

Phys 105, Fall 09

PART 1 Exam 1

V.A

SUBJECTIVE SCORE INSTRUCTOR USE ONLY				
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9	8	7	6	5
4	3	2	1	0

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IMPORTANT

USE NO. 2 PENCIL ONLY

- MAKE DARK MARKS
- ERASE COMPLETELY TO CHANGE
- EXAMPLE: A B C D E

TO USE SUBJECTIVE SCORE FEATURE:

- Mark total possible subjective points
- Only one mark per line on key
- 163 points maximum

EXAMPLE OF STUDENT SCORE:

100	90	80	70	60
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9	8	7	6	5
4	3	2	1	0

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As a student at NJIT I (sign) _____, will conduct myself in a professional manner and will comply with the provisions of the NJIT Academic Honor Code. I also understand that I must subscribe to the following pledge on major work submitted for credit as described in the NJIT Academic Honor code: On my honor, I pledge that I have not violated the provisions of the NJIT Academic Honor Code.

The exam is closed book and closed notes.

There are 15 multiple choice questions. Choose the answer closest to your calculated answer. Make sure you put your name, section, and ID number on the SCANTRON form. Put your answers on the SCANTRON form provided with a number 2 pencil. Make Give only one (1) answer to each question. If you erase an answer on the SCANTRON form, make sure all traces are removed.

1. Suppose an equation relating position, x (m), to time, t (s), is given by $x^2 = bt^3 + ct^4$, where b and c are constants. The dimensions of b and c are respectively:

- a. s^3, s^4
- b. $1/s^3, 1/s^4$
- c. $m/s^3, m/s^4$
- d. $m^2/s^3, m^2/s^4$
- e. $m \cdot s^3, m \cdot s^4$

Dimensional analysis

$$[x^2] = [bt^3 + ct^4]$$

all should have same dimension

$$[x^2] = [bt^3]$$

$$L^2 = [b]T^3, [b] = L^2/T^3$$

$$[x^2] = [ct^4] \rightarrow m^2/s^3$$

$$\therefore [c] = L^2/T^4 \rightarrow m^2/s^4$$

2. An object's velocity in equivalent words, is which of the following?

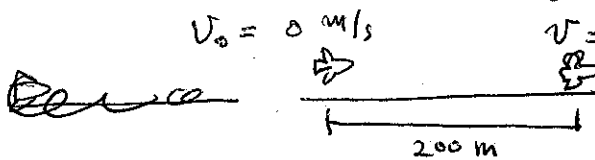
- a. distance
- b. rate of change of displacement
- c. rate of change of total distance traveled
- d. rate of change of acceleration
- e. none of the above

$$V = \frac{\Delta x}{\Delta t}$$

3. A airplane has a lift-off speed of 150 km/hr. What minimum constant acceleration does it need to take off in 200 m? The airplane starts from rest.

- a. 4.92 m/s^2
- b. 3.63 m/s^2
- c. 2.35 m/s^2
- d. 4.35 m/s^2
- e. 5.92 m/s^2

$$150 \text{ km/hr} = \frac{150 \times 1000 \text{ m}}{60 \times 60 \text{ s}} = 41.7 \text{ m/s}$$

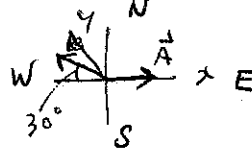


$$v^2 - v_0^2 = 2a \Delta x$$

$$a = \frac{41.7^2}{2 \times 200} = 4.35 \text{ m/s}^2$$

4. Find the resultant sum of the following two vectors: i) 25 units due east and ii) 50 units 30° north of west.

- a. 70 units 30° north of west
- b. 62 units 15° north of west
- c. 62 units 60° north of west
- d. 31 units 54° north of west
- e. 31 units 15° west of north



