TEST # 1. PHYS 203. Chapters 2-4. SPRING 2019. February 2019.

NAME:

ID:

SECTION:

madame od and let us see the answers until the date of collection.

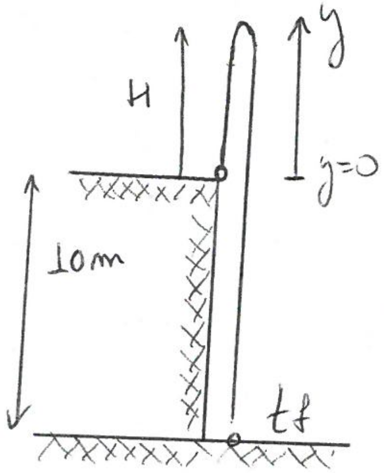
1. Kinematics in 1D (25 points).

A ball is thrown vertically upward from the top of a building at 10 m from the floor with a starting upward speed of 20 m/s at $t_0 = 0$. Find:

(a, 7 points) The position and velocity of the ball at $t = 1$ s.

(b, 7 points) The maximum height reached and the time at which it is reached.

(c, 11 points) The time when the ball reaches the floor.



(a) $y(1sec) = 20 m/s \cdot 1 s - \frac{1}{2} g (1s)^2 =$

$y(1s) = 15.1\ m$

$v(1s) = 20 m/s - 9.8 m/s^2 \cdot (1s)$

$v(1s) = 10.2\ m/s$ (-1)

(b) $y_{max} = H$

$0 = (20 m/s)^2 - 2g \cdot H \Rightarrow H = \frac{(20 m/s)^2}{2 \times 9.8 m/s^2} =$

$H = 20.41 m$

$H = 20.4 m$

$0 = 20 m/s - 9.8 m/s^2 \cdot t_H$

$t_H = 2$ sec

(5 partial credit)

(c) $-10m = 0 + 20 m/s \cdot t_f - \frac{1}{2} 9.8 m/s^2 \cdot t_f^2$ → 7 points

$4.9 t_f^2 - 20 t_f - 10 = 0$

$t_f = \frac{20 \pm \sqrt{20^2 + 4 \times 4.9 \times 10}}{2 \times 4.9} = 4.5 sec = t_f$

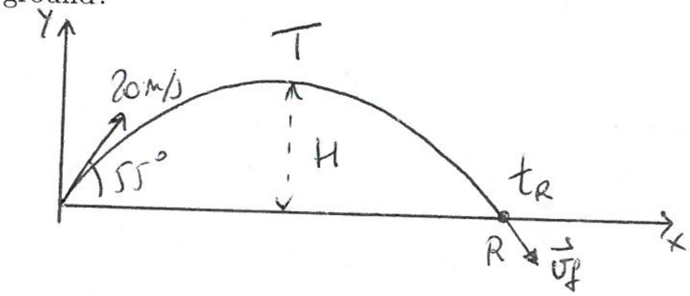
2. Kinematics in 2D. (25 points)

A batter hits a baseball so that it leaves the bat with initial speed $v_0 =$ 20m/s at an angle of 55^o with the horizontal.

(a, 10 points) Find the time T when the ball reaches the highest point and the maximum height H.

(b, 10 points) Find the time of flight and the horizontal range, that is the time and horizontal distance from the starting point to the point at which the ball hits the ground.

(c, 5 points) What is the velocity of the ball just before when it hits the ground?



(a) $v_{x_0} = 20\,m/s \times \cos 55^\circ = 11.5\,m/s$

$v_{0y} = 20\,m/s \times \sin 55^\circ = 16.4\,m/s$

$0 = 16.4\,m/s - 9.8\,m/s^2 \cdot T \Rightarrow T = 1.7\,s$

$H = 16.4\,m/s \cdot 1.7\,s - \frac{1}{2}\,9.8\,m/s^2 \cdot (1.7\,s)^2 = 13.7\,m$

