SECOND MIDTERM

Name (print) __________________________ Name (signed) __________________________

Discussion Instructor (circle one): Hamed Hari Molina Nott Paul Reeve Zhang

Discussion Section # ______

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) Convert 375 kg to slugs.

\[ 375 \, \text{kg} = 375 \, \text{kg} \times \frac{0.6232 \, \text{slug}}{1 \, \text{kg}} = 235.7 \, \text{slug} \]

(b) Find the weight in Newtons of a 256 slug mass.

\[ 256 \, \text{slug} = 256 \, \text{slug} \times \frac{1 \, \text{kg}}{2.205 \, \text{slug}} \Rightarrow \text{weight} = 3.66 \times 10^4 \, \text{N} \]

(c) The block is at rest on the plane. Its mass is 12.0 kg. The coefficients of friction are \( \mu_s = 0.75 \) and \( \mu_k = 0.60 \). Calculate the frictional force on it.

\[ N = mg \cos \theta = 12.0 \times 9.81 \times \cos 10^\circ \]

\[ F_f = mg \sin \theta = 80.42 \, \text{N (less 9 N)} \]

(d) A car travels at 55.0 mi/hr around a curve of radius 400 ft. Calculate the inward acceleration in ft/s^2.

\[ 55 \, \text{mi/hr} = 55 \times \frac{5280 \, \text{ft}}{3600 \, \text{s}} = 80.7 \, \text{ft/s} \Rightarrow a = \frac{v^2}{r} = 16.3 \, \text{ft/s}^2 \]

(e) A 3000 lb car is acted on by a horizontal force of 15.0 lb. If it starts at rest and there is no friction. Calculate how far it moves in 7.00 s.

\[ a = \frac{F}{m} = \frac{15}{3000/22.2} \approx 0.161 \, \text{ft/s}^2 \Rightarrow x = \frac{1}{2} at^2 = 3.74 \, \text{ft} \]

- 1 UNIT
- 1 SF

\[ 0.35 \]
A car stops from a speed of 60.0 mi/hr in a distance of 347 ft on a level road.

(a) Calculate the coefficient of friction between tires and road.
(b) If the car weighs 3750 pounds, calculate the force slowing the car.

\[ \frac{v^2}{2g} + 2ad = v_0^2 \]

\[ \mu = \frac{-v_0^2}{2a} = 11.2 \text{ (ft/s}^2) \]

\[ F = -\mu mg = \mu ma = -\frac{mv_0^2}{2a} \]

\[ \mu = \frac{v_0^2}{2ad} = \frac{0.347}{8 \text{ points}} \]

\[ (b) \quad F = \mu mg = 1300 \text{ lb} = 5.83 \times 10^3 \text{ (N)} \]

(9 points)
On the moon, a rock is thrown up a hill that is inclined at 16.0° to the horizontal. The rock lands 525 meters up the hill.

(a) Find the initial velocity.
(b) Calculate the magnitude and direction of the velocity when the rock lands. (Express the angle using a labeled drawing.)

\[ V_0 \cos 46° \cdot t = 525 \text{m \cdot cos 16}° \]
\[ V_0 \sin 46° \cdot t - \frac{1}{2} \cdot g \cdot t^2 = 525 \text{m \cdot sin 16}° \]

\[ t = \frac{525 \text{m \cdot cos 16}°}{V_0 \cos 46°} \]
\[ \Rightarrow 525 \text{m \cdot cos 16}° \tan 46° - \frac{1}{2} \cdot g \cdot \left( \frac{525 \text{m \cdot cos 16}°}{\cos 46°} \right)^2 \cdot \frac{1}{V_0^2} = 525 \text{m \cdot sin 16}° \]

\[ \Rightarrow V_0 = 34.2 \text{ m/sec.} \]

\[ t = \frac{525 \text{ cos 16}°}{V_0 \cos 46°} = 21.3 \text{ sec.} \]
\[ \Rightarrow V_y = V_0 - g \cdot t = V_0 \sin 46° - 1.67 \text{ m/sec.} \cdot t \]
\[ = - 10.9 \text{ m/sec.} \]
\[ V_x = V_{x0} = 23.8 \text{ m/sec.} \]
\[ |V| = \sqrt{V_x^2 + V_y^2} = 26.1 \text{ m/sec.} \]
\[ \theta = - 24.7° \]
A block of mass \( m = 1.35 \text{ kg} \) slides on an inclined plane with friction. The coefficients of friction are \( \mu_k = 0.60 \) and \( \mu_s = 0.70 \), between the block and the plane. An external force \( F \) is applied at an angle \( \phi = 15.0^\circ \) from the horizontal, as shown.

