first (given)	*last (family)*	**Physics 2211 AB**	Nine-digit Tech ID

Name, *printed* as it appears in Canvas

Spring 2020

Quiz

3A

- **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

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

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

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

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

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

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

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

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

$$s = r\theta$$

$$v = r\omega$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

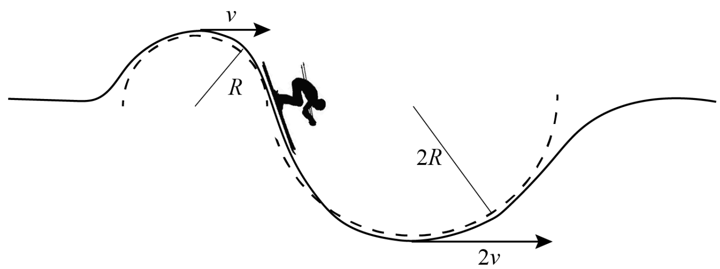
Physical Constants:

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

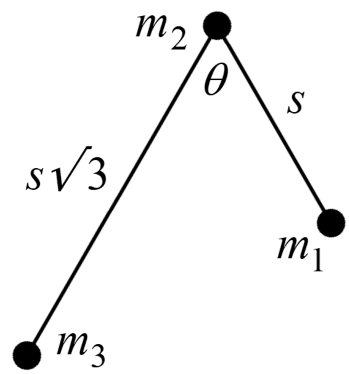
Unless otherwise directed, drag is to be neglected, all problems take place on Earth, use the gravitational definition of weight, and all springs, ropes, and pulleys are ideal. All derivatives and integrals in free-response problems must be evaluated.

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

I. (16 points) A skier goes over a small hill (of radius R) and through a larger trough (of radius $2R$) on the other side. At the top of the hill their speed is v; at the bottom of the trough they're moving faster, with speed $2v$). Their apparent weight at the top of the hill is $W_{\text{top}} = 883\,\text{N}$; at the bottom of the trough it's $W_{\text{bot}} = 1180\,\text{N}$. Find the mass of the skier. (*On Earth.)*



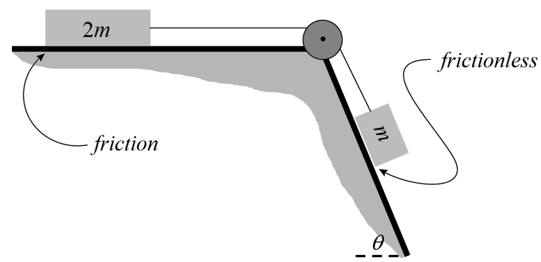
1. (6 points) Three point masses, $m_1 = 1.0\,\mathrm{kg}$, $m_2 = 2.0\,\mathrm{kg}$, and $m_3 = 3.0\,\mathrm{kg}$ are positioned as shown, with the distance $s = 11\,\mathrm{cm}$. Compare the magnitude of the gravitational force $F_{1\mathrm{on}2}$ of mass 1 on mass 2 with the magnitude of the gravitational force $F_{3\mathrm{on}2}$ of mass 3 on mass 2.



   (a) $F_{1\mathrm{on}2} = F_{3\mathrm{on}2}/3$
   (b) $F_{1\mathrm{on}2} = F_{3\mathrm{on}2}$
   (c) $F_{1\mathrm{on}2} = F_{3\mathrm{on}2}/\sqrt{3}$
   (d) $F_{1\mathrm{on}2} = \sqrt{3}F_{3\mathrm{on}2}$
   (e) $F_{1\mathrm{on}2} = 3F_{3\mathrm{on}2}$

II. (16 points) In the problem above, the angle $\theta = 60.0°$. What is the magnitude of the gravitational force on mass m_2? *NOT on Earth!*

III. A block of mass $2m$, on a horizontal surface with coefficients of kinetic and static friction μ_k and μ_s, respectively, is pulled by a block of mass m that slides down a frictionless slope that makes an angle θ with the horizontal. Find the magnitude of the tension in the rope in terms of parameters defined in the problem, and physical or mathematical constants. You may assume that the slope is steep enough that the blocks do slide. (*On Earth.*)

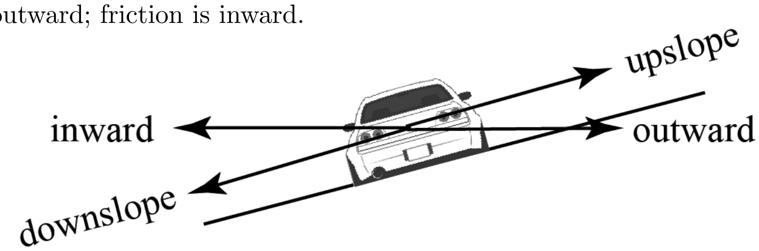


2. (6 points) Let the coefficient of static friction on the horizontal surface in the problem above be 1/4. If the slope is insufficiently steep, the blocks will not slide at all. At what angle θ above the horizontal does this happen?

(a) 30°
(b) 60°
(c) 14°
(d) 45°
(e) 76°

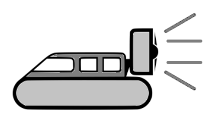
3. (8 points) A car is driving around a banked curve as shown. The car's trajectory lies in a horizontal plane, with the center of the curve to the left. What are the directions of the acceleration of the car, and the frictional force on the car?

