

THE TWENTY-FOURTH ANNUAL SLAPT PHYSICS CONTEST
SOUTHERN ILLINOIS UNIVERSITY EDWARDSVILLE
APRIL 25, 2009
9 – 11 AM

MECHANICS TEST

$$g = 9.8 \text{ m/s}^2$$

Please answer the following questions on the supplied answer sheet. You may write on this test booklet and keep it for your records. Only the answer sheets will be scored

Your answer sheets must have your name, your school, and MECHANICS on them.

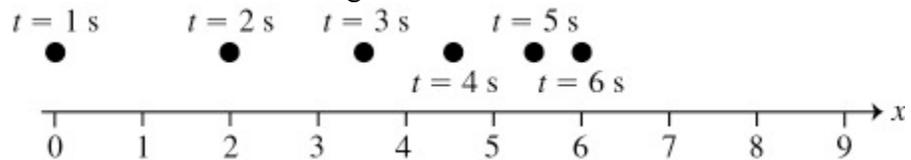
The cash prizes for this exam will be:
First Prize of \$100, Second Prize of \$50, and Third Prize of \$25.

Newton Awards will be presented to the next highest scoring twenty percent of the contestants,
and certificates to the top three scoring schools.

Award Ceremony at approximately 12:30 in this room

- 1) A CD-ROM disk can store approximately 600.0 megabytes of information. If an average word requires 9.0 bytes of storage, how many words can be stored on one disk?
- A) 6.7×10^7 words
 - B) 5.4×10^9 words
 - C) 2.1×10^7 words
 - D) 2.0×10^9 words
- 2) A marathon is 26 mi and 385 yd long. Estimate how many strides would be required to run a marathon. Assume a reasonable value for the average number of feet/stride.
- A) 4.5×10^4 strides
 - B) 4.5×10^3 strides
 - C) 4.5×10^5 strides
 - D) 4.5×10^6 strides

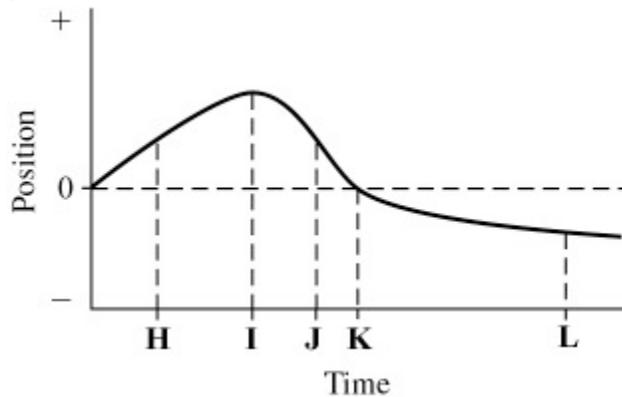
- 3) The figure below shows the position of a particle (moving along a straight line) as a function of time. Which of the following statements is true?



- A) The object is moving at a constant velocity.
 - B) The object is accelerating (speeding up).
 - C) The object is decelerating (slowing down).
- 4) If the fastest you can safely drive is 65 mi/h, what is the longest time you can stop for dinner if you must travel 541 mi in 9.6 h total?
- a. 1.0 hr
 - b. 1.3 hr
 - c. 1.4 hr
 - d. No time to stop

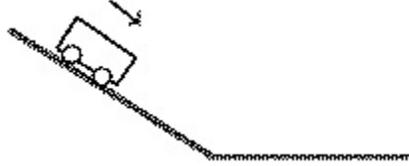
- 5) Acceleration is sometimes expressed in multiples of g , where $g = 9.8 \text{ m/s}^2$ is the acceleration due to the earth's gravity. In a car crash, the car's velocity may go from 26 m/s to 0 m/s in 0.15 s . How many g 's are experienced, on average, by the driver?
- 13 g
 - 18 g
 - 22 g
 - 23 g
- 6) A car accelerates from 10.0 m/s to 30 m/s at a rate of 3.0 m/s^2 . How far does it travel while accelerating?
- 80 m
 - 117 m
 - 133 m
 - 226 m
- 7) Human reaction times are worsened by alcohol. How much farther would a drunk driver's car travel before he hits the brakes than a sober driver's car? Assume both cars are initially traveling at 49.0 mi/h , the sober driver takes $.33 \text{ s}$ and the drunk driver takes 1.0 s to hit the brakes in a crisis.
- 34 ft
 - 40 ft
 - 45 ft
 - 48 ft
- 8) Assuming equal rates of deceleration in both cases, how much further would you travel if braking from 61 mi/h to rest than from 32 mi/h ?
- 1.9 times further
 - 2.9 times further
 - 3.6 times further
 - 4.3 times further
- 9) At the same moment, one rock is dropped and one is thrown downward with an initial velocity of 10 m/s from the top of a 300 m building. How much earlier does the thrown rock strike the ground?
- 0.95 s
 - 1.05 s
 - 2.10 s
 - They land at the same time

- 10) 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?