(a) Calculate the minimum value of \( F \) such that the block just starts to move. A free body diagram and a force diagram are necessary part of the problem.
(b) If the force \( F = 6.00 \text{ N} \) (not the same as in (a)), calculate the velocity of the block after it has moved 2.50 m down the plane.

\[ \text{Diagram showing FBD and force diagram.} \]

2nd law: \( N + F \sin(\phi + \theta) - mg \cos \theta = 0 \quad \Rightarrow \quad N = F \sin(\phi + \theta) + mg \cos \theta \)
\[ \text{FBD diagram and force diagram are shown.} \]

\[ F = \frac{mg (\mu_s \cos \theta - \sin \theta)}{\cos(\phi + \theta) + \mu_s \sin(\phi + \theta)} = \frac{1.35 \times 9.8 (0.7 \cos 25^\circ - \sin 5^\circ)}{\cos 40^\circ + 0.7 \sin 40^\circ} = 2.30 \text{ N} \]

(b) \( F = 6.00 \text{ N} \)

\[ \text{By 2nd law:} \quad N + F \sin(\phi + \theta) - mg \cos \theta = 0 \]
\[ \text{Apply 2nd law:} \quad F \cos(\phi + \theta) + mg \sin \theta + \mu_k (F \sin(\phi + \theta) - mg \cos \theta) = \frac{ma}{m} \]
\[ a = \frac{F \cos(\phi + \theta) + mg \sin \theta + \mu_k (F \sin(\phi + \theta) - mg \cos \theta)}{m} \]
\[ = 3.93 \text{ m/s}^2 \]
\[ u^2 - v^2 = 2a(x - x_0) \]
\[ 4.43 \text{ m/s} \]
\[ \bar{x} = 21.77 \]
\[ \sigma_n = 4.45 \]
\[ n = 232 \]

SECOND MIDTERM

Name (print): DiCarlo
Name (signed): 

Discussion Instructor (circle): Condella DiCarlo Ganesan Hollier Reeve

Discussion Section #: 

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) Calculate the weight (in N) of an object that weighs 556 pounds (on Earth).

\[
\frac{225 \text{lbf}}{556 \text{lbf}} \Rightarrow \frac{225 \text{N}}{556 \text{lb}} = 4.03 \times 10^3 \text{ N}
\]

(b) Determine the weight (in N) on the moon of an object that weighs 789 N on Earth.

\[
789 \text{ N} \cdot \frac{5.49}{32.2} = 134 \text{ N}
\]

(c) Find the mass on the moon of an object whose mass is 20.0 slugs on Earth.

\[
\begin{align*}
20.0 \text{ slugs} & \quad \text{same as} \quad 291 \text{ kg} \\
20.0 \text{ slugs} & \quad \text{or} \quad 291 \text{ kg}
\end{align*}
\]

(d) If the mass shown has \( m = 14.2 \text{ kg} \), calculate (on Earth) the force of friction on it if it is at rest.

\[
F_f = mg \sin \theta = (14.2 \text{ kg}) \times 9.8 \text{ m/s}^2 \times 0.2 \Rightarrow F_f = 24.6 \text{ N}
\]

(e) A 4,500 N force is applied horizontally (and parallel to the track) to a railroad car that weighs 100,000 N (on Earth). Find the acceleration that results, if friction is taken to be zero.

\[
F = Ma \Rightarrow 4,500 \text{ N} = 100,000 \text{ N m} \Rightarrow a = \frac{441 \text{ m/s}^2}{1500}
\]
A brick hangs from a string attached to the ceiling. When a horizontal force of 4.00 N is applied to the brick, the string makes an angle of 18.0° with the vertical.

