first (given)	last (family)

Name, *printed* as it appears in Canvas

Physics 2211 A

Fall 2020

Nine-digit Tech ID

Quiz

2A

- You may use the standard formula sheet and a calculator that cannot store letters, but no other aids or electronic devices.
- Free-response problems require a file upload. Show all your work clearly, including all steps and logic. Write **darkly**. Blue or black ink is recommended. Do not make any erasures in your free-response work. Cross out anything you do not want evaluated. Box your answer. Check your scan to make sure it is clear, and upload it to Gradescope. *Do not scan and upload this cover page.*
- Multiple-choice questions must be answered directly in Gradescope.
- Your score will be posted when your quiz has been graded. Quiz grades become final when the next quiz is administered.

Select your Multiple Choice answers directly in Gradescope.

Quiz and Exam Formulæ & Constants

$$\vec{v} = \frac{d\vec{r}}{dt}$$
$$\vec{\omega} = \frac{d\vec{\theta}}{dt}$$
$$\vec{a} = \frac{d\vec{v}}{dt}$$
$$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$$
$$v_{\mathrm{sf}} = v_{\mathrm{si}} + a_{\mathrm{s}}\,\Delta t$$
$$\omega_{\mathrm{f}} = \omega_{\mathrm{i}} + \alpha\,\Delta t$$
$$s_{\mathrm{f}} = s_{\mathrm{i}} + v_{\mathrm{si}}\,\Delta t + \tfrac{1}{2}a_{\mathrm{s}}\,(\Delta t)^2$$
$$\theta_{\mathrm{f}} = \theta_{\mathrm{i}} + \omega_{\mathrm{si}}\,\Delta t + \tfrac{1}{2}\alpha\,(\Delta t)^2$$
$$s = r\theta$$
$$v = r\omega$$
$$a_{\mathrm{t}} = r\alpha$$

$$\sum \vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$$
$$\sum \vec{F}_{\mathrm{ext}} = M\vec{a}_{\mathrm{cm}} = \frac{d\vec{P}}{dt}$$
$$\sum \vec{\tau}_{\mathrm{ext}} = I\vec{\alpha} = \frac{d\vec{L}}{dt}$$
$$f_{\mathrm{s,max}} = \mu_{\mathrm{s}} n$$
$$f_{\mathrm{k}} = \mu_{\mathrm{k}} n$$
$$a_{\mathrm{r}} = \frac{v^2}{r}$$
$$\vec{w} = m\vec{g}$$
$$|\vec{F}_{\mathrm{G}}| = \frac{Gm_1m_2}{|\vec{r}|^2}$$
$$D = \tfrac{1}{2}C\rho A v^2$$
$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$W = \int \vec{F} \cdot d\vec{s}$$
$$W_{\mathrm{ext}} = \Delta K + \Delta U + \Delta E_{\mathrm{th}}$$
$$K = \tfrac{1}{2}mv^2$$
$$K = \tfrac{1}{2}I\omega^2$$
$$U_{\mathrm{g}} = mgy$$
$$U_{\mathrm{s}} = \tfrac{1}{2}k\,(\Delta s)^2$$
$$U_{\mathrm{G}} = -\frac{Gm_1m_2}{r}$$
$$P = \frac{dE_{\mathrm{sys}}}{dt}$$
$$P = \vec{F} \cdot \vec{v}$$
$$\vec{J} = \int \vec{F}\,dt = \Delta\vec{p}$$
$$\vec{p} = m\vec{v}$$

$$\vec{r}_{\mathrm{cm}} = \frac{\sum \vec{r}_i m_i}{\sum m_i}$$
$$\vec{r}_{\mathrm{cm}} = \frac{\int \vec{r}\,dm}{\int dm}$$
$$I = \sum m_i r_i^2$$
$$I = \int r^2\,dm$$
$$I = I_{\mathrm{cm}} + Md^2$$
$$\vec{L} = \vec{r} \times \vec{p}$$
$$\vec{L} = I\vec{\omega}$$
$$x = A\cos(\omega t + \phi_0)$$
$$\vec{a}_{\mathrm{x}} = -\omega^2\vec{x}$$
$$\omega = \sqrt{k/m}$$
$$\omega = 2\pi f = \frac{2\pi}{T}$$