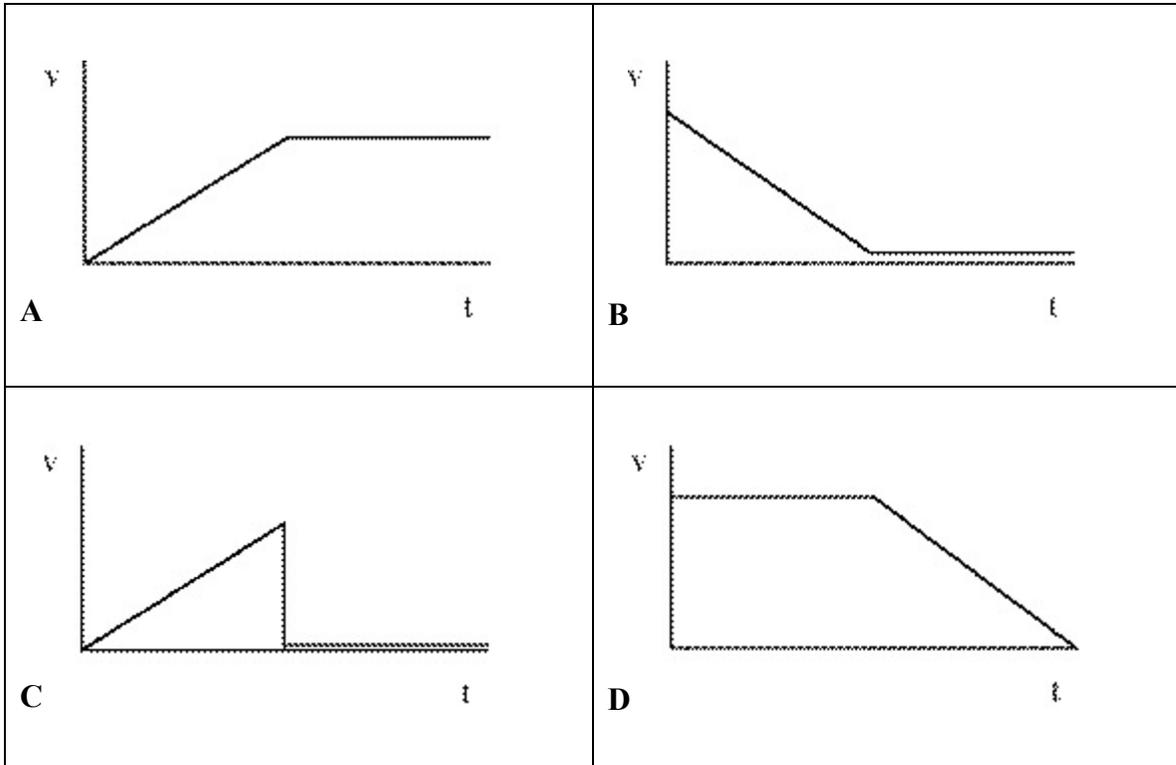


- a. H
b. I
c. J
d. K
- 11) Two identical stones are dropped from a tall building, *one after the other*. Assume air resistance is negligible. While both stones are falling, what will happen to the vertical distance between them?
- a. It will increase
b. It will decrease
c. It will remain the same
d. It will first increase, and then remain constant
- 12) A fisherman casts his bait into the river at an angle of 25° . As the line unravels, he notices that the bait and hook reach a maximum height of 3.9 m. What was the initial velocity he launched the bait with?
- a. 8.4 m/s
b. 9.2 m/s
c. 10 m/s
d. 21 m/s
- 13) Calculate the angular speed, in rad/s of a flywheel turning at 886.0 rpm.
- a. 69.59 rad/sec
b. 92.78 rad/sec
c. 103.9 rad/sec
d. 154.8 rad/sec

14) A trolley starts from rest and runs down a sloping track section onto a second level section as shown. Friction is negligible.



