first (given)	*last (family)*

Name, *printed* as it appears in Canvas

Physics 2211 A

Spring 2021

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

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

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

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

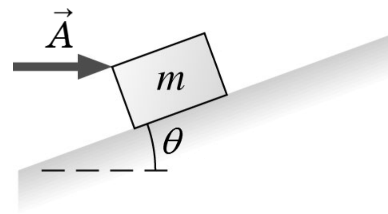
$$\vec{r}_{\mathrm{cm}} = \frac{\sum \vec{r}_i m_i}{\sum m_i}$$
$$\vec{r}_{\mathrm{cm}} = \frac{\int \vec{r}\,dm}{\int dm}$$
$$I = \sum m_i r_i^2$$
$$I = \int r^2\,dm$$
$$I = I_{\mathrm{cm}} + Md^2$$
$$\vec{L} = \vec{r} \times \vec{p}$$
$$\vec{L} = I\vec{\omega}$$
$$x = A\cos(\omega t + \phi_0)$$
$$\vec{a}_{\mathrm{x}}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

Physical Constants:

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

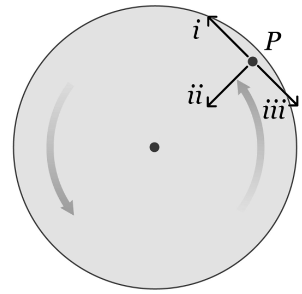
Unless otherwise directed, drag is to be neglected, all problems take place on Earth, use the gravitational definition of weight, and all springs, ropes, and pulleys are ideal.
All derivatives and integrals in free-response problems must be evaluated.

I. (16 points) A constant horizontal applied force $\vec{A}$ moves a block with mass m up an incline that makes an angle θ with the horizontal, as shown. The coefficient of static friction between the block and the incline is μ_s and that of kinetic friction is μ_k. What is the magnitude of the acceleration of the block up the incline? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants. (*On Earth.*)



II. (16 points) 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 speed ω_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 what angle 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. (*On Earth.*)

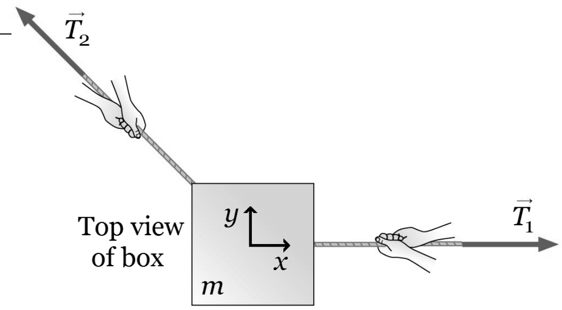
1. (6 points) The figure illustrates a top-view of the merry-go-round, as it rotates counterclockwise with a child sitting at point P. What is the direction of the child's acceleration as the merry-go-round slows down?



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

Initial:

III. (16 points) A block with mass $m = 5.0\,\text{kg}$ is at rest on a frictionless horizontal surface, as shown in a top view (*i.e.*, the surface is in the plane of the page). Two ropes are attached to it. One is pulled is pulled with tension $\vec{T}_1 = 440\,\text{N}$ in the $+x$ direction. The other is pulled with tension $\vec{T}_2 = 240\,\text{N}$ at an angle $\theta = 120°$ from the $+x$ axis. What is the magnitude of the block's acceleration? (*On Earth.*)

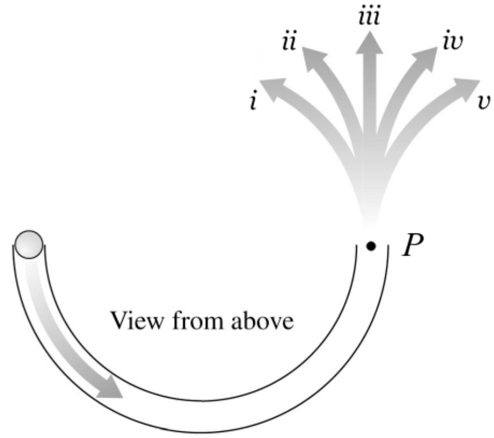


2. (6 points) In the problem above, what if the block were not at rest, but was moving in the $+y$ direction at a speed of $35\,\text{m/s}$ at the instant those same two tensions were applied? How would the block's acceleration compare to the situation when it was initially at rest?

