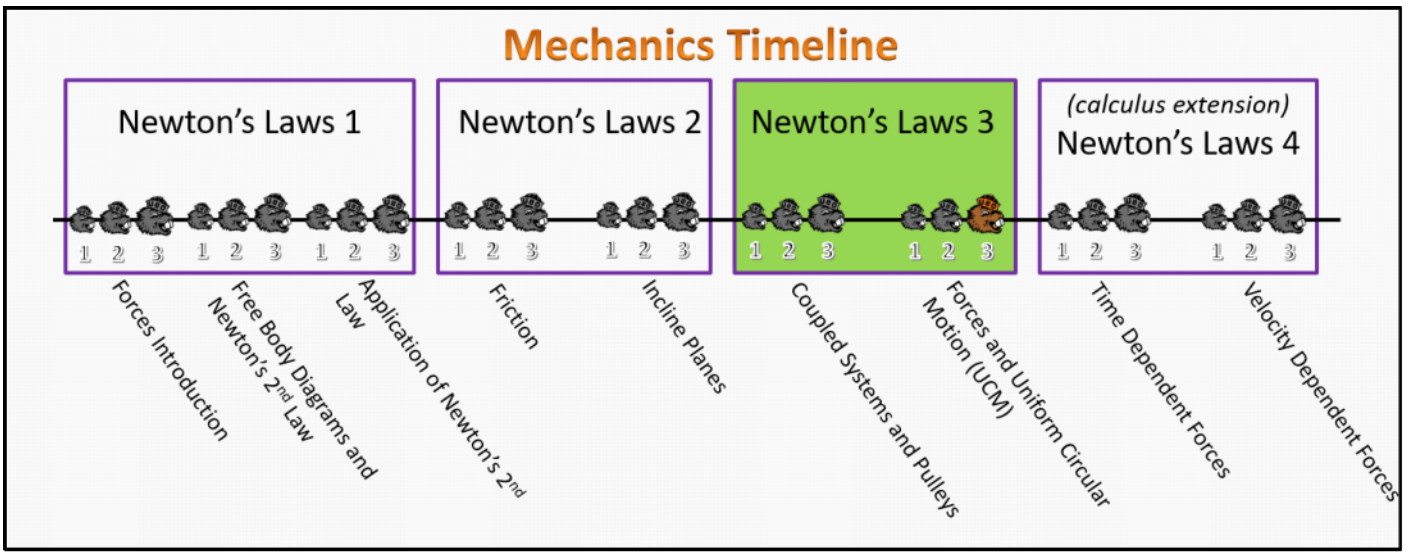
(N3.L2.3-sols) Practice Stage Solutions

Thursday, March 29, 2018 8:34 PM

Newton's Laws 3
Foundation Stage (N3.L2.3)

Post-Lecture 2
Forces and Uniform Circular Motion (UCM)



Questions

N3.L2.3-01

Description: Force analysis to find speed of plane making turn for UCM.

Learning Objectives: [?]

Problem Statement: An airplane is flying in a horizontal circle that has a radius of 9,300 meters. The plane's wing makes an angle of 30 degrees with respect to the horizontal. We eventually wish to determine the speed the plane must fly to make this turn and maintain its altitude.

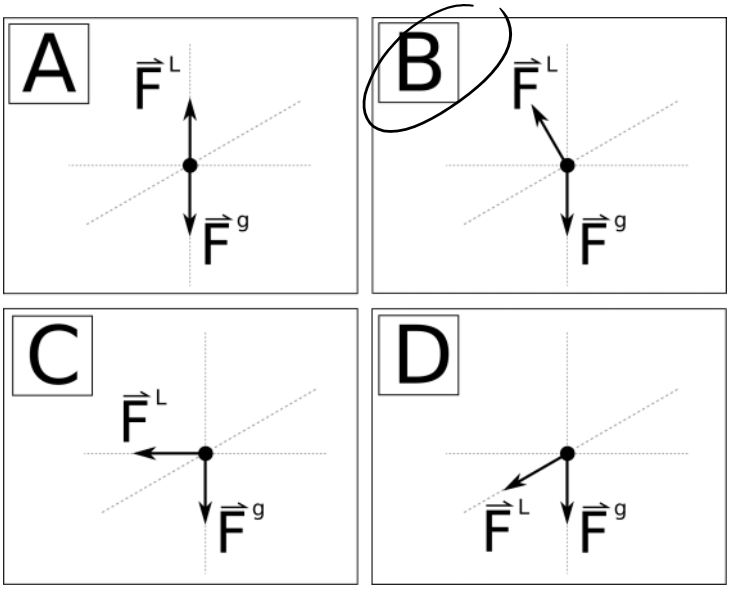
(a) What forces are acting on the plane?

(1) Gravity
(2) Normal
(3) Centripetal
(4) Force of acceleration
(5) Lift

(b) Lift can be approximated as a single force that is perpendicular to the wings of the airplane. Which of the following FBDs best

represent the forces acting on the system of the plane?

(1) A
(2) B
(3) C
(4) D



(c) An airplane is flying in a horizontal circle that has a radius of 9,300 meters. The plane's wing makes an angle of 30 degrees with respect to the horizontal. Determine the speed the plane must fly to make this turn and maintain its altitude. Use **g** = 9.80 m/s^2.

