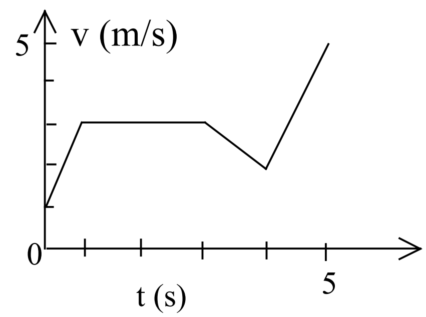
Name: ____

Useful constants: ρ_{water}=1000 kg/m^3, g=9.8 m/s^2, 1 hp = 746 W, 1 m = 100 cm, 1 km = 1000 m, 1kg = 1000 g (grams)

Choose the most nearly correct answer.

1. The plot below shows the speed of a dog versus time. How far did the dog travel during the time interval between t=1 and t=3 s?

A) 12 m
B) 2 m
C) 3 m
D) 6 m
E) none of the above



distance = average velocity x time
$\Delta x = v\, \Delta t$
where v= 3 m/s and Δt = 2 s

2. A block of mass 5.0 kg rests on a horizontal surface. The coefficient of sliding kinetic friction between the surfaces is 0.2. A string attached to the block is pulled horizontally, resulting in a 2 m/s^2 acceleration by the block. Find the tension in the string. (g = 9.8 m/s^2)

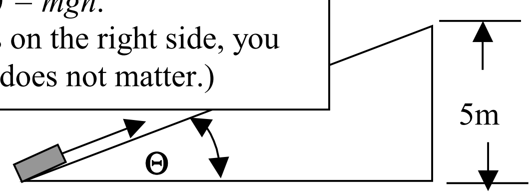
A) 0.2 kg m/s^2
B) 9.8 N
C) 19.8 N
D) 9.8 kg m^2/s^2
E) 19.8 kg m^2/s^2

Newton's 2nd Law applied to this case:
total force in direction of motion = $T - f = ma$,
where $f = \mu mg$. Thus $T = f + ma = m(\mu g + a)$.
Plug in $m=5$ kg, $a = 2$ m/s^2, $\mu = 0.2$ and $g = 9.8$ m/s^2, you get the value for T.

3. A 100 kg mass is pushed up a frictionless inclined plane. How much work has to be done against gravity to move the block from the bottom to the top of a plane whose height is 5 m and which makes an angle Θ = 37° with the horizontal?

Work = change in potential energy, hence:
$W = m\, g\, (h - 0) = mgh$.
Just plug in the numbers on the right side, you get it. (Note: the angle does not matter.)

A) 500 J
B) 1960 J
C) 3913 J
D) 4900 J
E) none of the above



4. A car traveling at a speed of 50 km/hr brakes to a stop over a distance of 20 m. How long does this take (in seconds). (Assume constant deceleration.)

A) 0.4
B) 0.7
C) 1.4
D) 2.5
E) none of the above

distance = average velocity x time.
Average velocity = $v = 0.5\ (0 + 50)\ km/hr = 25\ km/hr = 25 \times 1000 / 3600$ m/s
So,
time = 20 m / v

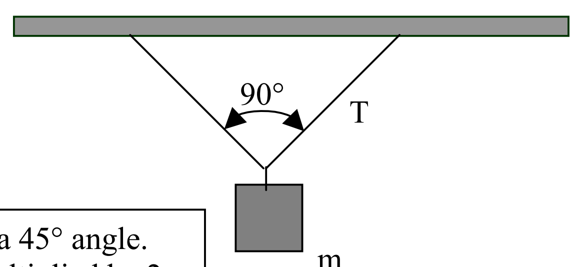
5. A lead ball with mass 2 kg is dropped from a height of 3 m. What is its kinetic energy just before it hits the ground? (g = 9.8 m/s2)

A) 6 J
B) 19.6 J
C) 29.4 J
D) 59 J
E) none of the above

Use conservation of energy:
Initial energy = P.E. only = mgh
final energy = K.E. only.
Equating the two, one gets
$K.E. = mgh = 2 \times 9.8 \times 3$ Joules

6. A 1 kg mass is suspended by a rope attached to the ceiling. If the angle at the point of suspension is 90°, what is the tension T in the rope?

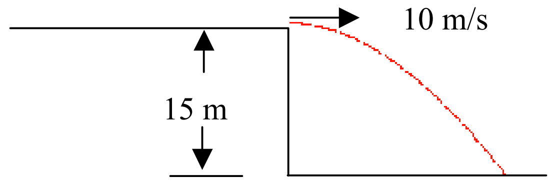
A) 1 N
B) 6.9 N
C) 9.8 N
D) 13.8 N
E) none of the above



The tension force is directed at a 45° angle. The vertical component of T multiplied by 2 (from both sides) is equal to the weight of the block: $2\ T \cos 45° = mg$. Since $\cos 45° = \sqrt{2}/2$, $T = mg / \sqrt{2}$

7. A ball is thrown horizontally from the top of a 15 m high cliff. If the initial speed of the ball is 10 m/s, what is the speed of the ball when it hits the ground?

A) 10 m/s
B) 15 m/s
C) 19.8 m/s
D) 29.8 m/s
E) none of the above



The easiest way to get the answer is by conservation of energy:
$E_i = ½\, m\, v_i^2 + mgh = E_f = ½\, m\, v_f^2$
By canceling the common factor of m, one gets $v_f^2 = v_i^2 + 2gh$. Now one can just plug in the numbers, and solve for v_f.

