Physics 2212 AB

Name

Fall 2018

Nine-digit Tech ID

Quiz #
3D

- Put *nothing* other than your name and nine-digit Tech ID 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 1–8. 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 know where to find 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 is given.

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

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

Quiz & Final Exam Formulæ & Constants

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

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

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

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

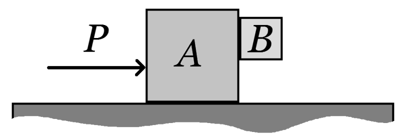
Physical Constants:

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 and all problems take place on Earth, use the gravitational definition of weight, and all springs, ropes and pulleys are ideal.

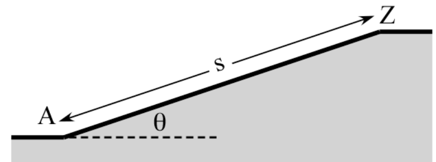
You may remove this sheet from your Quiz or Exam

I. 20 points) Block A in the illustration, with mass m_A, slides along a horizontal frictionless plane. Block B, with mass m_B, has a coefficient of static friction μ_s and a coefficient of kinetic friction μ_k with the front face of block A. What is the minimum magnitude, P, of a horizontal push force on block A so that block B does not slide downward? Express your answer in terms of parameters defined in the problem and physical or mathematical constants.



II. (15 points) Abe and Zeb are carpenters constructing a ramp inclined at an angle $\theta = 18°$ above the horizontal. Abe is at the bottom of the ramp, and shoves a box of nails up toward Zeb, at the top of the ramp a distance $s = 2.5\,\mathrm{m}$ away. Abe shoves the box with a speed v_0 that is just sufficient for it to slide all the way up to Zeb. The coefficient of friction between the box and the ramp is $\mu_k = 0.40$.

Determine the speed v_0 that will allow the box to reach the top of the ramp. **Work the problem symbolically, making numerical substitutions only at the last step.** (Credit will be deducted for numerically based solutions!)



1. (5 points) Zeb would like to give the box of nails a shove with the same speed v_0 and have it slide to a stop just as it reaches Abe. Can Zeb do this? If so, must he remove nails from the box, add nails, or leave the number of nails the same?

   (a) No, Zeb cannot do this, regardless of what he does with the number of nails.
   (b) Yes, Zeb can do this, but he must remove nails (and therefore mass) from the box.
   (c) Yes, Zeb can do this, but he must add nails (and therefore mass) to the box.
   (d) Yes, Zeb can do this, regardless of what he does with the number of nails.
   (e) Yes, Zeb can do this, but he must leave the number of nails unchanged.

Initial:

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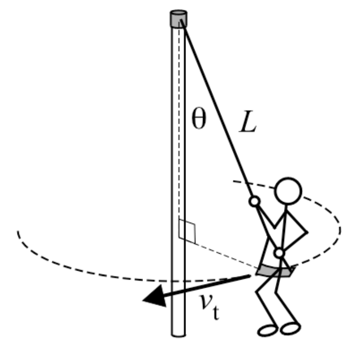
2. (5 points) A pole-swing in a childrens" playground consist of a seat attached to a central pole of height $H = 3.75\,\mathrm{m}$ by a cord of length $L = 3.00\,\mathrm{m}$. The swing can then be pivoted in a circle about the central pole. The cord is strong enough to sustain a maximum tension $T_{\mathrm{max}} = 37\,\mathrm{lb} = 1670\,\mathrm{N}$. One night, Georgia Tech defensive tackle T.J.B̃arnes (weight $W = 333\,\mathrm{lb} = 1480\,\mathrm{N}$) sneaks into the playground to ride the pole-swing.

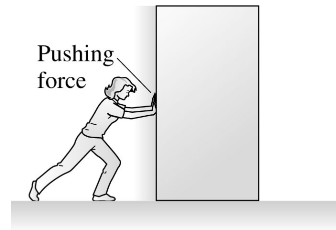


   Suppose T.J. rides the swing with the maximum possible speed v_t that will not break the cord. What will be the angle θ between the cord and the pole, when T.J. rides the swing at this maximum safe speed?

