first (given)	*last (family)*	

Name, *printed* as it appears in Canvas

Physics 2211 AB

Spring 2020

Nine-digit Tech ID

Quiz

1A

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

Quiz and Exam Formulæ & Constants

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

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

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

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

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.

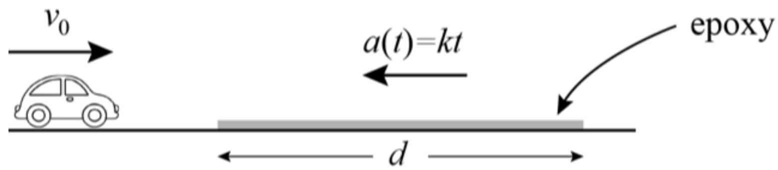
You may remove this sheet from your Quiz or Exam, but it must be submitted

I. (16 points) It's a hot day at the park, and you'd like a drink of water. You know there's a water fountain (let's call it "A") 160 m north and 55 m east of your current location. But there's a closer one ("B"), 116 m away, 21° north of East. After walking to this closer one, though, you find it is out of order. How far, and in what direction, must you walk directly from "B" to "A"? *Be sure to specify, clearly, the reference for your direction!*

1. (6 points) A toy car is rolling along a horizontal workbench, when at time $t = 0$ it encounters a large patch of epoxy that is in the process of drying. The epoxy slows down the car, and as it dries this effect becomes larger and larger: quantitatively, the epoxy produces an acceleration $a(t) = kt$, directed opposite to the car's motion, with $k = 0.10\,\mathrm{m/s^3}$.

   Which equation, if any, shows the relationship between the car's position, velocity, and acceleration as it moves through the epoxy?

   (a) None of the others is correct.
   (b) $x = x_0 + v_0 t - \frac{1}{2}at^2$
   (c) $v^2 - v_0^2 = -2a\,\Delta x$
   (d) $v^2 - v_0^2 = 2a\,\Delta x$
   (e) $x = x_0 + v_0 t + \frac{1}{2}at^2$



II. (16 points) In the problem above, if you launch the car with a speed of $0.20\,\mathrm{m/s}$, at what distance into the epoxy does the car come to a halt?

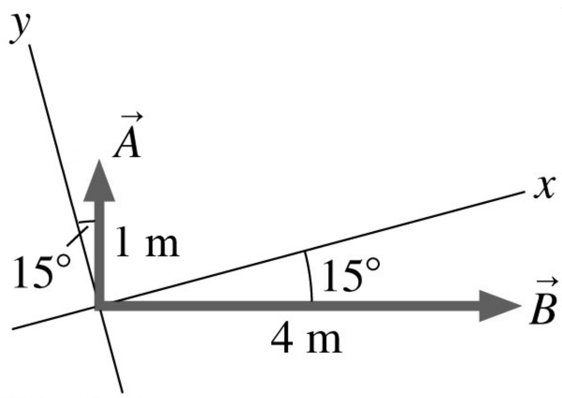
III. A steel ball (mass m) is dropped from rest from a height h above the ground. At the same instant, a brass ball (mass $2m$), is launched upward with a velocity v_0, from ground level. If the steel ball is dropped from too large a height, the balls won't collide before the brass ball returns to the ground. Find the maximum drop height h for which the balls collide in the air. Express your answer in terms of parameters defined in the problem, and physical or mathematical constants. (*On Earth.*)

2. (6 points) How would your answer for the maximum drop height h change if the mass of the brass ball is increased from $2m$ to $4m$?

   (a) is increased by a factor of 2
   (b) is reduced by a factor of 4
   (c) h is unchanged.
   (d) is increased by a factor of 4
   (e) is reduced by a factor of 2

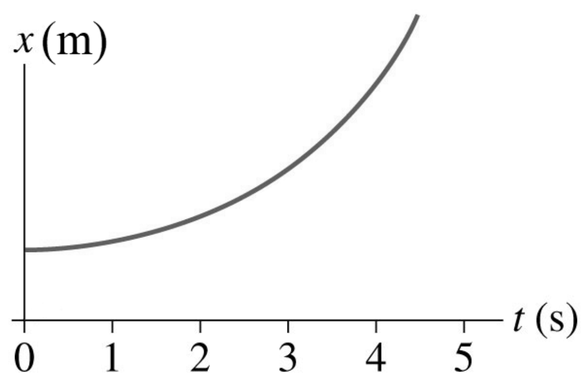
3. (8 points) Vector $\vec{A}$ has magnitude 1.0 m and vector $\vec{B}$ has magnitude 4.0 m, as shown. What is the magnitude of $3\vec{A}+\vec{B}$?