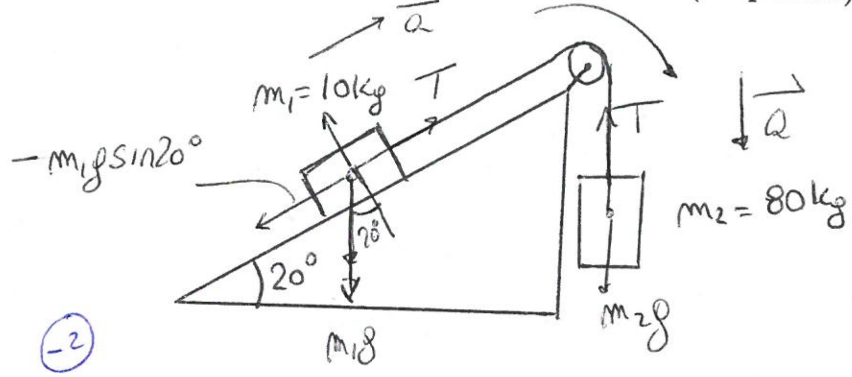
(b) $t_R = 2T = 3.4\,s$

$R = 11.5\,m/s \cdot 3.4\,s = 39.1\,m$

(c) $\vec{v}_f = (11.5\,m/s, -16.4\,m/s)$ $\qquad |\vec{v}_f|, \theta$

3. Newton's laws of motion. (30 points)

Two blocks are connected by a string. See figure. The inclined surface is frictionless. Find the direction and magnitude of the hanging block's acceleration **(20 points)** and the tension in the cord **(10 points)**.



(-2) (-2)

$$-m_1 g \sin 20^\circ + T = m_1 a$$

$$T - m_2 g = -m_2 a$$

$$T = m_2 (g - a)$$

20 points

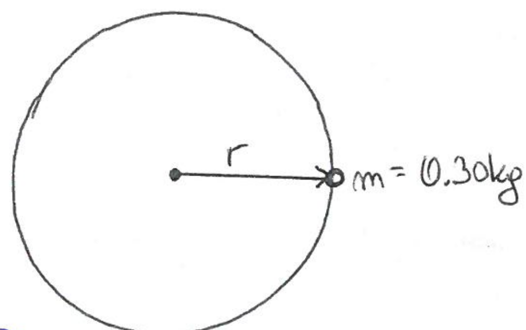
$$-m_1 g \sin 20^\circ + m_2 g - m_2 a = m_1 a$$

$$a = \left(\frac{m_2 - m_1 \sin 20^\circ}{m_1 + m_2}\right) g = 8.3\ m/s^2$$

$$T = 80kg\left(9.8\ m/s^2 - 8.3\ m/s^2\right) = 120\ N$$

4. Circular motion. (20 points)

A mass $m = 0.30$ kg revolves uniformly in a circle on a horizontal frictionless surface. The mass is attached by a cord 0.140 m long to a pin set in the surface. If the mass makes two complete revolutions per second, find the force exerted on it by the cord.



$r = 0.140\,m$

(-5)

$T = \frac{1}{2}$ sec $\Rightarrow$ $v = \frac{2\pi \times 0.140\,m}{0.5\,s} = 1.76\,m/s$

$F = m a_c = m \frac{v^2}{r} = 0.30\,kg \times \frac{(1.76\,m/s)^2}{0.14\,m} = 6.6\,N$

Eq.

Solucion

Check 90 exams (should be 100).

TEST # 2. PHYS 203. Chapters 6-9. SPRING 2019. April 4, 2019. Room MR4

NAME:

ID:

SECTION:

Rules for the exam:

