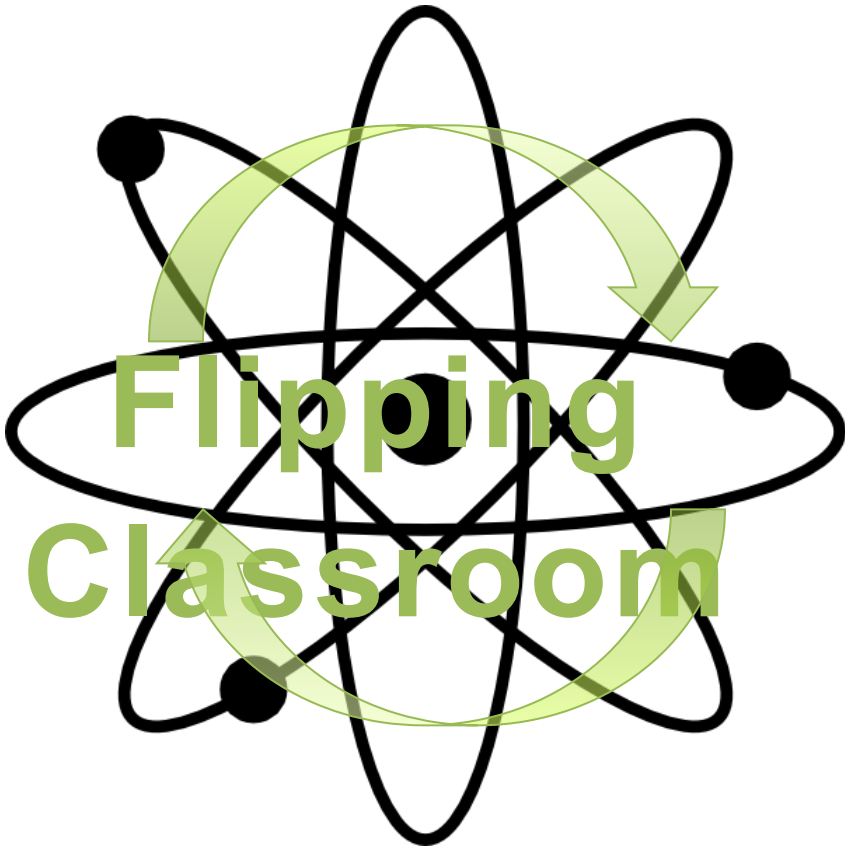
AP Physics C

Summer assignment

Review the topics below that you learned in your previous physics classes. Short algebra based quizzes will be given and graded at the beginning of each topic to assess your understanding of the concept prior to delving into the more complicated calculus based analysis of the concepts in this class.

Topics for review:
Kinematics, Dynamics, Work and Energy, Momentum, Rotational Motion, Universal Gravitation, Simple Harmonic Motion, Electric Charge and Field, Electric Potential and Capacitance, Magnetic Force and Field, Electromagnetic Induction.

To aid in your review I include an excellent resource prepared by former students. This resource will also be very useful during the school year so make sure to keep it. Feel free to use other resources as well such as physicsclassroom.com njctl.org and flippingphysics.com and each other in order to understand the problems and their solutions.



By Jenseric Calimag and Joshua Cayetano

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Introduction/Tips

This project is a compilation of a number of materials and sources designed to assist in the process of learning and honing problem-solving skills in AP Physics. AP Physics 1 is algebra-based and replaced the AP Physics B course, and also the yearly exam covering the first half of what would be on the AP Physics B. The other half of what would be covered on AP Physics B is covered in AP Physics 2. To enable students to have a better grasp on Physics and better understand the material the classroom is flipped. As opposed to doing homework at home and listening to your teacher during class, in a flipped classroom problems are done during school under the supervision and guidance of the teacher with your peers. The gathered problems and videos should not be the only source for preparation of the exam and understanding of the material in the course as there are other sources such as prep book, labs, your teacher, and each other! We hope that a flipped classroom will be more engaging and help to fulfill the end goal, a mastery of AP Physics 1.

Some tips recommended to study for the AP Physics 1 include:
-Begin preparations early into the year
-Practice problem-solving (I.e Free Response questions) by doing problems for homework. Understand how to do the problems. They are not there as fillers!
-Use other resources, such as textbooks outside of school (I.e Giancoli)
-Ask for help from your instructor
-Don't get too comfortable with a calculator and equation sheet, on exam day it won't be much help!

Flipping Classroom Chapter 1: Kinematics 1D

Physics, Kinematics, One Dimensional Horizontal Motion: An Explanation

Speed, Velocity, Acceleration

Graphing Motion: Regents Level

Graphing Motion: AP Physics

Physics, Kinematics, What is Free Fall? An Explanation

Calculations:

1. A car travels 200 meters north in 20 seconds. The same car travels 100 meters south in 8 seconds. What is the total distance and displacement of the car?
2. How long does it take a car to cross a 30.0m wide intersection after the light turns green, if the car accelerates from rest at a constant 2.00 m/s^2?
3. Suppose that a ball is dropped from a tower 70m high. How far will the ball have fallen after one second, two seconds, and three seconds? Draw a position-time graph, velocity-time graph, and acceleration-time graph of the ball's motion.
4. A person throws a ball upward into the air with an initial velocity of 15 m/s. Calculate (a) how high it goes, and (b) how long the ball is in the air before it comes back to his hand.
5. What must your car's average speed be in order to travel 235 km in 3.25h?
6. A car slows down uniformly from a speed of 25.0 m/s to rest in 8.00s. How far did it travel in that time?
7. A helicopter is ascending vertically with a speed of 5.20 m/s. At a height of 125m above the Earth, a package is dropped from a window. How much time does it take for the package to reach the ground.
8. A stone is dropped from the roof of a high building. A second stone is dropped 1.5s later. How far apart are the stones when the second one has reached a speed of 12.0 m/s?
9. Bill can throw a ball vertically at a speed 1.5 times greater than Joey. How many times higher will Bill's ball go than Joey's?
10. A ball is dropped from rest near Earth. Neglect air resistance. About how far will the ball fall in 3s?
11. A ball is launched upward at a velocity of 10 m/s and reaches a height of 30 meters. Determine the velocity at its apex (highest point.)

Conceptual Problems:

1. Can an object have zero velocity and nonzero acceleration at the same time? Give two examples.

2. In drag racing, is it possible for the car with the greatest speed crossing the finish line to lose the race? Explain

3. Can the kinematics equations be used for an object with constantly changing acceleration? If so, give an example. If not, explain.

4. a) Draw a velocity vs time graph showing a constant acceleration.
   b) Draw a position vs time graph showing a constant velocity.

