first (given)	*last (family)*	

Name, *printed* as it appears in Canvas

Physics 2211 AB

Fall 2019

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 after the first Reading Day, Wednesday, April 24.

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:

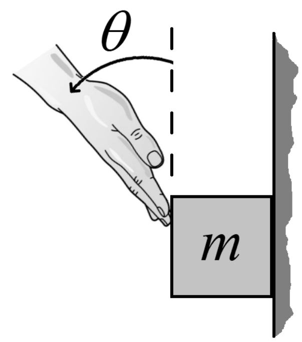
Universal Gravitation Constant $G = 6.673 \times 10^{-11}\,\text{N}\cdot\text{m}^2/\text{kg}^2$
Gravitational Acceleration at Earth's Surface $g = 9.81\,\text{m/s}^2$

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) The Earth has a radius of 6.38×10^6 m. The period of rotation of Earth is 24 hours (actually it's a bit less than 24 hours, but ignore that detail). What would the period of rotation have to be, in hours, so an object at the equator would have a centripetal acceleration magnitude equal to g ($9.8\,\mathrm{m/s^2}$)?

II. (16 points) A block of mass m is being slid down along a wall by an applied pushing force of magnitude A that makes an angle θ with the vertical, as illustrated. The coefficient of static friction between the block and the wall is μ_s, while the coefficient of kinetic friction is μ_k. What is the acceleration magnitude the block in terms parameters defined in the problem and physical or mathematical constants? (*On Earth.*)

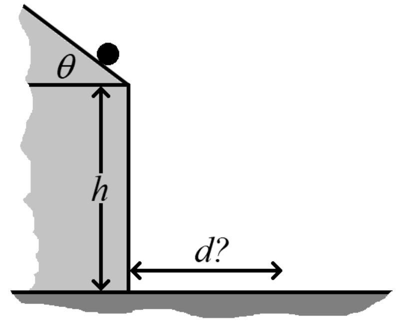


1. (6 points) In the problem above, what is the direction of the block's acceleration?

   The direction of the block's acceleration ...

   (a) cannot be determined without numeric values for the parameters defined in the problem.
   (b) is always downward.
   (c) is always upward.
   (d) is initially upward, but will become downward.
   (e) is initially downward, but will become upward.

III. (16 points) A bowling ball rolls off a roof that makes an angle of 37° with the horizontal, as shown. At the instant it leaves the roof, it is a distance $h = 14\,\mathrm{m}$ above the level ground, and traveling at $4.5\,\mathrm{m/s}$. At what distance d from the building does the ball strike the ground? (*On Earth.*)



2. (6 points) In the problem above, in what direction is ball travelling as it strikes the ground?
   (a) The ball is travelling in a direction 37° below the horizontal.
   (b) The ball is travelling in a direction 90° below the horizontal.
   (c) The ball is travelling in a direction between 37° and 90° below the horizontal.
   (d) The ball is travelling in a direction 0° below the horizontal.
   (e) The ball is travelling in a direction between 0° and 37° below the horizontal.

3. (8 points) A small skydiver of mass m and a large skydiver of mass $M > m$ are each falling at their own terminal speeds. There is a drag force d on the small skydiver and a drag force D on the large skydiver. Compare the *difference* between the drag force and the gravitational force on each skydiver. (*On Earth, do NOT neglect drag!*)

   (a) $d - mg = D - Mg < 0$
   (b) $d - mg = D - Mg > 0$
   (c) $d - mg > D - Mg$
   (d) $d - mg < D - Mg$
   (e) $d - mg = D - Mg = 0$

4. (8 points) A car starts at rest on a circular track, then speeds up with constant tangential acceleration. Describe the direction of the car's *total* acceleration.

   The car's total acceleration . . .

   (a) is always straight ahead of the car.
   (b) is always halfway between straight ahead of the car and toward the center of the track.
   (c) is always toward the center of the track.
   (d) is initially toward the center of the track, then becomes closer and closer to straight ahead of the car as time goes on.
   (e) is initially straight ahead of the car, then becomes closer and closer to toward the center of the track as time goes on.

5. (8 points) A blimp pilot wishes to fly directly East, but the wind is blowing from the North (toward the South). Therefore, the pilot points the blimp's nose at an angle θ north of East, enabling the blimp to move directly East over the ground.

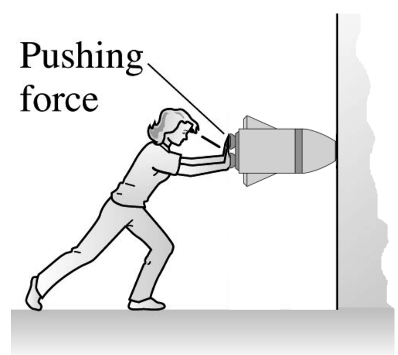
After arriving at the destination, the pilot wishes to return directly West to the starting point. The wind is still blowing from the North at the same speed, so the pilot points the blimps nose at an angle ϕ north of West, enabling the blimp to move directly West over the ground.

If the blimp has the same speed through the air for both trips, how are the angles θ and ϕ related?

(a) $\phi = \theta$
(b) $\phi < \theta$
(c) $\phi > \theta$
(d) Whether ϕ is greater than, the same as, or less than θ cannot be determined unless the actual speeds of the blimp and wind are known.
(e) The pilot can choose whether ϕ is greater than, the same as, or less than θ.

6. (8 points) Aaliyah pushes her model rocket horizontally against a wall. Static friction holds the rocket in place, so it doesn't move. If Aaliyah **doubles** the force with which she pushes her rocket, how is the static friction force affected? (*On Earth.*)

(a) The static friction force remains the same.
(b) The static friction force becomes zero.
(c) The static friction force doubles.
(d) The static friction force is halved.
(e) The effect on the static friction force cannot be determined from the information provided.



7. (8 points) A spaceship is subject to a force $3F_0$ in the positive direction of the x-axis, and to a second force $4F_0$, in the positive direction of the y-axis. This results in an acceleration of magnitude a. Then, the spaceship releases a probe with a mass 1/10 of that of the spaceship. This probe is subject to a force F_0 along the negative direction of the x-axis. What is the acceleration of the probe?

(a) $F_0/10$ along the negative direction of the x-axis
(b) $5F_0$ along the positive direction of the x-axis
(c) $10a$ somewhere between the positive directions of the x- and y-axes
(d) $a/2$ along the negative direction of the x-axis
(e) $2a$ along the negative direction of the x-axis