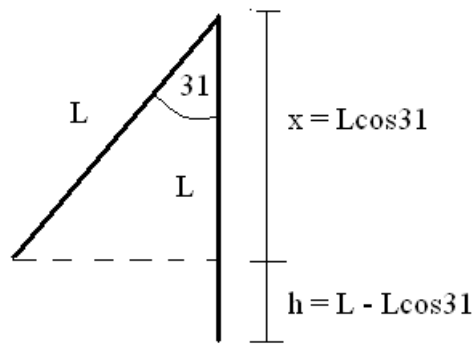
# Solutions – PHYS 250 Exam 2 Practice Test

1C




This questions really deals with conservation of energy, ΔK +ΔU = 0.

The main problem is determining the initial height, h, of the man just as he starts to swing.

The diagram above shows how the length of the rope, L, can be split into L = x + h, and how we can solve for the height using trig.

So we get the following equation:

$$\left(\tfrac{1}{2}mv_f^{\,2} - \tfrac{1}{2}mv_i^{\,2}\right) + (0 - mgh) = 0$$
$$v_f = 6.77 m/s$$

2E

This is another conservation of energy question, though this time we have friction, so we get: ΔK + ΔU = W(friction)

This breaks down to $\tfrac{1}{2}mv_f^{\,2} - mgh = -\mu mg\cos 40(6.22)$, where 6.22 is the distance the block travels down the incline given by (h/sin40).

From this the mass cancels out and v = 6.03 m/s

3E

This one's a little tricky. A lot of information is provided, but once they ask for net work and tell us that velocity is constant, we know that $\Delta K = 0$ and since there is no change in height, the net work done must be zero, since $\Delta K = W_{Net}$.

4B

We know that $\Delta K = W_{net}$

So we re-write Work into its components, $W_{net} = Fd + -\mu mgd$

We then solve for F, and get F = 9.96 N

5B

When each child throws the ball he/she gives the ball momentum, p = (0.35)(4.5) = 1.575 kg m/s

Since momentum must be conserved, the child also gets 1.575 kg m/s of momentum, just in the other direction.

Furthermore, after catching the ball, the child picks up another 1.575 kg m/s of momentum.

This means in total each child gets 3.15 kg m/s of momentum.

From this we can calculate the velocity, $v = \Delta p/m = 0.063$ m/s, where the mass is 490/9.8

6A

The easiest way to do this is to recognize that the two momentums are at right angles and thus their vectors can be combined using Pythagorean theory.

Since momentum is conserved p(initial) = p(final) and we can write: $(p_x)^2 + (p_y)^2 = p^2$

This becomes $(3m)^2 + (4m)^2 = (v2m)^2$

And then $25m^2 = 4m^2v^2$, and we get v = 2.5 m/s after the masses cancel out.

7D

From the first compression: $\frac{1}{2}kx^2 = 120$, so k = 24000 N/m

For the second we just plug in the new k value and solve for x = 0.1207 m

8C

Power, P is Work/Time. In this question the dog does work by lifting his own weight up the height of the stairs.

So we get: $P = \frac{W}{t} = \frac{mg(15 \times 0.25)}{11} = 83.5W$

9A

Since after the collision the object is now at some angle relative to its initial motion, we have to deal with conservation of momentum in each axis (x and y).

For the x-axis we get: $10m = (2.5\cos 20)m + (v_x)2m$, which gives us $v_x = 3.825$ m/s

For the y-axis we get: $0 = (2.5\sin 20)m + (v_y)2m$, which gives us $v_y = -0.428$ m/s

Note that the masses cancel out in both eqns.

Finally we combine the two velocity vectors to get the resultant velocity,

$$v = \sqrt{v_x^{\ 2} + v_y^{\ 2}} = 3.85 m/s$$

10B

Another case of conservation of energy:

$\frac{1}{2}mv^2 + mgh = \frac{1}{2}kx^2$, where $h = 6\sin 30 = 3$ m

From that we can solve for initial speed, $v = 6.1$ m/s

11A

The easiest way to do this is to recognize that the two momentums are at right angles and thus their vectors can be combined using Pythagorean theory.

Since momentum is conserved p(initial) = p(final) and we can write: $(p_x)^2 + (p_y)^2 = p^2$

This becomes $(3m)^2 + (4m)^2 = (v2m)^2$

And then $25m^2 = 4m^2v^2$, and we get $v = 2.5$ m/s after the masses cancel out.

12A

The net force acting on the spring on the block is given by $F = kx$. Since net force is always equal to mass x acc as well, we can set them equal to each other:

$$kx = ma$$

All we have to do now is solve for a:

$a = kx / m = 1.4$ m/s$^2$

13D

Remember that Newton's Second Law states that Force x Time = Change in Momentum.

Based on the information given, it appears that the wall is applying an average force to the ball over a short period of time, thus causing it's momentum to change, and giving us:

$$\Delta p = m\Delta v = m(v_f - v_i) = (1.0)[(+1.5) - (-2.0)] = +3.5 \text{ kg m/s}$$

Note the positive value for our answer indicates it must be acting away from the wall.

14A

To the change in momentum of the floor acting on the ball we use $\Delta P = m\Delta v$

Since we have the mass already, we are really looking for the velocity of the ball just before it hits the floor and the velocity just after as it begins to bounce back up.

Given that we have been provided with the initial height the ball is released from (20m) we can use the kinematic equations to determine the velocity just before it hits the floor:

Where: $V_i = 0$ m/s
$V_f = ?$
$a = -10$ m/s$^2$
$t =$
$\Delta y = -20$ m

Using $(V_f)^2 = (V_i)^2 + 2a\Delta y$
$V_f = -20$ m/s

(Note the sign could be + or – but we know it's negative because it's falling downwards when it hits the ground).

Next, we then use the information that after the bounce the ball reaches a maximum height of 5 m to determine the velocity just after it hits the floor and bounces back up:

Where: $V_i = ?$
$V_f = 0$
$a = -10$ m/s$^2$
$t =$
$\Delta y = +10$ m

Using $(V_f)^2 = (V_i)^2 + 2a\Delta y$
$V_i = 10$ m/s

(Note the sign could be + or – but we know it's positive because it's rising upwards after it hits the ground).

Lastly our goal is to calculate the momentum change, $m\Delta V$, however understand that the change in velocity is referring to just before it hits the ground and just after. Thus is we expand $m\Delta v$ to become $m(V_2 - V_1)$, $V_2$ would be the velocity just after the collision, +10 m/s, and $V_1$ would be the velocity just before, -20 m/s.

After plugging everything in we get:

$$m\Delta V = (0.1)[(+10) - (-20)] = 3.0 \text{ kg m/s}$$

15C

Remember that on flat surfaces the only force responsible for turning a vehicle such that it doesn't slip is static friction, which points along the radial axis and is equal to the centripetal force. Along the vertical axis the weight vector, mg, and the normal force, n, oppose one another and cancel out, such that we can write n = mg.

So, when setting up the equation for centripetal force we get:

$$F_C = f_s = \mu_s n = \mu_s mg = \frac{mv^2}{r}$$

$$v = \sqrt{\mu_s gr} = 10 \text{ m/s}$$