5. A large metal ball and a plastic ball are dropped from the same height, which object hits the ground first. Explain.

6. In a lecture demonstration, a 3.0-m-long vertical string with ten bolts tied to it at equal intervals is dropped from the ceiling of the lecture hall. The spring falls on a tin plate and the class hears the clink of each bolt as it hits the plate. The sounds will not occur at equal time intervals. Why? Will the time between clinks increase or decrease near the end of the fall? How could the bolts b tied so that the clinks occur at equal intervals?

7. Can an object increase in speed as its acceleration decreases? If so, give an example. If not, explain.

8. Which one of these motions is *not* at constant acceleration: a rock falling from a cliff, an elevator moving from the second floor to the fifth floor making stops along the way, a dish resting on a table?

9. In what ways can air resistance affect an object's motion?

10. Why does a pen flicked at the edge of a table with a height of 2m and a pencil dropped from the same height hit the ground at the same time?

Flipping Classroom Chapter 2: Kinematics 2D
Dan Fullerton Topic by Topic Videos:

High School Physics: Defining Motion
High School Physics: Graphing Motion

High School Physics: Kinematics Equation

High School Physics: Free Fall

AP Physics Projectile Motion

How To Solve Any Projectile Motion Problem (The Toolbox Method)

Horizontal Projectile Motion Sample Problems (Supplement Video for Horizontal Motion)

Angled Projectile Motion Sample Problems Video 1 (Supplement Video)

Angled Projectile Motion Sample Problems Video 2 (Supplement Video)
Reference Frames

RECAP VIDEOS
AP Physics 1: Kinematics Review

Kinematics (AP Physics SuperCram Review)

Conceptual Problems:

1. Give an example of an object's motion in which a great distance is traveled but the displacement is zero.

2. A child is sitting upright in a wagon which is moving to the right at a constant speed. The child extends her hand and throws an apple straight upward (from her own point of view), while the wagon continues to travel forward at constant speed. If air resistance is neglected, will the apple land (a) behind the wagon, (b) in the wagon, or (c) in front of the wagon? Explain.

3. A man in a small motor boat is trying to cross a river that flows due west with a strong current. The man starts on the south bank and is trying to reach the north bank directly from his starting point. Should he head due north, head due west, head in a northwesterly direction, or head in a northeasterly direction?

4. (a) True or false, you can use the kinematics equations with an acceleration that constantly changes. (b) True or false, you can use the kinematics equations with a constant acceleration.

5. In archery should the arrow be aimed directly at the target? Why?

6. One car travels east at 40 km/h and a second car travels north at 40 km/h. Are there velocities equal? Explain.

7. If you stand motionless under an umbrella in a rainstorm where the drops fall vertically, you remain relatively dry. However, if you start running, the rain begins to hit your legs even if they remain under the umbrella why?

8. Why can't the kinematic equations be used if the acceleration of an object is not constant?

9. A boy on a small hill aims his water=balloon slingshot horizontally, straight at a second boy hanging from a tree branch a distance *d* away. At the instant the water balloon is released, the second boy lets go and falls from the tree, hoping to avoid being hit. Show that he made the wrong move. Ignore air resistance.

Calculations Problems

1. A ball is launched upward at a velocity of 10 m/s and reaches a height of 30 meters. Determine the velocity at its apex (highest point.)

2. A tiger leaps horizontally from a 6.5-m-high rock with a speed of 3.5 m/s. How far from the base of the rock will she land?

3. A ball is thrown horizontally from the roof of a building 45.0m tall and lands 24.0m from the base. What was the ball's initial speed?

4. A student drops a pebble from the edge of a vertical cliff. The pebble hits the ground 4 s after it was dropped. What is the height of the cliff?

5. A student drops a pebble from the edge of a vertical cliff. The pebble hits the ground 4 s after it was dropped. What is the speed of the pebble just before it hits the ground?

6. A fire hose held near the ground shoots water at a speed of 6.8 m/s. At what angle(s) should the nozzle point in order that the water land 2.0m away? Why are there two different angles? Sketch the two trajectories.

7. A football is kicked at an angle theta = 36.0 degrees with a velocity of 25.0 m/s. Calculate (a) the maximum height, (b) the time of travel before the football hits the ground, (c) the acceleration vector at maximum height. Assume the ball leaves the foot at ground level, and ignore air resistance and rotation of the ball.

8. A movie stunt driver on a motorcycle speeds horizontally off a 50.0-m-cliff. How fast must the motorcycle leave the cliff top to land on level ground below, 90.0 m from the base of the cliff where the cameras are? Ignore air resistance. Afterwards, draw a position-time graph, velocity-time graph, and acceleration-time graph of the motion of the driver on the motorcycle.

9. A projectile is launched from ground level to the top of a cliff which is 195m away and 155m high. If the projectile lands on top of the cliff 8.6 s after it is fired, find the initial velocity of the projectile (magnitude and direction). Neglect air resistance.

Flipping Classroom Chapter 3 Dynamics:

Dan Fullerton's Playlist:

- High School Physics - Newton's 1st Law of Motion
- High School Physics - Free Body Diagrams
- High School Physics - Newton's 2nd Law
- AP Physics 1 - Elevators
- AP Physics 1 - Air Resistance
- High School Physics - Newton's 3rd Law
- High School Physics - Friction
- High School Physics - Ramps and Inclines
- Introduction to tension | Forces and Newton's laws of motion |
- Introduction to tension (part 2) | Forces and Newton's laws of motion |
- AP Physics - Atwood Machines
- Ramps and Inclines (Slightly Shorter)
- AP Physics 1: Dynamics Review
- Forces (AP Physics SuperCram Review)

Conceptual Problems:

1.You are driving along an empty straight road at a constant speed u. At some point you notice a tall wall at a distance D in front of you. Would it require a larger force to (a) continue moving straight and decelerate to a full stop before the wall, or (b) turn left or right to avoid the wall? (to make the calculation easier assume that the turn is done at a constant speed along a circular path).

2. A dancer is standing on one leg on a drawbridge that is about to open. Before the drawbridge starts to open, it is perfectly level with the ground. The dancer is standing still on one leg. What is the x component (horizontal component) of the friction force?

3. Why does a child in a wagon seem to fall backward when you give the wagon a sharp pull forward?

4. If an acceleration on an object is zero, are there no forces acting on it? Explain.

5. Travis pushes a book with a force of 10 Newtons moving the book a distance of 20 cm. If by Newton's third law the object exerts an equal and opposite force on Travis, but Travis does not move? Explain.

6. A block is given a push so that it slides up a ramp. After the block reaches its highest point, it slides down with an acceleration less than that of gravity. Why?

