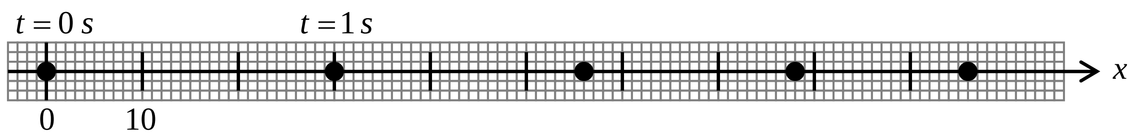
Physics 211 **Name:** ANSWER KEY

Summer 2009 / Dr. Zimmerman

Chapter 1 - 3 Quiz

Show all your work to get full credit.

(1) A particle undergoing constant acceleration has the following motion diagram. Each point represents a time interval of $1\,s$. Each little square represents $1\,m$. (a) Is the particle's displacement positive or negative? (b) Is the particle speeding up or slowing down? (c) If the velocity at $t=1\,s$ is $28\,m/s$, what was the initial velocity, at $t=0\,s$? (d) What is the velocity at $t=4\,s$?



(a) The displacement is positive.

(b) The particle is slowing down.

(c) For $t=1\rightarrow 2\,s$, $\Delta x = 26\,m = (28\,m/s)(1\,s)+\frac{1}{2}a(1\,s)^2 \quad\rightarrow\quad a=-4\,m/s^2$

$v_f = v_i + a\Delta t$

$28\,m/s = v_i - (4\,m/s^2)(1\,s)$

$v_i = \boxed{32\,m/s}$

(d) $v_f = 32\,m/s - (4\,m/s^2)(4\,s) = \boxed{16\,m/s}$

(2) Jon's falcon flies $200\,m$ southeast to a tree, then $100\,m$ east to a second tree, and finally $450\,m$ northwest to a third tree. (a) Establish a coordinate system and sketch the vectors. (b) Find the falcon's net displacement in component form. (c) Calculate Sparky's net displacement as a magnitude and an angle.

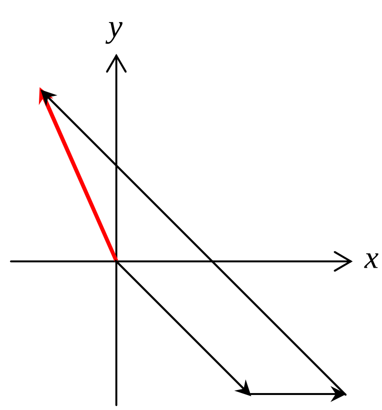
(b) $D_x = 200\cos(45^\circ)+100-450\cos(45^\circ) = \boxed{-76.8\,m}$

$D_y = -200\sin(45^\circ)+450\sin(45^\circ) = \boxed{177\,m}$

$\vec{D} = \boxed{-(76.8\,m)\,\hat{i}+(177\,m)\,\hat{j}}$

(c) $\vec{D} = \boxed{193\,m\ @\ 66.5^\circ\ N\ of\ W}$

(a)



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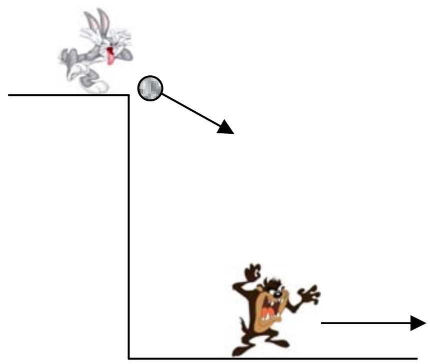
Dr. Zimmerman
Chapter 4 Quiz

Show all your work to get full credit.

While traveling in Tasmania, Bugs Bunny attempts to nail the Tasmanian Devil (TD) with his slingshot. Bugs is high atop a $50\ m-$cliff as shown, and the TD is moving at constant speed $10\ m/s$ to the right, beginning at the base of the cliff. If Bugs fires the rock at an angle of 30° below the horizontal at the moment the TD begins moving, at what speed should he fire the rock to nail the TD?



I put the origin at the base of the cliff.

