#18

Name (PRINT): Solution

Seat Assignment: ZEC_____ : _____

Specify your **EXAM ID** on the right. Use 000 if you do not know your exam ID.

Circle your LAB SECTION

	ZEC 270	ZEC 278
9:45 am	**B270 McKensie**	**B278 Matthew**
11:20 am	**C270 McKensie**	**C278 Katy**
12:55 pm	**D270 Matthew**	**D278 Katy**
2:30 pm	**E270 McKensie**	**E278 Katy**

		[ ]
0 ○	0 ○	0 ○
1 ○	1 ○	1 ○
2 ○	2 ○	2 ○
3 ○	3 ○	3 ○
4 ○	4 ○	4 ○
5 ○	5 ○	5 ○
6 ○	6 ○	6 ○
7 ○	7 ○	7 ○
8 ○	8 ○	8 ○
9 ○	9 ○	9 ○

Instructions

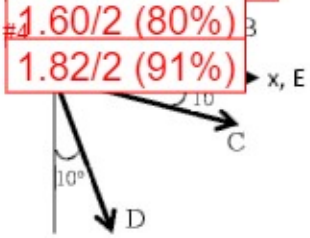
- Sit in your assigned seat.
- Do not open the exam until instructed to do so.
- **Completely color in the dot for your chosen answers on multiple choice.**
- When time is called, immediately stop writing, close your exam booklet, remain seated, and TAs will be around to pick up the exam.
- Working after time is called will be considered academic dishonesty.
- Turn your equation sheet and note card in at the end of the exam.
- You will have 75 minutes to complete the exam.

Guidelines

- **Assume 3 significant figures** for all given numbers unless otherwise stated
- **Show all of your work – no work, no credit**
- Any equation uses must first be written in symbolic form before substituting in values.
- Equations on provided reference sheet are the **only** equations that can be assumed true without any derivations.
- Write your final answer in the box provided
- Include units for all answers and directions for all vectors

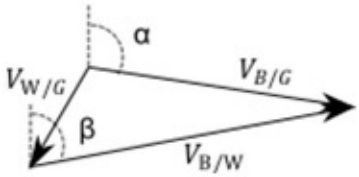
1-4 (2 pt each) Match each quantity with its correct direction. (answers can be used multiple times)

#1 1.61/2 (80.5%)
#2 1.91/2 (95.5%)
#3 1.60/2 (80%)
#4 1.82/2 (91%)



	10° N of E	10° N of W	10° E of S	10° W of S	350° CCW x-axis	80° CCW x-axis
A	○	○	○	○	○	●2
B	●2	○	○	○	○	○
C	○	○	○	○	●2	○
D	○	○	●2	○	○	○

5. (2 pt) In the vector diagram to the right, angle β is _____ angle α



#5 1.35/2 (67.5%)

Greater Than	Less Than	Equal To	Need more information to determine
○	●2	○	○

6. (2 pt) The x-component of vector $\vec{v} = (3\hat{\imath} + 7\hat{\jmath})m$ is

#6 1.93/2 (96.5%)

	$\hat{\imath}$	7	$\hat{\jmath}$
●2	○	○	○

7. (2 pt) On a velocity-time graph, the slope of the line represents _____.

#7 1.45/2 (72.5%)

	Velocity	Acceleration	Something else
○	○	●2	○

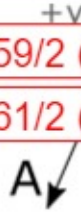
8. (2 pt) In Excel, a formula starts with

#8 1.99/2 (99.5%)

	= (equal)	$ (dollar sign)	((parenthesis)
○	●2	○	○

9-10 (2 pt each) What is the x-component (A_x) and the y component (A_y) of vector A?

#9 0.59/2 (29.5%)
#10 0.61/2 (30.5%)



	$\lvert A\rvert \sin\alpha$	$-\lvert A\rvert \sin\alpha$	$\lvert A\rvert \cos\alpha$	$-\lvert A\rvert \cos\alpha$	$\lvert A\rvert \tan\alpha$	$-\lvert A\rvert \tan\alpha$
A_x	○	○	●2	○	○	○
A_y	●2	○	○	○	○	○

#11 4.91/6 (81.8%)

formula =D$3 + D$4*(A1 – E$1) is entered in cell B1. If this formula were auto-filled down column B, write what the formula that would be displayed in cell B5:

