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. $0 \text{ km/h}$  
B. $50 \text{ km/h}$  
C. $100 \text{ km/h}$  
D. $200 \text{ km/h}$  
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. $0 \text{ km/h}$  
B. $50 \text{ km/h}$  
C. $100 \text{ km/h}$  
D. $200 \text{ km/h}$  
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. $4.0$  
C. $5.0$  
D. $6.0$  
E. $6.67$
4. As a rocket is accelerating vertically upward at 9.8 m/s² near Earth's surface, it releases a projectile. Immediately after release the acceleration (in m/s²) 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+x₀). On the graph, the acceleration is 0 wherever x(t) is a straight line.
E. B, D and E
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 \(v_x = 4.0 \text{ m/s} \)  
\(v_y = 3t\) \(\Rightarrow v(t = 2s) = \sqrt{v_x^2 + v_y^2} = \sqrt{4^2 + (3 \times 2)^2}\)  
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\(^\circ\)  
B. 15.0 m/s\(^2\) at 180\(^\circ\)  
C. 6.06 m/s\(^2\) at 98\(^\circ\)  
5.00 m/s\(^2\) at 180\(^\circ\)  
D. \(\ddot{a}_{avg} = \frac{\Delta \dot{v}}{\Delta t} = \frac{\dot{v}_2 - \dot{v}_1}{\Delta t}\)  
Construct \(\Delta v\) as indicated above  
E. 3.03 m/s\(^2\) at 98\(^\circ\)
The angle between vectors \( \mathbf{A} \) and \( \mathbf{B} \) is 30º, and their sum is \( \mathbf{C} \). Which vector diagram correctly describes the vectors \( \mathbf{A} \), \( \mathbf{B} \), and \( \mathbf{C} \)?

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

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

A. 1.56 m 
B. 4.0 m
C. 4.5 m = 12\cos(45) - 8\cos(60)
D. 14.4 m 
E. 20 m
10. Two objects, A and B, move with constant speed 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.
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/s²
B. 1.3 m/s²
C. 1.6 m/s²  \[ a = \frac{v^2}{R} = \frac{(25/5)^2}{25} = \frac{\pi}{2} \]
D. 3.9 m/s²
E. 6.3 m/s²
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/s²

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
\[ -\frac{1}{2} \times 10t^2 + 30t = 25 \Rightarrow t = 1s \text{ and } t = 5s \]

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}, \text{ no goose is hit since n must be an integer} \]

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