7. According to Newton's Third Law, each team in a tug of war pulls with equal force on the other team. What, then, determines which team will win?

8. Your baby cousin wants to ride on her sled. If you are flat on the ground, will you exert less force if you push her or pull her at an angle? Justify your answer.

9. The force of gravity on a 2-kg rock is twice as great as that on a 1-kg rock. Why then doesn't the heavier rock fall faster?

10. A stone hangs by a fine thread below the halfway point of the thread. Is the force tension equal throat the thread? Explain.

Calculations Problems:

1. Suppose that you are standing on a train accelerating at .20g. What minimum coefficient of static friction must exist between your feet and the floor if you are not to slide?
2. A net force of 265N accelerates a bike and rider at 2.30 m/s^2. What is the mass of the bike and rider together?
3. A block of mass 4m can move without friction on a horizontal table. This block is attached to another block of mass m by a string that passes over a frictionless pulley. If the masses of the string and the pulley are negligible, what is the magnitude of the acceleration of the descending block?
4. An elevator car weighs 5500 N. If the car accelerates upwards at a rate of 4.0 m/s2, what is the tension in the support cable lifting the car? Use g = 10 m/s2.
5. A circus clown weighs 900 N. The coefficient of static friction between the clown's feet and the ground is 0.4. He pulls vertically downward on a rope that passes around three pulleys and is tied around his feet. What is the minimum pulling force that the clown must exert to yank his feet out from under himself?
6. A 20.0 kg box rests on a table. (a.) What is the weight of the box and the normal force acting on it? (b.) A 10kg box is then placed on top of the 20kg box, now what is the normal force exerted by the table on the 20kg box, and the normal force of the 10 kg box on the 20 kg box?
7. A 7.0N block sits on a rough surface. It is being pulled by a force F1 at an angle theta = 30 degrees above the horizontal. The block is initially moving to the right with speed 5 m/s. The coefficient of friction between the block and the surface is .20. Justify all answers.

(a) Is it possible for the block to be slowing down? If so give a possible magnitude of F1 that would allow the block to slow down. If not, explain why not with reference to Newton's second law.

(b) In order to double the block's initial speed to 10 m/s, how must the magnitude of force F1 change?

8. A bus driver makes an emergency stop by slamming on the bus's breaks. Later, he slams on the breaks again, but this time his speed is twice as much as the first time. How far will the bus skid compared to the first time?

9. Two blocks A and B with masses m and 2m are in contact on a horizontal frictionless surface. A force F is applied to block A. What is the acceleration of the two blocks?

Flipping Classroom Chapter 4: Circular Motion; Gravitation

CIRCULAR MOTION

Uniform Circular Motion -AP Physics 1

Uniform Circular Motion: Crash Course Physics #7

Centripetal Forces (AP Physics SuperCram Review)

Gravitation

High School Physics - Newton's Law of Universal Gravitation

Newton's Law of Universal Gravitation by Professor Mac

High School Physics - Gravitational Fields

AP Physics 1: Universal Gravitation Review

Uniform Circular Motion

Conceptual Problems

1. At Texas Motor Speedway, the NASCAR drivers go around corner one traveling at speeds of 200mph (over 300km/hr)! What is going on with their acceleration when they are entering the corner? Is the car accelerating?

2. Describe all the forces acting on a child riding a horse on a merry-go-round. Which of these forces provides the centripetal acceleration of the child?

3. A bucket of water can be whirled in a vertical circle without water spilling out, even at the top of the circle when the bucket is upside down. Explain.

4. Why do bicycle riders lean inward when rounding a curve at high speed?

5. Suppose a car moves at constant speed along a hilly road. Where does the car exert the greatest and least forces on the road (a) at the top of a hill, (b) at a dip between two hills, (c) on a level stretch near the bottom of a hill?

6. A car is traveling on a road in hilly terrain, see figure above. Assume the car has speed v and the tops and bottoms of the hills have radius of curvature R. The driver of the car is most likely to feel weightless: (A) at the top of a hill when $v = \sqrt{gR}$ (B) at the bottom of a hill when $v > \sqrt{gR}$ (C) going down a hill when $v = \sqrt{gR}$ (D) at the top of a hill when $v < \sqrt{gR}$
7. When a student stands on a rotating table, the frictional force exerted on the student by the table is (A) greater in magnitude than the frictional force exerted on the table by the student (B) less in magnitude than the frictional force exerted on the table by the student (C) equal in magnitude than the frictional force exerted on the table by the student (D) directed away from the center of the table
8. A child whirls a ball at the end of a rope, in a uniform circular motion. Which of the following statements is NOT true? (A) The speed of the ball is constant. (B) The velocity of the ball is constant. (C) The radius is constant (D) The magnitude of the ball's acceleration is constant.

Calculations Problems

1. If a runner can make a full trip around a small track in 90 seconds, how much time would it take to complete 6 loops of the track?

2. If an object is traveling in circular motion and its period is 3.0s, how many revolutions will it complete in 1 minute?

3. A 5.0 kg object is spun around in a circle of radius 1.0 m with a period of 4.0s.
   a. What is the frequency of its rotation?
   b. *What is its velocity?
   c. *What is its acceleration?

4. A 15.0 kg mass is spun in a circle of radius 5.0 m with a frequency of 25 Hz.
   a. What is the period of its rotation?
   b. *What is its velocity?
   c. *What is its acceleration?

5. A roller coaster car moves on a track with one section that is a vertical circular loop of radius R. When the car is at the top of the loop it just maintains contact with the track. What is the car's acceleration at this point?

6. A centripetal force F is applied to an eraser moving at a constant speed v in a horizontal circle of radius r. If the same force is applied, but the radius is halved, what happens to the speed of the eraser? (A) Increased by a factor of 2 (B) decreased by a factor of 2 (C) increased by a factor of √2 (D) decreased by a factor of √2

7. A centripetal force F is applied to an object moving at a constant speed v in a horizontal circle of radius r. If the radius is quadrupled and the speed is doubled, what happens to the centripetal force? (A) Increased by a factor of 2 (B) decreased by a factor

of 2 (C) doesn't change (D) increased by a factor of √2

8. A roller coaster car is on a track that forms a circular loop of radius R in the vertical plane. If the car is to just maintain contact with track at the top of the loop, what is the minimum value for its velocity at this point? Answer in terms of gR.

Gravitation

Conceptual Problems

1. According to common wisdom, objects in outer space are "weightless". Why then do astronauts still have weight even as they orbit around in a space station? What's wrong with the common wisdom?