$= D\$3 + D\$4 * (A5 - E\$1)$

+4 correct row numbers
+1 $ placement
+1 correct operators

#12 4.38/6 (73%)

= 5ft 7 in. Convert 0.8 smoot^2 to in^2 +1 ea. correct sq.

$$\frac{0.8\ \text{smoot}^2 \left|\left(5\tfrac{7}{12}\ \text{ft}\right)^2\right| (12\ \text{in})^2}{\left|(1\ \text{smoot})^2\right| (1\ \text{ft})^2} = 3591.2\ \text{in}^2 = \boxed{3590\ \text{in}^2}$$

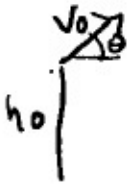
+2 final calculation with units
+2 Conversions
+2 both conversions squared
separate conversion ft -> in OK

#13 1.65/5 (33%)

ect is launched from a height of h_0 [ft] above the ground at a speed of v_0 [ft/s] and hits the ground t_1 seconds later. What angle θ [deg from horizontal] was the object launched at? Answer as a symbolic expression.

$$\theta = \sin^{-1}\left(\frac{-h_0 - \frac{1}{2}a t_1}{v_0 t_1}\right)$$

+1 final solution



$v_{0y} = v_0 \sin\theta$, $\Delta t = t_1$

$y_1 = h_0 + v_{0y}\Delta t + \frac{1}{2}a\Delta t^2$

+2 symbolic init. cond. eq.

$0 = h_0 + v_0 \sin\theta\, t_1 + \frac{1}{2}a t_1^2$

$v_0 \sin\theta\, t_1 = -h_0 - \frac{1}{2}a t_1^2$

$\sin\theta = \frac{-h_0 - \frac{1}{2}a t_1^2}{v_0 t_1} \Rightarrow \theta = \sin^{-1}(\cdots)$

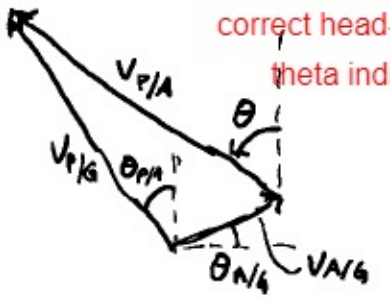
+2 complete algebra

#14 4.93/8 (61.6%)

14. (8 pts) Dr. Maczka is flying from Knoxville to Minneapolis, MN which is 792 mi at a bearing of 35 degrees W of N from Knoxville. The airplane has an airspeed of 350 mph and there is a wind blowing at 20 mph 30 degrees N of E. What direction (W of N) should the plane fly? Complete only the Represent and Organize steps for this problem. Use only symbols in representation, including all angles. Organization only requires relationships between symbols and values, no equations needed.

Representation:

+5 Correct/complete representation
labels for V_P/A, V_A/G, V_P/G
correct head-tail orientation
theta indicated correctly



Organization:

	mag	dir
$V_{P/A}$	350 mph	θ ∢
$V_{A/G}$	20 mph	30° ∠
$V_{P/G}$	?	35° ∢

+3 V_P/A, V_P/G, V_A/G symbol/value association

$V_{P/G} = V_{P/A} + V_{A/G}$

#15

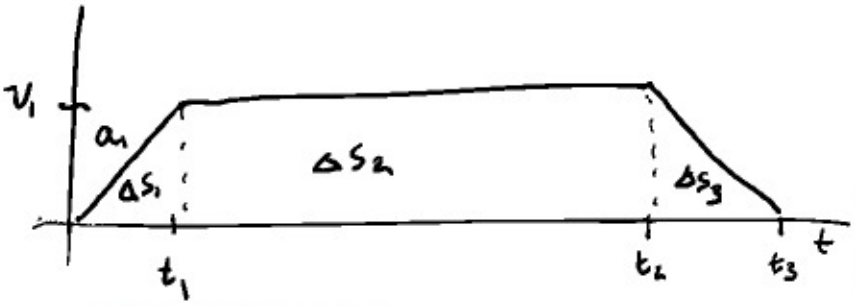
9.43/17 (55.5%)

is riding her bike from the Ag campus to ZEC. Starting from rest she accelerates at a constant rate of 5.5 ft/s^2 for 3.2 seconds. She continues at a constant speed for another 3 minutes. Pulling up to ZEC she slams on her breaks (deaccelerating at a constant rate) coming to a stop in 1.1 seconds just before crashing into Dr. McCave. What was the total distance she traveled?

