Exam 1
Phys 220
Fall 2013 – Version A

Name: Solution Lab group: _____

Fill out the scantron sheet for problems 1 - 17

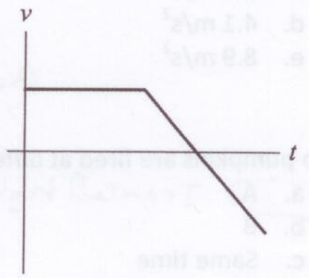
1. Rank in order, from the most to the fewest, the number of significant figures in the following numbers: A. 430 B. 43.0 C. 0.430 D. 4.30×10^2
   a. B=C = A=D (2 digits; 3 digits; 3 digits; 3 digits)
   b. D=A>C=B
   c. D=B>C>A
   d. B=D=C>A

2. If an object has a negative velocity and a negative acceleration, it means the object will
   a. slow to a stop.
   b. speed up.
   c. slow down, turn around and speed up in the other direction
   d. remain at a constant speed

3. When a ball is thrown up into the air with an initial velocity of 10 m/s, what is its velocity at the top of its flight?
   a. $v = 0$ m/s
   b. $v = -10$ m/s
   c. $v = 10$ m/s
   d. Not enough information is given.

4. When a ball is thrown up into the air, what is its acceleration at the top of its flight?
   a. $a = 0$ m/s^2
   b. $a = -9.8$ m/s^2 gravity always acts
   c. $a = 9.8$ m/s^2
   d. Not enough information is given.

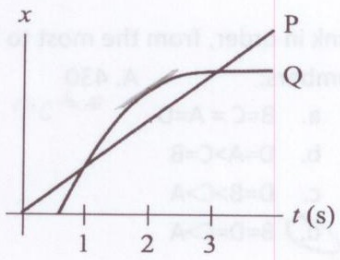
5. What does the slope of this graph represent?
   a. Position
   b. Velocity
   c. Acceleration



6. What does the area under the curve of this graph represent?
   a. Position
   b. Velocity
   c. Acceleration

7. Which of the following quantities includes direction?
   a. Position
   b. length
   c. speed
   d. acceleration
   e. more than one of the above

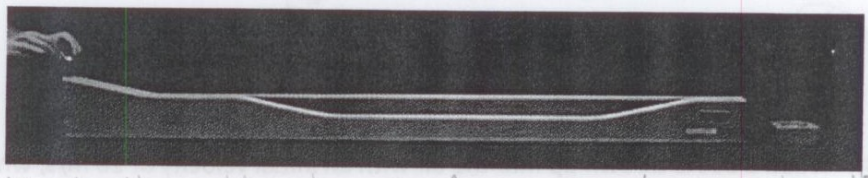
8. Soccer balls P and Q move with the position graphs as shown. Do P and Q ever have the same velocity? If so at what time or times?



   a. P and Q never have the same velocity.
   b. P and Q have the same velocity at 0 s.
   c. P and Q have the same velocity at 1 s, 2 s, and 3 s.
   d. P and Q have the same velocity at 1 s and 3 s.
   e. P and Q have the same velocity at 2 s.

Same slope at the 2 s mark

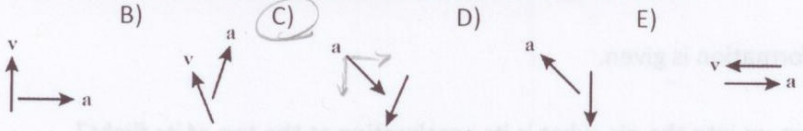
9. Two balls are released at the same time on the two tracks shown below. Which ball wins?
   a. The ball on the low road
   b. The ball on the high road
   c. They tie



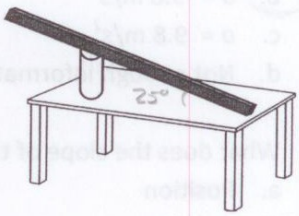
the ball on the low road is going faster when in the low section.

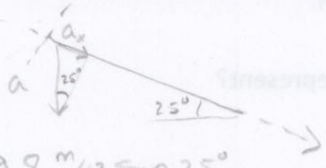
10. Shown here are the velocity and acceleration vectors for an object in several different types of motion. In which case is the object speeding up and turning to its left?

