MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1. The $x$- and $y$-coordinates of a particle in motion, as functions of time $t$, are given by:
   \[ x = 7t^2 - 7t + 6 \quad y = 4t^3 - 3t^2 - 12t - 5 \]
   At the instant the $x$-component of velocity is equal to zero, the $y$-component of the acceleration is closest to:
   
   \[ V_x = \frac{dx}{dt} = 14t - 7 = 0 \quad \Rightarrow \quad t = \frac{7}{14} \]
   
   A) $-30 \text{ m/s}^2$
   B) $6.0 \text{ m/s}^2$
   C) $-18 \text{ m/s}^2$
   D) $18 \text{ m/s}^2$
   E) $0.00 \text{ m/s}^2$

2. A projectile is fired from the origin (at $y = 0 \text{ m}$) as shown in the figure. The initial velocity components are $v_x = 980 \text{ m/s}$ and $v_y = 60 \text{ m/s}$. The projectile reaches maximum height at point $P$, then it falls and strikes the ground at point $Q$. In Fig. 3.2, the $y$-coordinate of point $P$ is closest to:
   
   A) $49,000 \text{ m}$
   B) $98,000 \text{ m}$
   C) $49,180 \text{ m}$
   D) $3180 \text{ m}$
   E) $370 \text{ m}$

3. A 50.0-N box is sliding on a rough horizontal floor, and the only horizontal force acting on it is friction. You observe that at one instant the box is sliding to the right at $1.75 \text{ m/s}$ and that it stops in $2.25 \text{ s}$ with uniform acceleration. The force that friction exerts on this box is closest to:
   
   A) $38.9 \text{ N}$
   B) $490 \text{ N}$
   C) $8.93 \text{ N}$
   D) $50.0 \text{ N}$
   E) $3.97 \text{ N}$

\[ a = \frac{\Delta v}{\Delta t} = \frac{1.75 \text{ m/s}}{2.25 \text{ s}} = \frac{1.75}{2.25} \text{ m/s}^2 \]

\[ F = ma = (5.1 \text{ kg})(-1.778 \text{ m/s}^2) = 3.97 \text{ N} \]

\[ m = \frac{F}{a} = \frac{5.1 \text{ N}}{9.8 \text{ m/s}^2} = 0.51 \text{ kg} \]
\[ \sum F_x = -40N \cos 25 + 30N \sin 35 + 50N \cos 40 \]
\[ = 19.3N \]

The opposite force is needed to keep things in equilibrium:
\[ B = 40N \]
\[ C = 50N \]
\[ -19.3N \]

Three forces \( A, B, \) and \( C \) act on a body as shown. A fourth force \( F \) is required to keep the body in equilibrium.

4. In Fig. 4.5, the \( x \)-component of force \( F \) is closest to:
   - A) -28 N
   - B) 19 N
   - C) -32 N
   - D) +28 N
   - E) +32 N

5. In Fig. 5.2, a block of mass \( M \) hangs in equilibrium. The rope that is fastened to the wall is horizontal and has a tension of 55 N. The rope that is fastened to the ceiling has a tension of 63 N, and makes an angle \( \theta \) with the ceiling. The angle \( \theta \) is:
   - A) 61°
   - B) 29°
   - C) 45°
   - D) 76°
   - E) 41°

\[ \sum F_x = -63N \cos \theta + 55N = 0 \]
\[ \cos \theta = \frac{55}{63} \]
\[ \theta = 29° \]
6. Blocks $A$ and $B$ of masses 19 kg and 15 kg, respectively, are connected by a rope, which passes over a light frictionless pulley, as shown. The horizontal surface is rough. The coefficients of static and kinetic friction are 0.40 and 0.20, respectively. External forces $P$ and $Q$ act on block $B$, as shown. In Fig. 5.9, force $P$ equals 60 N. The maximum value of force $Q$, for which the system remains at rest is closest to:

- A) 270 N
- B) 190 N
- C) 230 N
- D) 240 N
- E) 220 N

7. In Fig. 5.10, a T-bar ski tow pulls a skier up a hill inclined at $10^\circ$ above horizontal. The skier starts from rest and is pulled by a cable that exerts a tension $T$ at an angle of $30^\circ$ above the surface of the hill. The mass of the skier is 60 kg and the effective coefficient of friction between the skis and the snow is 0.10. What is the maximum tension in the cable if the starting acceleration is not to exceed 0.4 g?

