oil flow through the right-end cross section of the pipe which has a radius of 4.3 cm?

The speed of the oil, v_2 = _____ Units Select an answer .

At which cross section is the pressure higher? Select an answer .

Find the difference in pressure between the left- and right-end cross sections of the pipe.

The difference in pressure, Δp = _____ Units Select an answer .

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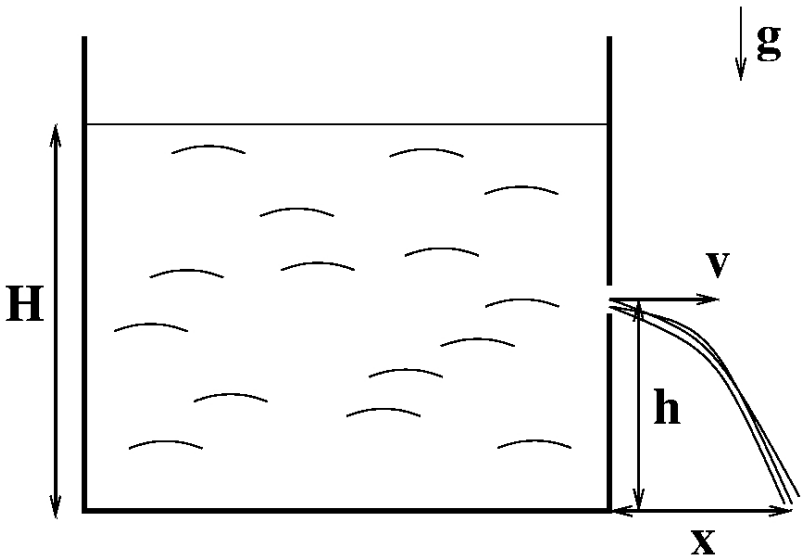
Question 14 0/1 pt 999 998

A tank is filled with water to a height of H = 83.2 cm. There is a small hole in the tank's wall at a height of h = 11.9 cm above the bottom of the tank as shown in the picture below. The water flows from the hole and hits the ground at a distance x from the tank. At what speed does the water flow from the hole?



The speed of the water, v = _____ Units Select an answer .

Find the distance from the tank's wall at which water hits the ground.

The distance from the wall, x = _____ Units Select an answer .

What is the total mass of the water which is in the free fall (in the stream between the the hole and the ground)? Assume ρ_{water} = 1 g/cm^3 for the density of the water and 0.6 cm^2 for the area of the hole. Hint: find the mass flow rate from in the hole and the time of the fall.

The mass of the water in the air, m = _____ Units Select an answer .

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HW #11

Roman Senkov

Question 1

0/1 pt 999 998

1. A spring-mass system undergoes simple harmonic motion. Which of the following statements are True/False?

The kinetic energy is maximum at the point of zero displacement. Select an answer

The potential energy is maximum at the point of maximum displacement. Select an answer

The force exerted by the spring is zero at the point of maximum displacement. Select an answer

The acceleration is greatest at the point of zero displacement. Select an answer

2. If the amplitude of the oscillations is doubled, then

The total energy of the system Select an answer .

The maximum restoring force Select an answer .

The frequency of the oscillations Select an answer .

The maximum speed Select an answer .

Note: you MUST answer all questions before submitting.

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Question 2

0/1 pt 999 998

1. A 3.5-kg mass is attached to an ideal 430-N/m spring. If the system undergoes simple harmonic motion, what are the frequency, angular frequency, and period of the motion?

The frequency, f = _____ Units Select an answer .

The angular frequency, ω = _____ Units Select an answer .

The period, T = _____ Units Select an answer .

2. If the total mechanical energy of the system is 69.8 Joules, what are the amplitude, maximum speed and maximum acceleration of the motion?

The amplitude, A = _____ Units Select an answer .

The maximum speed, v_{max} = _____ Units Select an answer .

The maximum acceleration, a_{max} = _____ Units Select an answer .

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Question 3

0/1 pt 999 998

A particle is in simple harmonic motion along the x-axis. At some moment the particle's kinetic energy is KE = 10.5 J and its potential energy is PE = 24.5 J. What are the kinetic and potential energies of the particle at different positions x. Fill out the table below.

	KE in Joules	PE in Joules
x = 0	_____	_____
x = A/3	_____	_____
x = A/2	_____	_____
x = A	_____	_____

Here A is the maximum displacement of x — the amplitude.