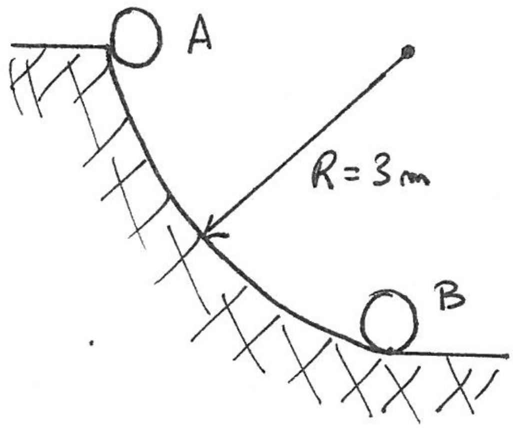
1. The exam will start promptly at 10:00AM and finish at 11:~~00~~ 40AM.
2. No questions allowed during the exam.
3. You can not leave the room under any circumstances.
4. You are allowed to have one cheat-sheet with no extra add-ons.
5. If you arrive to the exam after 10:15am, you will not be allowed to do the exam.
6. You can use a calculator. No smartphones, mobiles or computer devices allowed.
7. No make-up under any circumstance.

Problem 1. Work, Energy (30 points)

A package is thrown down a curved ramp as shown in the figure. The package moves from A to B through a quarter-circle with radius R=3.00 m. The mass of the package is 25.0 kg. The package starts from rest at point A and there is no friction.

(a, 20 points) Find the speed of the package at the bottom of the ramp (point B).

(b, 10 points) Consider now that the ramp is not frictionless and that the speed of the package at the bottom is 6.00 m/s. What work was done by the friction force acting on the package?



(a) $v_A = 0 \qquad v_B = ?$

$$mg\, 3\,m = \frac{1}{2} m v_B^2 \Rightarrow v_B = \sqrt{2 \times g \times 3\,m} =$$

$$v_B = 7.7\,m/s$$

(b) $v_A = 0 \qquad v_B = 6\,m/s$

$$W_{NC} = \Delta E = \frac{1}{2} m v_B^2 - m g\, 3\,m =$$

$$= \frac{1}{2} \times 25\,kg \times (6\,m/s)^2 - 25\,kg \times 9.8\,m/s^2 \cdot 3\,m =$$

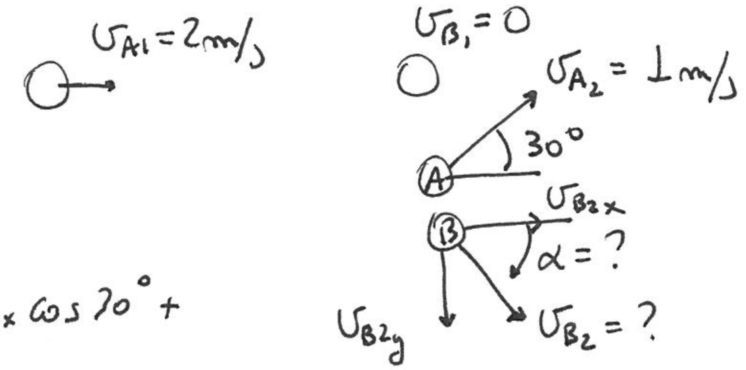
$$= 450\,J - 735\,J = -285\,J$$

Problem 2. Linear Momentum. Collision in a horizontal plane. (30 points)

Two chunks of ice are sliding on a frictionless frozen pond. Chunk A, with mass $m_A = 5.0$ kg, moves with initial velocity $v_{A1} = 2.0$ m/s parallel to the x-axis. It collides with chunk B, which has mass m_B=3.0 kg and is initially at rest. After the collision, the velocity of chunk A is found to be v_{A2} = 1.0 m/s in a direction making an angle $\alpha = 30^o$ with the initial direction. What is the final velocity of chunk B? Give magnitude and direction of this velocity.

before collision

after collision



$\hat{x}$: $m_A v_{A_1} = m_A v_{A_2} \times \cos 30^\circ + m_B v_{B2x}$

$\hat{y}$: $m_A v_{A_2} \sin 30^\circ - m_B v_{B2y} = 0$

$\Rightarrow \quad 5kg \times 2m/s = 5kg \times 1m/s \times \cos 30^\circ + 3kg \times v_{B2x}$

$$\Rightarrow v_{B2x} = \frac{5kg \times 2m/s - 5kg \times 1m/s \times \cos 30^\circ}{3kg} = \frac{10\,m/s - 4.33\,m/s}{3} = 1.9\,m/s$$

$$v_{B2y} = \frac{5kg \times 1m/s \times \sin 30^\circ}{3kg} = 0.83\,m/s$$

$v_{B2} = 2.07\,m/s$

$$\alpha = \arctan\left(\frac{0.83}{1.9}\right) = 23.6^\circ$$

Problem 3. Rotational kinematics (10 points)

The wheels of a bicycle have an angular velocity of +20.0 rad/s. Then, the brakes are applied. In coming to rest, each wheel makes an angular displacement of +15.92 revolutions. **(a, 5 points)** How much time does it take for the bike to come to rest? **(b, 5 points)** What is the angular acceleration in rad/s^2 of each wheel?

