Physics 1145 Fall 2023 Test 1 (4 pages)

Name: Solution **September 20, 2023** **Total Score:** 120 /120

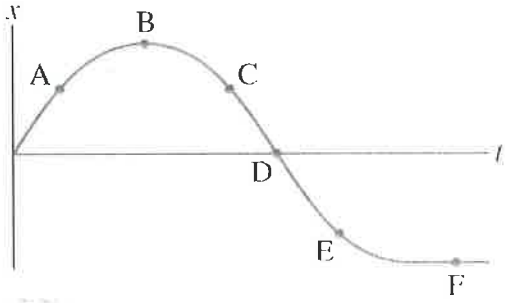
$x = x_i + v_{ix}\Delta t + \frac{1}{2} a_x(\Delta t)^2$ $v_x = v_{ix} + a_x\Delta t$ $v_x{}^2 = v_{ix}{}^2 + 2\,a_x(x - x_i)$

$y = y_i + v_{iy}\Delta t + \frac{1}{2} a_y(\Delta t)^2$ $v_y = v_{iy} + a_y\Delta t$ $v_y{}^2 = v_{iy}{}^2 + 2\,a_y(y - y_i)$

Free fall acceleration: g= 9.8m/s^2 Centripetal acceleration: $a_c = \frac{v^2}{R}$ $v = \frac{2\pi R}{T}$

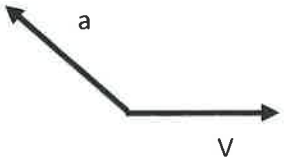
B 1.(5) The motion of an object is described by the *x*-*t*-diagram at the right. Which of the following is **true?**

A) The object moves to the left at A.
B) The object stops at B.
C) The object moves to the right at C.
D) The object stops at D



D 2. (5) A particle is moving with velocity V. At a particular instant, it experiences an acceleration a as shown in the figure. We know that the particle is:

A) only speeding up B) speeding up and changing direction of motion.
C) only slowing down D) slowing down and changing direction of motion



B 3. (5) A ball is kicked from the ground with an initial velocity V at 37° above the horizontal. It travels some distance and hits a wall at some height H above the ground. Which of the following is true about the ball at the instant just before it hits the wall?

A) Its speed is larger than the initial speed.
B) Its speed is smaller than the initial speed.
C) The magnitude of its acceleration is larger than the initial one.
D) The magnitude of its acceleration is smaller than the initial one

B 4. (5) A particle is moving in a circle with constant speed. The acceleration is

A) zero B) towards the center of the circle C) tangent to the circle
D) away from the center of the circle

A 5. (5) A particle rotates in a circle with centripetal acceleration *a*. If the period is doubled without changing the radius, the new acceleration will be

A) ¼ *a* B) ½ *a* C) 2 *a* D) 4 *a*

$T \to 2T$
$v \to \frac{1}{2}v$
$a \to \frac{1}{4}a$

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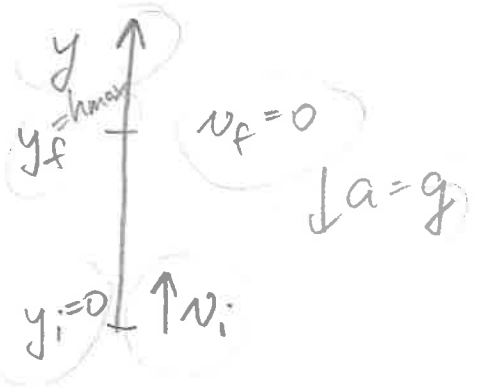
7.(30) A child throws a ball vertically upwards at an initial speed V_i=5 m/s.

a) (5) In the space provided, draw a complete diagram for the ball with all information needed to solve the tasks below. Remember, any quantity used in the calculation must be defined in the diagram.



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b) (10) Find the time ΔT the ball takes to reach the highest point. Derive a symbolic expression and calculate a numerical answer.

$v_y = v_{iy} + a_y \Delta t$ (0)

$0 = v_i - g\Delta t$

$\Delta t = \frac{v_i}{g}$ $\quad \Delta t = \frac{5\ m/s}{9.8\ m/s^2} = 0.51s$

c) (10) Find the height of the highest point above the launch point. Derive a symbolic expression and calculate a numerical answer.

