Name **Level 3 Review**

Base your answers to questions **314** through **316** on the information below and on your knowledge of physics.

A horizontal 20.-newton force is applied to a 5.0-kilogram box to push it across a rough, horizontal floor at a constant velocity of 3.0 meters per second to the right.

$F_A = 20N$
$m = 5kg$
$v = 3 m/s$
$F_{net} = 0$

314. Calculate the coefficient of kinetic friction between the box and the floor. [Show all work, including the equation and substitution with units]

$$\mu = \frac{F_f}{F_N} = \frac{20N}{49N} = .41$$

315. Calculate the weight of the box. [Show all work, including the equation and substitution with units.]

$$F_g = mg = (5kg)(9.81 m/s^2) = 49N$$

316. Determine the magnitude of the force of friction acting on the box.

$$F_f = F_A = 20N$$

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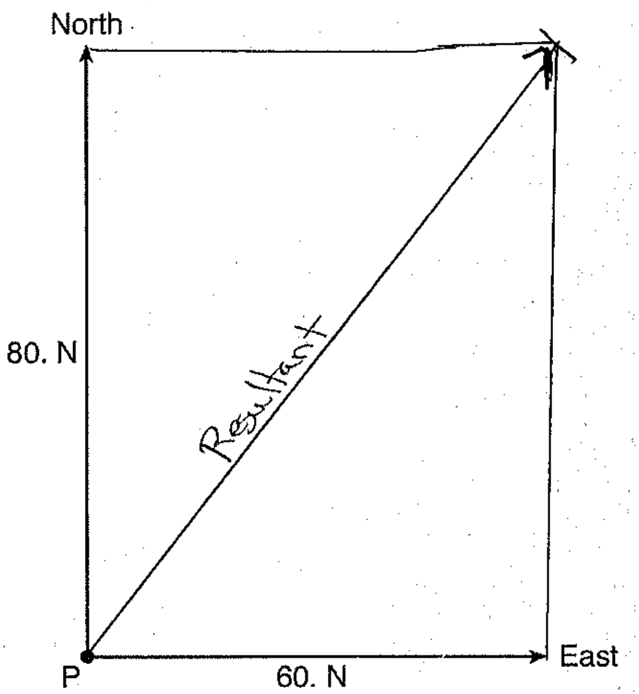
317. A 7.28-kilogram bowling ball traveling 8.50 meters per second east collides head-on with a 5.45 kilogram bowling ball traveling 10.0 meters per second west. Determine the magnitude of the total momentum of the two-ball system after the collision.

$m_1 = 7.28kg$ $m_2 = 5.45kg$
$v_1 = 8.5 m/s$ $v_2 = -10 m/s$

$P_{before} = p_{after}$
$m_1v_1 + m_2v_2 = p_{after}$
$(7.28kg)(8.5 m/s) + (5.45kg)(-10 m/s) = p_{after}$
$61.9 kg\,m/s + -54.5 kg\,m/s =$
$7.4 kg\,m/s = p_{after}$

Base your answers to questions 398 through ~~321~~ 401 on the information below and the scaled vector diagram below and on your knowledge of physics.

Two forces, a 60.-newton force east and an 80.-newton force north, act concurrently on an object located at point *P*, as shown.



398. Determine the measure of the angle, in degrees, between north and the resultant force, *R*.

53° use protractor or $\theta = \tan^{-1}\left(\frac{A_y}{A_x}\right) = \tan^{-1}\left(\frac{80N}{60N}\right) = 53^\circ$

399. Determine the magnitude of the resultant force, *R*.

$F_x = 60N$
$F_y = 80N$
$F = ?$

$F = \sqrt{F_x^2 + F_y^2}$
$F = \sqrt{(60N)^2 + (80N)^2} = 100N$

~~320~~ 400. Draw the resultant force vector to scale on the diagram. Label the vector "*R*."

