Physics 2210
Fall Semester 2007
David Ailion

EXAM 1

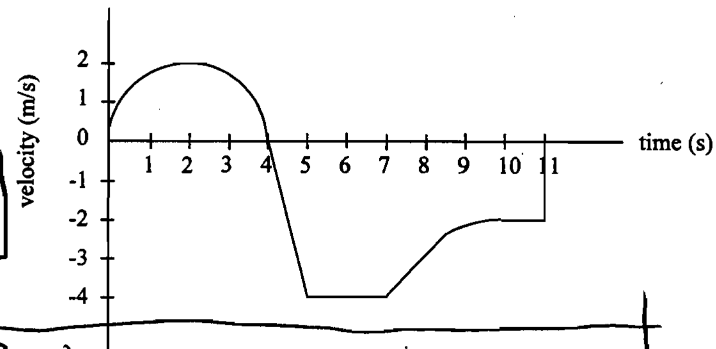
1

Name: Solutions unid: u _ _ _ _ _ _ _ _

Discussion TA (circle): Aaron Justin Mahamadou Monica Will

SHOW ALL WORK !!!
PLACE A CIRCLE OR BOX AROUND EACH ANSWER!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

Consider an obstinate donkey that moves forward (positive) or backwards (negative), as shown on the graph.



(a) *[4 pts.]* Identify all times (or ranges of time) when the donkey has stopped.

$\boxed{t = 0.00\,s,\ 4.00\,s,\ 11.0\,s}$

(b) *[4 pts.]* Identify all times (or ranges of time) when the donkey has zero acceleration.

$\boxed{t = 2.00\,s \quad 5.00\,s \le t \le 7.00\,s \quad 10.0\,s \le t \le 11.0\,s}$

(c) *[4 pts.]* Calculate the average acceleration over this 11 sec. time interval.

$$\boxed{\bar{a} = \frac{\Delta v}{\Delta t} = 0.00\ m/s^2}$$

(d) *[4 pts.]* Identify all times (or ranges of time) when the donkey is slowing down.

$\boxed{2.00\,s \le t \le 4.00\,s \quad 7.00\,s \le t \le 10.0\,s}$

(e) *[4 pts.]* Compared with the starting position at t = 0, the net displacement of the donkey at t = 11 sec is (circle one)

i. forward (positive)
ii. negative (backward)
iii zero
iv. There is not enough information in the graph to answer this question.

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The acceleration of a particle whose initial velocity is +6.00 m/s is given in m/s^2 for $t > 0$ by $a = 6.00\,t - 6.00$ where t is in seconds.

(a) *[10 pts.]* Calculate the displacement at t = 2.00 s.
(b) *[4 pts.]* Calculate the average velocity over the interval between t = 1.00 and t = 3.00 seconds.
(c) *[6 pts.]* What is the value of the displacement when the particle achieves the minimum velocity?

a.) Integrate a twice for displacement.

$v - v_0 = \int a\,dt = \int_0 (6.00t - 6.00)\,dt$
$= 3t^2 - 6t$

$v_0 = 6.00$ m/s

$v = 6.00$ m/s $- 6t + 3t^2$

$\Delta x = x - x_0 = 6.00t - \frac{6t^2}{2} + t^3 = 6.00t - 3t^2 + t^3$

$\Delta x = 6\cdot 2 - 3\cdot 2^2 + 2^3 = \boxed{8.00\,m}$
@ t=2.00s

b.) $\bar{v} = \frac{\Delta x}{\Delta t} = \frac{\Delta x(3) - \Delta x(1)}{2s} = \frac{3^3 - 3\cdot 3^2 + 6\cdot 3 - 1^3 + 3\cdot 1^2 - 6}{2}$
$= \boxed{7.00\ m/s}$

c.) min. velocity is for $\frac{dv}{dt} = 0 = a = 6.00t - 6$
so t=1s is when velocity is a minimum.
$\Delta x(1s) = 1^3 - 3\cdot 1^2 + 6 = \boxed{4.00\,m}$

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Consider the following vector equations: $\vec{A} + 2\vec{B} = 3\hat{i} + 5\hat{j}$ and $2\vec{A} - \vec{B} = 2\hat{i} - 6\hat{j}$

(a) *[10 pts.]* Give the Cartesian components of the vector $\vec{A}$.

(b) *[10 pts.]* Determine the magnitude of $\vec{A}$ and the angle θ that it makes with the positive x-axis.