A) B) C) D) E)



11. A cart is rolling down the ramp shown (inclined to 25° above the horizontal). What is the magnitude of the acceleration of the cart?
   a. 9.8 m/s²
   b. 0 m/s²
   c. 2.5 m/s²
   d. 4.1 m/s²
   e. 8.9 m/s²

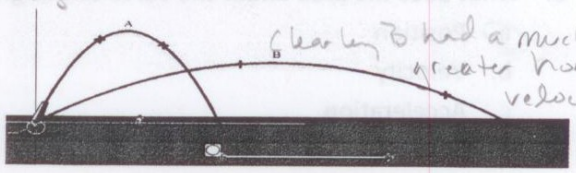




$a_x = 9.8\ m/s^2 \sin 25°$

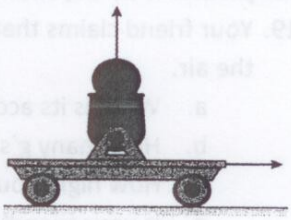
$= 4.1\ m/s^2$

12. Two pumpkins are fired at different angles (ignore air resistance). Which one is in the air longer?
   a. A Traveled higher so in the air longer
   b. B
   c. Same time
   d. Not enough information



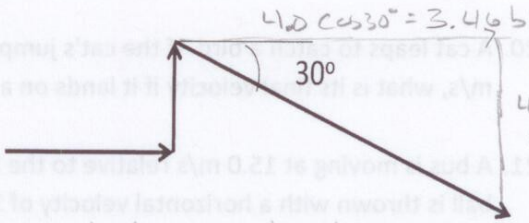
Clearly B had a much greater horizontal velocity

13. What will happen if the cart rolls at a constant velocity and then shoots a ball straight up?



a. The ball will land behind the cart
b. The ball will land in the cart. Both have the same horizontal velocity
c. The ball will land in front of the cart.
d. Depends on the initial velocity of the cart.

14. A person walks 2.0 blocks ~~west~~ East, 1.0 block North and then 4.0 blocks 30° ~~East of North~~ North of East. What is the magnitude of their total displacement?



a. 3.5 blocks
b. 3.9 blocks
c. 5.6 blocks
d. 6.2 blocks
e. 7.0 blocks

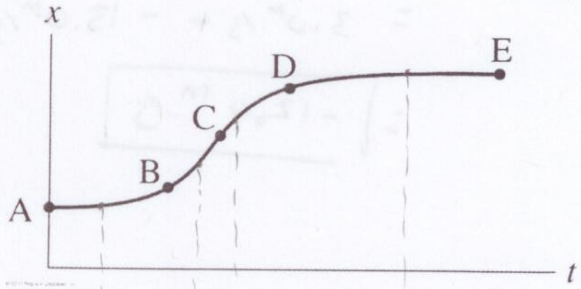
East: 2.0 blocks + 3.46 blocks = 5.46 blocks East
South: −1.0 block + 2.0 blocks = 1.0 block South
$(5.46)^2 + (1.0)^2 = 5.55$ blocks

15. A skate boarder jumps off of a ramp that is placed 10° above the horizontal. The skateboarder's initial velocity is 5.0 m/s. What is the skateboarder's initial velocity in the y direction?

a. 9.8 m/s
b. 5.0 m/s
c. 4.9 m/s
d. 1.4 m/s
e. 0.87 m/s

5.0 m/s @ 10°
5.0 m/s sin 10° = 0.868 m/s

Questions 16 –18 The plot to the right shows the position of an object as a function of time. The letters A-E represent particular moments of time.



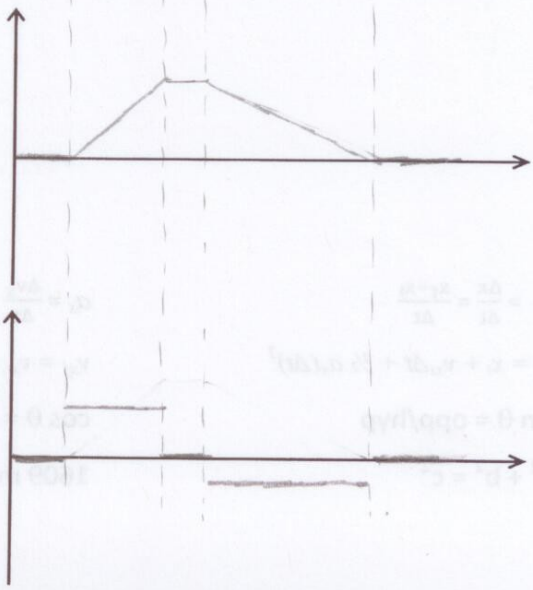
16. At which moment in time is the speed of the object the highest?

a. A
b. B
c. C steepest slope
d. D
e. E

17. At instant E the velocity of the object is

a. positive
b. negative
c. zero no slope
d. Not enough info

18. Sketch the corresponding velocity vs. time and acceleration vs. time graphs for the graph in #16. Use dashed lines to indicate where the graphs line up with each other.



