Final Exam Formulæ & Constants

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

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

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

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

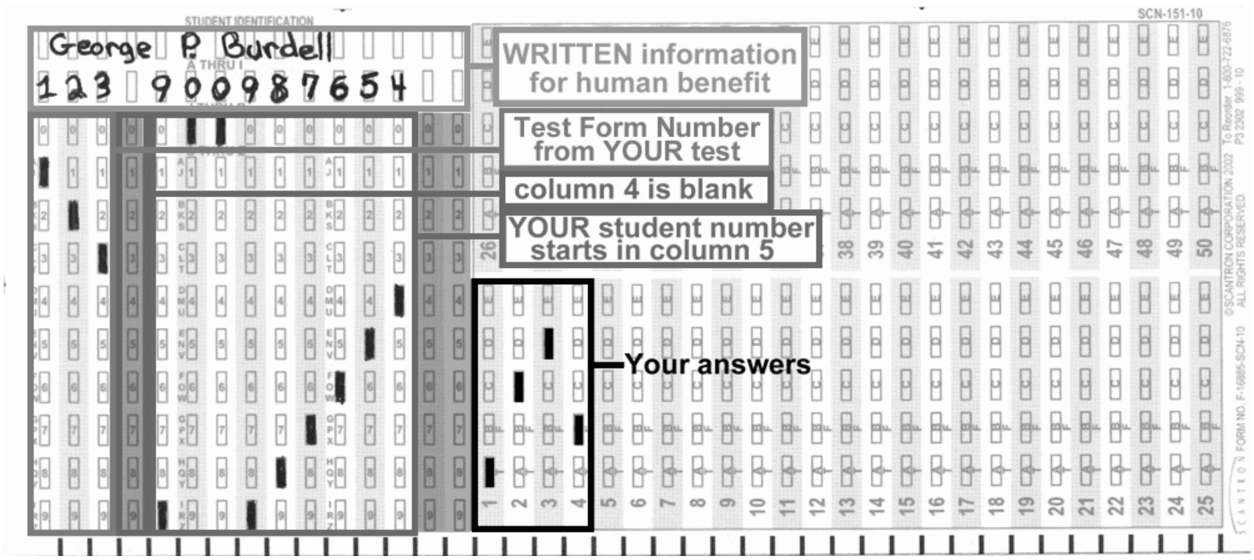
Physical Constants:

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

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

A

Please remove this sheet from your Quiz or Exam



YOUR form number is **215**

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 Quiz #2 Form #215 Name:________________________

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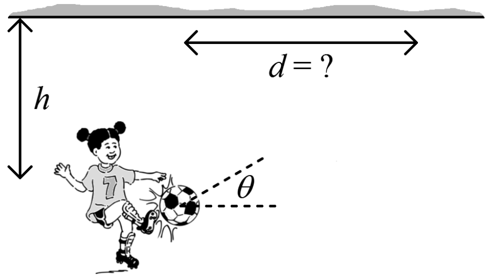
Physics 2211 ABC Spring 2017 Recitation Section:________________________

- 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) Two carts are in concentric circular tracks. The first is a distance 2.5 m from the center and the second is a distance 7.5 m from the center. They can both travel at a constant speed of 0.75 m/s. If they both pass $\theta = 0$ at time $t = 0$, what is the first time after that when they both pass through $\theta = 0$ together again?

II. (16 points) Rebecca practices soccer kicks—in her living room! When the ball leaves her foot, it is travelling 16 m/s at an angle $\theta = 35°$ above the horizontal, as shown. The ceiling is a height $h = 1.8$ m above the ball at that instant. At what horizontal distance d from that point does the ball strike the ceiling? (*On Earth.*)



1. (6 points) At what angle ϕ above the horizontal is the ball traveling at the instant it strikes the ceiling? *Hint:* Think about this before beginning calculations!

   (a) $\phi = \theta = 35°$
   (b) $\phi = \tan^{-1}(h/d)$
   (c) $\phi = 28°$
   (d) $\phi = -42°$
   (e) $\phi = 52°$

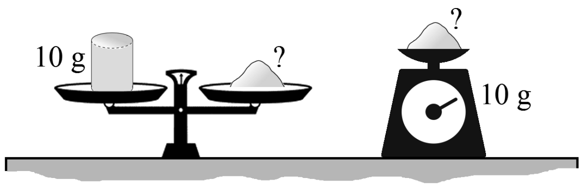
III. (16 points) A person is using a rope to pull a large stone of mass M along the level floor of a quarry. After initially pulling hard to get the stone moving, the person has pull with a constant tension force T_1 to keep the stone moving at a constant speed. How much force T_2 would the person have to exert to pull the same stone out of the quarry at the same constant speed, on a ramp that makes an angle θ with the horizontal? Express T_2 in terms of other parameters defined in the problem, and physical or mathematical constants. You may assume the ramp is made of the same material as the ground. (*On Earth.*)

2. (6 points) Consider the situation when the person is hauling the stone up the inclined ramp with force T_2 at a constant speed. If the rope suddenly breaks, what is the **initial** acceleration of the stone? *Hint:* Think about the net force on the stone immediately *before* the rope breaks.