$\omega_0 = 20$ rd/s $\qquad \omega_f = 0$

$\theta_f = 15.92$ ~~rev~~ $\times \frac{2\pi}{\text{rev}}$

(b) $\omega = \omega_0 + \alpha t$

$\omega^2 - \omega_0^2 = +2\alpha\theta_f$

$0 + (20\text{ rd/s})^2 = +2\alpha\, 15.92 \times 2\pi$

$\alpha = 400 \frac{\text{rd}^2}{\text{s}^2} \frac{1}{4\pi \times 15.92} =$

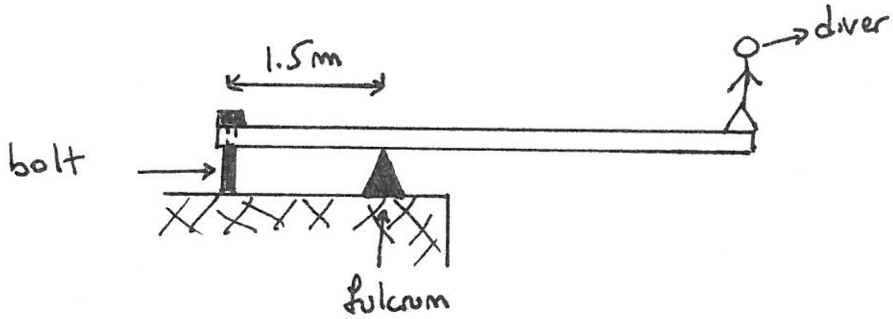
$\alpha = 2$ rd/s^2

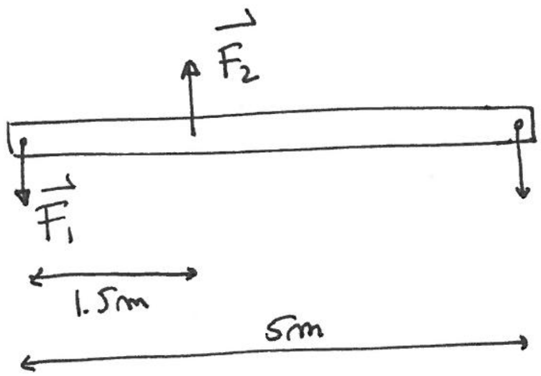
(a) $0 = 20\text{ rd/s} - 2\text{ rd/s}^2 \cdot t$

$t = \frac{10\ \cancel{20}\ \cancel{\text{rd}}/\cancel{\text{s}}}{\cancel{2}\ \cancel{\text{rd}}/\text{s}^2} = 10$ s

Problem 4. Rigid object at equilibrium. (30 points)

A 5m long diving board of negligible mass is supported by a pillar (fulcrum) and a bolt as in the figure. The bolt is at the left end of the diving board, the fulcrum is at 1.5 m from the left end. Find the forces exerted by the fulcrum and bolt when a 90 kg diver stands at the right end of the board.





