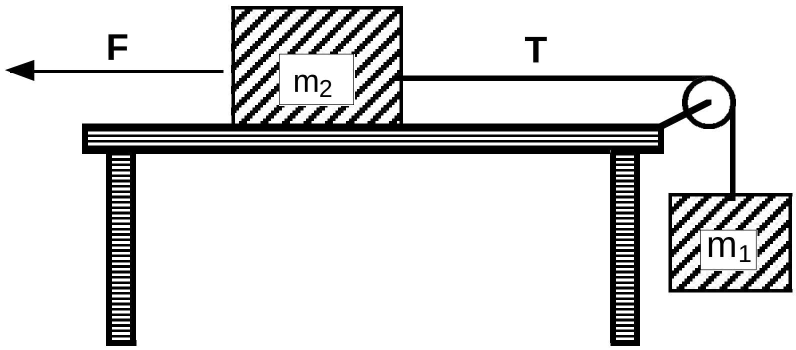
LAB PHYSICS TEST CHAPTER 4-5[D] 100 Pts 1997-98

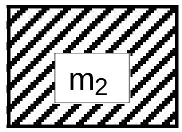
NEWTON'S LAWS OF MOTION

ANSWER EACH OF THE FOLLOWING PROBLEMS! BE SURE TO SHOW ALL WORK CAREFULLY!

1. A mass of m_2 = 8.0 kg is sitting on a horizontal surface which has a coefficient of sliding friction of μ_k = 0.505. A force F is applied to this mass so as to pull the mass to the left at a constant speed. This mass is in turn attached to a second mass m_1 = 5.0 kg by a string which has a tension T.

   a. On the diagram below indicate all the forces acting on mass m_2 as the system moves at a constant speed.[5 pts]





b. What will be the magnitude of the normal force acting on m_2 ? [5 pts]

c. What will be the magnitude of the frictional force acting on m_2 as it moves to the left at a constant speed? [5 pts]

d. What will be the magnitude of the tension T in the string between m_1 and m_2 as this system is pulled to the left at a constant speed? [5 pts]

e. How much force F should be applied if the mass m_2 is to move toward the left at a constant speed ? [5 pts]

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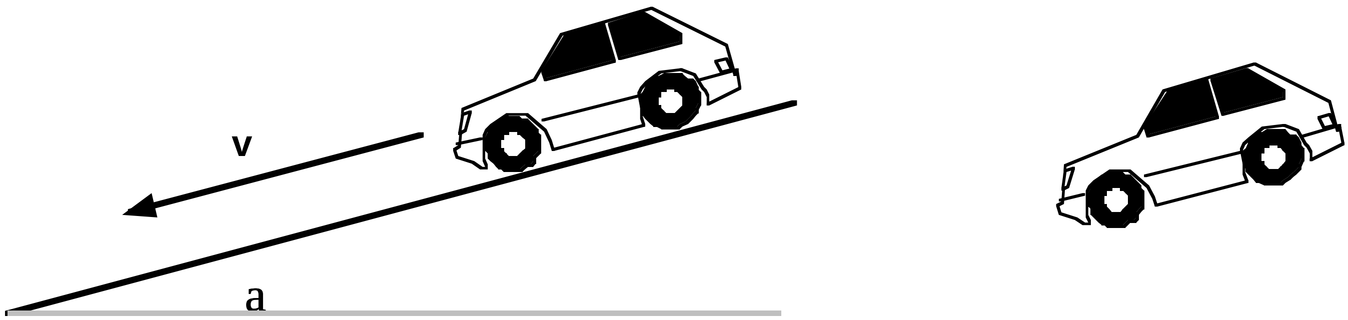
2. A car, which has a mass of 1350 kg., is moving with a velocity of 26.5 m/sec. down a hill which is inclined at an angle of $\alpha = 9.5^{o}$. The brakes are applied firmly and exert a force of 6460 N which acts to slow the car down as it moves down the hill.

   a. On the diagram below indicate all of the forces acting on the car as it accelerates down the hill. [5 pts]



   b. What is the minimum coefficient of friction μ between the tires of the car and the roadbed? [5 pts]
   c. What will be the acceleration of the car as it moves down the hill ? [5 pts]
   d. How long will it take for this car to come to a halt ? [5 pts]
   e. How far down the hill will the car move before it comes to a halt ? [5 pts]

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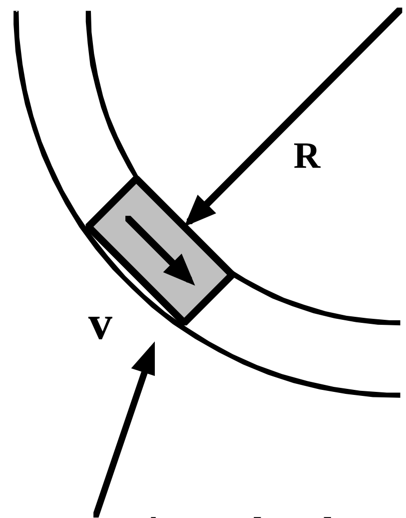
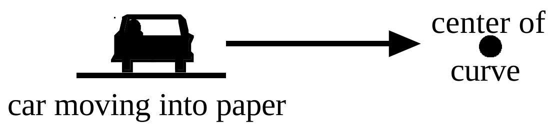
3. A car, which has a mass of 1650 kg., is moving through a curve in the highway. The curve has a radius of R = 92.0 meters and the car is moving with a velocity of v = 18.7.0 m/sec.



