Physics 105 Exam 1 2/13/09 Name (print): _____ A

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I pledge that I (sign name) _____ have not violated the provisions of the NJIT Honor Code which prohibits cheating and copying.

***Multiple Choice (15 questions)**: Choose the letter that best completes the statement or answers the question.*

1. On planet Z, the standard unit of length is the foose. Ann the Astronaut is 5.90 feet tall on earth. She lands on planet Z and is measured to be 94 foosi tall. Her partner Rachael is 88 foosi tall. How many feet tall is Rachael on Earth?

✓ a. 5.2 feet
b. 5.5 feet
c. 5.8 feet
d. 6.3 feet
e. 5.1 feet

$\frac{5.90}{94} = \frac{x}{88}$ $\quad x = \frac{88}{94}\,5.9 = 5.5\ ft$

2. The distance to the Andromeda Galaxy is about 2×10^6 light years. A light year is the distance traveled by light in one year. If the speed of light is 3×10^8 m/s, about how far is it from our galaxy to Andromeda? (1 year = 3.15×10^7 s)

a. 10×10^{15} m
b. 1×10^{18} m
✓ c. 2×10^{22} m
d. 6×10^{12} m
e. 8×10^{20} m

2×10^6 light years $\times\ 3.15\times10^7$

1 light year $= 3\times10^8 \frac{m}{s} \times 3.15\times10^7\ s = 9.45\times10^{15}$ m

2×10^6 ly $= 1.89\times10^{22}$ m

3. Water flows into a swimming pool at the rate of 8.0 gal/min. The pool is 16 ft wide, 32 ft long and 8.0 ft deep. How long does it take to fill? (1 U.S. gallon = 0.134 cubic feet, 1hr = 60min)

✓ a. 32 hours
b. 64 hours
c. 48 hours
d. 24 hours
e. 16 hours

$V_{pool} = 16\times32\times8\ ft^3 = 4.1\times10^3\ ft^3 = 3.06\times10^4\ gal$

fill rate $8.0\ \frac{gal}{min}$: time $= \frac{3.06\times10^4}{8.0}\ min = 3.82\times10^3\ min$

$= 63.68\ hr$

4. A cheetah runs at 100 mi/hr and a gazelle runs at 80mi/hr. The gazelle starts at 70.0 m ahead of the cheetah. How long does the cheetah need to catch the gazelle? (1mi = 1.60km, 1km = 10^3 m, 1hr = 3600s)

a. ~~12.6~~ 8.0 s
b. 25.2 s
c. ~~46.30~~ s
d. 10.7 s
e. 20.3 s

$V_c = 100\ \frac{mi}{hr}$ $\quad V_g = 80\ \frac{mi}{hr}$ $\quad X_{og} = 70m$

$X_c = V_c t$ $\quad X_g = X_{og} + V_g t$ } equal

$(V_c - V_g)t = X_{og}$

$t = \frac{X_{og}}{V_c - V_g}$

$t = \frac{70}{44 - 35.2}\ s$

$\frac{1\ mi}{hr} \times \frac{1.6\ km}{mi} \times \frac{1\ hr}{3600s} \times \frac{10^3\ m}{km} = .44\ \frac{m}{s}$

100 mph = 44 m/s

80 mph = 35.2 m/s

$= 8.05$

$1 \frac{\text{mi}}{\text{hr}} \times \frac{1.6 \text{ km}}{1 \text{ mi}} \times \frac{10^3 \text{ m}}{1 \text{ km}} \times \frac{1}{3600} \frac{\text{hr}}{\text{s}} = .44 \text{ m/s}$

$V_c \quad 100 \frac{\text{mi}}{\text{hr}} = 44 \frac{\text{m}}{\text{s}}$

$V_G \quad 50 \frac{\text{mi}}{\text{hr}} = 35.6 \frac{\text{m}}{\text{s}}$

in time t

cheetah $x_c = V_c t$

gazelle $x_g = x_{og} + V_G t$

} equal when catch

$V_c t = x_{og} + V_G t$

$(V_c - V_G) t = x_{og}$ $\qquad t = \frac{x_{og}}{V_c - V_G} = \frac{70}{44 - 35.6}$

$= 8.28 \text{ s}$

5. A European sports car dealer claims that his product will accelerate at a constant rate from rest to a speed of 100 km/hr in 8.00 s. What is the speed after the first 5.00 s of acceleration? (*Hint:* First convert the speed to m/s.)