Rock:

$$\left(x_f\right)_r = 0 + v_i\cos(30^\circ)\Delta t$$

$$0 = 50 - v_i\sin(30^\circ)\Delta t - 4.9(\Delta t)^2$$

TD:

$$\left(x_f\right)_{TD} = 0 + (10\ m/s)\Delta t$$

Need the horizontal position of the rock to be that of the TD,

$$\left(x_f\right)_r = \left(x_f\right)_{TD}$$

$$v_i\cos(30^\circ)\Delta t = (10\ m/s)\Delta t$$

$$v_i = \frac{10\ m/s}{\cos(30^\circ)} = \boxed{11.6\ m/s}$$

The time to fall is,

$$0 = 50 - v_i\sin(30^\circ)\Delta t - 4.9(\Delta t)^2$$

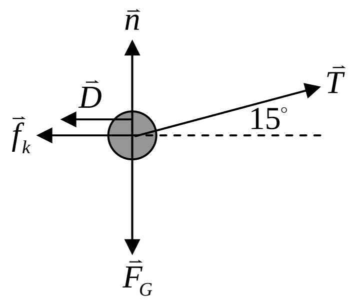
$$\Delta t = \frac{5.78 \pm \sqrt{(-5.78)^2 - 4(-4.9)(50)}}{2(-4.9)} = 2.66\ s$$

Physics 211 / Summer 2009 **Name: Answer Key**
Dr. Zimmerman
Chapter 5 Quiz

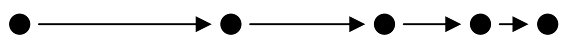
Show all your work to get full credit.

A water skier is being towed by a boat. She holds the rope, which makes an angle of 15° above the horizontal. (a) Draw a free-body diagram of all the forces that might possibly act on the water skier. (b) Now the skier lets go of the rope. Sketch a motion diagram for the skier from the instant she lets go of the rope to where she stops. (c) Describe in as much detail as possible her acceleration, velocity, and displacement from the instant she lets go until she stops.

(a)



(b)



(c) If she lets go of the rope, then the tension force is no longer acting. Thus, her acceleration is negative, caused by friction and drag (from the air and/or water).

The friction force is relatively constant and the part due to drag gets smaller as she slows down.

Thus, her velocity remains positive, but approaches zero (more quickly at first – her acceleration is negative and larger the moment she lets go).

She continues to move forward, but with smaller increments of distance per unit time interval (since she is slowing down.)

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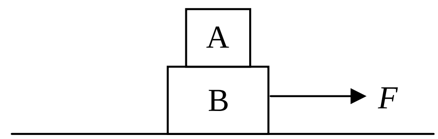
Chapter 7 Quiz

Show all your work to get full credit.

Block A rests on block B. Block B is pulled by a force of 10 N. Block A has a mass of 2.0 kg and block B, a mass of 4.0 kg. For simplicity, assume the floor is frictionless. (a) What minimum coefficient of static friction is required between A and B so that A does not slip on B? (b) What is the acceleration of block A?



Apply 2nd law to forces acting on block A :

x-direction: $\mu_s n_A = m_A a$
y-direction: $n_A - m_A g = 0$

So,

$$\mu_s m_A g = m_A a$$
$$a = \mu_s g$$

Apply 2nd law to forces acting on B:

x-direction: $-\mu_s n_A + F = m_B a$

$$-\mu_s n_A + F = m_B a$$
$$a = \frac{-\mu_s m_A g + F}{m_B}$$

The accelerations are equal,

$$\mu_s g = \frac{-\mu_s m_A g + F}{m_B}$$
$$\mu_s (m_A + m_B) g = F$$
$$\mu_s = \frac{F}{(m_A + m_B)g} = \boxed{0.17}$$

$$a = \mu_s g = (0.17)(9.8\ m/s^2) = 1.667\ m/s^2 = \boxed{1.7\ m/s^2}$$

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Chapter 8 Quiz c

A fighter pilot in a steep dive is moving at $470\ m/s$. What is the minimum radius curve he can pull out of the dive so as not to exceed 10 gees (i.e., his apparent weight exceeding ten times his actual weight)?

Apply Newton's 2nd law to the pilot:

$$n - mg = \frac{mv_t^2}{r}$$

10 gees implies $n = 10mg$ so,

$$10mg - mg = \frac{mv_t^2}{r}$$

$$r = \frac{v_t^2}{9g} = \frac{(470\ m/s)^2}{9(9.8\ m/s)^2} = \boxed{2500\ m}$$

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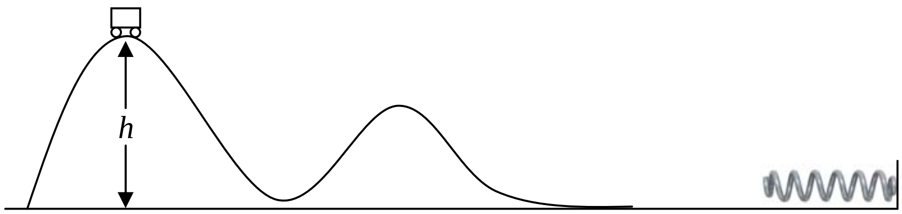
Chapter 10 Quiz

A $300\ kg$ – roller coaster car starts from rest at the top of the first hill of unknown height h. The second hill has a height of $37\ m$. (a) If the car is moving at a speed of $23\ m/s$ at the top of the second hill, how high is the first hill? (b) The car is stopped by a heavy spring at the end of the ride. If the spring has constant $1.6\times10^5\ N/m$, how far is it compressed? There is no friction anywhere on the ride.



