PH 1110 Summary Homework 1

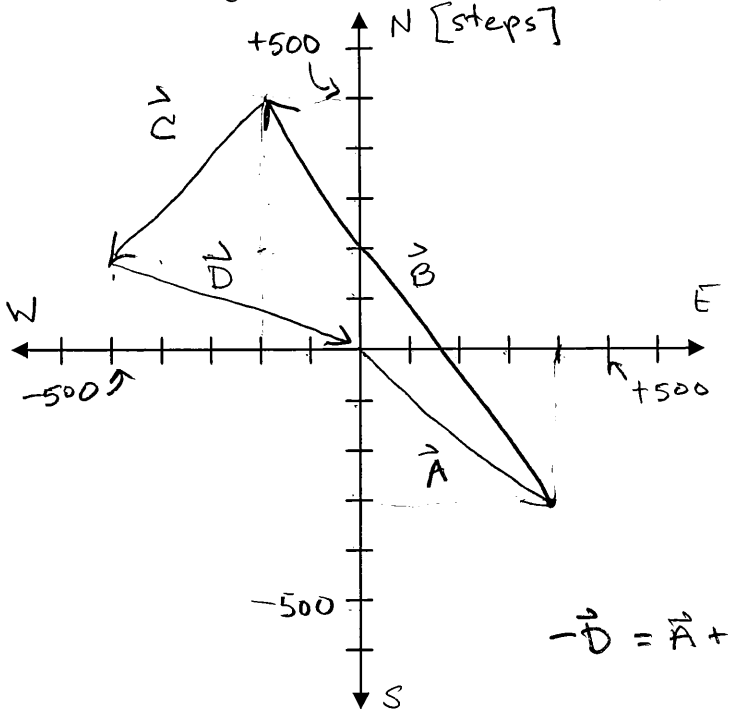
Name Solutions **Section Number** _____

This assignment assesses your readiness for Exam 1. Solutions will be available on-line.

1a. During orientation a new student is given instructions for a treasure hunt:

A: Walk 500 steps at angle -36.9°.
B: Turn to angle +126.9° and walk 1000 steps.
C: Turn to face Southwest and walk 424 steps to find the treasure.

On the graph below, sketch vectors that represent items **A**, **B**, and **C**, assuming the student started from the origin. Label them. Also label the axes (E, N, W, S) and scales (number of steps).



1b. What is the vector **D** representing the displacement that the student must take to return to the starting point? Sketch it on the graph, and express it in both **i, j**, notation and as a magnitude and angle with respect to East, measured counter-clockwise. Place your latter two answers in the boxes below.

$\vec{A} = 500\,(\cos(-36.9°)\hat{\imath} + \sin(-36.9°)\hat{\jmath})$ steps
$= (+400\hat{\imath} - 300\hat{\jmath})$ steps
$\vec{B} = 1000\,(\cos(126.9°)\hat{\imath} + \sin(126.9°))$s
$= (-600\hat{\imath} + 800\hat{\jmath})$s
$\vec{d} = 424\,(\cos 225°\,\hat{\imath} + \sin 225\hat{\jmath})$s
$= (-300\hat{\imath} - 300\hat{\jmath})$s
$-\vec{D} = \vec{A} + \vec{B} + \vec{C} = (-500\hat{\imath} + 200\hat{\jmath})$s

D = $(500\hat{\imath} - 200\hat{\jmath})$ steps

$|\vec{D}| = \sqrt{500^2 + 200^2}$ steps $= 539$ steps

$\tan\theta = \frac{-200}{500} \Rightarrow \theta = -21.8°$

D = 539 steps, ∠-21.8

1c. Express the direction of **D** as a unit vector in **ijk** notation to three significant digits. What is the magnitude of the unit vector? Put your answers in the appropriate boxes.