- A) 246 N
- B) 187 N
- C) 366 N
- D) 535 N
- E) 431 N
8. A box with weight $w = 990$ N is on a rough surface, inclined at an angle of 37 degrees. The box is kept from sliding down (in equilibrium) by means of an external force $F$. The other forces acting on the box are the normal and friction forces, denoted by $n$ and $f$. A force diagram, showing the four forces that act on the box, is shown in Fig. 4.4. The magnitude of $f$ is 270 N. The magnitude of the normal force $n$ is closest to:

A) 594 N  
B) 742 N  
C) 791 N  
D) 693 N  
E) 644 N

$$\sum F = n - w \cos \theta = 0$$

$$n = w \cos = (990 \text{ N}) \cos 37^\circ = 791 \text{ N}$$
Show all your work on the problems. Place boxes around your final answers. Partial credit will be given, but only if you show our work. Use the back of this sheet if you need more space.

Situation 5.2
Three objects are connected by massless wires over a massless frictionless pulley as shown in Fig. 5.4. The tension in the wire connecting the 10.0-kg and 15.0-kg objects is measured to be 133 N.

Figure 5.4

9. (a) Draw free-body diagrams for all three objects: mass M, the 15.00 kg mass, and the 10.00 kg mass. (b) Find the mass of M in kilograms.

Call the tension in the shorter wire \( T_2 = 133 \text{ N} \)

(a) \[ \begin{align*}
M & \quad T_1 \\
15: & \quad T_1 \\
10: & \quad T_2
\end{align*} \]

(b) First find the acceleration of the 10 kg block, which is also the acceleration of the whole system. It has the fewest unknowns.

\[ T_1 - mg = ma \]

\[ a = \frac{T_1 - mg}{m} = \frac{133 \text{ N} - (10 \text{ kg})(9.8 \text{ m/s}^2)}{10 \text{ kg}} \]

\[ = 3.5 \text{ m/s}^2 \uparrow \]
Next, use the diagram for the 15kg block to find the tension in the longer wire.

\[ \sum F_y = T_1 - mg - T_2 = ma \]

\[ T_1 = ma + mg + T_2 \]

\[ = (15\text{kg})(3.5\text{m/s}^2) + (15\text{kg})(9.8\text{m/s}^2) + 133\text{N} \]

\[ = 332.5\text{N} \]

Finally, use the last diagram to determine M.

\[ \sum F_y = T_1 - Mg = -Ma \] (this one is accelerating downward!)

\[ T_1 = M(g-a) \]

\[ M = \frac{T_1}{g-a} = \frac{332.5\text{N}}{9.8\text{m/s}^2 - 3.5\text{m/s}^2} = 52.8\text{kg} \]
10. A ball of mass 3.0 kg is suspended by two wires from a horizontal arm, which is attached to a vertical shaft, as shown in Fig. 5.12. The shaft is in uniform rotation about its axis such that the linear speed of the ball equals 2.5 m/s.

(a) Draw a free-body diagram for the ball.
(b) Find the tension in wire 2.

\[ T_2 = \frac{m v^2}{r \cos \theta} = \frac{(3 \text{kg})(2.5 \text{m/s})^2}{(1.8 \text{m})(0.8)} = 29 \text{N} \]
Answer Key
Testname: PHYS 116A (F2008) TEST 1

1. B
2. D
3. E
4. B
5. B
6. A
7. E
8. C
9. 52.8 kg
10. 29 N
Answer Key
Testname: PHYS 116A (F2008) TEST 1

1. A
2. D
3. D
4. • C
5. E
6. B
7. E
8. C
9. 52.8 kg
10. 81 N
Answer Key
Testname: PHYS 116A (F2008) TEST 1

1. A
2. E
3. D
4. C
5. D
6. C
7. A
8. E
9. 52.8 kg
10. 12 N