Which velocity–time graph below best represents the trolley's motion on both sections?

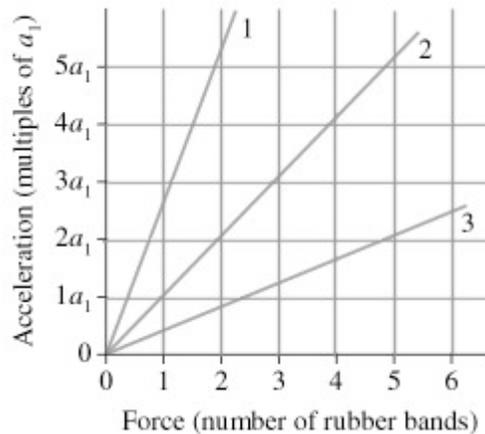


15) A glider is tugged by an airplane at 81 m/s when it is released. If the original speed was along the horizontal and the glider is now under a constant acceleration of 2.4 m/s^2 at 1.1° below the horizontal due to air drag, how long will it take to reach the ground 5.7 km below?

- 100 s
- 500 s
- 1000 s
- 2000 s

- 16) A hobby rocket reaches a height of 72.3 m and lands 111 m from the launch point. What was the angle of launch?
- 45°
 - 69°
 - 75°
 - 82°

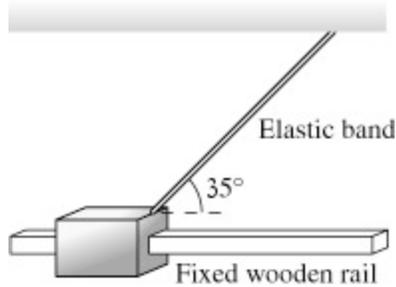
- 17) The figure shows an acceleration-versus-force graph for three objects pulled by rubber bands. The mass of object 2 is 36 kg. What are the masses of objects 1 and 3



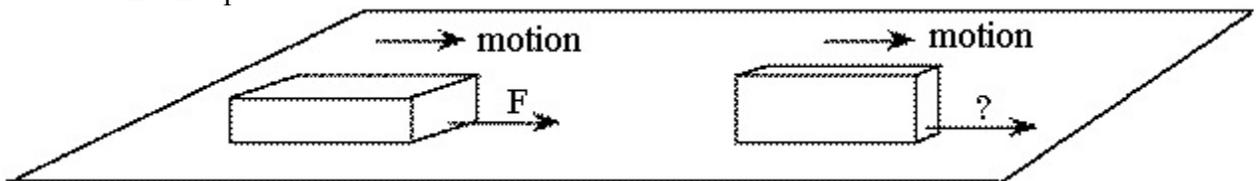
- 14 kg and 72 kg
 - 14 kg and 90 kg
 - 72 kg and 18 kg
 - 90 kg and 18 kg
- 18) A 27 kg object is accelerated at a rate of 1.7 m/s². What force does the object experience
- 16 N
 - 32 N
 - 40 N
 - 46 N
- 19) The engine of a 1250 kg car provides a forward directed force of 3651 N. If the car accelerates at a rate of 2.60 m/s², what is the total resistive force (wind resistance, friction, etc.) acting on the car?
- 3651 N
 - 3250 N
 - 566 N
 - 401N

- 20) A child on a sled starts from rest at the top of a 15.0° slope. If the trip to the bottom takes 15.2 s, how long is the slope? Assume that frictional forces may be neglected.
- 147 m
 - 293 m
 - 586 m
 - 1130 m
- 21) Suppose you are playing hockey on a new-age ice surface in which there is no friction between the ice and the hockey puck. You wind up and hit the puck as hard as you can. Just after the puck loses contact with your stick, the puck
- Will start to slow down
 - Will slow down a little then move at a constant rate
 - Will not slow down or speed up
 - Will speed up a little, then move at a constant rate
- 22) If I weigh 702 N on Earth and 5320 N on the surface of a nearby planet, what is the acceleration due to gravity on that planet?
- 54.2 m/s/s
 - 64.6 m/s/s
 - 74.2 m/s/s
 - 84.5 m/s/s
- 23) A driver in a 1000.0 kg car traveling at 20 m/s slams on the brakes and skids to a stop. If the coefficient of friction between the tires and the road is 0.80, how long will the skid marks be?
- 21 m
 - 26 m
 - 33 m
 - 36 m
- 24) Kieran takes off down a 50 m high, 10° slope on his jet-powered skis. The skis have a thrust of 280 N. The combined mass of skis and Kieran is 50kg (the fuel mass is negligible). Kieran's speed at the bottom is 40 m/s. What is the coefficient of kinetic friction of his skis on snow?
- 0.23
 - 0.29
 - 0.47
 - 0.58