√ make sure all vectors have arrows

~~321~~. Using a ruler, determine the scale used in the vector diagram.
401

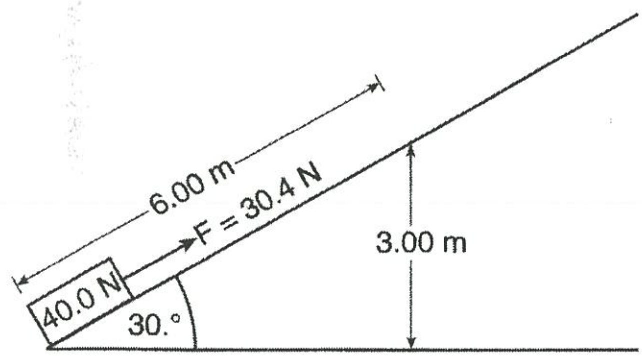
6cm = 60N so 1cm = 10N

~~322~~. Regardless of the method used to generate electrical energy, the amount of energy provided by
402 the source is always greater than the amount of electrical energy produced. Explain why there is a difference between the amount of energy provided by the source and the amount of electrical energy produced.

Some energy is lost to friction or resistance

Base your answers to questions **323** through **326** on the information and diagram below.

A 30.4-newton force is used to slide a 40.0-newton crate a distance of 6.00 meters at constant speed along an incline to a vertical heights of 3.00 meters.



~~323~~. State what happens to the internal energy of the crate as it slides along the incline.
403

Internal energy increases due to friction

Friction is present because F is greater than $F_{g\parallel}$

~~324~~. State what happened to the kinetic energy of the crate as it slides along the incline.
404

KE is constant (v is constant)

~~325~~. Calculate the total increase in the gravitational potential energy of the crate after it has slid 6.00
405 meters along the incline. [Show all work, including the equation and substitution with units.]

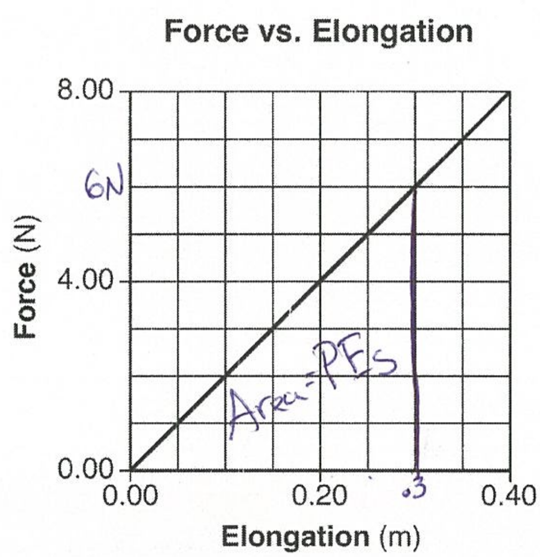
$PE = mg\Delta h$
$= (40N)(3m)$
$= 120J$

~~326~~. Determine the total work done by the 30.4-newton force in sliding the crate along the incline.
406

$W = Fd = (30.4N)(6m) = 182.4J$

Base your answers to questions **327** and **328** on the information below.

A student produced various elongations of a spring by applying a series of forces to the spring. The graph below represents the relationship between the applied force and the elongation of the spring.



~~327~~. Calculate the energy stored in the spring when the elongation is 0.30 meter. [Show all work,
407 including the equation and substitution with units.]

$PE_s = Area = \frac{1}{2}bh$
$\frac{1}{2}(.3m)(6N) = .9J$

~~328~~. Determine the spring constant of the spring.
408

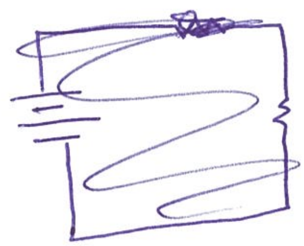
$$K = \frac{F_s}{x} = \frac{6N}{.3m} = 20 N/m$$

Base your answers to questions **329** through **331** on the information below and on your knowledge of physics.

A student constructed a series circuit consisting of a 12.0-volt battery, a 10.0-ohm lamp, and a resistor. The circuit does *not* contain a voltmeter or an ammeter. When the circuit is operating, the total current through the circuit is 0.50 ampere.

