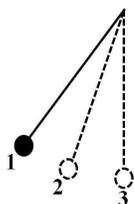


1 point(s)

**PendulumSwinging**

A pendulum composed of a simple mass attached to a string is swinging as shown. Three locations in its swing are indicated. Position 1 is when the pendulum is at its highest point. Position 3 is the lowest point in the pendulum's swing. Which set of arrows shown best indicate the direction of the **total acceleration** of the mass at each point indicated? **Note:** A dot indicates that the acceleration at that time is zero.



- A. 1 ↗ 2 ↗ 3 ↑
- B. 1 ↓ 2 → 3 ↑
- C. 1 ↘ 2 → 3 •
- D. 1 • 2 ↗ 3 ↑
- E. 1 ↘ 2 → 3 ↑

Tries 0/15

1 point(s)

**Identifying SHM 6**

Measurements of the behavior of two 1-dimensional oscillating physical systems are described below.

**System 1:** The acceleration of an object is measured at several values of its displacement from equilibrium, that is  $a_x(x)$ .

The results are:  $a_x(0.5 \text{ m}) = -1 \text{ m/s}^2$ ,  $a_x(1 \text{ m}) = -2 \text{ m/s}^2$ ,  $a_x(1.5 \text{ m}) = -3 \text{ m/s}^2$ ,  $a_x(2.0 \text{ m}) = -4 \text{ m/s}^2$

**System 2:** The period of oscillation for an object is measured at several values of its maximum amplitude of oscillation, that is  $T(A)$ .

The results are:  $T(0.5 \text{ m}) = 1 \text{ s}$ ,  $T(1 \text{ m}) = 2 \text{ s}$ ,  $T(1.5 \text{ m}) = 3 \text{ s}$ ,  $T(2 \text{ m}) = 4 \text{ s}$

Determine if each physical system is exhibiting simple harmonic motion.

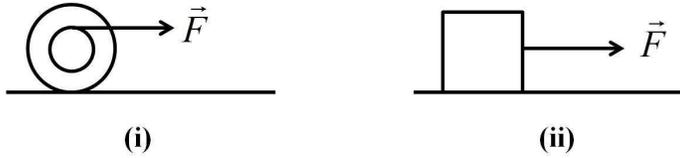
- A. **1:** yes, **2:** no
- B. **1:** no, **2:** yes
- C. **1:** no, **2:** no
- D. **1:** yes, **2:** yes

Tries 0/15

1 point(s)

### Sliding Vs Rolling

Consider a double radius object and a block being pulled across a horizontal surface by an **nonzero** applied force as shown. The double radius object rolls without slipping. Friction acts in both cases. By adjusting the magnitude of the force, is it possible to have the object move with a constant nonzero velocity in each case?



- A. (i) no (ii) no
- B. (i) yes (ii) yes
- C. (i) no (ii) yes
- D. (i) yes (ii) no
- E. There is not enough information to tell.

Tries 0/15

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1 point(s)

### Comparing maximum speeds in SHM

A small mass is hanging at rest from a vertical spring. You pull the mass down 17 cm from equilibrium. You give the mass an initial velocity of magnitude  $v_o$ , **up**. Call the maximum speed of the mass in this situation  $v_1$ . For situation 2, you pull the mass to the same position, but give it an initial velocity of magnitude  $v_o$ , **down**. Call the maximum speed of the mass in this situation  $v_2$ . Select the choice that gives the correct relationships between the speeds.

