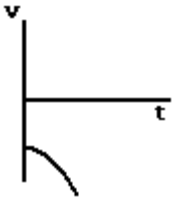
Fall 2012
Physics 301
Exam I
A

Name_____

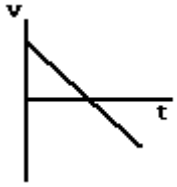
MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question (15 points).

1) A child standing on a bridge throws a rock straight down. The rock leaves the child's hand at t = 0. 1) _____
Which of the graphs shown here best represents the velocity of the stone as a function of time?

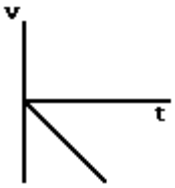
A)



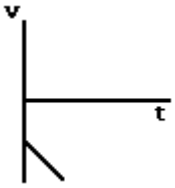
B)



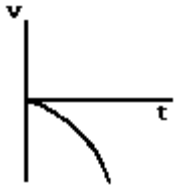
C)



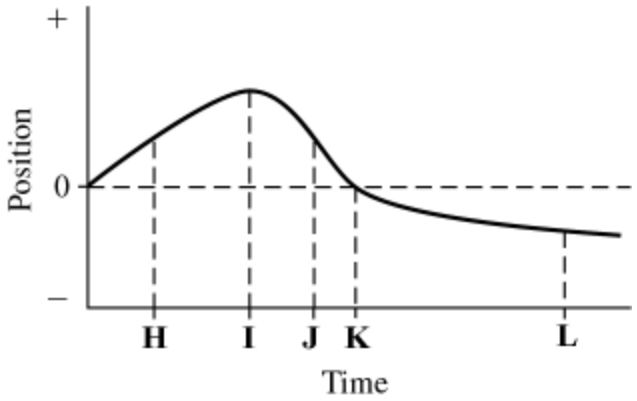
D)



E)



2) The plot below shows the position of an object as a function of time. The letters H–L represent particular moments of time. At which moment in time is the speed of the object the highest? 2) _____



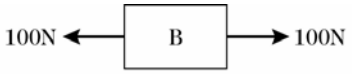
A) J B) H C) I D) K E) L

3) Two bullets are fired simultaneously parallel to a horizontal plane. The bullets have different masses and different initial velocities. Which one will strike the plane first? 3) _____

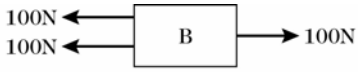
A) They strike the plane at the same time.
B) the slowest one
C) the fastest one
D) the lightest one
E) the heaviest one

4) Two blocks, A and B, are being pulled to the right along a horizontal surface by a horizontal 100 N pull, as shown in the figure. Both of them are moving together at a constant velocity of 2.0 m/s to the right, and both weigh the same. Which of the figures below shows a correct free–body diagram of the horizontal forces acting on lower block, B? 4) _____

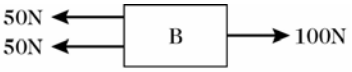
A)



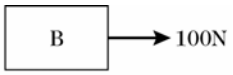
B)



C)



D)



E) None of these diagrams is correct.

5) The sum of two vectors has the greatest magnitude when the angle between these two vectors is 5) _____

A) 90°. B) 180°. C) 270°. D) 60°. E) 0°.

6) For which value of θ is the height of a projectile fired from ground level a maximum? 6) _____

A) 30° above the horizontal
B) 90° above the horizontal
C) 55° above the horizontal
D) 60° above the horizontal
E) 45° above the horizontal

7) A test rocket is fired straight up from rest with a net acceleration of 20 m/s^2. After 4 seconds the motor turns off, but the rocket continues to coast upward. What maximum elevation does the rocket reach? 7) _____