$mg = 90\,kg \times 9.8\,m/s^2 = 882\,N$

$F_2 - F_1 - mg = 0 \Rightarrow F_1 = F_2 - mg$

$F_2 \times 1.5\,m - mg \times 5\,m = 0 \Rightarrow F_2 = mg \times \frac{5\,m}{1.5\,m} =$

$= 882\,N \times \frac{5}{1.5} = 2940\,N$

$F_1 = 2940\,N - 882\,N = 2058\,N$

SOLUTION

TEST # 3. PHYS 203. Chapters 10-12. SPRING 2019. May 7, 2019. Room MR4

NAME:

ID:

SECTION:

Rules for the exam:

1. The exam will start promptly at 10:00AM and finish at 11:40AM.
2. No questions allowed during the exam.
3. You can not leave the room under any circumstances.
4. You are allowed to have one cheat-sheet with no extra add-ons.
5. If you arrive to the exam after 10:15am, you will not be allowed to do the exam.
6. You can use a calculator. No smartphones, mobiles or computer devices allowed.
7. No make-up under any circumstance.

send me the grade of
Ernest Kyeremeh
23703915

1. Harmonic motion. 30 points. A 1.70 kg block slides with velocity v on a horizontal, frictionless surface until it encounters a spring with a force constant of 955 N/m. The block comes to rest after compressing the spring a distance of 4.60 cm. Find the speed of the block v (ignore air resistance and any energy lost when the block collides with the spring).

$v_f = 0$

$$\frac{1}{2} m v_0^2 = \frac{1}{2} k x^2$$

$$1.70\,kg\, v_0^2 = 955\, \frac{kg\, m/s^2}{m} \times x^2$$

$$v_0^2 = \frac{955}{1.70} \frac{(4.60 \times 10^{-2} m)^2}{s^2}$$

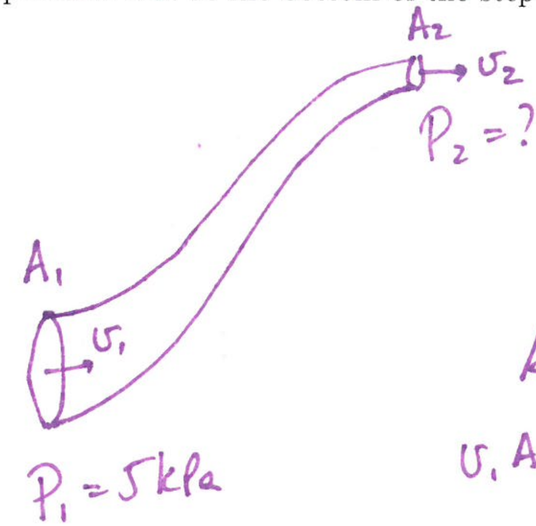
$$\boxed{v_0 = 1.09\ m/s} \approx 1.1\ m/s$$

if they answer negative or positive, it's ok

$v_0 = -1.1\ m/s$

2. Fluids. 35 points.

Water flows through a pipe that goes up a step of 20 cm high as shown in the figure. The water pressure at the bottom of the step is $P_1 = 5$ KPa. The speed of water at the bottom of the step is $v_1 = 1.20$ m/s. What is the pressure at the top of the step if the cross sectional area of the pipe on top of the step is half that at the bottom of the step?



$h = 0.20$ cm

$A_2 = \frac{1}{2} A_1$

$v_1 A_1 = v_2 A_2 \Rightarrow v_2 = v_1 \times \frac{A_1}{A_2} =$

$= 1.20 \text{m/s} \times 2 =$

$v_2 = 2.4 \text{ m/s}$

$$\frac{1}{2}\rho v_1^2 + P_1 = \frac{1}{2}\rho v_2^2 + P_2 + \rho g h$$

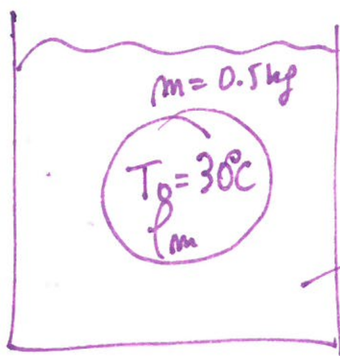
$$\frac{1}{2}\, 1000\, \text{kg/m}^3 \times \left[(1.2 \text{m/s})^2 - (2.4 \text{m/s})^2 \right] + 5\text{kPa} - 1000 \frac{\text{kg}}{\text{m}^3} \times 9.8 \text{m/s}^2 \times 0.2\text{m} =$$

$$= P_2$$

$$\boxed{P_2 = 880 \text{ Pa}}$$

3. Temperature and heat (35 points)

A 0.500-kg block of metal with an initial temperature of 30.0°C is dropped into a container holding 1.12 kg of water at 20.0°C. If the final temperature of the block-water system is 20.4°C, what is the specific heat of the metal? Assume the container can be ignored, and that no heat is exchanged with the surroundings. [specific heat of water: $c_w = 4186 J/(kg^oC)$].