~~329~~. Calculate the power consumed by the lamp. [Show all work, including the equation and substitution with the units.]
404

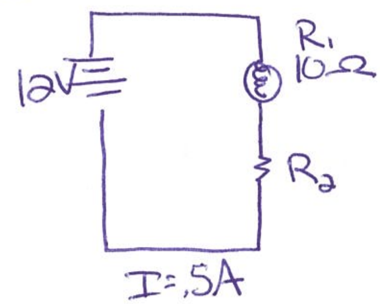
1 $P = I^2R = (.5A)^2(10\Omega) = 2.5W$



410
~~330~~. Determine the resistance of the resistor.

3 $R_{eq} = R_1 + R_2$ $R_2 = 14\Omega$

$24\Omega = 10\Omega + R_2$



~~331~~. Determine the equivalent resistance of the circuit.
411

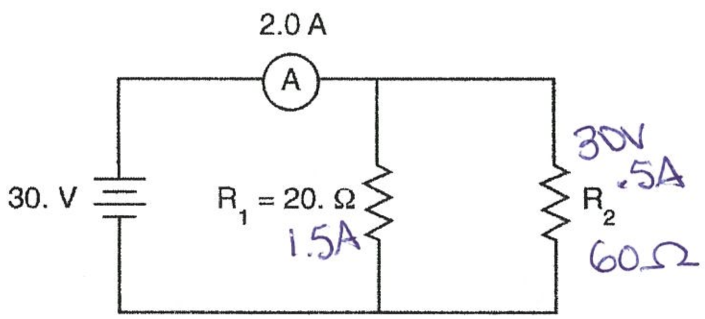
$$R_{eq} = \frac{12V}{.5A} = 24\Omega$$

2 $R_{eq} = \frac{V_T}{I_T}$

	V	I	R	P
1	5V	.5A	10Ω	2.5W
2	7V	.5A	14Ω	3.5W
	12V	.5A	24Ω	6W

~~332~~. 412 Base your answer to the following question on the information below.

A 20.-ohm resistor, R_1, and a resistor of unknown resistance, R_2, are connected in parallel to a 30.-volt source, as shown in the circuit diagram below. An ammeter in the circuit reads 2.0 amperes.



V	I	R
30V	1.5A	20Ω
30V	.5A	60Ω
30V	2A	15Ω

Calculate the resistance of resistor R_2. [Show all work, including the equation and substitution with units.]

Several methods exist

$$R_{eq} = \frac{V}{I} = \frac{30V}{2A} = 15\Omega$$

$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{15\Omega} = \frac{1}{20\Omega} + \frac{1}{R_2} \qquad R_2 = 6\Omega$$

OR

$$I_T = I_1 + I_2$$

$$2A = \frac{30V}{20\Omega} + I_2$$

$$2A = 1.5A + I_2$$

$$.5A = I_2$$

$$R = \frac{V}{I} = \frac{30V}{.5A} = 60\Omega$$

~~333~~. 413 Calculate the resistance of a 900.-watt toaster operating at 120 volts. [Show all work, including the equation and substitution with units.]