- 25) A device has a 100 g wooden shuttle that is pulled along a square wooden rail by an elastic band. The shuttle is released when the elastic band has 9.0 N tension at a 35° angle. What is the magnitude of the initial acceleration of the shuttle?



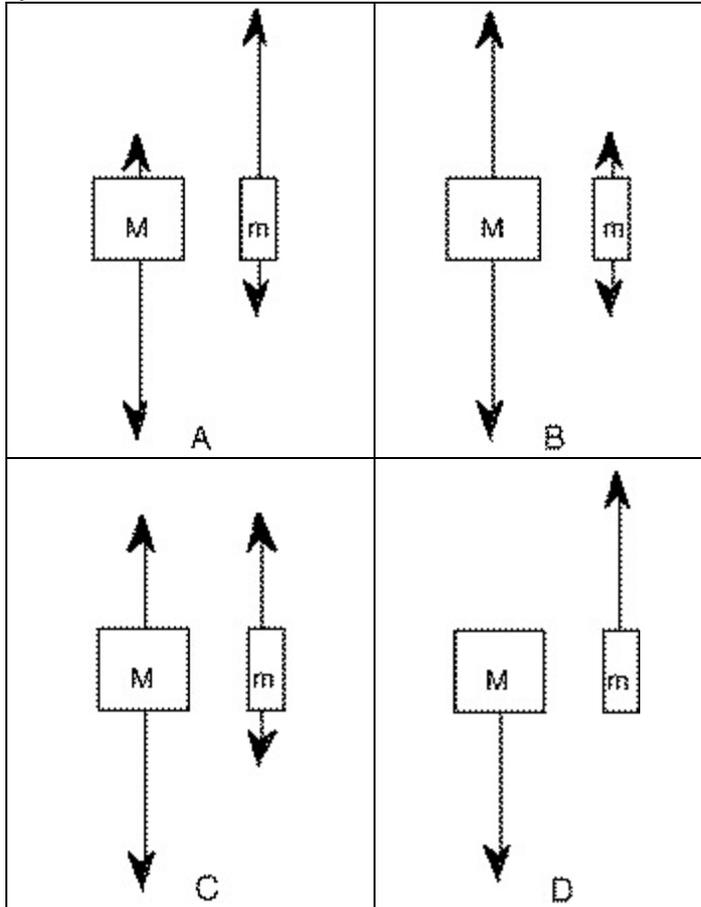
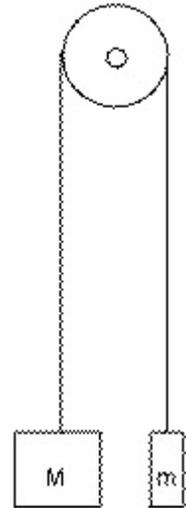
- a. 52 m /s /s
 b. 68 m /s /s
 c. 74 m /s /s
 d. 90 m /s /s
- 26) An object is moving to the right in a straight line. The net force acting on the object is also directed to the right, but the magnitude of the force is decreasing with time. The object will
- a. Continue to move to the right, with its speed increasing with time
 b. Continue to move to the right, with its speed decreasing with time
 c. Continue to move to the right, with a constant speed
 d. Stop and start moving to the left
- 27) A brick initially has its largest-area face in contact with a rough surface, as shown on the left in the figure. A force F is required to pull the brick along the surface at constant speed.



The brick is now flipped so that a face of smaller area is in contact, as on the right in the figure. The material of the brick is uniform on all faces. What force is now required to pull the brick along at constant speed as before?

