TEST 1

PHYSICS 1301, SPRING 2015

Professor Claudia Ratti

LAST NAME: _____

FIRST NAME: _____

UH ID: _____

MULTIPLE CHOICE. Choose the right answer and bubble it on the attached scantron. Bubble your name and UH ID # on the scantron as well.

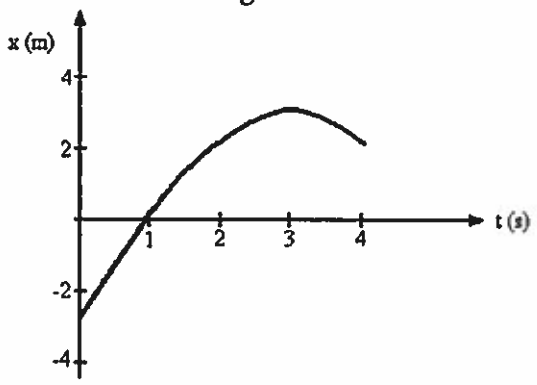
1) A runner runs around a track which is 400 m long. She completes one lap in 100 seconds. What is her average velocity?

A) 2.5 m/s
B) 5.0 m/s
C) 10 m/s
D) 0 m/s
E) 1.3 m/s

Average velocity $v_{AV} = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{\Delta t}$

Since $x_f = x_i$, $v_{AV} = 0$

Figure 1



2) Figure 1 represents the position of a particle as it travels along the x-axis. At what value of t is the speed of the particle equal to zero?

A) 0 s
B) 1 s
C) 2 s
~~D) 3 s~~
E) 4 s

The speed is the magnitude of the slope of the Tangent to the curve: the tangent is horizontal (slope = 0) at $t = 3s$

3) A car is traveling at 26.0 m/s when the driver suddenly applies the brakes, giving the car a constant deceleration. The car comes to a stop in a distance of 120.0 m. How fast was the car moving when it was 60.0 m past the point where the brakes were applied?

A) 22.5 m/s
~~B) 18.4 m/s~~
C) 15.0 m/s
D) 12.1 m/s
E) 9.20 m/s

We can find the (negative) acceleration through: $v^2 = v_0^2 + 2a\Delta x$

$\hookrightarrow 0 = \left(26.0 \frac{m}{s}\right)^2 + 2a \cdot (120\,m) \rightarrow a = -2.8 \frac{m}{s^2}$

Now we can solve the problem using the same formula:

$v^2 = v_0^2 + 2a\Delta x \rightarrow v = \sqrt{\left(26.0 \frac{m}{s}\right)^2 - 2\left(2.8 \frac{m}{s^2}\right) 60.0\,m}$

$= 18.4 m/s$

4) A drop of water falls from the top of a 19.6 m-tall building. How long does it take it to reach the ground?

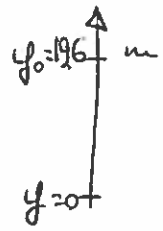
A) 4.2 s
B) 3.8 s
C) 2.8 s
D) 1.0 s
~~E) 2.0 s~~

$y = y_0 - \frac{1}{2} g t^2$

$y - y_0 = -\frac{1}{2} g t^2$

$-19.6\,m = -\frac{1}{2} \cdot 9.81 \frac{m}{s^2} \cdot t^2$

$\rightarrow t = \sqrt{\frac{2 \cdot 19.6\,m}{9.81\,m/s^2}} = 2.0\,s$



5) An object is thrown upwards with a speed of 13m/s. How long does it take it to reach a height of 4.0 m above the launch point while descending?

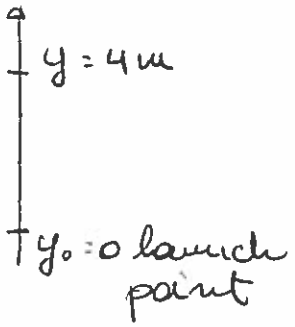
A) 0.42 s
B) 1.2 s
~~C) 2.3 s~~
D) 3.1 s
E) 4.2 s

$y = y_0 + v_0 t - \frac{1}{2} g t^2$

$y - y_0 - v_0 t + \frac{1}{2} g t^2 = 0$

$t = \frac{v_0 \pm \sqrt{v_0^2 - 2g(y - y_0)}}{g}$

Since we want to find the time when descending, we pick the solution with the "+": $t = 2.3\,s$.



6) An object is dropped from a bridge. A second object is thrown downwards 1.00 s later. They both reach the water 20.0 m below at the same instant. What was the initial speed of the second object?