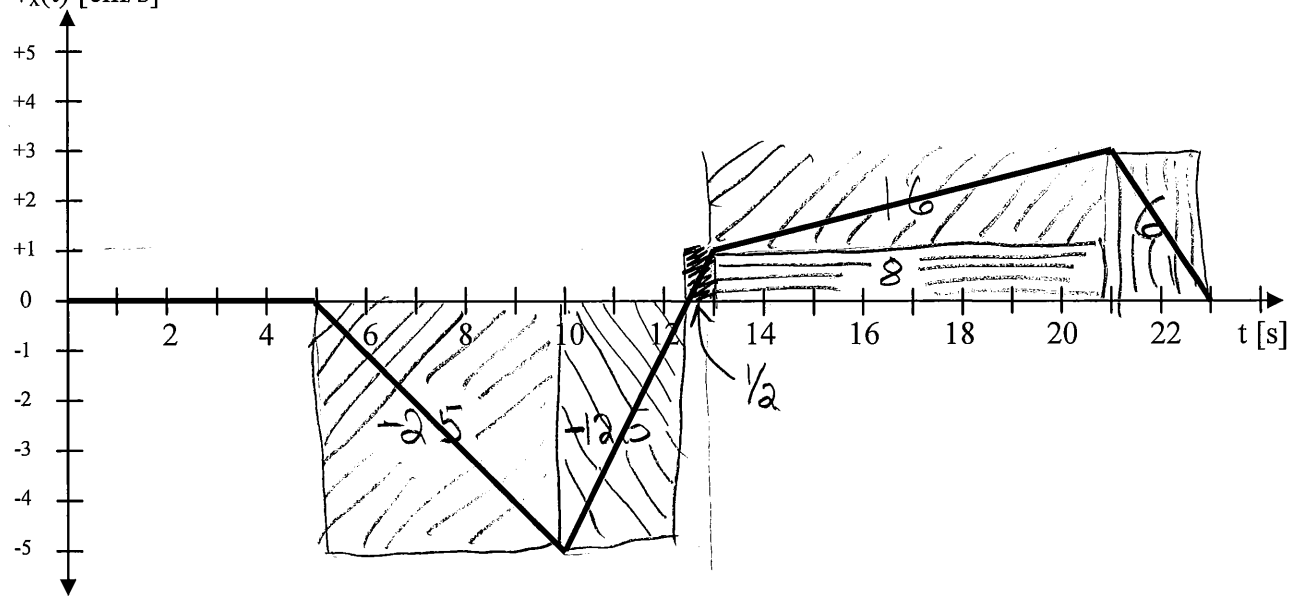
$\hat{D} = \left(\frac{500\hat{\imath} - 200\hat{\jmath}}{539}\right)\frac{\text{steps}}{\text{steps}}$

$\hat{\mathbf{D}}$ = $0.928\hat{\imath} - 0.371\hat{\jmath}$

$|\hat{\mathbf{D}}|$ = 0.999 steps (In principle, exactly 1)

Summary Homework 1, continued. **Initials** _____ **Section Number** _____

2. You make the following measurement of $v_x(t)$ of a cart on a track during Lab 1: end points stop start at integers



2a. What is $a_x(t)$ at 2 s, 8 s, 12 s, 16 s, and 22 s?

a_x: slopes of v_x curve

$a_x(2) =$ 0

$a_x(8) =$ -1

$a_x(12) =$ $+2$

$a_x(16) =$ $+1/4$

$a_x(22) =$ $-3/2$

$\frac{cm}{s^2}$

2b. What is the displacement of the cart during the time intervals 0-5 s, 5-10 s, 10-13 s, 13-21 s, 21-23 s?