+2 complete symbol/value

Representation:

+4 Complete with symbols



a1,v1,t1,t2,t3 symbols

Reasonable representation of a1,v, and times

No numbers

Organization:

+2 symbol/value association

$a_1 = 5.5\ ft/s^2$

$t_1 = 3.2\ s$

$t_2 - t_1 = 3\ min \left| \frac{60\ s}{1\ min} \right. = 180\ s$

$t_3 - t_2 = 1.1\ s$

$v_1 = v_0 + a\Delta t$ +2 acc. eq.

area $\Delta = \frac{1}{2} bh$

area $\square = lw$

distance = area under the curve

+3 complete area eqs.

OR complete dist. eqs

Calculations:

$v_1 = \cancel{v_0}^{0} + a_1 t_1$

$v_1 = 5.5\ ft/s^2\ 3.2\ s = 17.6\ ft/s$

distance $d = \Delta s_1 + \Delta s_2 + \Delta s_3$

$= \frac{1}{2} v_1 (t_1) + v_1 (t_2 - t_1) + \frac{1}{2} v_1 (t_3 - t_2)$

+3 complete symbolic distance eqs.

$= v_1 \left(\frac{1}{2} t_1 + (t_2 - t_1) + \frac{1}{2} (t_3 - t_2) \right)$

$= 17.6\ ft \left(\frac{1}{2} 3.2\ s + 180\ s + \frac{1}{2} 1.1\ s \right) = 3205.84\ ft$

$\simeq 3210\ ft$

+2 calculate v_1 and total distance

+1 answer w/ 3 sig. figs.

Answer:

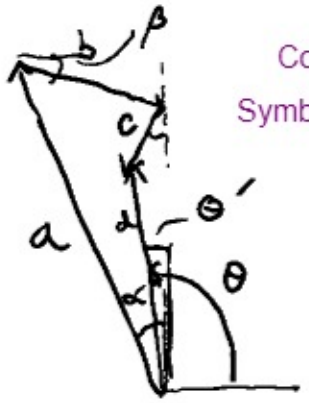
3210 ft

#16

8.37/17 (49.2%)

nd Katy start from the same location outside ZEC. Matthew walks 256 feet at a direction of 25 degrees West of North, then runs 128 feet at a direction of 32 degrees South of East, and finally skips 64 feet in the direction 10 degrees West of South. What direction (CCW from +x-axis) should Katy walk to go directly to Matthew's ending position?

Representation: +4 Correct Representation



All four vectors
Correct head-tail orientation

Symbolic labels all mag, directions

Organization: +3 Complete V1,V2,V3 info

	mag	dir	r_x	r_y
a	256	25° W	$-a\sin\alpha$	$a\cos\alpha$
b	128	32° S of E	$b\cos\beta$	$-b\sin\beta$
c	64	10° W of S	$-c\sin\gamma$	$-c\cos\gamma$

D θ D_x D_y

+1 Resultant angle, component symbolx

$r_x = \sum_{n=1}^{N} x_n$, $r_y = \sum_{n=1}^{N} y_n$

+2 symbolic theta

$\theta = \tan^{-1}\left(\frac{y}{x}\right)$ for θ ∠

$\theta = 90° + \theta'$

Calculations:

$D_x = -a\sin\alpha + b\cos\beta - c\sin\gamma$ +2 symbolic Dx

$= -256\sin 25 + 128\cos 32 - 64\sin 10$ +1 Dx calculation

$= -10.7536$

$D_y = a\cos\alpha - b\sin\beta - c\cos\gamma$ +2 symbolic Dy

$= 256\cos 25 - 128\sin 32 - 64\cos 10$

$= 101.1574$ +1 Dy calculation

$\theta' = \tan^{-1}\left(\frac{|D_x|}{|D_y|}\right) = \tan^{-1}\left(\frac{10.7536}{101.157}\right) = 6.069$ +1 theta calculation

