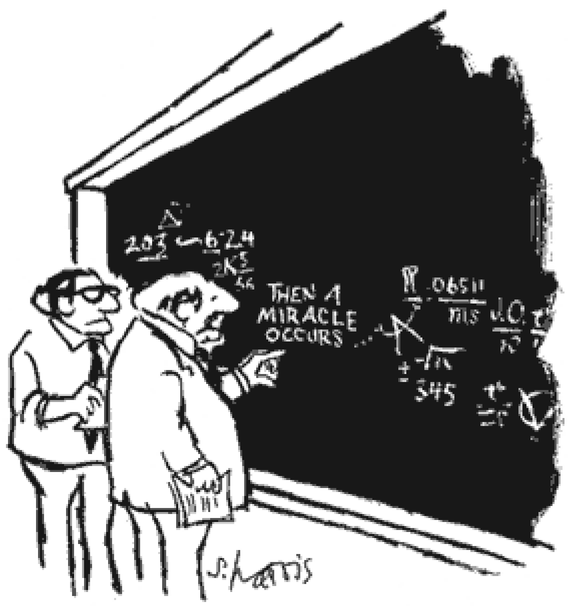
James M. Hill

Physics 122 Problem Set

2012 – 2013



"I THINK YOU SHOULD BE MORE EXPLICIT HERE IN STEP TWO."

Mr. P. MacDonald

1. A towrope is used to pull a 1750 kg car across a flat surface, giving it an acceleration of 1.35 m/s^2. What force does the rope exert? (F = 2360 N)

2. A racing car undergoes a uniform acceleration of 4.00 m/s^2. If the net force causing the acceleration is 3000 N, what is the mass of the car? (m = 750 kg)

3. A 5.2 kg bowling ball is accelerated from rest to a velocity of 12 m/s as the bowler covers 5.0 m of approach before releasing the ball. What force is exerted on the ball during this time? (F = 75 N)

4. A high jumper falling at a 4.0 m/s lands on foam pit and comes to rest compressing the pit 0.40 m. If the pit is able to exert an average force of 1200 N on the high jumper breaking the fall, what is the jumper's mass? (m = 60 kg)

5. When a 20 kg child steps off a 3.0 kg (initially) stationary skateboard with an acceleration of 0.50 m/s^2, with what acceleration will the skateboard travel in the opposite direction? – hint: apply Newton's third law (a = 3.3 m/s^2)

6. On Planet X, a 50 kg barbell can be lifted by only exerting a force of 180 N.
   a. What is the acceleration of gravity on Planet X? (a = 3.6 m/s^2)
   b. What minimum force is needed to lift this barbell on Earth? (F = 490 N)

7. An applied force of 20 N is needed to accelerate a 9.0 kg wagon at 2.0 m/s2 along a sidewalk.
   a. How large is the frictional force? (F_f = 2.0 N)
   b. What is the coefficient of friction? (μ = 0.023)

8. A 2.0 kg brick has a sliding coefficient of friction of 0.38. What force must be applied to the brick for it to move at a constant velocity? (F_a = 7.5 N)

9. In bench pressing 100 kg, a weight lifter applies a force of 1040 N. How large is the upward acceleration of the weights during the lift? (a = 0.59 m/s^2)

10. An elevator that weighs 3 000 N is accelerated upward at 1.5 m/s^2. What force does the cable apply to give this acceleration? (F_a = 3460 N)

11. An 873 kg dragster, starting from rest, attains a speed of 26.3 m/s in 0.59 s.
    a. Find the average acceleration of the dragster during this time interval. (a = 44.6 m/s^2)
    b. What is the size of the average force on the dragster during this time interval? (F = 38 900 N)
    c. If the driver has a mass of 68 kg, what force does the seatbelt exert on the driver? (F = 3030 N)

12. The downward acceleration of a karate chop is –6500 m/s^2. If the mass of the forearm is 0.70 kg, what is the force exerted by the arm? (F = –4550 N)

13. A car with a mass of 1550 kg is driving on track initially going 10 m/s. The driver accelerates to 30 m/s in 10 s. What is the average force acting on the car during that time? (F = 3100 N)

14. A car has a mass of 710 Kg. It starts from rest and travels 40 m in 3.0 s. What is the average force acting on the car assuming a uniform acceleration? (F = 6300 N)

15. A force of –9000 N is used to stop a 1500 kg car traveling 20 m/s. What breaking distance is needed to bring the car to a halt? (d = 33 m)

16. A 65 kg diver jumps of a 10 m high platform.
    d. Find the swimmer's velocity the instant he reaches the water. (v = –14 m)
    e. The swimmer comes to a stop 2.0 m below the surface of the water. Calculate the net stopping force exerted by the water. (F = 3200 N)

17. A 5.0 kg remote controlled car is used in an experiment to determine the coefficient of friction between the car's tires and the floor. The car is driven at a uniform velocity and then the tires are locked. The car comes to rest in 3.2 m in a time of 1.7 s. Assuming the only force stopping the car is friction; calculate the coefficient of friction between the tires and the floor. (μ = 0.23)

Physics 122: Applications of Vectors

1. If **A** = 28 m [E75^{o}N], **B** = 35 m [E24^{o}S], **C** = 22 m [W50^{o}N], and **D** = 40 m [W30^{o}S] Find:
    a. A + B {57 m [E46^{o}N]}
    b. 4C + 3D {160 m [W2.6^{o}N]}
    c. A – B {27.8 m [W27^{o}N]}
    d. 2D – C {79.2 m [W46^{o}S]}

2. What is the resultant displacement of 25 m [N], 18 m [S], and 12 m [E]? What is the average velocity if the trip took 37 seconds? {d = 13.9 m [E30^{o}N]; v = 0.376 m/s [E30^{o}N]}

3. Find the acceleration of an object that goes from 15.0 m/s [S] to 15 m/s [W] in 2.0 seconds. {a = 10.6 m/s^2 [W45^{o}N]}

4. A car is initially moving 7.5 m/s [N]. After 3.0 seconds it is moving 10.0 m/s [E40^{o}N]. Calculate:
    a. The acceleration. {a = 2.57 m/s^2 [E8.1^{o}S]}
    b. The velocity after 6.0 s if the acceleration remains constant. {v_f = 16.2 m/s [E19^{o}N]}

5. What is the acceleration of a car that changes its velocity from 20.0 m/s [N] to 20.0 m/s [E45^{o}N] in a time of 5.00 s? {a = 3.06 m/s^2 [E23^{o}S]}

6. A 500 kg airplane in initially flying 200 m/s [E45^{o}N] turns such that after 7.00 s the velocity is 140 m/s [E]. Find:
    a. The acceleration. {a = 20.2 m/s^2 [W89^{o}S]}
    b. The average force acting during the turn. {F = 10100 N [W89^{o}S]}

7. What is the force required to change to change the velocity of a 1200 kg car from 26.0 m/s [E] to 30.0 m/s [E30^{o}S] in a time of 5.00 seconds? {F = 3600 N [S]}

8. Three forces act simultaneously on an object. One force is 10.0 N [N], the second is 15 N [W], and the third is 15.0 N [E60^{o}N]. Determine the net force? {F = 24.2 N [W72^{o}N]}

9. On a boat you are sailing 6.5 m/s [E20^{o}S]. A gust of wind provides an acceleration equal to 2.1 m/s^2 [E60^{o}N] for 18 seconds.
    a. What is your velocity after the 18 seconds? {v = 39.4 m/s [E51^{o}N]}
    b. What is the displacement in during that time? {d = 378 m [E42^{o}N]}

10. A glider is flying 9.2 m/s [E25^{o}N]. A gust of wind changes the glider's trajectory to 11 m/s [E14^{o}S] in 7.9 seconds.
    a. What was the acceleration of the glider? {a = 0.88 m/s^2 [E70^{o}S]}
    b. What was the displacement of the glider during that time? {d = 75 m [E3.7^{o}N]}
    c. What was the average force if the glider has a mass of 55 kg? {F = 48 N [E70^{o}S]]}

11. You are 37 km [W20^{o}N] from Miramichi and must move to a position 15 km due West of the city. What displacement is required?{d = 23 km [E31^{o}S]}

Physics 122: Applications of Vectors

12. A coast guard boat (with a helicopter) is 75 km [E67°N] from port. A distress call comes in from a fishing vessel located 93km [E26°S] from port.
    a. How far is the fishing boat from the coast guard boat? {d = 122 km [E64°S]}
    b. What is the minimum velocity of the helicopter to reach the boat in distress within 0.5 hours? {v = 244 km/s [E64°S]}

13. When flying your awesome new plane you receive two distress calls from people stranded on two different islands. Island A is 150 km [E] of the airport and Island B is 175 km [E25°S]. You are located 65 km [W10°S]. You choose to rescue the closest group of people. Which island are you going to and what is your heading? {A, [E3°N]}

14. On a day when the wind is 80.0 km/h [E], an airplane is aimed [E65°N] and flown at a speed of 320 km/h. How far and in which direction will the plane fly in 0.33 hours? {d = 119 km [E53°N]}

15. A boat's heading is directly across a river at 5.0 km/h. The river is flowing east at 3.0 km/h.
    a. What is the velocity of the boat relative to someone standing on the dock where the boat departed? {v = 5.8 km/h [E53°N]}
    b. How far down stream does it land if the trip takes 0.5 h? {d_E = 1.5 km}
    c. How wide is the river? {d_N = 2.5 km}

16. On a day when the wind is blowing 70 km/h [W40°S] you wish to fly to a destination 830 km [E60°S] in 1.5 hours. What heading and speed should you fly your plane? {v = 545 km/h [E53°S]}

17. A river has a current of 6.0 m/s [E]. What speed must a boat be able to travel to go straight across the river when it is aimed 75° upstream? {v = 23.2 m/s}

18. It is a distance of 500 m straight east to get across a river. The river has a current of 3.7 m/s due south. You have a boat that can travel 10 m/s.
    a. Which way should you aim your boat to get directly across the river? {E22°N}
    b. How long will it take to cross the river? {54 s}

19. A boat can travel 7.5 m/s. Which way must it be aimed to travel directly across a river with a current of 3.6 m/s? {29° upstream}

20. A Canadian submarine is 185 km [E22°S] of Halifax. An enemy sub is spotted 425 km [E67°N] of Halifax. The enemy is heading directly towards Halifax at 45 km/h. What minimum velocity is required for the Canadian submarine to intercept the enemy sub 200 km from Halifax? {v_{sub} = 54 km/h [W70°N]}

21. An object is moving 35 m/s [E40°N] and undergoes an acceleration of 3.7 m/s^2 [W10°N]. How much time is required for the displacement to be 609 m [W72°N]? {t = 20 s]

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Force Problems - Type I

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17. A student pushes a 25 kg lawn mower with a force of 150 N. The handle makes an angle of 35° to the horizontal.

(a) Find the vertical and horizontal components of the applied force.

(b) Calculate the normal force supporting the lawn mower while it is being pushed.

(c) Calculate the net force propelling the mower if a frictional force of 85 N exists.

(d) Calculate the horizontal acceleration of the lawn mower. (Remember: Only part of the $F_{applied}$ is parallel to the direction of horizontal acceleration.)

a) 86 N, down
1.2 x 10^2 N, right
b) 3.3 x 10^2 N, up
c) 38 N, right
d) 1.5 m/s^2, right

MHR - Chapter 5 - Page 208

24. A toboggan with a mass of 15 kg is being pulled with an applied force of 45 N at an angle of 40° to the horizontal. What is the acceleration if the force of friction opposing the motion is 28 N?

0.43 m/s^2, right

25. A grocery cart is being pushed with a force of 450 N at an angle of 30.0° to the horizontal. If the mass of the cart and the groceries is 42 kg,

(a) Calculate the force of friction if the coefficient of friction is 0.60.

(b) Determine the acceleration of the cart.

a) 3.8 x 10^2 N, left
b) 0.23 m/s^2, right

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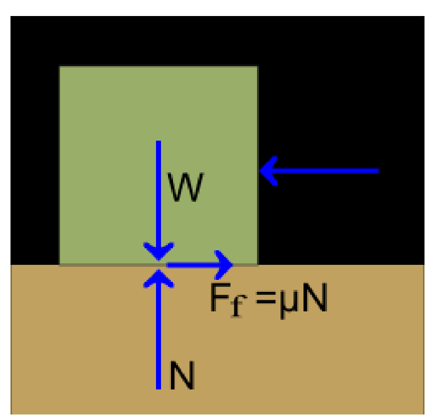
36. A 45.0 kg box is pulled with a force of 205 N by a rope held at an angle of 46.5° to the horizontal. The velocity of the box increases from 1.00 m/s to 1.50 m/s in 2.50 s. Calculate

(a) the net force acting horizontally on the box.

(b) the frictional force acting on the box.

(c) the horizontal component of the applied force.

(d) the coefficient of kinetic friction between the box and the floor.



a) 9.0 N, right
b) 132 N, left
c) 141 N, right
d) 0.451

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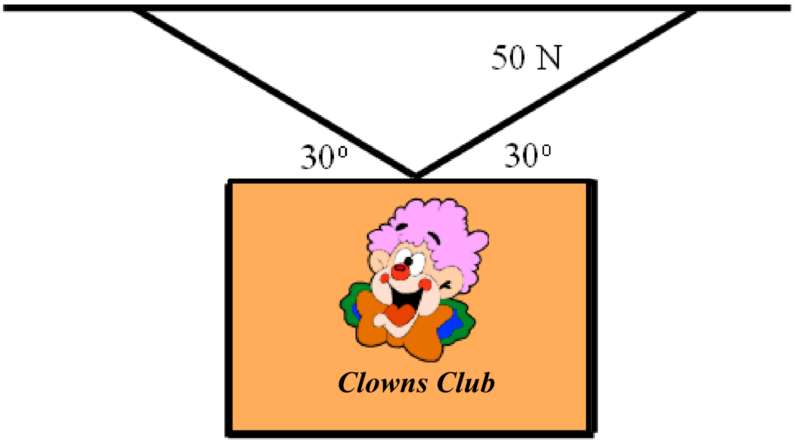
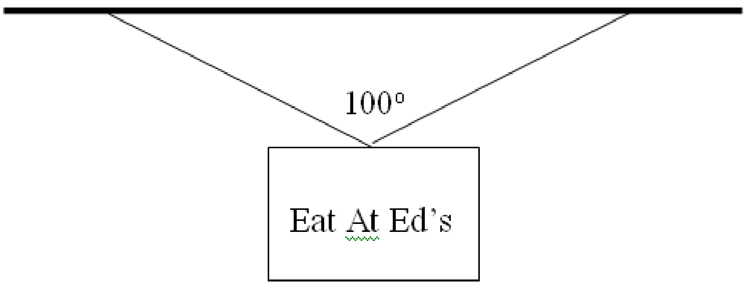
<u>Handout - Static Equlibrium -Hanging Signs</u>

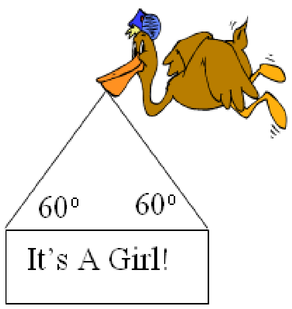
1. Find the magnitude of the weight of the clown's picture. (50 N)



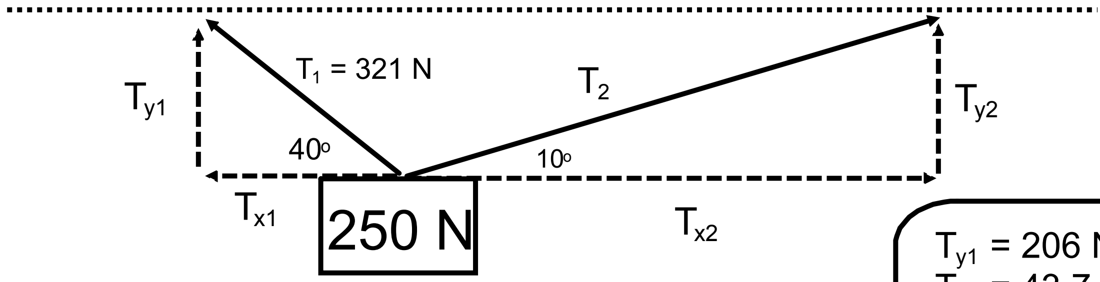
2. If the sign has a mass of 5.00 kg, what is the tension in the cables? (38 N)



3. The infamous stork announces good news. If the sign has a mass of 10 kg, then what is the force of tension in each cable? (57 N)



Determine T_{y1}, T_{y2}, T_2 , T_{x1}, and T_{x2} in the following sketch.



T_{y1} = 206 N
T_{y2} = 43.7 N
T_2 = 251 N
T_{x1} = 247 N (left)
T_{x2} = 247 N (right)

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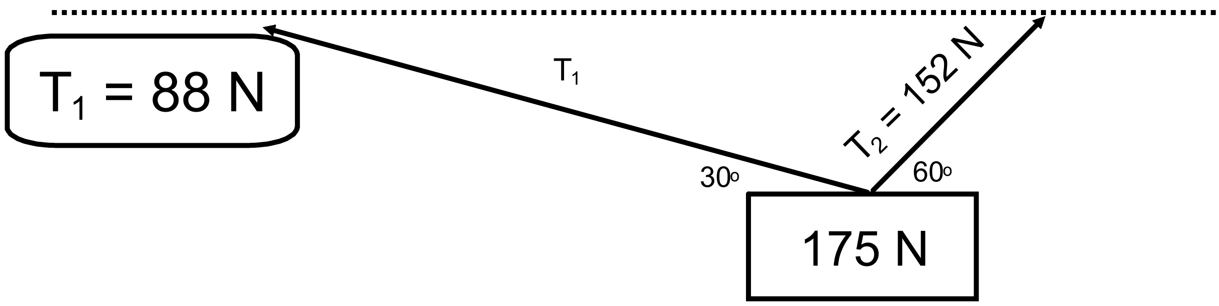
Determine T_1 in the following sketch.



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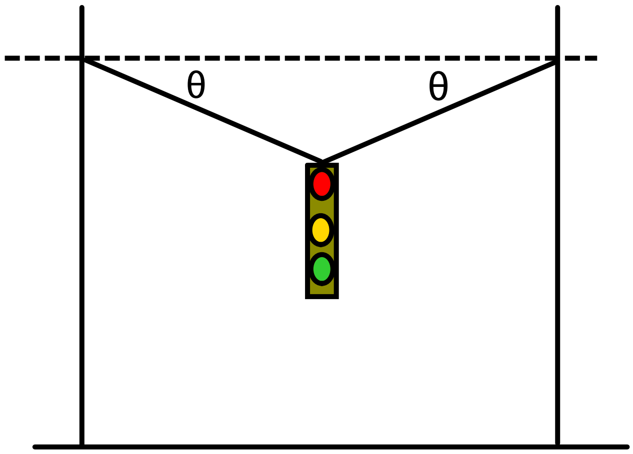
A traffic light is to be hung like in the diagram to the right (both angles are the same). The cable being used will break if their tension reaches 2100 N. What is the smallest angle that can be made if the lights have a mass of 110 kg? (Answer: 15°)



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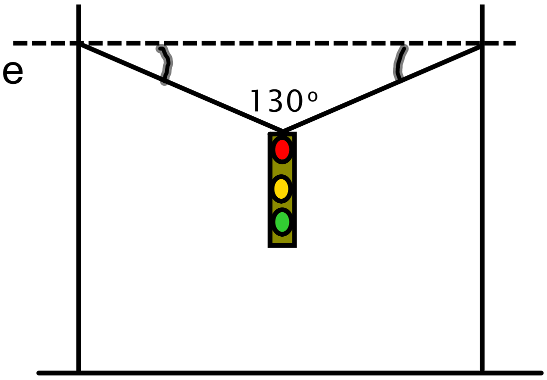
A traffic light is to be hung like in the diagram to the right. The cable being used will break if its tension reaches 1750 N. What is the largest mass that can be hung? (Answer: 151 kg)



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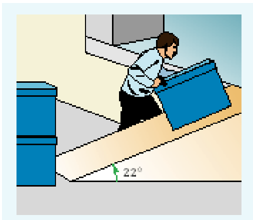
Sample Problems - **Inclined Planes** Handout

1. **A trunk weighing 562 N is resting on a plane inclined at** 30.0° from the horizontal. Find the components of the trunk's weight parallel and perpendicular to the plane.

2. A 562 N trunk is placed on a frictionless plane inclined at 30.0° from the horizontal. Find the magnitude and direction of the trunk's acceleration.

3. A worker places a large plastic waste container with a mass of 84 kg on the ramp of a loading dock. The ramp makes an angle of 22° with the horizontal. The worker turns to pick up another container before pushing the first one up the ramp. If the coefficient of static friction is 0.47, will the crate slide down the ramp?



4. A 1975 kg car is rolling down a hill inclined at an angle of 15° What is the acceleration of the car? Neglect friction.

5. A skier coasts down a 3.5° slope at a constant speed. Find the coefficient of kinetic friction between the skis and the snow covering the slope.

6. You slide a 325 N trunk up a 20.0° inclined plane with a constant velocity by exerting a force of 211 N parallel to the inclined plane.

   a) What is the sum of your applied force, friction and the parallel component of the trunk's weight? Justify your answer.

   b) What is the magnitude and direction of the force of friction?

   c) What is the coefficient of friction?