Δx = area under curve

Δx (0-5) = 0

Δx (5-10) = -12.5

Δx (10-13) = -6

Δx (13-21) = $+16$

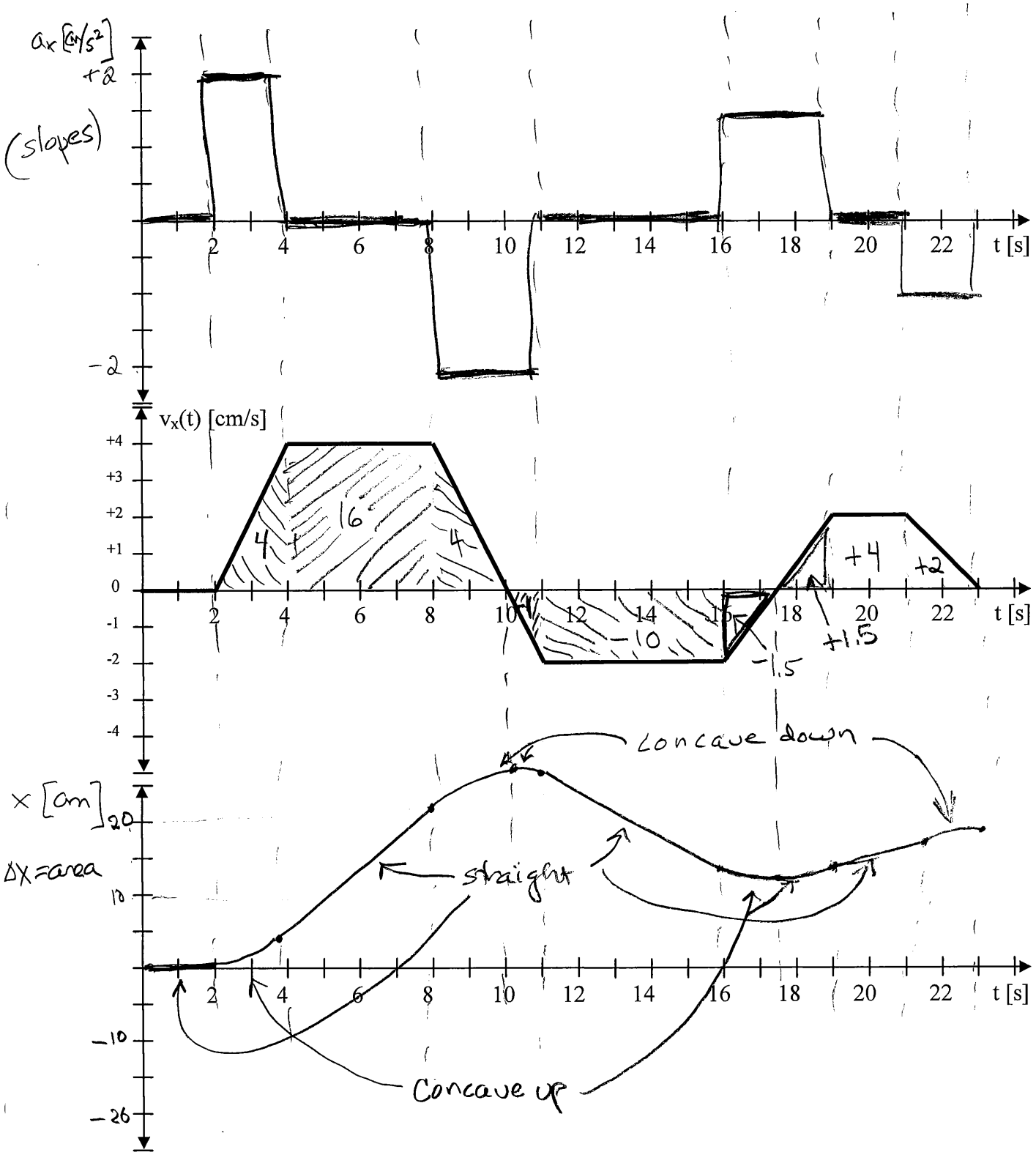
Δx (21-23) = $+3$

cm

2c. Assuming that the cart started at position $x_0 = 0$ cm, what is its position at t = 23 s?