$(A_x + 2B_x)\hat{i} + (A_y + 2B_y)\hat{j} = 3\hat{i} + 5\hat{j}$ & $(2A_x - B_x)\hat{i} + (2A_y - B_y)\hat{j} = 2\hat{i} - 6\hat{j}$

A) x comp:

$A_x + 2B_x = 3$

$2(2A_x - B_x = 2)$

$\Rightarrow A_x + 2B_x = 3$

$4A_x - 2B_x = 4$

$5A_x = 7$

$\boxed{A_x = 7/5}$ x-component

y comp:

$A_y + 2B_y = 5$

$2(2A_y - B_y = -6)$

$\Rightarrow A_y + 2B_y = 5$

$4A_y - 2B_y = -12$

$5A_y = -7$

$\boxed{A_y = -7/5}$ y-component

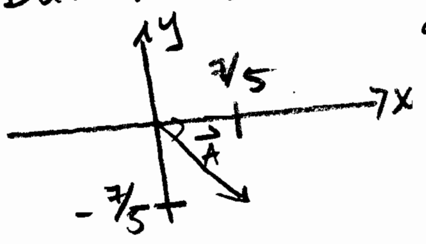
B) magnitude:

$|A| = \sqrt{A_x^2 + A_y^2} = \sqrt{(7/5)^2 + (-7/5)^2} = \boxed{1.98}$

angle:

$\tan\theta = \left(\frac{A_y}{A_x}\right) = \left(\frac{-7/5}{7/5}\right) = (-1) \Rightarrow \theta = \tan^{-1}(-1) = -45°$

But $\vec{A}$ is in the fourth Quadrant: So the angle is down from the positive x-axis. Therefore, we must subtract 360 − 45 to find the correct angle: $\boxed{\theta = 315°}$ or $\boxed{-45°}$



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An astronaut lands on a new planet of unknown size and unknown gravity. From the top of the ladder connecting the space ship to ground, he drops a rock and observes that it takes 3.00 seconds for the rock to fall 18.0 m to the ground. Accidentally he kicks the ladder over, so he jumps up and reaches a maximum height of 14.0 m above his starting point before falling to the ground below.

(a) *[8 pts.]* Calculate g_{planet}, as acceleration due to gravity on this planet.
(b) *[6 pts.]* How long will it take him to fall from the maximum height to the ground?
(c) *[6 pts.]* What is his initial upward velocity.

a) $\Delta y = V_0 t + \frac{1}{2} a t^2$

$\Delta y = -18.0\,m \quad V_0 = 0 \quad t = 3.00\ sec$

$a = \frac{-18(2)}{9} = \boxed{-4.00\ m/sec^2} = g_P$

b) $\Delta y = V_0 t - \frac{1}{2} g_P t^2$

$\Delta y = -32\,m \quad V_0 = 0$

$-32 = -\frac{1}{2}(4)t^2$

$t = \sqrt{\frac{32 \cdot 2}{4}} = \sqrt{16} = \boxed{4.0\ sec}$

c) $V_f^2 = V_0^2 - 2 g_P \Delta y$

$V_f = 0 \quad \Delta y = 32 - 18 = 14\,m$

$V_0^2 = 2(4) \cdot 14 \qquad V_0 = \sqrt{2 \cdot 4 \cdot 14} = \boxed{10.6\ m/sec}$

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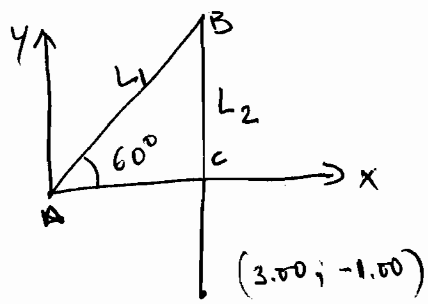
Two rods of length L_1 and L_2 that are attached at one end by a hinged joint are placed on a horizontal table. Suppose the free end of the rod of length L_1 is placed at the origin of a Cartesian coordinate system and L_1 makes an angle of 60° with respect to the x axis. When rod L_2 is parallel to the y-axis, its free end has x-y coordinates (3.00,-1.00) in meters.
Hint: It may help you to draw a picture.

(a) *[12 pts]* Find the length of L_1 and L_2.
(b) *[8 pts.]* Assume that L_2 is rotated about the hinged joint such that its free end now lies on the x-axis, but L_1 keeps the same orientation as in part (a). Calculate the value of the x-coordinate of the free end of L_2.

Solution :

a)



length L_1

$\cos 60 = \frac{3m}{L_1} \Rightarrow L_1 = \frac{3\,m}{\cos 60} = \boxed{6m}$

length L_2:
considering triangle ABC.

$L_2 = \cancel{AB} + BC = BC + 1\,m.$

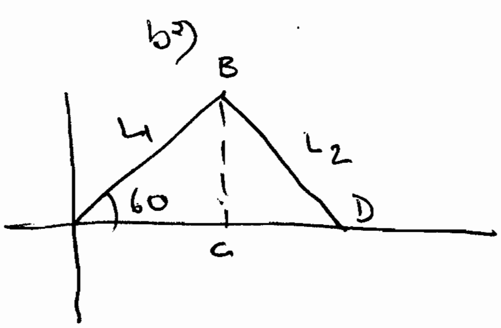
$\sin 60 = \frac{BC}{L_1} \Rightarrow BC = L_1 \sin 60$

$L_2 = BC + 1m = L_1 \sin 60 + 1\,m$

$= 6 \sin 60 + 1m = 6.196\,m.$

$\boxed{L_2 = 6.196m}$

b)



Considering triangle BCD.

$BC^2 + CD^2 = BD^2 \Rightarrow CD = \sqrt{BD^2 - BC^2}$

$CD = \sqrt{(6.196)^2 - (5.196)^2} = 3.375\,m.$

Hence the x-component of the free end of L_2 is:

$x = 3m + 3.375m = \boxed{6.375\,m}$