Inclined Plane - Solutions

1. $F_{gx} = 281\ N$, $F_{gy} = 487\ N$

2. $a_{gx} = 4.905\ m/s^2$ down the ramp

3. No, $F_f > F_g$ $F_f = 359\ N$; $F_{gx} = 309\ N$

4. $a_x = 2.53\ m/s^2$

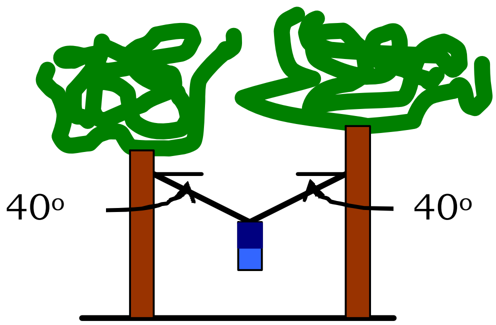
5. $\mu = 0.061$

6. a) $F_{netx} = 0\ N$
   b) $|F_f| = 100\ N$ down the ramp
   c) $\mu = 0.32$

<u>Physics 122/121</u>

Handout: Problems I, II and III

1. On a camping trip you stretch a rope between two trees and hang your backpack from the middle of it to keep it safe from bears. The mass of your backpack is 36.0 kg and each half of the rope makes an angle of 40.0^o with the horizontal.
   a) Find the amount of weight supported by each half of the rope.
   b) Find the magnitude of the tension in each rope.



2. A 2.5 kg brick is pulled at a constant speed across a table by a cord that makes an angle of 20^o with the horizontal. There is 7.0 N of force in the cord.
   a) Calculate the force of friction between the brick and the table.
   b) Calculate the magnitude of the normal force.

3. Joey moves a 26 kg wagon at a constant speed by pushing on the handle that makes an angle, theta, with the horizontal. Joey exerts a force of 54 N on the handle and the force of friction on the wagon is 34 N.
   a) Calculate the angle the handle of the wagon makes with the horizontal.
   b) What is the magnitude of the normal force acting on the wagon?

4. A 10 N block is held motionless on a frictionless inclined plane which makes an angle of 30^o with the horizontal. What force would be needed to hold the block in position?

5. An object weighing 600 N is pulled up a frictionless incline at a constant speed using a rope. If the incline makes an angle of 42.0^o with the horizontal, what is the magnitude of the force that is applied to the rope?

6. A 10 kg object, starting from rest, slides down a frictionless incline with a constant acceleration of 2.0 m/s^2. What angle does the incline make with the horizontal?

7. An object with a mass of 7.2 kg is allowed to slide from rest down an inclined plane. The plane makes an angle of 30^o with the horizontal and is 65 m long. The coefficient of friction between the plane and the object is 0.45. What is the velocity of the object at the bottom of the plane?

8. A piano is accelerating down a ramp that is inclined at an angle of 38.5^o above the horizontal. The acceleration is 4.62 m/s^2. What is the coefficient of friction between the piano and the ramp?

Answers

1. a)Each half of the rope supports half of the weight of the backpack, 176 N.
   b)The tension in each rope is 274 N.

2. a)The force of friction is 6.6 N, in a direction opposite to the motion of the brick.
   b)The magnitude of the normal force is 22 N.

3. a)The handle makes an angle of 51^{o} with the horizontal.
   b)The normal force is 3.0×10^{2} N.

4. A 5.0 N force exerted up the incline would be needed.

5. It is 401 N.

6. The incline makes an angle of 12^{o}.

7. The velocity of the object is –12 m/s.

8. The coefficient of friction is 0.193.

PRACTICE PROBLEM MHR Pg 197

29. Determine the momentum of the following objects.
    (a) 0.250 kg baseball travelling at 46.1 m/s[E]
    (b) 7.5×10^6 kg train travelling west at 125 km/h
    (c) 4.00×10^5 kg jet travelling south at 755 km/h
    (d) electron (9.11×10^{-31} kg) travelling north at 6.45×10^6 m/s

PRACTICE PROBLEMS MHR Pg 200

30. A sledgehammer strikes a spike with an average force of 2125 N[down] over a time interval of 0.0205 s. Calculate the impulse of the interaction.

31. In a crash test, a car strikes a wall with an average force of 1.23×10^7 N[S] over an interval of 21.0 ms. Calculate the impulse.

32. In a crash test similar to the one described in problem 31, another car, with the same mass and velocity as the first car, experiences an impulse identical to the value you calculated in problem 31. However, the second car was designed to crumple more slowly than the first. As a result, the duration of the interaction was 57.1 ms. Determine the average force exerted on the second car.

PRACTICE PROBLEMS MHR Pg 203

33. The velocity of the serve of some professional tennis players has been clocked at 43 m/s horizontally. (Hint: Assume that any vertical motion of the ball is negligible and consider only the horizontal direction of the ball after it was struck by the racquet.) If the mass of the ball was 0.060 kg, what was the impulse of the racquet on the ball?

34. A 0.35 kg baseball is travelling at 46 m/s toward the batter. After the batter hits the ball, it is travelling 62 m/s in the opposite direction. Calculate the impulse of the bat on the ball.

35. A student dropped a 1.5 kg book from a height of 1.75 m. Determine the impulse that the floor exerted on the book when the book hit the floor.

PRACTICE PROBLEMS MHR Pg 208

37. Determine the momentum of a 5.0 kg bowling ball rolling with a velocity of 3.5 m/s[N] toward a set of bowling pins.

38. What is the mass of a car that is travelling with a velocity of 28 m/s[W] and a momentum of 4.2×10^4 kg·m/s[W]?

39. The momentum of a 55.0 kg in-line skater is 66.0 kg m/s[S]. What is his velocity?

40. How fast would a 5.0×10^{-3} kg golf ball have to travel to have the same momentum as a 5.0 kg bowling ball that is rolling at 6.0 m/s[forward]?

41. Calculate the impulse for the following interactions.
    (a) A person knocks at the door with an average force of 9.1 N[E] over a time interval of 2.5×10^{-3} s.
    (b) A wooden mallet strikes a large iron gong with an average force of 4.2 N[S] over a time interval of 8.6×10^{-3} s.

42. A volleyball player spikes the ball with an impulse of 8.8 kg·m/s over a duration of 2.3×10^{-3} s. What was the average applied force?

43. If a tennis racquet exerts an average force of 55 N and an impulse of 2.0 N·s on a tennis ball, what is the duration of the contact?

44. (a) What is the impulse of a 0.300 kg hockey puck slapshot that strikes the goal post at a velocity of 44 m/s[N] and rebounds straight back with a velocity of 9.2 m/s[S]?
    (b) If the average force of the interaction was -2.5×10^3 N, what was the duration of the interaction?

45. A 2.5 kg curling stone is moving down the ice at 3.5 m/s[W]. What force would be needed to stop the stone in a time of 3.5×10^{-4} s?

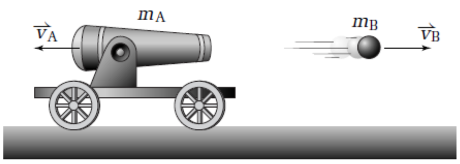
PRACTICE PROBLEMS MHR Pg 315

25. Claude and Heather are practising pairs skating for a competition. Heather (47 kg) is skating with a velocity of 2.2 m/s. Claude (72 kg) is directly behind her, skating with a velocity of 3.1 m/s. When he reaches her, he holds her waist and they skate together. At the instant after he takes hold of her waist, what is their velocity?

26. Two amusement park "wrecker cars" are heading directly toward each other. The combined mass of car A plus driver is 375 kg and it is moving with a velocity of +1.8 m/s. The combined mass of car B plus driver is 422 kg and it is moving with a velocity of −1.4 m/s. When they collide, they attach and continue moving along the same straight line. What is their velocity immediately after they collide?

PRACTICE PROBLEMS MHR Pg 317

27. A 1385 kg cannon containing a 58.5 kg cannon ball is on wheels. The cannon fires the cannon ball, giving it a velocity of 49.8 m/s north. What is the initial velocity of the cannon the instant after it fires the cannon ball?



28. While you are wearing in-line skates, you are standing still and holding a 1.7 kg rock. Assume that your mass is 57 kg. If you throw the rock directly west with a velocity of 3.8 m/s, what will be your recoil velocity?

29. The mass of a uranium-238 atom is 3.95×10^{-25} kg. A stationary uranium atom emits an alpha particle with a mass of 6.64×10^{-27} kg. If the alpha particle has a velocity of 1.42×10^{4} m/s, what is the recoil velocity of the uranium atom?

PRACTICE PROBLEMS MHR Pg 329

27. A 48.0 kg skateboarder kicks his 7.0 kg board ahead with a velocity of 2.6 m/s[E]. If he runs with a velocity of 3.2 m/s[E] and jumps onto the skateboard, what is the velocity of the skateboard and skateboarder immediately after he jumps on the board?

28. Astrid, who has a mass of 37.0 kg, steps off a stationary 8.0 kg toboggan onto the snow. If her forward velocity is 0.50 m/s, what is the recoil velocity of the toboggan? (Assume that the snow is level and the friction is negligible.)

29. A 60.0 t submarine, initially travelling forward at 1.5 m/s, fires a 5.0×10^{2} kg torpedo straight ahead with a velocity of 21 m/s in relation to the submarine. What is the velocity of the submarine immediately after it fires the torpedo?

30. Suppose that a 75.0 kg goalkeeper catches a 0.40 kg ball that is moving at 32 m/s. With what forward velocity must the goalkeeper jump when she catches the ball so that the goalkeeper and the ball have a horizontal velocity of zero?

31. You and a colleague are on a spacewalk, repairing your spacecraft that has stalled in deep space. Your 60.0 kg colleague, initially at rest, asks you to throw her a hammer, which has a mass of 3.0 kg. You throw it to her with a velocity of 4.5 m/s[forward].
    (a) What is her velocity after catching the hammer?
    (b) What impulse does the hammer exert on her?

PRACTICE PROBLEMS MHR Pg 509

Use both the scale diagram method and the method of components to solve each problem.

35. A 0.150 kg billiard ball (A) is rolling toward a stationary billiard ball (B) at 10.0 m/s. After the collision, ball A rolls off at 7.7 m/s at an angle of 40.0° clockwise from its original direction. What is the speed and direction of ball B after the collision?

36. A bowling ball with a mass of 6.00 kg rolls with a velocity of 1.20 m/s toward a single standing bowling pin that has a mass of 0.220 kg. When the ball strikes the bowling pin, the pin flies off at an angle of 70.0° counterclockwise from the original direction of the ball, with a velocity of 3.60 m/s. What was the velocity of the bowling ball after it hit the pin?

37. Car A (1750 kg) is travelling due south and car B (1450 kg) is travelling due east. They reach the same intersection at the same time and collide. The cars lock together and move off at 35.8 km/h[E31.6°S]. What was the velocity of each car before they collided?

PRACTICE PROBLEMS MHR Pg 513

38. You accidentally dropped a 3.5 kg glass platter. Before it hit the floor, the motion was entirely in the vertical direction. When it hit the floor, it broke into three pieces and they all moved out in the plane of the floor. Imagine a coordinate system on the floor. Piece 1 had a mass of 1.3 kg and it moved off with a velocity of 1.8 m/s at an angle of 52° counterclockwise from the positive x axis. Piece 2 with a mass of 1.2 kg moved off with a velocity of 2.5 m/s at an angle of 61° clockwise from the negative x axis. Find the mass and the velocity of piece 3.

Physics 122: Projectile Problems

1. Fizzicks jumps off a diving board with a horizontal velocity of +3.1 m/s and lands in the water 1.8 s later. How high was the diving board and how far from the edge of the board did he land? (16 m, 5.6 m)

2. A ball bearing traveling with constant speed rolls off a lab bench that is 0.928 m high. If it hits the ground 0.422 m from the edge of the bench, how fast was the ball bearing rolling across the table initially? (0.970 m/s)

3. Johnny shoots a stone horizontally with a velocity of +25 m/s from his slingshot while standing on the roof of a building on his father's farm. When he dropped an identical stone from the same spot, it took 1.85 s to hit the ground. What was the height of the building? (16.8 m)

4. A stone is thrown horizontally from a cliff 15.0 m high.
   a) The initial velocity is +24.0 m/s. How far from the base of the cliff does the stone strike the ground? (42.0 m)
   b) What is the final vertical velocity of the stone just before the stone hits the ground? (-17.1 m/s)
   c) Calculate the velocity of the stone just before the stone hits the ground? (29.5 m/s, 35.5° S of E)

5. A cannonball is fired from a cannon. If the initial horizontal and vertical components of the velocity are +32 m/s and +27 m/s respectively, at what angle was the cannon ball launched and at what speed was it fired? (40° to the horizontal, 42 m/s) How long will the cannonball be in the air? (5.5 s)

6. A projectile fired at an angle remains in the air for 8.42 s after it is fired. The initial horizontal component of its velocity is +150 m/s.
   a) How far forward did the projectile move forward before it hit the ground? (1.26×10^3 m)
   b) How long after being fired did it reach its maximum height? (4.21 s)

7. A ball is thrown from the top of one building toward the wall of a second taller building 15.2 m away. The ball is thrown with an initial velocity of 6.10 m/s at an angle of 40.0° to the horizontal. How far below its original position does the ball hit the second building? (39.1 m below its original position)

8. A baseball player throws a ball from center field to home plate with a velocity of 35.0 m/s at an angle of 30.0° with the ground. Assuming the ball is caught at the same height at which it was thrown; calculate the horizontal distance traveled by the ball before it is caught. (108 m)

9. A projectile is fired with an initial velocity of 75.2 m/s at an angle of 34.5° above the horizontal along a long flat firing range. Determine the
   a) maximum height reached by the projectile (92.7 m)
   b) range of the projectile (539 m)
   c) speed of the projectile 1.50 s after being fired (68.0 m/s)

10. A hockey player hits a puck with his hockey stick and the puck is launched at an angle of 45° to the ice surface. The puck hits the ice 35 m down the length of the rink. Find the velocity of the puck when it left the hockey stick. (19 m/s at 45° to the horizontal)

11. A no good thief steals Mrs. Corlette's purse and makes a run for it. Mrs. Corlette, being puny and weak, calls for help. Mr. MacDonald sees this happen and gets angry, turns green, muscles rip his shirt apart, and he wants to smash. Mr. MacDonald becomes the *Phulk* and grabs a red Volkswagen Beetle at the spot the purse was stolen and throws it East at an angle of 45° to the horizontal. The instant the doomed Beetle left the Phulk's hand the thief has run for 8.7 seconds at a constant velocity of 3.2 m/s [E]. With what initial speed does the Phulk have to throw the car so that it hits the running thief? (19 m/s)

12. A cannonball has a muzzle speed of 35 m/s. If the cannon ball is launched from the ground then what is the maximum range of the cannonball? (125 m)

13. Suppose the cannon from #12 were placed on a 17 m high castle wall. What is its new maximum range? (140 m)

14. How high should the cannon from #12 be placed to pulverize advancing orcs that are 200 m away; assuming that 200 m is the maximum range of the cannon? (120 m)

15. The King, fed up with stupid, ugly orcs, wants to increase the maximum range of his cannons to 500 m. The cannons are placed 25 m up in the castle. What muzzle speed should the cannonballs have? (68.3 m/s)

16. MHR Page 549 PP #14. Go ahead, try it. I double-dog dare ya.

PRACTICE PROBLEMS MHR Pg. 549

13. A circus stunt person was launched as a human cannon ball over a Ferris wheel. His initial velocity was 24.8 m/s at an angle of 55°. (Neglect friction)
   (a) Where should the safety net be positioned?
   (b) If the Ferris wheel was placed halfway between the launch position and the safety net, what is the maximum height of the Ferris wheel over which the stunt person could travel?
   (c) How much time did the stunt person spend in the air?

14. You want to shoot a stone with a slingshot and hit a target on the ground 14.6 m away. If you give the stone an initial velocity of 12.5 m/s, neglecting friction, what must be the launch angle in order for the stone to hit the target? What would be the maximum height reached by the stone? What would be its time of flight?

PRACTICE PROBLEMS MHR Pg. 570

15. You throw a rock off a 68 m cliff, giving it a horizontal velocity of 8.0 m/s.
   (a) How far from the base of the cliff will it land?
   (b) How long will the rock be in the air?

16. A rescue plane flying horizontally at 175 km/h[N], at an altitude of 150 m, drops a 25 kg emergency package to a group of explorers. Where will the package land relative to the point above which it was released? (Neglect friction.)

17. You throw a ball with a velocity of 18 m/s at 24° above the horizontal from the top of your garage, 5.8 m above the ground. Calculate the
   (a) time of flight
   (b) horizontal range
   (c) maximum height
   (d) velocity when the ball is 2.0 m above the roof
   (e) angle at which the ball hits the ground

18. Using a slingshot, you fire a stone horizontally from a tower that is 27 m tall. It lands 122 m from the base of the tower. What was its initial velocity?

19. At a ballpark, a batter hits a baseball at an angle of 37° to the horizontal with an initial velocity of 58 m/s. If the outfield fence is 3.15 m high and 323 m away, will the hit be a home run?

20. An archer shoots a 4.0 g arrow into the air, giving it a velocity of 40.0 m/s at an elevation angle of 65°. Find
   (a) its time of flight
   (b) its maximum height
   (c) its range
   (d) its horizontal and vertical distance from the starting point at 2.0 s after it leaves the bow
   (e) the horizontal and vertical components of its velocity at 6.0 s after it leaves the bow

Physics 122
Problems – Circular Motion

1. An electric train moving at constant speed on a circular track of radius 1.0 m goes around the track every 10 s. What is the centripetal acceleration of the train?

2. A plane flying at a constant speed in a circular path of radius 5500 m completes one revolution every 485 s.
   a) What is the speed of the plane?
   b) What is the acceleration of the plane?

3. A stone attached to a string 2.0 m long is whirled in a horizontal circle. At what speed must the stone move for its centripetal acceleration to equal to g?

4. The blade of a fan is 0.20 m long and makes 20 revolutions per second. What acceleration is experienced by a particle at the end of the blade?

5. An electron moves in a circular path of radius 0.20 m at a constant speed of 2.0×10^6 m/s.
   a) What is the period of its motion?
   b) What is its centripetal acceleration?

6. An object moving a long a circular path at a constant speed of 8.0 m/s completes one trip around the circle in 5.0 s.
   a) What is the radius of the circle?
   b) What is the acceleration of the object?

7. A student attaches a mass of 0.5 kg to one end of a rope. The student then swings the mass in a horizontal circle having a radius of 1 m so that the tangential speed is 4 m/s. What centripetal force must be exerted on the mass to keep it moving in a circle?

8. An artificial satellite has a period of 5.6×10^3 s and an orbital radius of 6.8×10^6 m. If its mass is 2.0×10^3 kg, what is the centripetal force keeping it in orbit?

9. If a 620 kg racecar takes 15.2 s to travel at constant speed once around a circular race track of 50.0 m radius, what are the centripetal acceleration of the car and centripetal force exerted by the track on the car's tires?

10. A knight holds a 1.6 m chain attached to 10.0 kg mace. He whirls the mace in a circle. If the mace has a frequency of 0.20 Hz, what is the centripetal acceleration of the mace and the tension in the chain?

Answers

1. The centripetal acceleration of the train is 0.39 m/s^2.
2. a) The speed of the plane is 71.2 m/s.
   b)The acceleration of the plane is 0.922 m/s^2.
3. Its speed must be 4.4 m/s.
4. The particle experiences an acceleration of 3.2×10^3 m/s^2.
5. a) The period is 6.3×10^{-7} s.
   b) The centripetal acceleration is 2.0×10^{13} m/s^2.
6. a)The radius of the circle was 6.4 m.
   b)The acceleration of the object is 10 m/s^2.
7. The centripetal force is 8 N.
8. The centripetal force is 1.7×10^4 N.
9. The centripetal acceleration and centripetal force are 8.53 m/s^2 and 5.29×10^3 N
10. The centripetal acceleration is 2.5 m/s^2 and the tension in the chain is 25 N.

