PHYS 211 Fall 2013 9:30AM Test #1 Name: KEY

1. Define speed, express its SI unit, and state whether it is a vector or scalar.

Speed = $\frac{\text{distance}}{\text{time}}$; m/s ; Scalar.

2. Define acceleration, express its SI unit, and state whether it is a vector or scalar.

Acceleration is the rate of change in velocity. $a = \frac{\Delta v}{\Delta t}$

m/s^2 ; Vector.

3. A particle moving along the x axis has a position (in meters) given by $x = 2t^3 - 4t + 3$, where t is in seconds. a. Find the time at which the particle momentarily stops?

b. What is the position and acceleration when the particle momentarily stops?

a. $x = 2t^3 - 4t + 3$

$v = \frac{dx}{dt} = 6t^2 - 4$

Momentarily stops

$v = 0$

$6t^2 - 4 = 0$

$t^2 = \frac{4}{6} = \frac{2}{3}$

$\boxed{t = 0.82 \text{ sec}}$

b. $x = 2t^3 - 4t + 3$

$= 2(0.82)^3 - 4(0.82) + 3$

$\boxed{x = 0.80 \text{ m}}$

b. $a = \frac{dv}{dt} = \frac{d}{dt}(6t^2 - 4) = 12t$

$\boxed{a = 9.84 \text{ m/s}^2}$

4. An airport terminal has a moving sidewalk to speed passengers through a long corridor. Larry does not use the moving sidewalk; he takes 150 s to walk through the corridor. Curly, who simply stands on the moving sidewalk, covers the same distance in 70 s. Moe boards the sidewalk and walks along it. How long does Moe take to move through the corridor? Assume that Larry and Moe walk at the same speed.

Length of Corridor = L (m)

Larry

speed of Larry = $\frac{L}{150}$ m/s

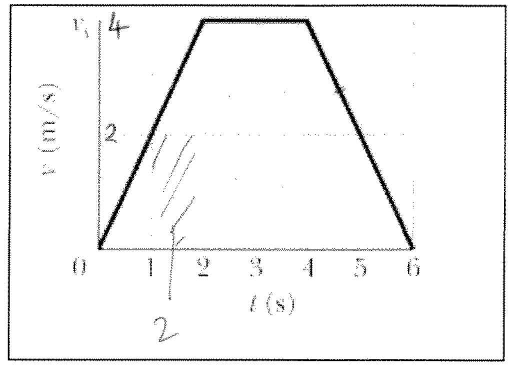
speed of Sidewalk = $\frac{L}{70}$ m/s

Speed of Moe = $\frac{L}{150} + \frac{L}{70}$

Time for Moe = $\dfrac{L}{\frac{L}{150} + \frac{L}{70}} = \dfrac{1}{\frac{1}{150} + \frac{1}{70}} = 47.7$ sec

7. A particle starts from the origin at $t = 0$ and moves along the positive x axis. A graph of the velocity of the particle as a function of the time is shown below; the v-axis scale is set by $v_s = 4.0$ m/s.

a. What is the velocity of the particle at 1s? $2\ m/s$



b. What is the acceleration of the particle at 4.5s?

$a = \frac{\Delta v}{\Delta t} = -\frac{4}{2} = -2\ m/s^2$

c. What is the x-coordinate of the particle at 6s?

displacement

8 boxes, ~~each~~ 2 → 16 m
each 2 →

8. Use the definition of scalar product, $\vec{a} \cdot \vec{b} = ab \cos\theta$, and the fact that $\vec{a} \cdot \vec{b} = a_x b_x + a_y b_y + a_z b_z$ and $a = \sqrt{a_x^2 + a_y^2 + a_z^2}$ to calculate the angle between the two vectors given by:
$\vec{a} = 2\hat{\imath} - 3\hat{\jmath} - 5\hat{k}$ and $\vec{b} = 3\hat{\imath} - 4\hat{\jmath} + 2\hat{k}$

$\vec{a} \cdot \vec{b} = ab \cos\theta$

$\cos\theta = \frac{\vec{a} \cdot \vec{b}}{a\, b} = \frac{8}{6.16 \times 5.39} = 0.241 = \cos\theta$

$\boxed{\theta = 76^\circ}$

$\vec{a} \cdot \vec{b} = (2\hat{\imath} - 3\hat{\jmath} - 5\hat{k}) \cdot (3\hat{\imath} - 4\hat{\jmath} + 2\hat{k})$

$\vec{a} \cdot \vec{b} = (6 + 12 - 10) = 8$

$\vec{a} = \sqrt{4 + 9 + 25} = 6.16$

$\vec{b} = \sqrt{9 + 16 + 2} = 5.39$

9. Find the cross product: $\vec{c} \times \vec{d}$, where the two vectors are given by:
$\vec{c} = 2\hat{\imath} - 5\hat{k}$ and $\vec{d} = 3\hat{\imath} - 4\hat{\jmath}$

