Name: _____ Total Points: _____
(Last) (First)

## Multiple choice questions [70 points]

Answer all of the following questions. Read each question carefully. **Fill the correct bubble on your scantron sheet**. Each question has exactly one correct answer. All questions are worth the same amount of points.

**1.** A car starts from point A, goes 50 km in a straight line to point B, immediately turns around, and returns to A. The time for this round trip is 2 hours. The magnitude of the average velocity of the car for this round trip is:

**A.** **0 km/h** $\vec{v}_{avg} = \frac{\Delta \vec{r}}{\Delta t}$ **and** $\Delta \vec{r} = 0$

**B.** **50 km/h**

**C.** **100 km/h**

**D.** **200 km/h**

**E.** Cannot be calculated without knowing the acceleration

**2.** Still referring to the situation described in the previous question, what is the average speed of the car?

**A.** **0 km/h**

**B.** **50 km/h** $speed = \frac{d}{\Delta t}$ **with d=100 km and** $\Delta t = 2\ hrs$

**C.** **100 km/h**

**D.** **200 km/h**

**E.** Cannot be calculated without knowing the acceleration

**3.** A ball rolls up a slope. At the end of 3 seconds its velocity is 20 cm/s; at the end of 8 seconds its velocity is 0 cm/s. What is the magnitude of the average acceleration (in $cm/s^2$) from the instant 3s to the instant 8s?

**A.** **2.5**

**B.** **4.0** $\vec{a}_{avg} = \frac{\Delta \vec{v}}{\Delta t}$**, thus** $\left|\vec{a}_{avg}\right| = \left|\frac{0-20}{8-3}\right| = 4\ cm\ /s^2$

**C.** **5.0**

**D.** **6.0**

**E.** **6.67**

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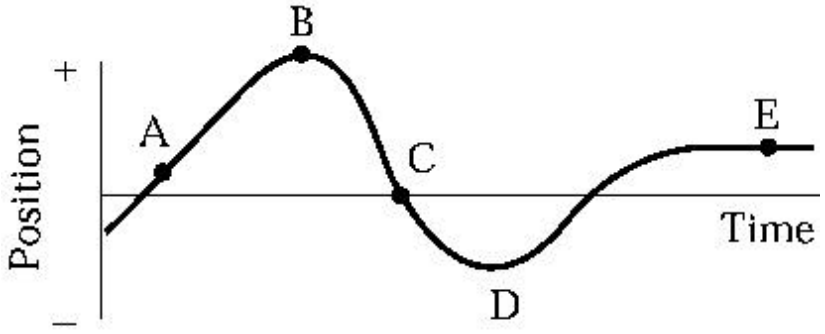
**4.** As a rocket is accelerating vertically upward at 9.8 m/s$^2$ near Earth's surface, it releases a projectile. Immediately after release the acceleration (in m/s$^2$) of the projectile is:

**A.** **`9.8 down`** since the projectile is free falling (it is no longer subjected to any force by the rocket).
**B.** **`0`**
**C.** **`9.8 up`**
**D.** **`19.6 up`**
**E.** None of the above

**5.**




An object moves along the horizontal axis as shown on the diagram. At which point or points is its acceleration zero?

**A.** C only
**B.** E only
**C.** B and D
**D.** A and E The acceleration is 0 when the position varies linearly with time ($x=vt+x_0$). On the graph, the acceleration is 0 wherever x(t) is a straight line.
**E.** B, D and E

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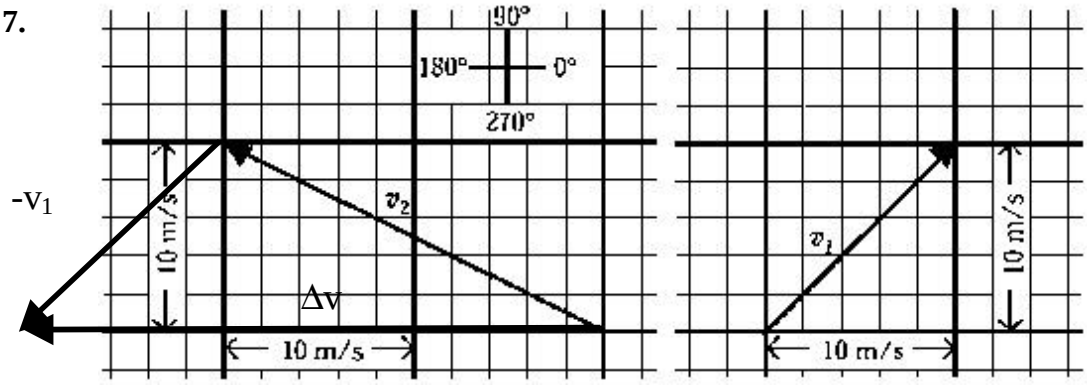
**6.** A particle initially moving at 4.0 m/s along the *x* axis is uniformly accelerated at 3.0 m/s$^2$ along the *y* axis for 2.0 s. The final speed of the particle is