(a) Calculate the mass of the brick.
(b) Determine the tension in the string.

\[ T_x = \frac{F}{\cos \theta} \]
\[ T_y = mg \]

\[ T_x = \frac{F}{\cos \theta} \]
\[ T_y = mg \]

\[ m = \frac{1}{2} \left( \frac{F}{\sin \theta} \right) \cos \theta = \frac{F}{2 \sin \theta \cos \theta} = \frac{4.00N}{(9.8m/s^2) \tan 18^\circ} = 1.256 \text{ kg} \]

\[ T = \frac{F}{\sin \theta} = \frac{4.00N}{\sin 18^\circ} = 12.94 \text{ N} \]

Grading Notes:
-1 for significant figure errors or missing or incorrect units.
-13 for making the force non-horizontal like this \( \overrightarrow{OF} \)
-5 for graphing the forces incorrectly.
-5 for mixing up the sign and each.
Problem 3

A golfer wants to land a ball on the green 145 m away and 5.50 m down. The golfer chooses an 8-iron that he knows will result in the ball leaving the tee at an angle of 60.0°.

(a) With what velocity should the ball leave the tee?

(b) What is the max. height of the ball above the green?

\[ y = (\tan \theta_0) x - \left( \frac{g}{2v_0^2 \cos^2 \theta_0} \right) x^2 \]

\[ \frac{g x^2}{2v_0^2 \cos^2 \theta_0} = (\tan \theta_0) x - y \]

\[ v_0 = \frac{(9.81)(145)^2}{2 \cos^2 \theta_0 (\tan \theta_0 x - y)} = \frac{(9.81)(145)^2}{2 \cos^2 60 \tan 60(145) + 5.5} \]

\[ v_0 = 40.1 \text{ m/s} \]

\[ h_{\text{max}} = \frac{v_0^2 \sin^2 \theta_0}{2g} + 5.5 \text{ m} = (61.5 + 5.5) \text{ m} \]

\[ h_{\text{max}} = 61.9 \text{ m} \]

\[ \text{Avg: } 17 \pm 6 \]
SECOND MIDTERM

SHOW ALL WORK!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Masses \( m_1 = 1.0 \text{ kg} \) and \( m_2 = 3.0 \text{ kg} \) are connected by a stretched rope. Mass \( m_2 \) is just over the edge of the ramp, as shown. The coefficient of kinetic friction of each mass with the surface is 0.21. At \( t = 0 \) the system is given an initial velocity of \( v_0 = 11.0 \text{ m/s} \) which starts \( m_2 \) down the ramp. Assume the rope and ramp are long enough that \( m_1 \) always stays on the flat, and \( m_2 \) always stays on the ramp. The pulley is massless and frictionless.

(a) Draw complete free body diagrams and separate force diagrams for each mass.
(b) Calculate the velocity of the system as a function of time.
(c) Find the displacement after 0.50 s.

\[
\begin{align*}
\text{(a)} & \\
\text{FBD:} & \quad T \rightarrow \begin{cases} \\
M_1 & N = m_1 g \\
M_2 & \end{cases} \\
\text{FD:} & \quad \begin{cases} \\
M_1: & T - f_k = m_1 a \\
M_2: & T = N_2 + m_2 g \\
\end{cases}
\end{align*}
\]

\[
\begin{align*}
\text{(b)} & \\
\text{Find acceleration:} & \quad (a_y = a_z = a) \\
M_1: & \quad a_y = \frac{\Sigma F_y}{m_1} = \frac{N - m_1 g}{m_1} \Rightarrow N_1 = m_1 g \\
& \quad a_x = \frac{\Sigma F_x}{m_1} = \frac{T - f_k}{m_1} \Rightarrow T = m_1 a + f_k = m_1 a + m_2 N_1 = m_1 a + m_2 m_1 g \Rightarrow T = m_1 a + m_2 m_1 g \\
M_2: & \quad a_x = \frac{\Sigma F_x}{m_2} = \frac{N_2 - m_2 g \cos \theta}{m_2} \Rightarrow N_2 = m_2 g \cos \theta \\
& \quad a_x = \frac{\Sigma F_x}{m_2} = \frac{m_2 g \sin \theta - T - f_k}{m_2} \Rightarrow m_2 a = m_2 g \sin \theta - T - f_k = m_2 g \sin \theta - m_1 \frac{m_1 a + m_2 m_1 g \cos \theta}{m_1} \cos \theta \\
& \quad \text{collect a:} \quad a = \frac{m_2 g \sin \theta - m_2 m_1 g - m_1 m_2 g \cos \theta}{m_1 + m_2} = \frac{1.92 \text{m/s}^2}{m_1 + m_2}
\end{align*}
\]