1.12 kg at 20°C

$T_f = 20.4°C$

$$0.5\,kg\; C_{metal} \left(30°C - 20.4°C\right) = 1.12\,kg \times \frac{4186\,J}{kg\,°C} \times \left(20.4°C - 20°C\right)$$

$$C_{metal} = \left(\frac{1.12}{0.5}\right) \frac{4186\,J}{kg\,°C} \times \left(\frac{0.4}{9.6}\right) =$$

$$\boxed{C_{metal} = 390 \frac{J}{kg\,°C}}$$

SOLUTION

FINAL. PHYS 203. SPRING 2019. May 21, 2019. Room MR4

NAME:

ID:

SECTION:

Rules for the exam:

1. The exam will start promptly at 8:00AM and finish at 10:15AM.
2. No questions allowed during the exam.
3. You can not leave the room under any circumstances.
4. You are allowed to have one cheat-sheet with no extra add-ons.
5. If you arrive to the exam after 8:15am, you will not be allowed to do the exam.
6. You can use a calculator. No smartphones, mobiles or computer devices allowed.
7. No make-up under any circumstance.

1. 2D Kinematics (17 points). A batter hits a baseball so that it leaves the bat with an initial speed $v_0 = 37.0\text{m/s}$ at an initial angle $\theta = 53^o$ with the horizontal.

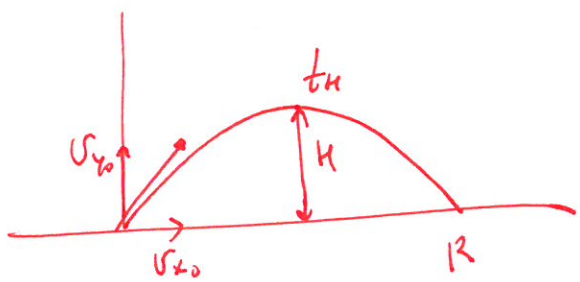
Find:

(a, 5 points) The position of the ball and the magnitude and direction of its velocity at t=2 s.

(b, 4 points) Find the time when the ball reaches the highest point of its flight.

(c, 4 points) Find the maximum height H at this point.

(d, 4 points) Find the horizontal range R.



$v_{x_0} = 37\,\text{m/s} \times \cos 53^\circ = 22.2\,\text{m/s}$

$v_{y0} = 29.5\,\text{m/s}$

(a) $x(2s) = 22.2\,\text{m/s} \times 2s = 44.4\,\text{m}$

$y(2s) = 29.5\,\text{m/s} \times 2s - \frac{1}{2} g (2s)^2$

$v_y(2s) = 29.5\,\text{m} - g \times 2s = 9.9\,\text{m/s}$

$v_x(2s) = 22.2\,\text{m/s}$

$|v| = 24.3\,\text{m/s}$

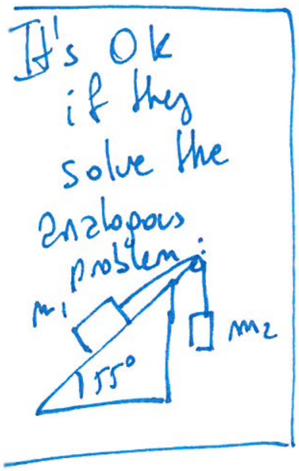
$\alpha = \text{arctg}\left(\frac{9.9}{22.2}\right)$