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Question 4

0/1 pt 999 998

The velocity of an object obeys the following equation:

$$v(t) = \left(2.5\frac{m}{s}\right) \cdot \sin\left[\left(86\frac{rad}{s}\right) \cdot t + 1.1\ rad\right].$$

How many oscillations will the system make in a 3.73-sec time interval (round your answer to an integer)?

The number of oscillations, N = _____ Units Select an answer .

What is the amplitude of this motion?

The amplitude, A = _____ Units Select an answer .

What is the velocity of the object at time 0.78 sec?

The velocity of the object, v(t = 0.78 s) = _____ Units Select an answer .

If the mass of the object is 3.8 kg, what is the total mechanical energy of the system?

The mechanical energy, E = _____ Units Select an answer .

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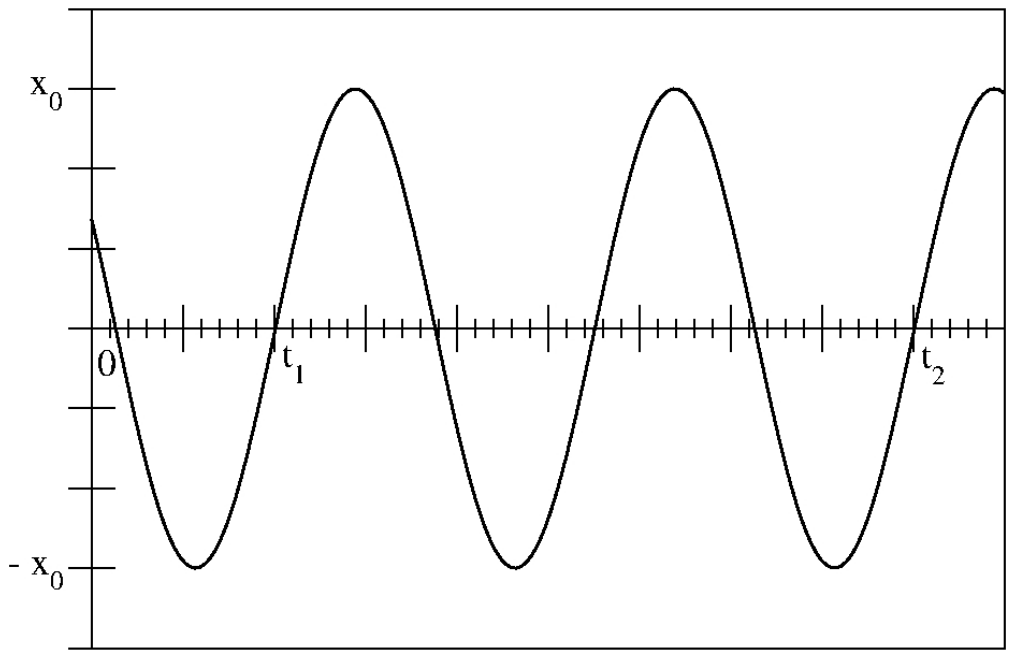
Question 5 0/1 pt 999 998

A 1.2-kg particle is attached to a rubber band and undergoes simple harmonic motion according to the graph shown below (the y-axis represents the position and the x-axis represents the time). Based on the information presented in the graph and taking x_0 = 5.1 cm and t_1 = 0.54 sec, find the spring constant of the rubber band.



The spring constant, k = _____ Units Select an answer .

The particle reaches its maximum speed when passes the equilibrium, for example, at times t_1 and t_2. What is this maximum speed?

The maximum speed, v_{max} = _____ Units Select an answer .

For the time interval shown in the graph, when for the first time the speed of the particle is zero?

The first time when the speed is zero, t = _____ Units Select an answer .

Note: each question assumes an accurate (not approximate) answer.

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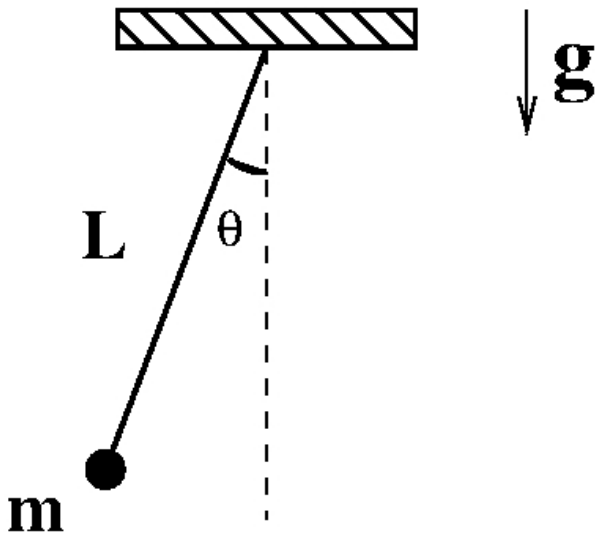
Question 6 0/1 pt 999 998

A 2-kg particle hanging from a string of length L = 15 cm fixed at a pivot point, the system undergoes simple harmonic motion. At t = 0 the particle is located at an angle θ = 16° relative the equilibrium and has zero velocity, so the motion of the particle is described as $\theta(t) = \theta_{\max} \cdot \cos(\omega t)$.