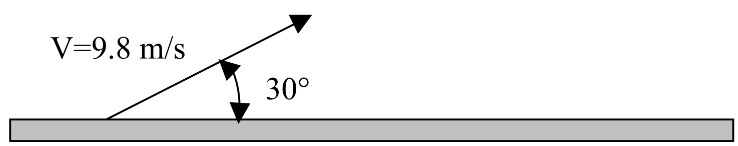
8. A hockey puck moving at 7 m/s coasts to a halt in 75 m on a smooth ice surface. What is the coefficient of friction between the ice and the puck?

A) $\mu = 0.025$
B) $\mu = 0.033$
C) $\mu = 0.12$
D) $\mu = 0.25$
E) $\mu = 0.30$

The information on velocity v (**7 m/s**) and displacement x (75 m), allow us to figure out the acceleration a from the formula $v^2 - 0 = 2ax$, or $a = v^2/ 2x$. This acceleration (actually decceleration) is due to the frictional force, hence f=ma=μmg. We then obtain:
$\mu = a/g = v^2/ 2xg = 49 / (2 \times 75 \times 9.8)$.

9. A ball is thrown with an initial velocity of 9.8 m/s at an angle of 30° with the horizontal. What is the maximum height reached by the ball?

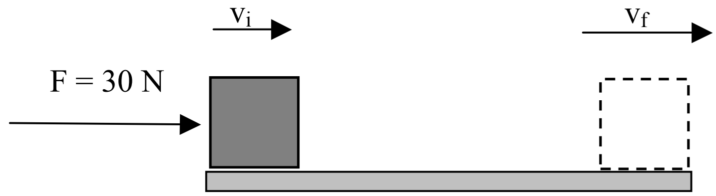
A) 1.0 m
B) 1.23 m
C) 4.9 m
D) 9.8 m
E) none of the above



Consider the horizontal and vertical motions separately. The horizontal motion is just one with constant velocity = V cos 30°.
The vertical motion starts at ground level with initial velocity $v_{y0} = V \sin 30° = V / 2$. At the height of the trajectory, $v_{yf} = 0$. Using, by now, the familiar relation $v_{y0}^2 = 2gh$, we get
$h = v_{y0}^2 / (2g) = V^2 / (8g) = (9.8)^2 / (8 \times 9.8)\ m = 9.8 / 8\ m$.

10. A force of magnitude 30 N acts on a 1.2 kg block. If the initial velocity of the block is 4 m/s and the force acts in the direction of this velocity, over what distance must this force act to change the block's velocity from 4 to 6 m/s?

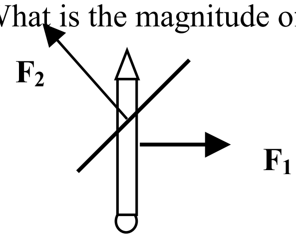
A) 0.2 m
B) 0.4 m
C) 2.0 m
D) 4.0 m
E) none of the above



Use Work-K.E. relation :
$W = F\,s = K.E.^f - K.E.^i = \frac{1}{2}\, m\, v_f^2 - \frac{1}{2}\, m\, v_i^2 = \frac{1}{2}\, m\, (v_f^2 - v_i^2)$
$= 0.5 \times 1.2\ (36 - 16)$ N-m. = 12 J. Therefore, $s = 12 / 30\ m = 0.4\ m$

11. A 2000 kg sail boat experiences an eastward force F_1 of 3000 N by the ocean tide and a wind force F_2 against its sails with magnitude of 6000 N directed toward the northwest (45˚ N of W). What is the magnitude of the resultant acceleration?

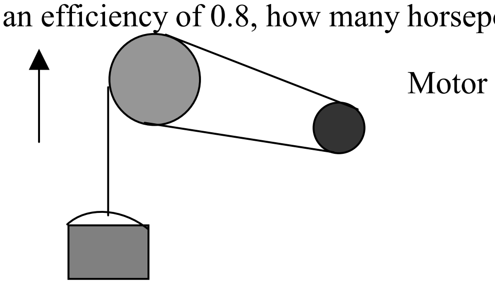
A) 2.2 m/s^2
B) 2.1 m/s^2
C) 1.5 m/s^2
D) 3.0 m/s2
E) 2.1 m/s



Let the net force be $\mathbf{F} = \mathbf{F_1} + \mathbf{F_2}$. Then
$F_x = F_{1x} + F_{2x} = 2000\text{ N} - 6000\text{ N} \cos 45°$
$F_y = F_{1y} + F_{2y} = 0 + 6000\text{ N} \sin 45°$
The magnitude of the total force is $F = \sqrt{(F_x^2 + F_y^2)}$.
And finally, the acceleration is $a = F / m$.

12. A bucket of water with total mass 125 kg is raised from a well at a constant speed of 3.6 m/s by means of a motor. Assuming an efficiency of 0.8, how many horsepower must the motor deliver?

A) 5.9 hp
B) 7.4 hp
C) 45 hp
D) 450 hp
E) **560 hp**



According to Eq.[5.16] : Power = force x velocity. In this case, the force is equal to the gravity force of mg. Therefore $P = F\,v = mgv$ = 125 x 9.8 x 3.6 J/s.
Since the efficiency of the motor is 0.8, it needs to deliver more -- the above number divided by 0.8. Finally, this number needs to be converted to horsepower by the conversion factor given in sheet one.