- A.  $v_1 > v_2 > v_o$
- B.  $v_2 > v_1 > v_o$
- C.  $v_1 > v_2 = v_o$
- D.  $v_1 = v_2 = v_o$
- E.  $v_1 = v_2 > v_o$

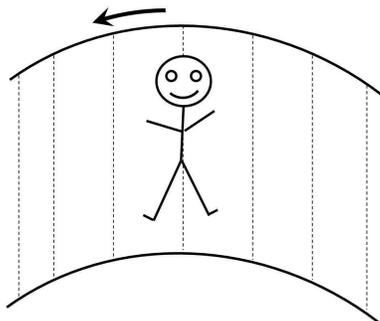
Tries 0/15

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1 point(s)

**WallOfDeath**

In the Wall Of Death circus attraction a person stands with their back against a vertical wall in a round room which begins to spin. Once the room is spinning fast enough, the floor is lowered and the person remains "stuck" to the wall by the force of static friction. At time  $t_1$  the floor has already been lowered, the person is "stuck" to the wall, and the room is spinning at a **constant** rate  $\omega_1$ . At time  $t_2$  the floor is still lowered but the room is now spinning at a **constant** rate  $\omega_2$  which is larger than  $\omega_1$ . Compare the magnitude of the force of static friction between the wall and the person and its maximum value between times  $t_1$  and  $t_2$ .



- A.  $f_s(t_1) = f_s(t_2), f_{s,max}(t_1) > f_{s,max}(t_2)$
- B.  $f_s(t_1) = f_s(t_2), f_{s,max}(t_1) < f_{s,max}(t_2)$
- C.  $f_s(t_1) > f_s(t_2), f_{s,max}(t_1) < f_{s,max}(t_2)$
- D.  $f_s(t_1) < f_s(t_2), f_{s,max}(t_1) = f_{s,max}(t_2)$
- E.  $f_s(t_1) < f_s(t_2), f_{s,max}(t_1) < f_{s,max}(t_2)$

Tries 0/15

1 point(s)

**Using an orbit to find the mass of a planet**

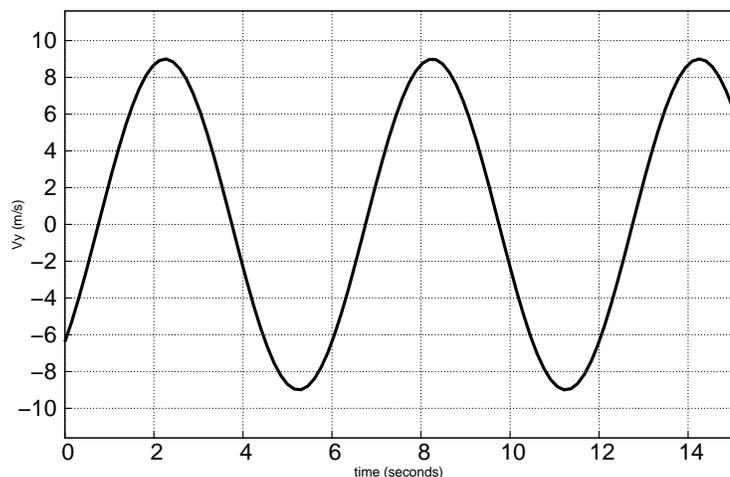
A small satellite is orbiting a planet along a circular path. The center-to-center distance between the satellite and planet is  $3.00E+10$  meters. The period of motion of the satellite is  $9.82E+7$  seconds. What is the mass of the planet?

Tries 0/15

2 point(s)

**SHM Graph**

A person is hanging vertically from a long bungee cord. In a coordinate system with the  $y$  axis pointing vertically up, the velocity of the person (in m/s) is shown below.



What is the period of the motion?

Tries 0/15

What is the amplitude of the position?

Tries 0/15

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1 point(s)

### Torque From Fperp

Alex is trying desperately to open a door by pushing on it with all of his might, despite the large sign that says "PULL TO OPEN". In a certain coordinate system, Alex's force on the door is given by  $\vec{F}_{Nd} = (0.435 \hat{i} + 0\hat{j})$  N and the vector pointing from the rotation axis (at the door's hinges) to the point where Alex is pushing on the door is given by  $\vec{r} = (16.9 \hat{i} + 25.35 \hat{j})$  m. If the width of the door is 0.87 m, calculate the magnitude of the torque that Alex is applying to the door about its hinged axis.

