Name:

Make your work clear to the grader. Show formulas used. Give correct units and significant figures. Partial credit is available if your work is clear. Point values are given in parenthesis. Exact conversions: 1 inch = 2.54 cm, 1 ft = 12 in., 1 mile = 5280 ft. 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=$10^{15}$. Use $g$=9.80 m/s$^2$.

1. (2) **T F** Because we live on a rotating Earth, we are undergoing a centripetal acceleration.

2. (2) **T F** As long as a car moves at constant speed, its acceleration is zero.

3. (6) Name three controls in your car that cause the car to accelerate:

   1.________________ 2. ________________ 3.________________

4. (2) A car of mass $m$ drives over the top of a hill, going fast. The normal force $N$ of the road on the car satisfies

   a. $N = mg$. b. $N < mg$. c. $N > mg$.

5. (2) A sample of blood is held inside a test tube that is spinning in a circle at high speed in a centrifuge. The **net force** on the blood sample

   a. is zero. b. points radially outward. c. points radially inward. d. points along the direction of motion.

6. (14) A 62.0-kg ice skater skates around a circle of radius 2.50 m once every 3.25 s.

   a) (4) Calculate the skater's speed.

   b) (4) What magnitude of centripetal acceleration is the skater experiencing?

   c) (6) How large is the centripetal force on the skater? What actual force is providing the centripetal force?

7. (2) A satellite is in orbit around the Earth. Yet the astronauts inside it experience weightlessness. The net force on one of the astronauts

a. is zero. b. points towards Earth's center. c. points away from Earth's center.

8. (2) Mercury is much less massive than Earth and closer to the Sun than Earth, and orbits the Sun in only 88 days. The reason its orbit takes less time than the time for Earth's orbit is

a. Its smaller mass is easier for the Sun to pull on, giving it a larger centripetal acceleration.
b. Its smaller distance from the Sun means it gets a larger centripetal acceleration.
c. both a and b. d. none of the above.

9. (2) **T F** If the Earth moved on the same orbit as Mercury does, it would have a period of 88 days.

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10. (16) Earth's mass is $M_E = 5.98 \times 10^{24}$ kg and its radius is $R_E = 6380$ km. Consider a 2500-kg satellite going around Earth in an orbit of radius $r = 8.00 \times R_E$.

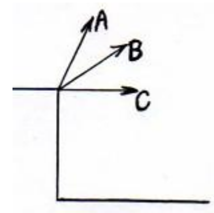
a) (6) That far from the Earth, how large is the acceleration due to gravity?

b) (4) How fast must the satellite be moving, to hold the orbit?

c) (6) What is the period of the orbit?

Name:

1. (4) Three identical balls are launched with the same speeds but different angles from a cliff, eventually landing on the level area 12.0 m below. Ignore air resistance.




a) (2) On which one is the most work done by the gravitational force?

a. Ball A. b. Ball B. c. Ball C. d. All have the same gravitational work.

b) (2) Which one has the highest speed just before landing?

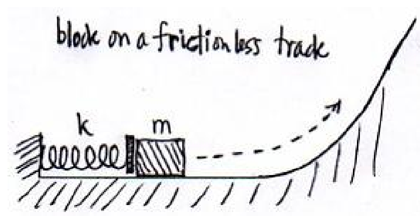
a. Ball A. b. Ball B. c. Ball C. d. All have the same speed before landing.

2. (3) If a spring placed vertically is compressed 2.00 cm when a 2.20 kg mass is placed on top of it, how large is its spring constant, $k$?

a. 1.10 N/m. b. 11.0 N/m. c. $1.10 \times 10^2$ N/m. d. 1.08 kN/m. e. 10.8 kN/m.

3. (6) A well-trained 62.0-kg runner is able to run a 10.0 km race in 30.0 minutes. Calculate her average kinetic energy during the race.

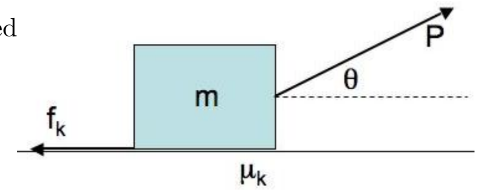
4. (16) A 0.500-kg block initially is pushed against a spring with $k = 250.0$ N/m, compressing it 6.00 cm. The block is released from that position, and slides without friction up the curved track.




a) (4) Initially, how much energy (in joules) is stored in the spring?

b) (6) When the block first leaves the spring, how fast is it going?

c) (6) What maximum height $h$ above the starting point will the block reach (before returning towards the spring)?




5. (14) This 12.0-kg box is pulled 3.00 m to the right along the floor by applied force $P = 40.0$ N at $\theta = 30.0°$. The coefficient of kinetic friction is $\mu_k = 0.200$.

a) (4) How much work is done by the applied force?

b) (4) How much work is done by the gravitational force on the box?

c) (4) How much work is done by the kinetic friction force?

d) (2) The kinetic energy of the box is

a. not changing. b. increasing. c. decreasing.

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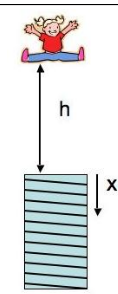
6. (3) A physics student (mass $m$) steps off a platform and falls height $h$ down onto a spring with spring constant $k$. Assuming that mechanical energy is conserved, which equation should be solved to find the maximum compression $x$ of the spring (before the student is shot back up)?




a. $mg = kx$ b. $mgh = kx$ c. $mgh = \frac{1}{2}kx^2$
d. $mgh - mgx = \frac{1}{2}kx^2$ e. $mgh + mgx = \frac{1}{2}kx^2$

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7. (4) Superman ($m = 99$ kg) can ascend vertically 1.00 km in 1.00 second. What minimum amount of mechanical power does that require?

## Chapter 6 Equations

Work & Kinetic & Potential Energies:

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

Conservation or Transformation of Energy:

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

Power:

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

## 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:

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

Orbits:

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

## Chapter 4 Equations

Newton's Second Law:

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

Static friction (magnitude):

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

Kinetic or sliding friction (magnitude):

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

Gravitational force near Earth:

$F_G = mg$, downward.

## Vectors

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

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

$V = \sqrt{V_x^2 + V_y^2}, \quad \tan\theta = \frac{V_y}{V_x}.$ $\qquad$ $\theta$ 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

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