Velocity as a function of time: \( v(t) = v_0 + at \)
\[
\begin{align*}
\text{(c)} & \quad \text{Displacement:} \\
\Delta x & \quad \text{at} t = 0.5 \text{ sec.} \\
\Delta x & = v(t)\Delta t + \frac{1}{2}a\Delta t^2 = 11.0 \text{ m/s} \cdot (5) + \frac{1}{2}(1.92 \text{m/s}^2)(5) \Rightarrow (5) = 5.73 \text{ m} \\
\Delta x & = 5.73 \text{ m}
\end{align*}
\]
SECOND MIDTERM

Name (print)  Guifu Chen  Name (signed)  Average: 21.35

Discussion Instructor (circle): Chakhbazian  Condella  DiCarlo  Gundlach  Paul  Romer  Wei

Discussion Section #: 

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) On a small planet a rock falling from rest acquires a velocity of 2.75 m/s after falling 150 m. Calculate \( g \) on this planet.

\[
U_f^2 - U_o^2 = 2g\Delta s \Rightarrow 2.75^2 = 2g\cdot150 \Rightarrow g = \frac{2.75^2}{300} = 2.52 \text{ m/s}^2
\]

(b) On the moon an object weighs 75.0 pounds. Calculate its mass on Earth.

\[
75.0 = mg \quad m = \frac{75.0}{\text{g}} = \frac{75.0}{5.48} \text{ slugs} = \frac{75.0}{5.48 \times 0.685} = 20.68
\]

(c) The block on the inclined plane has a mass of 1.50 kg. The coefficient of static friction is 0.80 and of kinetic friction 0.60. The block is not moving. Calculate the magnitude of the force of friction acting on the block (on Earth).

\[
f = mg \sin 9.00^\circ = 1.50 \times 9.8 \times \sin 9.00^\circ = 2.30 \text{ N}
\]

(d) An object has a mass of 6.00 slugs. Calculate its weight on the moon.

\[
W = mg \text{ moon} = 6.00 \times 5.48 = 329 \text{ lb}
\]

(e) An object has a mass of 35.0 kg. Calculate its weight (on Earth) in pounds. Use the data given.

\[
W = \text{m} \times \text{g} = 35.0 \times 9.80 \times 32.2 = 772 \text{ lb}
\]
A cannoneer wishes to shoot a cannon ball and strike the house at A. He is at the top of a cliff 175 feet high and the house is 5000 feet from the base of the cliff.

(a) If he sets the angle, \( \theta \), of his cannon 35.0° from the horizontal, what must the muzzle velocity of the cannonball be?

(b) What is the maximum height, \( H \), above the level of the house, of this cannon ball?

(c) What is the distance, \( x \), measured from the base of the cliff to the position of maximum height?

\[
x = v \cos \theta \cdot t \\
y = h + v \sin \theta \cdot t - \frac{1}{2} gt^2 = h + x \tan \theta - \frac{x^2 - a}{2v^2 \cos^2 \theta}
\]

\[
(a) \quad 0 = h + D \tan \theta - \frac{g D^2}{2v^2 \cos^2 \theta} \\
\Rightarrow \quad v = \sqrt{\frac{g D^2}{2 \cos^2 \theta (h + D \tan \theta)}} = 404 \text{ ft/s}.
\]

(b) \( v_y = v \sin \theta - g t = 0 \) at max height

\[
\Rightarrow \quad t = \frac{v \sin \theta}{g}
\]

\[
\Rightarrow \quad H = h + \frac{v^2 \sin^2 \theta}{2g} - \frac{v^2 \sin^2 \theta}{2g} = h + \frac{v^2 \sin^2 \theta}{2g} = 1009 \text{ ft}
\]

(c) \( x = \frac{v^2 \sin \theta \cdot \cos \theta}{\frac{g D^2}{2}} = 2.38 \times 10^3 \text{ ft} \)

**Grading Scheme**

(a) 10 pts: -8 for using range formula (without modification), -3 for inserting sign of \( v \).

(b) 10 pts: -3 for using \( y \)max formula and not adding \( h \).

(c) 5 pts: -1 for using \( x = H \tan \theta + \frac{D}{2} - \frac{D^2 \tan \theta}{H} \)
SHOW ALL WORK!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

For the system shown there is no friction between the blocks and the planes. The string is massless and the pulley is massless and frictionless.

\[ m_1 = 4.00 \text{ kg} \quad m_2 = 10.00 \text{ kg} \]

(a) If the positive direction is chosen as shown by the arrow, calculate the acceleration of the system, including sign.