$$|\vec{A}| = 25, \theta_A = 0^\circ$$

$$|\vec{B}| = 50, \theta_B = 180 - 30 = 150^\circ$$

$$\vec{C} = \vec{A} + \vec{B}$$

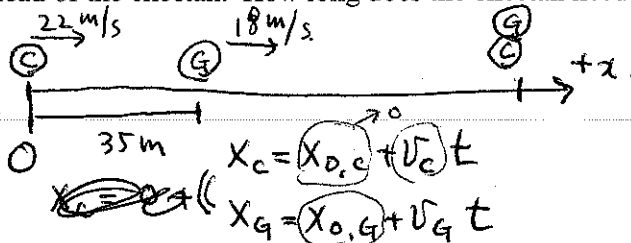
$$C_x = A_x + B_x = -18.3$$

$$C_y = A_y + B_y = 25$$

$$|\vec{C}| = \sqrt{18.3^2 + 25^2} = 30.9$$

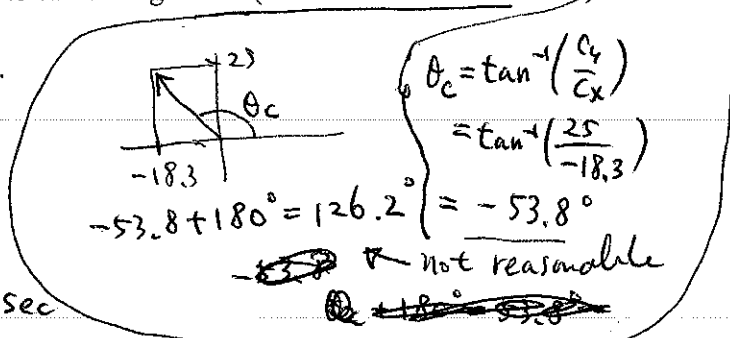
5. A cheetah is chasing a gazelle. The cheetah runs at 22.0 m/s and the gazelle runs at 18.0 m/s. The gazelle starts at 35.0 m ahead of the cheetah. How long does the cheetah need to catch the gazelle? (Work in consistent SI units)

- a. 8.75 s
- b. 4.36 s
- c. 6.30 s
- d. 10.7 s
- e. 5.35 s



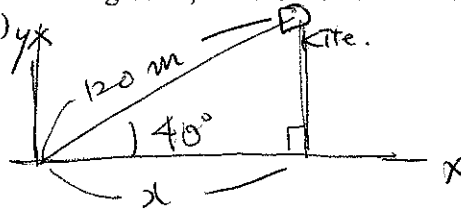
$$0 + 22 \cdot t = 35 + 18 \cdot t$$

$$\therefore 22t - 18t = 35, 4t = 35, t = \frac{35}{4} = 8.75 \text{ sec}$$



6. A string attached to an airborne kite is maintained at an angle of 40° with the horizontal. If a total of 120 m of string is reeled in while bringing the kite back to the ground, what is the horizontal displacement of the kite in the process? (Assume the kite string doesn't sag.)

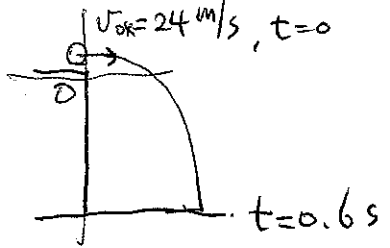
- a. 100 m
- b. 84 m
- c. 77 m
- d. 92 m
- e. 88 m



$$x = 120 \cdot \cos 40^\circ = 92 \text{ m}$$

7. A ball is rolled horizontally off a table with an initial speed of 0.24 m/s. A stopwatch measures the ball's trajectory time from table to the floor to be 0.60 s. What is the height of the table? (Use $g = 9.8 \text{ m/s}^2$ and neglect air resistance.)

- a. 1.76 m
- b. 0.74 m
- c. 2.94 m
- d. 1.26 m
- e. 0.44 m

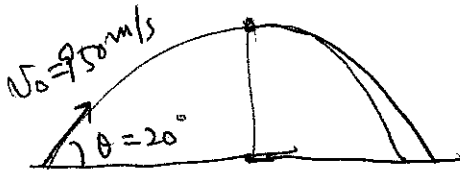


$$y = y_0 + \frac{v_{oy}}{1} t - \frac{1}{2} g t^2$$

$$y = -\frac{1}{2} \times 9.8 \times 0.6^2 = -1.76 \text{ m}$$

8. A projectile is launched from a level plane at 20° from horizontal with an initial velocity of 950 m/s. What is the maximum height above the plane the projectile will reach?

- A) 885 m
- B) 1.3 km
- C) 2.6 km
- D) 5.4 km
- E) 10 km



$$v_{x0} = v_0 \cos \theta = 950 \times \cos 20^\circ = 893 \text{ m/s}$$

$$v_{y0} = v_0 \sin \theta = 950 \times \sin 20^\circ = 325 \text{ m/s}$$

$$\frac{v_y^2 - v_{y0}^2}{1} = \frac{-2g \Delta y}{1} \therefore \Delta y = \frac{-324^2}{-2 \times 9.8} = 5356 \text{ m}$$

9. A European sports car will accelerate at a constant rate from rest to a speed of 150 km/hr in 10.0 s. What is the speed after the first 5.00 s of acceleration?

- a. 34.7 m/s
- b. 44.4 m/s
- c. 28.7 m/s
- d. 20.8 m/s
- e. 15.2 m/s

$$150 \text{ km/hr} = \frac{150 \times 1000 \text{ m}}{60 \times 60 \text{ s}} = 41.7 \text{ m/s}$$

$$v = v_0 + at \quad 41.7 = 0 + a \times 10 \quad \therefore a = \frac{41.7}{10} = 4.17$$

Again for $t = 5 \text{ sec}$

$$v = v_0 + at = 0 + 4.17 \times 5 \text{ sec} = 20.85 \text{ m/s}$$

10. Water flows into a swimming pool at the rate of 4.0 gal/min. The pool is 32 ft wide, 32 ft long and 8.0 ft deep. How long does it take to fill?

