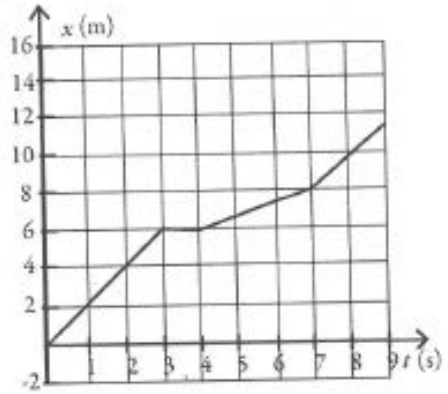
Part 1. Multiple Choice Questions (4 pts each)

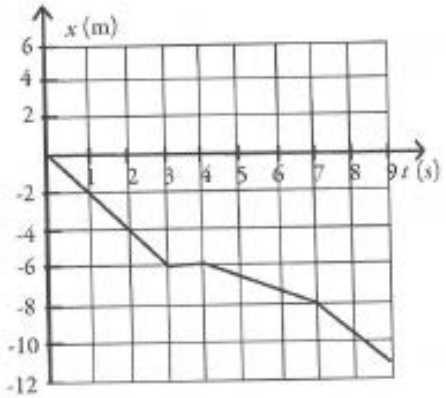
1) If a tree is 15 m tall, its height expressed in feet is x ft, where x is
   A) less than 15.
   B) greater than 15.

2) An object starts its motion with a constant velocity of 2.0 m/s toward the east. After 3.0 s, the object stops for 1.0 s. The object then moves toward the west a distance of 2.0 m in 3.0 s. The object continues traveling in the same direction, but increases its speed by 1.0 m/s for the next 2.0 s. Which graph below could represent the motion of this object?

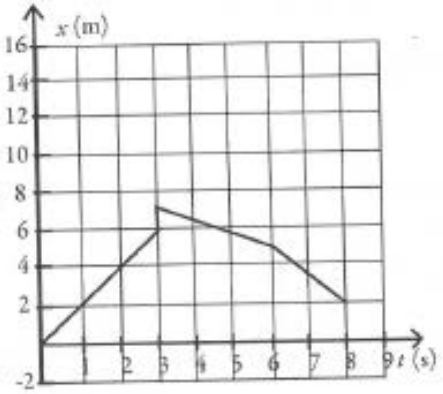
A)



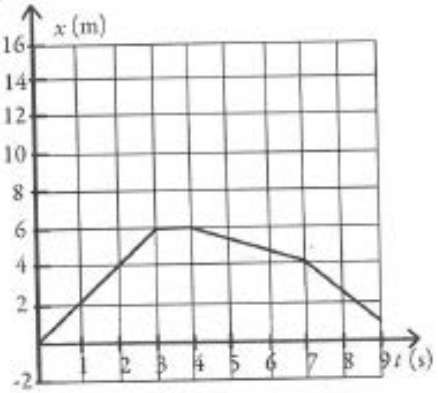
B)



C)



D)



3) If $A > B$, under what condition is $|\vec{A} - \vec{B}| = A - B$?
   A) Vectors $\vec{A}$ and $\vec{B}$ re in perpendicular directions.
   B) The statement is never true.
   C) Vectors $\vec{A}$ and $\vec{B}$ are in opposite directions.
   D) Vectors $\vec{A}$ and $\vec{B}$ are in the same direction.
   E) The statement is always true.

4) If the eastward component of vector $\vec{A}$ is equal to the westward component of vector $\vec{B}$, and their northward components are equal. Which one of the following statements about these two vectors is correct?

A) The magnitude of vector $\vec{A}$ is equal to the magnitude of vector $\vec{B}$.

B) Vectors $\vec{A}$ and $\vec{B}$ point in opposite directions.

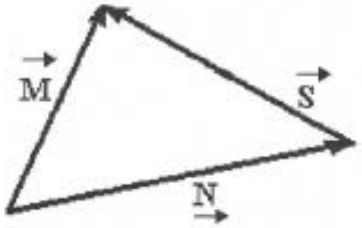
C) The magnitude of vector $\vec{A}$ is twice the magnitude of vector $\vec{B}$.