(b) Calculate the tension in the string when the system is accelerated, and moving with a speed of 1.00 m/s.

\[ T = m_1 g \cos 12^\circ - m_1 a \]
\[ m_2 g \cos 60^\circ - T = m_2 g \]

\[ a = \frac{g (m_2 \cos 60^\circ - m_1 \cos 12^\circ)}{m_1 + m_2} \]

\[ T = m_1 (g + g \cos 5^\circ) = m_1 g (\cos 12^\circ + \frac{m_2 \cos 60^\circ}{m_1 + m_2}) = \frac{m_2 m_1}{m_1 + m_2} g \left( \cos 12^\circ + \cos 60^\circ \right) = \frac{m_2 m_1}{m_1 + m_2} g \left( \frac{1}{2} + 0.5 \right) = 4.75 \text{ m/s}^2 \]
SECOND MIDTERM

Name (print)  Grader: Hao Hu

Discussion Instructor (circle): Chakhbazian Condella DiCarlo Gundlach Paul Romer Wei

Discussion Section #

SHOW ALL WORK!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

In the drawing shown the block is acted on by a constant force, F.

\( \mu_s = 0.80 \quad \mu_k = 0.60 \quad m = 3.20 \text{ kg} \)

(a) Show the free body diagram for the block. The angles between the vectors must be clearly shown. Make it big!

(b) Choose a sensible coordinate system, and to the right of the free body diagram show the force diagram for this system. Label things clearly!

(c) Calculate the magnitude of F such that the block moves with a constant acceleration down the plane of 1.25 m/s. Use the next page with this same problem number for that calculation.
SECOND MIDTERM

Name (print) __________________________________________ Name (signed) __________________________________

Discussion Instructor (circle): Chakhbazian Condella DiCarlo Gundlach Paul Romer Wei

Discussion Section # ______

SHOW ALL WORK!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(c).

\[ f_k = \mu_k N \]
\[ a = 1.25 \text{ m/s}^2 \]

\[ \sum F_x = F_g \cos 40^\circ + mg \sin 25^\circ - \mu_k N = ma \]

\[ \sum F_y = N + F \sin 40^\circ - mg \cos 25^\circ = 0 \]

From \( \sum F_x \) and \( \sum F_y \):

\[ N = mg \cos 25^\circ - F \sin 40^\circ \]
\[ F_g \cos 40^\circ + mg \sin 25^\circ - \mu_k (mg \cos 25^\circ - F \sin 40^\circ) = ma \]

\[ F = \frac{ma + \mu_k mg \cos 25^\circ - mg \sin 25^\circ}{\cos 40^\circ + \mu_k \sin 40^\circ} \]

\[ = \frac{3.20 \times 1.25 + (0.6 \times 0.625 - 0.25 \times 0.785)}{0.90 \times 0.6 + 0.6 \times 0.6} \]

\[ = 6.77 \text{ N} \]
SECOND MIDTERM

Name (print) ____________________________ Name (signed) ______________________________

Discussion Instructor (circle): Beskoe Chakhbazian Condella Hasan McMurray Paul Zhukov

Discussion Section # _______ THIS TEST HAS FOUR (4) PROBLEMS!

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) A rock is dropped from rest on the moon. Calculate its speed after it has fallen 175 m.

\[ v = \left(2gh\right)^{1/2} = 24.2 \text{ m/s} \]

(b) On a small planet a rock, whose mass is 1.25 kg, falls 27.0 m from rest in 15.0 s. Calculate the weight of this rock on that planet.

\[ W_p = mg_p = 3.00 \times 10^{-1} \text{ N} \]

\[ g_p = \frac{2g}{c^2} \]

(c) An astronaut weighs 175 pounds on Earth. Calculate the weight of the astronaut on the moon.

\[ W_m = \frac{W_e}{g_m} = 29.8 \text{ lb} \]

(d) In the drawing the mass is 1.35 kg. The coefficients of friction are \( \mu_s = 0.55 \) and \( \mu_k = 0.45 \). If the mass is not moving, calculate the frictional force on it.

\[ \Sigma F = 0 \Rightarrow f_s = mg \sin \theta = 2.52 \text{ N} \]

(e) Calculate in kg the mass of an object that weighs 975 pounds (on Earth).

\[ \frac{975}{32.2} \frac{1 \text{ kg}}{31.0 \times 9.8} = 4.42 \text{ kg} \]
A car is traveling on a circular track of radius $R = 750$ m. The initial velocity at point A, $v_A$, is 15.0 m/s. When the car is at point B the velocity is 35.0 m/s. The tangential acceleration between A and B is constant.