A) 487 m B) 160 m C) 327 m D) 320 m E) 408 m

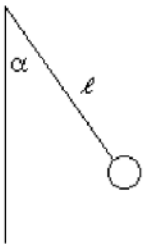
8) A bullet is fired from ground level with a speed of 150 m/s at an angle 30 ° above the horizontal at a location where g = 10.0 m/s^2. How long does it take before the bullet hits the ground? 8) _____

A) 15 seconds
B) 30 seconds
C) 7.5 seconds
D) 5.0 seconds
E) 10 seconds

9) A 40.0–kg box is being pushed along a horizontal, smooth surface. The pushing force is 15.0 N directed at an angle of 15.0° below the horizontal. What is the acceleration of the crate? 9) _____

A) 0.375 m/s^2 B) 0.362 m/s^2 C) 0.158 m/s^2 D) 0.684 m/s^2 E) 0.466 m/s^2

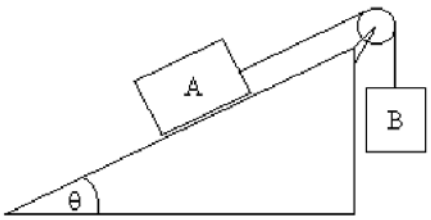
Figure 6–15



10) A 20.0–gram mass is attached to a 120 cm–long string as shown in Figure 6–15. It moves in a horizontal circle with a constant speed of 1.50 m/s. The angle α made due to this maotion is small. What is the angle α? (hint for small angles, tan α= sin α) 10) _____

A) 10.8° B) 49.2° C) 13.5° D) 17.7° E) 24.6°

Figure 6–12

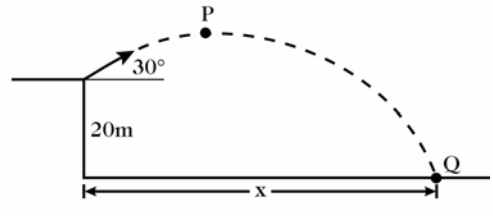


11) Two masses are connected by a string which goes over an ideal pulley as shown in Figure 6–12. Block A has a mass of 3.00 kg and can slide along a rough plane inclined 30.0 ° to the horizontal. The coefficient of kinetic friction between block A and the plane is 0.400. Block B has a mass of 2.77 kg. What is the acceleration of the blocks? 11) _____

A) 0 m/s^2 B) 1.96 m/s^2 C) 0.392 m/s^2 D) 3.12 m/s^2 E) 5.35 m/s^2

12) An ant walks down the surface of a ball. If the ant begins to slip when the normal force is less than one–third of the ant's weight, at what angle, measured from the top of the ball, does the ant begin to slip? 12) _____

A) 35.2° B) 18.4° C) 70.5° D) 19.5° E) 55.0°



13) A projectile is fired from the origin (at y = 0 m) as shown in the figure. The initial velocity components are v_{ox} = 940 m/s and v_{oy} = 96 m/s. The projectile reaches maximum height at point P, then it falls and strikes the ground at point Q. In the figure, the y–coordinate of point P is closest to: 13) _____

A) 45,550 m B) 90,160 m C) 940 m D) 45,080 m E) 470 m

14) A racquetball strikes a wall with a speed of 30 m/s and rebounds with a speed of 26 m/s. The collision takes 20 ms. What is the average acceleration of the ball during the collision? 14) _____

A) 1500 m/s^2 B) zero C) 1300 m/s^2 D) 200 m/s^2 E) 2800 m/s^2

15) A 36.0–kg child steps on a scale in an elevator. The scale reads 400 N. What is the magnitude of the acceleration of the elevator? 15) _____

A) 9.81 m/s^2 B) 0.206 m/s^2 C) 4.91 m/s^2 D) 0.969 m/s^2 E) 46.9 m/s^2

16) A 1000–kg car is picking up speed as it goes around a horizontal curve whose radius is 100 m. The coefficient of static friction between the tires and the road is 0.350. At what speed will the car begin to skid sideways? 16) _____