Find the frequency and period of the motion.

The frequency, f = _____ Units Select an answer .

The period, T = _____ Units Select an answer .

Find the amplitude (maximum angular displacement), maximum angular speed and maximum angular acceleration of the motion. Note that we use Ω for the angular velocity and we reserve ω for the angular frequency.

The amplitude, θ_{max} = _____ Units Select an answer .

The maximum speed, Ω_{max} = _____ Units Select an answer .

The maximum acceleration, α_{max} = _____ Units Select an answer .

Find the angular position of the particle at t = 5.02 sec.

The position, θ = _____ Units Select an answer .

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Question 7 0/1 pt 999 998

1. If placed at the surface of Earth, a physical pendulum has a period of 2.4 seconds. What will be the period of the same pendulum at the surface of the Moon (g_{Moon} = 1.62 m/s^2)?

The period at the Moon's surface, T = _____ Units Select an answer .

2. The same pendulum is placed at the surface of an unknown planet X. What is the free fall acceleration at the surface of this planet if the pendulum has a period of 1.34 sec?

The free fall acceleration at the planet X, g_X = _____ Units Select an answer .

3. If the pendulum consists of a mass attached to a string of an effective length L, find this length.

The effective length of the pendulum, L = _____ Units Select an answer .

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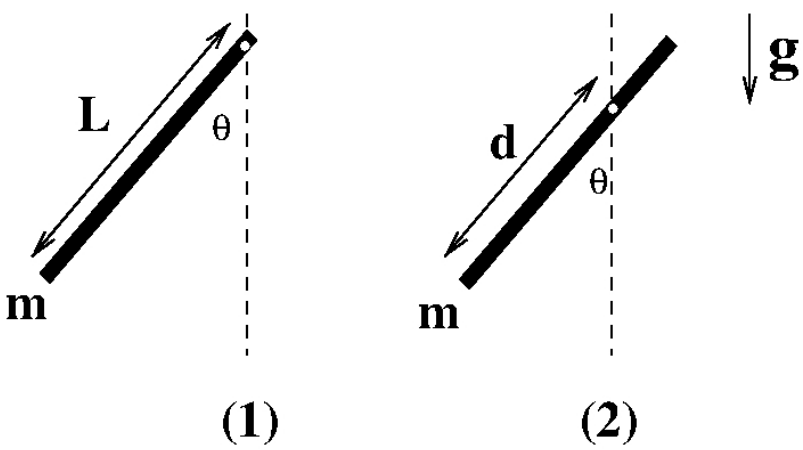
Question 8

0/1 pt 999 998

Find the periods of two physical pendulums consisting of identical thin rigid rods of length L = 186 cm. The first rod is pivoted about it's upper end, while the second rod is pivoted at a small hole drilled through the rod at a distance d = 136 cm from it's *lower end*, see the picture below. Note that the mass of the rod is not important — it cancels out. If it helps, take m = 1 kg.



The period of the first pendulum, T_1 = _____ Units Select an answer .

The period of the second pendulum, T_2 = _____ Units Select an answer .