- a. 256 hours
- b. 64 hours
- c. 128 hours
- d. 384 hours
- e. 32 hours

$\frac{4.0 \text{ gal}}{\text{min}}$ (Volume of the pool)

$$= 32 \text{ ft} \times 32 \text{ ft} \times 8 \text{ ft} = 8192 \text{ ft}^3$$

flow rate $4.0 \text{ gal/min} = 4.0 \times 0.134 \text{ ft}^3/\text{min} = 0.536 \text{ ft}^3/\text{min}$

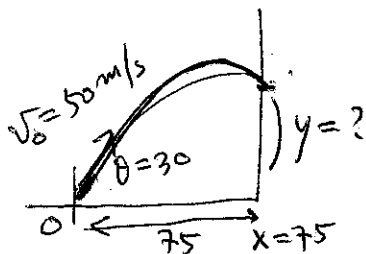
$$\text{Flow rate} = \frac{\text{Volume}}{\text{Time}} \text{ or } R = \frac{V}{T}$$

$$\therefore T = \frac{V}{R} = \frac{8192}{0.536} = 15284 \text{ min}$$

$$15284 / 60 = 255 \text{ hours}$$

11. A fireman, 75.0 m away from a burning building, directs a stream jet of water from a ground level fire hose at angle of 30° above the horizontal. If the speed of the stream as it leaves the hose is 50 m/s, at what height will the stream of water strike the building?

- a. 23.2 m
- b. 33.3 m
- c. 42.9 m
- d. 14.3 m
- e. 28.6 m



$$v_{0x} = v_0 \cos \theta = 50 \times \cos 30^\circ = 43.3 \text{ m/s}$$

$$x = x_0 + v_{0x} t$$

$$75 = 43.3 \times t \quad t = \frac{75}{43.3} = 1.73$$

$$y = y_0 + v_{0y} t - \frac{1}{2} g t^2 = 25 \times 1.73 - \frac{1}{2} \times 9.8 \times 1.73^2$$

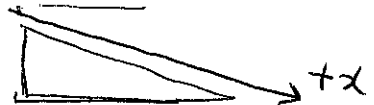
$$= 28.6 \text{ m.}$$

12. A car starts from rest and goes down a slope with a constant acceleration of 4 m/s^2 . After 6 s the car reaches the bottom of the hill. What is its speed at the bottom of the hill?

- A) 6.0 m/s
- B) 12.0 m/s
- C) 24 m/s
- D) 50 m/s
- E) 72 m/s

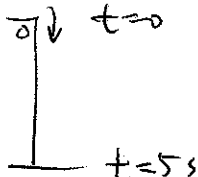
$$v = v_0 + at$$

$$= 0 + 4 \times 6 = 24$$



13. An object dropped from the window of a tall building hits the ground in 5 s. If its acceleration is 10 m/s^2 , the height of the window above the ground is:

- A) 25 m
- B) 50 m
- C) 125 m
- D) 170 m
- E) 330 m



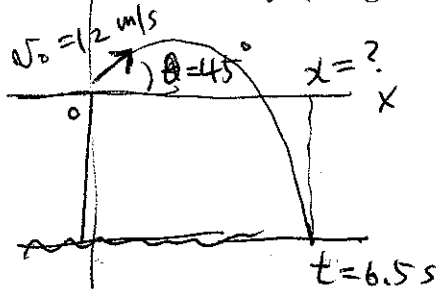
$$y = y_0 + v_{0y} t - \frac{1}{2} g t^2$$

$$= 0 + 0 - \frac{1}{2} \times 10 \times 5^2 = -125 \text{ m.}$$

~~Height = -122.5 m~~ Height = 125 m.

14. A stone is thrown at an angle of 45° above the horizontal from the top edge of a cliff with an initial speed of 12 m/s. A stop watch measures the stone's trajectory time from top of cliff to bottom to be 6.5 s. How far out from the cliff's edge does the stone travel horizontally? (Use $g = 9.8 \text{ m/s}^2$, neglect air resistance).

- a. 65 m
- b. 55 m
- c. 120 m
- d. 197 m
- e. 90 m



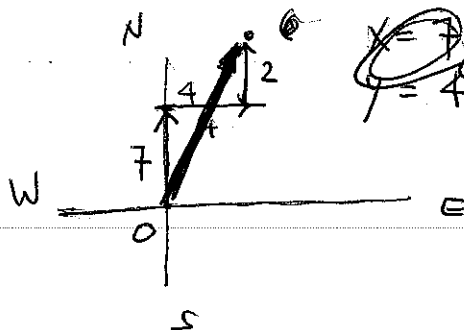
$$v_{0x} = v_0 \cos \theta = 12 \times \cos 45^\circ = 8.49 \text{ m/s.}$$

$$x = x_0 + v_{0x} t$$

$$= 0 + 8.49 \times 6.5 = 55.2 \text{ m.}$$

15. A taxicab travels 7.0 blocks due north (+y direction), then 4.0 blocks due east (+x direction) and then another 2.0 blocks due north. What is the magnitude of the taxicab's total displacement vector? (All blocks have the same length.)

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



~~x = 7 + 2 = 9~~ Final position
y = 4

$$x = 4$$

$$y = 7 + 2 = 9$$

$$|\Delta r| = \sqrt{x^2 + y^2}$$

$$= \sqrt{4^2 + 9^2} = 9.8 \text{ blocks}$$