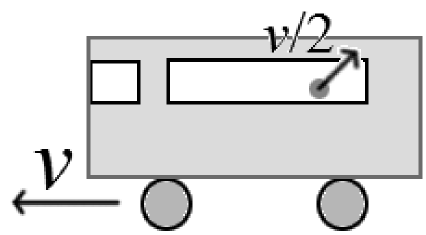
   (a) $(T_2 - T_2 \sin\theta - Mg\cos\theta)/M$ down the ramp
   (b) $(T_2 - T_2 \cos\theta - Mg\sin\theta)/M$ down the ramp
   (c) $(T_2 - Mg\sin\theta)/M$ down the ramp
   (d) $(T_2 - T_2 \cos\theta)/M$ down the ramp
   (e) T_2/M down the ramp

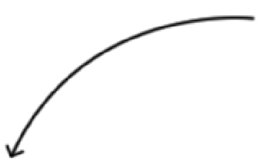
3. (8 points) While in an elevator accelerating upward, you decide to measure out 10 grams of sand. Should you use a pan balance, as on the left, in which the sand is compared to a 10 g cylinder? Or should you use a spring scale, as on the right, in which the upward force exerted by a spring is indicated by a needle pointing to 10 g? Or does it matter? (*On Earth.*)

(a) It doesn't matter, as both the pan balance and the spring scale result in 10 g of sand.
(b) Use the pan balance. The spring scale will really have more than 10 g of sand.
(c) It doesn't matter, as neither the pan balance nor the spring scale result in 10 g of sand.
(d) Use the spring scale. The pan balance will really have more than 10 g of sand.
(e) Use the pan balance. The spring scale will really have less than 10 g of sand.

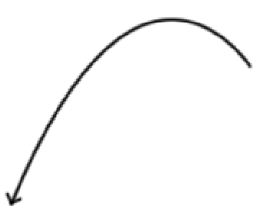


4. (8 points) A bus is moving toward the left with a constant speed v, and a boy throws a ball with speed $v/2$ and angle 45° above the horizontal as shown. Both speed and angle are measured relative to the bus. What is the trajectory of the ball seen by an observer standing on the ground near the bus? (*On Earth. Remember that drag should be ignored.*)

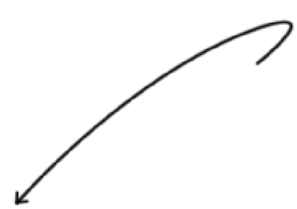


(a) 

(b) 

(c) 

(d) 

(e) 

5. (8 points) During the hammer throw Olympic event, athletes spin a large mass (called the hammer) at the end of a cable of radius r around in a circle, continuously accelerating rotationally until releasing the mass and letting it fly off on a tangent. During a typical throw the athlete starts at rest and then rotates through 4 complete rotations with a constant angular acceleration, α, before releasing the hammer with a final angular velocity of ω_1. If instead the athlete rotated through 8 complete rotations with the same angular acceleration α, what would the final angular velocity ω_2 be in terms of ω_1? (*On Earth.*)

(a) $\omega_2 = \omega_1 + \sqrt{2\pi\alpha}$
(b) $\omega_2 = \omega_1 + 2\pi\alpha$
(c) $\omega_2 = 4\omega_1$
(d) $\omega_2 = \sqrt{2}\omega_1$
(e) $\omega_2 = 2\omega_1$

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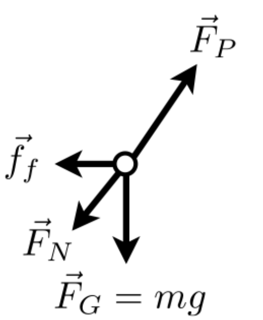
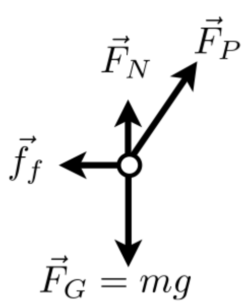
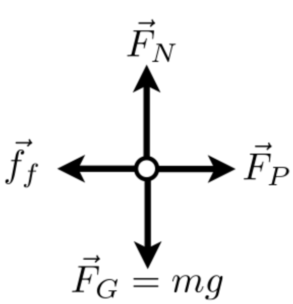
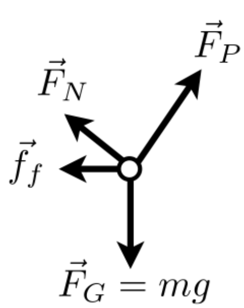
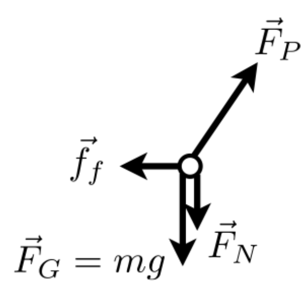
6. (8 points) A painter is painting a horizontal ceiling. He paints at a constant speed with brushstrokes moving from left to right, pressing the brush into the ceiling with a force $\vec{F}_P$. Which of the following free body diagrams best represents all of the forces exerted on the brush? $\vec{f}_f$ is a friction force, and $\vec{F}_N$ is a normal force. (*On Earth.*)

(a) 

(b) 

(c) 

(d) 

(e) 

7. (8 points) You are trying to move a 225 kg fridge by pulling on it with a rope at 15° above horizontal, but it won't budge. The coefficient of static friction between the fridge and the ground is $\mu_s = 0.70$ and the coefficient of kinetic friction is $\mu_k = 0.55$. You can pull on the rope with a maximum force of 1000 N. What is the force of friction on the fridge? (*On Earth.*)

(a) 1070 N
(b) 1540 N
(c) 1360 N
(d) 1210 N
(e) 970 N