A) 4.91 m/s
B) 14.6 m/s
C) 9.90 m/s
D) 19.6 m/s
E) 21.3 m/s

The first object is dropped: $v_0 = 0$

Let us find how long it takes for the first object to reach the water:

$$y - y_0 = -\frac{1}{2}gt^2 \rightarrow t = \sqrt{\frac{2(y-y_0)}{g}} = \sqrt{\frac{2 \cdot (20\,m)}{9.81\,m/s^2}} = 2.02\,s$$

The second object takes 1 s less to reach the water.

$$y - y_0 = v_0 t - \frac{1}{2}gt^2 \rightarrow v_0 = \frac{y-y_0}{t} + \frac{1}{2}gt = \frac{-20\,m}{1.02\,s} + \frac{1}{2}(9.81 \cdot 2.02)\frac{m}{s} = 14.6\frac{m}{s}$$

7) Person A walks 6.0 m at an angle of 30° north of east. Person B walks 7.0 m at an angle of 42° west of north. How does the component of the displacement of person A along the north direction compare with the component of the displacement of person B along the north direction?

A) It is larger.
B) It is smaller.
C) They are equal.
D) There is not sufficient information to tell.

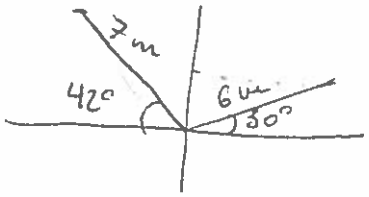
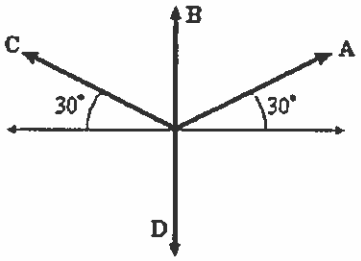


Figure 2



8) The magnitudes of the four vectors shown in Figure 2 are given as follows: $|\mathbf{A}| = 10.0$ m, $|\mathbf{B}| = 8.0$ m, $|\mathbf{C}| = 6.0$ m, and $|\mathbf{D}| = 2.0$ m. The components of the vector sum of these four vectors are

The vectors with components along x are A and C.

$$A_x = A\cos 30^\circ = 10\,m \cdot \cos 30^\circ = 8.66\,m$$

$$C_x = -C\cos 30^\circ = -6\,m \cdot \cos 30^\circ = 5.19\,m$$

$$A_x + C_x = 3.5\,m$$

Choice	x-component	y-component
1	1.5 m	6.0 m
2	13.5 m	20.0 m
3	3.5 m	14.0 m
4	-2.9 m	-14.0 m
5	18.1 m	-5.0 m

A) Choice 1
B) Choice 2
C) Choice 3
D) Choice 4
E) Choice 5

9) A car moves from the point (3.0 m)$\hat{x}$ + (5.0 m)$\hat{y}$ to the point (8.0 m)$\hat{x}$ - (7.0 m)$\hat{y}$ in 2.0s. What is the direction of the average velocity of the car?

A) 67° from the x-axis
B) -67° from the x-axis
C) 33° from the x-axis
D) -33° from the x-axis
E) 52° from the x-axis

The average velocity of the car has the same direction as the displacement.

$\Delta x = x_f - x_i = 8.0\,m - 3.0\,m = 5.0\,m$

$\Delta y = y_f - y_i = -7.0\,m - 5.0\,m = -12.0\,m$

$\theta = \tan^{-1}\frac{\Delta y}{\Delta x} = \tan^{-1}(2.4) = -67°$.

10) A ball rolls over the edge of a table with a horizontal velocity v m/s. The height of the table is 1.6 m and the horizontal range of the ball from the base of the table is 20 m. What is the initial speed of the ball?

A) 9.8 m/s
B) 20 m/s
C) 35 m/s
D) 4.9 m/s
E) 70 m/s

How long does it take the ball to hit the ground?

$y = y_0 - \frac{1}{2}gt^2 \rightarrow t = \sqrt{\frac{2(y-y_0)}{g}} = 0.57\,s$

The initial speed is in the x direction (motion with constant speed):

$v = \frac{x}{t} = \frac{20\,m}{0.57\,s} = 35\,m/s$

11) A bullet is fired from ground level with a speed of 150 m/s at an angle 30.0° above the horizontal. What is the horizontal component of its velocity after 4 seconds?