(a) Calculate the magnitude of the inward acceleration at point A.
(b) Determine the magnitude of the total acceleration at point B.
(c) Calculate the magnitude of the total acceleration at point C, exactly 450 m along the road from point A.
(d) Find the direction of the total acceleration in (c), and show on a clear diagram how you define the angle.

Solution:

\[ a = -\frac{v^2}{R} \]

\[ \dot{a} = 0.300 \text{ m/s}^2 \hat{e}_x \]

(b) The magnitude of the total acceleration at point B is

\[ a = \sqrt{a_t^2 + a_r^2} \]

where

\[ a_t = \frac{v_B^2 - v_A^2}{2s} = \frac{35.0^2 - 15.0^2}{2 \times \frac{\pi}{2} \times 750} = 0.424 \text{ m/s}^2 \]

\[ a_r = \frac{v_B}{R} = \frac{35.0}{750} = 0.463 \text{ m/s}^2 \]

\[ a = 1.68 \text{ m/s}^2, \quad 1.68 \text{ at } 1.69 \]

(c) At point C, \( a_r \) is a constant, which is

the velocity is

\[ \dot{v}_c = v_A + 2a_r s = 15.0 + 2 \times 450 \times 0.424 = 606.6 \]

\[ a_r = \frac{v_c^2}{R} = 0.809 \text{ m/s}^2 \]

The magnitude of the total acceleration is

\[ a = \sqrt{a_r^2 + a_t^2} = 0.913 \text{ m/s}^2 \]

(d) \[ \tan^{-1} \left( \frac{a_t}{a_r} \right) = 27.7^\circ \]

\[ a = -0.809 \hat{a}_r + 0.424 \hat{a}_t (\text{m/s}^2) \]

\[ \text{no picture} \]
SECOND MIDTERM

Name (print)_____________________________ Name (signed)________________________

Discussion Instructor (circle): Basko Chakhbazian Condella Hasan McMurray Paul Zhukov

Discussion Section #__________

SHOW ALL WORK!!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

A cannon is set up at 35° elevation. The cannonball just barely clears a 375 foot hill that is 700 feet from the initial spot of the cannon.

(a) Find the initial velocity of the cannonball.
(b) Calculate the range, R, to a point on the plain behind the hill. The plain is 150 feet higher than where the cannon sits.
(c) Determine the x and y components of the velocity of the cannonball at the point where it lands.

\[
\begin{align*}
(\dot{x}) &= \dot{V}_0 \cos \theta \\
(\dot{y}) &= \dot{V}_0 \sin \theta - \frac{1}{2} g t^2 \\
\dot{V}_0 &= \sqrt{\frac{9 x_1^2}{2 (x_1 \tan \theta - y_1) \cos \theta}} = \sqrt{\frac{32.2 \times 7.0 \times 2}{2 (7.0 \tan 35° - 5.75) \cos 35°}} = 320 \text{ ft/s}
\end{align*}
\]

\[
\begin{align*}
(\dot{x}) &= \dot{x}_1 \tan \theta - \frac{1}{2} g \frac{(x_1 \tan \theta)}{V_0 \cos \theta}^2 \\
\dot{x}_1 &= 23.2 \text{ ft} \quad \text{or} \quad 2.75 \times 10^3 \text{ ft}, \quad \text{Sw} \quad R = x_2 > x_1, \quad \therefore R = 2.75 \times 10^3 \text{ ft}
\end{align*}
\]

\[
\begin{align*}
V_{x1} &= \dot{V}_0 \cos \theta = 262 \text{ ft/s} \\
V_f &= \dot{V}_0 \sin \theta - g t = \dot{V}_0 \sin \theta - g \frac{R}{V_0 \cos \theta} = -155 \text{ ft/s}
\end{align*}
\]
\(N = 340\)

Average Credits: 14.81

SECOND MIDTERM

Name (print) __________________________ Name (signed) __________________________

Discussion Instructor (circle): Basko Chakhbazian Condella Hasan McMurray Paul Zhukov

Discussion Section # ________

SHOW ALL WORK!!!!!!

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!

Use the conversion constants and data given on the front page.

