first (given)	last (family)

Name, *printed* as it appears in Canvas

Physics 2211 AB

Spring 2020

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

Quiz and Exam Formulæ & Constants

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

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

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

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

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

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

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

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

$$s = r\theta$$

$$v = r\omega$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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.

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

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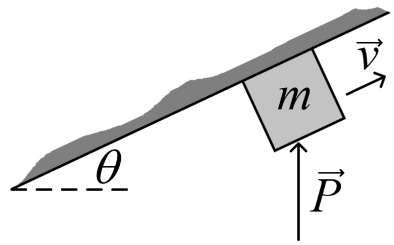
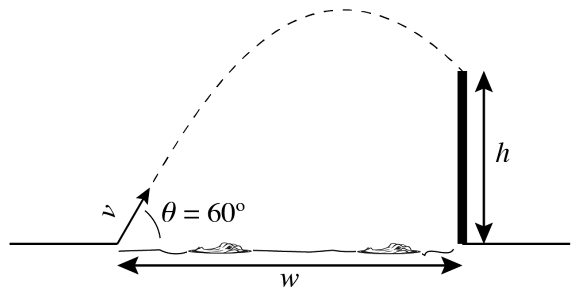
I. (16 points) A block of mass $m = 6.0\,\mathrm{kg}$ slides upward along a ceiling under the influence of a vertical push force $\vec{P}$ (magnitude $75\,\mathrm{N}$). The coefficient of kinetic friction between the block and the ceiling is $\mu_k = 0.35$. If the ceiling makes an angle $\theta = 25°$ with the horizontal, what is the acceleration (magnitude and direction) of the block? (*On Earth.)*



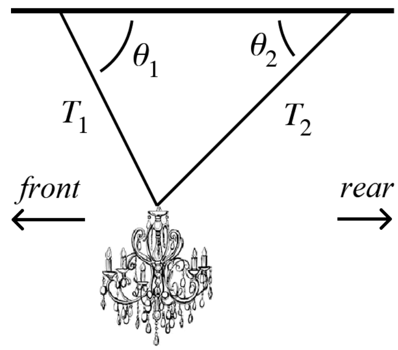
II. (16 points) You need to jump over a wall (of height h) that stands behind a moat (of width w). If you launch yourself at a $60°$ angle above the horizontal, what is the minimum jumping speed that will allow you to clear the wall? Simplify your answer using the fact that $\sin 60° = \sqrt{3})/2$ and $\cos 60° = 1/2$. (*On Earth.*)



1. (6 points) If the wall is too high, you will not be able to clear it (no matter how fast you jump). As a function of your jump angle θ above the horizontal, what is the highest wall H you can possibly clear? *Hint:* you can re-solve the previous problem again for a general launch angle θ, but it is also possible to figure this out by simple geometric reasoning.

   (a) $H = g/w$
   (b) $H = w/2$
   (c) $H = w \sin\theta$
   (d) $H = w \tan\theta$
   (e) $H = \frac{1}{2}gw^2$

III. A 53 kg chandelier in a luxury train is suspended by two wires, which make angles $\theta_1 = 60.0°$ and $\theta_2 = 45.0°$ with respect to the ceiling, as shown. Find the tension magnitudes T_1 and T_2 while the train is stationary at a station. (*On Earth.*)



2. (6 points) The train leaves the station, accelerating to the left. What happens to the tensions in the wires?
   (a) Both stay the same.
   (b) Both change, but which increases and which decreases cannot be determined from the information provided.
   (c) Both increase.
   (d) T_1 decreases. T_2 increases.
   (e) T_1 increases. T_2 decreases.

3. (8 points) An airplane pilot wishes to fly directly north. Because of a wind from the west, however, if he points the nose of his aircraft directly north, he finds himself flying over the ground at an angle θ east of north (*Fig. 1*). To compensate, the pilot points the nose of his aircraft at an angle ϕ west of north, so he flies over the ground directly to the north (*Fig. 2*). How does the angle ϕ compare to the angle θ, and how does the time required to reach his destination compare to the time required in still air?

(a) $\phi = \theta$ and the time is **greater than** that required in still air.
(b) $\phi > \theta$ and the time is **greater than** that required in still air.
(c) $\phi < \theta$ and the time is **the same as** that required in still air.
(d) $\phi > \theta$ and the time is **the same as** that required in still air.
(e) $\phi = \theta$ and the time is **the same as** that required in still air.

