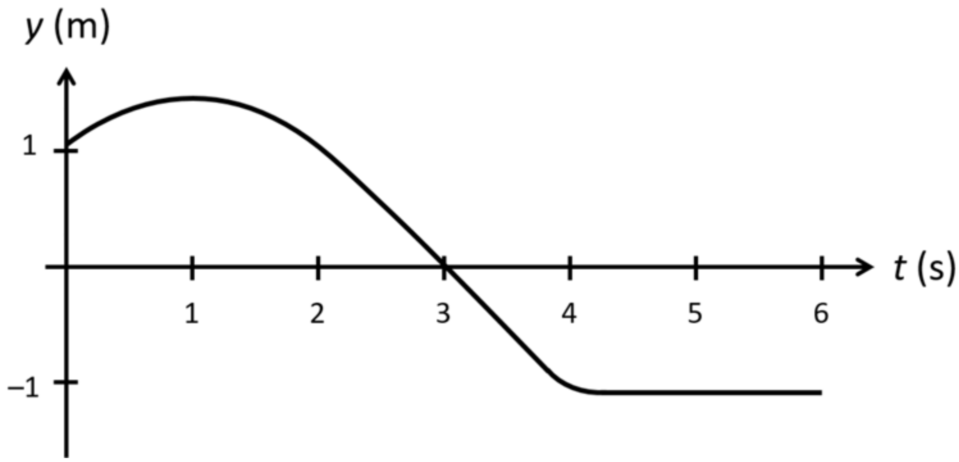
The next three questions pertain to the situation described below.



The figure plots the y position of a particle as a function of time

1) At $t = 3$ s, which of the following statements is <u>NOT</u> true?

a. the position $y = 0$
b. the velocity $v_y = 0$
c. the acceleration $a_y = 0$

2) At which of the following times is the acceleration $a_y < 0$?

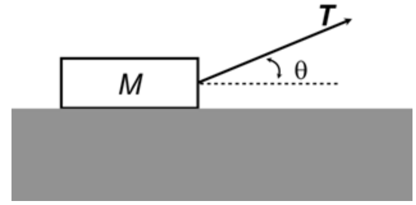
a. $t = 1$ s
b. $t = 3.5$ s
c. $t = 5.5$ s

3) At which of the following times is the velocity $v_y < 0$?

a. $t = 5.0$ s
b. $t = 2.0$ s
c. $t = 0.5$ s

The next four questions pertain to the situation described below.

A box of mass $M = 6$ kg is being pulled by a string along a rough horizontal surface. The tension in the string remains constant throughout the process and has a magnitude T. The string makes an angle $\theta = 28$ degrees with the surface. The box is initially at rest. After the box has moved by 2.3 meters, the work done by the string $W_{ST} = 50$ J and the work done by friction $W_{FR} = 41$ J.



4) What is the magnitude of the tension T?

a. $T = 46.3$ N
b. $T = 21.7$ N
c. $T = 24.6$ N

5) What is the speed of the box after it has traveled 2.3 m?

a. 1.92 m/s
b. 1.73 m/s
c. 3.7 m/s
d. 4.08 m/s
e. 4.34 m/s

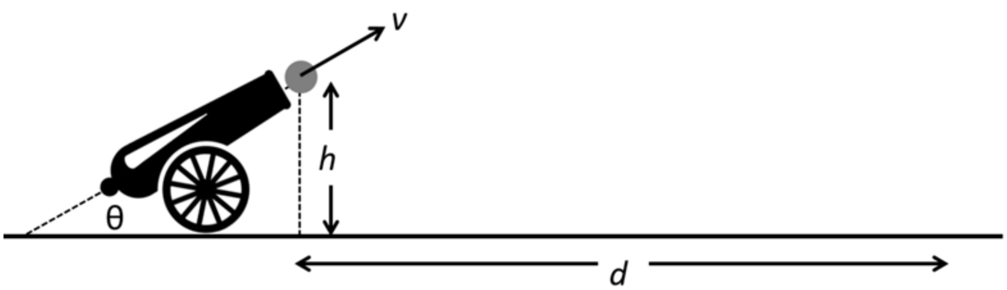
6) What is the coefficient of kinetic friction between the box and the surface?

a. 0.343
b. 0.303
c. 0.645
d. 0.161
e. 0.377

7) If the experiment is repeated, but this time pulling on the string with twice the force, the kinetic energy of the box after being pulled for 2.3 meters would be

a. less that twice the kinetic energy of the original case.
b. twice the kinetic energy of the original case.
c. more than twice the kinetic energy of the original case.