In the diagram shown P is applied to block 2 in a horizontal direction. \(\mu_s\) and \(\mu_k\) apply to ALL surfaces.

\[
\begin{align*}
\text{m}_1 &= 2.30 \text{ kg} & \mu_s &= 0.60 \\
\text{m}_2 &= 4.75 \text{ kg} & \mu_k &= 0.50 \\
\end{align*}
\]

(a) Draw clear, labeled free body and force diagrams for block 1.

(b) Draw clear, labeled free body and force diagrams for block 2.

(c) Calculate the maximum value of P such that block 1 does not slide with respect to block 2.

\[
\begin{align*}
\text{For Block 1,} & \quad N_1 = m_1 g \cos \theta & f_{1s} = \mu_s m_1 g \cos \theta \\
\text{a}_x &= \frac{f_{1s} - m_1 g \sin \theta}{m_1} = \mu_s g \cos \theta - g \sin \theta = 2.17 \text{ m/s}^2 \\
\text{For Block 2,} & \quad N_2 = N_1 + P \sin \theta + m_2 g \cos \theta & f_{2k} = \mu_k N_2 \\
& \quad P \cos \theta - \mu_k N_2 - \mu_s m_2 g \cos \theta - m_2 g \sin \theta = m_2 a_x \\
& \Rightarrow P \cos \theta - \mu_k m_2 g \cos \theta - \mu_s m_2 g \sin \theta - m_2 g \sin \theta - m_2 g \sin \theta = 0 \\
& \Rightarrow P = \frac{m_2 a_x + \mu_s (m_1 + m_2) g \cos \theta + \mu_s m_1 g \cos \theta - m_2 g \sin \theta - m_2 g \sin \theta}{\cos \theta - \mu_k \sin \theta} = 92.9 \text{ N}
\end{align*}
\]
SECOND MIDTERM

Name (print)  Nathan Rex  Name (signed)  

Discussion Instructor (circle): Gramada  Hansen  Li  Rex  Zhukov

Discussion Section #

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

(a) Convert 275 N to pounds.
\[
275 \text{ N} \times \frac{0.225 \text{ lbs}}{1 \text{ N}} = 61.9 \text{ lbs}
\]

(b) What is the weight, in Newtons, of a mass of 3.75 slugs?
\[
3.75 \text{ slug} \times \frac{1 \text{ kg}}{0.0685 \text{ slug}} = \frac{54.7 \text{ kg} \times 9.8 \text{ m/s}^2}{0.0685} = 536 \text{ N}
\]

(c) A mass of 367 kg is taken to the moon. What is the weight of the mass on the moon?
\[
367 \text{ kg} \times 1.67 \text{ m/s}^2 = 613 \text{ N}
\]

(d) In the drawing the mass is 7.25 kg. The coefficients of friction are \( \mu_k = 0.50 \) and \( \mu_s = 0.60 \). If the mass is not moving, calculate the frictional force on it.
\[
\begin{align*}
\text{not moving} : \quad & a = 0 \\
\text{fs} &= -mg \sin \theta \\
\text{fs} &= -7.25 \text{ kg} \times 9.8 \text{ m/s}^2 \times \sin 12.5^\circ \\
\text{fs} &= 15.4 \text{ N}
\end{align*}
\]

(e) A mass of 20.0 slugs on earth is taken to the moon. Calculate the mass on the moon in kg.
\[
20.0 \text{ slugs} \times \frac{1 \text{ kg}}{0.0685 \text{ slug}} = 292 \text{ kg}
\]

5 points each

- 1 sig fig
- 1 units
- 2 calculator problems

\[ n = 250 \]
\[ \bar{x} = 19.9 \]
\[ \sigma = 4.7 \]
SECOND MIDTERM

Name (print) Qingming Li Name (signed) Li

Discussion Instructor (circle): Gramada Hansen Li Rex Zhukov

Discussion Section #

SHOW ALL WORK!!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES:
Use the conversion constants and data given on the front page.

A car enters a curve at point A at a speed of 20 m/s. The radius of curvature of the curve is 200 meters. When the car reaches point B his speed is 15.0 m/s. B is exactly 1/4 of the way around a complete circle. Assume the rate of change of the speed of the car is constant between A and B.

(a) Calculate the inward acceleration at point C, exactly halfway between A and B.

(b) Calculate the magnitude of the TOTAL acceleration at point C.

