Final Exam Formulæ & Constants

$$\vec{v} = \frac{d\vec{r}}{dt}$$
$$\vec{\omega} = \frac{d\vec{\theta}}{dt}$$
$$\vec{a} = \frac{d\vec{v}}{dt}$$
$$\vec{\alpha} = \frac{d\vec{\omega}}{dt}$$
$$v_{\mathrm{sf}} = v_{\mathrm{si}} + a_{\mathrm{s}}\,\Delta t$$
$$\omega_{\mathrm{f}} = \omega_{\mathrm{i}} + \alpha\,\Delta t$$
$$s_{\mathrm{f}} = s_{\mathrm{i}} + v_{\mathrm{si}}\,\Delta t + \tfrac{1}{2}a_{\mathrm{s}}\,(\Delta t)^2$$
$$\theta_{\mathrm{f}} = \theta_{\mathrm{i}} + \omega_{\mathrm{si}}\,\Delta t + \tfrac{1}{2}\alpha\,(\Delta t)^2$$
$$s = r\theta$$
$$v = r\omega$$
$$a_{\mathrm{t}} = r\alpha$$

$$\sum \vec{F} = m\vec{a} = \frac{d\vec{p}}{dt}$$
$$\sum \vec{F}_{\mathrm{ext}} = M\vec{a}_{\mathrm{cm}} = \frac{d\vec{P}}{dt}$$
$$\sum \vec{\tau}_{\mathrm{ext}} = I\vec{\alpha} = \frac{d\vec{L}}{dt}$$
$$f_{\mathrm{s,max}} = \mu_{\mathrm{s}} n$$
$$f_{\mathrm{k}} = \mu_{\mathrm{k}} n$$
$$a_{\mathrm{r}} = \frac{v^2}{r}$$
$$\vec{w} = m\vec{g}$$
$$|\vec{F}_{\mathrm{G}}| = \frac{Gm_1m_2}{|\vec{r}|^2}$$
$$D = \tfrac{1}{2}C\rho A v^2$$
$$\vec{\tau} = \vec{r} \times \vec{F}$$

$$W = \int \vec{F} \cdot d\vec{s}$$
$$W_{\mathrm{ext}} = \Delta K + \Delta U + \Delta E_{\mathrm{th}}$$
$$K = \tfrac{1}{2}mv^2$$
$$K = \tfrac{1}{2}I\omega^2$$
$$U_{\mathrm{g}} = mgy$$
$$U_{\mathrm{s}} = \tfrac{1}{2}k\,(\Delta s)^2$$
$$U_{\mathrm{G}} = -\frac{Gm_1m_2}{r}$$
$$P = \frac{dE_{\mathrm{sys}}}{dt}$$
$$P = \vec{F} \cdot \vec{v}$$
$$\vec{J} = \int \vec{F}\,dt = \Delta\vec{p}$$
$$\vec{p} = m\vec{v}$$

$$\vec{r}_{\mathrm{cm}} = \frac{\sum \vec{r}_i m_i}{\sum m_i}$$
$$\vec{r}_{\mathrm{cm}} = \frac{\int \vec{r}\,dm}{\int dm}$$
$$I = \sum m_i r_i^2$$
$$I = \int r^2\,dm$$
$$I = I_{\mathrm{cm}} + Md^2$$
$$\vec{L} = \vec{r} \times \vec{p}$$
$$\vec{L} = I\vec{\omega}$$
$$x = A\cos(\omega t + \phi_0)$$
$$\vec{a}_{\mathrm{x}} = -\omega^2\vec{x}$$
$$\omega = \sqrt{k/m}$$
$$\omega = 2\pi f = \frac{2\pi}{T}$$