The next three questions pertain to the situation described below.



A cannon inclined at an angle of $\theta = 28°$ from the horizontal fires a projectile into the air, as shown in the figure. The projectile exits the cannon at a height $h = 1.3$ m from the ground and at a speed $v = 7$ m/s.

8) What is the speed v_{high} of the projectile when it reaches its highest point in its trajectory?

a. $v_{\text{high}} = 0$ m/s
b. $v_{\text{high}} = 6.18$ m/s
c. $v_{\text{high}} = 3.29$ m/s

9) At what horizontal distance *d* from the cannon exit does the projectile land on the ground?

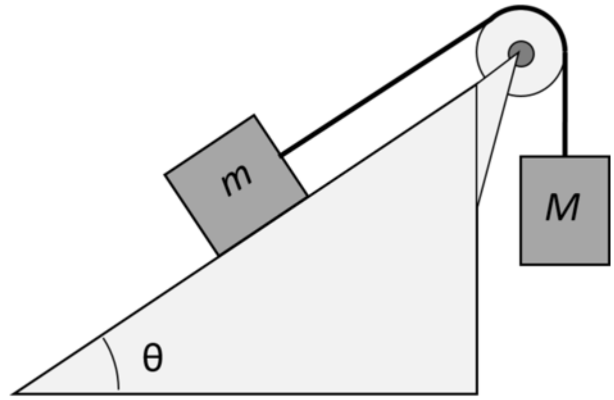
a. $d = 8.11$ m
b. $d = 5.87$ m
c. $d = 6.64$ m
d. $d = 3.12$ m
e. $d = 4.14$ m

10) What is the speed v_{land} of the projectile when it hits the ground?

a. $v_{\text{land}} = 12.1$ m/s
b. $v_{\text{land}} = 8.63$ m/s
c. $v_{\text{land}} = 7$ m/s

The next three questions pertain to the situation described below.

A block of mass m is at rest on a frictionless inclined plane at an angle $\theta = 30°$ from the horizontal, as shown in the figure. The block m is connected to a second block of mass M by a massless string around an ideal, frictionless pulley.



11) What must the mass M be for the blocks to remain at rest?

a. $M = m$
b. $M = m/2$
c. $M = 2m$

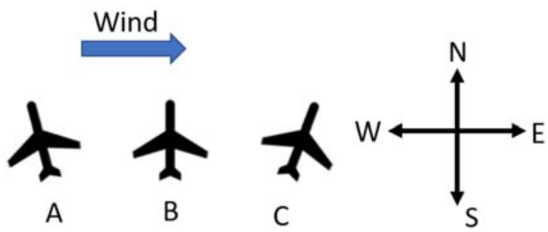
12) Now suppose that we add friction to the surface of the inclined plane, using material with coefficient of static friction $\mu_s = 0.4$ and kinetic friction $\mu_k = 0.3$. What is the maximum the mass M can be for the blocks to remain at rest?

a. $M_{max} = 0.5m$
b. $M_{max} = 0.65m$
c. $M_{max} = 1.65m$
d. $M_{max} = 0.85m$
e. $M_{max} = 0.15m$

13) If the block on the inclined plane had not been at rest but moving at a speed v initially, and we want it to maintain a constant speed, the mass M should be ________ compared to the previous problem.

a. the same
b. increased
c. decreased

The next three questions pertain to the situation described below.



Three airplanes of identical technical specifications and air speeds of 260 km/h depart from an airport on a day when the wind is blowing from west to east at speed of 45 km/h. Plane **A** sets a heading of 17 degrees west of north, plane **B** orients itself due north, plane **C** orients itself 17 degrees east of north.

14) After 15 minutes of flight, which plane has gone the furthest north?

a. Plane **C**
b. Plane **B**
c. Plane **A**

15) After 30 minutes of flight, which plane has deviated the least from a line on the ground that runs straight north?