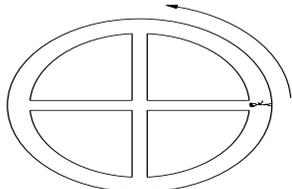
- A. 11.0 N · m
- B. 22.1 N · m
- C. 13.3 N · m
- D. 0.0 N · m
- E. 7.4 N · m

Tries 0/15

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4 point(s)

### Kinematics of non-uniformly rotating space station



A circular space station with a radius of 36 m has just been completed. In order to provide astronauts with the feeling of gravity, the space station will be set spinning about its central axis. To do this, solid fuel rockets have been attached around the perimeter of this station to start it spinning. These rockets fizzle out quickly, and produce a non-uniform angular acceleration of

$$\alpha = \alpha_0 e^{-bt}$$

Where  $\alpha_0 = 0.0236$  rad/s<sup>2</sup> and  $b = 0.071$  s<sup>-1</sup>. The station is at rest (is not spinning) when the rockets are ignited at  $t = 0$  s.

What is the tangential speed of the outer edge of the station about the center of the station at  $t = 28.59$  s?

Tries 0/15

Through what angle has the station rotated in that time?

Tries 0/15

Once the rockets are done burning (after a long time), what will the centripetal acceleration of the outer edge of the station be?

Tries 0/15

Once the rockets are done burning, how long does it take the station to complete one revolution?

Tries 0/15

3 point(s)

### A Mass Hanging on a Spring

**Note:** Because the argument of the trigonometric functions in this problem will be unitless, your calculator must be in radian mode if you use it to evaluate any trigonometric functions.

A massless spring is hanging vertically. With no load on the spring, it has a length of 0.38 m. When a mass of 0.61 kg is hung on it, the equilibrium length is 1.05 m. At  $t = 0$ , the mass (which is at the equilibrium point) is given a velocity of 4.06 m/s downward.

At  $t = 0.72$  s, what is the acceleration of the mass? (Positive for upward acceleration, negative for downward)

Tries 0/15

You hang a different mass (mass 2) vertically on a different spring, and the velocity as a function of time is given by

$$v_y(t) = v_o \sin(\omega t)$$

with up as the positive  $y$  direction,  $v_o = 2.52$  m/s, and  $\omega = 1.95$  rad/s.

What is the displacement of the mass relative from  $t = 0$  s until  $t = 0.60$  s.

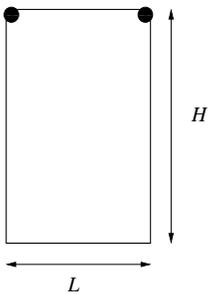
Tries 0/15

Since you don't know the mass of mass 2, it is impossible to find the force of the spring on mass 2 at any given time. However, you can find the ratio of the spring force to the mass,  $F_{\text{spring}}/m$ . When mass 2 is at the top of its swing, what is the ratio  $F_{\text{spring}}/m$ ?

Tries 0/15

5 point(s)

### Dynamics of a falling (pinned) sign



A uniform sign is nailed into a wall at its top two corners. The nail on the upper-right corner breaks, and the sign begins to rotate about the remaining nail in the upper-left corner. The mass of the sign is 164 kg,  $L = 4.8$  m,  $H = 9.6$  m, and the moment of inertia of the sign about the upper-left corner is  $6297 \text{ kg} \cdot \text{m}^2$ .

What is the moment of inertia about an axis that is parallel to the one through the upper-left nail but passes through the center of mass of the sign?

Tries 0/15

What is the angular acceleration of the sign just after the nail breaks?

Tries 0/15

What is the magnitude of the tangential acceleration of the center of mass of the sign just after the nail breaks?

Tries 0/15

What is the magnitude of the total acceleration of the center of mass of the sign just after the nail breaks?