(1 km = 10^3 m, 1 hr = 3600 s)

a. 34.7 m/s
b. 44.4 m/s
c. 28.7 m/s
✓ d. 17.4 m/s
e. 15.2 m/s

$\frac{1\ km}{hr} \times \frac{10^3\ m}{1\ km} \times \frac{1\ hr}{3600\ s} = .28\ \frac{m}{s}$

$V = a t_a \Rightarrow a = \frac{V}{t_a} = \frac{100 \times .28\ \frac{m}{s}}{8\ s} = 3.47\ \frac{m}{s^2}$

$V = at = (3.47)(5) = 17.4\ \frac{m}{s}$

6. When a drag strip vehicle reaches a velocity of 60 m/s, it begins a negative acceleration by releasing a drag chute and applying its brakes. While reducing its velocity back to zero, its acceleration along a straight line path is a constant $-7.5\ m/s^2$. What displacement does it undergo during this deceleration period?

a. 40 m
b. 80 m
c. 160 m
✓ d. 240 m
e. 310 m

$a = -7.5\ \frac{m}{s^2}$ $V_0 = 60\ \frac{m}{s}$ $V_f = 0$

$V^2 = V_0^2 + 2a\Delta x = 0$

$\Delta x = \frac{-V_0^2}{2a} = 240\ m$

7. A Cessna aircraft has a lift-off speed of 120 km/hr. What minimum constant acceleration does this require if the aircraft is to be airborne after a take-off run of 240 m? (From rest, 1 km = 10^3 m, 1 hr = 3600 s)

✓ a. $2.31\ m/s^2$
b. $3.63\ m/s^2$
c. $4.63\ m/s^2$
d. $5.55\ m/s^2$
e. $6.12\ m/s^2$

$V = 120\ \frac{km}{hr} = 33.6\ m/s$ $\Delta x = 240\ m$ $a = ?$

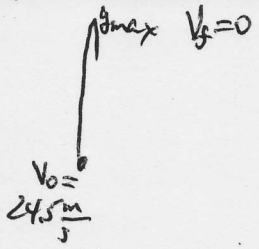
$V^2 = V_0^2 + 2a\Delta x$

$a = \frac{V^2}{2\Delta x} = \frac{1.13 \times 10^3}{(2)(240)} = 2.35\ \frac{m}{s^2}$

$1\ \frac{km}{hr} = .28\ \frac{m}{s}$ $120\ km/hr = 33.6\ m/s$

8. A rock is thrown straight up with an initial velocity of 24.5 m/s. What maximum height will the rock reach before starting to fall downward? (Take acceleration due to gravity as $9.80\ m/s^2$.)

a. 9.80 m
b. 19.6 m
c. 24.5 m
✓ d. 30.6 m
e. 35.3 m



$V_f^2 = V_0^2 - 2g\Delta y \Rightarrow$ (y_{max})

$0 = V_0^2 - 2g y_{max}$ $y_{max} = \frac{V_0^2}{2g} = 30.6\ m$

9. Suppose an equation relating position, x, to time, t, is given by $x = b t^3 + c t^4$, where b and c are constants. The dimensions of b and c are respectively:

a. T^3, T^4.
✓ b. $1/T^3$, $1/T^4$.
c. L/T^3, L/T^4.
d. $L^2 \cdot T^3$, $L^2 \cdot T^4$.
e. $L \cdot T^3$, $L \cdot T^4$.