Physics 122

Circular Motion: Unbanked and Banked Curves

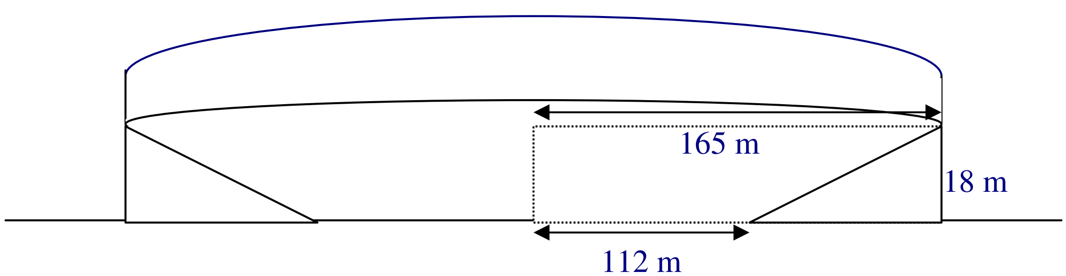
1. A car rounds an unbanked curve (radius = 92 m) without skidding at a speed of 26 m/s. What is the smallest possible coefficient of static friction between the tires and the road? (0.75)

2. At what angle should a curve of radius 150 m be banked so cars can travel safely at 25 m/s without relying on friction? (23^o)

3. A curve of radius 120 m is banked at an angle of 18^o. At what speed can it be negotiated under icy conditions when friction is neglected? (20 m/s)

4. A car is safely negotiating an unbanked circular turn at a speed of 21 m/s. The maximum static frictional force acts on the tires. Suddenly, a wet patch in the road reduces the maximum static frictional force a factor of three. If the car is to continue safely around the curve, to what speed must the driver slow the car? (12 m/s)

5. On a banked race track, the smallest circular path on which cars can move has a radius of 112 m, while the largest has a radius of 165 m, as the drawing illustrates. The height of the outer wall is 18 m. Find the smallest and largest speed at which cars can move on this track without relying on friction. (19 m/s, 23 m/s)



6. Two curves on a highway have the same radii. However, one is unbanked and the other is banked at an angle θ. A car can safely travel along the unbanked curve at a maximum speed v_o under conditions when the coefficient of static friction between the tires and the road is 0.81. The banked curve is frictionless, and the car can negotiate it at the same maximum speed v_o. Find the angle θ of the banked curve. (39^o)

PRACTICE PROBLEMS

MHR Pg. 566

20. An engineer designed a turn on a road so that a 1225 kg car would need 4825 N of centripetal force when travelling around the curve at 72.5 km/h. What is the radius of curvature of the road?

21. A car exits a highway on a ramp that is banked at 15° to the horizontal. The exit ramp has a radius of curvature of 65 m. If the conditions are extremely icy and the driver cannot depend on any friction to help make the turn, at what speed should the driver travel so that the car will not skid off the ramp?

22. An icy curve with a radius of curvature of 175 m is banked at 12°. At what speed must a car travel to ensure that it does not leave the road?

23. An engineer must design a highway curve with a radius of curvature of 155 m that can accommodate cars travelling at 85 km/h. At what angle should the curve be banked?

PRACTICE PROBLEMS

MHR Pg. 571

22. A beam of electrons is caused to move in a circular path of radius 3.00 m at a velocity of 2.00×10^7 m/s. The electron mass is 9.11×10^{-31} kg.

(a) What is the centripetal acceleration of one of the electrons?

(b) What is the centripetal force on one electron?

23. A car travelling on a curved road will skid if the road does not supply enough friction. Calculate the centripetal force required to keep a 1500 kg car travelling at 65 km/h on a flat curve of radius 1.0×10^2 m. What must be the coefficient of friction between the car's wheels and the ground?

24. Consider an icy curved road, banked 6.2° to the horizontal, with a radius of curvature of 75.0 m. At what speed must a 1200 kg car travel to stay on the road?

25. You want to design a curve, with a radius of curvature of 350 m, so that a car can turn at a velocity of 15 m/s on it without depending on friction. At what angle must the road be banked?

26. A motorcycle stunt rider wants to do a loop-the-loop within a vertical circular track. If the radius of the circular track is 10.0 m, what minimum speed must the motorcyclist maintain to stay on the track?

27. An amusement park ride consists of a large cylinder that rotates around a vertical axis. People stand on a ledge inside. When the rotational speed is high enough, the ledge drops away and people "stick" to the wall. If the period of rotation is 2.5 s and the radius is 2.5 m, what is the minimum coefficient of friction required to keep the riders from sliding down?

PRACTICE PROBLEMS MHR Pg. 580

1. Find the gravitational force between Earth and the Sun. (See Appendix B, Physical Constants and Data.)

2. Find the gravitational force between Earth and the Moon. (See Appendix B, Physical Constants and Data.)

3. How far apart would you have to place two 7.0 kg bowling balls so that the force of gravity between them would be 1.25×10^{-4} N? Would it be possible to place them at this distance? Why or why not?

4. Find the gravitational force between the electron and the proton in a hydrogen atom if they are 5.30×10^{-11} m apart. (See Appendix B, Physical Constants and Data.)

5. On Venus, a person with mass 68 kg would weigh 572 N. Find the mass of Venus from this data, given that the planet's radius is 6.31×10^{6} m.

6. In an experiment, an 8.0 kg lead sphere is brought close to a 1.5 kg mass. The gravitational force between the two objects is 1.28×10^{-8} N. How far apart are the centres of the objects?

7. The radius of the planet Uranus is 4.3 times the radius of earth. The mass of Uranus is 14.7 times Earth's mass. How does the gravitational force on Uranus' surface compare to that on Earth's surface?

8. Along a line connecting Earth and the Moon, at what distance from Earth's centre would an object have to be located so that the gravitational attractive force of Earth on the object was equal in magnitude and opposite in direction from the gravitational attractive force of the Moon on the object?

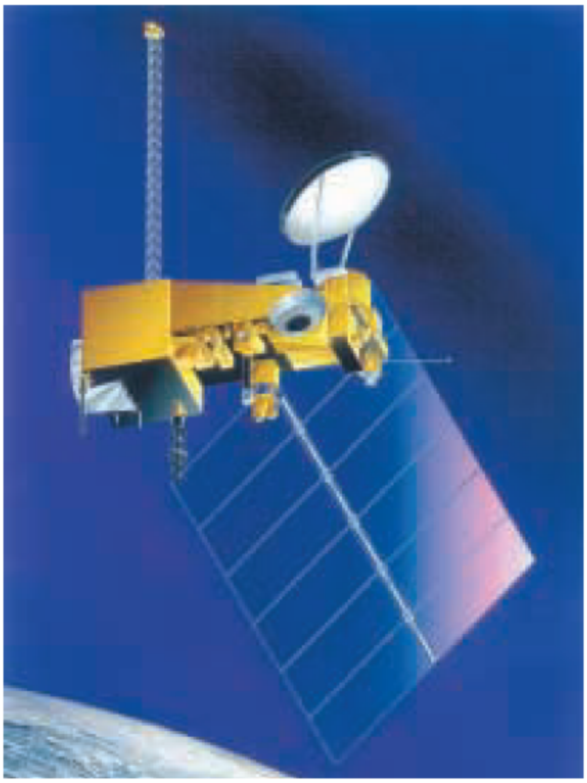
PRACTICE PROBLEMS MHR Pg. 591

15. The polar-orbiting environmental satellites (POES) and some military satellites orbit at a much lower level in order to obtain more detailed information. POES complete an Earth orbit 14.1 times per day. What are the orbital speed and the altitude of POES?

16. The International Space Station orbits at an altitude of approximately 226 km. What is its orbital speed and period?

17. (a) The planet Neptune has an orbital radius around the Sun of about 4.50×10^{12} m. What are its period and its orbital speed?

    (b) Neptune was discovered in 1846. How many orbits has it completed since its discovery?



NASA operates two polar-orbiting environmental satellites (POES) designed to collect global data on cloud cover; surface conditions such as ice, snow, and vegetation; atmospheric temperatures; and moisture, aerosol, and ozone distributions.

PRACTICE PROBLEMS

MHR Pg. 595

22. The gravitational force between two objects is 80.0 N. What would the force become if the mass of one object was halved and the distance between the two objects was doubled?

23. Two stars of masses $m*$ and $3m*$ are 7.5×10^{11} m apart. If the force on the large star is F, which of the following is the force on the small star?
(a) $F/9$ **(b)** $F/3$ **(c)** F **(d)** $3F$ **(e)** $9F$

24. For the above situation, if the acceleration of the small star is a, what is the acceleration of the large star?
(a) $a/9$ **(b)** $a/3$ **(c)** a **(d)** $3a$ **(e)** $9a$

25. **(a)** Use Newton's law of universal gravitation and the centripetal force of the Sun to determine Earth's orbital speed. Assume that Earth orbits in a circle.
(b) What is Earth's centripetal acceleration around the Sun?

26. Calculate the Sun's acceleration caused by the force of Earth.

27. A space shuttle is orbiting Earth at an altitude of 295 km. Calculate its acceleration and compare it to the acceleration at Earth's surface.

28. Orbital motions are routinely used by astronomers to calculate masses. A ring of high-velocity gas, orbiting at approximately 3.4×10^4 m/s at a distance of 25 light-years from the centre of the Milky Way, is considered to be evidence for a black hole at the centre. Calculate the mass of this putative black hole. How many times greater than the Sun's mass is it?

30. The Hubble space telescope orbits Earth with an orbital speed of 7.6×10^3 m/s.
(a) Calculate its altitude above Earth's surface.
(b) What is its period?

31. The Moon orbits Earth at a distance of 3.84×10^8 m. What are its orbital velocity and period?

32. The following table gives orbital information for five of Saturn's largest satellites.

Satellite	Mean orbital radius (m)	Period (days)
Tethys	2.95×10^8	1.888
Dione	3.78×10^8	2.737
Rhea	5.26×10^8	4.517
Titan	1.221×10^9	15.945
Iapetus	3.561×10^9	79.331

(a) Determine whether these satellites obey Kepler's third law.
(b) If they obey Kepler's third law, use the data for the satellites to calculate an average value for the mass of Saturn.

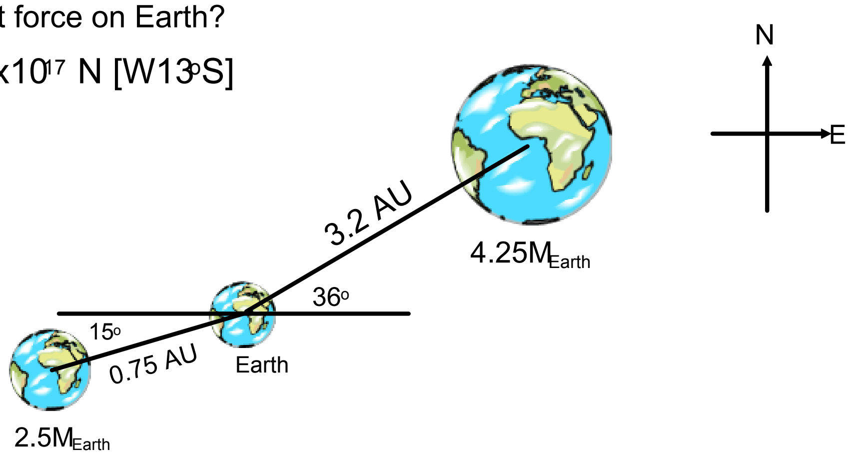
Suppose a planet is discovered that is 2.5 times as massive as the Earth. What would its radius have to be for its gravitational acceleration to be the same as Earth's?

A planet is found to be 3.75 times the radius of Earth. For it to have g = 9.81 m/s^2, what must its mass be relative to the Earth's?

A star at the edge of the Andromeda galaxy appears to be orbiting the centre of that galaxy at a speed of about 2.0×10^2 km/s. The star is 5×10^9 AU from the center of the galaxy. Calculate a rough estimate of the mass of the Andromeda galaxy. (4×10^{41} kg)

What is the net force on Earth?

Ans: *F* = 4.3x10^17 N [W13°S]



What is the gravitational acceleration 1000km above the Earth's surface?

$g = 7.33 m/s^2$

What is the acceleration of gravity on the surface of the Moon? $g = 1.62 m/s^2$

Suppose a new planet is discovered that has a radius 3 times that of the Earth and a mass 5 times that of the Earth. What is the acceleration of gravity on that planet's surface?

$g = 5.45 m/s^2$

How far from the Earth's surface do you have to go to experience 0.5*g*? $r = 2.64 \times 10^6 m$

What is the acceleration of the Moon towards the Earth? Earth towards the Moon?

$g_{m \to E} = 2.69 \times 10^{-3} m/s^2$ | $g_{E \to m} = 3.33 \times 10^{-5} m/s^2$

A cannon is fired from the surface of Mars. The speed is 25 m/s at an angle of 30° to the surface. What is the maximum height of the cannon ball? How far from the cannon does the ball land? (Mass of Mars = 6.421x10^23 kg, Radius = 3.39x10^6 m) $y_{max} = 21m$ $x = 148m$

PRACTICE PROBLEMS — Hooke's Law, MHR Pg. 258

35. A spring scale is marked from 0 to 50 N. The scale is 9.5 cm long. What is the spring constant of the spring in the scale?

36. A slingshot has an elastic cord tied to a Y-shaped frame. The cord has a spring constant of 1.10×10^3 N/m. A force of 455 N is applied to the cord.
   (a) How far does the cord stretch?
   (b) What is the restoring force from the spring?

37. The spring in a typical Hooke's law apparatus has a force constant of 1.50 N/m and a maximum extension of 10.0 cm. What is the largest mass that can be placed on the spring without damaging it?

PRACTICE PROBLEMS — Elastic Potential Energy, MHR Pg. 261

38. An object is hung from a vertical spring, extending it by 24 cm. If the spring constant is 35 N/m, what is the potential energy of the stretched spring?

39. An unruly student pulls an elastic band that has a spring constant of 48 N/m, producing a 2.2 J increase in its potential energy. How far did the student stretch the elastic band?

40. A force of 18 N compresses a spring by 15 cm. By how much does the spring's potential energy change?

PRACTICE PROBLEMS — Kinetic Energy, MHR Pg. 238

19. A 0.100 kg tennis ball is travelling at 145 km/h. What is its kinetic energy?

20. A bowling ball, travelling at 0.95 m/s, has 4.5 J of kinetic energy. What is its mass?

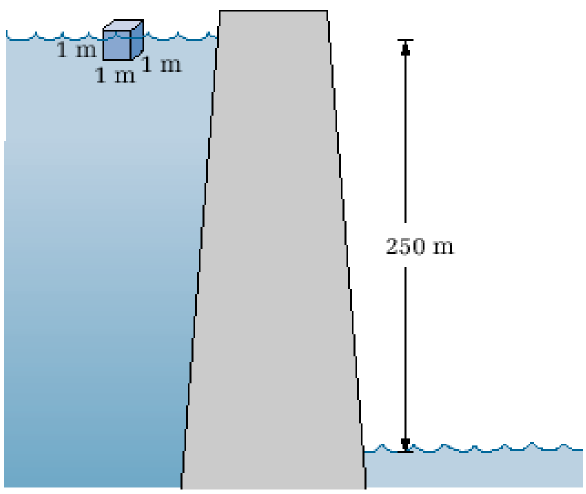
21. A 69.0 kg skier reaches the bottom of a ski hill with a velocity of 7.25 m/s. Find the kinetic energy of the skier at the bottom of the hill.

PRACTICE PROBLEMS — Potential Energy, MHR Pg. 250

27. A framed picture that is to be hung on the wall is lifted vertically through a distance of 2.0 m. If the picture has a mass of 4.45 kg, calculate its gravitational potential energy with respect to the ground.

28. The water level in a reservoir is 250 m above the water in front of the dam. What is the potential energy of each cubic metre of surface water behind the dam? (Take the density of water to be 1.00 kg/L.)

29. How high would you have to raise a 0.300 kg baseball in order to give it 12.0 J of gravitational potential energy?



PRACTICE PROBLEMS Work, MHR Pg. 221

1. A weight lifter, Paul Anderson, used a circular platform attached to a harness to lift a class of 30 children and their teacher. While the children and teacher sat on the platform, Paul lifted them. The total weight of the platform plus people was 1.1×10^4 N. When he lifted them a distance of 52 cm, at a constant velocity, how much work did he do? How high would you have to lift one child, weighing 135 N, in order to do the same amount of work that Paul did?

2. A 75 kg boulder rolled off a cliff and fell to the ground below. If the force of gravity did 6.0×10^4 J of work on the boulder, how far did it fall?

3. A student in physics lab pushed a 0.100 kg cart on an air track over a distance of 10.0 cm, doing 0.0230 J of work. Calculate the acceleration of the cart. (Hint: Since the cart was on an air track, you can assume that there was no friction.)

PRACTICE PROBLEMS Work, MHR Pg. 225

4. With a 3.00×10^2 N force, a mover pushes a heavy box down a hall. If the work done on the box by the mover is 1.90×10^3 J, find the length of the hallway.

5. A large piano is moved 12.0 m across a room. Find the average horizontal force that must be exerted on the piano if the amount of work done by this force is 2.70×10^3 J.

6. A crane lifts a 487 kg beam vertically at a constant velocity. If the crane does 5.20×10^4 J of work on the beam, find the vertical distance that it lifted the beam.

7. A teacher carries his briefcase 20.0 m down the hall to the staff room. The teacher's hand exerts a 30.0 N force upward as he moves down the hall at constant velocity.
   (a) Calculate the work done by the teacher's hand on the briefcase.
   (b) Explain the results obtained in part (a).

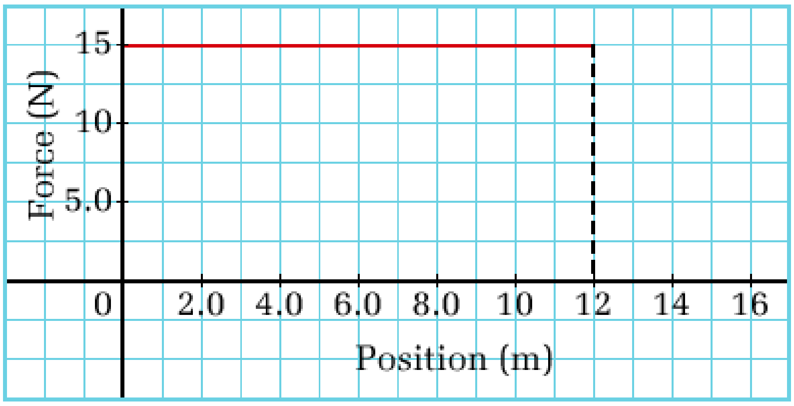
8. A 2.00×10^2 N force acts horizontally on a bowling ball over a displacement of 1.50 m. Calculate the work done on the bowling ball by this force.

9. The *Voyager* space probe has left our solar system and is travelling through deep space, which can be considered to be void of all matter. Assume that gravitational effects may be considered negligible when *Voyager* is far from our solar system.
   (a) How much work is done on the probe if it covers 1.00×10^6 km travelling at 3.00×10^4 m/s?
   (b) Explain the results obtained in part (a).

10. An energetic group of students attempts to remove an old tree stump for use as firewood during a party. The students apply an average upward force of 650 N. The 865 kg tree stump does not move after 15.0 min of continuous effort, and the group gives up.
    (a) How much work did the students do on the tree stump?
    (b) Explain the results obtained in part (a).

11. Determine the amount of work done by the forces represented in the four force-versus-position plots that follow.

A



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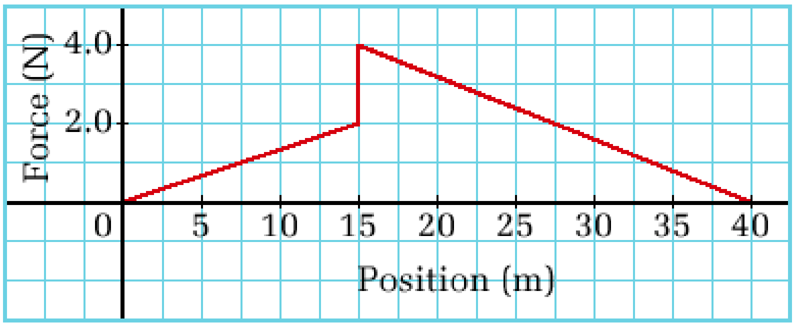

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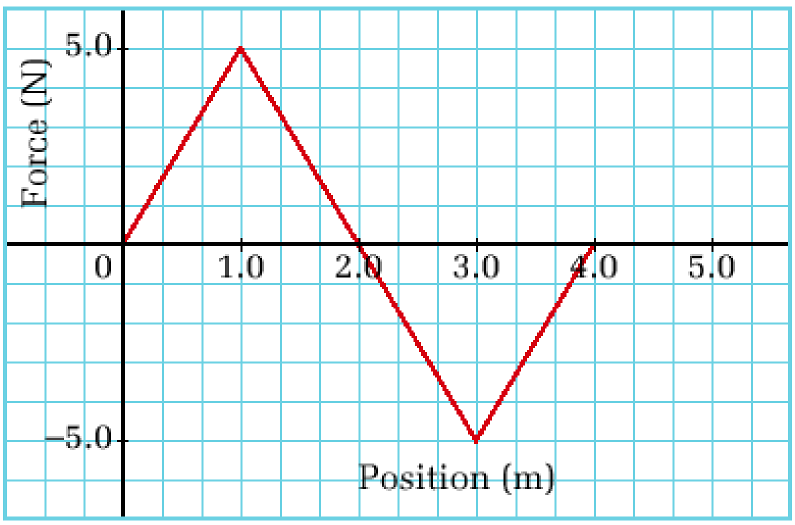


PRACTICE PROBLEMS — Work E_k Theorem, MHR Pg. 245

22. A 6.30 kg rock is pushed horizontally across a 20.0 m frozen pond with a force of 30.0 N. Find the velocity of the rock once it has travelled 13.9 m. (Assume there is no friction.)

23. The mass of an electron is 9.1×10^{-31} kg. At what speed does the electron travel if it possesses 7.6×10^{-18} J of kinetic energy?

24. A small cart with a mass of 500 g is accelerated, uniformly, from rest to a velocity of 1.2 m/s along a level, frictionless track. Find the kinetic energy of the cart once it has reached a velocity of 1.2 m/s. Calculate the force that was exerted on the cart over a distance of 0.1 m in order to cause this change in kinetic energy.