D) Vector $\vec{A}$ is perpendicular to vector $\vec{B}$.

E) Vector $\vec{A}$ is parallel to vector $\vec{B}$.

Part II: Short Answer (6 pts each)

5) For the vectors shown in the figure, express vector $\vec{S}$ in terms of vectors $\vec{M}$ and $\vec{N}$.



$\vec{N} + \vec{S} = \vec{M}$

So $\vec{S} = \vec{M} - \vec{N}$

Answer $\vec{M} - \vec{N}$

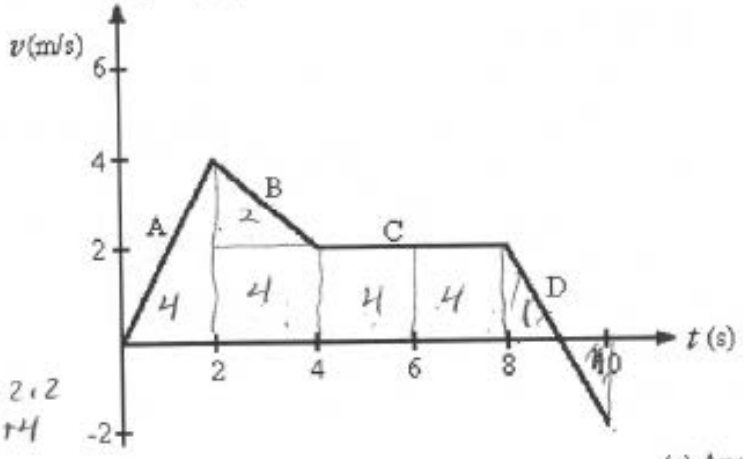
6) The following exact conversion equivalents are given: 1 m = 100 cm, 1 in = 2.54 cm, and 1 ft = 12 in. If a computer screen has an area of 1.27 ft^2, find the area in m^2.

$$1.27\ ft^2 \times \left(\frac{12\ in}{ft}\right)^2 \times \left(\frac{2.54\ cm}{1\ in}\right)^2 \times \left(\frac{1\ m}{100\ cm}\right)^2 = 0.118\ m^2$$

Answer $0.118\ m^2$

Part III: Problems. (12 pts each). Be sure to show your work to receive full credit. Write your answers in the spaces provided, including appropriate units. Note: The space given does not necessarily indicate the difficulty or complexity of the problem.

7) The figure shows a graph of the velocity as a function of time for a basketball player traveling up and down the court in a straight-line path. for the 10 s shown on the graph, find
(a) the net displacement of the player.
(b) the total distance run by the player.



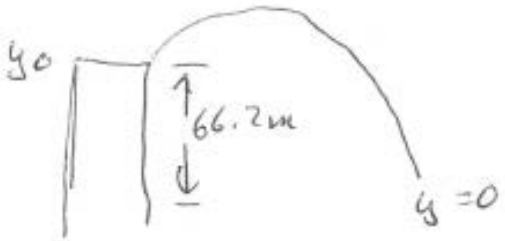
Displacement =
$\frac{1}{2}(4 \cdot 2) + \frac{1}{2}(2 \cdot 2) + 2 \cdot 2 + 2 \cdot 2 + 2 \cdot 2 = 4 + 2 + 4 + 4 + 4$
$= 18$

(a) Answer 18 m

Distance $= 4 + 2 + 4 + 4 + 4 + 1 + 1 = 20$

(b) Answer 20 m

8) A rock is thrown directly upward from the edge of the roof of a building that is 66.2 meters tall. The rock misses the building on its way down, and is observed to strike the ground 4.00 seconds after being thrown. Neglect any effects of air resistance. With what speed was the rock thrown?