$P = 900W$

$V = 120V$

$R = ?$

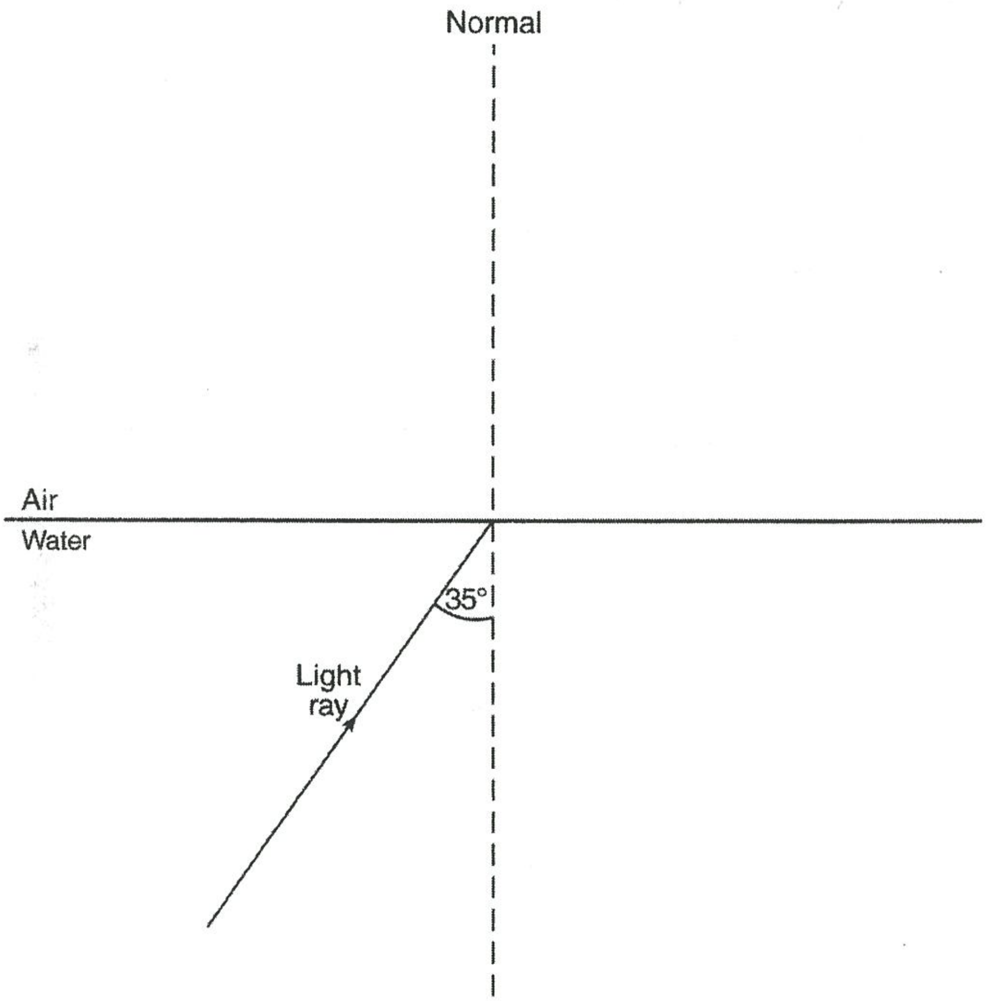
$$P = V^2/R$$

$$R = V^2/P$$

$$R = \frac{(120V)^2}{900W} = 16\Omega$$

Base your answers to questions **334** through **336** on the information below.

A light ray with a frequency of 5.09×10^{14} hertz traveling in water has an angle of incidence of 35° on a water-air interface. At the interface, part of the ray is reflected from the interface and part of the ray is refracted as it enters the air.



~~334~~ 414. Identify *one* characteristics of this light ray that is the same in *both* the water and the air.

frequency

~~335~~. 415 Calculate the angle of refraction of the light ray as it enters the air. [Show all work, including the equation and substitution with units.]

$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$1.33 \sin 35° = 1 \sin\theta_2$ $\qquad \theta_2 = 49.7°$

~~336~~. 416 What is the angle of reflection of the light ray at the interface?

$\theta_i = \theta_r \qquad r = 35°$

Base your answers to questions **337** through **340** on the information below and on your knowledge of physics.

An electron traveling with a speed of 2.50×10^6 meters per second collides with a photon having a frequency of 1.00×10^{16} hertz. After the collision, the photon has 3.18×10^{-18} joule of energy.

~~337~~. 417 Determine the energy lost by the photon during the collision.

$\cancel{E_{photon} = \frac{hc}{\lambda} = \frac{(6.63\times10^{-34}\,Js)(3\times10^{8}\,m/s)}{\lambda}} \qquad = 3.45\times10^{-18}\,J$

$E_{photon\ before} - E_{photon\ after} = 6.63\times10^{-18}\,J - 3.18\times10^{-18}\,J$

~~338~~. 418 Calculate the original kinetic energy of the electron. [Show all work, including the equation and substitution with units.]

$KE = \frac{1}{2}mv^2 = \frac{1}{2}(9.11\times10^{-31}\,kg)(2.5\times10^{6}\,m/s)^2 = 2.85\times10^{-18}\,J$

~~339~~. 419 Name *two* physical quantities conserved in the collision.