25. A child's toy race car travels across the floor with a constant velocity of 2.10 m/s. If the car possesses 14.0 J of kinetic energy, find the mass of the car.

Work E_g Theorem, MHR Pg. 254

PRACTICE PROBLEMS

30. A student lifts her 2.20 kg pile of textbooks into her locker from where they rest on the ground. She must do 25.0 J of work in order to lift the books. Calculate the height that the student must lift the books.

31. A 46.0 kg child cycles up a large hill to a point that is a vertical distance of 5.25 m above the starting position. Find

(a) the change in the child's gravitational potential energy

(b) the amount of work done by the child against gravity

32. A 2.50 kg pendulum is raised vertically 65.2 cm from its rest position. Find the gravitational potential energy of the pendulum.

33. A roller-coaster train lifts its passengers up vertically through a height of 39.4 m from its starting position. Find the change in gravitational potential energy if the mass of the train and its passengers is 3.90×10^3 kg.

Work - Energy - Power, MHR Pg. 266

PRACTICE PROBLEMS

41. A mover pushes a 25.5 kg box with a force of 85 N down a 15 m corridor. If it takes him 8.30 s to reach the other end of the hallway, find the power generated by the mover, in watts. (1.5×10^2 W)

42. A chair lift carries skiers uphill to the top of the ski run. If the lift is able to do 1.85×10^5 J of work in 12.0 s, what is the power of the chair lift in both watts and horsepower? (1.54×10^4 W, 20.6 hp)

43. A 75.0 kg student runs up two flights of stairs in order to reach her next class. The total height of the stairs is 5.75 m from the ground level. If the student can generate 200 W of power and has 20.0 s to reach her classroom at the top of the stairs, will the student be on time for class?

PRACTICE PROBLEMS Work & Springs Pg. 306

9. A 1.2 kg dynamics cart is rolling to the right along a horizontal lab desk at 3.6 m/s, when it collides head on with a spring bumper that has a spring constant of 2.00×10^2 N/m.
   (a) Determine the maximum compression of the spring.
   (b) Determine the speed of the cart at the moment that the spring was compressed by 0.10 m.
   (c) Determine the acceleration of the cart at the moment that the spring was compressed 0.10 m.

10. A circus car with a clown has a total mass of 150 kg. It is coasting at 6.0 m/s, when it hits a large spring head on. If it is brought to a stop by the time the spring is compressed 2.0 m, what is the spring constant of the spring?

11. An archery bow has an effective spring constant of 485 N/m. The archer draws the bow a distance of 45.0 cm. If the arrow has a mass of 0.030 kg, what will be its speed at the moment it leaves the bow?

12. A 0.0250 kg mass on a frictionless surface is attached to a horizontal spring having a spring constant of 124 N/m. The spring is stretched to an amplitude of 9.00 cm and released. Find:
   (a) the maximum speed of the mass
   (b) the speed of the mass at 3.00 cm on either side of its equilibrium position.

13. A 0.150 kg mass on a frictionless surface is attached to a spring having a spring constant of 215 N/m. A motion detector determines that the mass is travelling at 15.0 m/s when it passes the equilibrium position.
   (a) What is the amplitude of the motion of the mass?
   (b) How much work was done to stretch the spring to its maximum amplitude?

14. An object on a frictionless surface is attached to a spring having a spring constant of 235 N/m. 50.0 J of work were done on the spring to stretch it to its maximum amplitude. As the mass passed through its equilibrium position, a motion detector determined that its speed was 14.6 m/s.
   (a) What was the mass of the object?
   (b) What was its amplitude?
   (c) What was the object's position when its speed was 5.00 m/s?

PRACTICE PROBLEMS Work & Falling on a Spring Pg. 308

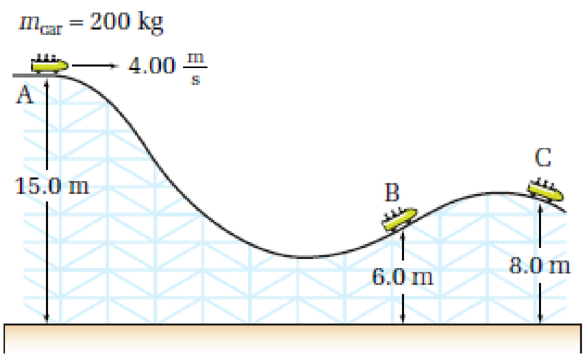
15. A 70.0 kg person steps through the window of a burning building and drops to a rescue net held 8.00 m below. If the surface of the net is 1.40 m above the ground, what must be the value of the spring constant for the net so that the person just touches the ground when the net stretches downward?

16. A 6.0 kg block is falling toward a spring located 1.80 m below. If it has a speed of 4.0 m/s at that instant, what will be the maximum compression of the spring? The spring constant is 2.000×10^3 N/m.

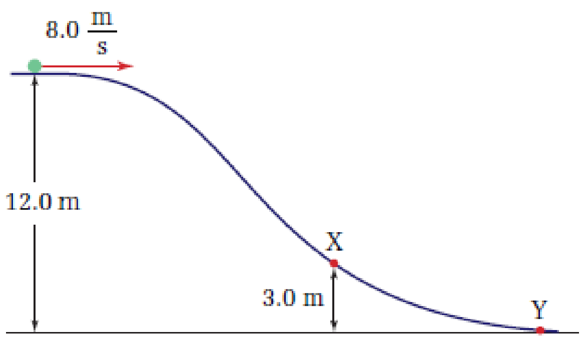
17. In a "head dip" bungee jump from a bridge over a river, the bungee cord is fastened to the jumper's ankles. The jumper then steps off and falls toward the river until the cord becomes taut. At that point, the cord begins to slow the jumper's descent, until his head just touches the water. The bridge is 22.0 m above the river. The unstretched length of the cord is 12.2 m. The jumper is 1.80 m tall and has a mass of 60.0 kg. Determine the
   (a) required value of the spring constant for this jump to be successful
   (b) acceleration of the jumper at the bottom of the descent

PRACTICE PROBLEMS Work & Friction Pg. 318

18. Determine the speed of the roller-coaster car in the sample problem at point C if point C is 8.0 m above the ground and another 4.00×10^2 J of heat energy are dissipated by friction between points B and C.



19. A sled at the top of a snowy hill is moving forward at 8.0 m/s, as shown in the diagram. The height of the hill is 12.0 m. The total mass of the sled and rider is 70.0 kg. Determine the speed of the sled at point X, which is 3.0 m above the base of the hill, if the sled does 1.22×10^3 J of work on the snow on the way to point X.



20. If the sled in the previous question reaches the base of the hill with a speed of 15.6 m/s, how much work was done by the snow on the sled between points X and Y?

21. A 0.50 kg basketball falls from a 2.3 m shelf onto the floor, then bounces up to a height of 1.4 m before you catch it.

(a) Calculate the gravitational potential energy of the ball before it falls.

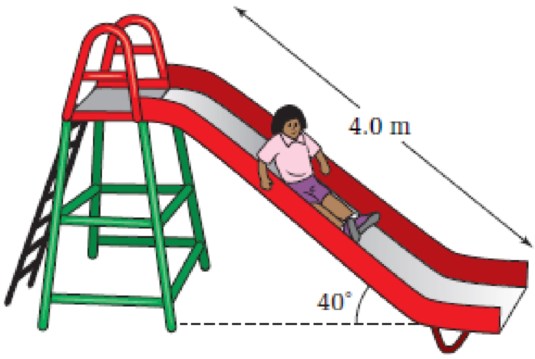
(b) Ignoring frictional effects, determine the speed of the ball as it strikes the floor, assuming that it fell from rest.

(c) How fast is the ball moving just before you catch it?

22. A 2.0 g bullet initially moving with a velocity of 87 m/s passes through a block of wood. On exiting the block of wood, the bullet's velocity is 12 m/s. How much work did the force of friction do on the bullet as it passed through the wood? If the wood block was 4.0 cm thick, what was the average force that the wood exerted on the block?

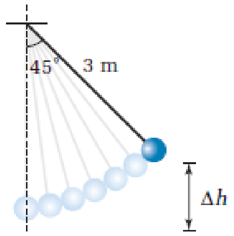
23. The Millennium Force, the tallest roller coaster in North America, is 94.5 m high at its highest point. What is the maximum possible speed of the roller coaster? The roller coaster's actual maximum speed is 41.1 m/s. What percentage of its total mechanical energy is lost to thermal energy due to friction?

24. A 15 kg child slides, from rest, down a playground slide that is 4.0 m long, as shown in the figure. The slide makes a 40° angle with the horizontal. The child's speed at the bottom is 3.2 m/s. What was the force of friction that the slide was exerting on the child?

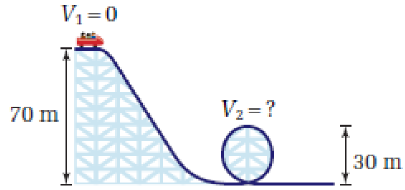


PRACTICE PROBLEMS Work Pg. 329

21. A 2.00 kg mass is attached to a 3.00 m string and is raised at an angle of 45° relative to the rest position, as shown. Calculate the gravitational potential energy of the pendulum relative to its rest position. If the mass is released, determine its velocity when it reaches its rest position.



22. A roller coaster at a popular amusement park has a portion of the track that is similar to the diagram provided. Assuming that the roller coaster is frictionless, find its velocity at the top of the loop.



23. A simple pendulum swings freely and rises at the end of its swing to a position 8.5 cm above its lowest point. What is its speed at its lowest point?

24. A 50.0 g pen has a retractable tip controlled by a button on the other end and an internal spring that has a constant of 1200 N/m. Suppose you hold the pen vertically on a table with the tip pointing up. Clicking the button into the table compresses the spring 0.50 cm. When the pen is released, how fast will it rise from the table? To what vertical height will it rise? (Assume for simplicity that the mass of the pen is concentrated in the button.)

25. A spring with a spring constant of 950 N/m is compressed 0.20 m. What speed can it give to a 1.5 kg ball when it is released?

26. A 48.0 kg in-line skater begins with a speed of 2.2 m/s. Friction also does –150 J of work on her. Assume that she did not push on the ground any more. If her final speed is 5.9 m/s,

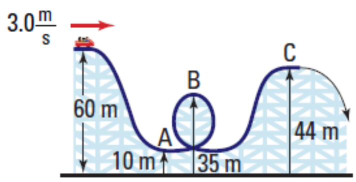
(a) determine the change (final – initial) in her gravitational potential energy.

(b) By how much, and in which direction (up or down), has her height changed?

PRACTICE PROBLEMS Work Review Pg. 332

38. How fast will a 2.55 kg bowling ball be travelling if the 358 J of work done to the ball are transformed into kinetic energy?

39. A 250 kg roller coaster cart loaded with people has an initial velocity of 3.0 m/s. Find the velocity of the cart at A, B, and C. Assume that friction is negligible.



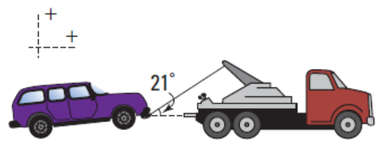
40. A 45 kg cyclist travelling 15 m/s on a 7.0 kg bike brakes suddenly and slides to a stop in 3.2 m.

(a) Calculate the work done by friction to stop the cyclist.

(b) Calculate the coefficient of friction between the skidding tires and the ground.

(c) Are you able to determine if the tires were digging into the ground from your answer in part (b)? Explain.

41. A tow truck pulls a car by a cable that makes an angle of 21° to the horizontal. The tension in the cable is 6.5×10^3 N.



(a) How large is the force that causes the car to move horizontally?

(b) How much work has the tow truck done on the car after pulling it 3.0 km?

44. An 8.0 kg stone falls off a 10.0 m cliff.

(a) How much work is done on it by the gravitational force?

(b) How much gravitational potential energy does it lose?

45. You are in a 1400 kg car, coasting down a 25° slope. When the car's speed is 15 m/s, you apply the brakes. If the car is to stop after travelling 75 m, what constant force (parallel to the road) must be applied?

46. An archery bow has a spring constant of 1.9×10^2 N/m. By how much does its elastic potential energy increase if it is stretched (a) 5.0 cm and (b) 71.0 cm?

PRACTICE PROBLEMS

Work Review Pg. 332

47. You exert 72 N to compress a spring with a spring constant of 225 N/m a certain distance.
- **(a)** What distance is the spring displaced?
- **(b)** What is the elastic potential energy of the displaced spring?

48. A 2.50 kg mass is attached to one end of a spring on a horizontal, frictionless surface. The other end of the spring is attached to one end of a spring is attached to a solid wall. The spring has a spring constant of 75.0 N/m. The spring is stretched to 25.0 cm from its equilibrium point and released.
- **(a)** What is the total energy of the mass-spring system?
- **(b)** What is the velocity of the mass when it passes the equilibrium position?
- **(c)** What is the elastic potential energy stored in the spring when the mass passes a point that is 15.0 cm from its equilibrium position?
- **(d)** What is the velocity of the spring when it passes a point that is 15.0 cm from its equilibrium position?

49. A 275 g ball is resting on top of a spring that is mounted to the floor. You exert a force of 325 N on the ball and it compresses the spring 44.5 cm. If you release the ball from that position, how high, above the equilibrium position of the spring-ball system will the ball rise?

50. A 186 kg cart is released at the top of a hill.
- **(a)** How much gravitational potential energy is lost after it descends through a vertical height of 8.0 m?
- **(b)** If the amount of friction acting on the cart is negligible, determine the kinetic energy and the speed of the cart after it has descended through a vertical height of 8.0 m.

51. A small 95 g toy consists of a piece of plastic attached to a spring with a spring constant of 365 N/m. You compress the spring against the floor through a displacement of 5.5 cm, then release the toy. How fast is it travelling when it rises to a height of 10.0 cm?

52. Suppose a 1.5 kg block of wood is slid along a floor and it compresses a spring that is attached horizontally to a wall. The spring constant is 555 N/m and the block of wood is travelling 9.0 m/s when it hits the spring. Assume that the floor is frictionless and the spring is ideal.
- **(a)** By how much does the block of wood compress the spring?

53. A spring with a spring constant of 120 N/m is stretched 5.0 cm from its rest position.
- **(a)** Calculate the average force applied.
- **(b)** Calculate the work done.
- **(c)** If the spring is then stretched from its 5.0 cm position to 8.0 cm, calculate the work done.
- **(d)** Sketch a graph of the applied force versus the spring displacement to show the extension of the spring. Explain how you can determine the amount of work done by analyzing the graph.

54. A 32.0 kg child descends a slide 4.00 m high. She reaches the bottom with a speed of 2.40 m/s. Was the mechanical energy conserved? Explain your reasoning and identify the energy transformations involved.

55. A 2.5 kg wooden block slides from rest down an inclined plane that makes an angle of 30° with the horizontal.
- **(a)** If the plane is frictionless, what is the speed of the block after slipping a distance of 2.0 m?
- **(b)** If the plane has a coefficient of kinetic friction of 0.20, what is the speed of the block after slipping a distance of 2.0 m?

Conservation of Energy Problems

1. A 200 g stone is whirled in a circle on a string 1.50 m long. It takes 1.20 s to make one revolution. Calculate:

a) the kinetic energy of the stone.

b) the centripetal force acting on the stone.

c) the work done by the centripetal force in one revolution.

2. A car with a mass of 1200 kg goes around a 90^{o} corner with a radius of 10.0 m in a time of 4.50 s. The total frictional forces acting on the care are 10.0 kN. Calculate:

a) the kinetic energy of the car.

b) the centripetal force acting on the car.

c) the work done by the car's motor keeping the car going at a constant speed around the corner.

3. A model airplane with a mass of 5.60 kg is flying in a circle with a radius of 22.0 m. The airplane is flying once around the circle every 7.25 s. Calculate:

a) the kinetic energy of the airplane.

b) the centripetal force acting on the airplane.

c) the work done by the centripetal force as it flies halfway around the circle.

4. A 2000 kg car goes through a 90^{o} corner with a radius of 10.0 m in a time of 1.53 s. Calculate:

a) the centripetal force acting on the car.

b) the kinetic energy of the car.

c) the work done on the car by the centripetal force.

5. A 950 g model train goes around a 90^{o} corner with a radius of 1.50 m at a constant speed of 2.16 m/s. The force of friction acting on the train is 5.90 N. Calculate the work done on the train:

a) by the motor.

b) by the tracks.

6. A 3.50 kg mass with a kinetic energy of 43.75 J goes through a 90^{o} corner with a radius of 1.25 m. If the centripetal force acting on the mass in the corner is 70.0 N, calculate the velocity of the mass as it leaves the corner.

7. An object starts at rest and is subjected to a force over a distance of 7.00 m. After the object is free of the above force, a 224 N force can turn the object through a 90^{o} corner with a radius of 0.25 m. How great was the initial force?

8. A model train car is coasting (no driving force) on a circular track. Initially the centripetal force necessary to keep the car going around the track is 5.00 N. If after the car has gone halfway around the circle the necessary force has been reduced to 1.86 N, what force of friction must be acting on the car?

9. A model train is on a circular track. The force of friction is 5.60 N. The train started at rest and was driven by a force of 10.0 N for a distance of 0.454 m. The driving force was then reduced and held constant at 5.60N. The centripetal force that must be provided by the track is 2.00 N. Calculate the circumference of the track.

10. A toy pop gun is going to fire plastic 10.0 g bullets. When it is loaded the spring is compressed 7.00cm. The equation for this spring is F = 30.0x.

a) At what speed will the gun fire the bullets?

b) How much force will be required to load the gun?

11. A toy cannon is to be designed to shoot 100 g projectiles at 5.00 m/s. The projectiles are to be powered by a spring. There is only 15.0 cm of barrel length for the spring to propel the projectile.

a) What must the k-value of the spring be?

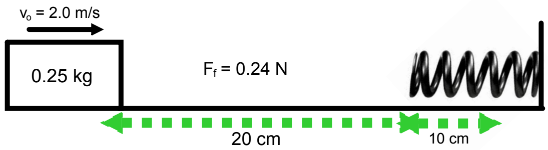
b) How much force will it take to load the cannon?

12. A spring, F = 100x, is used to fire 100 g darts from a gun. If when the fun is loaded the spring is compressed 10.0 cm, calculate the velocity the darts will have as they leave the gun.

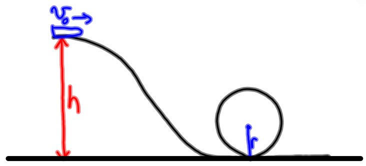
13. In the given diagram, the 0.250 kg mass is 20.0 cm away from the spring bumper moving towards it at 2.00 m/s/ The force of friction between the mass and the surface on which it is sliding is 0.240 N. If the mass compresses the spring 10.0 cm determine:

a) the k-value of the spring.

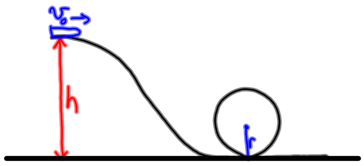
b) how fast the mass will be moving as it leaves the spring.



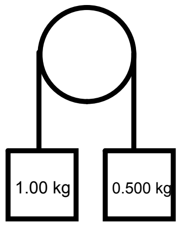
14. A roller coaster is to be constructed such that, starting from rest, a car will survive a 15 m radius loop. Assuming negligible friction, calculate the starting height of the roller coaster.



15. A car atop a roller coaster sits at rest 42 m above ground level. What is the largest circular loop it can survive. There is no friction and the base of the loop is at ground level.



16. Both masses start at rest and the pulley is frictionless. Calculate the velocity of each mass when the 0.500 kg mass is 1.00 m above the 1.00 kg mass.



17. A 2.00 kg ball is dropped from a height of 10.0 m.

a) what is the initial potential energy of the ball?

b) What is the potential energy of the ball 4.00 m into its fall?

c) Neglecting air resistance, with what speed would the ball hit the ground?

d) If the ball actually hit the ground at a speed of 12.0 m/s, what was the average air drag force?

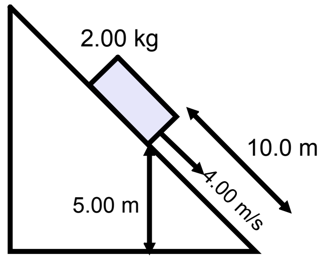
18. A 200 g golf ball is dropped from a window 12.0 m above the ground. Calculate:

a) how far the ball has fallen when the speed is 7.50 m/s.

b) the speed when it hits the ground.

c) the air resistance force acting on the ball if when it is at a height of 2.00 m it is moving 12.0 m/s.

19. Calculate the velocity at the bottom of the ramp if the force of friction acting on the mass is 3.30 N. See the image to the right for the initial values.



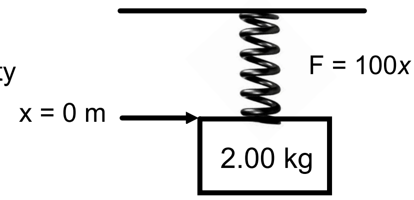
20. A 2.00 kg object is dropped 1.80 m on to a platform which is supported by a strong spring.

a) How fast is the object falling just as it hits the platform?

b) If the object sticks to the platform, and compresses the spring 70.0 cm, calculate the k-value of the spring.