1a. Push

$y_i = 0m$

$y_f = 0.005m$

$v_{yi} = 0 m/s$

$v_{yf} = 6 m/s$

$a_y =$

$\Delta t = ?$

Free Fall

$y_i = 0.005m$

$y_F = ?$

$V_E = 6 m/s$

$V_F = 0 m/s$

$a_y = -9.8 m/s^2$

$\Delta t = ?$

a. $V_{yF}^2 = V_{yi}^2 + 2a_y \Delta y$

$6 m^2/s^2 = 0 m^2/s^2 + 2a_y(0.005m - 0m)$

$36 m^2/s^2 = 2a_y\, 0.005m$

$\frac{36 m^2/s^2}{0.01 m} = \boxed{3600 m/s^2}$

b. $3600 m/s^2 \left(\frac{1g}{9.8 m/s^2}\right) = 367 g's \Rightarrow \boxed{400 g's}$ with safety

c. $V_{yF}^2 = V_{yi}^2 + 2a\Delta y$

$(0 m/s)^2 = (6 m/s)^2 + 2(-9.8 m/s^2)(y_f - 0.005m)$

$-36 m^2/s^2 = -19.6 m/s^2 y_f + 0.098 m^2/s^2$

$\frac{-36.098 m^2/s^2}{-19.6 m/s^2} = y_f = \boxed{1.8 m}$

d. Not likely. The grasshopper would be jumping as high as you are tall!

20. $x_i = 0m$
$x_f = ?$
$v_{xi} = 5.0 m/s \cos 60° = 2.5 m/s$
$v_{xf} = 2.5 m/s$
$a_x = 0 m/s^2$
$\Delta t = ?$

$y_i = 0m$
$y_f = 0.50m$
$v_{yi} = 5.0 m/s \sin 60° = 4.33 m/s$
$v_{yf} = ?$
$a_y = -9.8 m/s^2$
$\Delta t = ?$

$v_{fy}^2 = v_{iy}^2 + 2a\Delta y$

$v_{fy}^2 = (4.33 m/s)^2 + 2(-9.8 m/s^2)(0.50m - 0m)$

$v_{fy}^2 = 18.75 m^2/s^2 + -9.8 m^2/s^2$

$= 8.95 m^2/s^2$

$v_{fy} = \pm 2.99 m/s$ + if cat lands on way up
− if cat lands on way down

I drew cat landing on the way down so

$v_{fy} = \underline{-3.0 m/s}$

$v_f = \sqrt{v_{xf}^2 + v_{yf}^2}$

$= \sqrt{(2.5 m/s)^2 + (3.0 m/s)^2}$

$= \boxed{3.9 m/s}$

$\tan\theta = \frac{v_{yf}}{v_{xf}} = \frac{-3.0 m/s}{2.5 m/s}$

$\theta = \tan^{-1}(-1.2)$

$= \boxed{-50°}$

If your cat landed on the way up the angle would be +50°

For problems 19-21, show all your work for credit!

19. Your friend claims that a grasshopper can accelerate from 0 to 6 m/s when jumping straight up into the air.
    a. What is its acceleration if its legs extend over a distance of 0.5 cm while pushing off?
    b. How many g's does it undergo?
    c. How high would the grasshopper jump?
    d. Is your friend's claim reasonable? Why or why not?

20. A cat leaps to catch a bird. If the cat's jump was at 60.0° off the ground and its initial velocity was 5.0 m/s, what is its final velocity if it lands on a chair 0.50 m off the floor? Include a diagram for clarity.

21. A bus is moving at 15.0 m/s relative to the Earth. A passenger throws a football to his friend. If the ball is thrown with a horizontal velocity of 3.0 meters per second relative to the Earth, what is its velocity relative to the bus? Use the symbolic notation for relative velocity to solve this problem.

$V_{BE} = 15.0\ m/s \rightarrow V_{EB} = -15.0\ m/s$

$V_{FE} = 3.0\ m/s$

$V_{FB} = V_{FE} + V_{EB}$

$= 3.0\ m/s + -15.0\ m/s$

$= \boxed{-12.0\ m/s}$

$v_x = \frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{\Delta t}$ $\quad a_x = \frac{\Delta v_x}{\Delta t} = \frac{v_{xf} - v_{xi}}{\Delta t}$ $\quad a = \frac{v^2}{r}$ $\quad f = \frac{1}{T}$

$x_f = x_i + v_{xi}\Delta t + \frac{1}{2}\, a_x(\Delta t)^2$ $\quad v_{xf} = v_{xi} + a_x\Delta t$ $\quad v_{xf}^2 = v_{xi}^2 + 2a_x(\Delta x)$

$\sin\theta$ = opp/hyp $\quad \cos\theta$ = adj/hyp $\quad \tan\theta$ = opp/adj

$a^2 + b^2 = c^2$ $\quad$ 1609 meters = 1 mile $\quad$ 3600 seconds = 1 hour