Instructor(s):

PHYSICS DEPARTMENT

PHY 2048 Exam 1 January 29, 2007

Name (print, last first): ______________________ Signature: ______________________

On my honor, I have neither given nor received unauthorized aid on this examination.

YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

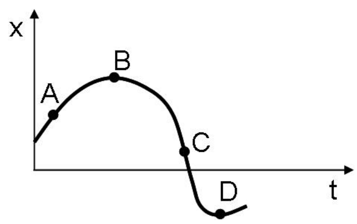
(1) **Code your test number on your answer sheet (use lines 76–80 on the answer sheet for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. Code your UFID number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere on this exam that you like. **Circle your answers on the test form.** At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout.
(4) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink**. Do not make any stray marks or some answers may be counted as incorrect.
(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing. If you believe that no listed answer is correct, **leave the form blank**.
(6) **Hand in the answer sheet separately.**

g=10 m/s^2	1 mile = 1.6 km	1 ft = 12 inches	1 inch = 25.4 mm

1. How many gallons are in 1 cubic foot? One gallon is approximately 3.8 liters. One liter is a volume of a cube with a 10-cm side.

(1) 7.5 (2) 0.8 (3) 1.2 (4) 1.3 (5) 2.5

2. The plot below shows particle's coordinate x versus time t. At which of the four points shown on the graph is the magnitude of particle's velocity the greatest?



(1) C (2) B (3) A (4) D (5) cannot be determined from the graph

3. The position of a body moving along the x-axis is given by $x(t) = 5 + 3t - 3t^2$. What is the magnitude of its average velocity between $t = 0$ and $t = 1$?

(1) 0 (2) 3 (3) 6 (4) 1.5 (5) 4.5

4. If particle's velocity in m/s changes as $v(t) = 9 - 4t^3$, calculate its total displacement in meters between $t = 0$ and $t = 2$ s.

(1) 2 (2) 23 (3) 48 (4) 12 (5) 7

5. A dog, lying far inside a room, observes a cat falling in time t past the window which spans a vertical distance h. Which of the following is the correct formula for the magnitude of the initial velocity when the cat first falls in the dog's field of vision?

(1) $\frac{h}{t} - \frac{gt}{2}$ (2) $\frac{h}{t} + \frac{gt}{2}$ (3) $\frac{h}{t} + 2gt$ (4) $\frac{h}{t} - 2gt$ (5) $\frac{h}{t} + \sqrt{2gh}$

6. You throw a ball up with velocity v. Two seconds later, you throw a second ball up with the same velocity v. If the two balls collide 5 seconds after you threw the first ball, find their initial velocities v in m/s?

(1) 40 (2) 30 (3) 20 (4) 60 (5) 50

7. Two runners start a 10 km race in a stadium with a race track loop of 400 m. From the very start to the finish, the first runner maintains her speed of 20 km/h, while the second runner runs at 19 km/h. When, after starting the race, does the first (faster) runner lap (pass for the first time) the slower runner?

(1) 24 min (2) 26 min (3) 28 min (4) 30 min (5) 22 min

8. The car accelerates from zero velocity to 60 mile/hour with a constant acceleration in 6 seconds. How far does the car travel during this time, in meters?

(1) 80 (2) 120 (3) 100 (4) 160 (5) 60

9. If $\vec{a} = 3\hat{i} + 4\hat{j}$ and $\vec{b} = 4\hat{i} + 3\hat{j}$, then what is the cosine of the angle between these two vectors?

(1) $\frac{24}{25}$ (2) $\frac{4}{5}$ (3) 1 (4) $\frac{3}{5}$ (5) $\frac{12}{25}$

10. A vector $\vec{r} = 4\hat{i} + 10\hat{j}$ is rotated in the (x, y)-plane so that its x-component is doubled. What is the value of the new y-component? *Hint: When rotated, vectors do not change their length.*

(1) 7.2 (2) 9.4 (3) 5.4 (4) 2.6 (5) 4.2

11. If a particle moves such that $y = 2t^2 - 13$ and $x = 3t + 36$, what is the speed of the particle when $t = 1$?

(1) 5 (2) 10 (3) $\sqrt{41}$ (4) $\sqrt{1642}$ (5) $\sqrt{5}$

12. An astronaut is rotated in a horizontal centrifuge at a radius of 5 m and experiences centripetal acceleration of $7g$. How many revolutions per minute are required to produce this acceleration?

