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

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

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

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

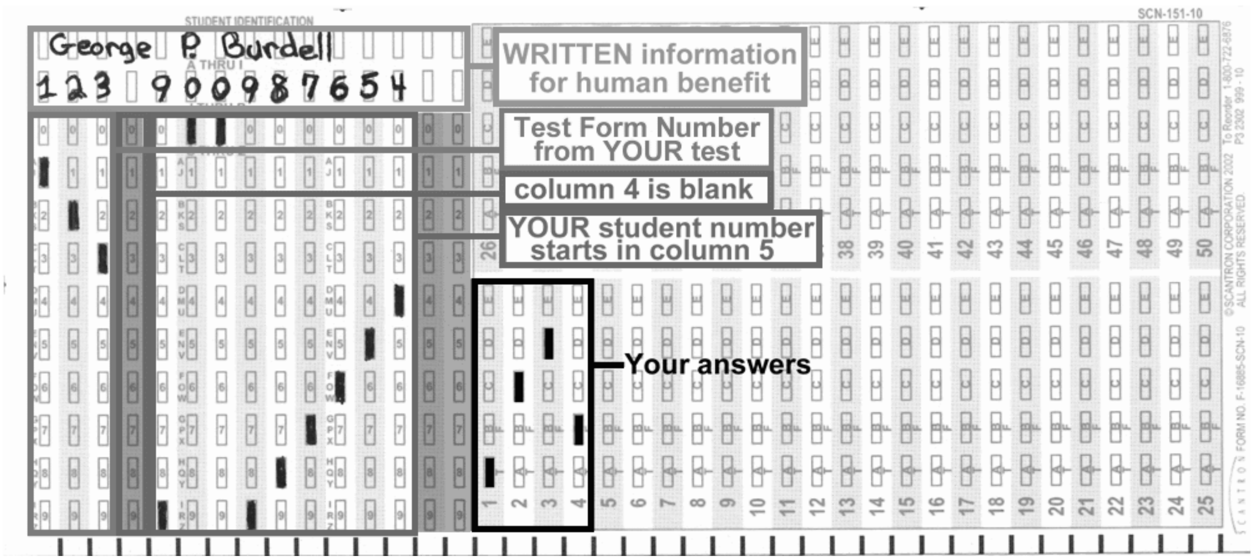
Physical Constants:

Universal Gravitation Constant $G = 6.673 \times 10^{-11}\,\text{N}\cdot\text{m}^2/\text{kg}^2$
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 springs, ropes and pulleys are ideal.

A

Please remove this sheet from your Quiz or Exam



YOUR form number is **315**

Recitation Sections

	Room 123	Room 125	Room 325
Tuesday			
12:30–1:20 pm	M01 Gaire, Vinod		
2:35–3:25 pm		M02 Gaire, Vinod	
Wednesday			
12:30–1:20 pm			M03 Pallantla, Ravi Kumar
2:25–3:15 pm			M04 Pallantla, Ravi Kumar
4:30–5:20 pm			M05 Pallantla, Ravi Kumar
Thursday			
12:30–1:20 pm	M06 Gaire, Vinod		
2:35–3:25 pm		M07 Gaire, Vinod	

Version A | Quiz #3 Form #315 | Name: ____________________

Physics 2211 M Summer 2017 | Recitation Section: ____________________

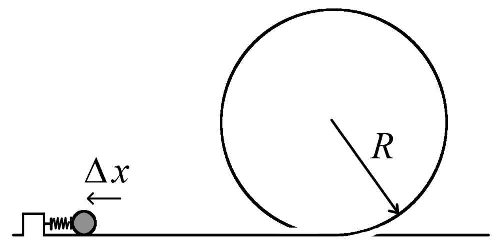
- Print your name, quiz form number (3 digits at the top of this form), and student number (9 digit Georgia Tech ID number) in the section of the answer card labeled "Student Identification."
- Bubble the Quiz Form Number in columns 1–3, skip column 4, then bubble your Student Number in columns 5–13.
- 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) A 0.50 kg object moves along the x axis. It is traveling at +1.6 m/s when it reaches $x = 1.0\,\mathrm{m}$ and a force

$$\vec{F} = \frac{2.0\,\mathrm{N{\cdot}m^2}}{x^2}\,\hat{\imath}$$

begins to act on it. What is the velocity of the object when it reaches $x = 3.0\,\mathrm{m}$?

