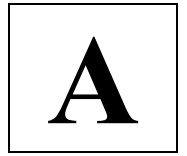


**Test 1**

Recitation Section (see cover page): \_\_\_\_\_

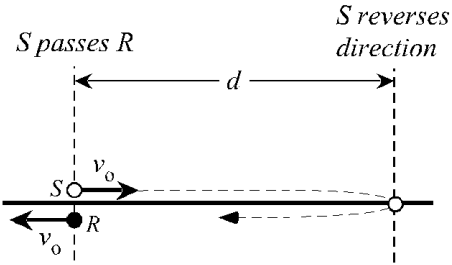
- 1) Print your name, test form number (above), and nine-digit student number in the section of the answer card labeled "STUDENT IDENTIFICATION".
- 2) Bubble your test form number (**ABOVE**) in columns 1-3, skip column 4, then bubble in your student number in columns 5-13.
- 3) For each free-response question, show all relevant work supporting your answer. **Clearly box or underline your final answer.** "Correct" answers which are not supported by adequate calculations and/or reasoning will be counted wrong.
- 4) For each multiple-choice question, select the answer most nearly correct, **circle this answer on your test**, and bubble it in on your answer card. **Show all relevant work on your quiz.**
- 5) Be prepared to present your Buzzcard as you turn in your test. Scores will be posted to WebAssign after they have been graded. **Test grades become final when the next quiz is given.**
- 6) You may use a simple scientific calculator capable of logarithms, exponentials, and trigonometric functions. **Programmable engineering calculators with text or graphical capabilities are not allowed. Wireless devices are prohibited.**



- 
- [I]** (20 points) A skydiver is falling with her primary chute deployed. She falls a distance  $D$  at a constant speed  $v$ , when suddenly her primary chute fails. She immediately deploys her emergency chute, and falls the remaining distance to the ground,  $2D$ , at a speed  $4/3 v$ . What is her average speed during the descent? Express your answer as a multiple of  $v$ . (You may assume that the emergency chute is deployed after a negligible time delay.)

The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

[III] (20 points) Spiff the Spaceman is in his saucer, traveling through space at speed  $v_0$ , when he suddenly passes his nemesis, Roger the Raider, who is traveling in the opposite direction in his rocketship, also at speed  $v_0$ . Spiff engages his inertial thruster, giving him a backward acceleration of constant magnitude  $a$ , in order to pursue Roger. Spiff travels a total distance  $d$  in the wrong direction (i.e. forward) while coming to a stop and reversing course, maintaining his acceleration as he starts to overtake Roger—who continues to travel at constant speed  $v_0$ .



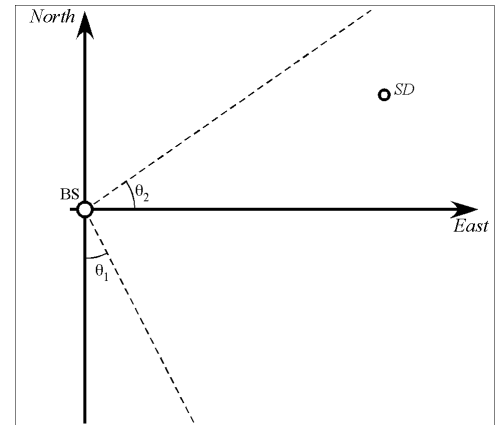
How far will Spiff be from his starting point (where he originally passed Roger), when he finally overtakes Roger? Express your answer as a multiple of the stopping distance  $d$ .

Hint: Start by finding a relationship between  $v_0$ ,  $a$ , and  $d$ .

The following problem will be hand-graded. Show all your work for this problem. Make no marks and leave no space on your answer card for it.

- [III]** (20 points) You are a Lunar colonist. You set out from Burdell Station with a partner, to repair a pair of relay antennas. You decide to split up, so your partner travels a distance  $d_1 = 12.0$  km in a direction  $\theta_1 = 27.0^\circ$  east of south to the 1<sup>st</sup> antenna, while you travel a distance  $d_2 = 15.0$  km in a direction  $\theta_2 = 35.0^\circ$  north of east to the 2<sup>nd</sup> antenna. You perform your repair quickly, but your partner needs some spare fiberoptic cable. You travel to a supply depot that is 4.00 km due southeast of your location to pick up the cable. What displacement (magnitude and direction) will take you directly from the depot to your partner?

*Hint: your grader will probably find it easier to credit your work if you solve symbolically, and save numerical calculations for the final steps.*



*Question value 8 points*

(1) Each of the motion diagrams below displays three frames, numbered in sequential order 0→1→2. Each diagram also indicates a coordinate system, with a directional arrow denoting the positive direction and a crosshair indicating the location of the origin. Which of the diagrams displays a particle with positive position, negative velocity, and negative acceleration?