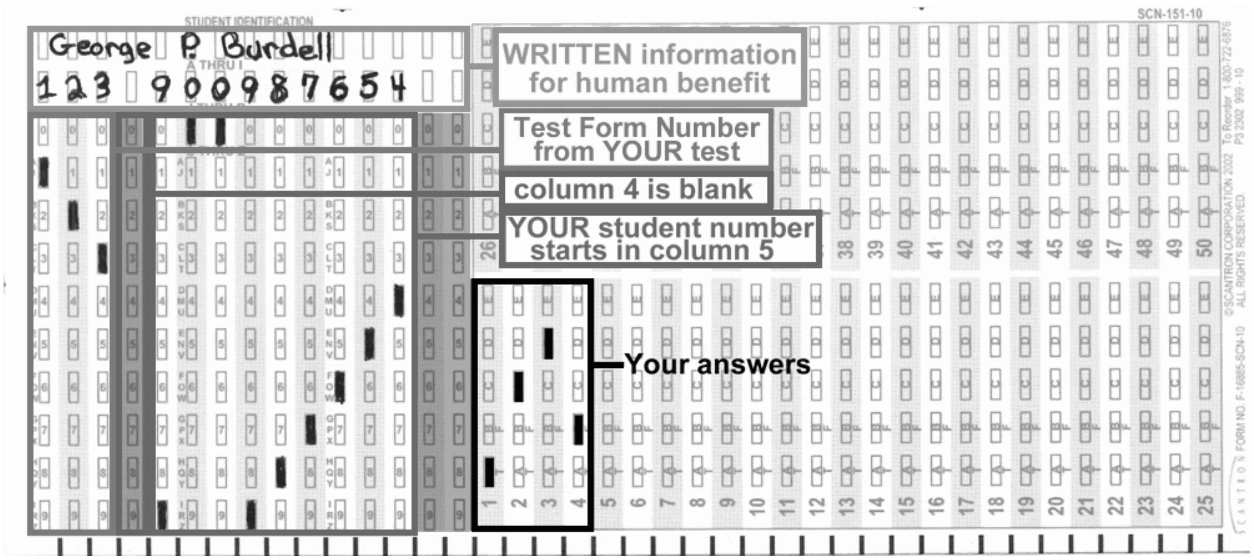
Physical Constants:

Gravitational Acceleration at Earth's Surface $g = 9.81\,\mathrm{m/s^2}$

Unless otherwise directed, drag is to be neglected and all problems take place on Earth, use the gravitational definition of weight, and all ropes and pulleys are ideal.

A

Please remove this sheet from your Quiz or Exam



YOUR form number is **315**

Recitation Sections

	Clough 125	Clough 127	Clough 131	Clough 325
Monday				
2:05 – 2:55 pm	B01 Gaire, Vinod	B05 Roberts, Kelli		A07 Whitley, Lee
3:05 – 3:55 pm	B02 Gaire, Vinod	C02 Roberts, Kelli		
4:05 – 4:55 pm	B06 Gaire, Vinod	B09 Pallantla, Ravi Kumar	C01 Biewer, John	
Tuesday				
2:05 – 2:55 pm	C03 Gaire, Vinod			
3:05 – 3:55 pm	B04 Gaire, Vinod		C04 Cowan, Erika	
4:05 – 4:55 pm	B03 Gaire, Vinod		A01 Cowan, Erika	
5:05 – 5:55 pm	A02 Cowan, Erika			
Wednesday				
2:05 – 2:55 pm				A03 Kim, Sirwoo
3:05 – 3:55 pm	C05 Kim, Sirwoo			
4:05 – 4:55 pm	C06 Kim, Sirwoo			A04 Biewer, John
Thursday				
2:05 – 2:55 pm	A05 Pallantla, Ravi Kumar			B07 Whitley, Lee
3:05 – 3:55 pm	C08 Pallantla, Ravi Kumar			
4:05 – 4:55 pm	C07 Pallantla, Ravi Kumar			B08 Cowan, Erika
5:05 – 5:55 pm	C10 Cowan, Erika			
6:05 – 6:55 pm	A06 Cowan, Erika	C09 Pallantla, Ravi Kumar		
7:05 – 7:55 pm				

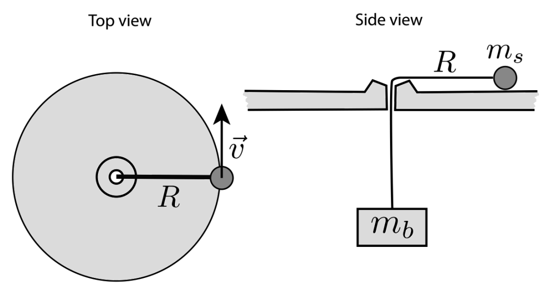
Version A — Quiz #3 Form #315 — Physics 2211 ABC Spring 2017

Name:____________________

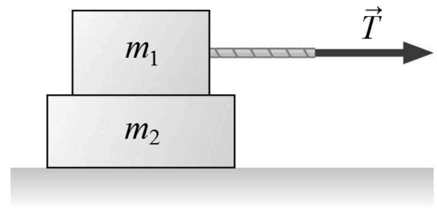
Recitation Section:____________________

- Print your name, quiz form number (3 digits at the top of this form), and student number (9 digit Georgia Tech ID number) in the section of the answer card labeled "Student Identification."
- Bubble the Quiz Form Number in columns 1–3, skip column 4, then bubble your Student Number in columns 5–13.
- Free-response questions are numbered I–III. For each, make no marks and leave no space on your card. Show all your work clearly, including all steps and logic. Box your answer.
- Multiple-choice questions are numbered 1–7. For each, select the answer most nearly correct, circle this answer on your quiz, and bubble it on your answer card. Do not put any extra marks on the card.
- Turn in your quiz and answer card as you leave. Your score will be posted when your quiz has been graded. Quiz grades become final when the next quiz is given.
- You may use a calculator that cannot store letters, but no other aids or electronic devices.