2. Which pulls harder gravitationally, the Earth on the Moon, or the Moon on the Earth? Which accelerates more?

3. Will an object weigh more at the equator or at the poles? What two effects are at work? Do they oppose each other?

4. What keeps a satellite up in its orbit around Earth?

5. What would happen to objects on the Earth's surface if…
    a. The earth's gravitational field gradually disappeared?
    b. The earth's gravitational field was fine, but the Earth slowly stopped rotating?

6. The Sun's gravitational pull on the Earth is much larger than the Moon's. Yet the Moon's is mainly responsible for the tides. Explain.

7. If the Earth's mass were double what it is, in what ways would the Moon's orbit be different?

8. The Sun's gravitational pull on the Earth is much larger than the Moon's. Yet the Moon's is mainly responsible for the tides. Explain. [Hint: Consider the difference in gravitational pull from one side of the Earth to the other.]

9. The mass of Pluto was not known until it was discovered to have a moon. Explain how this discovery enabled an estimate of Pluto's mass.

10. Derive a formula for the mass of a planet in terms of its radius, *r*, the acceleration due to gravity on its surface *g* and the Gravitational constant *G*.

Calculations Problems

1. Two objects attract each other gravitationally. If the distance between their centers is cut in half, the gravitational force.

2. The earth has a radius about twice as great and a mass ten times greater than the planet Mars. How does the acceleration due to gravity on Mars compare to that on earth?

3. Two objects, with masses m1 and m2, are originally a distance r apart. The magnitude of the gravitational force between them is F. The masses are changed to 2m1 and 2m2, and the distance is changed to 4r. What is the magnitude of the new gravitational force?

4. Calculate the weight of a 75 kg astronaut on the surface of the Earth.

5. Calculate the force of gravity between a 3.0 kg newborn baby and a 75 kg doctor standing 0.25 m away.

6. The force of gravity of a planet on a satellite is 20,000N. What is the force of the satellite on the planet?

7. A hypothetical planet has a mass 1.66 that of Earth, and has a radius 2 times that of the earth. What is g near its surface? Do not leave in terms of g.

8. A hypothetical planet has a mass of half that of the Earth and a radius of twice that of the Earth. What is the acceleration due to gravity on the planet in terms of g, the acceleration due to gravity at the Earth?

9. Two moons orbit a planet in nearly circular orbits. Moon A has orbital radius r, and moon B has orbital radius 4r. Moon A takes 20 days to

complete one orbit. How long does it take moon B to complete an orbit? A) 20 days B) 80 days C) 160 days D) 320 days

10. An object weighs 432 N on the surface of Earth. At a height of 3REarth above Earth's surface, what is its weight?

Flipping Physics Chapter 5: Work and Energy
Work and Energy

Videos
Khan Academy: Introduction to Work and Energy

Potential and Kinetic Energy

Work and Power

Work and Energy

Energy, Work and Power

AP Physics 1 - Work-Energy Theorem

Work Energy Principle

Khan Academy: Work and Energy Part II

AP Physics 1: Work, Energy and Power Review

Bozeman Science: Work and Energy

Work, Energy, Power (AP Physics SuperCram Review)

Conceptual Problems

1. What happens to the gravitational potential energy when water at the top of a waterfall falls to the pool below?
2. Describe the energy transformations when a child hops around in a pogo stick.
3. Do kinetic friction forces always negative do the work? If so, explain. If not give an example.
4. When a "superball" is dropped, can it rebound to a height greater than its original height? Explain.
5. Why is it easier to climb a mountain via a zigzag trail than to climb straight up?
6. If my system is the earth and a block attached to a spring, when the block is lowered does the potential energy of the system increase, decrease, or remain the same?
7. A bowling ball is hung from the ceiling by a steel wire. The instructor pulls the ball back and stands against the wall with the ball against his nose. To avoid injury the instructor is supposed to release the ball without pushing it. Why?
8. Water balloons are tossed from the roof of a building, all with the same speed but with different launch angles. Which one has the highest speed on impact? Ignore air resistance.
9. Two water slides at a pool are shaped differently, but have the same length and start at the same height h. Two riders, Paul and Kathleen, start from rest at the same time on different sides. (a) Which rider, Paul or Kathleen is traveling faster at the bottom? (b) Which rider makes it to the bottom first? Ignore friction.

10. Describe the energy transformations when a ball is launched horizontally from the top of a building.

Calculation Problems

1. A driver in a 2000 kg Porsche wishes to pass a slow moving school bus on a 4-lane road. What is the average power in watts required to accelerate the sports car from 30 m/s to 60 m/s in 9 seconds? A. 1,800 B. 5,000 C. 100,000 D. 300,000
2. A force of 20 N compresses a spring with a spring constant 50 N/m. How much energy is stored in the spring?
3. An apple of mass m is thrown horizontally from the edge of a cliff of height H. What is the total mechanical energy of the apple with respect to the ground when it is at the edge of the cliff? A. ½ mv^2 B. mgH C. mgH + ½ mv^2 D. ½ mv^2 - mgH.
4. Li Ping Phar, the esteemed Chinese ski jumper, has a mass of 59.6 kg. He is moving with a speed of 23.4 m/s at a height of 44.6 meters above the ground. Determine the total mechanical energy of Li Ping Phar.
5. A crate of mass 50 kg is pushed along a floor with a force of 20N for a distance of 5m. Calculate the work done.
6. What is the kinetic energy of a 2 kg ball that travels a distance of 50 meters in 5 seconds?
7. Two projectiles A and B are launched from the ground with velocities of 50 m/s at 60˚(projectile A) and 50 m/s at 30˚(projectile B) with respect to the horizontal. Assuming there is no air resistance involved, which projectile has greater kinetic energy when it reaches the highest point? A.) Projectile A) B. Projectile B C.) They both have the same non-zero kinetic energy D.) they both have zero kinetic energy
8. A girl runs up a 5-meter high flight of stairs and she has 1000 J of potential energy at the top. Calculate her mass.

9. A new conveyor system at the local packaging plan will utilize a motor-powered mechanical arm to exert an average force of 890 N to push large crates a distance of 12 meters in 22 seconds. Determine the power output required of such a motor.
10. How much work must be done to stop a 1250-kg car traveling at 105 km/h.