Charge, momentum, mass & Energy

~~340~~. 420 Determine the energy in joules of the photon before the collision.

$E = hf = (6.63\times10^{-34}\,Js)(1\times10^{16}\,Hz) = 6.63\times10^{-18}\,J$

Base your answers to questions **341** through **344** on the information below.

Two experiments running simultaneously at the Fermi National Accelerator Laboratory in Batavia, Ill., have observed a new particle called the cascade baryon. It is one of the most massive examples yet of a baryon—a class of particles made of three quarks held together by the strong nuclear force—and the first to contain one quark from each of the three known families, or generations, of these elementary particles.

Protons and neutrons are made of up and down quarks, the two first-generation quarks. Strange and charm quarks constitute the second generation, while the top and bottom varieties make up the third. Physicists had long conjectured that a down quark could combine with a strange and a bottom quark to form the three-generation cascade baryon.

On June 13, the scientists running Dzero, one of two detectors at Fermilab's Tevatron accelerator, announced that they had detected characteristic showers of particles from the decay of cascade baryons. The baryons formed in proton-antiproton collisions and lived no more than a trillionth of a second. A week later, physicists at CDF, the Tevatron's other detector, reported their own sighting of the baryon...

Source: D.C., "Pas de deux for a three-scoop particle," Science News, Vol. 172, July 7, 2007

~~341~~ 421. Calculate the maximum total mass, in kilograms, of particles that could be created in the head-on collision of a proton and an antiproton, each having an energy of 1.60×10^{-7} joule. [Show all work, including the equation and substitution with units.]

$E = 2 \times 1.6\times10^{-7}\,J = 3.2\times10^{-7}\,J$

$m = ?$

$c = 3\times10^{8}\,m/s$

$E = mc^2$

$3.2\times10^{-7}\,J = m(3\times10^{8}\,m/s)^2$

$m = 3.56\times10^{-24}\,kg$

~~342~~ 422. The Tevatron derives its name from teraelectronvolt, the maximum energy it can impart to a particle. Determine the energy, in joules, equivalent to 1.00 teraelectronvolt.

~~1×10^{12} TeV ×~~

$1\,TeV = 1\times10^{12}\,eV \times \frac{1.6\times10^{-19}\,J}{1\,eV} = 1.6\times10^{-7}\,J$

~~343~~ 423. What is the magnitude and sign of the charge, in elementary charges, of a cascade baryon?

Cascade = dsb

$-\frac{1}{3}, -\frac{1}{3}, -\frac{1}{3}$

$= -1e$

~~344~~ 424. Which combination of *three* quarks will produce a neutron?

udd

Base your answers to questions **345** through **347** on the information below and on your knowledge of physics.

Pluto orbits the Sun at an average distance of 5.91×10^{12} meters. Pluto's diameter is 2.30×10^{6} meters and its mass is 1.31×10^{22} kilograms.

Charon orbits Pluto with their centers separated by a distance of 1.96×10^{7} meters. Charon has a diameter of 1.21×10^{6} meters and a mass of 1.55×10^{21} kilograms.

425 ~~345~~. State the reason why the magnitude of the Sun's gravitational force on Pluto is greater than the magnitude of the Sun's gravitational force on Charon.

① Pluto has a greater mass than Charon

~~346~~. Calculate the magnitude of the acceleration of Charon toward Pluto. [Show all work, including the equation and substitution with units.]
426

$$a = \frac{F_{net}}{m} = \frac{3.53\times10^{18}\,N}{1.55\times10^{21}\,kg} = 2.27\times10^{-3}\,N/kg \text{ or } m/s^2$$

③

~~347~~. Calculate the magnitude of the gravitational force of attraction that Pluto exerts on Charon.
427 [Show all work, including the equation and substitution with units.]

$$F_g = G\frac{m_1 m_2}{r^2} = \frac{(6.67\times10^{-11}\,N\,m^2/kg^2)(1.31\times10^{22}\,kg)(1.55\times10^{21}\,kg)}{(1.96\times10^{7}\,m)^2} = 3.53\times10^{18}\,N$$