- a. Unable to determine without knowing the coefficient of friction
 b. A greater Force
 c. A smaller force
 d. The same force

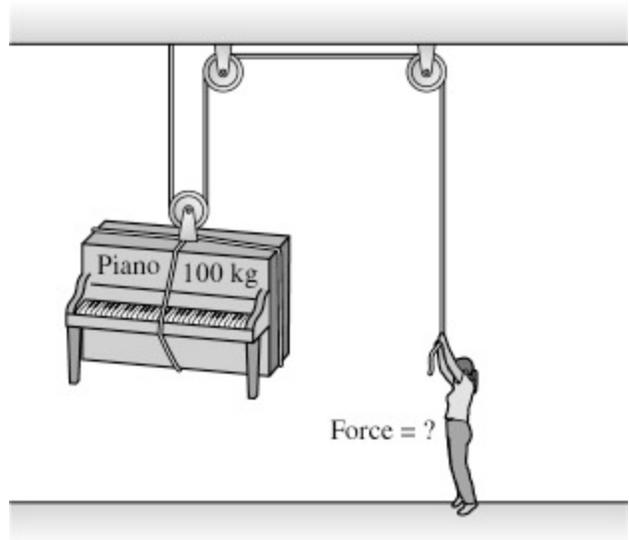
28) Two unequal masses M and m are connected by a light cord passing over a pulley of negligible mass. When released, the system accelerates. Friction is negligible. Which figure below gives the correct free-body force diagrams for the two masses in the moving system?



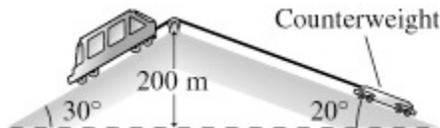
- 29) A 65 kg ice skater pushes off his partner and accelerates backwards at 1.3 m/s^2 . If the partner accelerates in the opposite direction at 2.0 m/s^2 , what is the mass of the other skater? Assume that frictional forces are negligible.
- 100 kg
 - 65 kg
 - 45 kg
 - 42 kg

- 30) A 12 kg block on a table is connected by a string to a 26 kg mass, which is hanging over the edge of the table. If the 12 kg block is 3.1 m from the edge of the table, how much time will pass before the block falls off the table from when the other block is released? Assume that frictional forces may be neglected.
- 0.96 s
 - 0.82 s
 - 0.68 s
 - 0.58 s

- 31) A piano mover raises a 100 kg piano at a constant rate using a frictionless pulley system, as shown below. With roughly what force is the mover pulling down on the rope?
- 2000 N
 - 1000 N
 - 500 N
 - 250 N



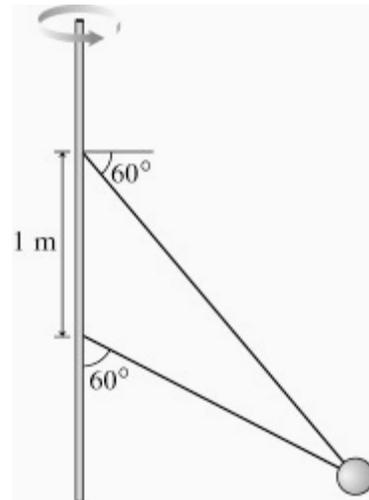
- 32) The figure shows a 2000 kg cable car descending a high hill. A counterweight of mass 1800 kg on the other side of the hill aids the brakes in controlling the cable car's speed. The rolling friction of both the cable car and the counterweight are negligible. How much braking force does the cable car need to descend at constant speed?



- 48000 N
- 9800 N
- 3800 N
- 2900 N

- 33) A large truck collides head-on with a cyclist. During the collision
- The truck exerts a greater amount of force than the cyclist exerts on the truck
 - The truck exerts the same amount of force as the cyclist exerts on the truck
 - The truck exerts a lesser amount of force than the cyclist exerts on the truck
 - The truck exerts a force on the cyclist, but the cyclist exerts no force on the truck

- 34) The figure shows two wires tied to a 3.3 kg sphere which revolves in a horizontal circle at constant speed. At this particular speed the tension is the same in both wires. What is the tension?