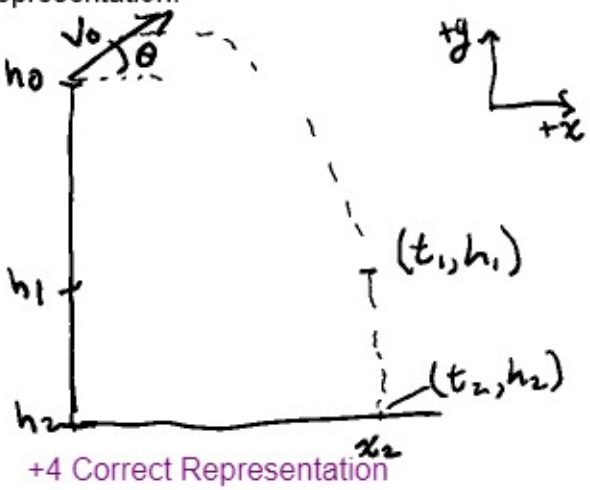
$\theta = 90 + 6.069 = 96.069 = 96.1°$ CCW from +x

Answer:

96.1° CCW from +x-axis

17. (21 pts) Dr. McCave launches a box of old EF141 exams at a speed of 1.8 m/s out her office window 10 meters from the ground. Exactly 1.387 seconds later, Mia sees it pass the Student Success office window at a height of 2 meters off the ground. How far from the building does the box land? Assume the ground is perfectly level and forms a right angle with the side of the building.

Representation:



+4 Correct Representation

correct symbolic representation of h0,h1,h2,v0,theta,t1,t2. no numbers.

Organization: +2 Value/symbol associations

$v_0 = 1.8$ m/s $h_1 = 2$m

$h_0 = 10$m $t_1 = 1.387$s

$t_0 = 0$ s $a = -g = -9.81\ m/s^2$

$y = y_0 + v_{0y}\Delta t + \frac{1}{2}a\Delta t^2$

$x = x_0 + v_{0x}\Delta t$ +2 proj. motion equations

$v_x = |v|\cos\theta$, $v_y = |v|\sin\theta$ ← 0

+2 vector comp. equations OR $c^2 = a^2 + b^2$

Calculations:

(1a) $\theta = ?$ see soln to #13

$$\sin\theta = \frac{\Delta h_1 - \frac{1}{2}a t_1^2}{v_0 t_1}$$ OR

$$\theta = \sin^{-1}\left(\frac{\Delta h_1 - \frac{1}{2}a t_1^2}{v_0 t_1}\right)$$

$\Delta h_1 = 2 - 10 = -8$

$$\theta = \sin^{-1}\left(\frac{-8 - \frac{-9.81}{2}(1.387)^2}{1.8(1.387)}\right) = 35.115$$

(1b) $v_{0y} = ?$

$h_1 = h_0 + v_{0y}t_1 + \frac{1}{2}a t_1^2$ OR

$v_{0y} t_1 = h_1 - h_0 - \frac{1}{2}a t_1^2$

$$v_{0y} = \frac{h_1 - h_0 - \frac{1}{2}a t_1^2}{t_1}$$

then find θ via $v_{0y} = v_0 \sin\theta$

$\theta = \sin^{-1}\left(\frac{v_{0y}}{v_0}\right)$

$v_{0x} = v_0 \sin\theta$

OR

skip θ, find v_{0x} via $v_0^2 = v_{0x}^2 + v_{0y}^2$

OR

$v_{0x}^2 = v_0^2 - v_{0y}^2$

$v_{0x} = \sqrt{v_0^2 - v_{0y}^2}$

(2) $t_2 = ?$ +3 v_0y, v_0x symbolic

$v_{0y} = v_0 \sin\theta$ +1 v_0y calc

$= 1.8 \sin(35.115) = 1.0353$

$y = h_2 = 0$, $y_0 = h_0$

$0 = h_0 + v_{0y}t_2 + \frac{1}{2}a t_2^2$ 0 = ... with "solver" OK

$$t_2 = \frac{-v_{0y} \pm \sqrt{v_{0y}^2 - 4\frac{1}{2}a h_0}}{2(\frac{1}{2}a)}$$ +2 t_2 symbolic

$= -1.3266$ or 1.5373

$t_2 = 1.5373$ +1 t_2 calculation

(3) $x_2 = ?$

$v_{0x} = v_0 \cos\theta = 1.8\cos(35.115) = 1.4724$ +1 calculate v_0x

$x_0 = 0$, $x = x_2$, $\Delta t = t_2$

$x_2 = x_0 + v_{0x}t_2$

$= 1.472 \cdot 1.5373 = 2.2635 = 2.26$ m +1 x_2 calculation

+2 x_2 symbolic

Answer: 2.26 m