General Physics I **Quiz 2 - Chs. 4,5,6 - Forces, Circular Motion, Energy** **Oct. 14, 2009**

Name Rec. Instr. Rec. Time

For full credit, make your work clear to the grader. Show the formulas you use, the essential steps, and results with correct units and correct number of significant figures. Partial credit is available if your work is clear. Points shown in parenthesis. For true-false and multiple choice questions, choose the *best* answer.
Use $g = 9.80\ m/s^2$, $G = 6.67\times10^{-11}\ N\ m^2/kg^2$. 1 inch = 2.54 cm, 1 ft = 12 in., 1 mile = 5280 ft, 1 hp = 746 W.
Prefixes: f=10^{-15}, p=10^{-12}, n=10^{-9}, $\mu = 10^{-6}$, m=10^{-3}, c=10^{-2}, k=10^{3}, M=10^{6}, G=10^{9}, T=10^{12}, P=10^{15}.

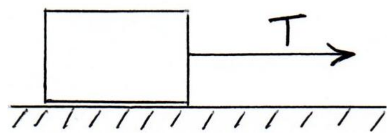
1. (2) A truck drives up a straight incline at constant speed. The net force on the truck is equal to

   a. the normal force of the road on its tires. b. the friction force of the road on the tires.
   c. the component of the gravitational force along the incline. d. zero.

2. (2) When a 100-kg athlete throws a 0.60-kg basketball, which force has the greater magnitude?

   a. the force of the basketball on the athlete. b. the force of the athlete on the basketball. c. it's a tie.

3. (20) A 12.0 kg block is pulled at constant speed on a table surface by a horizontal cord with a tension of 25.0 N. It was noticed that it initially required a tension of 35.0 N just to get the block started moving.



a) (4) How large is the normal force of the table acting on the block?

b) (4) How large is the kinetic friction force while the block slides on the table?

c) (6) How large is the coefficient of kinetic friction?

d) (6) If the block is pulled with a tension of 50.0 N, how large will its acceleration be?

4. (10) Bill gets on an elevator at the 4th floor, standing on a bathroom scales inside the elevator. Before the elevator starts to move, the scales reads 980 N.

a) (2) When the elevator accelerates upwards, the reading on the scales will be

   a. 980 N b. less than 980 N. c. greater than 980 N.

b) (2) When the elevator accelerates downwards, the reading on the scales will be

   a. 980 N b. less than 980 N. c. greater than 980 N.

c) (6) What is the scales reading (in newtons) if the elevator has an upward acceleration of 0.40 g?

5. (2) If a runner starts from rest and accelerates forward, what force causes her acceleration?

a. The normal force of the floor on her shoes. b. The gravitational force on her body.
c. The friction force of the floor on her shoes. d. The friction force of the shoes on the floor.

6. (2) **T** **F** Friction forces always dissipate energy and do negative work.

7. (2) **T** **F** The gravitational force does positive work on a falling object.

8. (2) **T** **F** Potential energy stored in springs is never negative.

9. (2) **T** **F** By descending a flight of stairs, you increase your gravitational potential energy.

10. (2) **T** **F** A car can accelerate faster if the friction between the road and its tires is reduced.

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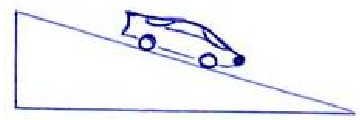
11. (14) A 1600-kg car is descending an 8.0° incline. The coefficients of friction between tires and road are $\mu_s = 0.80$ and $\mu_k = 0.60$, and air resistance is negligible.



a) (6) If the car descends at *constant speed*, what is the force of friction of the road on all four tires combined? [Note: Is the driver applying the brakes to do this?]

b) (8) What maximum deceleration magnitude can the car can achieve (in m/s^2) when applying the brakes?

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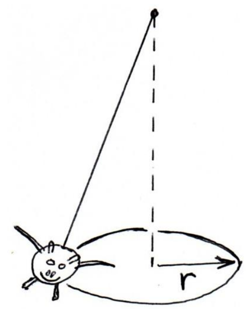
12. (14) Io is a moon of Jupiter, with a mass $M = 8.90 \times 10^{22}$ kg, and a radius of 1820 km.

a) (8) If NASA wants to put a satellite in a very low orbit around Io, what orbital speed is needed? (The orbit's altitude is very small compared to Io's radius.)

b) (6) What period will this satellite have?

13. (20) A 12.0-kg flying pig is suspended by a cable while moving in a horizontal circle of radius $r = 94.4$ cm at a constant speed of 4.00 m/s.



a) (6) How large (in m/s^2) is the flying pig's centripetal acceleration?

b) (8) How large is the centripetal force on the pig? What force (or force component) provides the pig's centripetal force?

c) (6) How large is the tension in the cable?

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14. (12) A 0.250-kg rock is thrown straight up, accelerated by an average upward net force of 242 N that acted on it while it moved 32.0 cm upward. Ignore friction or air resistance.

