X1.17a **2050**

PHYS-205(17) (Kaldon-20619) Name S O L U T I O N

WMU-Summer I 2006

Exam 1A - 100,000 points + 20,000 ☆ points Book Title ____________________

05/17/2006•Rev.6

State Any Assumptions You Need To Make – Show All Work – Circle Any Final Answers
Use Your Time Wisely – Work on What You Can – Be Sure to Write Down Equations
Feel Free to Ask Any Questions ☐☆2a ☐☆2b ☐☆2c ☐☆2e

EXAM 1 [FORM - A]

PHYS-2050 (KALDON-17)

SUMMER I 2006

WMU

Cartoon Physics vs. Reality (35,000 points)

1.) In a popular series of cartoons, Wile E. Coyote (*canus hungrius*) is forever trying to capture the Road Runner (*birdus fastus*). Using a set of Acme™ Rocket Powered Roller Skates, the Coyote will attempt to leap the 62.9 m wide gorge while traveling at a constant horizontal speed of 34.5 m/s.

(a) How long does it take for the Coyote to cross the horizontal gap?

$$d = v\,t \qquad t = \frac{d}{v} = \frac{(62.9m)}{(34.5m/s)} = 1.823\sec$$

(b) Now to properly cross the gap, the Coyote needs to jump up at v_{0y}, so that he will land at the same height on the other side. How fast is v_{0y}?

$$v_y = v_{0y} - g\,t$$
$$-v_{0y} = v_{0y} - g\,t$$
$$-2v_{0y} = -g\,t$$
$$v_{0y} = \frac{g\,t}{2} = \frac{(9.81m/s^2)(1.823\sec)}{2}$$
$$= 8.942m/s$$

OR

$$v_y = v_{0y} - g\,t$$
$$0 = v_{0y} - g\,t$$
$$v_{0y} = g\,t$$
$$v_{0y} = g\,t = (9.81m/s^2)(\tfrac{1}{2})(1.823\sec)$$
$$= 8.942m/s$$

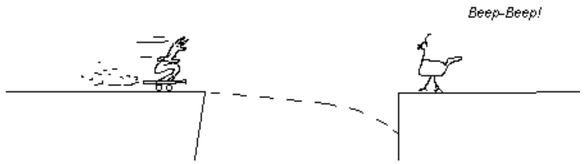
(c) Find the initial vector velocity, $\vec{v}_0$, and give your answer in Standard Form. *If you did not get an answer to (b), use v_{0y} = 3.21 m/s.*

$$v_0 = \sqrt{v_{0x}^2 + v_{0y}^2}$$
$$= \sqrt{(34.5m/s)^2 + (8.942m/s)^2}$$
$$= 35.64\,m/s$$

$$\theta = \tan^{-1}\left(\frac{v_{0y}}{v_{0x}}\right)$$
$$= \tan^{-1}\left(\frac{+8.942m/s}{+34.5m/s}\right)$$
$$= 14.5^\circ$$

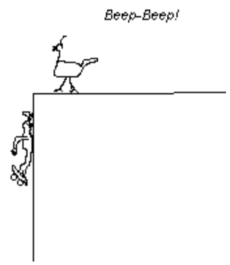
$$\vec{v} = 35.64\,m/s @ 14.5^\circ$$

(d) Unfortunately, this is a Coyote & Road Runner cartoon, so the Coyote forgets to jump up. Instead, find the distance he falls before he runs into the canyon wall… and comes to a stop. *Splat!*



$$y = y_0 + v_{0y} - \tfrac{1}{2} g t^2$$
$$y = -\tfrac{1}{2} g t^2 = -\tfrac{1}{2}\left(9.81 m/s^2\right)\left(1.823\,\text{sec}\right)^2$$
$$= -16.30 m$$

(e) It is 2650 m to the bottom of the gorge and the Coyote is at rest. How long will it take for the Coyote to hit bottom?



$$y = y_0 + v_{0y} - \tfrac{1}{2} g t^2$$
$$y = -\tfrac{1}{2} g t^2$$
$$t^2 = \frac{-2y}{g}$$
$$t = \sqrt{\frac{-2y}{g}} = \sqrt{\frac{-2(-2650 m)}{9.81 m/s^2}} = 23.24\,\text{sec}$$

Reaching for the Star Problems…! (30,000 points)

2.) An object's equation of motion is $\frac{dx}{dt} = 4.00 m/s + (4.00 m/s^3)\, t^2$. *All other constants are zero.*

☆(a) Find the equation for the position of this object.

$$x = \int \frac{dx}{dt} dt = \int \left[4.00 m/s + (4.00 m/s^3)\, t^2\right] dt$$
$$= \left(4.00 m/s\right) t + \tfrac{1}{3}(4.00 m/s^3)\, t^3 + C \quad (C = 0)$$
$$= \left(4.00 m/s\right) t + (1.333 m/s^3)\, t^3$$

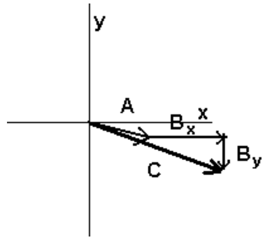
☆(b) Find the equation for the acceleration of this object.

