Union County College **Test3S**

A car uniformly accelerates from 10 m/s to 40m/s in a semicircular arc of 220m.

1. **Determine the tangential acceleration of the car**

$V_{0C} := 10\frac{m}{s}$ $V_{FC} := 40\frac{m}{s}$ $R_a := 220m$

This is 5 formula problem, where we know V_o, V_F and the distance, which is half the circumference

$\Delta s := \pi \cdot R_a$ $\Delta s = 691\,m$

a_T	V_{Fc}	V_{oc}	ΔS	Δt
?	40	10	691	

$$a_T := \frac{V_{FC}^2 - V_{0C}^2}{2\cdot\Delta s}$$ $\boxed{a_T = 1.1\,\frac{m}{s^2}}$

2. **Determine the radial acceleration halfway through the turn**

We must first find the speed of the car half through the turn. In this case $V_{0C} = 10\,\frac{m}{s}$

$a_T = 1.1\,\frac{m}{s^2}$ and $\Delta s_h := \frac{\pi\cdot R_a}{2}$ $\Delta s_h = 346\,m$

a_T	V_{Fc}	V_{oc}	ΔS	Δt
1.1	?	10	346	

$V_{fch} := \sqrt{V_{0C}^2 + 2\cdot a_T\cdot\Delta s_h}$ $V_{fch} = 29\,\frac{m}{s}$

now the Radial acceleration half thorugh the turn is $a_{Rh} := \frac{V_{fch}^2}{R_a}$ $\boxed{a_{Rh} = 3.9\,\frac{m}{s^2}}$ $\boxed{\text{inward}}$

3. **If the curve is flat what is he coefficient of static friction to ensure this acceleration from the car?**

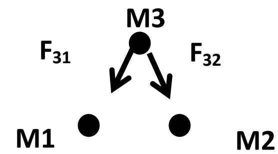
From 2nd Law in vertical $Fn = m_c\cdot g$ The frictional force provides the centrepital forc

$F_s = m\cdot a_{Rh}$ the coefficient of staic friction half way through the curve must be at leas

$\mu_s = \frac{F_s}{F_n} = \frac{a_{Rh}}{g}$ $\boxed{\mu_s = 0.394}$

Three masses are on the vertices of an equilateral triangle with side of .5m. M1=5KG, M2=4KG, M3=7KG

4. Find the force on the top charge due to the other two charges



$m_1 := 5kg \qquad m_2 := 4kg \qquad m_3 := 7kg$

$G := 6.67 \cdot 10^{-11} \cdot \frac{N \cdot m^2}{kg^2} \qquad s_e := .5m \qquad \theta_e := 60deg \qquad r_{13} := .5m \qquad r_{23} := .5m$

$F_{31} := \frac{G\, m_1 \cdot m_3}{r_{13}^2} \qquad F_{31} = 9.3 \times 10^{-9}\ N \qquad \theta_{31} := 180deg + \theta_e \qquad \theta_{31} = 240deg$

$F_{32} := \frac{G\, m_2 \cdot m_3}{r_{23}^2} \qquad F_{32} = 7.5 \times 10^{-9}\ N \qquad \theta_{32} := 360deg - \theta_e \qquad \theta_{32} = 300deg$

$F_{t3x} := F_{31} \cdot \cos(\theta_{31}) + F_{32} \cdot \cos(\theta_{32}) \qquad F_{t3x} = -9.338 \times 10^{-10}\ N$

$F_{t3y} := F_{31} \cdot \sin(\theta_{31}) + F_{32} \cdot \sin(\theta_{32}) \qquad F_{t3y} = -1.456 \times 10^{-8}\ N$

$F_{t3} := \sqrt{F_{t3x}^2 + F_{t3y}^2} \qquad \boxed{F_{t3} = 1.5 \times 10^{-8}\ N}$

$\theta_{t3} := atan\left(\left|\frac{F_{t3y}}{F_{t3x}}\right|\right) \qquad \boxed{\theta_{t3} = 86.33deg} \qquad \boxed{3rdQ}$

A 300 kg bobsled starts from rest and slides down a 30 degree incline 100m long. It then continues on level ground until coming to a stop.. The coefficient of friction is 0.092 on the incline and on the flat surface.