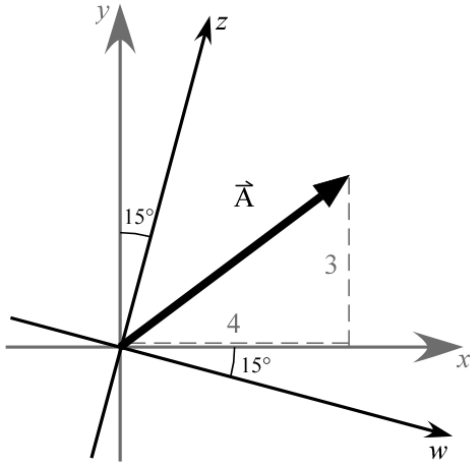
- (a)
- (b)
- (c)
- (d)
- (e)

*Question value 8 points*

(2) In the diagram at right, vector  $\vec{A}$  is shown decomposed into its  $x$  and  $y$  components:

$$\vec{A} = \langle x, y \rangle = \langle 4.00, 3.00 \rangle$$

The diagram also shows a tilted “ $w$ - $z$  coordinate system”, that has been rotated  $15.0^\circ$  clockwise from the  $x$ - $y$  coordinate system. What are the components of vector  $\vec{A}$  in the  $w$ - $z$  system?



- (a)  $\langle w, z \rangle = \langle 3.54, 3.54 \rangle$
- (b)  $\langle w, z \rangle = \langle 1.86, 4.64 \rangle$
- (c)  $\langle w, z \rangle = \langle 3.93, 3.09 \rangle$
- (d)  $\langle w, z \rangle = \langle 4.64, 1.86 \rangle$
- (e)  $\langle w, z \rangle = \langle 3.09, 3.93 \rangle$

*Question value 8 points*

- (3) 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...

*[Hint: draw a motion diagram for the acrobat!]*

- (a) zero.
- (b) positive.
- (c) negative.
- (d) upward.
- (e) downward.

*Question value 8 points*

- (4) A stone is dropped from the roof of a very tall building, and then, two seconds later, a 2<sup>nd</sup> stone is also dropped. If we neglect air resistance, which of the following statements is most nearly correct? *Hint: Draw side-by-side motion diagrams for both stones and label the frames of each diagram; 0-1-2-3... for the first stone and 2-3-4-5... for the second!*

- (a) The stone that was dropped first will have a greater acceleration magnitude at all points in time.
- (b) Once both stones are falling, the separation distance between them will constantly increase.
- (c) Once both stones are falling, the separation distance between them will constantly decrease.
- (d) The stone that was dropped second will eventually catch up to the first stone...before either one hits the ground.
- (e) Once both stones are falling, the separation distance between them will remain constant.

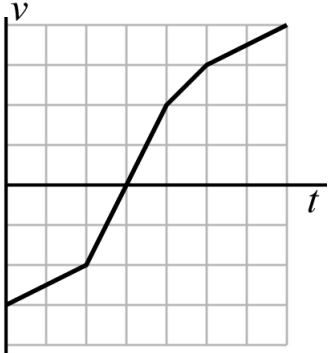
The next two questions involve the following situation:

The graph at right depicts the velocity of a toy car as it moves in a straight line. Each gridline along the horizontal axis corresponds to one second of elapsed time, and each gridline along the vertical axis corresponds to 4 m/s of speed. The car is observed to be at position  $\vec{x}_i = \langle -4.0 \text{ m} \rangle$  at time  $t = 0$ .

Question value 4 points

(5) Where will the car be located at the very end of the time interval displayed in the graph?

- (a)  $\vec{x}_f = \langle +6.0 \text{ m} \rangle$
- (b)  $\vec{x}_f = \langle +18.0 \text{ m} \rangle$
- (c)  $\vec{x}_f = \langle +10.0 \text{ m} \rangle$
- (d)  $\vec{x}_f = \langle +14.0 \text{ m} \rangle$
- (e)  $\vec{x}_f = \langle +28.0 \text{ m} \rangle$



Question value 4 points

(6) What is the average acceleration of the car, during the full time interval displayed in the graph?

- (a)  $\vec{a} = \langle -3.0 \text{ m/s}^2 \rangle$
- (b)  $\vec{a} = \langle +5.0 \text{ m/s}^2 \rangle$
- (c)  $\vec{a} = \langle +4.0 \text{ m/s}^2 \rangle$
- (d)  $\vec{a} = \langle 0 \rangle$
- (e)  $\vec{a} = \langle +7.0 \text{ m/s}^2 \rangle$