   (a) Acceleration is inward; friction could be upslope or downslope.
   (b) Acceleration is downslope; friction is upslope.
   (c) Acceleration is inward; friction is downslope.
   (d) Acceleration is inward; friction is upslope.
   (e) Acceleration is outward; friction is inward.

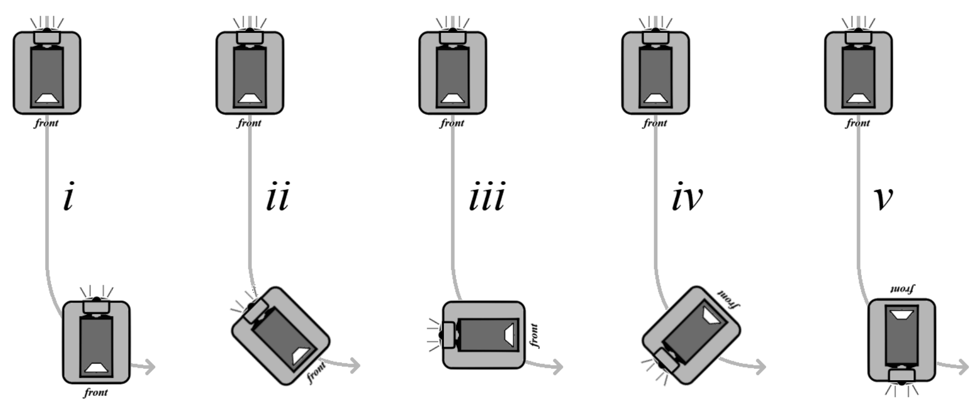


---

4. (8 points) A hovercraft, powered by a fan at its stern, is heading south. It turns 90° to the east, slowing as it does so, as shown in the top views below. When it is halfway around its turn, how should it be oriented?



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

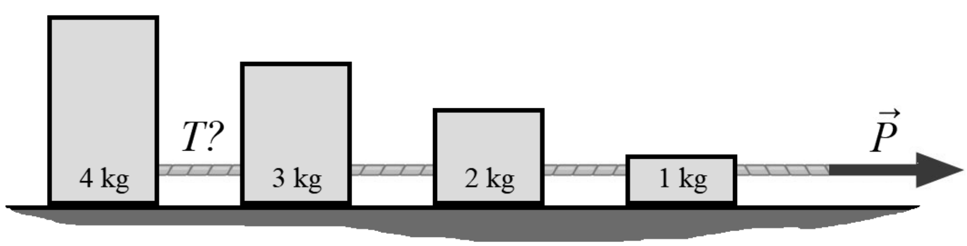


5. (8 points) The newly discovered planet X is composed of material that is half as dense as the Earth, while its diameter is three times the Earth's. How does the acceleration due to gravity at the surface of planet X (g_{X}) compare to the acceleration due to gravity on Earth (g_{E})?

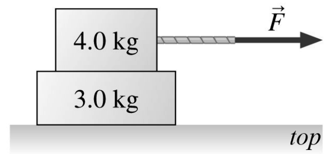
   (a) $g_{\mathrm{X}} = 8g_{\mathrm{E}}/9$
   (b) $g_{\mathrm{X}} = g_{\mathrm{E}}/4$
   (c) $g_{\mathrm{X}} = g_{\mathrm{E}}/6$
   (d) $g_{\mathrm{X}} = 27g_{\mathrm{E}}/4$
   (e) $g_{\mathrm{X}} = 3g_{\mathrm{E}}/2$

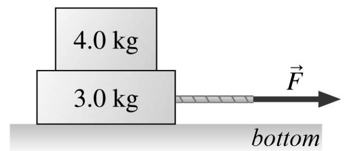
6. (8 points) Four blocks, with masses 1.0, 2.0, 3.0, and 4.0 kg, are tied together with ideal cords as shown, and pulled to the right on a frictionless level surface by horizontal pull force $\vec{P}$. Compare the tension magnitude T in the cord connecting the 3.0 and 4.0 kg blocks, with the magnitude of the pull force. (*On Earth.*)

   (a) $T = 0.57P$
   (b) $T = P$
   (c) $T = 0.40P$
   (d) $T = 0.25P$
   (e) $T = 0.75P$



7. (8 points) A 4.0 kg block and a 3.0 kg block are stacked on a level frictionless surface, as shown. A horizontal force $\vec{F}$ may be applied to the top block, or that same horizontal force $\vec{F}$ may be applied to the bottom block. In either case, friction between the blocks keeps them moving together. (*On Earth.*)





When the force $\vec{F}$ is applied to the bottom block, what is the direction of the friction force on the bottom block? How does the magnitude of the friction force on the bottom block compare to the magnitude on it when the force $\vec{F}$ is applied to the top block?

When the force $\vec{F}$ is applied to the bottom block, the friction force on the bottom block . . .

(a) is **to the right**, and its magnitude is **the same as** when $\vec{F}$ is applied to the top block.
(b) is **to the left**, and its magnitude is **greater than** when $\vec{F}$ is applied to the top block.
(c) is **to the right**, and its magnitude is **greater than** when $\vec{F}$ is applied to the top block.
(d) is **to the left**, and its magnitude is **the same as** when $\vec{F}$ is applied to the top block.
(e) is **to the left**, and its magnitude is **less than** when $\vec{F}$ is applied to the top block.