   (a) The acceleration of the initially moving block would have the same magnitude as the initially stationary one, but a different direction.
   (b) The acceleration of the initially moving block would have a greater magnitude than the initially stationary one, but the same direction.
   (c) The acceleration of the initially moving block would have a lesser magnitude than the initially stationary one, but the same direction.
   (d) The acceleration of the initially moving block would have the same magnitude and direction as the initially stationary one.
   (e) The acceleration of the initially moving block would have a greater magnitude than the initially stationary one, and a different direction.

3. (8 points) A ball rolls inside a hose that has been shaped as a semicircle and laid flat on a table, as shown in the figure. At point P the ball leaves the hose. Which of the arrows best reflects the ball's trajectory after leaving the hose? Assume there is no friction. (*On Earth.*)

   (a) v
   (b) iv
   (c) i
   (d) ii
   (e) iii

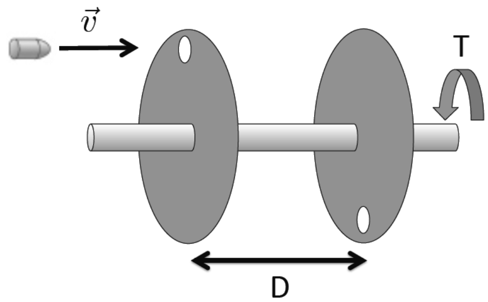


4. (8 points) A skydiver is falling at terminal speed v, and then opens their parachute. Soon, they reach a new terminal speed v'. How does the magnitude of the skydiver's acceleration change during the time from just after their parachute is opened, to just before they reach their new terminal speed? (*On Earth, do NOT neglect drag!*)

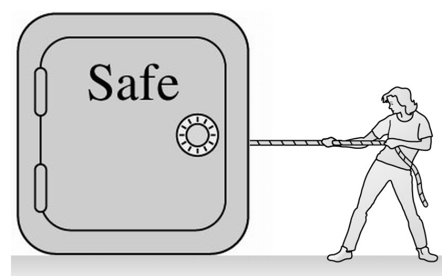
   (a) The magnitude of their acceleration first **decreases**, then **increases**.
   (b) The magnitude of their acceleration **increases**.
   (c) The magnitude of their acceleration **decreases**.
   (d) The magnitude of their acceleration first **increases**, then **decreases**.
   (e) The magnitude of their acceleration **remains the same**.

5. (8 points) A bullet is shot through two cardboard disks attached a distance D apart to a shaft turning with a rotational period (the time to make one revolution) T, as shown. Each disk has a hole, and the holes lie at the same radial distance from the shaft. If the two holes are 180° apart, what speed must the bullet have if it is to pass through both holes within a single revolution of the shaft?

(a) $v = 2DT$
(b) $v = 2\pi D/T$
(c) $v = 2D/T$
(d) $v = \pi D/T$
(e) $v = 2\pi DT$

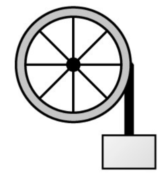


6. (8 points) A 6000 N safe is at rest on level ground. The coefficient of kinetic friction between the safe and the ground is 0.33, and the coefficient of static friction between the safe and the ground is 0.50. A student ties a rope to the safe, and pulls with a horizontal force of 1000 N, but the safe doesn't move. What is the magnitude of the friction force on the safe? (*On Earth.*)



(a) 1000 N
(b) 6000 N
(c) 2000 N
(d) 5000 N
(e) 3000 N

7. (8 points) The wheel in the figure has a diameter of 3.0 m. It is wrapped with a cord, which is tied to a block with mass 4.0 kg. The block is released from rest. At the instant the wheel has turned though an angle of 540°, how far has the block fallen? (*On Earth.*)



(a) 16 m
(b) 8.1 m
(c) 14 m
(d) 4.7 m
(e) 28 m