| first (given) | last (family) |
|---|---|

Name, *printed* as it appears in Canvas

**Physics 2211 A**

Spring 2021

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Nine-digit Tech ID

Quiz

# 1A

- You may use the standard formula sheet and a calculator that cannot store letters, but no other aids or electronic devices.
- Free-response problems require a file upload. 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. Check your scan to make sure it is clear, and upload it to Gradescope. *Do not scan and upload this cover page.*
- Multiple-choice questions must be answered directly in Gradescope.
- Your score will be posted when your quiz has been graded. Quiz grades become final when the next quiz is administered.

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*Select your Multiple Choice answers directly in Gradescope.*

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

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

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

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

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

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

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

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

$$s = r\theta$$

$$v = r\omega$$

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Physical Constants:

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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.*

Initial:

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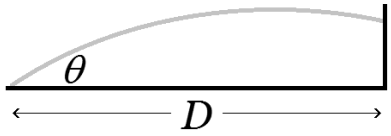
*I*. (16 points) A spring-loaded toy cannon launches its ball at an angle $\theta = 35^\circ$ above the horizontal. The ball reaches its maximum height at a time $t_{\max} = 0.48\,\text{s}$ after launch. At what time after launch does the ball hit the wall a distance $D = 3.7\,\text{m}$ from the cannon? (*On Earth.*)



1. (6 points) An object moves in one dimension with a velocity $\vec{v}$ that depends on time $t$ according to

$$\vec{v} = \left(At^2 - Bt - C\right)\hat{\imath}$$

where $A = 9.0\,\mathrm{m/s^3}$, $B = 6.0\,\mathrm{m/s^2}$, and $C = 4.0\,\mathrm{m/s}$. Which constant-acceleration kinematic equation from your text can be used to find the acceleration of the object?

(a) $s_\mathrm{f} = s_\mathrm{i} + v_\mathrm{i}\,\Delta t + \frac{1}{2}a\,(\Delta t)^2$
(b) No constant-acceleration kinematic equation from the text can be used.
(c) $v_\mathrm{f} = v_\mathrm{i} + a\,\Delta t$
(d) $v_\mathrm{f}^2 = v_\mathrm{i}^2 + 2a\,\Delta s$
(e) A combination of two constant-acceleration kinematic equations from the text must be used.

*II*. (16 points) In the problem above, if the object is at position $\vec{x} = +5.0\hat{\imath}\,\mathrm{m}$ at time $t = 0\,\mathrm{s}$, what is its position at time $t = 2.0\,\mathrm{s}$?

Initial:

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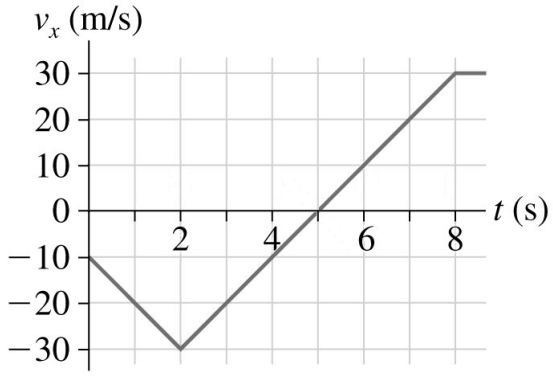
*III*. (16 points) A particle moves along the $x$ axis, starting at position $\vec{x} = +10\,\text{m}$ at time $t = 0\,\text{s}$. Its velocity $\vec{v}$ depends on time, as shown. What is the position of the particle at time $t = 8\,\text{s}$?

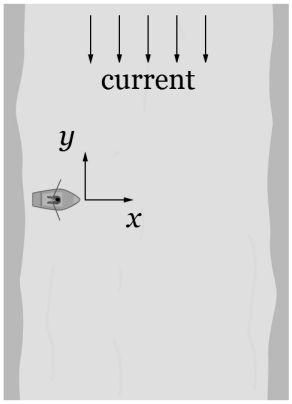



2. (6 points) If it can be determined in the problem above, at what time in the range $t = 0\,\text{s}$ to $t = 8\,\text{s}$ does the particle achieve its maximum distance from the origin?

   (a) At time $t = 5\,\text{s}$.
   (b) At time $t = 0\,\text{s}$.
   (c) At time $t = 2\,\text{s}$.
   (d) This cannot be determined from the given velocity-time graph.
   (e) At time $t = 8\,\text{s}$.

