

Printed Name

Nine-digit GT ID

signature

Spring 2019

PHYS 2211 ABC

Test 01

- Put nothing other than your name and nine-digit GT ID in the blocks above. Print clearly so that OCR software can properly identify you. Sign your name on the line immediately below your printed name.
- 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 1–6. For each, select the answer most nearly correct, circle it on your test, 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. Place any added pages at the **back** of your test, when submitting your exam.
- You may use a calculator that cannot store letters, but no other aids or electronic devices.
- Scores will be posted when your test has been graded. Test grades become final when the next is given.

Test Form:

**1A**

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

- 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)



The following problem will be hand-graded. Show all supporting work for this problem.

- [1] (20 points) The Tortoise and the Hare are in a footrace covering a total straight-line distance  $D$ . The Tortoise walks at a constant speed  $v$  and the Hare runs at a constant speed  $3v$ . At the start of the race, the Hare shows off by intentionally running in the wrong direction. When he sees the Tortoise reach the halfway mark, he turns around and starts running toward the finish line. The Tortoise wins the race, but the Hare continues to the finish line anyway, at speed  $3v$ .

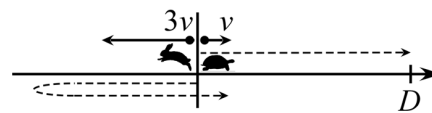


figure is not necessarily to scale

What is the Hare's average velocity during the time interval required for the hare to reach the finish line? Express your answer as a velocity vector with a magnitude that is some multiple or fraction of  $v$ .

## Form 1A

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The following problem will be hand-graded. Show all supporting work for this problem.

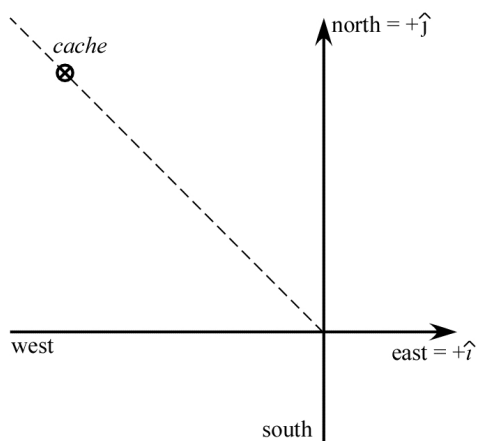
- [II] (20 points) A car and a train move together along straight, parallel paths with the same initial speed  $v_0$ . At time  $t = 0$  the car driver notices a red light ahead and slows down with constant acceleration of magnitude  $a$ . Just as the car comes to a full stop, the light immediately turns green, and the car then speeds up with a constant acceleration of the same magnitude  $a$ , continuing until it catches up to the train. During the same time interval, the train continues to travel at the constant speed  $v_0$ .

What total distance does the car travel before catching back up to the train? How fast is it travelling at that moment? Express both answers in terms of the parameters  $v_0$  and  $a$ .

Hint: the expression  $au^2 + bu + c = 0$  has solutions  $u = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

The following problem will be hand-graded. Show all supporting work for this problem.

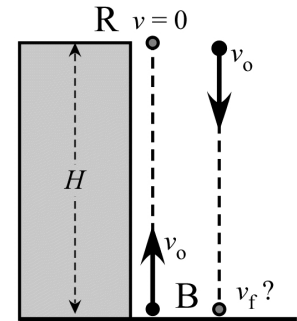
- [III]** (20 points) You are a cast member on a reality TV show in which contestants must navigate in the wilderness using only a map, a compass and a stopwatch. Your task is to travel 5.0 miles northwest (i.e. exactly  $45^\circ$  north of west) to retrieve a cache of water and supplies. However, after traveling for 1.4 hrs at a steady speed of 5.0 mph, in a direction that you believe to be northwest, you still have not reached the cache. Examining the compass closely, you realize that one of your rivals has sabotaged it using a tiny magnet. Removing the magnet, you realize that you have really been travelling  $10^\circ$  off course, in a direction  $35^\circ$  north of west. What displacement (magnitude and direction) will take you directly to the cache?



## Form 1A

*Question value 8 points*

- (01) Rasputin stands on the roof of a building of height  $H$ , while Bernoulli stands at the base of the building. Bernoulli throws an avocado straight upward with an initial speed  $v_o$  that is just fast enough for the avocado to reach the roof, where Rasputin catches it as it comes (momentarily) to rest. If Rasputin throws the avocado back down at Bernoulli with the same speed  $v_o$  that it was thrown upward, with what speed will it hit the ground?