A) 9.25 m/s B) 18.5 m/s C) 34.3 m/s D) 35.0 m/s E) 23.6 m/s

17) You walk 53 m to the north, then turn 60° to your right and walk another 45 m. Determine the direction of your displacement vector. Express your answer as an angle relative to east. 17) _____

A) 50° N of E B) 57° N of E C) 63° N of E D) 69° N of E

18) A 50.0–kg block is being pulled up a 13.0° slope by a force of 250 N which is parallel to the slope, but the block does not slide up the slope. What is the minimum value of the coefficient of static friction required for this to happen? 18) _____

A) 0.566 B) 0.359 C) 0.230 D) 0.654 E) 0.115

19) A 50.0–kg box is resting on a horizontal floor. A force of 250 N directed at an angle of 20.7° below the horizontal is applied to the box. The coefficient of kinetic friction between the box and the surface is 0.300. What is the acceleration of the box? 19) _____

A) 1.77 m/s^2 B) 1.74 m/s^2 C) 2.84 m/s^2 D) 5.14 m/s^2 E) 3.54 m/s^2

20) Consider a particle moving with constant speed such that its acceleration of constant magnitude is always perpendicular to its velocity. 20) _____

A) It is moving in a parabola.
B) It is moving in a circle.
C) It is moving in a straight line.
D) It is moving in a hyperbola.
E) None of the above is definitely true all of the time.

Answer Key
Testname: EXAM 1-A

1) D
2) A
3) A
4) A
5) E
6) B
7) A
8) A
9) B
10) E
11) C
12) C
13) E
14) E
15) D
16) B
17) C
18) C
19) B
20) B

Fall 2012
Physics 301
Exam I - Solution

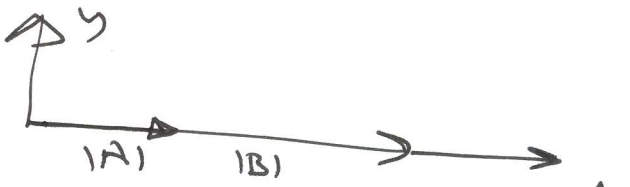
#1 Answer is "D" since $v_y = v_{oy} - gt$ so it is is a linear function of time.

#2 Answer is "A" "J" segment has the highest slope.

#3 answer is "A" since y is the same for both.

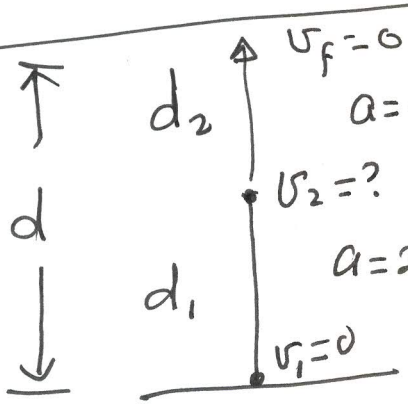
#4 Answer is A since the net force is zero so $a = 0 \Rightarrow v$ is constant.

#5 Answer is "E" if the angle is 0° then the sum $|A| + |B|$ would be maxium.



#6 Aswer is 90° "B"

#7



$$d_1 = v_0 t + \frac{1}{2} a t^2$$

$$d_1 = \frac{1}{2} a t^2 = \frac{1}{2} \times (20)(4)^2$$

$$= 160 \text{ meters.}$$

$$v_2 = v_1 + at \Rightarrow v_2 = 0 + 20 \times 4 = 80 \text{ m/s}$$

~~$d_2 = \frac{1}{2} v_2 t - \frac{1}{2} g t^2$~~

$$v_F^2 = v_2^2 - 2g\Delta y$$

$$0 = (80)^2 - 2 \times 9.8 \times \Delta y$$

$$\Delta y = \frac{6400}{2 \times 9.8} = 326.53$$

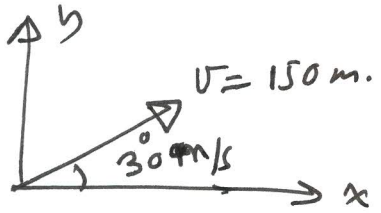
$$d_2 = \Delta y = 326.53$$

$$\therefore d = d_1 + d_2 = 160 + 326.53$$

$$d = 486.5 \text{ m}$$

Answer is "A"