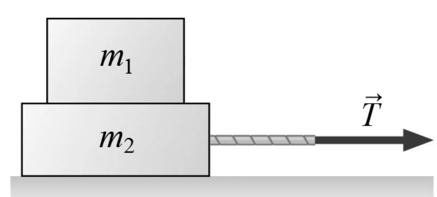
I. (16 points) A block of mass m_b is suspended vertically on a ideal cord that then passes through a frictionless hole and is attached to a sphere of mass m_s, which is rotating on a frictionless flat surface. If the sphere moves in a circle of radius R, the block will eventually come to rest while hanging from the cord. At this equilibrium point, what is the speed, v, of the sphere in terms of the masses of the two objects, the radius R, and g? (*On Earth.*)



II. (16 points) Two blocks, with masses m_1 and m_2, are stacked on a frictionless surface with m_1 above m_2, as shown. The coefficient of static friction between the blocks is μ_s and the coefficient of kinetic friction is μ_k. With what maximum tension T_top may the rope attached to the top block be pulled, if the top block is not to slide on the bottom block? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants. (*On Earth.*)

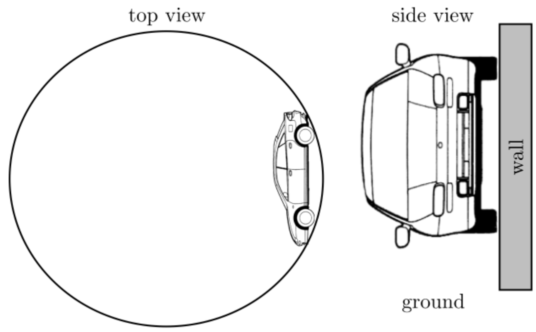


1. (6 points) If the rope is, instead, attached to the bottom block, how does the new maximum force T_bottom with which it can be pulled, if the top block is not to slide on the bottom block, compare to the value for T_top found above? (Hint: consider the friction force between the blocks in the two situations.)



(a) $T_\text{bottom} < T_\text{top}$ regardless of the relationship between m_2 and m_1.
(b) $T_\text{bottom} = T_\text{top}$ regardless of the relationship between m_2 and m_1.
(c) $T_\text{bottom} > T_\text{top}$ if $m_2 > m_1$, but $T_\text{bottom} < T_\text{top}$ if $m_2 < m_1$.
(d) $T_\text{bottom} > T_\text{top}$ if $m_2 < m_1$, but $T_\text{bottom} < T_\text{top}$ if $m_2 > m_1$.
(e) $T_\text{bottom} > T_\text{top}$ regardless of the relationship between m_2 and m_1.

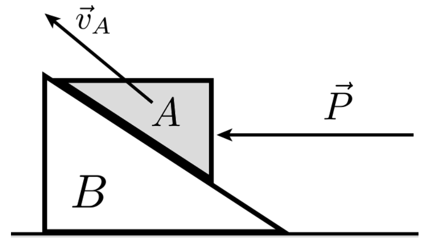
III. (16 points) A 525 kg car is about to attempt the stunt the Wall of Death, where it drives around a vertical wall in a circular track of radius 21 m. The coefficients of static and kinetic friction between the tires and the wall are $\mu_s = 0.75$ and $\mu_k = 0.60$, respectively. What is the minimum speed the car must maintain to stay on the wall? (*On Earth.*)

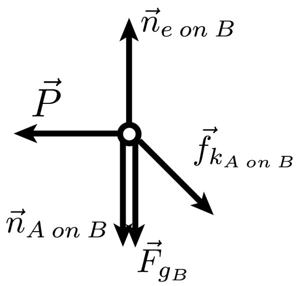


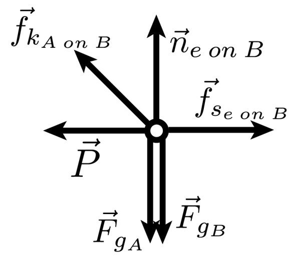
2. (6 points) If the car is traveling around the track at 28 m/s, what is the magnitude of the apparent weight felt by the 75 kg driver?