$x(23) =$ 0.500 cm

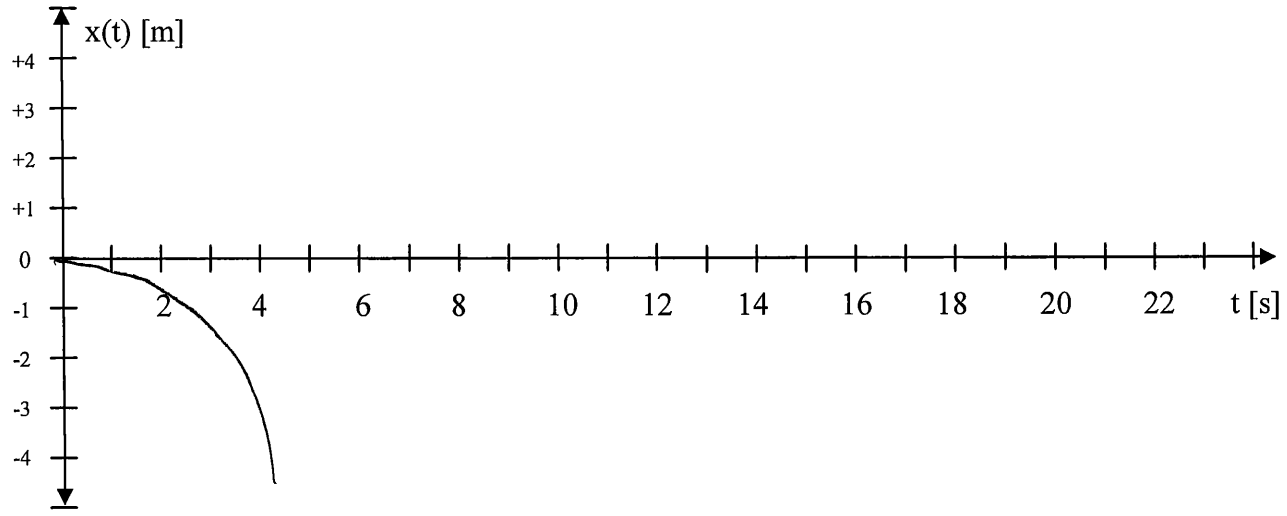
3. You measure $v_x(t)$ of a cart on a track during Lab 2, but for some reason, the x(t) and $a_x(t)$ data are not recorded. Sketch x(t) and $a_x(t)$, given the $v_x(t)$ data below. Its initial position, x(0), is 0 cm. Be sure to label and scale the y-axes. The endpoints of the straight lines in the $v_x(t)$ graph start and end at integers.



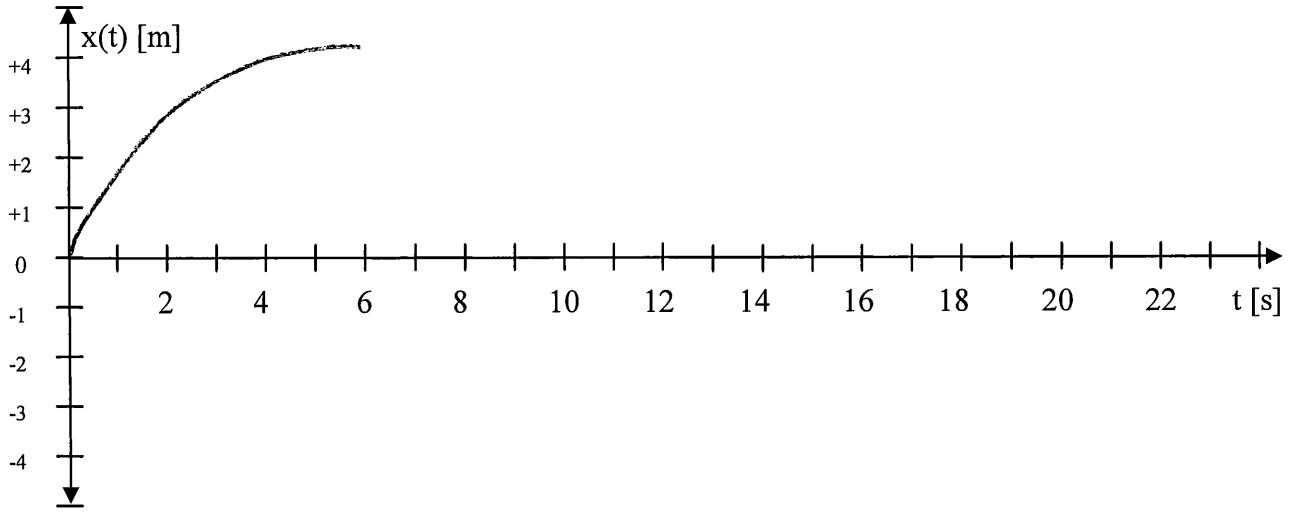
4a. Logger Pro tells you that the slope of an x-position curve is $v_x =$ (0.167 ± 0.004) m/s
(0.16657 ± 0.0038250) m/s. Write this velocity component in standard form.

