first (given)	*last (family)*	

Name, *printed* as it appears in Canvas

Physics 2211 A

Fall 2021

Nine-digit Tech ID

Quiz

2A

- **Print** your name and nine-digit Tech ID *very neatly* in the spaces above.
- Free-response problems are numbered I–III. 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.
- Multiple-choice questions are numbered 1–7. For each, select the answer most nearly correct, circle it on your quiz, and fill the bubble for your answer on this front page.
- Initial the odd pages in the top margin, in case the pages of your quiz get separated.
- The standard formula sheet is on the back of this page, which may be removed from the quiz form if you wish, but it must be submitted.
- If the page for a free-response problem has insufficient space for your work, ask a proctor for an additional sheet. If you wish this work to be evaluated, put your name on the sheet and make a note on the problem page, so graders will know where to look for your work.
- You may use a calculator that cannot store letters, but no other aids or electronic devices.
- Your score will be posted when your quiz has been graded. Quiz grades become final when the next quiz is administered.

Fill in bubbles for your Multiple Choice answers darkly and neatly.

	a	b	c	d	e
1	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
2	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
3	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
4	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
5	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
6	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
7	ⓐ	ⓑ	ⓒ	ⓓ	ⓔ
	a	b	c	d	e

Quiz and Exam Formulæ & Constants

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

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

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

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

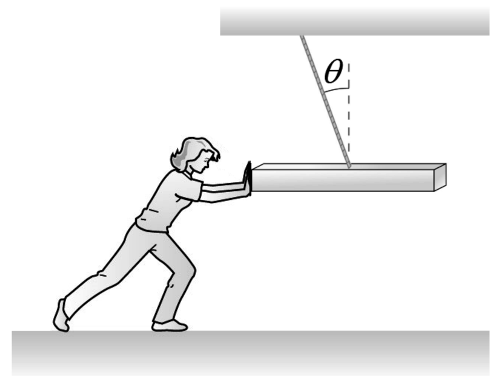
Physical Constants:

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

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.

You may remove this sheet from your Quiz or Exam, but it must be submitted

I. (16 points) Angelina pushes horizontally on a steel rail of mass m hanging by a rope from the ceiling. With what force magnitude must she push to hold the rail in place with its rope an angle θ from the vertical? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants. (*On Earth.*)



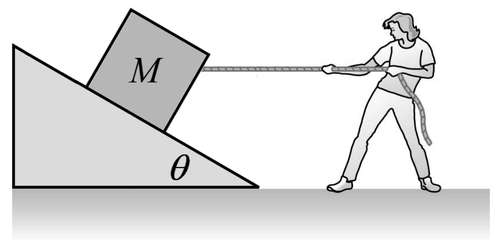
II. (16 points) A car on a circular track of radius R accelerates from rest at time $t = 0$ with constant tangential acceleration magnitude a_{T}. At what time is the magnitude of its acceleration $3a_{\mathrm{T}}/2$? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants. (*On Earth.*)

1. (6 points) At the time you determined in the problem above, what is the direction of the car's acceleration?

   (a) Toward the center of the track.
   (b) Somewhere between directly forward and toward the center of the track.
   (c) Away from the center of the track.
   (d) Directly forward.
   (e) Somewhere between directly forward and away from the center of the track.

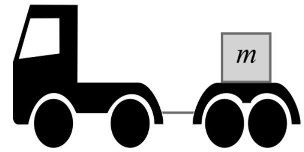
2. (6 points) Angelina pulls horizontally with force magnitude P on a box of mass M as it moves down a fixed ramp that makes an angle θ with the horizontal, as shown. Describe the normal force magnitude n exerted on the box by the ramp. (*On Earth.*)

   (a) $n > mg$
   (b) $n = mg\cos\theta$
   (c) $n < mg\cos\theta$
   (d) $mg > n > mg\cos\theta$
   (e) $n = mg$



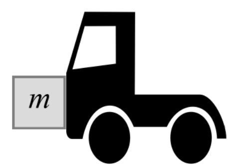
III. (16 points) If the coefficient of kinetic friction between the box and the ramp in the problem above is μ_k, what is the magnitude of the acceleration of the box?

3. (8 points) A truck towing a small trailer is stopped at a traffic light. A box of mass m is on the trailer, as shown. When the light turns green, the truck, trailer, and box accelerate leftward together. Even though the box is not attached to the trailer, it does not slide. What force is responsible for the acceleration of the box? (*On Earth.*)



(a) Static friction to the right.
(b) Tension to the right.
(c) Static friction to the left.
(d) Kinetic friction to the left.
(e) Kinetic friction to the right.

4. (8 points) The truck accelerates to the left, exerting a normal force on the box of mass m, as shown. There is a minimum acceleration magnitude a_{min} for which the friction force f_{min} on the box prevents it from sliding down the front of the truck. If the truck doubles its acceleration to $a_2 = 2a_{\text{min}}$, what is the friction force f_2 on the box? (*On Earth.*)



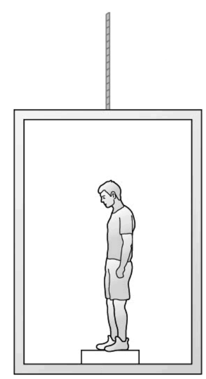
(a) This is a meaningless question, as the box will slide if the acceleration doubles.
(b) $f_2 = 2f_{\text{min}}$
(c) $f_2 = f_{\text{min}}/2$
(d) $f_2 = f_{\text{min}}$
(e) f_2 cannot be determined with the information provided.

5. (8 points) You're the passenger in an old car with slick vinyl seats and no seat belts. The driver makes a sharp left turn, and you slide rightward until you hit the door. What force is responsible for your acceleration to the right?

   (a) The kinetic friction force.
   (b) No force.
   (c) The centripetal force.
   (d) The $m\vec{a}$ force.
   (e) The static friction force.

6. (8 points) Zach is descending in his elevator at increasing speed. Using the gravitational definition, his weight is w_{grav}. Using the operational definition, his weight is w_{op}. If possible, compare the magnitudes of w_{grav} and w_{op}. (*On Earth.*)

   (a) w_{grav} is the same as w_{op} because w_{grav} is *always* the same as w_{op}
   (b) w_{grav} is less than w_{op}
   (c) w_{grav} is the same as w_{op} *in this case*
   (d) This is a meaningless question, as w_{grav} and w_{op} have different dimensions (units)
   (e) w_{grav} is greater than w_{op}



7. (8 points) Two solid spheres, A and B, are made of the same material and have the same drag coefficient. Sphere B has twice the radius of sphere A (that is, $R_B = 2R_A$), so sphere B has eight times the mass of sphere A (that is, $M_B = 8M_A$). Compare the magnitudes of their accelerations at an instant when they are falling through the air with the same speed. (*On Earth, do NOT neglect drag!*)

(a) Acceleration of sphere B is twice that of sphere A.
(b) Acceleration of sphere B is half that of sphere A.
(c) Acceleration of sphere B is greater than that of sphere A, but how much greater cannot be determined with the information provided.
(d) Acceleration of sphere B is less than that of sphere A, but how much less cannot be determined with the information provided.
(e) Acceleration of sphere B is equal to that of sphere A.