first (given)	last (family)

Name, *printed* as it appears in Canvas

Physics 2211 A

Spring 2021

Nine-digit Tech ID

Quiz

3A

- 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.

$$\vec{v} = \frac{d\vec{r}}{dt}$$

$$\vec{\omega} = \frac{d\vec{\theta}}{dt}$$

$$\vec{a} = \frac{d\vec{v}}{dt}$$

$$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$$

$$v_{\mathrm{sf}} = v_{\mathrm{si}} + a_{\mathrm{s}}\,\Delta t$$

$$\omega_{\mathrm{f}} = \omega_{\mathrm{i}} + \alpha\,\Delta t$$

$$s_{\mathrm{f}} = s_{\mathrm{i}} + v_{\mathrm{si}}\,\Delta t + \tfrac{1}{2}a_{\mathrm{s}}\,(\Delta t)^2$$

$$\theta_{\mathrm{f}} = \theta_{\mathrm{i}} + \omega_{\mathrm{si}}\,\Delta t + \tfrac{1}{2}\alpha\,(\Delta t)^2$$

$$s = r\theta$$

$$v = r\omega$$

$$a_{\mathrm{t}} = r\alpha$$

$$\sum \vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$$

$$\sum \vec{F}_{\mathrm{ext}} = M\vec{a}_{\mathrm{cm}} = \frac{d\vec{P}}{dt}$$

$$\sum \vec{\tau}_{\mathrm{ext}} = I\vec{\alpha} = \frac{d\vec{L}}{dt}$$

$$f_{\mathrm{s,max}} = \mu_{\mathrm{s}} n$$

$$f_{\mathrm{k}} = \mu_{\mathrm{k}} n$$

$$a_{\mathrm{r}} = \frac{v^2}{r}$$

$$\vec{w} = m\vec{g}$$

$$|\vec{F}_{\mathrm{G}}| = \frac{Gm_1m_2}{|\vec{r}|^2}$$

$$D = \tfrac{1}{2}C\rho A v^2$$

$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$W = \int \vec{F} \cdot d\vec{s}$$

$$W_{\mathrm{ext}} = \Delta K + \Delta U + \Delta E_{\mathrm{th}}$$

$$K = \tfrac{1}{2}mv^2$$

$$K = \tfrac{1}{2}I\omega^2$$

$$U_{\mathrm{g}} = mgy$$

$$U_{\mathrm{s}} = \tfrac{1}{2}k\,(\Delta s)^2$$

$$U_{\mathrm{G}} = -\frac{Gm_1m_2}{r}$$

$$P = \frac{dE_{\mathrm{sys}}}{dt}$$

$$P = \vec{F} \cdot \vec{v}$$

$$\vec{J} = \int \vec{F}\,dt = \Delta\vec{p}$$

$$\vec{p} = m\vec{v}$$

$$\vec{r}_{\mathrm{cm}} = \frac{\sum \vec{r}_i m_i}{\sum m_i}$$

$$\vec{r}_{\mathrm{cm}} = \frac{\int \vec{r}\,dm}{\int dm}$$

$$I = \sum m_i r_i^2$$

$$I = \int r^2\,dm$$

$$I = I_{\mathrm{cm}} + Md^2$$

$$\vec{L} = \vec{r} \times \vec{p}$$

$$\vec{L} = I\vec{\omega}$$

$$x = A\cos(\omega t + \phi_0)$$

$$\vec{a}_{\mathrm{x}} = -\omega^2\vec{x}$$

$$\omega = \sqrt{k/m}$$

$$\omega = 2\pi f = \frac{2\pi}{T}$$

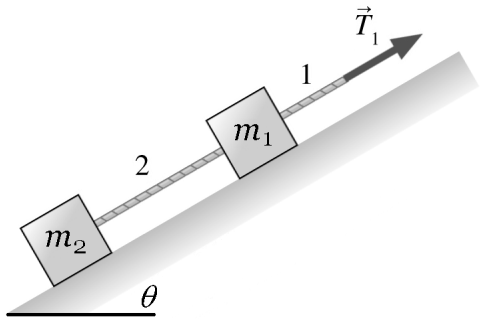
Physical Constants:

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

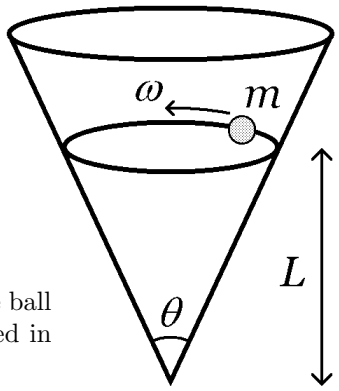
Unless otherwise directed, drag is to be neglected, all problems take place on Earth, use the gravitational definition of weight, and all springs, ropes, and pulleys are ideal. All derivatives and integrals in free-response problems must be evaluated.

Initial:

I. (16 points) Two blocks of mass m_1 and m_2 are tied together and pulled so that it travels up a frictionless incline that makes an angle θ with the horizontal, as illustrated. The force pulling them is a tension of magnitude T_1, and their resulting acceleration is not zero. What is the tension magnitude T_2 in rope 2, which ties the blocks together, in terms of other parameters defined in the problem, and physical or mathematical constants? (*On Earth.*)



1. (6 points) A ball of mass m is placed at a height L in the frictionless hollow cone shown. It is put into uniform circular motion. What is the radius R of its path? (*On Earth.*)



   (a) $R = L\cos(\theta)$
   (b) $R = L\cos(\theta/2)$
   (c) $R = L\sin(\theta/2)$
   (d) $R = L\tan(\theta/2)$
   (e) $R = L\sin(\theta)$

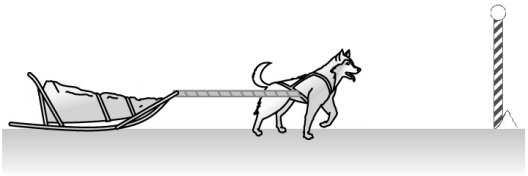
II. (16 points) In the problem above, what angular speed ω is required to keep the ball at the height L? Express your answer in terms of R, other parameters defined in the problem and figure, and physical or mathematical constants.