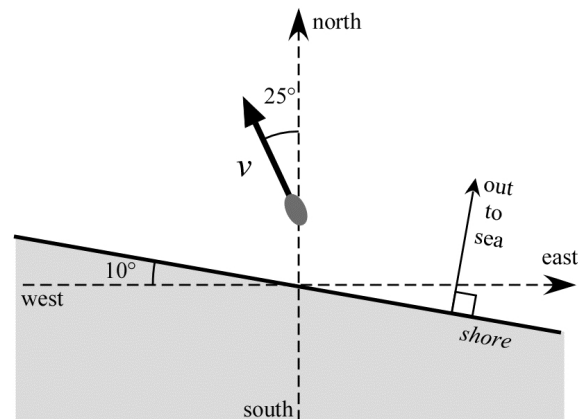


- (a)  $v_f = -2 v_o$
- (b)  $v_f = \sqrt{2} v_o$
- (c)  $v_f = 2 v_o$
- (d)  $v_f = 4 v_o$
- (e)  $v_f = v_o$

*Question value 8 points*

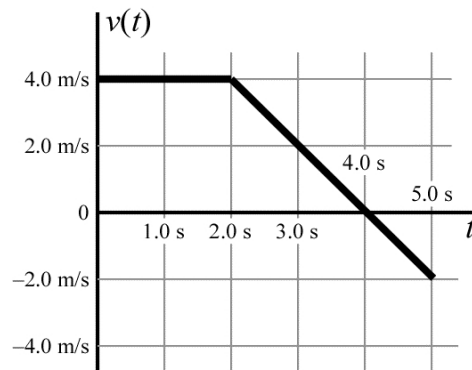
- (02) You are in a boat that is travelling at speed  $v$ , in a direction  $25^\circ$  west of north. To your south, the shoreline runs along a line that is oriented  $10^\circ$  south of east. At what rate is your boat moving out to sea, *straight away from shore*?

- (a)  $v \cos 80^\circ$
- (b)  $v \cos 65^\circ$
- (c)  $v \cos 55^\circ$
- (d)  $v \cos 35^\circ$
- (e)  $v \cos 25^\circ$



The next two questions involve the following situation:

A particle moves along the  $x$ -axis. At time  $t = 0$ , it is located at  $\vec{x}_0 = \langle -3.0 \text{ m} \rangle$ . Its velocity-versus-time graph is plotted at right.



- (03) *Question value 4 points*  
What is the average acceleration of the particle, between times  $t = 1.0$  sec and  $t = 5.0$  sec?

- (a)  $\vec{a} = \langle -1.5 \text{ m/s}^2 \rangle$
- (b)  $\vec{a} = \langle -2.5 \text{ m/s}^2 \rangle$
- (c)  $\vec{a} = \langle +5.5 \text{ m/s}^2 \rangle$
- (d)  $\vec{a} = \langle -2.0 \text{ m/s}^2 \rangle$
- (e)  $\vec{a} = \langle +2.5 \text{ m/s}^2 \rangle$

- (04) *Question value 4 points*  
Where will the particle be at time  $t = 5.0$  sec?

- (a)  $\vec{x}_f = \langle +12 \text{ m} \rangle$
- (b)  $\vec{x}_f = \langle +5.0 \text{ m} \rangle$
- (c)  $\vec{x}_f = \langle +7.0 \text{ m} \rangle$
- (d)  $\vec{x}_f = \langle +8.0 \text{ m} \rangle$
- (e)  $\vec{x}_f = \langle +11 \text{ m} \rangle$

## Form 1A

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*Question value 8 points*

- (05) A sportscar moves in a straight line, with its velocity given by the expression  $v(t) = At - Bt^2$ , where the quantities  $A$  and  $B$  are both positively-valued constants. It starts at the origin at time  $t = 0$ . What is the maximum speed of the car, during the time it is travelling in the positive direction?

(a)  $v_{\max} = \frac{A^2}{B}$

(b)  $v_{\max} = \frac{B}{2A}$

(c)  $v_{\max} = \frac{A^2}{2B}$

(d)  $v_{\max} = \frac{B}{4A}$

(e)  $v_{\max} = \frac{A^2}{4B}$

*Question value 8 points*

- (06) A circus acrobat steps off a platform and drops straight down onto a trampoline, and then bounces straight back up to her original position. At the moment when she is at her lowest point of her “bounce” (i.e. with the maximum sag in the trampoline), the acrobat’s acceleration is necessarily...

(a) ...upward.

(b) ...zero.

(c) ...negative.

(d) ...positive.

(e) ...downward.