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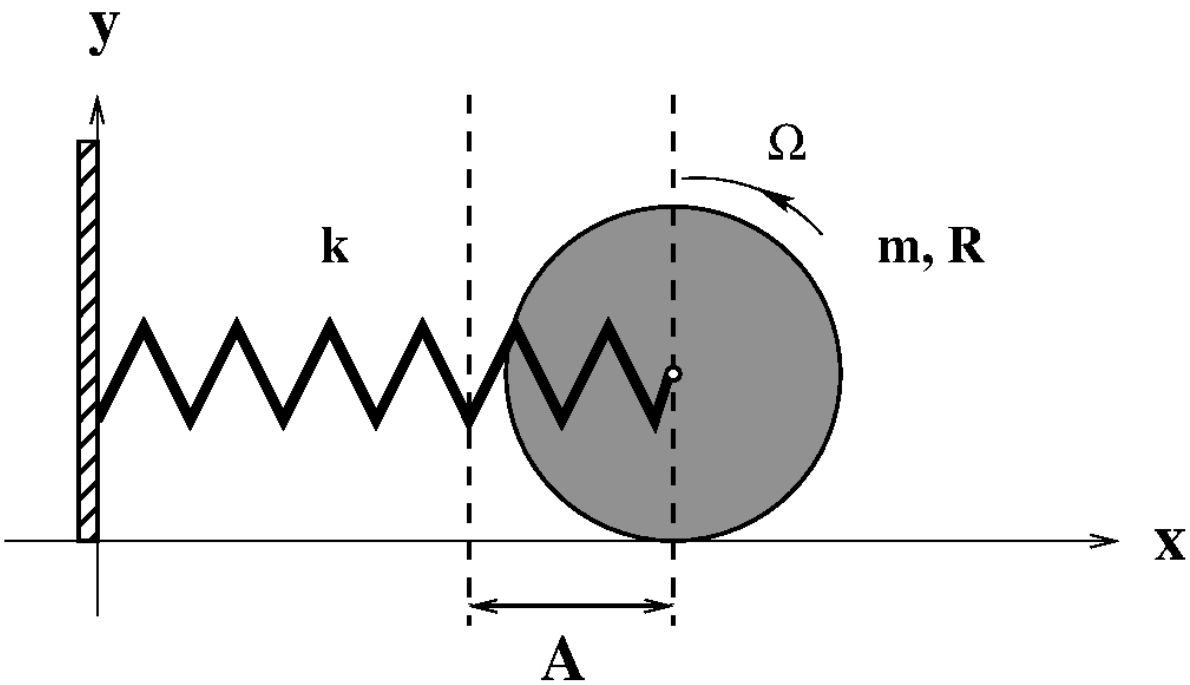
Question 9

0/1 pt 999 998

A solid sphere of mass m = 0.4 kg and radius R = 70 cm is attached to a Hooke's law spring with the spring constant k = 80 N/m. Initially the sphere is at rest and shifted from the equilibrium by a distance of A = 10 cm, see the picture below. Then the sphere is released. How long will it take for the sphere to reach the equilibrium if it rolls without slipping?



The time, t = _____ Units Select an answer .

What is the angular velocity of the sphere when it passes the equilibrium?

The angular velocity, Ω = _____ Units Select an answer .

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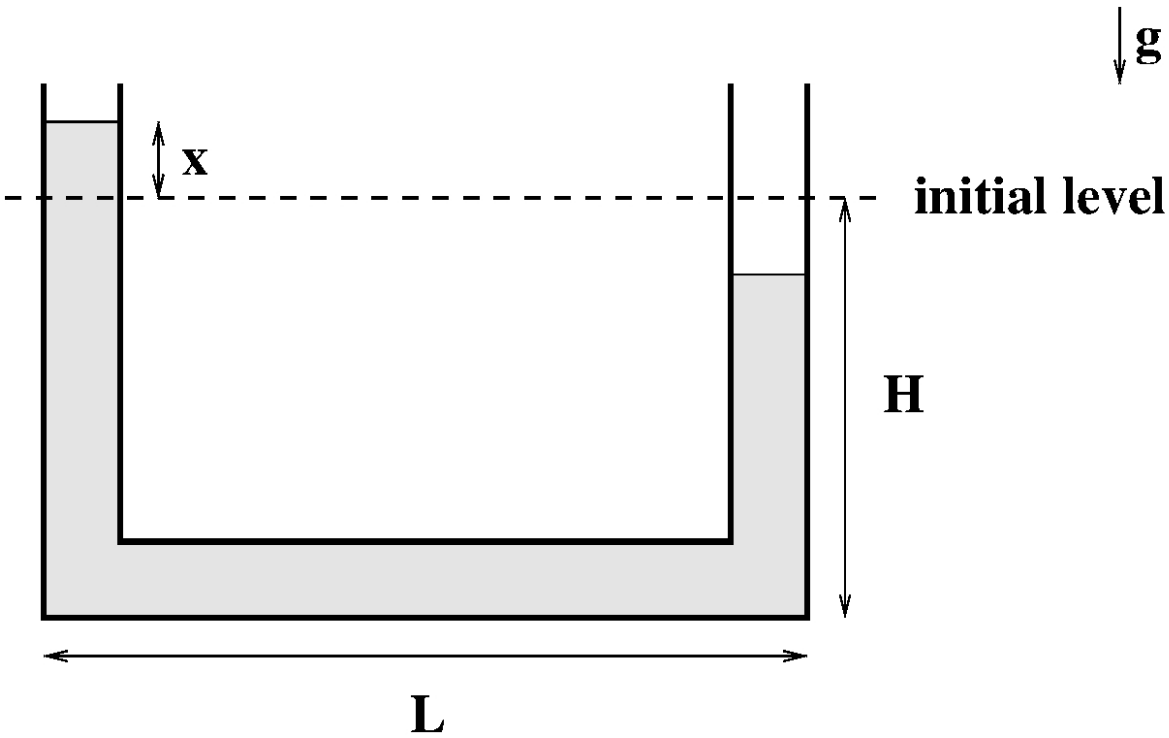
Question 10 0/1 pt 999 998