2. (6 points) It is the end of the dog sled race, and a dog approaches the finish line over level ground pulling a 55 kg sled. At 5.0 m from the finish line, the sled is traveling at 6.0 m/s. The coefficient of kinetic friction between the sled and the ground is 0.18 in these last 5.0 m. The tiring dog exerts a force, $\vec{F}$, on the sled whose magnitude decreases as the finish line is approached, according to

$$\left|\vec{F}(x)\right| = \left(32\,\mathrm{N/m^{1/2}}\right)\sqrt{x}$$

where x is the distance from the sled to the finish line. Is the work done by the dog on the sled the force exerted by the dog times the distance of 5.0 m? *(On Earth.)*

(a) No, work is never "force times distance".
(b) Yes, work is "force times distance" in this case.
(c) Yes, work is always "force times distance".
(d) No, work is not "force times distance" in this case.



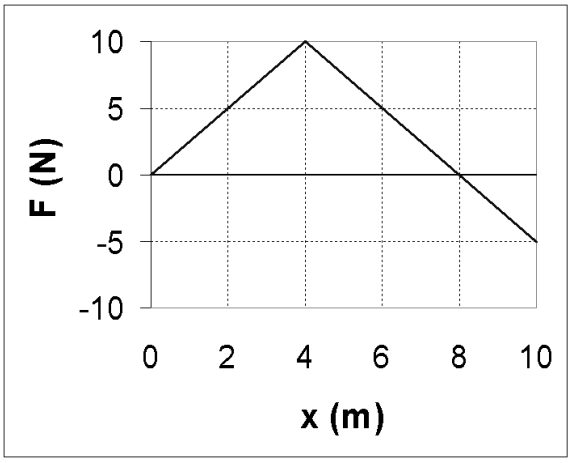
III. (16 points) In the problem above, what is the speed of the sled as it crosses the finish line?

3. (8 points) Two cars, A and B, on level ground have the same mass and their engines provide the same power. Each increases its speed by the same amount Δv. Car A, however, increases its speed from rest, while car B is already traveling at speed v_0 before its speed increases. Which car, if either, requires less time to complete its speed change?

   (a) Car A requires less time than car B to change its speed by Δv.
   (b) Which car requires less time to change its speed by Δv cannot be determined from the information provided.
   (c) Car B requires less time than car A to change its speed by Δv.
   (d) Both cars requires the same time to change their speeds by Δv.

4. (8 points) A 2.0 kg particle moving on the x axis is subject to the force shown on the graph. If the particle's velocity is +5.0 m/s as it passes through the origin, what is its kinetic energy when it reaches +10 m?

   (a) 70 J
   (b) 25 J
   (c) 35 J
   (d) 50 J
   (e) 60 J



Initial:

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5. (8 points) I slid the book a distance d to the left across the level table at constant speed. In terms of magnitudes, there is an applied force F_h from my hand, a gravitational force mg from the Earth, a normal force n from the table, and a kinetic friction force f_k from the table. What description(s) of the energy transformations is/are valid? Just as you do with "Choose all that apply" questions in class, express your answer as number, with your choices in numeric order. (*On Earth.*)

1 For a system consisting of just the book, my hand does external work $F_h d$.

2 For a system consisting of just the book, my hand does external work $F_h d$, and friction does external work $-f_k d$.

3 For a system consisting of just the book, my hand does external work $F_h d$, and friction increases the thermal energy by $f_k d$.

4 For a system consisting of the book and the table, my hand does external work $F_h d$.

5 For a system consisting of the book and the table, my hand does external work $F_h d$, and friction does external work $-f_k d$.

6 For a system consisting of the book and the table, my hand does external work $F_h d$, and friction increases the thermal energy by $f_k d$.

Answer: _____

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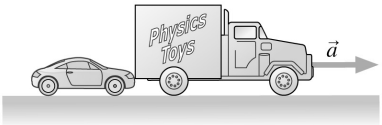
6. (8 points) A small car is pushing a larger truck with a dead battery, causing it to speed up to the right, as illustrated. The mass of the truck is greater than that of the car. Which of the following statements is true? (*On Earth.*)

(a) The car exerts a force of greater magnitude on the truck than the truck exerts on the car.
(b) The car exerts a force on the truck, but the truck does not exert a force on the car.
(c) The car exerts the same magnitude force on the truck as the truck exerts on the car.
(d) The truck exerts a force on the car, but the car does not exert a force on the truck.
(e) The truck exerts a force of greater magnitude on the car than the car exerts on the truck.



7. (8 points) Rank the gravitational acceleration at the surface of the four illustrated planets, from greatest to least. Planet i has mass M and radius R.

(a) $iii > i > iv > ii$
(b) $ii > i > iv > iii$
(c) $iii > iv = i > ii$
(d) $ii > iv = i > iii$
(e) $ii > iv > i > iii$