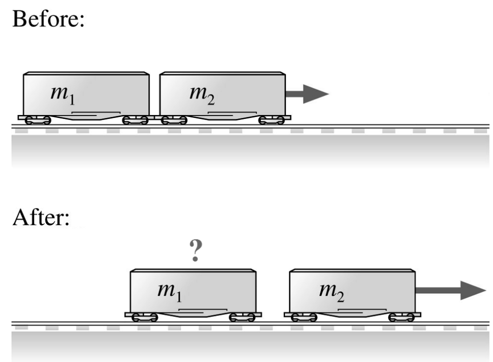
II. (16 points) A small ball with mass m is pushed against a spring with spring constant k. The ball is then released to travel on a frictionless loop-the-loop track with radius R. What is the minimum compression of the spring Δx for the ball stay in contact with the track all the way around? Express your answer in terms of parameters defined in the problem, and physical or mathematical constants. (*On Earth.*)



1. (6 points) In the problem above, the ball falls off the track before it reaches the top if the spring is compressed $\Delta x'$. How does $\Delta x'$ compare to Δx found above?

   (a) $\Delta x < \Delta x' < 2\Delta X$
   (b) $\Delta x' < 0$
   (c) $0 < \Delta x' < \Delta x$
   (d) $\Delta x' = \Delta x$
   (e) $\Delta x' > 2\Delta x$

III. (16 points) Coupled railcars with masses m_1 and m_2 are coasting along level frictionless rails at 12 m/s to the right, as shown. A chemical explosion separates the cars, after which the car with mass m_2 is found to be traveling at 18 m/s to the right. If m_1 = 15,000 kg and m_2 = 25,000 kg, what is the resulting **velocity** of the car with mass m_1? (*On Earth.*)

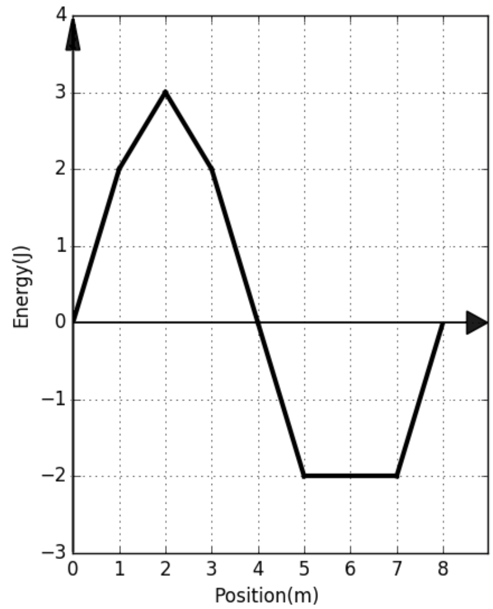


2. (6 points) In the problem above, if, instead of a chemical explosion, the cars were separated by compressed air, or a big spring, how would the resulting velocity of the car with mass m_1 be affected? Assume the initial velocity of the cars, and the final speed of the car with mass m_2, are the same as stated above.

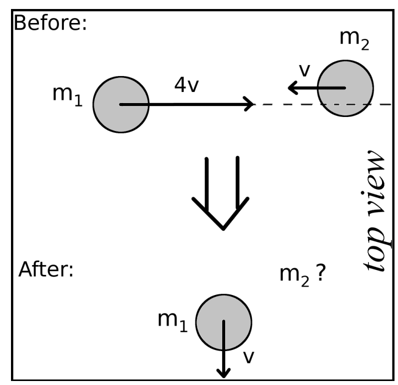
(a) The big spring results in the greatest speed for the m_1 car, then the chemical explosion, and the compressed air results in the least.
(b) All three separation methods result in the same speed for the m_1 car.
(c) The big spring results in the greatest speed for the m_1 car, then the compressed air, and the chemical explosion results in the least.
(d) The compressed air results in the greatest speed for the m_1 car, then the big spring, and the chemical explosion results in the least.
(e) The chemical explosion results in the greatest speed for the m_1 car, then the compressed air, and the big spring results in the least.