**A.** **4.0 m/s**
**B.** **6.3 m/s**
**C.** **7.2 m/s** $\left.\begin{matrix} v_x = 4.0\ m/s \\ v_y = 3t \end{matrix}\right\} \Rightarrow v(t=2s) = \sqrt{v_x^2 + v_y^2} = \sqrt{4^2 + (3\times 2)^2}$
**D.** **8.4 m/s**
**E.** None of these is correct.

**7.**




The instantaneous velocity of a particle at $t_1$ is represented by $v_1$, and at $t_2$ by $v_2$. Each heavy graph division is 10 m/s on each side. Let $t_1$ = 1 s and $t_2$ = 7 s. Then the average acceleration of the particle between time $t_1$ and $t_2$ is

**A.** **18.2 m/s$^2$ at 0°**
**B.** **15.0 m/s$^2$ at 180°**
**C.** **6.06 m/s$^2$ at 98°**
**5.00 m/s$^2$ at 180°**
**D.** $\vec{a}_{avg} = \dfrac{\Delta\vec{v}}{\Delta t} = \dfrac{\vec{v}_2 - \vec{v}_1}{\Delta t}$
Construct Δv as indicated above
**E.** **3.03 m/s$^2$ at 98°**

Name: _____ Total Points: _____
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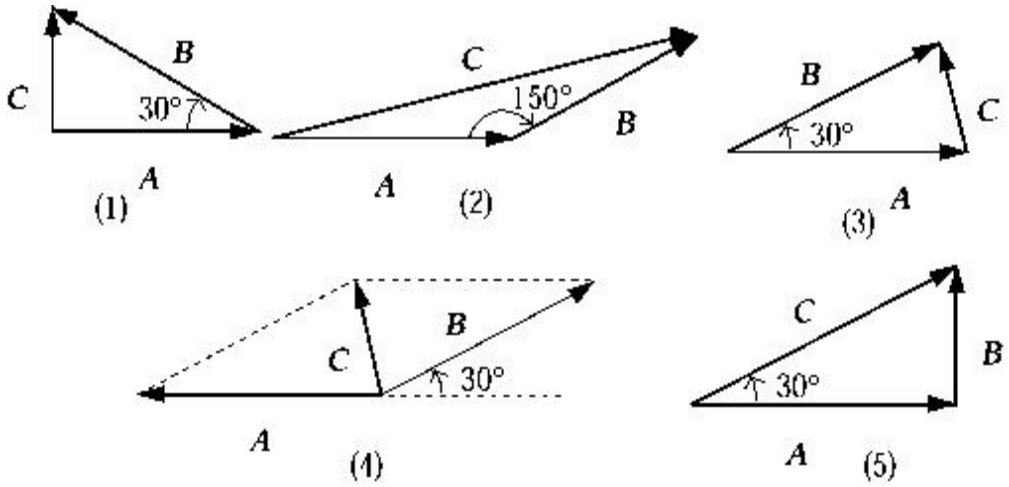
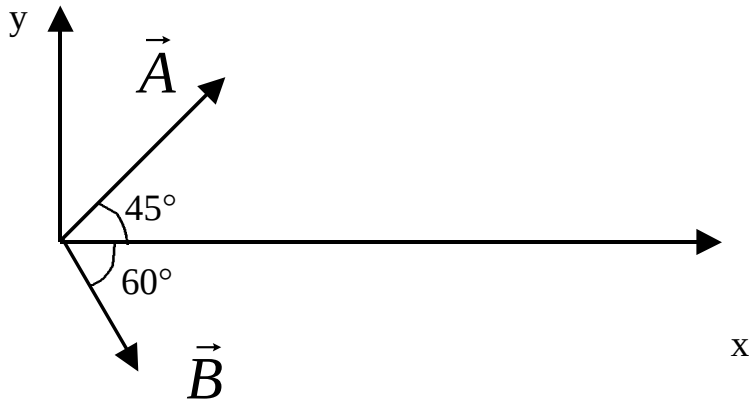
**8.**




The angle between vectors ***A*** and ***B*** is 30º, and their sum is ***C***. Which vector diagram correctly describes the vectors ***A***, ***B***, and ***C***?