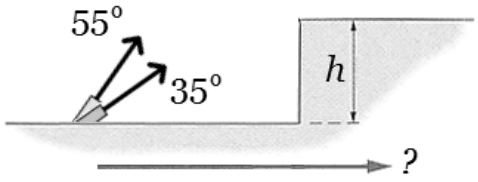
3. (8 points) Mary needs to row her boat across a 100 m wide river that flows in the $-y$ direction at 1 m/s. Mary can row a a speed of 2 m/s. Assume that Mary wants to land directly across the river (i.e., in the $+x$ direction) from the point at which she started. What will be her speed with respect to the shore?

   (a) Between 2 m/s and $\sqrt{5}$ m/s.
   (b) 2 m/s.
   (c) More than $\sqrt{5}$ m/s.
   (d) $\sqrt{5}$ m/s.
   (e) Less than 2 m/s.




4. (8 points) A cannon is aimed 35° above the horizontal, and fires a shell which lands on a plain a height $h$ above the cannon. The cannon is then aimed at 55° above the horizontal, and fires an identical shell at the same speed, which also lands on that same plain. Which shell, if either, travels a greater horizontal distance to the point at which it lands? Assume that, unlike the figure, the size of the cannon is small compared to the height $h$. Remember that both shells *do* land on the plain! (*On Earth.) Hint:* Sketch the situation in which there is no raised plain, and the shells land at their launch height.

   (a) The shell fired at 55° travels a greater horizontal distance.
   (b) This depends on the identical initial speed—when it is "high", the shell fired at 35° travels a greater horizontal distance, but when it is "low" the shell fired at 55° travels a greater horizontal distance.
   (c) This depends on the identical initial speed—when it is "high", the shell fired at 55° travels a greater horizontal distance, but when it is "low" the shell fired at 35° travels a greater horizontal distance.
   (d) The shell fired at 35° travels a greater horizontal distance.
   (e) Both shells travel the same horizontal distance.



Initial:

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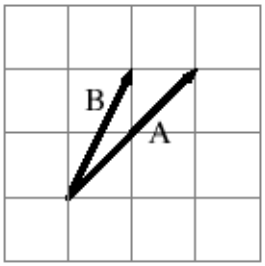
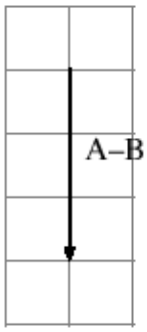
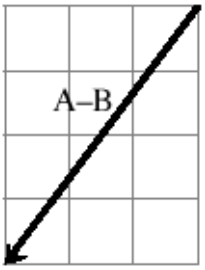
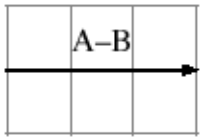
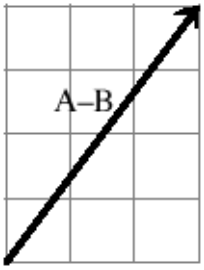
5. (8 points) Consider the two vectors $\vec{A}$ and $\vec{B}$ shown at right. Which of the following is the correct sketch for the vector difference $\vec{A} - \vec{B}$?

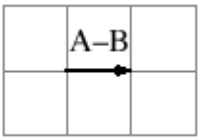



(a)



(b)



(c)



(d)



(e)
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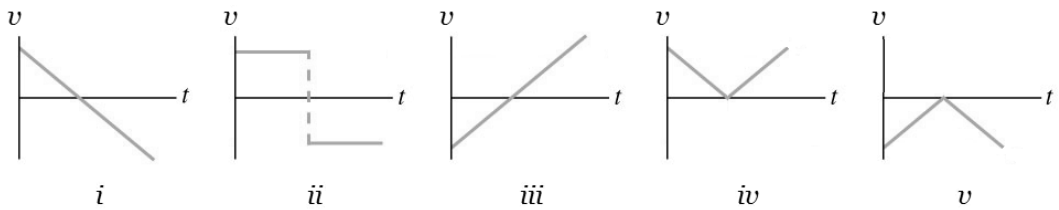
6. (8 points) An object is thrown upward. It reaches a peak, and falls back downward. If upward is the positive direction, which graph shows its velocity as a function of time during this process? (*On Earth.*)

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



7. (8 points) A car drives through a semi-circular valley at constant speed. Three motion diagrams are shown, with velocity vectors between the car's locations, and an acceleration vector at the instant the car is at the very bottom of the valley. Which diagram or diagrams, if any, shows a correct acceleration vector? (*On Earth.*)

   (a) Either diagram *i* or *ii* could be correct.
   (b) Only diagram *ii* is correct.
   (c) None of the three diagrams could be correct.
   (d) Only diagram *iii* is correct.
   (e) Only diagram *i* is correct.