Tries 0/15

The angular speed of the sign is 0.065 rad/s when the center of mass of the sign is directly below the remaining nail. What is the magnitude of the centripetal acceleration of the center of mass at this point?

Tries 0/15

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1 point(s)

### Finding the torque on a wrench

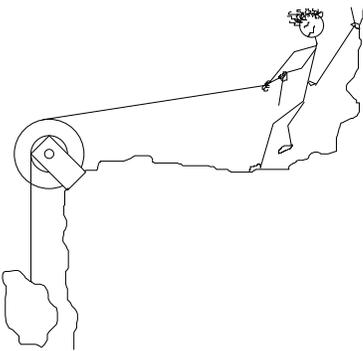
A motorist is trying to loosen a stubborn lugnut by standing on the end of a wrench. The wrench is inclined 33.2 degrees above the horizontal and the distance from the center of the nut to the end of the wrench is 0.7 m. Assuming the motorist does not bounce up and down on the wrench, how much torque can a 88 kg motorist create on the lugnut by standing on the end of the wrench?

Tries 0/15

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2 point(s)

### Two radii pulley lifting a pack



You are pulling on a rope attached to the outer radius of a pulley with a moment of inertia  $I = 4.81 \text{ kg} \cdot \text{m}^2$  as shown. The tension in the rope that you are pulling is 415.3 N. A pack of mass 26.1 kg is attached to the pulley's inner radius as shown. If the inner radius of the pulley is 0.51 m and the outer radius is 0.72 m, what is the magnitude of the linear acceleration of the pack?

Tries 0/15

If instead of using a pulley with two radii, you were to replace the two radii pulley with a simple pulley of one radius: how would using the simple pulley instead of the two radii pulley affect the difficulty of holding the pack at rest over the edge?

- A. It will be harder to hold the pack.
- B. It will be easier to hold the pack.
- C. There will be no difference.
- D. Not enough information to tell.

Tries 0/15

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1 point(s)

### Net Torque From Omega As Function of Time

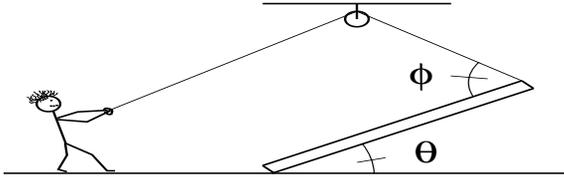
A uniform disk of radius 0.9 m and mass 4 kg is rotating about its center of mass. Its moment of inertia about its center of mass is  $I = \frac{1}{2}mR^2$ . Its angular velocity as a function of time is given by  $\omega(t) = 7kt^6/t_1^7$  where  $k = 4.1$  rad and  $t_1 = 3$  s. Find the magnitude of the net torque about the center of mass acting on the disk at  $t = 8$  seconds.

Tries 0/15

---

3 point(s)

### Holding a beam at an angle



A person is holding a beam at rest as shown with  $\theta = 39.8$  degrees and  $\phi = 64.8$  degrees. The beam has a mass of 20 kg.

What is the tension in the rope attached to the beam?

Tries 0/15

Now the person is holding a new beam of mass 16.0 kg with  $\theta = 35.9$  degrees and  $\phi = 61.6$  degrees. If the tension in the rope attached to the beam in this situation is 72.3 N, what is the magnitude of the normal force from the ground on the beam?

Tries 0/15

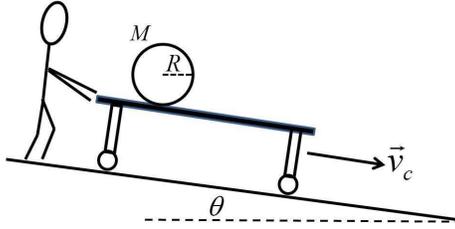
What is the magnitude of the friction force from the ground on the beam?