Chapter 6: Linear Momentum
Momentum and Impulse

Videos
Introduction to momentum | Impacts and linear momentum | Physics | Khan Academy

Bozeman Physics: Momentum

Elastic and Inelastic Collisions: Difference and Principles

High School Physics - Momentum & Impulse

High School Physics - Conservation of Momentum

High School Physics - Impulse-Momentum Theorem and Sample Problems

Flipping Physics:AP Physics 1: Linear Momentum and Impulse Review

We are Showboat: Review of Momentum and Impulse

Conceptual Problems

1. (a) An empty sled is sliding on frictionless ice when Susan drops vertically from a tree above onto the sled. When she lands, does the sled speed up, slow down, or keep the same speed? (b) Later, Susan falls sideways off the sled. When she drops off, does the sled speed up, slow down, or keep the same speed?
2. In terms of physics and momentum explain how airbags keep people safe in a car accident.
3. We claim that momentum is conserved, yet most moving objects eventually slow down and stop. Explain?
4. When a person jumps from a tree to the ground, what happens to the momentum of the person upon striking the ground?
5. A girl on a boat wants to go west. In what direction should she throw her baggage to go west? Explain.
6. Is it possible for an object to receive a larger impulse from a small force than from a large force? Explain.
7. A light object and heavy object have the same kinetic energy. Which has the greater momentum. Explain.
8. Is it possible for an object to receive a larger impulse from a small force than from a large force? Explain.
9. A car on a freeway collides with a mosquito, which was initially at rest. Justify all answers thoroughly.

(a) Did the total momentum of the car-mosquito system increase, decrease, or remain the same after the collision?
(b) Did the momentum of the mosquito increase, decrease, or remain the same after the collision?
(c) Did the momentum of the car increase, decrease, or remain the same after the collision?
(d) Which changed its speed by more in the collision, the car or the mosquito? (Or did they change speed by the same amount?)

(e) Which changed its momentum by more in the collision, the car or the mosquito? (Or did they change by the same amount?)
(f) Which experienced a greater impulse in the collision, the car or the mosquito? Or did they experience the same impulse?)
(g) Which experienced a greater magnitude of net force during the collision, the car or the mosquito? (Or did they experience the same net force?)

Calculation Problems

1. What is the magnitude of the momentum of a 28-g sparrow flying with a speed of 8.4 m/s?
2. When a ping-pong ball rolling with a speed of 3.0 m/s collides with a bowling ball at rest, the ping-pong's speed after the collision will be close to: A. 0 m/s B. 3.0 m/s C. 6.0 m/s D. 12 m/s
3. A 3 kg ball is dropped onto a concrete floor. What is the magnitude of the ball's change in momentum if its speed just before striking the floor is 7 m/s and its rebound speed is 3 m/s?
4. A bowling ball moving with speed, v collides head-on with a stationary tennis ball. The collision is elastic, and there is no friction. The bowling ball barely slows down. What is the speed of the tennis ball after the collision? A.) Nearly v B.) Nearly 2v C.) Nearly 3v D.) nearly 4v
5. According to the Guinness Book of World Records, Nolan Ryan delivered the fastest recorded baseball pitch in 1974. The pitch was clocked at 100.9 mi/hr. (45.0 m/s). Determine the impulse required to give a 0.145-kg baseball such a momentum.
6. An elastic collision occurs in one dimension, in which a 10 kg block traveling at 5 m/s collides with a 5 kg block traveling at 3 m/s in the same direction. What are the velocities of the two blocks immediately after the collision?
7. A 9300-kg boxcar traveling at 15.0 m/s strikes a second boxcar at rest. The two stick together and move off with a speed of 6.0 m/s. What is the mass of the second car? What type of collision is this?

8. Object A of mass 8.1 kg travels to the east at 2.9 m/s and object B of mass 5.6 kg travels to the south at 1.2 m/s. They collide and stick together in a perfect inelastic collision. What is the magnitude and

direction (with respect to the horizontal) of the velocity of the two objects after the collision?

9. Object A with mass 8.0 kg travels to the east at 10.0 m/s and object B with mass 3.0 kg travels south at 20.0 m/s. The two objects collide and stick together as shown below. What is the magnitude of the velocity they have after the collision? What is the direction of the velocity they have after the collision?
10. A 12-kg hammer strikes a nail at a velocity of 8.5 m/s and comes to rest in a time interval of 8.0 ms. What is the impulse given to the nail and the average force?

Chapter 7: Simple Harmonic Motion

Videos

Intro to springs and Hooke's law | Work and energy | Physics | Khan Academy

Bozeman Science: Simple Harmonic Motion

Harmonic motion part 3 (no calculus) | Oscillatory motion | Physics | Khan Academy

Simple Harmonic Motion 8 - The Simple Pendulum

AP Physics 1: Simple Harmonic Motion Review

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We are Showboat Videos:

Intuition about simple harmonic oscillators

Definition of Amplitude and Period

Equation for simple harmonic oscillators

Period dependence for mass on spring

Pendulum

Calculations Problems

1. A simple pendulum consists of a mass M attached to a vertical string L. When the string is displaced to the right the ball moves up by a distance 0.2 m. When the ball is released from rest what is the maximum speed?
2. How would the frequency of a horizontal mass-spring system change if it was taken to the Moon? What about a vertical mass-spring system? What about a pendulum?

6. A mass-spring oscillating system undergoes SHM with a period T. What is the period of the system if the amplitude is doubled?

7. To double the period of a pendulum what could I do? Give two ways.

8. The period of a pendulum is 12s. The mass of the pendulum is 12kg. If on earth, what is the length of the string?

9. The period of a mass-spring oscillator is 6s. The mass of the mass-spring oscillator is 14kg; the height of the oscillator is 3m. Note that the oscillator is on Jupiter. Find the spring constant.

10. A mass-spring oscillating system undergoes SHM with a period T when it is located on Earth. What is the period of the system when it is located on Moon?

11. A simple pendulum consists of a mass M attached to a vertical string L. The string is displaced to the right by an angle Θ. When the pendulum is released from rest what is the speed of the ball at the lowest point?

12. A student wishes to determine the spring constant of a spring in a mass-spring oscillating system. Which of the following pieces of equipment

will provide the measured quantities needed for this calculation? Select two answers.

A) Meter stick

B) Balance

C) Stopwatch

D) Accelerometer

Conceptual Problems

1. Which of the following represent a simple harmonic oscillator: (*a)* F = -.5x^2, (b) -2.3y, (c) F= -4θ. Justify your answer.

2. While treading water, you notice a buoy way out towards the horizon. The buoy is bobbing up and down in simple harmonic motion. You only see the buoy at the most upward part of its cycle. You see the buoy appear 10 times over the course of one minute. What is the force that is leading to simple harmonic motion?

3. How could you double the maximum speed of a simple harmonic oscillator?

4. A tire swing hanging from a tree branch reaches nearly to the ground. How could you estimate the height of the branch using only a stopwatch?