②

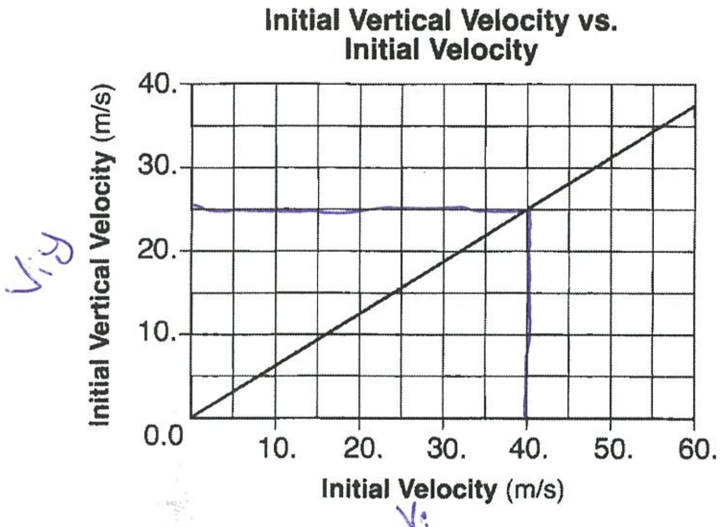
~~348~~. A toy rocket is launched twice into the air from level ground and returns to level ground. The
428 rocket is first launched with initial speed *v* at an angle of 45° above the horizontal. It is launched the second time with the same initial speed, but with the launch angle increased to 60.° above the horizontal. Describe how *both* the total horizontal distance the rocket travels and the time in the air are affected by the increase in launch angle. [Neglect friction.]

total horizontal distance would decrease

time in air would increase

Base your answers to questions **349** through **351** on the information and graph below.

A machine fired several projectiles at the same angle, θ, above the horizontal. Each projectile was fired with a different initial velocity, v_i. The graph below represents the
relationship between the magnitude of the initial vertical velocity, v_{iy}, and the magnitude of the corresponding initial velocity, v_i, of these projectiles



~~349~~. 429 Calculate the magnitude of the initial horizontal velocity of the projectile, v_{ix}, when the magnitude of its initial velocity, v_i, was 40. meters per second. [Show all work, including the equation and substitution with units.]

$V_{ix} = ?$ $\quad V_i^2 = V_{ix}^2 + V_{iy}^2$ $\quad V_{ix} = 31.2\ m/s$

$V_{iy} = 25\ m/s$ $\quad (40\ m/s)^2 = V_{ix}^2 + (25\ m/s)^2$

$V_i = 40\ m/s$

~~350~~. 430 Determine the angle, θ, above the horizontal at which the projectiles were fired.

$\theta = ?$ $\quad V_{iy} = V_i \cos\theta$

$V_i = 40\ m/s$ $\quad 25\ m/s = 40\ m/s \cos\theta$

$V_{iy} = 25\ m/s$ $\quad \theta = \cos^{-1}\left(\frac{25\ m/s}{40\ m/s}\right) = 51.3^\circ$

~~351~~. 431 Determine the magnitude of the initial vertical velocity of the projectile, v_{iy}, when the magnitude of its initial velocity, v_i, was 40. meters per second.

when $v_i = 40\ m/s$ $\quad V_{iy} = 25\ m/s$

~~352~~. 432 A baby and stroller have a total mass of 20. kilograms. A force of 36 newtons keeps the stroller moving in a circular path with a radius of 5.0 meters. Calculate the speed at which the stroller moves around the curve. [Show all work, including the equation and substitution with units.]

$m = 20\,kg$ $\quad F_c = \frac{mv^2}{r}$ $\quad v^2 = 9\,m^2/s^2$

$F_c = 36\,N$ $\quad 36\,N = \frac{(20\,kg)(v^2)}{5\,m}$ $\quad v = 3\,m/s$

$r = 5\,m$

$v = ?$

Base your answers to questions **353** and **354** on the information below.

