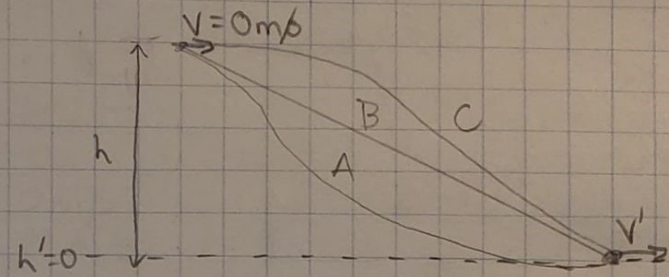
Unit 3 - Assignment (I)

David Wagji
Due: Dec 11, 2020

1.



We know that the given ball will always start at a certain height and end at a certain height, irrespective of pathway. We can therefore claim that the ball always ends at a height of h' of 0 m and starts at a height of h.

We also know that the force of gravity is the only force acting on the ball as there is no applied force or friction.

Finally, since the ball starts at rest, the ball will always have an initial velocity of 0 m/s. We can then solve for v' using the formula from the Law of Conservation of Energy, $E_T = E_T'$.

Expanding this formula, we get $E_k + E_g = E_k' + E_g'$, and further expending we get $\frac{1}{2}mv^2 + mgh = \frac{1}{2}m(v')^2 + mgh'$.

Subbing in values of $h' = 0\,m$ & $v = 0\,m/s$:

$$\frac{1}{2}mv^2 + mgh = \frac{1}{2}m(v')^2 + mgh'$$
$$\frac{1}{2}m(0)^2 + mgh = \frac{1}{2}m(v')^2 + mg(0)$$
$$mgh = \frac{1}{2}m(v')^2$$

This equation makes sense because at the top of the ramps, the E_k for the ball on all pathways will be 0 (no kinetic motion is occuring). Additionally, the gravitational potential energy at the bottom of the ramps will always be 0 (end height is at 0 so no E_g').

Unit 3 - Assignment (II)

David Waffi

1. (cont.)

Solving for v', we end up with:

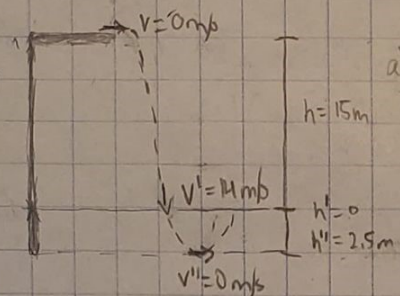
$$\cancel{m}gh = \frac{1}{2}\cancel{m}(v')^2$$
$$(v')^2 = 2gh$$
$$v' = \sqrt{2gh}$$

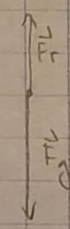
Since the initial height of the ball is the same on all pathways and g is constant, v' will be the same for the ball, no matter which of the pathways are chosen. This means that the greatest speed can be achieved on all 3 paths.

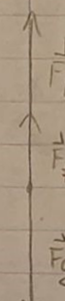
Unit 3 - Assignment (III)

David Wals.
Due: Dec 11, 2020

3. $m = 57\ kg$
$h = 15\ m$
$h' = 0\ m$
$v = 0\ m/s$
$v' = 14\ m/s$
$g = 9.8\ m/s^2\ [\downarrow]$
$F_B = 500\ N\ [\uparrow]$
$F_r = $ (a)
$F_f = $ (b)
$h'' = 2.5\ m$



a) 

b) 

Variable subscript:
$v'_{rn} = v'$ with no air resistance

a) $E_T = E_T'$

$\cancel{E_k}^{0} + E_g = E_k' + \cancel{E_g'}^{0}$

$\cancel{m}gh = \frac{1}{2}\cancel{m}(v'_{rn})^2$

$(v'_{rn})^2 = 2gh$

$v'_{rn} = \sqrt{2gh}$

$v'_{rn} = \sqrt{2(9.8)(15)}$

$= \sqrt{294}$

$v'_{rn} = 17.1\ m/s$

$\therefore\ W = \Delta E_K$

$= \frac{1}{2} m \Delta(v^2)$

$= \frac{1}{2} m ((v'_{rn})^2 - (v')^2)$

$= \frac{1}{2}(57)(17.1^2 - 14^2)$

$W = 2793\ J$

$\therefore\ W = F d \cos\theta$

$W = F_r \cdot h \cos 0°$

$F_r = \frac{W}{h}$

$= \frac{2793}{15}$

$F_r = 186\ N$

$\therefore$ The average force of air resistance acting on the diver is 186 N [↑].

b) $W = \Delta E_K$

$= E_{K2} - E_{K1}$

$= \frac{1}{2}m(v')^2 - \cancel{\frac{1}{2}mv^2}^{0}$

$= \frac{1}{2}(57)(14)^2$

$W = 5586\ J$

$\therefore\ W = F \Delta d \cos\theta$

$W = (F_f + F_B)\, h'' \cos 0°$

$F_f = \frac{W}{h''} - F_B$

$= \frac{5586}{2.5} - 500$

$F_f = 1734.4\ N$

$\therefore$ The force of friction underwater is 1734 N [↑]