4b. Logger Pro tells you that the slope of an x-velocity curve is $a_x =$ (0.108 ± 0.018) m/s²
(0.10835 ± 0.017598) m/s/s. Write this acceleration component in standard form.

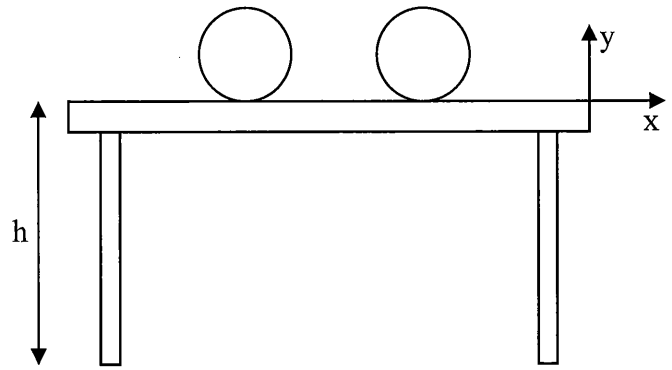
4c. Sketch an x(t) curve, starting from t = 0, for which the object's velocity and acceleration are both negative.



4d. Sketch an x(t) curve, starting from t = 0, for which the object's velocity is positive and acceleration is negative.



5 Two balls lie on top of a horizontal table of height h. The coordinate system is as shown. The magnitude of gravitational acceleration is g. There is no significant air resistance.



5a. One ball is given a gentle nudge, such that it rolls very slowly to the edge of the table and falls off. If t = 0 corresponds to the moment it begins its descent, at what time t_1 does it hit the ground?

$-h = -\frac{1}{2}gt_1^2$

$t_1 =$ $\sqrt{\frac{2h}{g}}$

5b. The other ball is given a good shove, such that it rolls quickly to the edge of the table with velocity $\mathbf{v} = v_0\,\mathbf{i}$, then falls off. If t = 0 corresponds to the moment it begins its descent, at what time t_2 does it hit the ground?

$-h = -\frac{1}{2}gt^2$

$t_2 =$ $\sqrt{\frac{2h}{g}}$

5c. If g is measured in units of cm/(μs)^2, and h is measured in centimeters, what is the unit of t?

$\sqrt{\frac{cm}{\frac{cm}{(\mu s)^2}}}$

Unit = μs

5d. Give the position **r** of the second ball's impact with the ground. Use only the known variables h, g, and v_0 in your answer.

$\vec{r} = v_0 t_2 \hat{\imath} - h\hat{\jmath}$

r = $v_0\sqrt{\frac{2h}{g}}\,\hat{\imath} - h\hat{\jmath}$

5e. If the first ball started at position $\mathbf{r}_0 = -x_0\,\mathbf{i}$, what is the distance d and displacement **d** initial - final position. Use only the known variables h, g, v_o, and x_o in your answers.

$|\vec{d}| = \sqrt{x_0^2 + h^2}$

$\vec{d} = x_0\hat{\imath} - h\hat{\jmath}$

d = $\sqrt{x_0^2 + h^2}$

d = $x_0\hat{\imath} - h\hat{\jmath}$

5f. Of the five variables t_1, t_2, **r**, d and **d**, which are vectors and which are scalars?