Io (pronounced "EYE oh") is one of Jupiter's moons discovered by Galileo. Io is slightly larger than Earth's Moon. The mass of Io is 8.93×10^{22} kilograms and the mass of Jupiter is 1.90×10^{27} kilograms. The distance between the centers of Io and Jupiter is 4.22×10^{8} meters.

~~353~~. 433 Calculate the magnitude of the acceleration of Io due to the gravitational force exerted by Jupiter. [Show all work, including the equation and substitution with units.]

$$a = \frac{F_{net}}{m} = \frac{6.35 \times 10^{22}\,N}{8.93 \times 10^{22}\,kg} = .71\,m/s^2$$

~~354~~. 434 Calculate the magnitude of the gravitational force of attraction that Jupiter exerts on Io. [Show all work, including the equation and substitution with units.]

$$F_g = \frac{G m_1 m_2}{r^2} = \frac{(6.67 \times 10^{-11}\,Nm^2/kg^2)(8.93 \times 10^{22}\,kg)(1.9 \times 10^{27}\,kg)}{(4.22 \times 10^{8}\,m)^2} = 6.35 \times 10^{22}\,N$$

~~355~~. 435 Calculate the magnitude of the centripetal force acting on Earth as it orbits the Sun, assuming a circular orbit and an orbital speed of 3.00×10^{4} meters per second. [Show all work, including the equation and substitution with units.]

$F_c = ?$ $\quad F_c = \frac{mv^2}{r}$

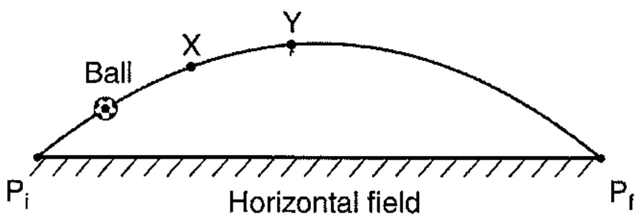
$v = 3 \times 10^{4}\,m/s$

$r = 1.5 \times 10^{11}\,m$ $\quad = \frac{(5.98 \times 10^{24}\,kg)(3 \times 10^{4}\,m/s)^2}{1.5 \times 10^{11}\,m} = 3.6 \times 10^{22}\,N$

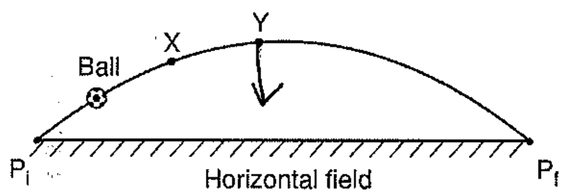
$m = 5.98 \times 10^{24}\,kg$

~~35.~~ 436 Base your answer to the following question on the information below.

A soccer ball is kicked from point Pi at an angle above a horizontal field. The ball follows an ideal path before landing on the field at point Pf.

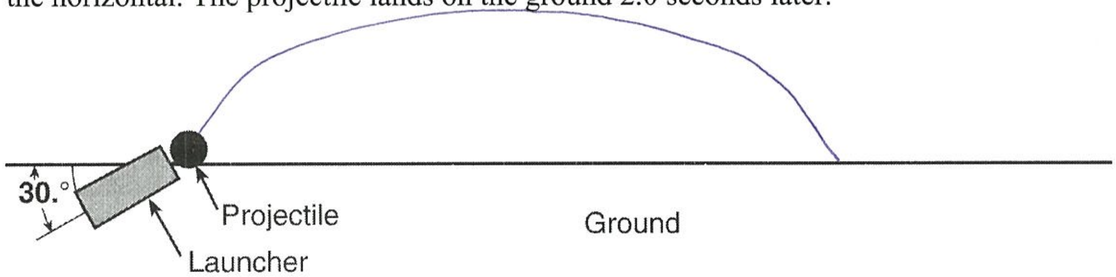


On the diagram below, draw an arrow to represent the direction of the acceleration of the ball at position Y. Label the arrow a. [Neglect friction.]



Base your answers to questions **357** through **359** on the information below.

A projectile is launched into the air with an initial speed of v_i at a launch angle of 30.° above the horizontal. The projectile lands on the ground 2.0 seconds later.