a. Draw a **freebody diagram** below indicating each of the relevant forces acting on the car as it moves through the curve ? [5 pts]



b. What will be the **direction** of the centripetal acceleration of the car while is the position shown ? [5 pts]

c. What will be the **magnitude** of the frictional force acting on the car as it moves through the curve? [5 pts]

d. What will be the minimum **coefficient of static friction** μ_S between the tires of the car and the road if the car is to make it safely through the curve ? [5 pts]

e. What will be the maximum **safe speed** for this car if the road is ice covered and the resulting coefficient of friction drops to $\mu_S = 0.126$? [5 pts]

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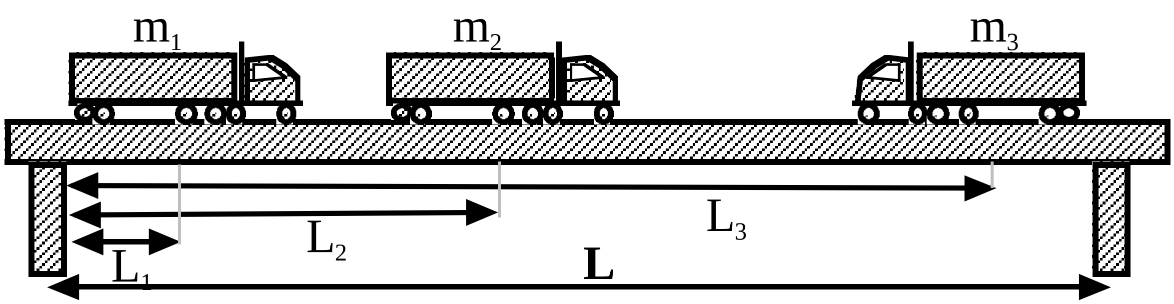
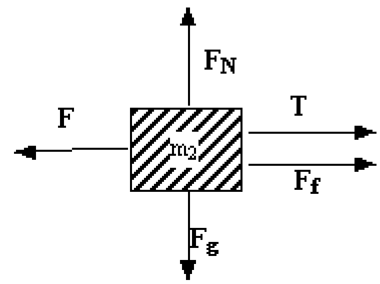


4. A bridge consists of a long central span of L = 74.0 meters supported at each end by a pier. The bridge itself has a mass of 110,000 kg. On this bridge are three trucks. The first truck m_1 has a mass of 41,000 kg and is sitting L_1 = 9.0 meters from the left end of the bridge, the second truck m_2 has a mass of 24,500 kg and is sitting L_2 = 32.0 meters from the left end and the third truck m_3 has a mass of 66,000 kg and is sitting L_3 = 58.0 meters from the left end of the bridge as shown above.
   a. Below complete the vector diagram indicating all of the forces acting on the bridge. [5 pts]
   b. What is the direction and magnitude of the torque exerted by the first truck m_1 about the left pier? [5 pts]
   c. What will be the magnitude of the force exerted by the left pier on the bridge? [5 pts]
   d. What will be the magnitude of the force exerted on the bridge by the right pier? [5 pts]
   e. Where along the length of the bridge could a single upward force be applied so as to lift the bridge and the three vehicles without tipping? [5 pts]

Lab Physics Test D Newton's Laws 1997-98

1. $m_2 := 8.0 \cdot kg \quad \mu := 0.505 \quad F := 1 \cdot N \quad m_1 := 5.0 \cdot kg \quad T := 1 \cdot N$

a. The freebody diagram at the right. [5 pts]



b. $F_N := m_2 \cdot g$ $\quad F_N = 78.453\,N$ 1b. The normal force acting on m2. [5 pts]

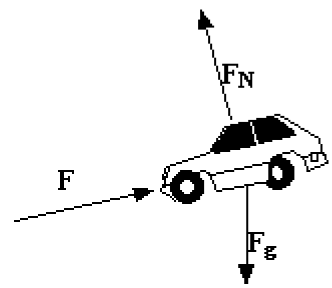
c. $F_f := F_N \cdot \mu$ $\quad F_f = 39.619\,N$ 1c. The frictional force acting on m2. [5 pts]

d. $T := m_1 \cdot g$ $\quad T = 49.033\,N$ 1d. The tension in the string. [5 pts]

e. $F := T + F_f$ $\quad F = 88.652\,N$ 1e. The magnitude of theapplied force F. [5 pts]

2. $m_{car} := 1350 \cdot kg \quad v_o := 26.5 \cdot \frac{m}{sec} \quad \alpha := 9.50 \cdot deg \quad F := 6460 \cdot N \quad a := 1 \cdot \frac{m}{sec^2} \quad v_f := 0 \cdot \frac{m}{s}$

a. The freebody diagram to the right. [5 pts] $\quad t := 1 \cdot sec$



b. $F_f := F \quad F_f = 6.46 \times 10^3\,N \quad F_N := m_{car} \cdot g \cdot \cos(\alpha) \quad F_N = 1.306 \times 10^4\,N$