(a) 6.1 m
(b) 7.0 m
(c) 6.8 m
(d) 5.0 m
(e) 3.6 m

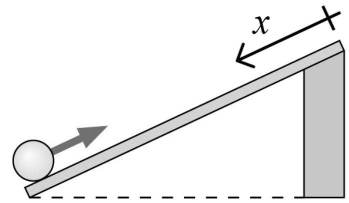


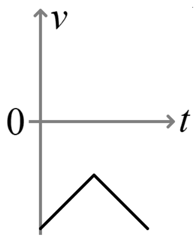
4. (8 points) The position x of an object moving in one dimension is shown as a function of time t. At about what time, if any, is the instantaneous velocity of the object equal to its average velocity over the time interval 0 to 4.5 s?

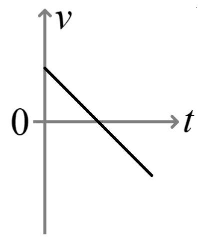
(a) At about $t = 3$ s.
(b) At about $t = 4$ s.
(c) At about $t = 2$ s.
(d) At no time.
(e) At about $t = 1$ s.

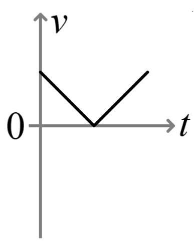


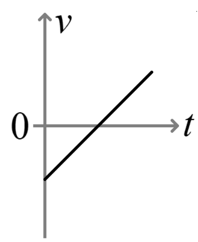
5. (8 points) An object is given an initial velocity up an inclined plane. It rolls halfway up the plane before it stops and rolls back down. If the origin is at the top of the plane with the positive direction down the plane, what is the graph of the object's velocity as a function of time? (*On Earth.*)

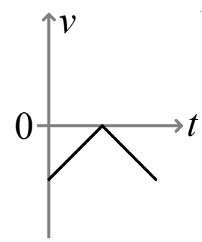


(a) 

(b) 

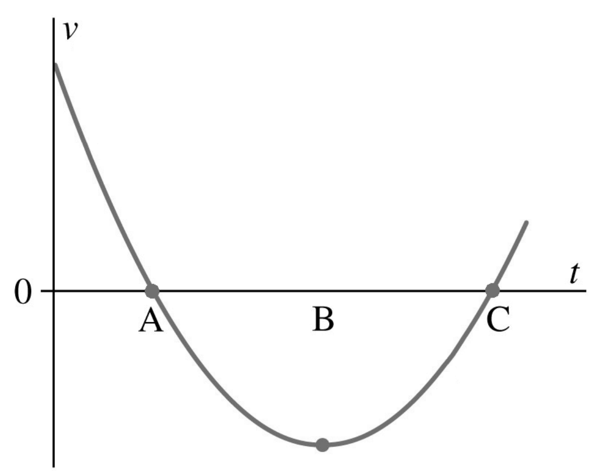
(c) 

(d) 

(e) 

6. (8 points) The velocity v of an object moving in one dimension is shown as a function of time t. At what times in the range from zero to C is the object's speed increasing?

(a) Only between times B and C.
(b) Between times zero and A, and between times B and C.
(c) Only between times zero and A.
(d) Between times A and C.
(e) Only between times A and B.



7. (8 points) Car A is traveling at constant velocity. Car B is at rest at the origin, and begins to travel with constant acceleration when car A passes at time $t = 0$. At what time, if at all, does car B catch up to car A?

   (a) Car B never catches car A.
   (b) At some time between t_1 and t_2.
   (c) At some time between $t = 0$ and t_1.
   (d) At time t_1.
   (e) At time t_2.