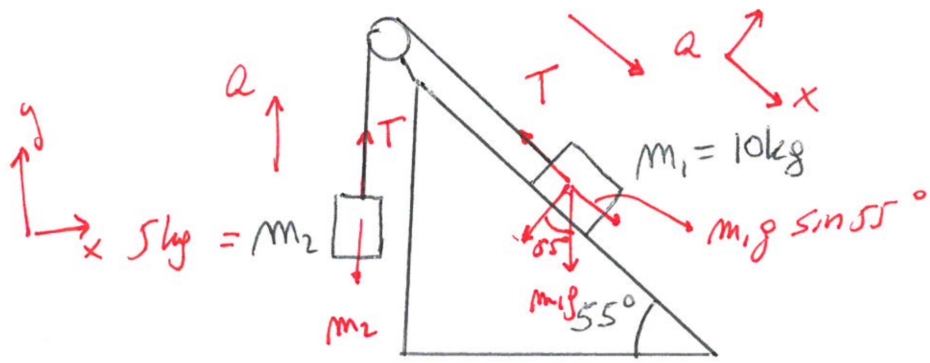
(c) $(29.5\,\text{m/s})^2 = 2gH \Rightarrow H = \frac{(29.5\,\text{m/s})^2}{2 \times 9.8\,\text{m/s}^2} = 1.5\,\text{m}$

(b) $0 = 29.5\,\text{m/s} - g\, t_H \Rightarrow t_H = 3\,\text{sec}$

(d) $R = v_{x_0} \times 6\,\text{sec} = 133.2\,\text{m}$

2. Forces (17 points). In the figure, an object of mass $m_1 = 10\text{Kg}$ moves on a level frictionless surface. It's connected to a mass $m_2 = 5\text{Kg}$ by a massless cord that passes over a frictionless pulley. Find the acceleration of each body **(10 points)** and the tension in the cord **(7 points)**.





$$m_1 g \sin 55^\circ - T = m_1 a \qquad -m_2 g + T = m_2 a$$

$$T = m_2 (a + g)$$

$$m_1 g \sin 55^\circ - m_2 a - m_2 g = m_1 a$$

$$m_1 g \sin 55^\circ - m_2 g = a (m_1 + m_2)$$

~~a = g m_1 g si.~~

$$a = \frac{g(m_1 \sin 55^\circ - m_2)}{(m_1 + m_2)} = 2.1\, m/s^2$$

$$T = m_2 (2.1\, m/s^2 + 9.8\, m/s^2) = 59.4\, N$$

3. Rotational Kinematics (16 points)

3. 1. (8 points) A circular disk 0.20 m in diameter starts from rest and accelerates with constant angular acceleration to an angular velocity of 210 rad/s in 10.00 s. Find the angular acceleration and the angle which the disk has turned in degrees.

3. 2. (8 points) A wheel turns with constant angular acceleration 0.450 rad/s^2. **(a, 4 points)** How much time does it take to reach an angular velocity of 8 rad/s, starting from rest? **(b, 4 points)** Through how many revolutions does the wheel turn in this time interval?

3.1 $\omega_0 = 0$ $\omega_f = 210\ rd/s$ in $\Delta t = 10\ s$

$\alpha = \frac{210\ rd/s}{10\ s} = 21\ rd/s^2$

$\theta_f = \frac{1}{2}\alpha t^2 = \frac{1}{2} \times 21 \frac{rd}{s^2} \cdot (10s)^2 \longrightarrow$ degrees

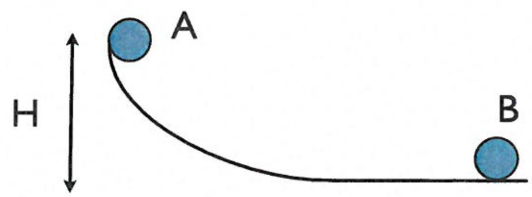
3.2 $\alpha = 0.450\ rd/s^2$

(a) $\omega_f = 8\ rd/s \rightarrow 8\ rd/s = \alpha t$

$t = \frac{8\ rd/s}{0.450\ rd/s^2}$

(b) $\frac{\theta}{2\pi} = \frac{1}{2} \frac{0.450\ rd/s^2}{2\pi} \times t^2 =$ ______ rev

$\frac{\theta}{2\pi} = \frac{1}{2} \times \frac{0.450\ rd}{2\pi\ s^2} \times \frac{8}{0.450} s^2 =$ 1.41 rev



4. Energy conservation (17 points)

Consider the track plus a level surface as shown in the figure.