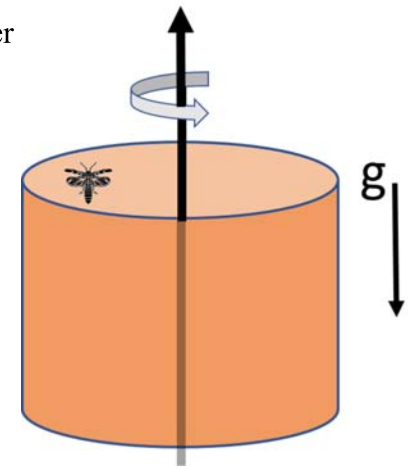
a. Plane **A**
b. Plane **C**
c. Plane **B**

16) After 1 hour of flight, how far is plane C from the airport?

a. 277 km
b. 253 km
c. 264 km
d. 305 km
e. 215 km

The next three questions pertain to the situation described below.

A hollow cylinder of inner radius 0.18 m spins around a vertical axis with a constant angular speed of 8 rad/s. A bug sits on the inside surface of the cylinder and does not move relative to the cylinder. The normal force of the cylinder on the bug is 0.035 N.



17) What is the mass of the bug?

a. m = 0.00357 kg
b. m = 0.00304 kg
c. m = 0.0243 kg

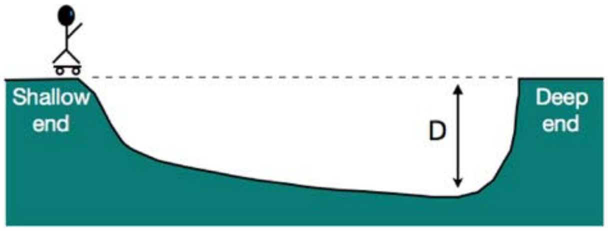
18) What is the minimum coefficient of static friction that is required in order for friction alone to be the only force preventing the bug from falling?

a. $\mu_s = 0.958$
b. $\mu_s = 1.01$
c. $\mu_s = 1.17$
d. $\mu_s = 1.06$
e. $\mu_s = 0.852$

19) Which of the following correctly describes the net force acting on the bug?

a. The net force is zero.
b. The net force has at least some component in the tangential direction.
c. The net force points purely toward the center of the cylinder.

The next three questions pertain to the situation described below.



A skateboarder stands at the edge of a dry swimming pool. The pool's floor varies smoothly from the shallow to the deep end, as shown in the figure. The skateboarder's mass is 55 kg without the skateboard; the mass of the skateboard is 1.6 kg. The pool's deepest point is located D=3.4 meters below the pool's edge.

20) First, the skateboarder checks her skateboard by rolling it down by itself from the shallow end's edge of the pool to find the skateboard rising 0.2 m below the deep end's edge before sliding back. What was the work done by friction on the skateboard during its first passage across the pool?

a. -3.14 J
b. 0 J
c. 3.14 J

21) After adjusting the skateboard to run nearly frictionless, the skateboarder drops in on her skateboard from the shallow end of the pool. As she goes along the floor of the pool she "pumps" the skateboard and then exits the pool at the deep end's edge (e.g. same height from which she started) vertically upward with the speed of v = 4 m/s. How much work did the skateboarder do on the skateboard during the run?

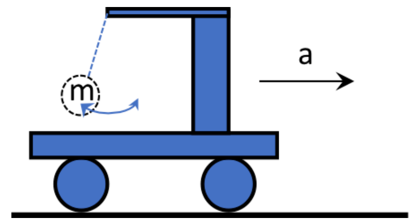
a. -1890 J
b. 906 J
c. 453 J
d. 1890 J
e. -906 J

22) How much air does she get? Here, "air" refers to the maximum height that the skateboarder raises above the pool's edge. Assume the skateboard remains in contact with the skateboarder.

a. 0.543 m
b. 0.326 m
c. 0.815 m

The next two questions pertain to the situation described below.

A rail car is set up to have a 2.5 kg mass suspended from a string. In both situations below the mass is at rest relative to the car. (Note the arrow in the figure illustrates a range of possible positions for the mass.)



23) If the rail car is moving at constant speed relative to the ground, a stationary observer on the ground will see the mass to be hanging straight down

a. False
b. True

24) If the rail car is accelerating forward with an acceleration of 4 m/s^2, what is the tension in the string?

a. 26.5 N
b. 10 N
c. 14.5 N
d. 34.5 N
e. 24.5 N