A thin U-shaped tube contains some fluid of density $\rho = 1.6$ g/cm^3. Initially the fluid is at rest. It reaches a level of $H = 6$ cm in the tube, see the picture below. Then the fluid is removed from the equilibrium and starts to oscillate. Introducing the deviation from the equilibrium x and the velocity $v = \dot{x}$ as the variables find the potential and kinetic energies of the system as functions of x and v. Use Joules for the units, but do not put them explicitly in $PE(x)$ and $KE(v)$. The tube's width is $L = 16$ cm and cross section area $A = 0.35$ cm^2. The free fall acceleration is g = 9.81 m/s^2.



The potential energy, $PE(x) =$ _____ Units Select an answer .

The kinetic energy, $KE(v) =$ _____ Units Select an answer .

From the previous steps determine the effective mass and effective spring constant of the system. Use these parameters to find the period of oscillations of the fluid.

The period, $T =$ _____ Units Select an answer .

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Question 11 0/1 pt 999 998

The amplitude of an underdamped simple harmonic motion "decays" according to the following exponential law:

`A(t) = A_0 e^(-\gamma t),`

where `A_0` is the amplitude at time zero, `t` is the time, and `gamma` is the decay coefficient. It is also convenient to introduce the decay time defined as `tau = 1 \/ gamma`, which gives the typical time for the amplitude to decrease.

Find the decay coefficient and decay time of a damped SHM if the amplitude has dropped by 21% after the first 1 sec (from t = 0 sec).

The decay coefficient, `gamma` = _____ Units Select an answer .

The decay time, `tau` = _____ Units Select an answer .

By how much (in %) will the amplitude drop after 2 sec from the beginning of the motion (the time is doubled)?

The amplitude, `delta A \/A times 100%` = _____ Units Select an answer .

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Question 12

0/1 pt 999 998

A spring-mass system undergoes a damped SHM with the resistance force `vec F_r =-beta * vec v`. The parameters of the system are the following: the mass m = 0.38 kg, the spring constant k = 200 N/m, and the resistance force coefficient `beta = 14.5` kg/s. Find the decay coefficient, undamped angular frequency (frequency without resistance force), and angular frequency of the oscillator.

The decay coefficient, γ = _____ Units Select an answer .

The undamped angular frequency, ω_0 = _____ Units Select an answer .

The angular frequency, ω = _____ Units Select an answer .

What are the period and decay time of the oscillations?

The period, T = _____ Units Select an answer .

The decay time, τ = _____ Units Select an answer .

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Question 13

0/1 pt 999 998

An object attached to a spring undergoes a damped SHM. If the undamped angular frequency ω_0 = 12.5 rad/s and the decay constant γ = 0.0242 1/s, how many oscillation will the system make before the amplitude drops by a factor of 2?

The number of oscillations, N = _____ .

If the mass of the object is 4.5 kg, what are the spring constant and the resistance force coefficient of the system?

The spring constant, k = _____ Units Select an answer .

The force coefficient, β = _____ Units Select an answer .

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Question 14

0/1 pt 999 998

A spring-mass system, with the spring constant k = 250 N/m and mass m = 1.65 kg, experiences an external harmonic force which has the following form

`F_(ext) = (0.7 N)*cos[(11.88  rad \/s)*t],`

where t is the time. Find the angular frequency and amplitude of the steady solution.

The angular frequency, ω = _____ Units Select an answer .

The amplitude, A(ω) = _____ Units Select an answer .

If, in stead of the harmonic force, a constant force of the same magnitude 0.7 N is applied to the system, what is the amplitude of the steady solution in this case?

The amplitude, A(0) = _____ Units Select an answer .

At what angular frequency of the external force (assuming it can be adjusted) the amplitude of the steady solution is the greatest?

The resonance frequency, ω_{res} = _____ Units Select an answer .

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