#8



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

$$v_{oy} = v_0 \sin 30 = 150 \times \frac{1}{2} = 75$$

$$\therefore \quad 0 = 0 + 75 \times t - \frac{1}{2} \times 10 \times t^2$$

$$\left(75 - \frac{1}{2} \times 10t\right)t = 0 \quad \Rightarrow t = 0$$

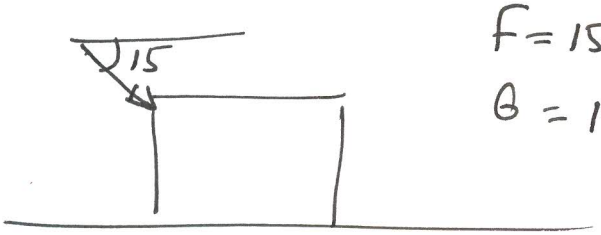
or

$$5t = 75$$

$$t = 75/5 = 15 \text{ sec.}$$

Answer is A

#9



$F = 15\ N$

$\theta = 15^\circ$

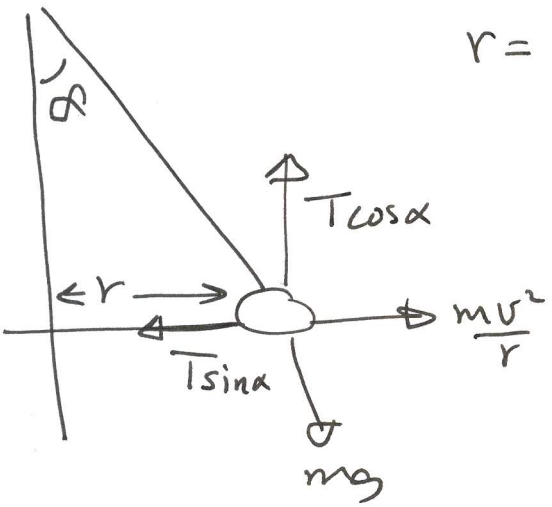
$F_x = F \cos\theta$

$= 15 \cos 15 = 14.48\ N$

$$\Rightarrow a = \frac{14.48}{40} = 0.362\ m/s^2$$

Answer is B

10



$r = l\sin\alpha$

$$T\sin\alpha = \frac{mv^2}{r}$$

$$T\cos\alpha = mg$$

$$\tan\alpha = \frac{mv^2}{mgr} = \frac{v^2}{gl\sin\alpha}$$

$$gl\sin\alpha\tan\alpha = v^2$$

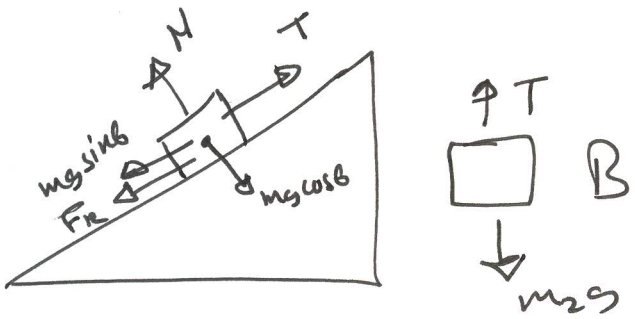
$$\Rightarrow \quad gl\sin^2\alpha = v^2$$

$$\Rightarrow \sin\alpha = \sqrt{\frac{v^2}{gl}} = 0.43$$

$$\Rightarrow \alpha = 25.9$$

Answer is "E"