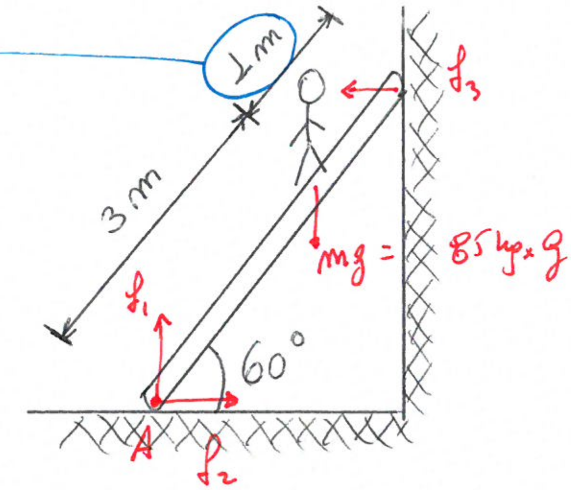
A 4 kg package is released from rest at point A which is at a height H. The object slides down on a frictionless track until it reaches point B with speed of 4.20 m/s. Calculate the height H.

$$mgH = \frac{1}{2} m (4.2\,m/s)^2$$

$$H = \frac{1}{2} \frac{(4.2\,m/s)^2}{9.8\,m/s^2} = 0.9\,m$$

5. Rigid objects in equilibrium. (17 points)

An 85-kg person stands on a lightweight ladder with zero weight. The floor is rough; hence it exerts both a normal force, f_1, and a frictional force, f_2, on the ladder. The wall, on the other hand, is frictionless; it exerts only a normal force, f_3. Using the dimensions given in the figure, find the magnitude of the forces.



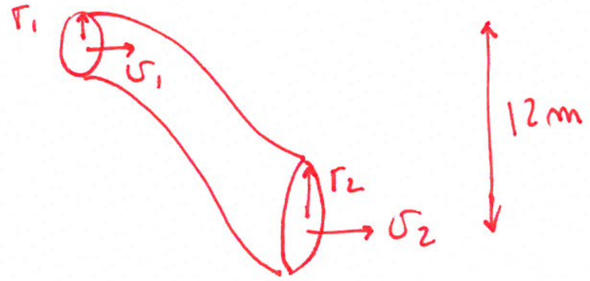
This is one meter. If they interpret this as two meters, it's OK.

$$f_1 = 85kg \times 9.8 m/s^2 = 833\ N$$

$$\sum \tau_A = 0 \qquad -mg \times 3m \times \cos 60^\circ + f_3 \times 4m \sin 60^\circ = 0$$

$$f_3 = mg \frac{\cos 60^\circ}{\sin 60^\circ} \times \frac{3}{4} = 360.7 N$$

6. Fluids (16 points). At one point in a vertical pipeline the water's speed is 3.00 m/s and the pressure is 5.00×10^5 Pa. At a second point in the line, 12.0 m lower than the first, the diameter of the pipe is twice that at the first ($\rho_{water} = 1000$ kg/m^3). **(a, 8 points)** Find the water's speed at the second point. **(b, points)** Find the pressure at the second point.



$r_2 = 2r_1$

$v_1 A_1 = v_2 A_2$

$v_1 r_1^2 = v_2 r_2^2 =$

$= v_2 * 4 r_1^2$

(a) $v_2 = v_1/4 = \frac{3}{4}$ m/s

(b)

$P_2 + \frac{1}{2}\, 1000\ kg/m^3 \times .75^2\ \frac{m^2}{s^2} =$

$= 5 \times 10^5\ Pa + \frac{1}{2}\, 1000\ kg/m^3 \times 3^2\ \frac{m^2}{s^2} +$

$+\ 1000\ kg/m^3 \times 9.8\ m/s^2\ 12m$

$P_2 = 6.2 \times 10^5\ Pa$