(1) 36 (2) 30 (3) 24 (4) 18 (5) 12

13. A projectile's launch speed is three times its speed at maximum height. Find launch angle θ_0.

(1) 71° (2) 19° (3) 43° (4) 47° (5) 45°

14. A car is traveling at 5 m/s. A child in the car throws a toy out of the window from a height of 1.25 m above the ground. Measured relative to the car, the toy starts with a velocity of 5 m/s in a direction perpendicular to the side of the car. With what speed does the toy hit the ground (measured relative to the ground), in m/s? *Hint: think of the toy motion in 3d.*

(1) $5\sqrt{3}$ (2) 7.5 (3) $10\sqrt{2}$ (4) 15 (5) $5\sqrt{2}$

15. A cannon is aimed at 30-degree angle above the horizontal. It shoots a cannonball with a speed of 30 m/s at the castle wall which is 50 m away. The cannonball just grazes the top of the wall. How high is the castle wall in meters?

(1) 10 (2) 8 (3) 12 (4) 14 (5) 16

SOLUTIONS TO EXAM 1
PHY 2048 (SPRING 2007)

(1) $(1\ ft)^3 = (12\ inches)^3 = (12 \times 2.54\ cm)^3 = 28316.85\ cm^3$

$1\ Gallon = 3.8 \times (10\ cm)^3 = 3800\ cm^3$

$1\ ft^3 = \frac{28316.85}{3800}\ Gallons \sim \underline{7.5}\ Gallons$

(3) $V_{avg} = \frac{\Delta X}{\Delta t} = \frac{X_f - X_i}{t_f - t_i}$ $\quad X(t) = 5 + 3t - 3t^2$

$X(0) = 5$

$X(1) = 5$

$\Rightarrow \Delta X = 0$

$\Rightarrow \underline{V_{avg} = 0}$

(4) $V(t) = 9 - 4t^3$ $\quad \Delta X = \int_{t_i}^{t_f} V(t)\,dt = \int_0^2 (9 - 4t^3)\,dt = \left[9t - t^4\right]_0^2$

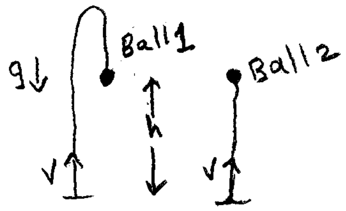
$= 18 - 16 = 2m$

$\underline{\Delta X = 2m}$

(5) $h = V_i t + \frac{1}{2} g t^2$ Choose downward direction to be positive

$\underline{V_i = h/t - \frac{gt}{2}}$

(6) The displacements of the two balls are equal when they collide



<u>Ball 1</u> $h = Vt - \frac{1}{2} g t^2 \Big|_{t=5}$

<u>Ball 2</u> $h = Vt - \frac{1}{2} g t^2 \Big|_{t=3}$

$\Rightarrow V5 - 5 \cdot 5^2 = V3 - 5 \cdot 3^2$

$2V = 80 \Rightarrow \underline{V = 40\ m/s}$

(7) Distance travelled by the first runner $= D = 20 \frac{Km}{hr} t$

Distance travelled by the Second runner $= D - 0.4\ Km = 19 \frac{Km}{hr} t$

$\Rightarrow 20 \frac{Km}{hr} t - 0.4 = 19 \frac{Km}{hr} t$

$t = 0.4\ hr$

$\underline{t = 24\ min}$

(8) $a = \frac{v_f - v_i}{t} = \frac{26.67}{6} = 4.44\ m/s$ $\left(60\ miles/hr = \frac{60 \times 1.6 \times 1000}{3600}\ m/s\right)$

$= 26.67\ m/s$

$d = v_i t + \frac{1}{2}at^2 = 0 + \frac{1}{2} 4.44(6)^2$

$= \underline{\underline{80\,m}}$

(9) $\vec{a} = 3\hat{i} + 4\hat{j}$ $\quad \vec{a}\cdot\vec{b} = 3\cdot 4 + 4\cdot 3 = 24$