- 20 N
- 22 N
- 24 N
- 26 N

- 35) Future space stations will create an artificial gravity by rotating. Consider a cylindrical space station of 390 m diameter rotating about its axis. Astronauts walk on the inside surface of the space station. What rotation period will provide "normal" gravity
- 4.4 s
 - 6.3 s
 - 14 s
 - 28 s

- 36) A 480 kg car moving at 14.4 m/s hits from behind another car moving at 13.3 m/s in the same direction. If the second car has a mass of 570 kg and a new speed of 17.9 m/s, what is the velocity of the first car after the collision
- 8.94 m/s
 - 6.4 m/s
 - 6.4 m/s
 - 8.94 m/s

- 37) A 14 cm diameter champagne bottle rests on its side on top of a frictionless table. Suddenly, the cork pops and the bottle slides backward for a distance of 22.0 cm in 0.44 s. If the mass of the bottle is 500 times the mass of the cork, find the distance from the original position the cork will land on the table.
- 8.5 cm
 - 85 cm
 - 3 m
 - 6 m
- 38) Two vehicles approach a right angle intersection and then collide. After the collision, they become entangled. If their mass ratios were 1: 5 and their respective speeds as they approached were 16 m/s and 17 m/s, find the final velocity of the wreck
- 14.4 m/s at 79°
 - 16.9 m/s at 79°
 - 17.3 m/s at 79°
 - 19.2 m/s at 79°
- 39) Three cars, car X, car Y, and car Z, begin accelerating from rest, at the same time. Car X is more massive than car Y, which is more massive than car Z. The net force exerted on each car is identical. After 10 seconds, which car has the most momentum?
- Car X
 - Car Y
 - Car Z
 - They all have the same momentum.
- 40) A 1200 kg cannon fires a 100.0 kg cannonball at 52 m/s. What is the recoil velocity of the cannon? Assume that frictional forces are negligible and the cannon is fired horizontally
- 52 m/s
 - 5.2 m/s
 - 4.3 m/s
 - 3.9 m/s
- 41) A massless spring hangs from the ceiling. How much does its potential energy increase, if a 28.8-kg mass is attached to it? The spring constant is 4800 N/m.
- 17 kJ
 - 8.3 kJ
 - 17 J
 - 8.3 J

- 42) A block starts from rest at the top of a 31.0° inclined plane and encounters a spring, of constant 3.4 k N/m , rigidly attached to the plane. If the block's mass is 33.0 kg and it compresses the spring by 37.0 cm , find the distance the block travelled before it encountered the spring
- 1.0 m
 - 1.37 m
 - 1.74 m
 - 1.82 m
- 43) Calculate the kinetic energy of a 0.300 kg baseball thrown at a velocity of 44 m/s .
- 580 m/s
 - 290 m/s
 - 13.2 m/s
 - 6.6 m/s
- 44) A prankster drops a water balloon from the top of a building on an unsuspecting person on the sidewalk below. If the balloon is traveling at 30.3 m/s when it strikes a person's head (1.5 m above the ground), how tall is the building?
- 48 m
 - 49 m
 - 50 m
 - 51 m
- 45) A 2.3 kg object moving at 7.3 m/s collides inelastically with a 4.0 kg object which is initially at rest. What percentage of the initial kinetic energy of the system is lost during the collision.
- 47%
 - 50%
 - 58%
 - 63%
- 46) A person stands on the edge of a cliff. She throws three identical rocks with the same speed. Rock X is thrown vertically upward, rock Y is thrown horizontally, and rock Z is thrown vertically downward. Assuming the elevation loss of the three rocks is the same (the ground at the base of the cliff is flat), which rock hits the ground with the highest speed?
- Rock X
 - Rock Y
 - Rock Z
 - They all hit the ground with the same speed.

- 47) How much work must be done by frictional forces in slowing a 1000.0 kg car from 19.8 m/s to rest?
- a. $3.55 \times 10^5 \text{ J}$
 - b. $4.18 \times 10^5 \text{ J}$
 - c. $4.44 \times 10^5 \text{ J}$
 - d. $5.33 \times 10^5 \text{ J}$
- 48) Three cars with identical engines and tires start from rest, and accelerate at their maximum rate. Car X is the most massive, and car Z is the least massive. Which car needs to travel the farthest before reaching a speed of 60 mi/h?
- a. All Cars need the same distance
 - b. Car X
 - c. Car Y
 - d. Car Z
- 49) A traveler pulls on a suitcase strap at an angle 36° above the horizontal. If 908 J of work are done by the strap while moving the suitcase a horizontal distance of 15 m, what is the tension in the strap?
- a. 61 N
 - b. 75 N
 - c. 85 N
 - d. 92 N
- 50) A force of 16 N is applied to the end of a 0.63 m-long torque wrench at an angle 45° from a line joining the pivot point to the handle. What is the magnitude of the torque generated about the pivot point?
- a. 0 Nm
 - b. 7.1 Nm
 - c. 10.1 Nm
 - d. 11.3 Nm