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$v_y^2 = v_{iy}^2 + 2a_y(y - y_i)$ (0)

$0 = v_i^2 + 2(-g)h_{max}$

$h_{max} = \frac{v_i^2}{2g} = \frac{(5\ m/s)^2}{2 \cdot 9.8\ m/s^2} = 1.27m$

or $y = y_i + v_{iy}\Delta t + \frac{1}{2}a_y(\Delta t)^2$

$h_{max} = v_i\left(\frac{v_i}{g}\right) + \frac{1}{2}(-g)\left(\frac{v_i}{g}\right)^2$

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d) (5) How big are the ball's velocity and acceleration at the highest point?

$v_f = 0$

$a_{f_y} = -g$

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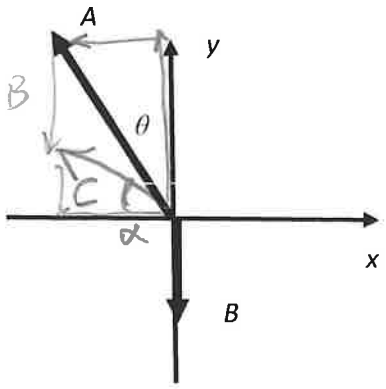
8. (25) In the figure, the magnitudes of the vectors are A= 6 and B=3. The angle θ equals 30°.



a) Calculate the vector components A_x, A_y, B_x, B_y.

$A_x = -A\sin\theta = -6\cdot\sin 30^\circ = -3$

$A_y = A\cos\theta = 6\cdot\cos 30^\circ = 5.2$

$B_x = 0$

$B_y = -B = -3$

b) The vector $\vec{C} = \vec{A} + \vec{B}$. Sketch vector $\vec{C}$ in the diagram and calculate its components, magnitude, and direction.

$C_x = A_x + B_x = -3 + 0 = -3$

$C_y = A_y + B_y = 5.2 + (-3) = 2.2$

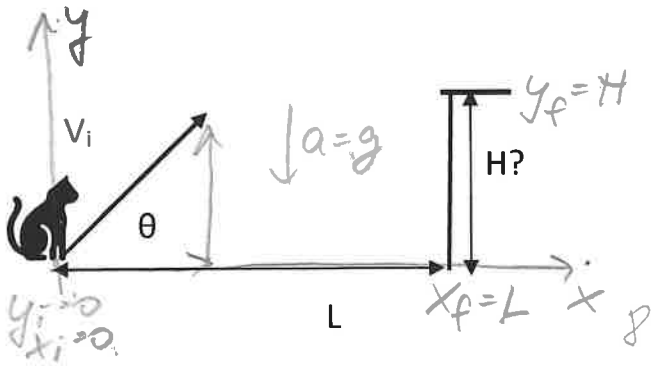
$C = \sqrt{C_x^2 + C_y^2} = \sqrt{(-3)^2 + (2.2)^2} = 3.72$

$\tan\alpha = \left|\frac{C_y}{C_x}\right| \qquad \alpha = \arctan\left|\frac{2.2}{3}\right| = 36.2^\circ$

or $\beta = 53.7^\circ$ from the y-axis

25 /25 points for this page

9. (40) Raisin the cat jumps off the floor with an initial velocity of magnitude *Vi* directed at an angle θ with respect to the horizontal and lands on the platform of her cat tree a horizontal distance *L* away.



a) Complete the diagram on the right with all information necessary to solve the parts below.

b) Derive a symbolic expression for the time Δt it takes Raisin to reach the platform, in terms of *Vi, L*, θ and *g* (or a subset thereof).

$x = x_i^{\,0} + v_{ix}\Delta t + \frac{1}{2}a_x^{\,0}(\Delta t)^2$

$L = v_i \cos\theta \, \Delta t$

$$\Delta t = \frac{L}{v_i \cos\theta}$$

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c) Derive a symbolic expression for the height *H* of the platform, in terms of *Vi*, θ and *g,* and Δt from part b).

$y = y_i^{\,0} + v_{iy}\Delta t + \frac{1}{2}a_y(\Delta t)^2$

$$H = v_i \sin\theta \, \Delta t + \frac{1}{2}(-g)(\Delta t)^2$$

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d) What is the *x*- component of Raisin's velocity when she reaches the platform?

$v_x = v_{ix} + a_x^{\,0}\Delta t$

$$v_x = v_i \cos\theta$$

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