$\vec{b} = 4\hat{i} + 3\hat{j}$ $\quad |\vec{a}| = \sqrt{3^2+4^2} = 5$

$|\vec{b}| = \sqrt{4^2+3^2} = 5$

$\vec{a}\cdot\vec{b} = |\vec{a}|\,|\vec{b}|\cos\theta \Rightarrow \cos\theta = \underline{\underline{\frac{24}{25}}}$

(10) $\vec{r} = 4\hat{i} + 10\hat{j}$ $\quad |\vec{r}| = |\vec{r}\,'|$

$\vec{r}\,' = 8\hat{i} + y\hat{j}$ $\quad \Rightarrow 4^2 + 10^2 = 8^2 + y^2 \Rightarrow y^2 = 52$

$\underline{\underline{y = 7.21}}$

(11) $y = 2t^2 - 13$ $\quad v_y = 4t$

$x = 3t + 36$ $\quad v_x = 3$

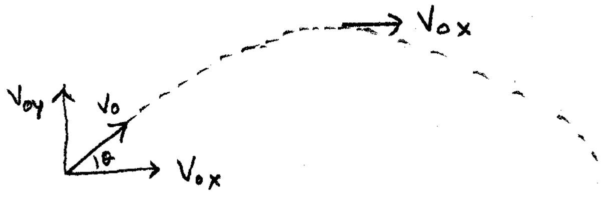
At $t=1$ $\begin{cases} v_x = 3 \\ v_y = 4 \end{cases}$ $\quad |\vec{v}| = \sqrt{3^2+4^2} = \underline{\underline{5}}$

(12) $a_{cent} = \frac{v^2}{r} = \omega^2 r \Rightarrow 79 = \omega^2 5$

$\omega^2 = 70/5 \Rightarrow \underline{\omega = 3.74\ rad/s} \Rightarrow \frac{3.74 \times 60}{2\pi}\ rev/min$

$= \underline{\underline{35.7\ rev/min}}$

(13)



$3V_{ox} = \sqrt{V_{ox}^2 + V_{oy}^2} \Rightarrow 9V_{ox}^2 = V_{ox}^2 + V_{oy}^2$

$\Rightarrow 8V_{ox}^2 = V_{oy}^2 \Rightarrow \frac{V_{oy}}{V_{ox}} = 2\sqrt{2}$

$\theta = \tan^{-1}\left(\frac{V_{oy}}{V_{ox}}\right) = \tan^{-1}(2\sqrt{2}) = \underline{\underline{70.5^\circ}}$

(14)

$V_{ox} = 5\ m/s$ $\quad a_x = 0$

$V_{oy} = 0$ $\quad a_y = g = 10 m/s^2$ $\quad \Delta Y = 1.25 m$

$V_{oz} = 5 m/s$ $\quad a_z = 0$

Time taken to hit the ground = 't'

$$\Delta Y = V_{oy} t + \tfrac{1}{2} g t^2$$

$$\Rightarrow 1.25 = \tfrac{1}{2} 10\, t^2 \quad \Rightarrow t^2 = 0.25\ ;\ \underline{t = 0.5\ sec}$$

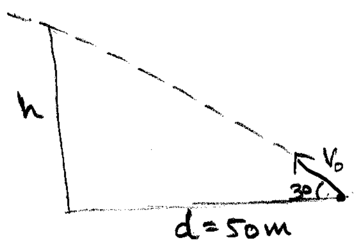
$$V_y = V_{oy} + gt = 0 + 10(0.5) = 5 m/s$$

When the toy hits the ground its velocity components are

$$V_x = 5 m/s,\ V_y = 5 m/s,\ V_z = 5 m/s$$

$$|V| = \sqrt{5^2 + 5^2 + 5^2} = \underline{5\sqrt{3}\ m/s}$$

(15)



$V_{ox} = V_o \cos 30 = 30 \cos 30 = 26 m/s$

$V_{oy} = V_o \sin 30 = 30 \sin 30 = 15 m/s$

$$d = V_{ox} t \Rightarrow 50 = 26 t$$
$$\Rightarrow \underline{t = 1.92\ sec}$$

$$h = V_{oy} t - \tfrac{1}{2} g t^2$$
$$= 15(1.92) - 5(1.92)^2 = \underline{10.3\ m}$$

(2) The steepest point is "C", ie the magnitude of the slope is the greatest at the point "C". Hence that point has the greatest speed.