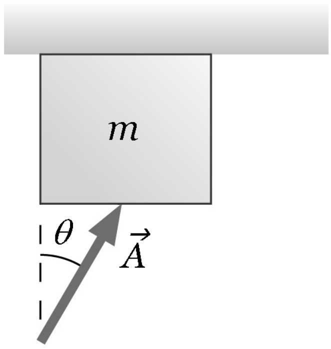
Physical Constants:

Universal Gravitation Constant $G = 6.673 \times 10^{-11}\,\mathrm{N{\cdot}m^2/kg^2}$
Gravitational Acceleration at Earth's Surface $g = 9.81\,\mathrm{m/s^2}$

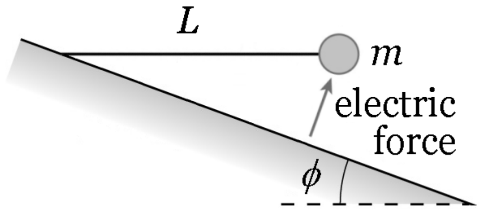
Unless otherwise directed, drag is to be neglected, all problems take place on Earth, use the gravitational definition of weight, and all springs, ropes, and pulleys are ideal.

All derivatives and integrals in free-response problems must be evaluated.

I. (16 points) A block of mass m is being slid to the right along a horizontal ceiling by an applied force of magnitude A that makes an angle θ with the vertical, as illustrated. The coefficient of static friction between the block and the ceiling is μ_s, while the coefficient of kinetic friction is μ_k. What is the acceleration magnitude the block, in terms of parameters defined in the problem, and physical or mathematical constants? (*On Earth.*)



II. (16 points) In an electricity experiment, a plastic ball of mass $m = 65\,\text{g}$ is attached to a string of length $L = 81\,\text{cm}$ and given an electric charge. The string is tied to a charged plane, inclined at an angle $\phi 28°$ to the horizontal. The plane exerts an electrical force on the ball, perpendicular to the plane, causing the ball to swing up until the string is horizontal and remain there. What is the magnitude of the tension in the string? (*On Earth.*)

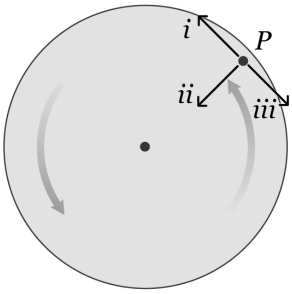


1. (6 points) If it can be determined in the problem above, how is the electric force, $\vec{F}_E$, related to the tension in the string, $\vec{T}$, and the weight of the ball, $\vec{w}$? (*Hint:* Remember the notation, $F_E = |\vec{F}_E|$, etc.)

   (a) $F_E = T + w$
   (b) $F_E = -T - w$
   (c) This cannot be determined from the information provided.
   (d) $\vec{F}_E = \vec{T} + \vec{w}$
   (e) $\vec{F}_E = -\vec{T} - \vec{w}$

III. A child is riding a merry-go-round (a horizontal circular ride found in an amusement park). The merry-go-round is rotating with a constant period T_0. The operator then applies the brakes, giving the merry-go-round a constant angular acceleration so it comes to a stop in time Δt. Through how many revolutions does it turn from the time the operator applies the brakes to the time it comes to a complete stop? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants.

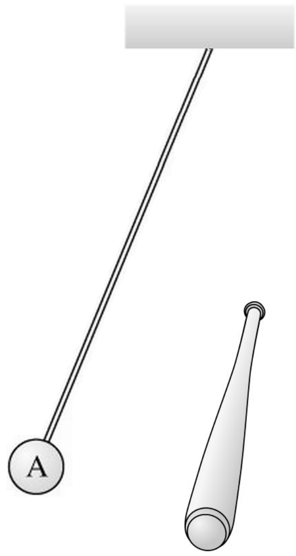
2. (6 points) The figure illustrates a top-view of the merry-go-round, as it rotates counterclockwise with a child sitting at point P. What is the direction of the child's acceleration as the merry-go-round slows down?



(a) Direction *ii*.
(b) Somewhere between directions *ii* and *iii*.
(c) Direction *iii*.
(d) Direction *i*.
(e) Somewhere between directions *i* and *ii*.