~~357~~ 437. How does the total horizontal distance traveled by the projectile change as the launch angle is increased from 30.° to 45° above the horizontal? [Assume the same initial speed, v_i.]

Total horizontal distance increases as the angle increases from 30° to 45°

~~358~~ 438. How does the maximum altitude of the projectile change as the launch angle is increased from 30.° to 45° above the horizontal? [Assume the same initial speed, v_i.]

as the launch angle increases, the maximum height increases

~~359~~ 439. On the diagram above, sketch the ideal path of the projectile.

Extra challenge

$t = 2s$ $\qquad \Delta V = at = (9.81 m/s^2)(2s)$

$a = -9.81 m/s^2$ $\qquad = -19.6 m/s$

$\Delta V_y = ?$

$V_{iy} = 9.8 m/s \quad V_f = -9.8 m/s$

what is the initial velocity

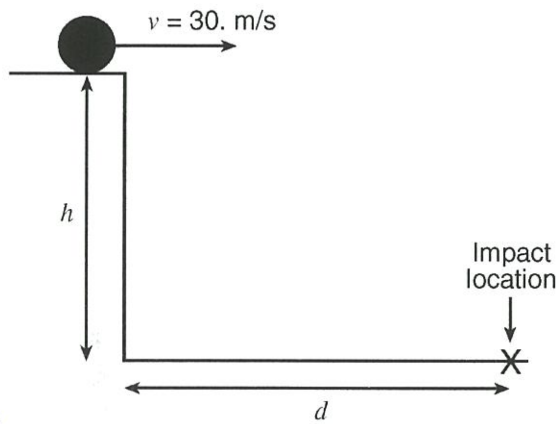
$V_{iy} = 9.8 m/s \qquad V_{iy} = V_i \sin\theta$

$\theta = 30°$ $\qquad 9.8 m/s = V_i \sin 30°$

$V_i = ?$ $\qquad V_i = 19.6 m/s$

Base your answers to questions **360** and **361** on the information and diagram below.

A projectile is launched horizontally at a speed of 30. meters per second from a platform located a vertical distance h above the ground. The projectile strikes the ground after time t at horizontal distance d from the base of the platform. [Neglect friction.]



440 ~~360~~. Express the projectile's total time of flight, t, in terms of the vertical distance, h, and the acceleration due to gravity, g. [Write an appropriate equation and solve it for t.]

$t=\sqrt{\frac{2h}{g}}$

$d=\frac{1}{2}gt^2$

$h=\frac{1}{2}gt^2$

$2h=gt^2$

~~361~~ 441. Calculate the horizontal distance, d, if the projectile's total time of flight is 2.5 seconds. [Show all work, including the equation and substitution with units.]

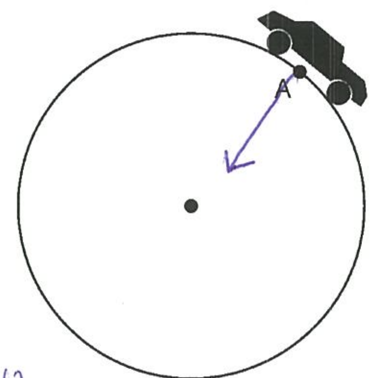
$d=v_x t$

$d=(30\text{ m/s})(2.5\text{ s})$

$d=75\text{ m}$

Base your answers to questions **362** through **364** on the information below.

The combined mass of a race car and its driver is 600. kilograms. Traveling at constant speed, the car completes one lap around a circular track of radius 160 meters in 36 seconds.



442 ~~362~~. Calculate the magnitude of the centripetal acceleration of the car.

$a_c=\frac{v^2}{r}=\frac{(27.9\text{ m/s})^2}{160\text{ m}}=4.87\text{ m/s}^2$

443 ~~363~~. On the diagram *above*, draw an arrow to represent the direction of the net force acting on the car when it is in position *A*.

444 ~~364~~. Calculate the speed of the car.

$v=\frac{2\pi r}{T}=\frac{2\pi(160\text{ m})}{36\text{ s}}=27.9\text{ m/s}$