Tries 0/15

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1 point(s)

**Rolling Object On Moving Cart**



A student is pushing a cart down a slight incline at a constant speed  $v_c = 0.5 \frac{m}{s}$ . A basketball on the cart rolls due to the incline. The basketball has a mass  $M = 0.5 \text{ kg}$  and radius  $R = 0.25 \text{ m}$ . The incline is at  $\theta = 15^\circ$  and the basketball may be treated as a hollow sphere with  $I_{cm} = \frac{2}{3}MR^2$ .

What is the magnitude of the force of static friction acting on the ball?

Tries 0/15

PHGN100 Exam 2 Free Response

Name: Vince CWID: F1ourney Exam Code KEY

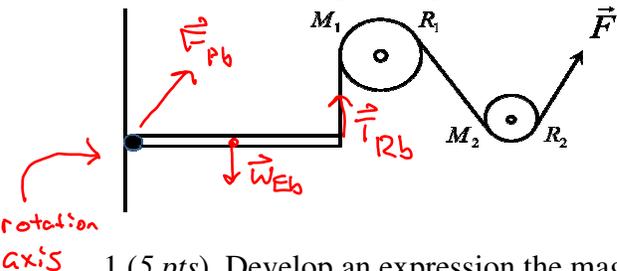


do not write in the box above

Circle Studio Time: 8-10 10-12 12-2 2-4

Note: Your responses will be graded for accuracy and presentation. Please circle your final answer

A uniform beam of mass  $m_b$  and length  $L$  is pinned to a wall and supported at the opposite end by a rope which is fed through two pulleys. The end of the rope is pulled with a force  $\vec{F}$  to make the system static.



Since each pulley is static ( $\alpha = 0$ ) the net torque on each must be zero. So the magnitude of the tension in each part of the rope must be the same, and equal to  $F$ .

1.(5 pts) Develop an expression the magnitude of the force  $F$  in terms of  $m_b, L, M_1, R_1, M_2, R_2$  and  $g$ .

+ system = beam

$$\sum \vec{\tau} = I \vec{\alpha} = 0$$

$$\frac{L}{2} m_b g - L T_{Rb} = 0 \Rightarrow F = \frac{m_b g}{2}$$

$L = F$  (from argument above)

2.(5 pts) Develop an expression for the horizontal force that the pin exerts on the beam in terms of  $m_b, L, M_1, R_1, M_2, R_2$  and  $g$ .

system = beam

$$\sum \vec{F} = m \vec{a} = 0$$

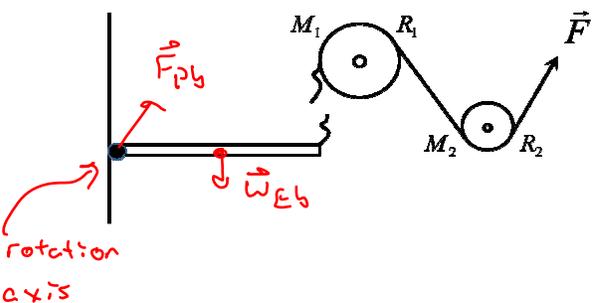
x:  $F_{pb,x} = 0$

3.(5 pts) If you wanted to raise the beam by increasing  $F$ , do the pulleys make this easier or harder than pulling straight up on the end of the beam with a force  $F$ ? Make sure you explain your reasoning.

Starting from rest, to raise the beam we have to accelerate the beam and the pulleys. Without the pulleys, we would only have to accelerate the beam.

So including the pulleys makes lifting the beam harder.

3.(5 pts) The rope suddenly breaks. Develop an expression for the magnitude of the tangential acceleration of the end of the beam at the instant after the rope breaks in terms of  $m_b, L$  and  $g$ .



system = beam

$$\sum \vec{\tau} = I \vec{\alpha}$$

$$\frac{L}{2} m_b g = \frac{1}{3} m_b L^2 \alpha \Rightarrow \alpha = \frac{3g}{2L}$$

$a_T = L \alpha = \frac{3g}{2}$