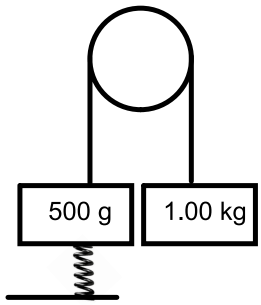
21. If when a 200 g mass is dropped 2.00 m, it sticks to a platform and compresses it 20.0 cm, calculate the k-value.

22. The mass in the image to the right starts at rest and the spring attached to the mass starts at its normal length. Calculate the velocity the mass will have after if falls 10.0 cm.

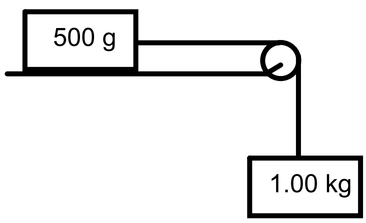


23. A spring that has a constant of 24.5 N/m is hung vertically on a stand. A 500 g mass is attached to the bottom of the spring (similar to the setup in the previous problem). The spring is stretched a bit and then the mass is allowed to drop. If the mass falls 10.0 cm, calculate how much the spring was stretched at the beginning of the fall.

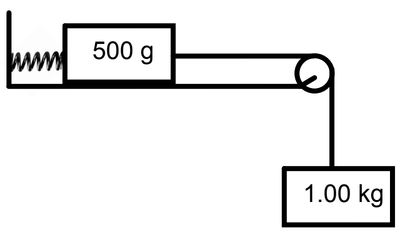
24. In the given diagram to the right the pulley is frictionless and the force equation for the given spring is $F = 98x$. If the system starts at rest with the spring at its normal length, x = 0 m, calculate the velocity of the 1.00 kg mass after it has fallen 10.0 cm.



25. If the force of friction on the table is 2.80 N, and the pulley is frictionless; calculate how far the 1.00 kg mass must fall to five the 500 g mass a velocity of 2.50 m/s if both masses start at rest.



26. In the given diagram, the pulley is frictionless and the force of friction between the 500 g mass and the table is 4.80 N. The force equation for the spring is $F = 50x$. If the system starts at rest with the spring at its normal length, calculate the maximum speed the 1.0 kg mass will reach.



Physics 122

Charge and Coulomb's Law (Two Charges)

1. How many electrons are needed to make up 25 C of charge?
   (1.6×10^{20} electrons)

2. How many coulombs of charge do 1.88×10^{19} electrons have?
   (3.01 C)

3. How many electrons must be removed from a small pith ball to give it a charge of 1.0×10^{-12} C? (6.3×10^{6})

4. How many excess electrons are on a ball with a charge of 2.04×10^{-17} C?
   (128)

5. Two charges, q_1 and q_2, are separated by a distance, d, and exert a force, F, on each other. What new force will exist if:
   a) q_2 is doubled?
   b) d is tripled?
   c) q_1 is halved and q_2 is tripled?
   d) q_2 is doubled and d is tripled?
   e) q_1 is halved, q_2 is one-fourth its original value and d is one-fourth its original value?

6. A positive charge of 1.8×10^{-6} C and a negative charge of 1.0×10^{-6} C are 0.040 m apart. What is the magnitude of the force between the two charges?
   (10 N).

7. A negative charge of 4.0×10^{-6} C exerts a force of repulsion of 7.2 N on a second charge. The charges are separated by 0.050 m. What is the sign and magnitude of the second charge? (-5.0×10^{-7} C)

8. How far apart are two charges of 1.0 μ C and –1.0 μC if they exert a force of attraction of 440 N on each other? (4.5×10^{-3} m)

9. What is the magnitude of the electrostatic force exerted by the proton in a hydrogen atom on the electron that orbits the nucleus when the electron is
   5.3×10^{-11} m from the proton? (8.2×10^{-8} N)

10. How far apart are two electrons if they exert a force of repulsion of 1.80×10^{-10} N on each other? (1.13×10^{-9} m)

11. At what separation distance do two point charges of 2.0 μC and –3.0 μC exert a force of attraction on each other of 565 N? (9.8×10^{-3} m)

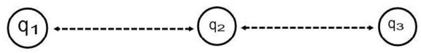
12. A distance of 0.64 m separates two neutral spheres. If 2.0×10^{13} electrons are removed from one sphere and placed on the other, what is the magnitude of the force that exists between the spheres? (0.23 N)

13. Two spheres, one with three times the charge of the other, are located 24 cm apart and exert a repulsive force of 72 N on each other. What is the magnitude of the charge of the sphere with more charge? (3.7×10^{-5} C)

Science 122

Electrostatics: 3 Charges

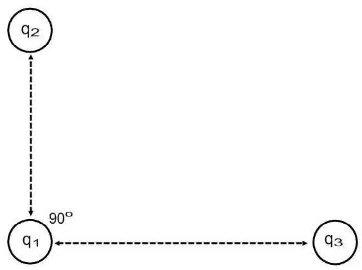
1. Three charges are lined up (see image below). Given the information that follows, what is the net electrostatic force acting on q_1? $q_1 = 3.5\,\mu\text{C}$, $q_2 = -1.5\mu C$, $q_3 = 4.0\,\mu\text{C}$, $r_{12} = 0.54\,\text{m}$, $r_{23} = 1.39\,\text{m}$



2. Three charges are lined up (see image below). Given the information that follows, what is the net electrostatic force acting on q_2? $q_1 = 3.5\,\mu\text{C}$, $q_2 = -1.5\mu C$, $q_3 = 4.0\,\mu\text{C}$, $r_{12} = 0.54\,\text{m}$, $r_{23} = 1.39\,\text{m}$

3. Three charges are lined up (see image below). Given the information that follows, what is the net electrostatic force acting on q_3? $q_1 = 3.5\,\mu\text{C}$, $q_2 = -1.5\ \mu\text{C}$, $q_3 = 4.0\,\mu\text{C}$, $r_{12} = 0.54\,\text{m}$, $r_{23} = 1.39\,\text{m}$

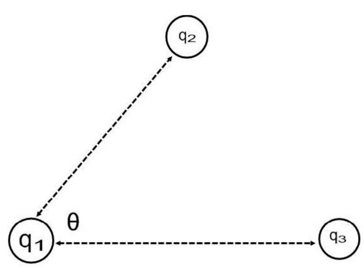
4. Three charges are arranged as depicted below. Given the information that follows, what is the net electrostatic force acting on q_1? $q_1 = -2.5\,\mu\text{C}$, $q_2 = -3.1\,\mu\text{C}$, $q_3 = -3.8\,\mu\text{C}$, $r_{12} = 0.25\,\text{m}$, $r_{13} = 0.75\,\text{m}$



5. Three charges are arranged as depicted below. Given the information that follows, what is the net electrostatic force acting on q_2? $q_1 = -2.5\,\mu\text{C}$, $q_2 = -3.1\,\mu\text{C}$, $q_3 = -3.8\,\mu\text{C}$, $r_{12} = 0.25\,\text{m}$, $r_{13} = 0.75\,\text{m}$

6. Three charges are arranged as depicted below. Given the information that follows, what is the net electrostatic force acting on q_3? $q_1 = -2.5\,\mu\text{C}$, $q_2 = -3.1\,\mu\text{C}$, $q_3 = -3.8\,\mu\text{C}$, $r_{12} = 0.25\,\text{m}$, $r_{13} = 0.75\,\text{m}$

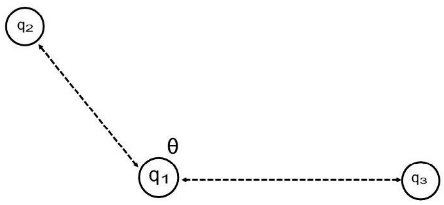
7. Three charges are arranged as depicted below. Given the information that follows, what is the net electrostatic force acting on q_1? $q_1 = -7.25\,\mu\text{C}$, $q_2 = -5.0\,\mu\text{C}$, $q_3 = 9.5\,\mu\text{C}$, $r_{12} = 1.75\,\text{m}$, $r_{13} = 2.7\,\text{m}$, $\theta = 25^\circ$



8. Three charges are arranged as depicted below. Given the information that follows, what is the net electrostatic force acting on q_2? $q_1 = -7.25\,\mu\text{C}$, $q_2 = -5.0\,\mu\text{C}$, $q_3 = 9.5\,\mu\text{C}$, $r_{12} = 1.75\,\text{m}$, $r_{13} = 2.7\,\text{m}$, $\theta = 25^\circ$

9. Three charges are arranged as depicted below. Given the information that follows, what is the net electrostatic force acting on q_3? $q_1 = -7.25\,\mu\text{C}$, $q_2 = -5.0\,\mu\text{C}$, $q_3 = 9.5\,\mu\text{C}$, $r_{12} = 1.75\,\text{m}$, $r_{13} = 2.7\,\text{m}$, $\theta = 25^\circ$

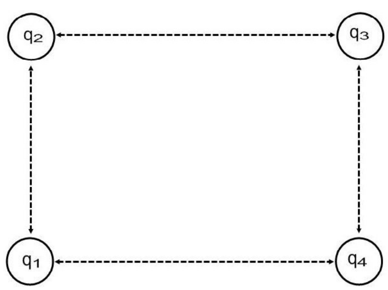
10. Three charges are arranged as depicted below. Given the information that follows, what is the net electrostatic force acting on q_1? $q_1 = 10.0\,\mu\text{C}$, $q_2 = -5.0\,\mu\text{C}$, $q_3 = -20.0\,\mu\text{C}$, $r_{12} = 1.5\,\text{m}$, $r_{13} = 3.0\,\text{m}$, $\theta = 150^\circ$



11. Three charges are arranged as depicted below. Given the information that follows, what is the net electrostatic force acting on q_2? $q_1 = 10.0\,\mu\text{C}$, $q_2 = -5.0\,\mu\text{C}$, $q_3 = -20.0\,\mu\text{C}$, $r_{12} = 1.5\,\text{m}$, $r_{13} = 3.0\,\text{m}$, $\theta = 150^\circ$

12. Three charges are arranged as depicted below. Given the information that follows, what is the net electrostatic force acting on q_3? $q_1 = 10.0\,\mu\text{C}$, $q_2 = -5.0\,\mu\text{C}$, $q_3 = -20.0\,\mu\text{C}$, $r_{12} = 1.5\,\text{m}$, $r_{13} = 3.0\,\text{m}$, $\theta = 150^\circ$

13. Four charges are arranged in a rectangle (depicted below). Given the information that follows, what is the net electrostatic force acting on q_1? $q_1 = 5.0\,\mu\text{C}$, $q_2 = -7.0\,\mu\text{C}$, $q_3 = -3.0\,\mu\text{C}$, $q_4 = 9.0\,\mu\text{C}$, $r_{12} = 3.0\,\text{m}$, $r_{13} = 4.0\,\text{m}$



14. Four charges are arranged in a rectangle (depicted below). Given the information that follows, what is the net electrostatic force acting on q_2? $q_1 = 5.0\,\mu\text{C}$, $q_2 = -7.0\,\mu\text{C}$, $q_3 = -3.0\,\mu\text{C}$, $q_4 = 9.0\,\mu\text{C}$, $r_{12} = 3.0\,\text{m}$, $r_{13} = 4.0\,\text{m}$

15. Four charges are arranged in a rectangle (depicted below). Given the information that follows, what is the net electrostatic force acting on q_3? $q_1 = 5.0\,\mu\text{C}$, $q_2 = -7.0\,\mu\text{C}$, $q_3 = -3.0\,\mu\text{C}$, $q_4 = 9.0\,\mu\text{C}$, $r_{12} = 3.0\,\text{m}$, $r_{13} = 4.0\,\text{m}$

16. Four charges are arranged in a rectangle (depicted below). Given the information that follows, what is the net electrostatic force acting on q_4? $q_1 = 5.0\,\mu\text{C}$, $q_2 = -7.0\,\mu\text{C}$, $q_3 = -3.0\,\mu\text{C}$, $q_4 = 9.0\,\mu\text{C}$, $r_{12} = 3.0\,\text{m}$, $r_{13} = 4.0\,\text{m}$

PRACTICE PROBLEMS MHR Pg. 692

1. What is the potential difference of a battery if it does 7.50×10^{-2} J of work when it moves 3.75×10^{-3} C of charge onto the anode?

2. A 9.00 V battery causes a charge of 4.20×10^{-2} C to move through a circuit. Calculate the work done on the charge.

3. A 12 V battery does 0.75 J of work on a quantity of charge it moved through a circuit. Calculate the amount of charge that was moved.

PRACTICE PROBLEMS MHR Pg. 696

4. A battery sends a 2.25 A current through a circuit for 1.50 min. If a total of 8.10×10^{2} J of work was done by the current, what was the potential difference of the battery?

5. How long would it take a 17 V battery, sending a 5.0 A current through a circuit, to do 680 J of work?

6. How much work is done by a 25.0 V battery when it drives a 4.70 A current through a circuit for 36.0 s?

7. If a 160 V battery did 9.6×10^{5} J of work in 2 min, what was the current?

8. A light draws a current of 0.48 A. How long must it be left on for charge of 36 C to pass through it?

9. An electric circuit draws 20 A. If the electric potential drop over the entire circuit is 120 V, calculate the total charge passing through the circuit in 1 h.

10. A cellular phone battery is recharged in 0.25 h after receiving 2.5×10^{3} C of charge. Calculate the amount of electric current that the battery draws during recharging?

11. A physics student wishes to determine the amount of electric energy consumed in one day at his school as a result of classroom and hallway lighting. A quick survey revealed that there were approximately 200 40W fluorescent lights operating under a potential difference of 240 V for 16 hours each day. How much electric energy was used to light the school for one day?

PRACTICE PROBLEMS MHR Pg. 700

12. Calculate the current if 2.85×10^{20} elementary charges pass a point in a circuit in 5.70 min.

13. A 16.0 V battery does 5.40×10^{4} J of work in 360.0 s.
    (a) Calculate the current through the battery.
    (b) Calculate the number of elementary charges that pass through the battery.

14. Calculate the number of elementary charges that pass a point in a circuit when a current of 3.50 A flows for 24.0 s.

15. In transferring 2.5×10^{20} elementary charges in 12 s, a battery does 68 J of work.
    (a) Calculate the current through the battery.
    (b) Calculate the potential difference of the battery.

PRACTICE PROBLEMS MHR Pg. 714

21. The heating element of an electric kettle draws 7.5 A when connected to a 120 V power supply. What is the resistance of the element?

22. A toaster is designed to operate on a 120 V (1.20×10^2 V) system. If the resistance of the toaster element is 9.60 Ω, what current does it draw?

23. A small, decorative light bulb has a resistance of 36 Ω. If the bulb draws 140 mA, what is its operating potential difference? (**Note:** The prefix "m" before a unit always means "milli-" or one one-thousandth. 1 mA is 1×10^{-3} A.)

24. The light bulb in the tail-light of an automobile with a 12 V electrical system has a resistance of 5.8 Ω. The bulb is left on for 8.0 min.

(a) What quantity of charge passes through the bulb?

(b) What was the current in the tail-light?

25. An iron transforms 3.35×10^5 J of electric energy to thermal energy in the 4.50 min it takes to press a pair of slacks. If the iron operates at 120 V (1.20×10^2 V), what is its resistance?

26. In Europe, some countries use 240 V (2.40×10^2 V) power supplies. How long will it take an electric kettle that has a resistance of 60.0 Ω to produce 4.32×10^5 J of thermal energy?

PRACTICE PROBLEMS MHR Pg. 719

27. Three loads, connected in series to a battery, have resistances of 15.0 Ω, 24.0 Ω, and 36.0 Ω. If the current through the first load is 2.2A, calculate

(a) the potential difference across each of the loads

(b) the equivalent resistance for the three loads

(c) the potential difference of the battery

28. Two loads, 25.0 Ω and 35.0 Ω, are connected in series. If the potential difference across the 25.0 Ω load is 65.0 V, calculate

(a) the potential difference across the 35.0 Ω load

(b) the potential difference of the battery

29. Two loads in series are connected to a 75.0 V battery. One of the loads is known to have a resistance of 48.0 Ω. You measure the potential difference across the 48.0 Ω load and find it is 40.0 V. Calculate the resistance of the second load.

30. Two loads, R_1 and R_2, are connected in series to a battery. The potential difference across R_1 is 56.0 V. The current measured at R_2 is 7.00 A. If R_2 is known to be 24.0 Ω, find

(a) the resistance of R_1

(b) the potential difference of the battery

(c) the equivalent resistance of the circuit

31. A 240 V (2.40×10^2 V) power supply is connected to three loads in series. The current in the circuit is measured to be 1.50 A. The resistance of the first load is 42.0 Ω and the potential difference across the second load is 111 V. Calculate the resistance of the third load.

PRACTICE PROBLEMS MHR Pg. 724

Draw a circuit diagram for each problem below. As an aid, write the known values on the diagram.

32. A 9.00 V battery is supplying power to three light bulbs connected in parallel to each other. The resistances, R_1, R_2, and R_3, of the bulbs are 13.5 Ω, 9.00 Ω, and 6.75 Ω, respectively. Find the current through each load and the equivalent resistance of the circuit.

33. A light bulb and a heating coil are connected in parallel to a 45.0 V battery. The current from the battery is 9.75 A, of which 7.50 A passes through the heating coil. Find the resistances of the light bulb and the heating coil, and the equivalent resistance for the circuit.

34. A circuit contains a 12.0 Ω load in parallel with an unknown load. The current in the 12.0 Ω load is 3.20 A, while the current in the unknown load is 4.80 A. Find the resistance of the unknown load and the equivalent resistance for the two parallel loads.

35. A current of 4.80 A leaves a battery and separates into three currents running through three parallel loads. The current to the first load is 2.50 A, the current through the second load is 1.80 A, and the resistance of the third load is 108 Ω. Calculate (a) the equivalent resistance for the circuit, and (b) the resistance of the first and second loads.

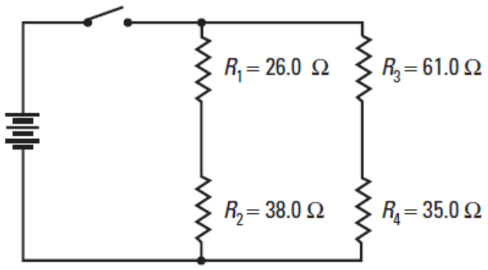
PRACTICE PROBLEMS MHR Pg. 728

36. For the circuit in the diagram shown below, the potential difference of the power supply is 144 V. Calculate

(a) the equivalent resistance for the circuit

(b) the current through R_1

(c) the potential difference across R_3

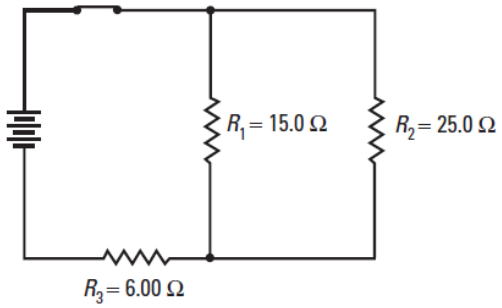


37. For the circuit shown in the diagram below, the potential difference of the power supply is 25.0 V. Calculate

(a) the equivalent resistance of the circuit

(b) the potential difference across R_3

(c) the current through R_1



PRACTICE PROBLEMS MHR Pg. 731

38. A battery has an *emf* of 15.0 V and an internal resistance of 0.0800 Ω.

(a) What is the terminal voltage if the current to the circuit is 2.50 A?

(b) What is the terminal voltage when the current increases to 5.00 A?

39. A battery has an internal resistance of 0.120 Ω. The terminal voltage of the battery is 10.6 V when a current of 7.00 A flows from it.

(a) What is its *emf*?

(b) What would be the potential difference of its terminals if the current was 2.20 A?

PRACTICE PROBLEMS MHR Pg. 737

40. An electric toaster is rated at 875 W at 120 V.

(a) Calculate the current the toaster draws when it is on.

(b) Calculate the electric resistance of the toaster.

41. A light bulb designed for use with a 120 V power supply has a filament with a resistance of 240 Ω.

(a) What is the power output of the bulb when the potential difference is 120 V?

(b) If the bulb is inadvertently connected to an 80.0 V power supply, what would be the power output of the bulb?

(c) If you wanted to construct a bulb to use with an 80.0 V power supply so that it would have the same power output as a 240 Ω bulb connected to a 120 V power supply, what should be the resistance of the bulb's filament?

42. A heater has a resistance of 15 Ω.

(a) If the heater is drawing a current of 7.5 A, what is its power output?

(b) If the current to the heater was cut in half, what would happen to the power output?

PRACTICE PROBLEMS MHR Pg. 740

43. **(a)** What is the power output of a 45 Ω resistance when connected to

- a 180 V power supply?
- a 270 V power supply?

(b) Find the ratio of the potential differences and the ratio of the power outputs. What is the relationship between the two ratios?

44. A load has a power rating of 160 W when the current in it is 6.0 A. What will be the power output if the current increases to 15 A?

45. **(a)** What is the power output of a circuit that consists of a 25 Ω resistance when connected to a 100 V supply?

(b) If a second 25 Ω resistance is connected in series with the first, what will be the power output of the circuit? Why has the power output of the circuit decreased?

