Quiz 3 (Energy and Momentum)

In this quiz you will get the same questions but with different numbers.

You will not get all 6 questions but will get a selection of 4 of them. You, therefore, need to understand how to solve them all.

1) A child does 200 J of work while pulling a box from the ground up to his tree house with a rope. The tree house is 4.0 m above the ground. What is the mass of the box?

Solution:

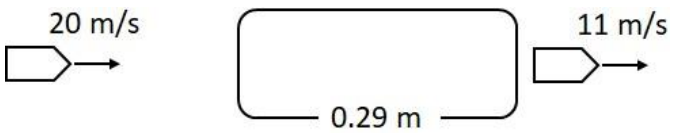
$$W = F.s$$
$$200 = (m \times 9.8)\ 4$$
$$m = 5.1\ kg$$

2) A spring with a spring constant of 10 N/m is stretched from equilibrium to 2.9 m. How much work is done in the process?

Solution:

$$U_e = \frac{1}{2}\ k\ x^2 = \frac{1}{2}\ 10\ 2.9^2$$
$$= 42.1\ J$$

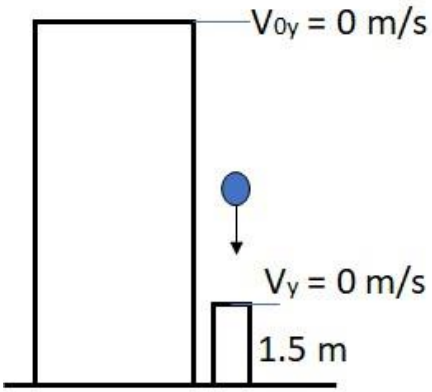
3) A 31 g bullet pierces a sand bag 29.0 cm thick. If the initial bullet velocity was 20 m/s and it emerged from the sandbag with 11 m/s, what is the magnitude of the friction force (assuming it to be constant) the bullet experienced while it traveled through the bag?
Solution:



$$F = m\ a \Rightarrow a = ?$$
$$v^2 = v_0^2 + 2\ a\ \Delta x$$
$$a = -481\ m/s^2$$

$$F = 31 \times 10^{-3}\ (-481) = -15\ N$$

4) 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 50 m/s when it strikes a person's head (1.5 m above the ground), how tall is the building? Neglect air resistance.
Solution:

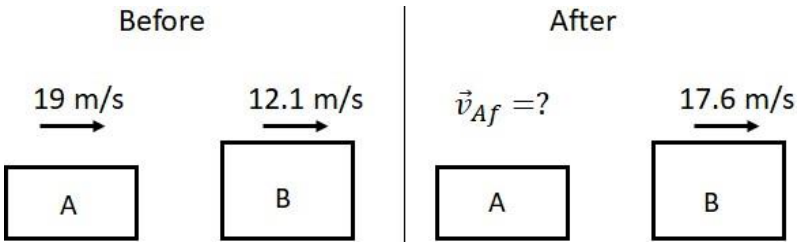


$$v^2 = v_o^2 + 2\ a\ \Delta y$$
$$50^2 = 0^2 + 2\ (-9.8)\ \Delta y$$
$$\Delta y = -128 m$$

$$height = 128 + 1.5 = 129.5\ m$$

5) A 324 kg car moving at 19.1 m/s hits from behind another car moving at 12.1 m/s in the same direction. If the second car has a mass of 495 kg and a new speed of 17.6 m/s, what is the velocity of the first car after the collision?

Solution:

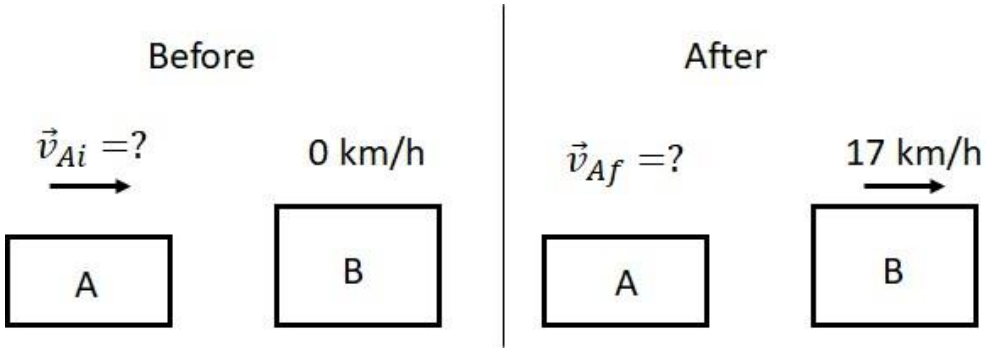


$$p_{Ai} + p_{Bi} = p_{Af} + p_{Bf}$$

$$324 \times 19.1 + 495 \times 12.1 = 324 \times v_{Af} + 495 \times 17.6$$

$$v_{Af} = 10.7 m/s$$

6) A car of mass 1411 kg collides head-on with a parked truck of mass 2000 kg. Spring mounted bumpers ensure that the collision is essentially elastic. If the velocity of the truck is 17 km/h (in the same direction as the car's initial velocity) after the collision, what is the initial speed of the car?
Solution:



Momentum:

$$p_{Ai} + p_{Bi} = p_{Af} + p_{Bf}$$
$$1411 \times v_{Ai} + 0 = 1411 \times v_{Af} + 2000 \times 17 \Rightarrow \textit{two unknowns}$$
$$v_{Bf} - v_{Af} = -(v_{Bi} - v_{Ai})$$
$$17 - v_{Af} = -(0 - v_{Ai})$$
$$v_{Af} = 17 - v_{Ai}$$
$$-\textit{sub. in first equ.}:$$
$$1411 \times v_{Ai} = 1411 \times (17 - v_{Ai}) + 34,000$$
$$v_{Ai} = 20.5\ km/h$$