$$a = \frac{d^2 x}{d t^2} = \frac{d}{dt}\left(\frac{dx}{dt}\right)$$
$$= \frac{d}{dt}\left(4.00 m/s + (4.00 m/s^3)\, t^2\right)$$
$$= 0 + 2(4.00 m/s^3)\, t$$
$$= (8.00 m/s^3)\, t$$

☆(c) Find the equation for the jerk of this object.

$$j = \frac{d^3 x}{d t^3} = \frac{d}{dt}\left(\frac{d^2 x}{d t^2}\right)$$
$$= \frac{d}{dt}\left((8.00 m/s^3)\, t\right)$$
$$= 8.00 m/s^3$$

(d) Sketch the vector $\vec{C} = \vec{A} + \vec{B}$, where $\vec{A}$ = *3.44 m @ 342°* and $\vec{B} = +5.71m\,\hat{i} - 2.60m\,\hat{j}$.
Find $\vec{C}$ in Standard Form .



	$A_x = A\cos\theta$	$A_y = A\sin\theta$
$\vec{A}$ = *3.44 m @ 342°*	*(3.44 m)(cos 342°)*	*(3.44 m)(sin 342°)*
	3.272 m	*-1.063 m*
$\vec{B} = +5.71m\,\hat{i} - 2.60m\,\hat{j}$	*+5.71 m*	*-2.60 m*

$\vec{C} = \vec{A} + \vec{B}$ $\quad C_x = 8.982$ m $\quad C_y = -3.663$ m

$$C = \sqrt{C_x^2 + C_y^2} = \sqrt{(8.982m)^2 + (-3.663m)^2} = 9.700m$$

$$\theta = \tan^{-1}\left(\frac{C_y}{C_x}\right) = \tan^{-1}\left(\frac{-3.663\,m/s}{8.982\,m/s}\right) = -22.2° = 337.8°$$

$$\vec{C} = 9.700m \ @ \ 337.8°$$

☆(e) An object has its motion given as $a(t) = (6.00m/s^2)$. Find the second derivative of x with respect to time at time *t = 1.00 sec.*

$$a(t) = \frac{d^2x}{dt^2} = (6.00m/s^2)$$

This is a constant, so doesn't change when you try to plug in t = 1.00 sec.

It's A New World Record from Doha, Qatar! (35,000 points)

3.) Last weekend American Justin Gatlin set a new world record in the 100. meter dash, in a time of 9.76 seconds. (a) Find his average speed, *v*.

$$v = \frac{d}{t} = \frac{100.m}{9.76\sec} = 10.25m/s$$

(b) Of course Justin didn't race at a constant speed for the 100. meters. Suppose he accelerated from rest to 10.0 m/s in the first 10.0 meters of the race. Find his average acceleration, *a*.

$$v^2 = v_0^2 + 2a(x - x_0)$$
$$v^2 = a\,x$$
$$a = \frac{v^2}{x} = \frac{(10.0m/s)^2}{10.0m} = 10.00m/s^2$$

(c) Or perhaps Justin accelerated from rest to 10.0 m/s in the first 1.10 seconds of the race. Find his average acceleration, *a*.

$$a = \frac{\Delta v}{\Delta t} = \frac{10.0m/s}{1.10\sec} = 9.091m/s^2$$

(d) Nigeria's Olusoji Fasuba finished second in 9.84 seconds – an African record – with Shawn Crawford of the United States third in 10.08 seconds. When Justin crossed the finish line at exactly 100. meters at 9.76 seconds, find how far back Fasuba and Crawford each were. *You can see by the photo that we're not talking very large distances here!*

$$v_{OF} = \frac{d}{t} = \frac{100.m}{9.84\sec} = 10.16m/s$$
$$d = v\,t = (10.16m/s)(9.76\sec) = 99.16m$$
$$100.m - 99.16m = 0.84m \text{ (for 2nd place)}$$
$$v_{SC} = \frac{d}{t} = \frac{100.m}{10.08\sec} = 9.921m/s$$
$$d = v\,t = (9.921m/s)(9.76\sec) = 96.83m$$
$$100.m - 96.83m = 3.17m \text{ (for 3rd place)}$$

(e) As I was collecting information on the Internet for this problem on Wednesday afternoon, a brand new CNN story said that there had been a mistake. Justin Gatlin's time was actually 9.766 seconds, which the computer should've rounded *up* to 9.77 seconds, instead of truncating to 9.76 seconds. So really, Justin *tied* with the previous 100. meter world record of 9.77 seconds set in 2005 by Asafa Powell. By how much faster should Justin have run this race, if his time was 9.766 seconds instead of 9.760 seconds?

$$v = \frac{d}{t} = \frac{100.m}{9.760\sec} = 10.25m/s$$

$$v = \frac{d}{t} = \frac{100.m}{9.766\sec} = 10.24m/s$$

$$10.25m/s - 10.24m/s = 0.01m/s$$