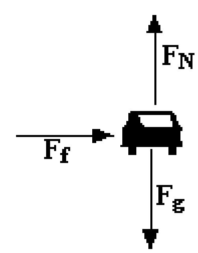
$\mu := \frac{F_f}{F_N}$ $\quad \mu = 0.495$ 2b. The minimum coefficient of friction. [5 pts]

c. Given $\quad F - m_{car} \cdot g \cdot \sin(\alpha) = m_{car} \cdot a \quad a := Find(a)$ $\quad a = 3.167\,\frac{m}{sec^2}$ 2c. The acceleration of this car. [5 pts]

d. Given $\quad v_f = -a \cdot t + v_o \quad t := Find(t)$ $\quad t = 8.369\,s$ 2d. Time for the car to stop. [5 pts]

e. $D_f := \frac{-1}{2} \cdot (a \cdot t^2) + v_o \cdot t$ $\quad D_f = 111\,m$ 2e. The final displacement of the car. [5 pts]

3. $m_{car} := 1650 \cdot kg \quad R := 92.0 \cdot m \quad v := 18.7 \cdot \frac{m}{sec}$ 3a. The freebody diagram on the car. [5 pts]



b. The centripetal acceleration is directed NE, toward the center. [5 pts]

c. $F_c := \frac{m_{car} \cdot v^2}{R}$ $\quad F_c = 6272\,N$ 3c. The centripetal force on this car. [5 pts]

d. $F_f := F_c \quad \mu := \frac{F_f}{m_{car} \cdot g}$ $\quad \mu = 0.388$ 3d. The coefficient of friction. [5 pts]

e. $\mu := 0.126 \quad v_{max} := 10 \cdot \frac{m}{sec}$

Given $\quad m_{car} \cdot g \cdot \mu = \frac{m_{car} \cdot v_{max}^2}{R} \quad v_{max} := Find(v_{max})$ $\quad v_{max} = 10.662\,\frac{m}{sec}$ 3e. The maximum safe velocity. [5 pts]

Lab Physics Test D Newton's Law 1997-98

4. $L := 74.0 \cdot m$ $M := 110000 \cdot kg$ $m_1 := 41000 \cdot kg$ $m_2 := 24500 \cdot kg$ $m_3 := 66000 \cdot kg$ $F_A := 1 \cdot N$ $F_B := 1 \cdot N$

$W := M \cdot g$ $W = 1.079 \times 10^6 N$ $F_1 := m_1 \cdot g$ $F_1 = 4.021 \times 10^5 N$ $F_2 := m_2 \cdot g$ $F_2 = 2.403 \times 10^5 N$ $F_3 := m_3 \cdot g$ $F_3 = 6.472 \times 10^5 N$

$R_1 := 9.0 \cdot m$ $R_2 := 32.0 \cdot m$ $R_3 := 58.0m$

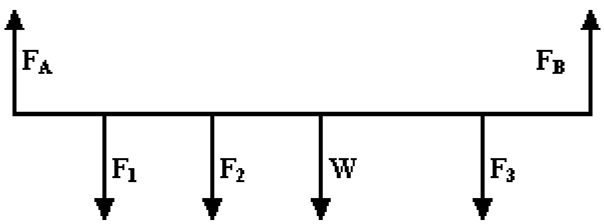
$T_1 := F_1 \cdot R_1$ $T_1 = 3.619 \times 10^6 N \cdot m$

$T_2 := F_2 \cdot R_2$ $T_2 = 7.688 \times 10^6 N \cdot m$

$T_3 := F_3 \cdot R_3$ $T_3 = 3.754 \times 10^7 N \cdot m$

$T_{Bridge} := W \cdot \frac{L}{2}$ $T_{Bridge} = 3.991 \times 10^7 N \cdot m$

4a. The freebody diagram of the bridge. [5 pts]



b. $T_1 = 3.619 \times 10^6 N \cdot m$ 4b. The torque exerted on the bridge by the first truck. [5 pts]

d. $F_B := \frac{T_1 + T_2 + T_3 + T_{Bridge}}{L}$ $F_B = 1.199 \times 10^6 N$ 4d. The force exerted by the RIGHT pier. [5 pts]

c. $F_{total} := m_1 \cdot g + m_2 \cdot g + m_3 \cdot g + M \cdot g$ $F_{total} = 2.368 \times 10^6 N$

$F_A := F_{total} - F_B$ $F_A = 1.17 \times 10^6 N$ 4c. The force exerted by the LEFT pier. [5 pts]

e. $F_{up} := F_{total}$ $F_{up} = 2.368 \times 10^6 N$ $T_{total} := T_1 + T_2 + T_3 + T_{Bridge}$ $T_{total} = 8.876 \times 10^7 N \cdot m$

$x_{up} := \frac{T_{total}}{F_{up}}$ $x_{up} = 37.478 m$ 4e. The point where a single upward force would support the bridge. [5 pts]