$x\ [L]$

$b t^3\ [L]$ $\quad t\ [T] \Rightarrow b = \frac{L}{T^3}$

$c = \frac{L}{T^4}$

10. Which point is nearest the *x* axis?

a. (–3, 4)
b. (4, 5)
c. (–5, 3)
d. (5, –2)
e. (–4, 4)

$x=-3$ $y=4$
$x=4$ $y=5$
$x=-5$ $y=3$
$x=5$ $y=-2$ — closest
$x=-4$ $y=-4$

closest to y axis $y=0$

11. A bird has constant acceleration from rest. It experiences a displacement of 28 m in 11 s. What is the velocity of the bird after 11 s?

a. 1.8 m/s
b. 3.2 m/s
c. 5.1 m/s
d. 6.7 m/s
e. 0.0 m/s

$\Delta x = 28\text{m}$ in $t = 11\text{s}$
$V_0 = 0$
$V^2 = V_0^2 + 2a\Delta x$
$V = \sqrt{(2)(.46)(28)} = 5.1 \frac{m}{s}$

$\Delta x = V_0 t + \frac{1}{2} a t^2$
$a = \frac{2\Delta x}{t^2} = \frac{2(28)}{(11)^2} = .46 \frac{m}{s^2}$

12. A baseball is released at rest from the top of the Washington Monument. It hits the ground after falling for 6.0 s. What was the height from which the ball was dropped? ($g = 9.8$ m/s^2 and assume air resistance is negligible)

a. 1.5×10^2 m
b. 1.8×10^2 m
c. 1.1×10^2 m
d. 2.1×10^2 m
e. 2.5×10^2 m

$\Delta y = V_0 t + \frac{1}{2} g t^2$ $t = 6.0\text{s}$ $g = 9.8\text{ m/s}^2$
$\Delta y = -h \Rightarrow$
$h = \frac{1}{2} g t^2 = \frac{1}{2} \times 9.8 \times 36\text{ m} = 1.8 \times 10^2\text{m}$

13. Vector $\vec{A}$ is 3 m long and vector $\vec{B}$ is 4 m long. The length of the sum of the vectors must be:

a. 5 m.
b. 7 m.
c. 12 m.
d. some value from 1 m to 7 m.
e. some value from 3 m to 4 m.

shortest anti $\parallel \Rightarrow 1\text{m}$
longest $\parallel \Rightarrow 7\text{m}$

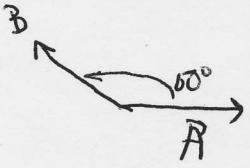
14. A taxicab travels 5.0 blocks due north (+y direction), then 2.0 blocks due east (+x direction) and then another 2.0 blocks due north. What is the magnitude of the taxicab's total displacement? (All blocks have the same length.)

a. 12 blocks
b. 9.8 blocks
c. 9.2 blocks
d. 8.6 blocks
e. ~~8~~ 7.3 blocks

$x = 2$
$y = 7$
$r = \sqrt{2^2 + 7^2} = \sqrt{53} = 7.28$

15. Vector $\vec{A}$ is 3.0 units in length and points along the positive *x-axis*; vector $\vec{B}$ is 4.0 units in length and points along a direction 150° from the positive *x-axis*. What is the direction of the resultant with respect to the positive *x-axis*?

a. 77°
b. 13°
c. 86°
d. 103°
e. 114°



$A = 3$ at $0°$ $A_x = 3$ $A_y = 0$
$B = 4$ @ $150°$ $B_x = 4\cos 150° = -3.46$ $B_y = 4\sin 150° = 2$
$\vec{C} = \vec{A} + \vec{B} = -.46\hat{i} + 2\hat{j}$
$\tan\theta = \frac{2}{.46}$ $\theta = -77°$ add $180°$ QII
$103°$