**A.** **1**
**B.** **2**
**C.** **3**
**D.** **4**
**E.** **5**

**9.** In the diagram, $\vec{A}$ has magnitude 12 m and $\vec{B}$ has magnitude 8 m. The x component of $\vec{A}-\vec{B}$ is about




**A.** **1.56 m**
**B.** **4.0 m**
**C.** **4.5 m = 12cos(45)-8cos(60)**
**D.** **14.4 m**
**E.** **20 m**

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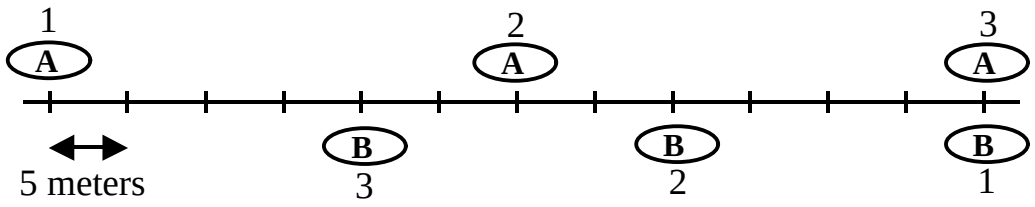
**10.** Two objects, A and B, move with <u>constant speed</u> relative to a straight line. The strobe diagram shows the positions of the objects at instant 1-3, separated by one-second time intervals. (Note that each tick mark on the diagram represents 5 meters.)




At instant 2 what is the direction of the instantaneous velocity of object A in the frame of reference of object B?

**A.** to the left
**B.** to the right (see next question)
**C.** Undefined: the velocity is zero

**11.** Still referring to the problem of the previous question, at instant 2, what is the magnitude of the instantaneous velocity of object A in the frame of reference of object B?

**A.** 0 m/s
**B.** 10 m/s
**C.** 20 m/s
**D.** 30 m/s
**E.** 50 m/s

Since the velocities are constant, instantaneous and average velocities are equal. Compute the average velocity between for instance instant $t_1$ and instant $t_2$

$$\vec{v}_{A/B} = \frac{\vec{r}_{A/B}(t_2) - \vec{r}_{A/B}(t_1)}{t_2 - t_1} = \frac{(-2\times 5)\hat{x} - (-12\times 5)\hat{x}}{1} = 50 m/s\ \hat{x}$$

where $\hat{x}$ is a unit vector directed to the right.

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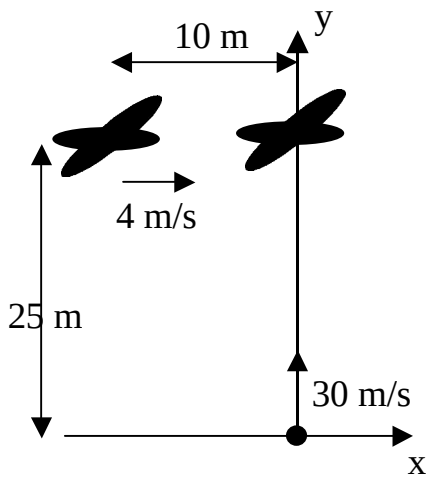
**12.** A girl on a merry-go-round moves horizontally in a circle at constant speed. She travels one fourth of a revolution , a distance of 25m along the circumference of the circle, in 5.0s. The magnitude of her acceleration is

**A.** 0.31 m/s$^2$
**B.** 1.3 m/s$^2$
**C.** 1.6 m/s$^2$ $a = \frac{v^2}{R} = \frac{(25/5)^2}{\frac{25}{p/2}} = p/2$
**D.** 3.9 m/s$^2$
**E.** 6.3 m/s$^2$

Name: _____ Total Points: _____
(Last) (First)

# PROBLEM [40 points]




A boy hurls a stone with a sling shot at a flying line of Canada geese. The stone is thrown at 30m/s vertically upward exactly when the first of the line of geese is overhead (t=0). The geese fly 4m/s, 10 m apart at an altitude of 25m (counted from the position of the stone at t=0). Take g=10 m/s$^2$

1). [10 pts] If the boy misses the geese, when does the stone reach its maximum height?

The velocity is 0 at t such that

$v = -10t + 30 \Rightarrow t = 3s$

2). [15 pts] When does the stone cross the path of the geese (make sure that you count all possible crossings)?

Solve y=25m for t

$-\frac{1}{2}\times 10t^2 + 30t = 25 \Rightarrow t = 1s \; and \; t = 5s$

3). [15 pts] Does the stone hit a goose; if so which one (first goose is #1)?

The position of goose n is given by

$x_n = 4t - 10(n-1)$

To be hit the goose crosses the path of the stone ($x_n$=0) at t=1s or at t=5s

at t=1s, $x_n$=0$\Rightarrow n = \frac{14}{10}$, no goose is hit since n must be an integer

at t=5s, $x_n$=0$\Rightarrow n = \frac{30}{10} = 3$, goose **3** is hit.