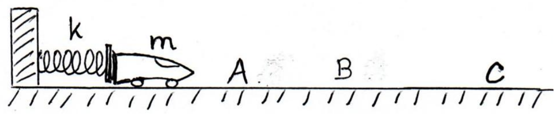
a) (6) How much net work was done to accelerate the rock to its launch speed?

b) (6) What maximum height above the launch point will the rock reach? [Hint: Use energy ideas.]

Exam 2 Score: ____________/132

15. (18) A 1850-kg car is set in motion on a level road by a spring with spring constant $k = 2.40 \times 10^6$ N/m that has been compressed 1.50 m. The car leaves the spring as it passes point A, and the driver slams on the brakes at point B. The wheels lock and the car skids to a stop at point C, due to kinetic friction with coefficient $\mu_k = 0.700$.

a) (6) What is the initial mechanical energy of the system, with the spring compressed 1.50 m, before the car is released?



b) (6) What speed will the car have when it leaves the spring at point A?

c) (6) Over what distance (BC) will the car skid to a stop after the brakes are applied and the wheels lock?

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16. (8) For training, a 75-kg athlete starts from rest and then sprints on a level track, reaching a final speed of 7.0 m/s after 2.5 seconds. What average mechanical power was used to achieve this?

Chapter 6 Equations

Work & Kinetic & Potential Energies:

$W = Fd\cos\theta$, $\mathrm{KE} = \frac{1}{2}mv^2$, $\mathrm{PE}_{\text{gravity}} = mgy$, $\mathrm{PE}_{\text{spring}} = \frac{1}{2}kx^2$.

Conservation or Transformation of Energy:

"work-KE theorem" $\Delta\mathrm{KE} = W_{\text{net}}$, **or use conservation law** $\Delta\mathrm{KE} + \Delta\mathrm{PE} = W_{\mathrm{NC}}$.

Power:

$P_{\text{ave}} = \frac{W}{t}$, or use $P_{\text{ave}} = \frac{\text{energy}}{\text{time}}$.

Chapter 5 Equations

Centripetal Acceleration:

$a_R = \frac{v^2}{r}$, towards the center of the circle.

Circular motion:

speed $v = \frac{2\pi r}{T} = 2\pi r f$, frequency $f = \frac{1}{T}$, where T is the period of one revolution.

Gravitation:

$F = G\frac{m_1 m_2}{r^2}$; $g = \frac{GM}{r^2}$, where $G = 6.67 \times 10^{-11}$ $\mathrm{Nm^2/kg^2}$;

Orbits:

$\frac{v^2}{r} = g = \frac{GM}{r^2}$; $v = \sqrt{\frac{GM}{r}}$.

Chapter 4 Equations

Newton's Second Law:

$\vec{F}_{\text{net}} = m\vec{a}$, which means $\Sigma F_x = ma_x$ and $\Sigma F_y = ma_y$.

Static friction (magnitude):

$f_s \le \mu_s N$ or $F_{\text{fr}} \le \mu_s F_N$.

Kinetic or sliding friction (magnitude):

$f_k = \mu_k N$ or $F_{\text{fr}} = \mu_k F_N$.

Gravitational force near Earth:

$F_G = mg$, downward.

Acceleration Equations

$\bar{v} = \frac{\Delta x}{\Delta t}$, $\Delta x = x - x_0$, slope of $x(t) = v(t)$.

$\bar{a} = \frac{\Delta v}{\Delta t}$, $\Delta v = v - v_0$, slope of $v(t) = a(t)$.

For constant acceleration in one-dimension:

$\bar{v} = \frac{1}{2}(v_0 + v)$, $v = v_0 + at$, $x = x_0 + v_0 t + \frac{1}{2}at^2$, $v^2 = v_0^2 + 2a(x - x_0)$.

Vectors

Written $\vec{V}$ or $\mathbf{V}$, described by magnitude=V, direction=θ or by components (V_x, V_y).

$V_x = V\cos\theta, \quad V_y = V\sin\theta,$

$V = \sqrt{V_x^2 + V_y^2}, \quad \tan\theta = \frac{V_y}{V_x}.$ θ is the angle from $\vec{V}$ to $+x$-axis.

Addition: $\mathbf{A} + \mathbf{B}$, head to tail. Subtraction: $\mathbf{A} - \mathbf{B}$ is $\mathbf{A} + (-\mathbf{B})$, $-\mathbf{B}$ is $\mathbf{B}$ reversed.

Trig summary

$\sin\theta = \frac{(\text{opp})}{(\text{hyp})},$ $\cos\theta = \frac{(\text{adj})}{(\text{hyp})},$ $\tan\theta = \frac{(\text{opp})}{(\text{adj})},$ $(\text{opp})^2 + (\text{adj})^2 = (\text{hyp})^2.$

$\sin\theta = \sin(180^\circ - \theta), \quad \cos\theta = \cos(-\theta), \quad \tan\theta = \tan(180^\circ + \theta), \quad \sin^2\theta + \cos^2\theta = 1.$