PRACTICE PROBLEMS MHR Pg. 744

46. A filament in a light bulb rated at 192 W, has a resistance of 12.0 Ω. Calculate the potential difference at which the bulb is designed to operate.

47. An electric kettle is rated at 960 W when operating at 120 V. What must be the resistance of the heating element in the kettle?

48. If a current of 3.50 A is flowing through a resistance of 24.0 Ω, what is the power output?

49. A toaster that has a power rating of 900 W (9.00×10^2 W) draws a current of 7.50 A. If 2.40×10^5 J of electric energy are consumed while toasting some bread, calculate how much charge passed through the toaster.

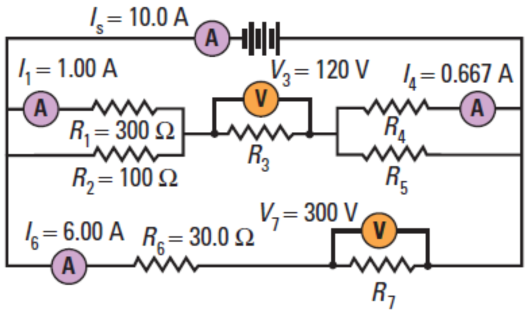
50. A floodlight filament has an operating resistance of 22.0 Ω. The lamp is designed to operate at 110 V.

(a) What is its power rating?

(b) How much energy is consumed if you use the lamp for 2.50 hours?

PRACTICE PROBLEMS MHR Pg. 748

18. In the circuit diagram below, values for some of the quantities for each part of the circuit are given. Calculate the missing currents, resistances, and the potential differences for each of the loads in the circuit. Find the equivalent resistance for the circuit and the power output for the circuit.



29. A load, R_1, is connected in series with two loads, R_2 and R_3, which are connected in parallel with each other. If the potential difference of the power supply is 180 V, find the current through and the potential difference across each of the loads. The loads have resistances of 25.0 Ω, 30.0 Ω and 6.00 Ω, respectively.

30. A motor draws a current of 4.80 A from a 36.0 V battery. How long would it take the motor to lift a 5.00 kg mass to a height of 35.0 m? Assume 100% efficiency.

31. A 45.0 m extension cord is made using 18 gauge copper wire. It is connected to a 120 V power supply to operate a 1.0×10^2 W-120 V light bulb.

(a) What is the resistance of the extension cord? (Remember that there are two wires to carry the current in the cord.)

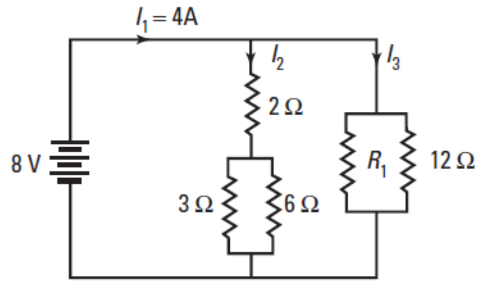
(b) What is the resistance of the filament in the light bulb?

(c) What is the current through the cord to the light bulb?

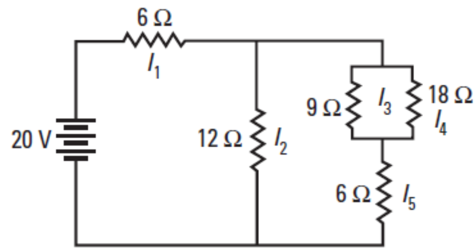
(d) What is the actual power output of the light bulb?

32. When a battery is connected to a load with a resistance of 40.0 Ω, the terminal voltage is 24.0 V. When the resistance of the load is reduced to 15.0 Ω, the terminal voltage is 23.5 V. Find the *emf* and the internal resistance of the battery.

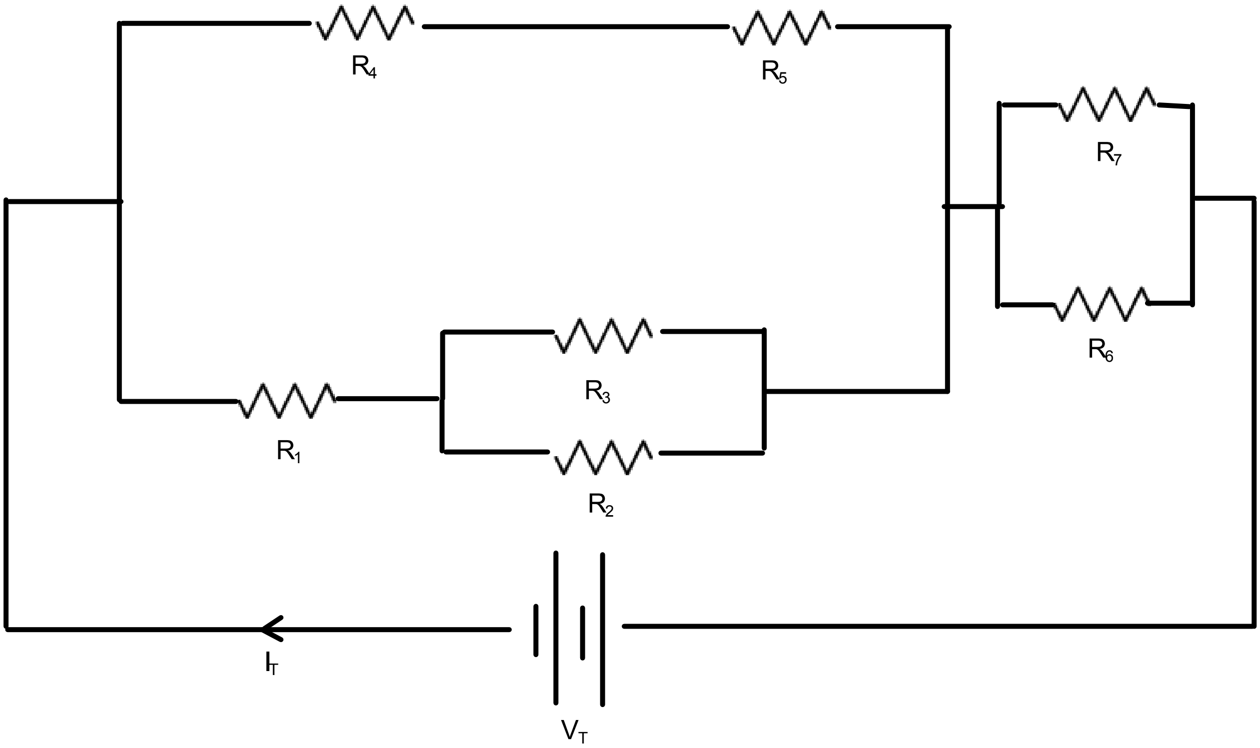
33. Find all of the missing currents and resistances and the equivalent resistance of the circuit.



34. Find all of the equivalent resistance of the circuit and the current through each resistor.

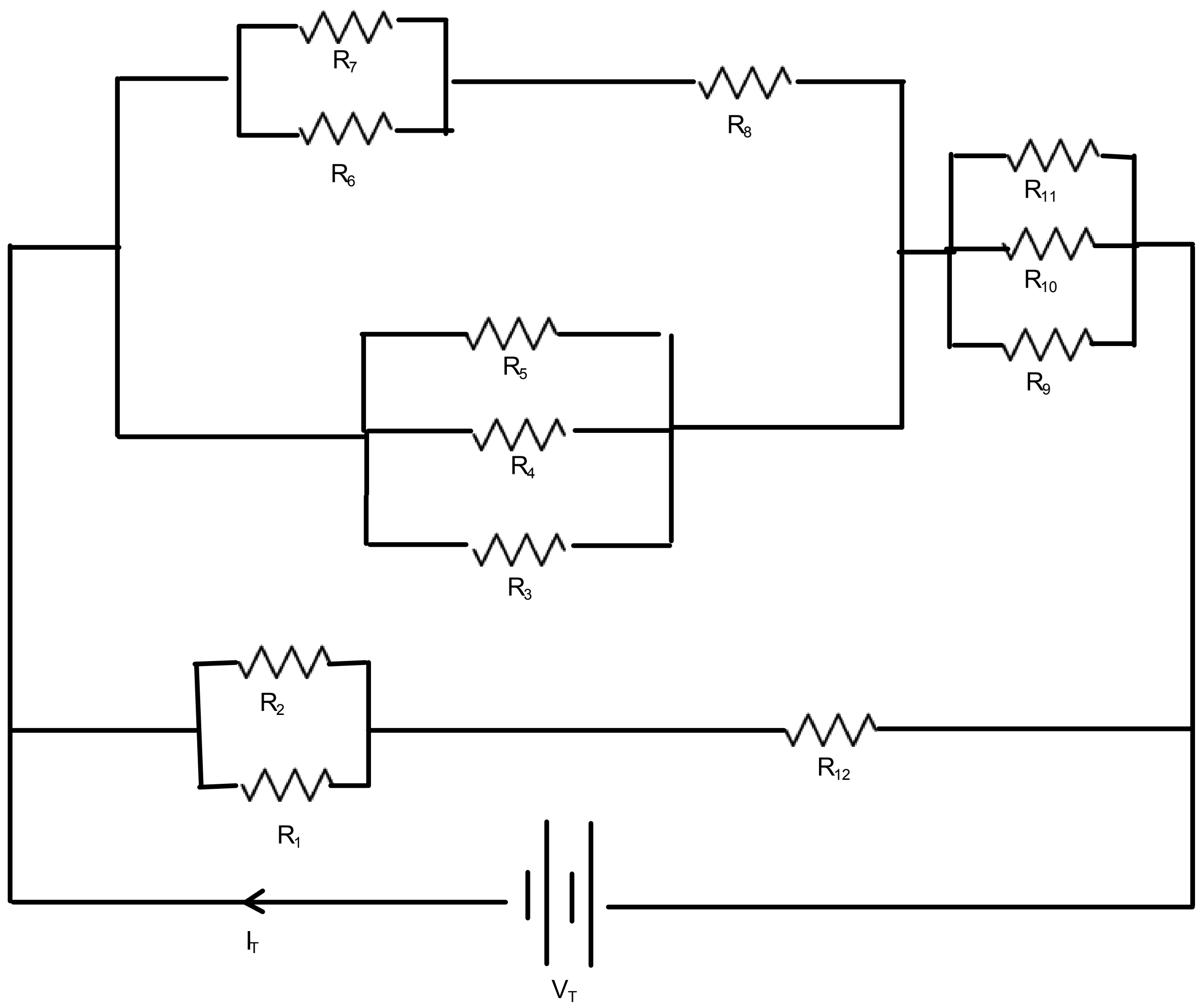


Practice: Fill in the V - I - R table given each resistor and the voltage of the battery.



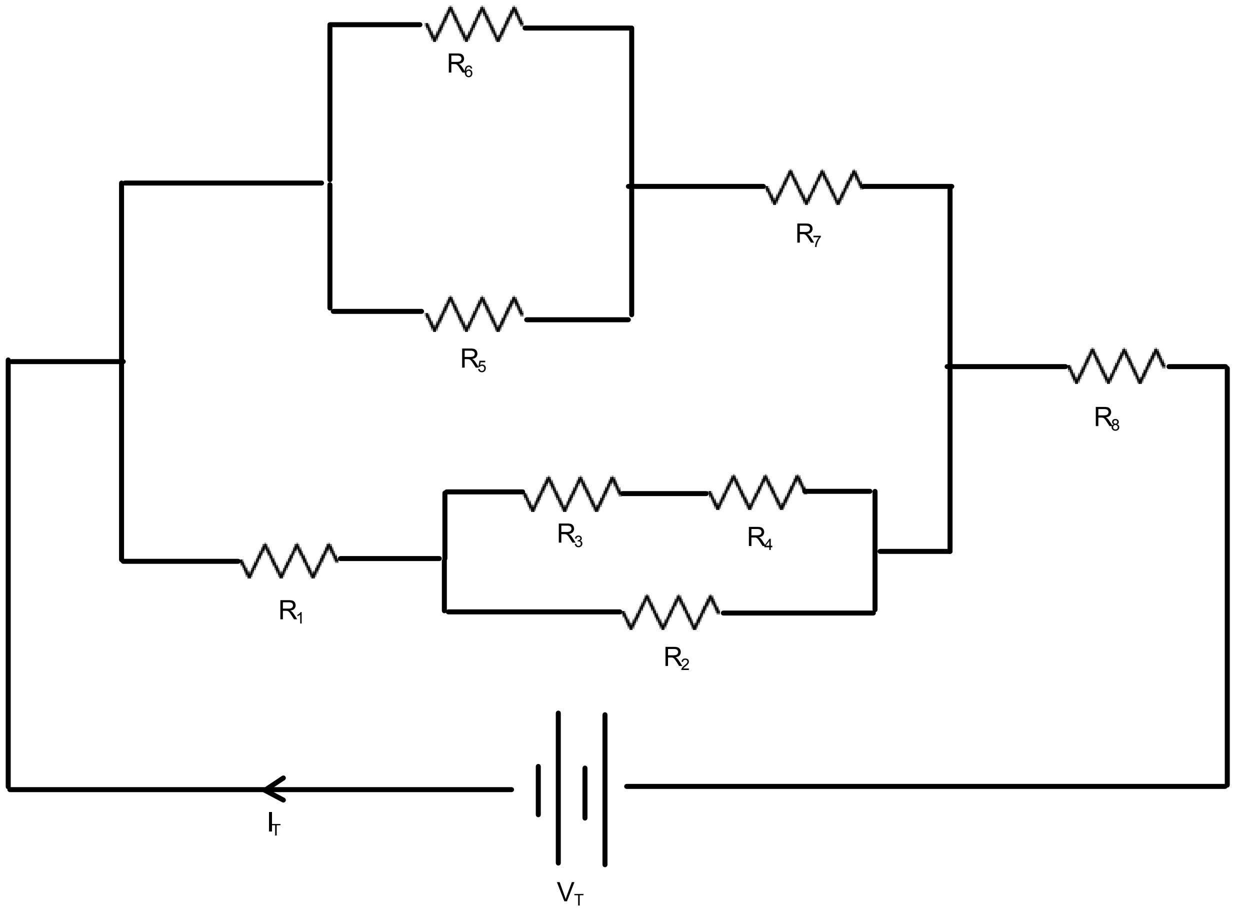
#	V (V)	I (A)	R (Ω)
1			3.0
2			8.0
3			4.5
4			2.5
5			5.5
6			6.0
7			6.0
	$V_T = 60$	$I_T =$	$R_{eq} =$

Practice: Fill in the V - I - R table given each resistor and the voltage of the battery.



#	V (V)	I (A)	R (Ω)
1			3.0
2			8.0
3			4.5
4			2.5
5			5.5
6			6.0
7			8.5
8			3.5
9			2.5
10			9.0
11			5.0
12			3.5
	$V_T = 70$	$I_T =$	$R_{eq} =$

Fill in the V - I - R table given each resistor and the voltage of the battery.



#	V (V)	I (A)	R (Ω)
1			2.0
2			5.0
3			4.0
4			6.5
5			3.0
6			2.0
7			1.5
8			3.5
	$V_T = 40$	$I_T =$	$R_{eq} =$

Practice Problems and Chapter and Unit Review Problems

Chapter 1 Review

Problems for Understanding

15. 2.6%

16. (a) 0.03%

17. (a) 11.5 Hz
(b) 11 Hz
(c) 11 Hz

Chapter 2

Practice Problems

1. –1.0 m/s

2. 1.2 m/s[N57°W]

3. (a) 0.29 m/s **(b)** 75 m or 175 m
(c) 75 m **(d)** 0.87 m/s

4. for linear segments: 2.5 m/s, –7.5 m/s, 0.0 m/s, 3.8 m/s

Chapter 2 Review

Problems for Understanding

15. (a) with respect to the ground
(b) with respect to the truck

17. (a) 17 km **(b)** 7.0 km[S]
(c) 7.0 km[N]

18. 26 km[W]

19. (a) 0.40 km [downstream]
(b) 0.53 km/h [downstream]

20. 4.35 years

21. (a) 11.4 km from Vectorville
(b) 0.571 h or 34.2 min

22. (a) uniform **(b)** non-uniform
(c) non-uniform **(d)** non-uniform
(e) uniform

24. -2.8 m/s^2

25. 2.7 m/s, 0.45 m/s^2

26. 2.0×10^1 m[E] from the foul line

28. (1) 0 to 3.0 s, **(2)** 3.0 to 8.0 s, **(3)** 8.0 to 12 s, **(4)** 12 to 18 s

30. (a) 41 km
(b) 28 km[W28°N]
(c) 46 km/h
(d) 31 km/h[W28°N]

Chapter 3

Practice Problems

1. 8.0 m/s^2

2. 2.5 m/s^2[up]

3. 24 m/s

4. (a) 5.0 m **(b)** 1.6 m/s^2

5. 34 s

6. 6×10^2 m

7. 10 m/s

8. (a) 4.0×10^2 km[E28°N]
(b) W28°S

9. (a) 5.0 km **(b)** E37°S

10. 5.8 km[18° away from the horizontal from the lookout]

11. (a) 62.6 km [W11.3°N]
(b) E11.0°S

12. (a) (i) 27 km[N] **(ii)** 24 km[N12°E]
(iii) 24 km[S12°W]
(b) (i) 27 km[N] **(ii)** 24 km[N12°E]
(iii) 6.0 km[W34°N]

13. 67 km/h [W48°N]

14. 346 km/h[E30.0°N]

15. 10 m/s in direction 7° away from the normal to the boards, towards the puck's initial direction

16. (a) 8.4 m/s[N7.1°W]
(b) 5.5 m/s[N40°E]
(c) 3.6 m/s[E57°N]

17. 5.7 km/h[S42°W]

18. (a) 48 km/h[W29°N]
(b) 1.2×10^2 km/h [E29°S]

19. 5.8×10^3 m[N23°W]

20. (a) 9.2 km[N24°W]
(b) 3.1 km/h[N24°W]

21. 1.8 m/s[downstream]

22. 12 m/s[S24°W]

23. (a) N20.5°E
(b) 227 km/h[N30.0°E]
(c) 1.10 h

24. (a) 1.6×10^2 km[W18°N]
(b) 3.0×10^2 km/h[N], 2.2×10^2 km/h[W], 2.5×10^2 km/h[S]
(c) 1.3×10^2 km/h[W18°N]

25. (a) N25°E **(b)** 69 s

26. (a) 2.1 km[W54°N]
(b) S54°E
(c) 2.4 h

27. (a) 1.6 m/s[E18°S]

Chapter 3 Review

Problems for Understanding

11. 3 m/s

12. –1.9 m/s

13. (a) 17 m/s **(b)** 2.8 m/s^2

14. (a) 27 m **(b)** 8.0 m/s

15. (a) -1.2 m/s^2 **(b)** 6.9 s

16. 1.2×10^2 m[down]

17. (a) 23 s **(b)** 550 m

18. (a) 71 km/h[SW]
(b) 3.9 m/s^2[SW] or 5.1×10^4 km/h^2[SW]

19. (b) 3.6 km[S34°W]

20. (a) 6.6 km[N31°W]
(b) 4.4 km/h[N31°W]

21. (b) 7.9 m/s[NW]

22. (a) 18 km[W24°S]
(b) 14 km/h[W24°S]

23. (a) 1.3 m/s[N] **(b)** 3.7 m/s[S]

24. (a) [E26°N] **(b)** 1.7 m/s[E]
(c) 47 min

25. 4.4 m/s[N5.4°E]

26. 12 km[W24°N]

27. (a) 2.0×10^1 km[N16°E]
(b) 9.9 km/h[N16°E]

28. 0.217 m/s^2[S19.7°W]

29. (a) He should aim upstream at an angle 41° with respect to the river bank.
(b) 2.3 min

Unit 1 Review

34. 13 km[E13°S]

35. 64 km/h[E51°S]

36. (a) 0.50 h **(b)** 55 km[S]
(c) 110 km/h[S]

37. (i) B **(ii)** C **(iii)** A **(iv)** D

38. (a) 3.7×10^2 km **(b)** 79 km/h

39. 7.2 s

41. (a) 0.4 km **(b)** 6 min
(c) 1 km

42. 2.5 m/s^2[N]

43. 5.0×10^1 m

44. 9.0 s

45. 20 s

46. (i) A **(ii)** C **(iii)** E

47. (a) 5.1 km[S28°E]
(b) 1.7 m/s[S28°E]

48. 1.8 m/s[N19°E]; 8.8×10^2 s; 5.3×10^2 m downstream

49. (a) 7.4 m/s[N] **(b)** 9.5 m/s[N]
(c) 5.3 m/s[N]

50. (a) Deke **(b)** 6.2 min

51. 4.9×10^2 m

53. 59 km/h[E17°S]

54. 45 km/h[E45°S]

55. Heading[N23.5°W]; 201 m/s[N30.0°W]

56. 1.9×10^4 m/s^2[N]

57. 6.8 m/s^2[NW]

58. 3.9 m/s[NE]

Chapter 4

Practice Problems

1. 23 N
2. (a) 66.722 kg (b) 656.03 N (c) 605.81 N
3. $W_{Earth} = 2.05 \times 10^3$ N, $W_{Moon} = 3.43 \times 10^2$ N
4. 3.25×10^{-2} m/s^2
5. (a) 5.89 N (b) 3.50 N; 0.595 (c) μ_k
6. (a) 1.23×10^3 N (b) 527 N (c) 264 N
7. 1.95×10^2 N
8. 0.34