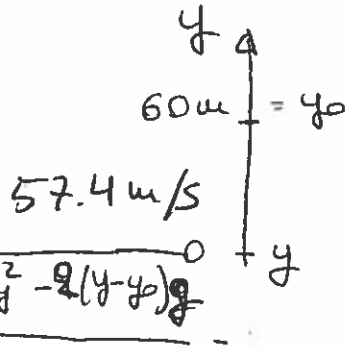
A) 150 m/s
B) 35 m/s
~~C)~~ 130 m/s
D) 75.0 m/s
E) 37.5 m/s

The horizontal component of the velocity stays the same all the time, and it is equal to the initial one:

$v_x = v \cos 30° = 130 \text{ m/s}$

12) A projectile is shot from the edge of a vertical cliff 60.0 m above the ocean. It has a speed of 100 m/s and is fired at an angle of 35.0° above the horizontal. How far from the foot of the vertical cliff does the projectile hit the water?

A) 126 m
B) 312 m
C) 684 m
~~D)~~ 1040 m
E) 540 m



Motion along y:

$y = y_0 + v_{oy} t - \frac{1}{2} g t^2$

$v_{oy} = v_0 \sin 35° = 57.4 \text{ m/s}$

We solve for t: $t = \frac{+v_{oy} \pm \sqrt{v_{oy}^2 - 2(y - y_0)g}}{g} = 12.7 \text{ s}$

Along x we have:

$x = v_{ox} t = v_0 \cos 35° \cdot (12.7 \text{ s}) = 1040 \text{ m}$

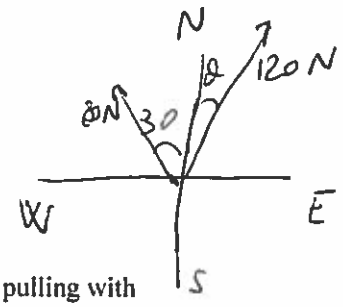
13) A boy kicks a football from ground level with a certain initial velocity v_0 at an angle 30.0° above the horizontal. In 2.00 seconds the ball completes its trajectory and hits the ground. What is the value of v_0?

A) 9.80 m/s
B) 4.90 m/s
C) 39.2 m/s
~~D)~~ 19.6 m/s
E) 78.4 m/s

$y = y_0 + v_{oy} t - \frac{1}{2} g t^2 \qquad y_0 = y = 0$

$v_{oy} = \frac{1}{2} g t = 9.81 \text{ m/s}$

$v_0 = \frac{v_{oy}}{\sin 30°} = 19.6 \text{ m/s}$



14) A 1000-kg barge is being towed by means of two horizontal cables. One cable is pulling with a force of 80.0 N in a direction 30.0° west of north. In what direction should the second cable pull so that the barge will accelerate northward, if the force exerted by the cable is 120 N?

~~A)~~ 19.5° east of north
B) 21.1° east of north
C) 39.0° east of north
D) 47.5° east of north
E) 54.7° east of north

The horizontal components of the two forces have to cancel each other:

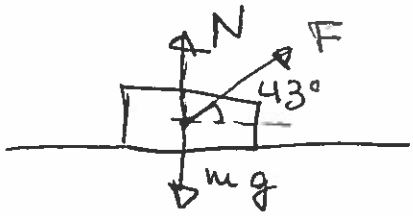
$80.0\,N \cdot \sin 30° = 120\,N \sin\theta$

$40N = 120\,N \sin\theta$

$\sin\theta = \frac{1}{3} \rightarrow \theta = 19.5° \text{ E of N.}$

15) A 40.0-kg suitcase is being pulled along the ground by means of a strap which exerts a force of 10.0 N at an angle of 43.0° above the horizontal. What is the normal force exerted by the ground?

A) 17.1 N
B) 15.7 N
~~C)~~ 386 N
D) 272 N
E) 398 N



$N + F\sin 43° - mg = 0$

$N = mg - F\sin 43° = 386N$

16) An object rests on an inclined surface. If the inclination of the surface is made steeper, what does the normal force on the object do?

A) increase
~~B)~~ decrease
C) stays the same
D) The normal force is zero N.
E) Cannot be determined without additional information.

17) An elevator is moving downwards with an acceleration of -1 m/s^2. What is the apparent weight of an 80-kg man standing in the elevator?

A) 785 N
B) 1000 N
C) 650 N
~~D)~~ 705 N
E) 865 N

$W = m(g - a) = 80kg \cdot 8.81\frac{m}{s^2} = 705N$