Note: you can answer each question by using the top of the first hill as the initial position.

(a) Conservation of energy:

$$K_i + U_i = K_f + U_f$$

$$0 + \cancel{m}(9.8\ m/s^2)h = \tfrac{1}{2}\cancel{m}(23\ m/s)^2 + \cancel{m}(9.8\ m/s^2)(37\ m)$$

$$h = \frac{627.1\ m^2/s^2}{9.8\ m/s^2} = \boxed{64\ m}$$

(b) Conservation of energy:

$$K_i + U_i = K_f + U_f$$

$$0 + (300\ kg)(9.8\ m/s^2)(64\ m) = 0 + \tfrac{1}{2}(1.6\times10^5\ N/m)(\Delta x)^2$$

$$\Delta x = \sqrt{\frac{376320\ N\cdot m}{160000\ N/m}} = \boxed{1.5\ m}$$

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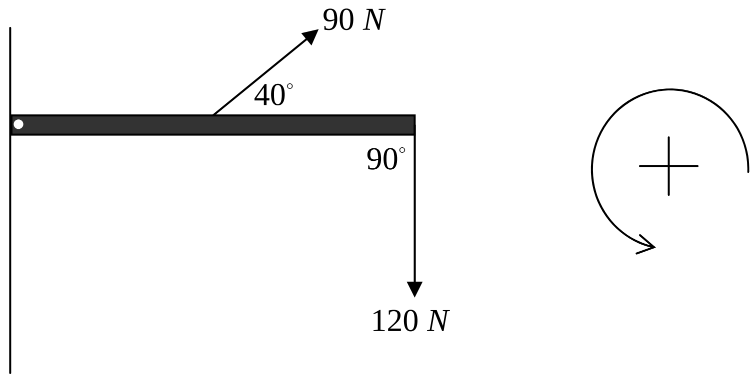
Chapter 12 Quiz

<u>Show all your work to get full credit.</u>

Two forces (shown) are applied to a solid rod that is attached to a wall. It is hinged at one end and free to rotate without friction. The rod has a length $L = 0.5\ m$ and a mass $M = 3.0\ kg$. The moment of inertia is given as $\frac{1}{3}ML^2$. (a) If initially held in place in the position shown, determine the angular acceleration of the rod the instant it is released. The $90\ N$ force acts at the rod's center. (b) Is it possible to use the angular kinematic equations to determine the angular speed of the rod the moment it strikes the wall? Explain.



(a) *Three forces cause torque:*

$$\tau_{net} = (0.25\ m)(90\ N)\sin(40^\circ) - (0.5\ m)(120\ N)\sin(90^\circ) - (3.0\ kg)(9.8\ m/s^2)(0.25\ m) = -52.9\ N\cdot m$$

$$\alpha = \frac{\tau_{net}}{I} = \frac{-52.9\ N\cdot m}{\frac{1}{3}(3.0\ kg)(0.5\ m)^2} = \boxed{-212\ rad/s^2}$$

(b) The kinematic equations cannot be used because the torque is not constant, thus the angular acceleration is not constant.

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Chapter 13 Quiz

Show all your work to get full credit.

Mars has a small moon, Phobos, that orbits with a period of $7\ h\ \ 39\ min$. The radius of Phobos' orbit is $9.4\times10^{6}\ m$. (a) What is the orbital speed of Phobos? (b) Assuming Phobos is in a circular orbit, use Newton's Universal Law of Gravitation to determine the mass of Mars.

(a) *We get the orbital speed of Phobos using its period,*

$$v = \frac{2\pi R}{T} = 2145\ m/s$$

(b) *We apply Newton's 2nd Law for radial forces,*

$$\sum F_r = -m_p \frac{v^2}{R}$$

$$-\frac{G m_M \cancel{m_p}}{R^{\cancel{2}}} = -\cancel{m_p} \frac{v^2}{\cancel{R}}$$

$$m_M = \frac{R v^2}{G}$$

Thus,

$$m_M = \frac{R v^2}{G} = \frac{(9.4\times10^{6}\ m)(2145\ m/s)^2}{6.67\times10^{-11}\ N\cdot m^2/kg^2} = \boxed{6.48\times10^{23}\ kg}$$