11



$F_R = \mu_k m_1 g \cos\theta$

$\Rightarrow$ for A

$$T - m_1 g \sin\theta - \mu_k m_1 g \cos\theta = m_1 a \quad - (1)$$

for B

$$m_2 g - T = m_2 g \quad - (2)$$

adding (1) and (2)

$$m_2 g - m_1 g \sin\theta - \mu_k m_1 g \cos\theta = (m_1 + m_2) a$$

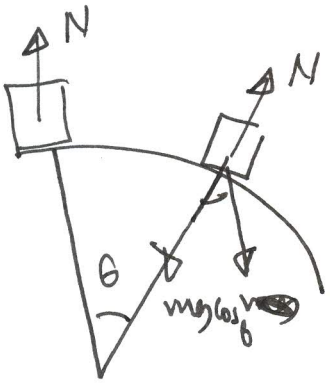
$$a = \frac{m_2 - (m_1 \sin\theta + \mu_k m_1 \cos\theta)}{m_1 + m_2} g$$

$$= \frac{2.77 - (3 \times \sin 30 + 0.4 \times 3 \times \cos 30)}{5.77} 9.8$$

$$= 0.392 \text{ m/s}^2$$

// Answer is C

#12



$mg\cos\theta = N = \frac{1}{3}mg$

$\Rightarrow \cos\theta = \frac{1}{3}$

$\theta = \cos^{-1}\left(\frac{1}{3}\right)$

$\theta = 70.5^\circ$

Answer is C

#13

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

and $v_y = v_{oy} - gt$ when $v_y = 0$

$$-v_{oy} = -gt$$

$$t = \frac{96}{9.8} = 9.795 \text{ sec.}$$

$$\Rightarrow y = 0 + 96 \times 9.795 - \frac{1}{2} \times 9.8 (9.795)^2$$

$$y = 940.4 - \frac{1}{2} \times 9.8 \times (9.795)^2$$

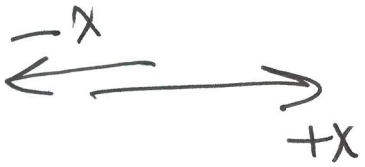
$$= 940.4 - 470.11 = 470.28 \text{ m}$$

Answer is E

#14

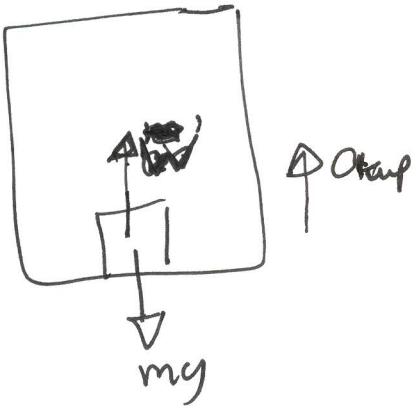
$$a = \frac{v_2 - v_1}{\Delta t} = \frac{30 - -26}{20 \times 10^{-3}}$$

$$= 2800 \text{ m/s}^2$$



Answer is E

#15



$a =$

$W - mg = ma$

$400 - 36 \times 9.8 = 36.a$

$$a = \frac{400 - 352.8}{36} = 1.31 \text{ m/s}^2$$

Answer is "D"