5. At x=0 what forms of energy does the simple-harmonic oscillator have?

6. Why can't one use the kinematics equations for simple-harmonic oscillators?

7. Why doesn't the period of a pendulum depend on the mass of the pendulum weight? Shouldn't a heavier weight feel a stronger force of gravity?

8. Is the acceleration of a simple harmonic oscillator ever zero? If so, where?

9. If a pendulum clock is accurate at sea level, will it gain or lose time when taken to high altitude? Why?

10. What is the force that causes a mass-spring system to "bob" back and forth?

Chapter 8: Rotational Motion

Videos

Introduction to Rotational Motion

Angular motion variables

Torque

Rotational Inertia

Center of Mass

AP Physics 1 - Rotational Kinematics

AP Physics 1: Rotational Kinematics Review

AP Physics 1 - Rotational Dynamics

AP Physics 1: Rotational Dynamics Review

Rotational Dynamics Sample Problems

Angular Momentum

Conservation of Angular Momentum

We are Showboat: AP Physics 1 Review of Torque and Angular momentum

Conceptual Problems

1. Can a small force ever exert a greater torque than a larger force? Explain.
2. Why do skaters pull in their arms in order for them to rotate faster?
3. If a wheel and ice block of equal mass are rolling down an incline, if one of them reaches the bottom first, which one will it be? Explain.
4. On a rotating carousel or merry-go-round, one child sits on a horse near the outer edge and another child sits on a lion halfway out from the center. (*a*) Which child has the greater linear velocity? (*b*) Which child has the greater angular velocity?
5. Mr. Murad is holding a spinning bicycle wheel while he stands on a stationary frictionless turntable. What will happen if Mr. Murad suddenly flips the bicycle wheel over so that it is spinning in the opposite direction?
6. Mammals that depend on being able to run fast often have very thin lower legs and thick, muscular upper legs. Discuss why this would allow them to run faster.
7. Even though we claim that momentum and angular momentum are conserved how come moving or rotating objects slow down and stop?
8. Two barrels are rolling down the Niagara Falls. The barrels have the same rotational kinetic energy but Barrel A is rotating faster than Barrel B. Explain how this is possible.
9. If global warming worsened and all the ice in the world melted, how would this affect the length of the day?

a) Describe using words the energy conversion for the ball from its release until it reaches the bottom of the incline.

b) Is the mechanical energy of the ball-Earth system conserved during its roll?
c) The ball is replaced by another ball, whose surface and mass are identical to that of the first ball, but which is instead predominantly hollow inside. Describe any differences in its roll down the incline without slipping with specific references to forms of energy.

10. Two solid spheres simultaneously start rolling from rest down an incline. One sphere has twice the radius and twice the mass of the other. Which sphere reaches the bottom of the incline first? Which has the greater speed there? Which has the greater total kinetic energy at the bottom?

Calculation Problems

1. A rod rotates about a pivot at its center at 2 rad/s. Its angular velocity increases uniformly to 14 rad/s in 3 s. Find the rod's angular acceleration over this time period.
2. A rod rotates about a pivot at its center at 2 rad/s. Its angular velocity increases uniformly to 14 rad/s in 3 s. Find the rod's angular displacement over this time period.
3. A force, F is applied to a doorknob and a second force, 2F is applied to the same door at its midpoint. Both forces are perpendicular to the door plane. What is the ratio between the torque of the first force and the torque of the second force?
4. An object starts from rest and accelerates at a constant rate in a circular path. After a certain time t, the object reaches the angular velocity ω. how many revolutions did it make during time t? A. $4\pi\omega$ B. $4\omega/\pi t$ C. $\omega t/4\pi$ D. $4\omega t$
5. A rotating merry-go-round makes one complete revolution in 4s. (a) What is the linear speed of a child seated 1.2m from the center? (b) What is her acceleration (give components)?
6. An object starts from rest and accelerates at a constant rate α in a circular path with a radius R. The radius describes an angle θ after time t. which of the following represents the angular velocity as a function of θ? A. $2\alpha\theta$ B. $2\theta/\alpha$ C. $\sqrt{2\alpha\theta}$ D. $\sqrt{2\theta}/\alpha$
7. A centrifuge accelerates uniformly from rest to 15,000 rpm (revolutions per minute) in 220s. Through how many revolutions did it turn in this time?

8. A person exerts a force of 55 N on the end of a door 74 cm wide. What is the magnitude of the torque if the force exerted (*a*) perpendicular to the door, and (*b*) at a 45-degree angle to the face of the door?
9. Calculate the moment of inertia of a bicycle wheel 66.7cm in diameter. The rim and tire have a combined mass of 1.25 kg. The mass of the hub can be ignored (why?).
10. A 2.3-m-long pole is balanced vertically on its tip. It starts to fall and its lower end does not slip. What will be the speed of the upper end of the pole just before it hits the ground? [Hint: Use conservation of energy.]

Chapter 9: Sound Waves

Introduction to waves | Mechanical waves and sound | Physics | Khan Academy

Sound Waves-Bozeman Science

Speed of Sound

AP Physics Standing Waves Overview With Sample Problems and Open/Closed Tubes (Dan Fullerton)

Speed of sound in different materials

Wave interference | Mechanical waves and sound | Physics | Khan Academy

The Doppler Effect: what does motion do to waves?

Conceptual Questions

1. When a sound wave travels from air into water, do you expect the frequency or wavelength to change?

2. The voice of a person who has inhaled helium sounds high-pitched. Why?

3. A rule of thumb that tells how close lightning has hit is, "one mile for every five seconds before the thunder is heard." Justify, noting that the speed of light is so high (3 x 10^8 m/s, almost a million times faster than sound) that the time for light to travel is negligible compared to the time for sound.

4. If the frequency is doubled does the speed of the wave increase, decrease, or remain the same? Explain why this is so.

5. Explain why sound waves cannot travel through space.

6. Explain why the sirens of ambulances or police cars become louder as they approach you.

7. Explain the differences between a longitudinal and transverse wave.

8. What is the difference between a node and an antinode and where can they be found?

9. Is there a Doppler shift if the source and observer move in the same direction, with the same velocity? Explain.

10. Standing waves can be said to be due to "interference in space," whereas beats can be said to be due to "interference in time." Explain.