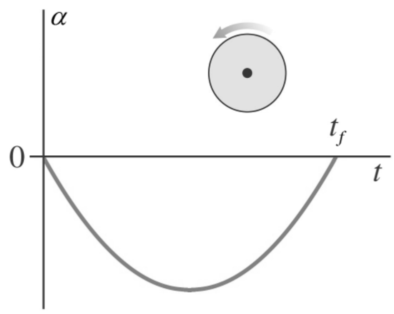
3. (8 points) The pendulum bob, A, was struck by the bat, and is now swinging upward. Which items on this list are forces acting on the bob as it swings upward? Just as you do with "Choose all that apply" questions in class, express your answer as number, with your choices in numeric order. For example, if you believe that $m\vec{a}$ and the gravitational force are the forces on the bob, your answer would be "12". (*On Earth.*)

1 $m\vec{a}$
2 gravitational force
3 centripetal force
4 normal force
5 tension force
6 strike force
7 no forces act on the bob as it swings



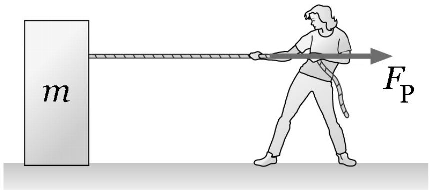
Answer: ______

4. (8 points) A wheel is rotating counterclockwise with angular velocity ω_0. Let this direction be positive. It is then given a non-uniform angular acceleration, α, shown in the graph, from time $t = 0$ to time $t = t_f$. How does the *magnitude* of the angular velocity, ω_f, at time t_f, compare to the *magnitude* of ω_0?



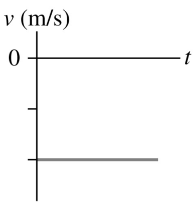
(a) $|\omega_f|$ is greater than $|\omega_0|$
(b) This cannot be determined from the information provided.
(c) $|\omega_f|$ is less than $|\omega_0|$, because $|\omega_f|$ is zero.
(d) $|\omega_f|$ is the same as $|\omega_0|$
(e) $|\omega_f|$ is less than $|\omega_0|$, but $|\omega_f|$ is not zero.

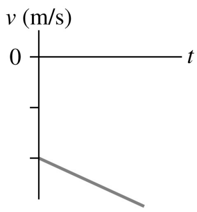
5. (8 points) Sue is pulling on the crate with a force magnitude F_P. The crate has mass m, and coefficient of static friction μ_s with the level ground. Because of this static friction, the crate does not move. Sue gets tired, and reduces her force to $F_P/2$. What is the magnitude of the static friction force f_s on the crate, now that Sue has reduced her force? (*On Earth.*)

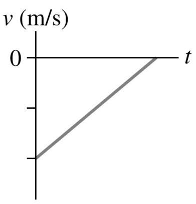


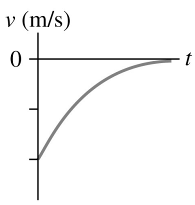
(a) $f_s = \mu_s mg/2$
(b) $f_s = F_P/2$
(c) $f_s = \mu_s mg$
(d) $f_s = F_P$
(e) $f_s = mg/2$

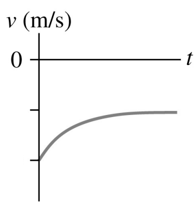
6. (8 points) A ping-pong ball of mass m is thrown straight downward with a speed that is twice its terminal speed. If positive is chosen upward, which graph best represents the velocity of the ping-pong ball as a function of time? (*On Earth, do* **NOT** *neglect drag!*)

(a) 

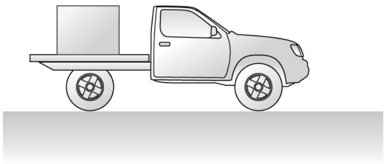
(b) 

(c) 

(d) 

(e) 

7. (8 points) The truck can accelerate to the right over level ground without causing the crate on the bed to slide. If the acceleration is too great, however, the crate will slide and fall off the back of the truck. If the crate does slide and fall off the back, what horizontal force, if any, is acting on the crate while it slides, and in what direction? (*On Earth.*)



(a) A force of kinetic friction acts toward the right.
(b) A force of kinetic friction acts toward the left.
(c) A force of static friction acts toward the right.
(d) A force of kinetic friction acts toward the left.
(e) No horizontal force acts on the crate while it slides.