$y = y_0 + v_0 \Delta t + \frac{1}{2} g t^2$

$v_0 = \frac{y - y_0 + \frac{1}{2} g \Delta t^2}{\Delta t}$

$= \frac{-66.2 + \frac{1}{2}(9.8)(4s)^2}{4} = 3.05 \text{ m/s}$

Answer 3.05 m/s

9) A toy rocket is launched vertically from ground level ($y = 0.00$ m), at time $t = 0.00$ s. The rocket engine provides constant upward acceleration during the burn phase. At the instant of engine burnout, the rocket has risen to 72 m and acquired a velocity of 30 m/s. The rocket continues to rise in unpowered flight, reaches maximum height, and falls back to the ground with negligible air resistance. What is the speed of the rocket upon impact?

Height gained while coasting

$2(-9.8)(\Delta y) = 0 - (30\,m/s)^2$

$\Delta y = \dfrac{-(30\,m/s)^2}{2(-9.8)} = 45.92\,m$

Total height $= (72 + 45.92)\,m = 117.92\,m$

At max height, $V_0 = 0$

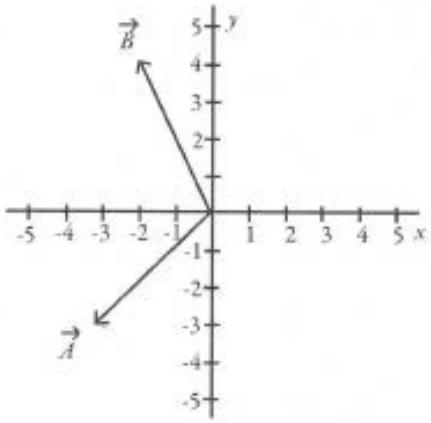
$2(-g)(-117.92\,m) = V^2$

$V = \sqrt{2(9.8)(117.92)}$

$= 48.07\,m/s$

Answer 48.07 m/s

10) Vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. What is $\left|-5.00\,\vec{A} + 4.00\,\vec{B}\right|$?



$\vec{A} = -3\hat{i} - 3\hat{j}$

$\vec{B} = -2\hat{i} + 4\hat{j}$

$-5\vec{A} = 15\hat{i} + 15\hat{j}$

$4\vec{B} = -8\hat{i} + 16\hat{j}$

$-5\vec{A} + 4\vec{B} = 7\hat{i} + 31\hat{j}$

$|-5\vec{A} + 4\vec{B}| = \sqrt{7^2 + (31)^2}$

$= 31.8$

Answer 31.8

11) Vector $\vec{A} = 1.00\,\hat{i} + -2.00\,\hat{j}$ and vector $\vec{B} = 3.00\,\hat{i} + 4.00\,\hat{j}$. What are the magnitude and direction of vector $\vec{C} = \vec{A} + \vec{B}$?

$\vec{A} + \vec{B} = 4\hat{i} + 2\hat{j}$

$|\vec{A} + \vec{B}| = \sqrt{4^2 + 2^2}$

$= \sqrt{20}$

$= 4.47$

$\tan\theta = \frac{2}{4}$

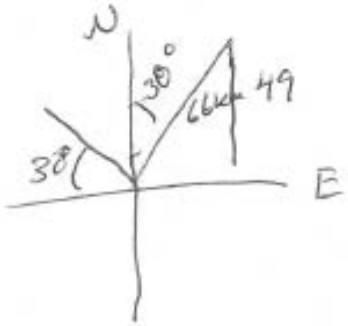
$\theta = \text{atan}\left(\frac{1}{2}\right)$

$= 26.6^\circ$

Magnitude 4.47

26.6 ° counterclockwise from the positive x axis

12) An airplane undergoes the following displacements: First, it flies 66 km in a direction 30° east of north. Next, it flies 49 km due south. Finally, it flies 100 km 30° north of west. Using vector components, determine how far the airplane ends up from its starting point.



$\vec{A} = 66\left(\cos(60)^\circ \hat{i} + \sin 60\,\hat{j}\right)$

$\vec{B} = -49\,\hat{j}$

$\vec{C} = 100\left(-\cos(30)\,\hat{i} + \sin(30)\,\hat{j}\right)$

$\vec{A} + \vec{B} + \vec{C} = -53.6\,\hat{i} + 58.16\,\hat{j}$

$|\vec{A} + \vec{B} + \vec{C}| = \sqrt{(53.6)^2 + (58.16)^2}$

$= 79.1$ km

Answer 79.1 km