Calculation Questions

1. A string is attached to a tuning fork of frequency 256 Hz, and a wave travels along the string with a speed of 200 m/s. Determine the wavelength of the wave in the string.
2. A harmonic wave is traveling along a rope. It is observed that the oscillator that generates the wave completes 40.0 vibrations in 30.0 s. Also, a given maximum travels 425 cm along a rope in 10.0 s . What is the wavelength?
3. The speed of sound waves in air is found to be 340 m/s. Determine the fundamental frequency (1st harmonic) of an open-end air column, which has a length of 67.5 cm.
4. The windpipe of a typical whooping crane is about 1.525-m long. What is the lowest resonant frequency of this pipe assuming it is a pipe closed at one end? Assume a temperature of 37°C
5. A sound wave resonates in an open pipe with a length of 4 m. What is the resonating frequency? (Vsound = 340 m/s)
6. Two loudspeakers generate sound waves with frequencies of 680 Hz. What is the extra distance traveled by the second wave if a stationary observer detects maximum intensity of sound at point P?
7. How long would it take a sound wave to travel completely around the Earth? (The average surface temperature on earth is about 13.5 , which gives a speed of sound of about 340 m/s.)
8. The A key above "Middle C" on the piano produces a sound wave with a frequency of 440 Hz. The speed of sound in air at room temperature is 344 m/s. What is the wavelength of the sound waves associated with middle C?

9. What is the beat frequency if middle C (260 Hz) and C# (277 Hz) are played together? What if each is played two octaves lower (each frequency reduced by a factor of 4)?
10. The wavelength of a sound wave in air is 2.74m at 20 degrees Celsius. What is the wavelength of this sound wave in fresh water at 20 degrees Celsius?
11. Two loudspeakers are 3.00m apart. A person stands 7.00m from one speaker. How far must this person be from the second speaker to detect destructive interference when the speakers emit an 1150-Hz sound? Assume the temperature is 20 degrees Celsius.
12. Waves moving on a lake are observed to have a speed of 2.0 m/s, and to have a distance of .0 m between wave crests.

a) Determine the frequency and period of the waves.

Chapter 10: Waves

Videos

Introduction to Waves | Mechanical Waves and Sound | Physics | Khan Academy

Bozeman Science: Standing Waves

Bozeman Science - Introducing Concept of Waves

Bozeman Science -Transverse and Longitudinal Waves

Bozeman Science -Wave Interference

Standing Waves in Open Tubes

Standing Waves in Closed Tubes

Flipping Physics: Mechanical Waves Reviews

Conceptual Problems

1. Explain the difference between the speed of a transverse wave traveling down a cord and the speed of a tiny piece of the cord.
2. Cellular phones operate by radio waves with frequencies of about 1 or 2 GHz (1 gigahertz = 10^9 Hz). These waves cannot penetrate objects that conduct electricity, such as a tree trunk or a sheet of metal. The connection is best if the transmitting antenna is within clear view of the handset. Yet it is possible to carry on a phone conversation even if the tower is blocked by trees, or if the handset is inside a car. Why?
3. A wave travels on a chord. The wave travels to the right along the chord. Particles of the cord oscillate back and forth on the tabletop. Is the velocity of a wave moving along a cord the same as the velocity of a particle of the cord? Explain.
4. A wave travels along a string. Does the speed of the wave increase or decrease as the string becomes tighter and why?
5. Give two reasons why circular water waves decrease in amplitude as the travel away from the source.
6. Why do the strings used for the lowest-frequency notes on a piano normally have wire wrapped around them?
7. The driver of a Toyota blows her horn as the Toyota approaches you.

(a) Compared to the horn's pitch heard by the driver, will the pitch observed by you be higher, lower, or the same? Explain.

(b) The car passes you, while the driver continues to blow the horn. After the car passes, you notice that the horn doesn't sound as LOUD

as it did when it was near you. If this observation a result of the Doppler effect?

(c) The car recedes from you after passing you, still producing sound waves from the horn. Discuss how the amplitude, period, and frequency of the sound waves that you would measure compare to the amplitude, period, and frequency of the sound waves that the driver would measure.

8. In a pipe closed at one end and filled with air, a 384-Hz tuning fork resonates when the pipe is 22-cm long; this tuning fork does not resonate for any smaller pipe.

(a) State three other lengths at which those with the 384-Hz tuning fork.

(b) The end of the pipe that was closed is now opened, so that the pipe is open at both ends. Describe any changes in the lengths of pipe that will resonate with the 384-Hz tuning fork.

(c) The air in the closed pipe is replaced with helium. Describe an experiment that would use the pipe to determine the speed of sound in helium.

Calculations Problems

1. A string with a length of 3 m oscillates at a frequency 6 Hz. What is the speed of the wave in the string?
2. A student tunes her guitar by striking a 110-Hertz A-note on a tuning fork, and simultaneously playing the 5th string on her guitar. Listening closely, she hears the amplitude of the combined sound oscillating twice per second. What is most likely the current frequency of the 5th string on her guitar?
3. A transverse wave travels in medium X with a speed of 800 m/s and a wavelength of 4 m. The wave then moves into medium Y, traveling with a speed of 1600 m/s. Determine the frequency of the wave in medium Y.
4. If the distance between two successive crests of a traveling wave is equal to 50 cm and its frequency is equal to 500 Hz, then what is its speed?
5. A fisherman notices that wave crests pass the bow if his anchored boat every 10.0s. He measures the distance between two crests to be 6.5m. How fast are the waves traveling?
6. A cord of mass 0.80 kg is stretched between two supports 28m apart. If the tension in the cord is 150N, how long will it take a pulse to travel from one support to the other?
7. If a violin string vibrates at 440 Hz as its fundamental frequency, what are the frequencies of the first four harmonics?
8. The velocity of waves on a string is 92 m/s. If the frequency of standing waves is 475 Hz, how far apart are two adjacent nodes?
9. A sound wave in air has a frequency of 262 Hz and travels with a speed of 434 m/s. How far apart are the wave crests (compressions)?
10. A ski gondola is connected to the top of a hill by a steel cable of length 620m and diameter 1.5 cm. As the gondola comes to the end of its run, it bumps into the terminal and sends a wave pulse along the end of the cable. It is observed that it took 16s for the pulse to return. What is the speed of the pulse?
11. Which type of wave exhibits the Doppler effect? Which of them can be transmitted through space? Choose all that apply. Briefly justify your answer.

(a) Visible light
(b) Radio waves
(c) Gamma waves
(d) Sound waves

Chapter 11: Electrostatics

Videos

Electrostatics (part 1): Introduction to Charge and Coulomb's Law

Review of Electrostatics (lasseviren1)

Flipping Physics: Electrostatics Review

Electric Field, Force, Potential, Potential Energy (AP Physics SuperCram Review)

Dan Fullerton's Playlist:
High School Physics - Electric Charge

High School Physics - The Standard Model

High School Physics - Conduction and Induction

High School Physics - Coulomb's Law

High School Physics - Electric Potential Difference

High School Physics - Parallel Plates and Equipotential Lines

AP Physics – Capacitors Basic

Conceptual Problems

1. A neutral hollow metal box is placed between two parallel charged plates. What is the field like inside the box?

2. What is stronger the gravitational or electric force? Explain in terms of the variables in the equations.

3. (a) What is a test charge?
(b) What is it used for?
(c) Why must the chest charge be small when measuring electric fields?