(1) 229 m/s
(2) 213 m/s
(3) 281 m/s
(4) 397 m/s

FBD

$\Sigma F_r = ma_r$ $\quad \Sigma F_y = ma_y = 0$

$F^L \sin\theta = m\frac{v_t^2}{r}$ $\quad F^L \cos\theta - mg = 0$

$F^L = \frac{mg}{\cos\theta}$

$\frac{mg\sin\theta}{\cos\theta} = \frac{mv_t^2}{r}$

$g\tan\theta = \frac{v_t^2}{r}$

$v_t = \sqrt{gr\tan\theta} \simeq 229.38\ m/s$

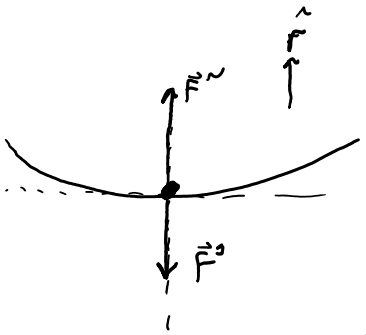
N3.L2.3-02

Description: Force analysis to find speed of car at bottom of circular hill.

Learning Objectives: [?]

Problem Statement: A car is traveling at the bottom of a 9.00-meter-radius circular hill with a constant speed **v**. The moment the car is at the bottom of the hill, it is noted that a person sitting on a scale in the car reads a value off the scale that is 80% more than normally when the scale is at rest in a bathroom. With what speed is the car traveling? Use **g** = 9.80 m/s^2.

(1) Need to know the mass in order to find the speed.
(2) 8.40 m/s
(3) 9.39 m/s
(4) 12.6 m/s



$F^N = 1.8mg$

$\Sigma F_r = ma_r$

$F^N - mg = m\frac{v_t^2}{r}$

$1.8mg - mg = m\frac{v_t^2}{r}$

$0.8mg = m\frac{v_t^2}{r}$

$v_t = \sqrt{0.8gr}$

$v_t = 8.4\ m/s$

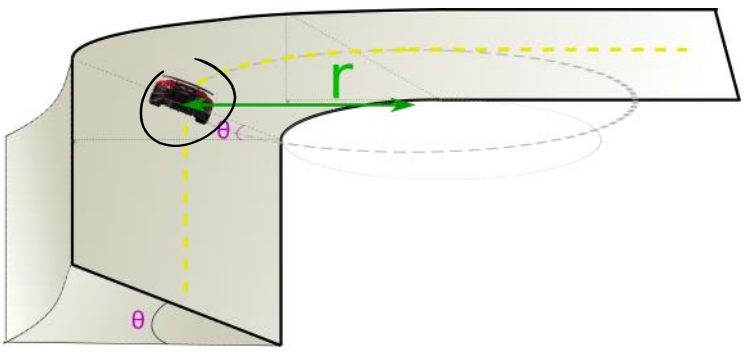
N3.L2.3-03

Description: Force analysis to find maximum speed of car going around banked turn with friction.

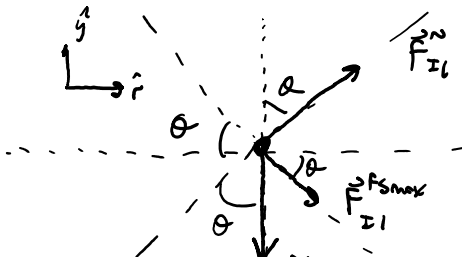
Learning Objectives: [?]

Problem Statement: A 2016 Dodge Viper ACR has a mass of about 1530 kg and the coefficient of static friction between the ground and the tires are about 1.11. A banked track has a radius of about 31.4 meters and is banked at an angle of 20.0° with respect to the horizontal as shown in the figure below. What is the maximum speed the Viper can go around this turn without slipping?

(1) 18.0 m/s
(2) 18.5 m/s
(3) 27.6 m/s
(4) 40.0 m/s

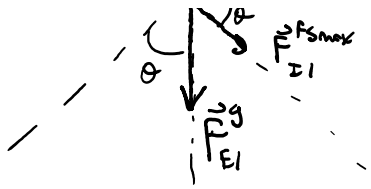


FBD



$\Sigma F_r = ma_r$

$F^N \sin\theta + F^{f_{s\max}} \cos\theta = mv_t^2$



$\Sigma F_\theta = ma_\theta^{\,0}$

$F_{N1}\cos\theta - F_{s1}^{f_{s max}}\sin\theta - m_1 g = 0$

$F_{N1}\cos\theta - \mu_s F_{N1}\sin\theta = m_1 g$

$F_{N1}(\cos\theta - \mu_s \sin\theta) = m_1 g$

$$F_{N1} = \frac{m_1 g}{\cos\theta - \mu_s \sin\theta}$$

$\Sigma F_r = ma_r$

$F_{N1}\sin\theta + F_{s1}^{f_{s max}}\cos\theta = m_1\frac{v_t^2}{r}$

$F_{N1}\sin\theta + \mu_s F_{N1}\cos\theta = \frac{m_1 v_t^2}{r}$

$F_{N1}(\sin\theta + \mu_s\cos\theta) = \frac{m_1 v_t^2}{r}$

$$\frac{m_1 g}{\cos\theta - \mu_s\sin\theta}\cdot(\sin\theta + \mu_s\cos\theta) = \frac{m_1 v_t^2}{r}$$

$$\sqrt{\frac{gr(\sin\theta + \mu_s\cos\theta)}{\cos\theta - \mu_s\sin\theta}} = v_t$$

$v_t = 27.5868\ m/s$