Chapter 4 Review

Problems for Understanding

26. 11 kg
27. 90.4 N, 205 N
28. 1.2×10^2 N
29. 62%
30. 0.87
31. 2.0×10^2 kg
32. 49 N
33. 37.5% or a 171 N reduction
34. (a) 4.4×10^3 N (b) 1.5×10^3 N (c) 0.25

Chapter 5

Practice Problems

1. 0.55 m/s^2[E]
2. 0.53 m/s^2[E]
3. 1.7 kg
4. 1.6 m[N]
5. (a) 5.6 m/s^2[E] (b) 2.0×10^2 m[E]
6. 0.23
7. 9.6×10^{-13} N
8. 9.3 m/s
9. –7.7 m/s^2
10. (a) 0.249 N (b) 0.00127
11. 78 N
12. (a) 58 N (b) 16 m/s^2
13. 6.7 m
14. 40 N[N30°E]
15. (a) 43 N[E] (b) 7.4 N[N] (c) 15 N[E] (d) 15 N[W28°S]
16. (a) 1.4×10^3 N (b) 3.9×10^2 N
17. (a) $F_x = 120$ N, $F_y = -86$ N (b) 3.3×10^2 N (c) 38 N (d) 1.5 m/s^2
18. 1.6×10^3 N, 9.1×10^2 N
19. (a) 21 N (b) 15 N
20. (a) 74 N (b) 34 N
21. negative; 5.9×10^2 N
22. down (negative); 6.9×10^2 N
23. up (positive); 5.9×10^2 N
24. 15 m/s
25. (a) 1.2 m/s^2 (b) 0.16 m/s^2 (c) 12 s
26. 0.061
27. 0.34 m
28. 0.37
29. (a) 11.5 kg m/s[E] (b) 2.6×10^8 kg m/s[W] (c) 8.39×10^7 kg m/s[S] (d) 5.88×10^{-24} kg m/s[N]
30. 43.6 N·s[down]
31. 2.58×10^5 N·s[S]
32. 4.52×10^6 N[S]
33. 2.6 kg m/s[forward]
34. –38 kg m/s
35. 8.8 kg m/s[up]

Chapter 5 Review

Problems for Understanding

24. 0.4 m/s^2
25. (a) 3.8×10^2 N (b) 0.18 m/s^2
26. 50 N[E70°N]
27. (a) 0.80 m/s^2 (b) 16 N
28. (a) $v = 0$; $a = -9.8$ m/s^2 (b) 3.5 m/s; –9.8m/s^2
29. (a) 1.34 m/s^2 (b) 334 N
30. 1.2 N
31. (a) 0.062 m/s^2 (b) 0.40 m/s^2 (c) A friction force of magnitude 3.4 N operates to reduce the ideal acceleration ($a = F/m$)
32. 11 m
33. (a) 5.4 m/s[down] (b) 3.7×10^4 N[up]
34. 1.3 m/s^2
35. (a) $a_2 = 2.5a_1$ (b) $d_2 = 2.5d_1$
36. (a) 9.00 N (b) –132 N (c) 141 N (d) 0.451
37. 18 kg m/s[N]
38. 1.5×10^3 kg
39. 1.20 m/s[S]
40. 6.0×10^3 m/s[forward]
41. (a) 0.023 N·s[E] (b) 0.036 N·s[S]
42. 3.8×10^3 N
43. 3.6×10^{-2} s
44. (a) 16 kg m/s[S] (b) 6.4×10^{-3} s
45. 2.5×10^4 N[E]
46. 2.9×10^4 N[backward]

Unit 2 Review

29. (a) 4.70×10^2 N (b) 178 N (c) 1.24×10^3 N
30. (a) 3.7×10^2 N (b) 1.9×10^2 N
31. (a) 62 N (b) 31 N
32. 4.60×10^3[E]
33. 89.7 kg
34. 0.441 m/s[E0.0121°N]
35. (b) It would accelerate in the horizontal direction. (c) It would have constant velocity. (d) It would slow down and stop.
36. 1.2×10^2 N[up]
37. (a) 2.00 (b) 2.00
38. (a) 1.5×10^4 N (b) 3.8×10^3 N (c) 2.5 m/s^2 (d) 22 m/s = 81 km/h (e) 9.0 s
39. 2.0×10^2 N
40. 6.9×10^3 N
41. (a) 612 N (b) 437 N (c) 786 N (d) 612 N
42. (a) 1.7×10^2 N (b) 29 m/s
43. (a) 2.74×10^3 N[W] (b) 1.05×10^3 N[W]
44. 3.5×10^4 kg m/s[N]
45. (a) 6.6 kg m/s (b) 4.0×10^1 kg m/s (c) 3.0×10^3 kg m/s
46. (a) 9.6 kg m/s[N] (b) –17 kg m/s[N] (c) 17 kg m/s[S] (d) 2.6×10^2 N[N] (e) 2.6×10^2 N[S]
47. (a) 45 N (b) 42 m/s

Chapter 6

Practice Problems

1. 5.7×10^3 J; 42 m
2. 82 m
3. 2.30 m/s^2
4. 6.33 m
5. 225 N
6. 10.9 m
7. (a) 0 J (b) force is perpendicular to direction of motion
8. 3.00×10^2 J
9. (a) 0 J (b) no forces are acting so no work is done (velocity is constant)
10. (a) 0 J (b) the tree did not move, so Δd is zero

11. A. 180 J B. 65 J
C. 0 J D. ~230 J

14. (a) 4.1×10^3 J (b) -4.1×10^3 J
(c) gravity and applied force

15. raising: +126 J; lowering: –126 J

16. 1.9×10^3 J

17. 1.4×10^2 N

18. 40.0°

19. 81.1 J

20. 1.0×10^1 kg

21. 1810 J

22. 11.5 m/s

23. 4.1×10^6 m/s

24. 0.36 J; 3.6 N 6.35 kg

25. 6.35 kg

26. 3000 N; 40 M; 160 m; $d \propto v^2$

27. 87 J

28. 2.4×10^6 J

29. 4.08 m

30. 1.16 m

31. (a) 2370 J (b) 2370 J

32. 16.0 J

33. 1.51×10^6 J

34. (a) 1.59×10^5 J (b) 2.38×10^5 J
(c) 3.97×10^5 J

35. 5×10^2 N/m

36. (a) 0.414 m (b) –455 N

37. 0.0153 kg

38. 1.0 J

39. 0.30 m

40. 1.4 J

41. 1.5×10^2 W

42. 15.4 kW; 20.7 hp

43. No, the student will be 1.15 s late

44. (a) 75%
(b) into friction of moving parts

45. 25.5%

46. 19.0%

47. (a) $\text{Eff}_{\text{incand}} = 4\%$, $\text{Eff}_{\text{fl}} = 8\%$
(b) the florescent bulb heats up less than the incandescent bulb

48. 87.2%

49. (a) 66.3 J (b) 6.01 J (c) 90.9%

50. 34%

Chapter 6 Review

Problems for Understanding

15. (a) Ground pushes up, gravity pulls down, engine propels car forward, ground resists backward.
(b) The forward force (from the car's engine) does work.

16. 44 N

17. 3.50×10^2 J

18. 1.44×10^4 J

19. 6.2×10^2 J

20. 4.38 J

21. 5.0 m: 1.0×10^2 J, 13 m/s;
15.0 m: 5.8×10^2 J, 31 m/s;
25.0 m: 8.1×10^2 J, 36 m/s

22. 73°

23. the 55 kg athlete

24. (a) 3.2 m/s; 3.4×10^2 J

25. 5.0×10^1 kg

26. (a) 0.035 N (b) –0.025 J
(c) 0.025 J

27. (a) 16 J (b) 16 J

28. (a) 7.7×10^3 J (b) 6.7×10^3 J
(c) 9.4 m/s; 8.7 m/s
(d) infinity (no friction); 1.3×10^2 m

29. 2.6×10^3 J

30. 4.5×10^2 N/m

31. (a) 0.38 J (b) 9.6 N

32. 3.6 m/s

33. 2.3 m/s

34. 0.45 m

35. 0.096 m

36. 3.5×10^2 W

37. (a) 2.7×10^5 J (b) 2×10^6 J
(c) 4×10^6 J (d) 4.5×10^9 J

38. (b) 1.0 m/s^2 (c) 4.6 m
(d) 56 J (e) 18 W

39. 5 kW

Chapter 7

Practice Problems

1. 13 m/s
2. 7.7 m
3. 4.8 m
4. 5.1 m
5. $E_g = 4140$ J; $E_k = 4140$ J; $v = 5.12$ m/s
6. ball: 610 J, 22 m/s; shot: 13 J, 22 m/s
7. 1.0×10^1 m
8. 15 floors; 49.3 m/s 152 J
9. (a) 0.28 m (b) 1.3 m/s
(c) 17 m/s^2
10. 1.4×10^3 N/m
11. 57 m/s
12. (a) 80.4 m/s (b) 5.98 m/s
13. (a) 39.6 cm (b) 16.9 J
14. (a) 469 g (b) 65.2 cm
(c) 61.3 cm
15. 6.59×10^3 N/m
16. 0.42 m
17. (a) 405 N/m (b) 44.1 m/s^2
18. 11 m/s
19. 14.3 m/s
20. 7.40×10^2 J
21. (a) 11 J (b) 6.7 m/s
(c) 4.2 m/s
22. –7.4 J; –180 N
23. 43.1 m/s; 8.9%
24. 75 N
25. 2.7 m/s
26. 0.11 m/s[in the direction that car A was travelling]
27. 2.10 m/s[S]
28. 0.11 m/s[E]
29. -2.43×10^2 m/s
30. $v_2 = 6.32$ m/s[41.5° counterclockwise from the original direction of the first ball]; the collision is not elastic: $E_k = 12.1$ J; $E_k' = 10.2$ J
31. 1.24×10^5 kg km/h = 3.44×10^4 kg m/s[N39.5°W]; the collision was not elastic: $E_k = 3.60 \times 10^6$ kg km^2/h^2; $E_k' = 1.80 \times 10^6$ kg km^2/h^2

Chapter 7 Review

Problems for Understanding

20. 0.36 m
21. 17 J; 4.2 m/s
22. 30 m/s
23. 1.3 m/s
24. 0.77 m/s; 0.031 m
25. 5.0 m/s
26. (a) -8.7×10^2 J (b) –1.8 m
27. 3.1 m/s[E]
28. –2.3 m/s
29. 1.3 m/s[forward]
30. 0.17 m/s[forward]
31. (a) 0.21 m/s (b) 13 kg·m/s
(c) 95%

Unit 3 Review

38. 16.8 m/s
39. 31 m/s, 22 m/s, 18 m/s
40. (a) -5.8×10^3 J (b) 3.6
(c) yes, $\mu > 1$
41. (a) 6.1×10^3 N (b) 1.8×10^7 J
42. (a) 1.3×10^4 kg m/s
(b) -1.3×10^4 kg m/s
(c) -1.3×10^4 kg m/s
(d) 19 m/s
43. 260 m/s
44. (a) 780 J (b) It loses 780 J

45. -7.9×10^3 N

46. (a) 0.24 J (b) 48 J

47. (a) 0.32 m (b) 12 J

48. 15 kg

49. 60.0 m

50. (a) 1.46×10^4 J
(b) 1.46×10^4 J; 12.5 m/s

51. 3.1 m/s

52. (a) 0.47 m

53. (a) 6.0 N (b) 0.15 J (c) 0.023 J

54. 1.16×10^3 J. No, work is done by friction forces.

55. (a) 4.4 m/s (b) 3.5 m/s

Chapter 8

Practice Problems

1. 0.98 Hz; 1.0 s
2. 7.5 to 11 Hz
3. 29.7 s
4. 0.04 Hz; 2.5 s
5. 7.5 m/s; 0.80 s
6. 1.4×10^9 Hz
7. 3.1×10^{-4} Hz
8. (a) 8.80 Hz (b) 853 m
(c) constant frequency
9. (a) 1.34 m (b) 0.670 m

Chapter 8 Review

Problems for Understanding

21. 0.25 Hz

22. the wavelength doubles

23. 0.4 m

24. 1.67×10^{-2} Hz; 5.72 m

25. (a) 1.4 Hz (b) 3.7 cm/s

26. 1.6 Hz

27. 680 km

28. (a) 1.2 Hz (b) 0.84 s

29. (a) 1.02 s (b) 2.56%
(c) 225 h or 9.38 days
(d) shorten the pendulum

Chapter 9

Practice Problems

1. (a) 3.5×10^2 m/s (b) 3.4×10^2 m/s
(c) 3.5×10^2 m/s (d) 3.2×10^2 m/s
2. (a) 35.6 °C (b) 11.9 °C
(c) 5.1 °C (d) –20.3 °C
3. (a) 6.2×10^2 m
4. 0.005 s
5. 2.0×10^2 m
6. (a) 5.8 s (b) 6.7×10^{-6} m
(c) 2.8 km
7. 1.31, ice
8. 29.7°
9. 51°
10. 39.5°
11. 31.0°
12. 47.2°
13. 58.9°
14. 78.5°
15. 2.6 m
16. (a) 68 cm (b) 85 cm
17. (a) 96 cm, 160 cm
(b) 64 cm, 96 cm
18. 19 cm, 57 cm
19. 32 cm, 96 cm
20. (a) 1.34 m (b) 64 Hz
21. 512 Hz, 768 Hz
22. (a) 64.9 Hz (b) 130 Hz, 195 Hz
23. (a) 175 Hz (b) 1.97 m
24. (b) 6.00 Hz
25. 9.0 beats
26. 251 Hz or 261 Hz
27. (a) 443 Hz

Chapter 9 Review

Problems for Understanding

40. (a) 307 m/s (b) 3.3×10^2 m/s
(c) 343 m/s (d) 352 m/s

41. (a) 40.7 °C (b) 22.0 °C
(c) 3.39 °C (d) –22.0 °C

42. 4.0 °C

43. 7.0×10^2 m

44. (a) 436.5 Hz or 443.5 Hz
(b) If, as the string is tightened, the beat frequency increases, then the guitar was at 443.5 Hz, while if the beat frequency decreases, then the guitar was at 436.6 Hz.

45. (a) The human brain responds to harmonics, i.e. simple fraction ratios of pitch.

46. (a) Increases in pitch at specific, well-defined tube lengths.
(b) $L_1 = 0.098$ m, $L_2 = 0.29$ m, $L_3 = 0.49$ m, $L_4 = 0.68$ m

47. (a) 0.38 m (b) 9.0×10^2 Hz

48. The well is less than 176 m deep.

49. 0.062 m

50. 2.8×10^3 km/h

51. 1.3×10^2 m

52. Yes, with 0.03 s to spare.

53. (a) 55° (b) 110°

54. 56°

55. 38°

56. 1.95

57. 22.8°

58. The ray exits at 30°, 5.7 cm from the bottom corner (assuming it entered 3.5 cm from the same corner).

59. 2.4×10^{-9} s

60. (a) 1.2 (b) 11° (c) 39°

61. 22°

62. 68°

63. 4 cm

64. 4.8×10^2 nm

65. 589 nm

Unit 4 Review

Problems for Understanding

39. 3.0 m/s

40. 0.167 Hz

41. 0.8 m

42. 7.14×10^9 Hz

43. 0.73 m

44. 312 Hz

45. 0.259 m

46. 382.8 Hz or 385.2 Hz

47. 2.4 s

48. 2.00 m

49. –8 °C

50. 1.60×10^8 m/s

51. 1.0×10^{-9} s

52. 1.4

53. 25°

54. 15°

55. 1.39

56. 60°

57. 38.6°

58. 0.12 m; 2.5×10^9 Hz; 4.0×10^{-10} s

59. 2.1×10^5 Hz; 1.4×10^3 m

60. 5.5×10^{16} cycles

61. 1.5×10^2 m

62. 9.4607×10^{15} m

63. 8×10^{-7} m

Chapter 10

Practice Problems

1. (a) 4.1 m, 15 m
(b) -6.6 m/s^2, 4.6 m/s^2
(c) –11.3 m/s, –11.3 m/s
2. (a) 6.84 km, 18.8 km
(b) 2.6 m/s, –1.5 m/s
(c) –2.3 m/s, 6.4 m/s
3. 3.0×10^1 km[E], 5.2×10^1 km[N]
4. (a) 5.9 km[E34°?]
(b) [W56°N]
5. (a) W17°S
(b) 8.7 min

6. 15 m/s in a direction 4.9° to the shuttle
7. (a) 1.6×10^2 N[W58°S]
(b) 2.1×10^2 N[W16°N]
(c) 1.3×10^2 N[S50°W]
8. (a) 1.6×10^2 N[W58°S]
(b) 2.1×10^2 N[W16°N]
(c) 1.3×10^2 N[S50°W]
9. 1.5×10^3 N by each cable
10. (a) No (b) $> 1.7 \times 10^2$ N
11. (a) 20° (b) 0.028 m/s^2
12. 4.0×10^2 N
13. (a) $> 8.3 \times 10^2$ N (b) $> 7.3 \times 10^2$ N
14. –1.9 m/s^2
15. No, the climber must limit his descent to $a = -2.5$ m/s^2
16. (a) downward (b) –1.1 m/s^2
(c) 87 N
17. 1.7×10^2 N
18. 1.8 m/s^2
19. 0.49 m/s^2; 39 N
20. 14 kg; 75 N
21. 62 kg; 1.6 m/s^2
22. 17 N
23. Both of them will rise, with $a = +1.0$ m/s^2
24. (a) 3.88 N (b) 2.04 m/s^2
25. 0.67 s
26. 2.77 s
27. (a) 0.69 m/s (b) 0.81 N
28. (a) 0.91 N (b) 0.87 m/s^2
(c) 5.3 N
29. 65 N·m
30. 5.1×10^2 N·m
31. 1.1×10^3 N
32. 9.6×10^2 N
33. (a) 4.3×10^2 N (b) 6.7×10^2 N
34. 4.4×10^2 N
35. 6.4 m/s[40.0° counterclockwise]
36. 1.16 m/s[6.1° clockwise from original direction]
37. V_A = 34.3km/h[S];
V_B = 67.km/h[E]
38. 1.4 Kg, 2.6 m/s [83° counterclockwise from the *x*-axis]
39. V_2 = 6.32 m/s[41.5° counterclockwise from the original direction of the first ball]; the collision is not elastic: E_k = 12.1 J; E'_k = 10.2 J
40. 1.24×10^5 kg km/h =
3.44×10^4 kg m/s[N39.5°W];
the collision was not elastic:
$E_k = 3.60 \times 10^6$ kg km^2/h^2;
$E'_k = 1.80 \times 10^6$ kg km^2/h^2
41. 261 m/s
42. The cart will stop at 0.018 m; therefore, it will not reach the end of the track.
43. 55.5 km/h = 15.4 m/s
44. 18.2 m/s
45. 3.62 m/s; 1.71 m

Chapter 10 Review

Problems for Understanding

23. (a) N36°E (b) 1.5 m/s[E]
(c) 29s
24. (a) 1.0×10^2 N[E27°N]
(b) 34 N[S0.61°E]
(c) 1.5×10^2 N[67° counterclockwise from the *x*-axis]
25. 2.3×10^2 N [1.4° to the right of backward]
26. (a) No (c) 2.8 kg (d) 5.7 m/s^2
27. 3.9×10^2 N[up], 5.0×10^2 N[up]
28. (a) 8.58×10^3 N
(b) 1.00×10^4 N[43.3° cw from arm]
29. 4.4 m/s[35.2° clockwise]
30. (a) 0.29 m/s[W21°N]
(b) 70%

Chapter 11

Practice Problems

1. 677 m [before drop point]
2. 4.67 m/s
3. 89.6 m, 45.2 m/s [60.3° below the horizontal]
4. 0.156 m
5. 3.05 m/s
6. 0.55 m
7. 74 m
8. (a) 153 m
(b) 5.00 m/s [down]
9. 85 m
10. 4.0×10^1 m
11. 18 m/s [52° below the horizontal]
12. 2.8 m/s
13. (a) 58.9 m (b) 21.0 m (c) 4.14 s
14. 33.2°; 2.39 m; 1.40 s
15. 47.0 m/s
16. 2.7×10^2 m
17. (a) 48.6 N (b) 54.2 N (c) 9.62 m/s
18. 5.9×10^3 N
19. 84 m
20. 103 m
21. 13 m/s (47 km/h)
22. 19.1 m/s (68.8 km/h)
23. 20.1°

Chapter 11 Review

Problems for Understanding

15. (a) 3.0×10^1 m (b) 3.7 s
16. 2.7×10^2 m
17. (a) 2.1 s (b) 34 m
(c) 8.5 m [above the ground]
(d) v_x = 16 m/s; v_y = +3.8 m/s or –3.8m/s
(e) 38.2°
18. 52 m/s
19. Yes. It travels 330 m.
20. (a) 7.4 s (b) 67 m
(c) 1.2×10^2 m (d) x: 34 m, y: 53 m
(e) v_x = 17 m/s; v_y = –23 m/s
21. (a) 2.1 m/s (b) 1.2 m/s^2
22. (a) 1.33×10^{14} m/s^2
(b) 1.21×10^{-16} N
23. 0.33
24. 8.9 m/s
25. 33°
26. 9.90 m/s
27. 0.62
28. (a) 4.64×10^2 m/s
(b) 2.0 N (for m = 60.0 kg)
(c) Toward the centre of Earth; gravity
(d) mg = 589 N (for m = 60.0 kg)
(e) $N = mg - mv^2/r$ = 587 N
(f) $mg - N = ma_c$; because $mg > N$, there is a net acceleration toward the centre of Earth.