5. Find the speed of the bobsled at the bottom of the hill using energy methods

$m_{bs} := 300kg \quad \theta := 30deg \quad \mu_k := 0.092 \quad d := 100m \quad V_{0bs} := 0\frac{m}{s}$

Energy methods $\boxed{W_{nc} = \Delta KE + \Delta GPE}$ The vertical height change is $\Delta h := -d \cdot \sin(\theta)$

$\Delta h = -50\,m \quad \Delta GPE := m_{bs} \cdot g \cdot \Delta h \quad \boxed{\Delta GPE = -1.471 \times 10^5\ J}$

by 2nd law $F_n := m_{bs} \cdot g \cdot \cos(\theta) \quad F_n = 2.548 \times 10^3\ N$ the frictional force is

$f_k := \mu_k \cdot F_n \quad f_k = 234\ N \quad W_{F.k} := f_k \cdot \cos(180deg) \cdot d \quad W_{F.k} = -2.344 \times 10^4\ J$

The two Non-conservative forces are the Normal Force and the frictional force. The normal force is perpendicular to the direction of motion so it does no work There fore $\boxed{W_{nc} := W_{F.k}}$

$\boxed{\Delta KE = \frac{1}{2} \cdot m_{bs} \cdot V_{fbs}^2 - \frac{1}{2} \cdot m_{bs} \cdot V_{0bs}^2 = \frac{1}{2} \cdot m_{bs} \cdot V_{fbs}^2}$ since $V_{0bs} = 0$

Substituting into the energy equation $\boxed{W_{nc} = \Delta KE + \Delta GPE}$ and solving we have $\boxed{V_{fbs} = 29\frac{m}{s}}$

6. *Fin*d the distance the bobsled travels on the flat ground using energy methods

on the flat ground $V_{0g} := V_{fbs}$ and $V_{fg} := 0\frac{m}{s}$

$\Delta KE_g := \left(\frac{1}{2} \cdot m_{bs} \cdot V_{fg}^2 - \frac{1}{2} \cdot m_{bs} \cdot V_{0g}^2\right) \quad \Delta KE_g = -1.237 \times 10^5\ J$ by 2nd law $F_{ng} := m_{bs} \cdot g$

$F_{ng} = 2.942 \times 10^3\ N$ the frictional force is $f_{kg} := \mu_k \cdot F_{ng} \quad f_{kg} = 271\ N$

The weight and the normal force are both perpendicular to the diorection of motion so neither force does any work. $W_{net} = W_{Fn} + W_{mg} + W_{F.k} = W_{F.k}$

From work energy theorem $W_{net} = \Delta KE$ we have $W_{F.kg} := \Delta KE_g \quad W_{F.kg} = -1.237 \times 10^5\ J$

From the definiton of work we solve for the distance $d_g := \frac{W_{F.kg}}{\cos(180deg) \cdot f_{kg}} \quad \boxed{d_g = 457m}$

A 0.160 kg baseball is pitched at 38 m/s and hit on a horizontal line drive straight back toward the pitcher at 53m/s. The time of contact between the ball and the bat is 3ms.

7. Find the initial momentum of the ball

$m_B := 0.160kg$ to the right is + $V_{0B} := 38\frac{m}{s}$ $V_{fB} := -53\frac{m}{s}$ $\Delta t := 3\cdot 10^{-3} s$

$P_{ob} := m_B \cdot V_{0B}$ $\boxed{P_{ob} = 6.08\frac{m\cdot kg}{s}}$

8. Find the final momentum of the ball

$P_{Fb} := m_B \cdot V_{fB}$ $\boxed{P_{Fb} = -8.48\frac{m\cdot kg}{s}}$

9. Find the change in the momentum of the ball

$\Delta P := P_{Fb} - P_{ob}$ $\boxed{\Delta P = -14.56\frac{m\cdot kg}{s}}$

10. Find the average force exerted on the ball by the bat

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$F_{net} := \frac{\Delta P}{\Delta t}$ $\boxed{F_{net} = -4.853\times 10^{3}\ N}$