(c) Draw a clear picture showing the direction of the total acceleration at C and include a numerical value of the angle between the total acceleration and the radius direction.

\[
\Delta V = 15.4
\]

\[\theta
\]

\[
\begin{align*}
\Delta \eta \chi &= V_f^2 - V_i^2 \\
\alpha_t &= \frac{V_f^2 - V_i^2}{2x} = \frac{15^2 - 20^2}{2 \times 20 \times 200} \\
\alpha_t &= -0.2785 \text{ (m/s}^2) \\

V_f' &= V_i^2 + 2\alpha_t x \\
&= 20^2 - 2 \times 0.2785 \times 2 \times 20 \times 200 \\
&= 312.5 \\
V_f' &= 17.7 \text{ (m/s)}
\end{align*}
\]

\[
\begin{align*}
\alpha_{in} &= \frac{V_i^2}{R} = \frac{312.5}{200} = 1.56 \text{ (m/s}^2) \\
\end{align*}
\]

\[
\begin{align*}
\alpha_{total} &= \sqrt{\alpha_{in}^2 + \alpha_t^2} = 1.587 = 1.59 \text{ (m/s}^2) \\
\cos \theta &= -\frac{\alpha_t}{\alpha_{in}} \Rightarrow \theta = 10.1^\circ
\end{align*}
\]
A block is on an inclined plane. The inclined plane has an angle of 15° from the horizontal. An external force, \( F \), is applied to the block at an angle of 40.0° from the horizontal. The coefficients of friction are \( \mu_k = 0.55 \) and \( \mu_s = 0.65 \). The mass is 4.27 kg.

(a) Calculate the acceleration of the block in m/s² if the force \( F \) is 35.0 N. The positive direction is up the plane as shown.

(b) Determine the value of the force (in N) needed to move the block at a constant speed up the incline.

\[ \begin{align*}
N &= W \cos 15° - F \sin 25°. \\
F_f &= \mu N; \text{ kinetic friction needed} \Rightarrow F_f = \mu_k N \\
a &= \frac{F \cos 25° - W \sin 15° - \mu_k (W \cos 15° - F \sin 25°)}{m} \\
&= 1.59 \text{ m/s}^2 \\
\Rightarrow \quad \text{a)} \\
\Rightarrow \quad \text{b)} \quad a = 0 \Rightarrow F \cos 25° - W \sin 15° - \mu_k (W \cos 15° - F \sin 25°) = 0. \\
\Rightarrow \quad F = W \frac{\sin 15° + \mu_k \cos 15°}{\cos 25° + \mu_k \sin 25°} = 29.0 \text{ N} \\
\end{align*} \]
SECOND MIDTERM

A cannon is pointed at a mountain. The top of the mountain is 300 ft above the cannon and is 2000 ft horizontally from it. Take the initial velocity of the cannonball as 500 ft/s.

(a) The initial angle is set at 25.0° [not the correct answer to part (c)]. Calculate the time until the cannonball is directly above the top of the mountain.

(b) For the conditions in part (a), find the total velocity, magnitude and direction (as an angle measured from the horizontal), when the cannonball is directly above the mountain.

(c) Determine the angle of the cannon (θ) such that the ball lands on top of the mountain (two answers).

\[
\begin{align*}
\text{B} & \quad \text{a) } x = v_{ex} t \Rightarrow t = \frac{x}{v_{ex}} = \frac{2000 \text{ ft}}{500 \text{ ft/s} \cdot \cos 25°} = 4.41 \text{ s} \\
\text{B} & \quad \text{b) } v_x = 453 \text{ ft/s} \\
& \quad \quad v_y = v_{oy} + at = 500 \text{ ft/s} \sin 25° - (32.2 \text{ ft/s}^2)(4.41 \text{ s}) \\
& \quad \quad v_y = 69.2 \text{ ft/s} \\
& \quad \quad \text{v}\sqrt{v_x^2 + v_y^2} = 69.2 \text{ ft/s} \\
& \quad \quad \theta = \tan^{-1}
\end{align*}
\]

\[
\begin{align*}
\text{c) } y = xu + \frac{a(1+u^2)}{2}x^2 \\
& \quad \text{Substituting values in:} \\
& \quad \quad 2576u^2 - 2000u + 557.6 = 0 \\
& \quad \quad \theta = 82.4°, 16.2°
\end{align*}
\]

using the quadratic equation obtains