Chapter 12

Practice Problems

1. 3.58×10^{22} N
2. 1.99×10^{20} N
3. 5.1×10^{-3} m. This is much smaller than the radii of the bowling balls.
4. 3.61×10^{-47} N
5. 5.0×10^{24} kg
6. 0.25 m
7. $F_{Uranus} = 0.80 \times F_{Earth}$
8. 0.9 × Earth – Moon distance
9. 1.899×10^{27} kg
10. 1.472×10^{22} kg
11. 2.74×10^5 m
12. 1.02×10^3 m/s
13. (a) 6.18×10^4 s (17.2 h)
(b) 7.93×10^2 m/s
14. 4×10^{41} kg = $2 \times 10^{11} \times M_{Sun}$
15. 7.42×10^3 m/s; 8.59×10^5 m
16. 7.77×10^3 m/s; 5.34×10^3 s (89.0 min)

17. (a) 5.21×10^9 s (165 years); 5.43×10^3 m/s
(b) It will complete one orbit, after its discovery, in the year 2011.

Chapter 12 Review

Problems for Understanding

22. 1/8
23. (c) F
24. (b) a/3
25. (a) 3.0×10^4 m/s
(b) 6.0×10^{-3} m/s^2
26. 1.8×10^{-8} m/s^2
27. 9.03 m/s^2 = 92% of acceleration due to gravity at Earth's surface
28. 4.1×10^{36} kg = $2.0 \times 10^6 \times m_{Sun}$
29. 2.7×10^{-10} N
30. (a) 5.3×10^5 m
(b) 5.7×10^3 s = 95 min
31. 1.02×10^3 m/s; 2.37×10^6 s = 27.4 days
32. (a) Yes. (b) 5.69×10^{26} kg
33. (a) 4×10^{15} kg (b) 4×10^{27} kg
(c) $m_{Oort} = 700m_{Earth} = 2m_{Jupiter}$

Chapter 13

Practice Problems

1. 0.494 s
2. 17 N/m
3. (a) 0.253 s (b) 8.4 m/s
(c) 7.4 m/s
4. 8.2×10^4 N/m
5. (a) 71 N/m
(b) 0.897 s using k = 71.05 n/m
6. (a) $k = 2.2 \times 10^3$ N/m
(b) 0.98 s
7. 1.3 s
8. 4.0 m
9. 0.25 m
10. 0.88 s

Chapter 13 Review

Problems for Understanding

22. 0.245 s, 0.297 s, 0.42 s, 0.149 s, 0.181 s, 0.26 s
23. 0.48 s
24. (a) 0.82 J (b) 1.37 m/s
25. (a) 81 J (b) 8.0×10^2 N/m
(c) 0.13 s
26. 44 N/m
27. 0.21 s
28. 0.016 m
29. 0.097 m
30. 1.5 m/s

Unit 5 Review

33. 15 N[E19°S]
34. 1.4 m/s^2
35. (a) 7×10^3 N
(b) 9.15 × true weight
36. 17°
37. (a) 9.8×10^2 N (b) 13 km
38. (a) 33 m/s^2 (b) 23 N
39. (a) 21.3 m/s (b) 1.53 m
(c) down
40. (a) 4.4×10^2 N; 1 × weight
(b) 2.0×10^2 N; 0.45 × weight
(c) 4.4×10^2 N; 1 × weight
(d) 6.8×10^2 N; 1.5 × weight
41. 29 m/s
42. 4.2×10^3 m/s
43. (a) 4.6×10^2 m/s
(b) 7.9×10^2 m/s
44. 59.7 m
45. 44°
46. (a) 0.342 J (b) 1.45 m/s

Chapter 14

Practice Problems

1. 0.34 N
2. 0.80 m
3. 5.1×10^{-7} C
4. 0.50 N (attractive)
5. 0.17 N (repulsive)
6. 0.12 m (directly above the first proton)
7. $F_A = 1.2 \times 10^{-2}$ N[W73°S]; $F_B = 1.6 \times 10^{-2}$ N[E63°N]; $F_C = 4.6 \times 10^{-3}$ N[W36°S]
8. 8.7 N[E18°N]
9. 2.0×10^{-8} C
10. 7.9×10^{-8} C
11. 1.5×10^5 N/C (to the right)
12. 0.019 N[W]
13. 2.5×10^4 N/C (to the left)
14. -4.0×10^{-4} C
15. 3.8 N/kg[down]
16. 52 N[down]
17. 3.46 kg
18. 2.60 N/kg[down]
19. 2.60 m/s^2[toward centre]
20. -7.8×10^5 N/C (toward the sphere)
21. -1.2×10^{-5} C
22. 0.32 m
23. 5.80×10^9 electrons
24. -1.5×10^6 N/C (toward the sphere)
25. 0.080 m
26. 5.3×10^8N/C[81.4° above the $+x$-axis]
27. 1.9×10^4 N/C[86.7° above the $+x$-axis]
28. 3.4×10^6 N/C[23.7° above the $-x$-axis]
29. 2.25×10^{14} N/C (toward the negative charge)
30. 2.9×10^7 N/C[73.6° above the $+x$-axis]
31. 5.7×10^{-2} N/kg
32. 3.81×10^7 m
33. 8.09 N/kg[toward centre]
34. 5.82×10^{23} kg
35. 5.0×10^{-11} N/kg [toward centre]
36. 8.09 N/kg[toward centre]
37. 1.03×10^{26} kg
38. -4.7×10^{-2} J
39. 0.18 J
40. 5.1×10^2 m
41. 1.55×10^{-4} C. The signs of the two charges must be the same, either both positive or both negative.
42. 4.8×10^6 N/C
43. 1.5×10^{10} m
44. 2.9×10^{-5} J
45. -4.7×10^{-12} C
46. If the positive charge is placed at 0.0 cm and the negative charge is placed at 10.0 cm, there are two locations where the electric potential will be zero: 6.2 cm and 27 cm.
47. 1.1×10^6 V
48. 8.0 V
49. -2.1×10^6 V
50. 1.6×10^6 V
51. 1.4×10^{-6} C
52. 2.0 V
53. 12 J
54. -2.4×10^4 V
55. (a) 1.9×10^5 V
(b) 1.2×10^{-3} J
(c) A. It takes positive work to move a positive test charge to a higher potential. Since in this case, you invest positive work to move your positive test charge from B to A, A must be at a higher potential.
56. 5.3 cm and 16 cm to the right of the positive charge.
57. any point lying on a line midway between the two charges and perpendicular to the line that connects them
58. The potential is zero 3.4 cm above the origin and 24 cm below the origin.

59. If the distances of the first and second charges, q_1 and q_2, from the point of zero potential are d_1 and d_2, then d_2 must satisfy $d_2 = (-q_2/q_1)d_1$, with $q_2 > 0$. For example, if $q_2 = -8.0\mu C$, then $d_2 = 16$ cm and the charge would be located either 24 cm to the right of q_1 or 8.0 cm to the left of q_1. Other solutions can be similarly determined.

60. 4.0 cm to the right of the $-4.0\mu C$ charge.

Chapter 14 Review

Problems for Understanding

18. 9×10^3 N
19. 2.3×10^{-8} N
20. 5.6 cm
21. $F_A = 4.5 \times 10^{-2}$ N to the left; $F_B = 0.29$ N to the right; $F_C = 0.24$ N to the left
22. $F_A = 3.8$ N[N3.0°E]; $F_B = 4.4$ N[E23°S]; $F_C = 4.7$ N[W26°S]
23. $F_Q = 8.2 \times 10^{-8}$ N; $F_g = 3.6 \times 10^{-47}$ N
24. The charges on Earth (q_E) and the Moon (q_M) must satisfy $|q_E| \times |q_M| = 3.3 \times 10^{27}$ C^2, and they must have opposite signs.
25. 4.2×10^{42}
26. −57 C
27. 5.2×10^{-3} N
28. (a) 8.65×10^{25} kg
 (b) 8.81 N/kg
 (c) 881 N
29. 2/9 g_{Earth} = 2.18 N/kg
30. (a) 8.24×10^{-8} N
 (b) 2.19×10^6 m/s
 (c) 5.14×10^{11} N/C
 (d) 27.2 V
31. 1.86×10^{-9} kg $= 2.04 \times 10^{21} \times m_{actual}$
32. 9×10^{-5} N[W]
33. 0.51 m
34. 6.0×10^4 N/C[E37°N]
35. (a) -8×10^{-8} J
 (b) It loses energy.
36. -3×10^{-6} J
37. 2.8×10^2 C
38. (a) 4.5×10^3 V
 (b) Yes; the spheres have to be at equal potential, because the same point cannot have two different potentials.
 (c) big sphere: 52 nC; small sphere: 23 nC
39. (a) $E = 0$; $V = 2.2 \times 10^5$ V
 (b) $E = 4.3 \times 10^5$ N/C; $V = 0$
40. (a) 2.3 J (b) 1.2×10^6 V
 (c) X
41. (a) 4.0×10^5 V (b) R

Chapter 15

Practice Problems

1. 20.0 V
2. 0.378 J
3. 6.5×10^{-2} C
4. 40.0 V
5. 8.0 s
6. 4.23×10^3 J
7. 50 A
8. 57 s
9. 7×10^4 C
10. 2.8 A
11. 4.6×10^7 J
12. 0.133 A
13. (a) 9.38 A
 (b) 2.11×10^{22} elementary charges
14. 5.25×10^{20} elementary charges
15. (a) 3.3 A (b) 1.7 V
16. 2.2 Ω
17. 4.08 m
18. 1.6×10^{-6} m
19. 0.45 Ω
20. 2.4 mm
21. 16 Ω
22. 12.5 A
23. 5.0 V
24. (a) 9.9×10^2 C (b) 2.1 A
25. 11.6 Ω
26. 7.50 min
27. (a) 33 V, 53 V and 79 V respectively
 (b) 75 Ω (c) 1.6×10^2 V
28. (a) 91.0 V (b) 156 V
29. 42.0 Ω
30. (a) 8.00 Ω (b) 224 V (c) 32.0 Ω
31. 44.0 Ω
32. 0.667 A, 1.00 A and 1.33 A respectively; 3.00 Ω
33. $R_{coil} = 6.00$ Ω, $R_{bulb} = 20.0$ Ω, $R_S = 4.62$ Ω
34. $R_{unknown} = 8.00$ Ω, $R_S = 4.80$ Ω
35. (a) 11.2 Ω (b) 21.6 Ω, 30.0 Ω
36. (a) 38.4 Ω (b) 2.25 A (c) 91.5 V
37. (a) 15.4 Ω (b) 9.76 V (c) 1.02 A
38. (a) 14.8 V (b) 14.6 V
39. (a) 11.4 V (b) 11.2 V
40. (a) 7.3 A (b) 16 Ω
41. (a) 6.0×10^1 W (b) 27 W
 (c) 1.1×10^2 Ω
42. (a) 840 W
 (b) The power output drops to 1/4 its original value, or 210 W
43. (a) $P_a = 720$W, $P_b = 1.6 \times 10^3$ W
 (b) $P_a/P_b = 4/9$; $V_a/V_b = 2/3$; $P_a/P_b = (V_a/V_b)^2$
44. 1.0×10^3 W
45. (a) 400 W
 (b) 200 W. Increasing the resistance decreased the current for the given potential difference.
46. 48.0 V
47. 15 Ω
48. 294 W
49. 2.00×10^3 C
50. (a) 550 W (b) 5.0×10^6 J
51. 3.75 cents
52. 1.08 cents
53. (a) 1.4×10^2 W (b) 0.50 cents

Chapter 15 Review

Problems for Understanding

24. 3×10^3 Ω
25. (a) 12 A (b) 2.5×10^3 C
 (c) 3.0×10^5 J
26. 5.0×10^5 J
27. 1.77 cents
28. 37.5 Ω
29. $I_1 = 6.0$ A, $V_1 = 150$ V, $I_2 = 1.0$ A, $V_2 = 3.0 \times 10^1$ V, $I_3 = 5.0$ A, $V_3 = 3.0 \times 10^1$ V
30. 9.93 s
31. (a) 1.9 Ω (b) 1.4×10^2 Ω
 (c) 0.82 A (d) 98 W
32. 24.3 V, 0.517 Ω

Chapter 16

Practice Problems

1. 0.72 N[left]
2. 7.7 N[down]
3. 6.38 A[down]
4. 0.204 T[out of page]

Chapter 16 Review

Problems for Understanding

27. (a) 2 times increase
 (b) 9 times increase
 (c) 2 times increase

Unit 6 Review

38. 8.23×10^{-8} N

39. $\pm 14\ \mu C$

40. 1.5×10^4 electrons

41. 1.8×10^{13} C

42. -1.0×10^4 C

43. 0.12 m

44. 9.2×10^{-26} N

45. 1.1×10^{-5} C

46. 6.2×10^{12} electrons

47. (a) 0 J (b) -8.6×10^{-7} J
(c) equipotential surfaces

48. 0.10 T

49. 1.2 A (into page)

50. (a) 14 N[up] (b) 0

51. 4.00 Ω; 1.2 A, 5.0 V

52. Series 5.00 Ω; 1.2 A, 6.2 V
Parallel 5.00 Ω, 3.8 V; 7.5 Ω;
5 A, 3.8 V

53. (a) 17 V (b) 6.5 Ω (c) 14 V

Chapter 17

Practice Problems

1. (a) 4.8×10^{-13} s (b) 1.5×10^{-13} s
2. 257 s
3. $0.94c = 2.8 \times 10^8$ m/s
4. 702 km
5. 0.31 m
6. (a) 1.74×10^8 m/s
(b) The sphere's diameter appears contracted only in the direction parallel to the spacecraft's motion. Therefore, the sphere appears to be distorted.
7. 465 μg
8. 1.68×10^{-27} kg
9. $0.9987c = 2.994 \times 10^8$ m/s
10. 4.68×10^{-11} J
11. 1.01×10^{-10} J
12. 2.6×10^8 m/s
13. 7.91×10^{-11} J
14. 1.64×10^{-13} J
15. 1.3×10^9 J
16. 4.3×10^9 kg/s

Chapter 17 Review

Problems for Understanding

18. $0.87c$

19. (a) 3.2 m (b) 1.9 m
(c) 6.8×10^{-8} s

20. (a) 2.5×10^{-27} kg (b) 1.7×10^{-27} kg

21. plot

22. 3.0×10^2 m/s

23. (a) c (b) c (c) c

24. (a) 3.2 (b) 5.8×10^{-8} s
(c) 16 m

25. 1.2×10^{-30} kg, which is 1.3 times its rest mass

26. (a) 4.1×10^{-20} J (b) 4.1×10^{-16} J
(c) 1.3×10^{-14} J (d) 5.0×10^{-13} J
(e) (a) and (b)

27. $0.14c = 4.2 \times 10^7$ m/s

28. 3×10^4 light bulbs

29. 4.8×10^{-30} kg; $m/m_o = 5.3$;
$0.98c = 2.9 \times 10^8$ m/s

30. (a) 1.4 g (b) 29% or 0.40 g

Chapter 18

Practice Problems

1. (a) 2.40 J
(b) 1.25×10^{15} Hz
(c) UV
2. 1.26×10^{15} Hz
3. calcium
4. 275 nm $\le \lambda \le$ 427 nm
5. 4.28×10^{-34} kg·m/s
6. 9.44×10^{-22} kg·m/s
7. 4.59×10^{-15} m
8. 3.66×10^{25} photons
9. 1.11×10^{10} Hz; radio
10. 1.05×10^{-13} m
11. 7.80×10^{-15} m
12. 1.04×10^{-32} m
13. 2.39×10^{-41} m
14. 5.77×10^{-12} m
15. 2.19×10^6 m/s

Chapter 18 Review

Problems for Understanding

16. (a) 1.24×10^{15} Hz

17. (a) 2.900 eV
(b) lithium

18. 1.5×10^{15} Hz

19. 2.2 eV

20. 5.8×10^{18} photons/s

21. (a) 1.2×10^{-27} kg m/s
(b) 1.3×10^{-27} kg m/s
(c) 9.92×10^{-26} kg m/s

22. 1.7×10^{17} Hz

23. 5.5×10^{-33} kg m/s

24. (a) 3.1×10^{-7} m
(b) 6.14×10^{-10} m
(c) 4.7×10^{-24} kg m/s

Chapter 19 Review

Problems for Understanding

16. (a) 4.8×10^{-10} m
(b) -1.5 eV, This is the n = 3 energy level.

17. 486 nm

18. (a) 6.9×10^{14} Hz (b) 4.4×10^{-7} m
(c) -0.54 (d) 1.3×10^{-9} m
(e) 9.5×10^{-8} m

Unit 7 Review

Problems for Understanding

26. (a) $0.14c$ (b) $0.045c$

27. (a) 9×10^{16} J (b) 3×10^7 a

28. (a) 3.1 light-year (b) 4.7 a
(c) 6.3 a

29. (a) 1.1×10^{-13} J
(b) $1.3 \times$ rest mass energy
(c) 2.1×10^{-30} kg or $2.3 \times$ rest mass

30. (a) 3×10^9 J (b) 4×10^{-8} kg

31. 1.12 eV = 1.80×10^{-19} J

32. 4.7 eV = 7.5×10^{-19} J

33. (a) 1.05×10^{15} Hz
(b) 287 nm

34. (a) 1.25 nm (b) 0.153 nm

35. (a) 2.47×10^{15} Hz
(b) 1.22×10^{-7} m
(c) Lyman

36. 486 nm

37. (a) 3.0×10^{-19} J
(b) 8.1×10^{17} photons

38. (a) 6.91×10^{14} Hz
(b) 4.34×10^{-7} m
(c) -0.544 eV = -8.70×10^{-20} J
(d) 1.32 nm
(e) 9.49×10^{-8} m
(f) UV

Chapter 20

Practice Problems

1. 0.06066 u = 1.0073×10^{-28} kg
2. 1.237×10^{-11} J
3. 2.858×10^{-10} J
4. 2.6×10^9 a
5. 3.5×10^3 a
6. 8.49×10^{-8} mg

Chapter 20 Review

Problems for Understanding

12. **(a)** 20 p, 20 n, 18 e
(b) 26 p, 30 n, 26 e
(c) 17 p, 18 n, 18 e

13. **(a)** 1.4765×10^{-11} J
(b) 1.7927×10^{-10} J

14. ${}^{230}_{90}\text{Th} \rightarrow {}^{4}_{2}\text{He} + {}^{226}_{88}\text{Ra}$

15. **(a)** 1/4 **(b)** 1/16
(c) 1/4096

16. **(a)** 4.876 MeV
(b) $v_{He} = 1.520 \times 10^7$ m/s; $v_{Rn} = 2.740 \times 10^5$ m/s
(c) 98.1%

17. 1.19×10^{-7} g

18. 43 min

19. 1.2×10^4 a

20. **(a)** 200 **(b)** 600
(c) 25 **(d)** 775
(e) ${}^{D}N = {}^{P}N_0\left(1 - \left(\frac{1}{2}\right)^{\frac{\Delta t}{T_{\frac{1}{2}}}}\right)$, where ${}^{D}N$ is the number of daughter nuclei at any time t, ${}^{P}N_0$ is the number of parent nuclei at time $t = 0$, and $T_{\frac{1}{2}}$ is the half-life of the parent nucleus.

21. **(a)** $\frac{N_U}{N_{Pb}} = \frac{\left(\frac{1}{2}\right)^{\frac{\Delta t}{T_{\frac{1}{2}}}}}{1 - \left(\frac{1}{2}\right)^{\frac{\Delta t}{T_{\frac{1}{2}}}}}$
(b) 4.26×10^9 a; 3.89×10^9 a; 2.93×10^9 a
(c) Since the ratios and therefore the ages differ, the rocks must not have solidified at the same time.
(d) More than one half-life has elapsed.

Chapter 21

Practice Problems

1. 0.14168 u = 2.3527×10^{-28} kg; 2.114×10^{-11} J

2. 2.818×10^{-12} J

3. **(a)** 0.0265 u = 4.40×10^{-29} kg; 3.96×10^{-12} J
(b) 5.96×10^{11} J

Chapter 21 Review

Problems for Understanding

20. 8.194×10^{-14} J

21. ${}^{1}_{0}\text{n} + {}^{235}_{92}\text{U} \rightarrow {}^{90}_{37}\text{Rb} + {}^{144}_{55}\text{Cs} + 2\,{}^{1}_{0}\text{n}$

Unit 8 Review

26. **(a)** 3.96×10^{-12} J/reaction
(b) 9.68×10^{37} reactions/s
(c) 6.64×10^{-27} kg/reaction
(d) 6.43×10^{11} kg/s
(e) 9.82×10^{9} a

27. **(a)** 4.40×10^{-29} kg
(b) 0.6580%
(c) 1.18×10^{45} J
(d) 9.59×10^{9} a

28. 88.2 N

29. 5.9 days

30. 9.580×10^{-13} J