   (a) 37°
   (b) 42°
   (c) 28°
   (d) 62°
   (e) 48°

III. (15 points) In the problem above, what will be the period of T.J.'s rotation around the pole at the maximum safe speed?

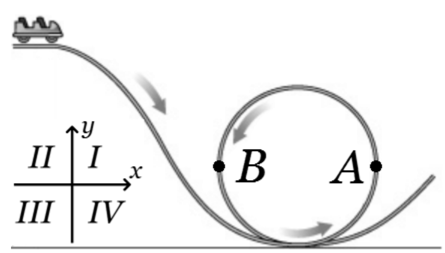
3. (6 points) A block of mass m is pushed a distance d across a horizontal floor. The pushing force $\vec{P}$ is horizontal, and the block moves at constant speed due to the coefficient of kinetic friction μ_k between the block and the floor. Describe the change in thermal energy.



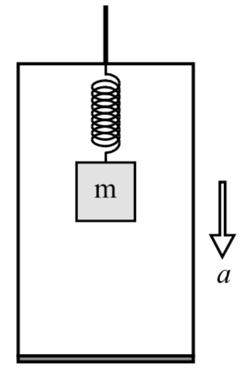
(a) The thermal energy of the block increases by Pd, while the thermal energy of the floor decreases by Pd.
(b) The thermal energy of the block increases by Pd, while the thermal energy of the floor remains unchanged as it is outside the system.
(c) The thermal energy of the floor increases by Pd, while the thermal energy of the block remains unchanged as its kinetic energy is constant.
(d) The thermal energy of the floor increases by Pd, while the thermal energy of the block decreases by Pd.
(e) The thermal energy of the block and floor together increases by a total Pd.

4. (6 points) The roller-coaster in the illustration is truly a "coaster" — the car speeds up as it descends on its frictionless track, and slows down again as it ascends. Assuming it starts high enough that it completes the loop, what is the direction of the car's acceleration as it passes through point A?

(a) In the $+x$ direction.
(b) Somewhere in quadrant III.
(c) In the $-x$ direction.
(d) In the $-y$ direction.
(e) Somewhere in quadrant IV.



5. (10 points) A block of mass $m = 0.60\,\mathrm{kg}$ hangs from the ceiling of an elevator by a spring of unstretched length $L_0 = 36\,\mathrm{cm}$ having elastic constant $k = 48\,\mathrm{N/m}$. What will be the total length of the spring when the elevator is experiencing a downward-directed acceleration of magnitude $a = 2.6\,\mathrm{m/s^2}$?



(a) 45 cm
(b) 39 cm
(c) 48 cm
(d) 36 cm
(e) 27 cm

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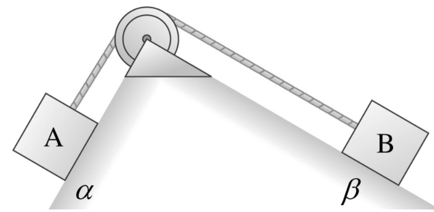
6. (6 points) Two blocks, one with mass m and one with mass $2m$, are traveling along level frictionless tracks with the same kinetic energy. Identical applied forces $\vec{F}$ will be used to bring each block to a stop. Compare the distances required to stop the blocks.

(a) The relative distances to stop the blocks **cannot be determined** from the information provided.
(b) The distance to stop the block with mass $2m$ is **the same** as that to stop the block with mass m.
(c) The distance to stop the block with mass $2m$ is **less than** that to stop the block with mass m.
(d) The distance to stop the block with mass $2m$ is **greater than** that to stop the block with mass m.

7. (6 points) The inclines in the illustration are frictionless, and make angles α and β with the horizontal, where $\alpha > \beta$. The blocks have the same mass m and are initially at rest. In which direction, if any, do the two blocks move?



   (a) The blocks do not move.
   (b) The direction cannot be determined from the information provided.
   (c) The blocks move to the left.
   (d) The blocks move to the right.

8. (6 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) Which car requires less time to change its speed by Δv cannot be determined from the information provided.
   (b) Car B requires less time than car A to change its speed by Δv.
   (c) Car A requires less time than car B to change its speed by Δv.
   (d) Both cars requires the same time to change their speeds by Δv.