4. When an electroscope is charged, its two leaves repel each other and remain at an angle. What balances the electric force of repulsion so that the leaves don't separate further?

5. Why can electric field lines never cross?

6. When a charged ruler attracts small pieces of paper, sometimes a piece jumps quickly away after touching the ruler. Explain.

7. Is the electric force a conservative force? Why or why not?

8. In the nucleus of an atom, there exists the strong nuclear force. The strong nuclear force keeps the nucleus together and is the strongest force but only acts at a small distance. The ratio of protons and neutrons is 1:1 for smaller atoms but for atoms with more protons the ratio becomes 1.5:1. Explain why this is so.

9. Positively charged sphere B is placed between two neutral spheres A and C. We cut connection of A and C with ground. If we put A closer to the first electroscope and touch C to the sphere of second electroscope, find the type of charge electroscopes have.

10. Draw the electric field lines surrounding to negative electric charges a distance *l* apart.

11. If you charge a pocket comb by rubbing it with a silk scarf, how can you determine if the comb is positively or negatively charged?

Calculation Problems

1. If we touch two spheres to each other, one having a charge of positive 20, and the other having a charge of negative 5, find the final charges of the spheres.
2. A point charge (q1) has a magnitude of 3C. A second charge (q2) has a magnitude of 1.5C and is located 0.12 from the first charge. Determine the electrostatic force each charge exerts on the other.
3. Two positive charges +Q and +2Q are separated by a distance a.

(a) Which is greater, the force of the +Q on the +2Q charge, or the force of the +2Q charge on the +Q charge.

(b) In terms of given variables and fundamental constants, determine the magnitude and direction of the force of the +2Q charge on the +Q charge.

(c) By what factor would the force calculated in (b) change if the distance between the charges were increased to 3*a*?

(d) Now the +Q charge is replaced by a negative charge of the same magnitude and the distance between the charges is returned to *a*. Describe how the magnitude and direction of the force exerted by each charge on the other will change from the original situation.

4. A 3.0-g copper penny has a positive charge of 38μC. What fraction of its electrons has it lost?
5. A proton (m = 1.67) is suspended at rest in a uniform electric field E. Take into account gravity at the Earth's surface, and determine E.
6. A water droplet of radius 0.018 mm remains stationary in the air. If the downward-directed electric field of the Earth is 150 N/C, how many excess electron charges must the water droplet have?
7. Suppose that electrical attraction, rather than gravity, were responsible for holding the Moon in orbit around the Earth. If equal and opposite charges Q were placed on the Earth and the Moon, what would be the value of Q to maintain the present orbit? Use these data: Mass of Earth = 5.98kg, Mass of Moon = 7.35, Radius (Distance) of Orbit = 3.84. Treat the Earth and Moon as point particles.

Chapter 12: Circuits

Introduction to circuits and Ohm's law | Circuits | Physics | Khan Academy

Bozeman Science: Voltage, Current and Resistance

Bozeman Science: Series and Parallel Circuits

Bozeman Science: Electric Circuits

Circuits (AP Physics SuperCram Review)

AP Physics 1: Electricity Review

Conceptual Problems

1. Justify the following answers in short paragraphs.

(a) Should an ammeter be connected in series or parallel with the resistor it measures?

(b) Should a voltmeter be connected in series or parallel with the resistor it measures?

(c) Does an ideal ammeter have large or small resistance?

(d) Does an ideal voltmeter have large or small resistance?

2. Two light bulbs of resistance R1 and R2 (R2 > R1) are connected in series. Which is brighter? What if they are connected in parallel? Explain.

3. State Kirchhoff's loop rule and Kirchhoff's Junction rule.

4. With two identical light bulbs and two identical batteries, how would you arrange the bulbs and batteries in a circuit to get the maximum total power out?

5. Household outlets are often double outlets. Are these connected in series or parallel? How do you know?

6. There are two different circuits with 2 identical light bulbs in each circuit. The first circuit is in series while the second one is in parallel. Which circuit produces more light? Also, which way do you think the headlights of a car are wired, in series or parallel? Explain.

7. Discuss the advantages and disadvantages of Christmas tree lights connected in parallel versus those that are connected in series.

8. If all you have is a 120-V line, would it be possible to light several 6-V lamps without burning them out? How?

9. Why is it more dangerous to turn on an electric appliance when you are standing outside in bare feet than when you are inside wearing shoes with thick soles?

10. Explain why birds can sit on power lines safely, whereas leaning a metal ladder up against a power line is extremely dangerous.

<u>Calculation Problems</u>

1. What is the diameter of a 1.00-m length of tungsten wire whose resistance is 0.445Ω?
2. The length and radius of an aluminum wire is quadrupled. By which factor does the resistance change?
3. What is the resistance of a 7.5-m length of copper wire 1.5mm in diameter?
4. In the circuit two identical resistors R are connected in series with 8-Ω resistor and 12- V battery. What is the value of R if the current in the circuit I = 1 A?
5. A certain coffeepot draws 2.0 A of current when it is operated on 110 V household lines. If electrical energy costs 10 cents per kilowatt-hour, how much does it cost to operate the coffeepot for 5 hours?
6. A 1200-Watt hair dryer is plugged into a 120-volt circuit. What is the current drawn by the hair dryer?
7. A 95-Watt TV is plugged into a 115-volt circuit. The TV operates for 120 minutes. If the cost of energy is 8¢ per kW-hr, how much does it cost to run the TV for 120 minutes?
8. At $0.095 per kWh of energy, what does it cost to leave a 25-W porch light on day and night for a whole year?
9. Determine the resistance of, and the current through, a 45-W light bulb connected to its proper source voltage of 120 V. Then, find out the same variables for a 440-W bulb.
10. A kitchen in North America has three appliances connected to a 120 V circuit with a 15 Amp circuit breaker: an 850 W coffee maker, a 1200 W microwave oven, and a 900 W toaster. Which of these appliances can be operated simultaneously without tripping the circuit breaker?
11. Calculate the terminal voltage for a battery with an internal resistance of 0.750Ω and an EMF of 6.0V when the battery is connected in series with and 81.0Ω resistor, then an 810Ω resistor.
12. What is the internal resistance of a 12.0 V car battery whose terminal voltage drops to 8.4 V when the starter draws 75 A? What is the resistance of the starter?