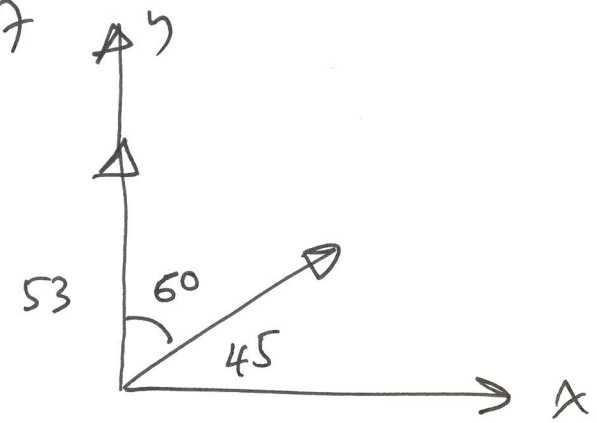
#16

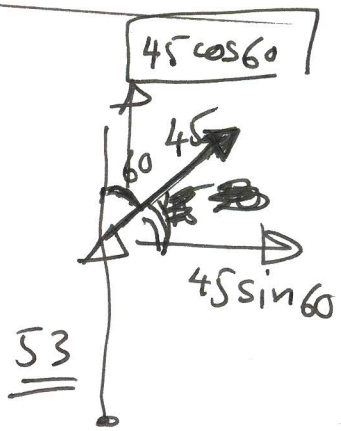
$$v = \sqrt{\mu_s g r} = \sqrt{0.35 \times 9.8 \times 100}$$

$$= 18.5 \text{ m/s}$$

Answer is B

#17





$$A_y = 53 + 45\cos 60 = 53 + 22.5 = 75.5 \text{ m}.$$

$$A_x = 45 \sin 60 = 38.9$$

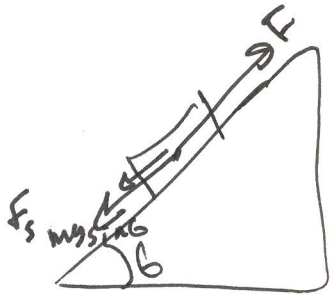
$$\Rightarrow A = \sqrt{A_x^2 + A_y^2} = 84.46$$

$$\theta = \tan^{-1}\left(\frac{75.5}{38.9}\right)$$

$\theta = 63^\circ$ North of east.

Answer is C

#18



$F - \mu_s mg\cos\theta - mg\sin\theta = 0$

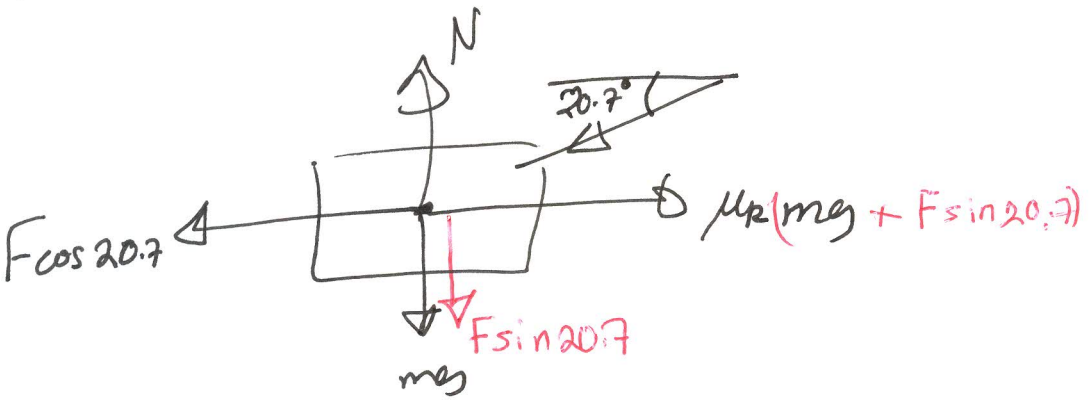
$\Rightarrow \mu_s = \frac{F}{mg\cos\theta} - \tan\theta$

$\tan\theta = \tan 13$

$\mu_s = 0.29$

Answer is C

#19



$F\cos 20.7 - \mu_k(mg + F\sin 20.7) = ma$

$$a = \frac{250 \times \cos 20.7 - 0.3 \times [50 \times 9.8 + 250 \times \sin 20.7}{50}$$

$$= \frac{233.86 - 147}{50} = 1.74 \text{ m/s}^2$$

$$= \frac{233.86 - 173}{50} = 1.2 \text{ m/s}^2$$

Answer is B

#20

Answer is B