3. (8 points) The potential energy of a system depends on the position of an object within the system as shown. In which range will maximum force be on the object?

   (a) 3 to 4 meters
   (b) 0 to 1 meters
   (c) 1 to 2 meters
   (d) 5 to 7 meters
   (e) 2 to 3 meters



4. (8 points) Two identical balls have a collision on a frictionless table as shown in a top view. The initial speeds of m_1 and m_2 are $4v$ and v respectfully. After the collision, the velocity of m_1 is shown, what is the direction of the velocity of m_2?



(a)

(b)

(c)

(d)

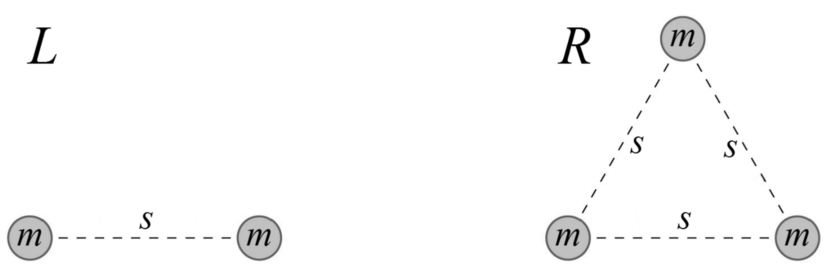
(e)

5. (8 points) A block with kinetic energy K is sliding along a horizontal table top, then comes to a stop in a distance d due to friction. If the friction force on the block has magnitude f, ...

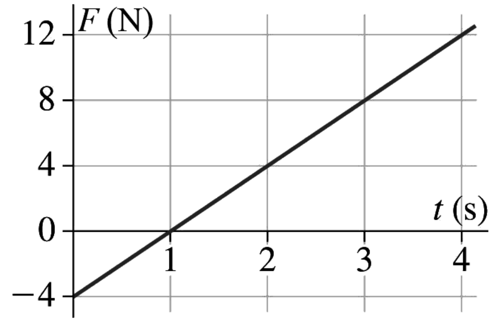
(a) the kinetic energy of the block changes by $-K$ while the thermal energy of the block increases by fd.
(b) the kinetic energy of the block changes by $-K$ while the thermal energy of the block increases by K.
(c) the total energy of the block changes by $-K$ while the thermal energy of the table top increases by K.
(d) the kinetic energy of the block changes by $-K$ while
the thermal energy of the block and table top increases by fd.
(e) the total energy of the block changes by $-K$ due to work $-fd$ done on it by friction.

6. (8 points) The system on the left (L) consists of two particles with mass m separated by a center-to-center distance s. The system on the right (R) consists of three particles with mass m arranged on the vertexes of an equilateral triangle with sides of length s. With respect to zero at infinite separation, compare the gravitational potential energy U_R of the system on the right, with U_L, the gravitational potential energy of the system on the left.

(a) $U_R = 2U_L$ (b) $U_R = 3U_L$ (c) $U_R = U_L$ (d) $U_R = \frac{3}{2}U_L$ (e) $U_R = \frac{2}{3}U_L$



7. (8 points) A 2.0 kg object is travelling in the positive direction at 5.0 m/s when it becomes subject to the force depicted in the graph at time $t = 0\,\text{s}$. What is the velocity of the object at time $t = 3.0\,\text{s}$?



(a) $+\sqrt{31}\,\text{m/s}$
(b) $+\sqrt{35}\,\text{m/s}$
(c) $+8.0\,\text{m/s}$
(d) $+20\,\text{m/s}$
(e) $+11\,\text{m/s}$