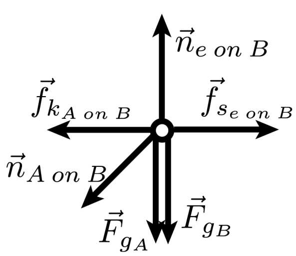
(a) 2985 N
(b) 2800 N
(c) 3535 N
(d) 750 N
(e) 2065 N

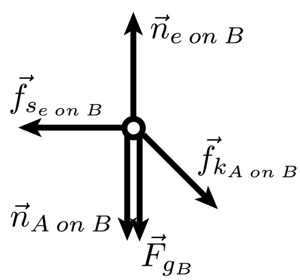
3. (8 points) Two slanted blocks are placed on top of each other and the top block (A) is given a push to the left. As a result, block A slides up the lower block (B). However, block B is resting on the Earth and does not move. Which of the free body diagrams below is the best Free Body Diagram for **block B**? (Hint. Draw a FBD for block A and use interaction pairs).

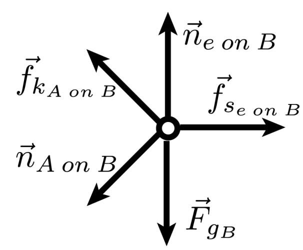


(a)


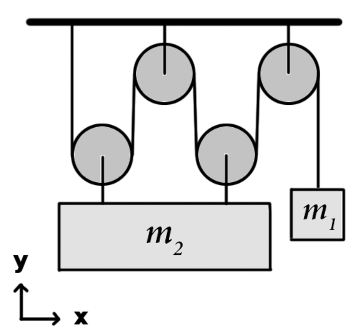
(b)


(c)


(d)


(e)


4. (8 points) A pulley system with two objects m_1 and $m_2 = 3m_1$ is shown. m_1 is released from rest. After releasing, the y components of the acceleration for m_1 and m_2 are a_1 and a_2. What is the sign of a_2 in the given coordinate system, and how does its magnitude compare to a_1?



(a) $a_2 > 0$ and $|a_2| = |a_1|/4$
(b) $a_2 < 0$ and $|a_2| = 4|a_1|$
(c) $a_2 < 0$ and $|a_2| = 3|a_1|$
(d) $a_2 > 0$ and $|a_2| = |a_1|/2$
(e) $a_2 > 0$ and $|a_2| = |a_1|/3$

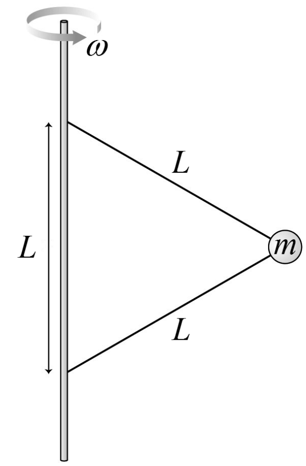
5. (8 points) In a safely-operating Ferris wheel, passengers never leave their seats. Consider passengers in the car at the very top of the rotating wheel. A normal force from the seat supports them. What force or forces, if any, make a Newton's Third Law force pair with that normal force?

   (a) The centripetal force.
   (b) The gravitational force from the Earth on the passengers.
   (c) That force is not part of a force pair.
   (d) The normal force from the passengers on the seat.
   (e) The sum of the gravitational force from the Earth on the passengers and the normal force from the passengers on the seat.

6. (8 points) A satellite is orbiting a planet of radius R and mass $m_1 = M$ at an altitude of h meters and at speed v_1. An identical satellite is orbiting a different planet, also of radius R, but with mass $m_2 = 2M$. If this second satellite is also at an altitude of h, how does the orbital speed of the second satellite v_2 compare to the orbital speed of the first satellite v_1?

   (a) $v_2 = v_1$
   (b) $v_2 = v_1\sqrt{2}$
   (c) $v_2 = v_1/\sqrt{2}$
   (d) $v_2 = 2v_1$
   (e) $v_2 = 4v_1$

7. (8 points) Two strings of length L are tied to the sphere of mass m, as shown. The whole apparatus spins with constant angular speed ω. Is it possible for both strings to exert a tension force? If so, how do the tensions in the upper and lower strings compare? (*On Earth.*)



(a) It **is** possible for both strings to exert a tension force, but which string has greater tension **cannot be determined** without values for L, m, or ω.
(b) It is **NOT** possible for both strings to exert a tension force.
(c) It **is** possible for both strings to exert a tension force.
The upper string must have **greater** tension than the lower string.
(d) It **is** possible for both strings to exert a tension force.
The upper string must have **the same** tension as the lower string.
(e) It **is** possible for both strings to exert a tension force.
The upper string must have **less** tension than the lower string.