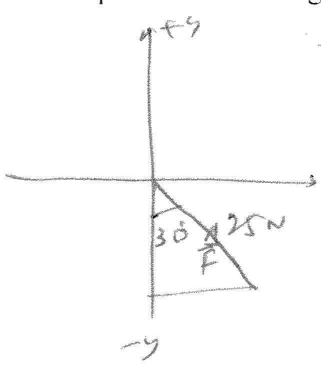
$\vec{c} \times \vec{d} = (2\hat{\imath} - 5\hat{k}) \times (3\hat{\imath} - 4\hat{\jmath})$

$= (2\hat{\imath} \times 3\hat{\imath}) + 2\hat{\imath} \times (-4\hat{\jmath}) - 5\hat{k} \times (3\hat{\imath}) + 5\hat{k} \times 4\hat{\jmath}$

$= 0 \quad -8\hat{k} \quad -15\hat{\jmath} \quad -20\hat{\imath}$

$\vec{c} \times \vec{d} = -20\hat{\imath} - 15\hat{\jmath} - 8\hat{k}$

10. Express the following vector in unit-vector notation: 25 N, at 30^0 counterclockwise from the –Y axis.



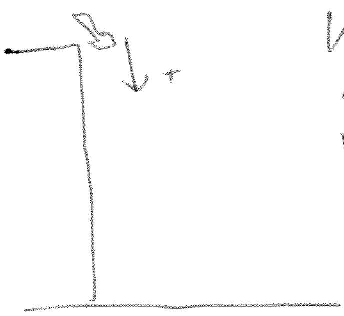
$\vec{F} = (25 \sin 30\ \hat{\imath} - 25 \cos 30°\ \hat{\jmath})$ N

$\vec{F} = (12.5\hat{\imath} - 21.65\hat{\jmath})$ N

Equations of kinematics for constant acceleration: (acceleration due to gravity = 9.8 m/s^2, down)
Final velocity = v, Initial velocity = v_0, Acceleration = a, Time interval = t, Displacement = $\Delta y = y - y_0$

1.	2.	3.	4.	5.
$v = v_0 + at$	$y - y_0 = \frac{1}{2}(v + v_0)t$	$v^2 = v_0{}^2 + 2a(y - y_0)$	$y - y_0 = v_0 t + \frac{1}{2}at^2$	$y - y_0 = vt - \frac{1}{2}at^2$

5. At a construction site a pipe wrench struck the ground with a speed of 24 m/s. (a) From what height was it inadvertently dropped? (b) How long was it falling? (c) Sketch graphs of v, and a versus t for the wrench.

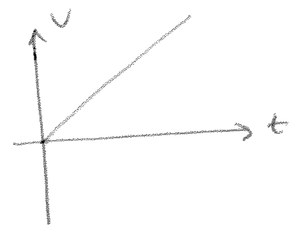


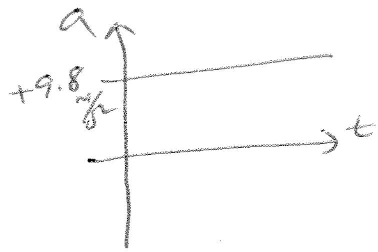
$V_0 = 0$
$a = +9.8\ m/s^2$
$V = 24\ m/s$

$V = V_0 + at$
$24 = 0 + 9.8t$
$2.45\ sec = \frac{24}{9.8} = t$

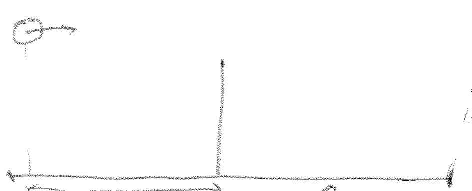
b. $\boxed{t = 2.45\ s}$

$\Delta y = \frac{1}{2}(v + v_0)t$
$\Delta y = \frac{1}{2}(24 + 0) \times 2.45$
$\boxed{\Delta y = 29.4\ m}$





6. For women's volleyball the top of the net is 2.24 m above the floor and the court measures 9.0 m by 9.0 m on each side of the net. Using a jump serve, a player strikes the ball at a point that is 3.0 m above the floor and a horizontal distance of 8.0 m from the net. If the initial velocity of the ball is horizontal, what maximum magnitude can it have if the ball is to strike the floor inside the back line on the other side of the net?



$V_{0y} = 0$
$a_y = +9.8\ m/s^2$
$\Delta y = 3\ m$
$\Delta y = V_{0y}t + \frac{1}{2}at^2$
$3 = 0 + \frac{1}{2} \times 9.8\ t^2$
$t^2 = \frac{6}{9.8}$
$t = \sqrt{6/9.8}$
$t = 0.78\ sec$

$V_{0x} = V_{max}$
$\Delta x = 17\ m$
$t = 0.28\ sec$
$\Delta x = V_{0x}t + \frac{1}{2}a_x t^2$ (with $a_x = 0$)
$17 = V_{max}\ 0.78$
$V_{max} = \frac{17}{0.78} = 21.8\ m/s$
$\boxed{V_{max} = 21.8\ m/s}$