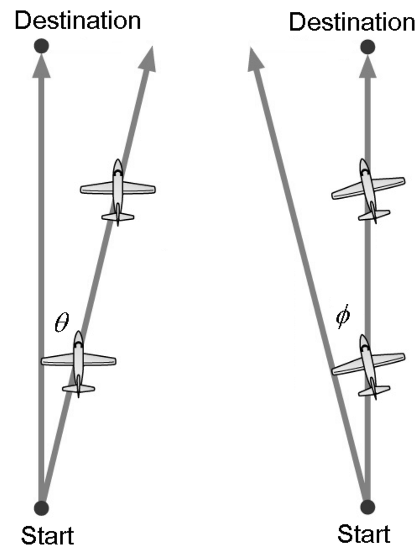
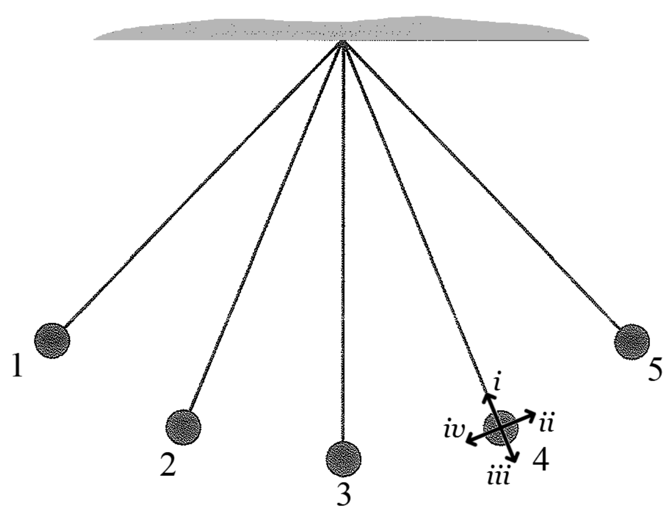


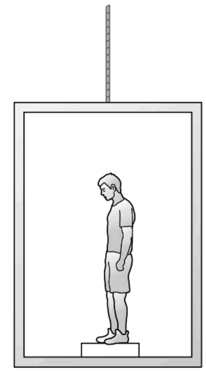
Fig. 1 *Fig. 2*

4. (8 points) A pendulum swings to the left. It stops momentarily at position 1 on the extreme left, then swings back to the right through positions 2 through 5. At the instant it is passing rightward through position 4, what is the direction of the bob's acceleration? (*On Earth.*)

(a) Direction i.
(b) Between directions iii and iv.
(c) Between directions i and iv.
(d) Between directions i and ii.
(e) Direction iii.



5. (8 points) Zouhair's mass is 75 kg. When he stands on a bathroom scale in an elevator, the reading is 700 N. Describe the motion of the elevator. (*On Earth.*)



   (a) It must be stationary.
   (b) It must be moving down.
   (c) It could be moving up or down, or could remain stationary.
   (d) It could be moving up or down, but can't remain stationary.
   (e) It must be moving up.

6. (8 points) You push a book horizontally against the wall with just enough force force to prevent it from sliding down. The coefficients of static and kinetic friction between the book and the wall are the same as between the book and your hand: 0.8 and 0.6, respectively. (*On Earth.*)

   If you push on the book twice as hard, what happens to amount of frictional force on the book?

   (a) It stays the same.
   (b) It increases to 1.6 times its previous value.
   (c) It increases to 1.8 times its previous value.
   (d) It doubles.
   (e) It decreases to half its previous value.

7. (8 points) When a sphere of radius R and mass m is dropped through the atmosphere, it reaches a terminal speed v_{T}. When it is towed at constant speed behind a horizontally-flying airplane, the tow-rope is at an angle of 45° below the horizontal. What is the speed of the airplane? (*On Earth, do NOT neglect drag.*)

(a) $v_{\mathrm{T}}/\sqrt{2}$
(b) $\sqrt{2}v_{\mathrm{T}}$
(c) v_{T}
(d) $2v_{\mathrm{T}}$
(e) $v_{\mathrm{T}}/2$