Vectors: $\vec{r}, \vec{d}$ Scalars: t_1, t_2, d

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

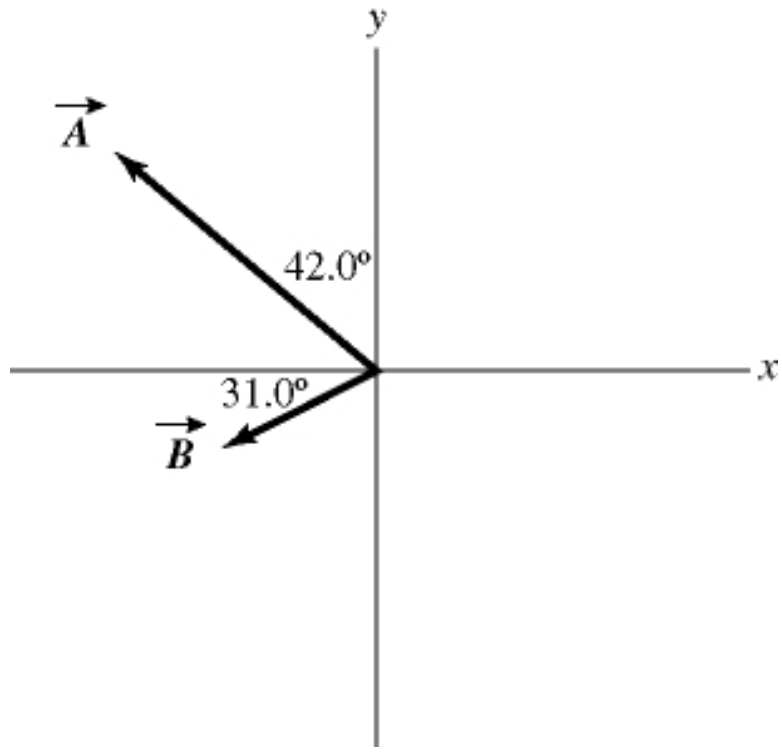
1) What is $\frac{0.674}{0.74}$ to the proper number of significant figures? 1) D

A) 0.9 B) 0.911 C) 0.9108 D) 0.91

2) 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, this area is closest to 2) B

A) 0.0465 m^2.
B) 0.118 m^2.
C) 0.00284 m^2.
D) 4.65 m^2.
E) 0.284 m^2.

3) Vectors $\vec{A}$ and $\vec{B}$ are shown in the figure. Vector $\vec{C}$ is given by $\vec{C} = \vec{B} - \vec{A}$. The magnitude of vector $\vec{A}$ is 16.0 units, and the magnitude of vector $\vec{B}$ is 7.00 units. What is the magnitude of vector $\vec{C}$? 3) A



A) 16.2 B) 17.5 C) 9.00 D) 9.53 E) 15.5

4) You walk 53 m to the north, then turn 60° to your right and walk another 45 m. Determine the direction of your displacement vector. Express your answer as an angle relative to east. 4) A

A) 63° N of E B) 50° N of E C) 69° N of E D) 57° N of E

5) The position of an object as a function of time is given by $x = bt^2 - ct$, where b = 2.0 m/s^2 and c = 6.7 m/s, and x and t are in SI units. What is the instantaneous velocity of the object when t = 2.2? 5) D

A) 2.3 m/s B) 1.7 m/s C) 2.7 m/s D) 2.1 m/s

6) A car accelerates from 10.0 m/s to 30.0 m/s at a rate of 3.00 m/s^2. How far does the car travel while accelerating? 6) C

A) 399 m B) 226 m C) 133 m D) 80.0 m

7) A package is dropped from a helicopter moving upward at 15 m/s. If it takes 16.0 s before the package strikes the ground, how high above the ground was the package when it was released if air resistance is negligible? 7) B

A) 1500 m B) 1000 m C) 1200 m D) 810 m

8) An electron moves with a constant horizontal velocity of 3.0×10^6 m/s and no initial vertical velocity as it enters a deflector inside a TV tube. The electron strikes the screen after traveling 17.0 cm horizontally and 40.0 cm vertically upward with no horizontal acceleration. What is the constant vertical acceleration provided by the deflector? (The effects of gravity can be ignored.) 8) C

A) 1.4×10^4 m/s^2 B) 1.2×10^{14} m/s^2 C) 2.5×10^{14} m/s^2 D) 8.3×10^2 m/s^2