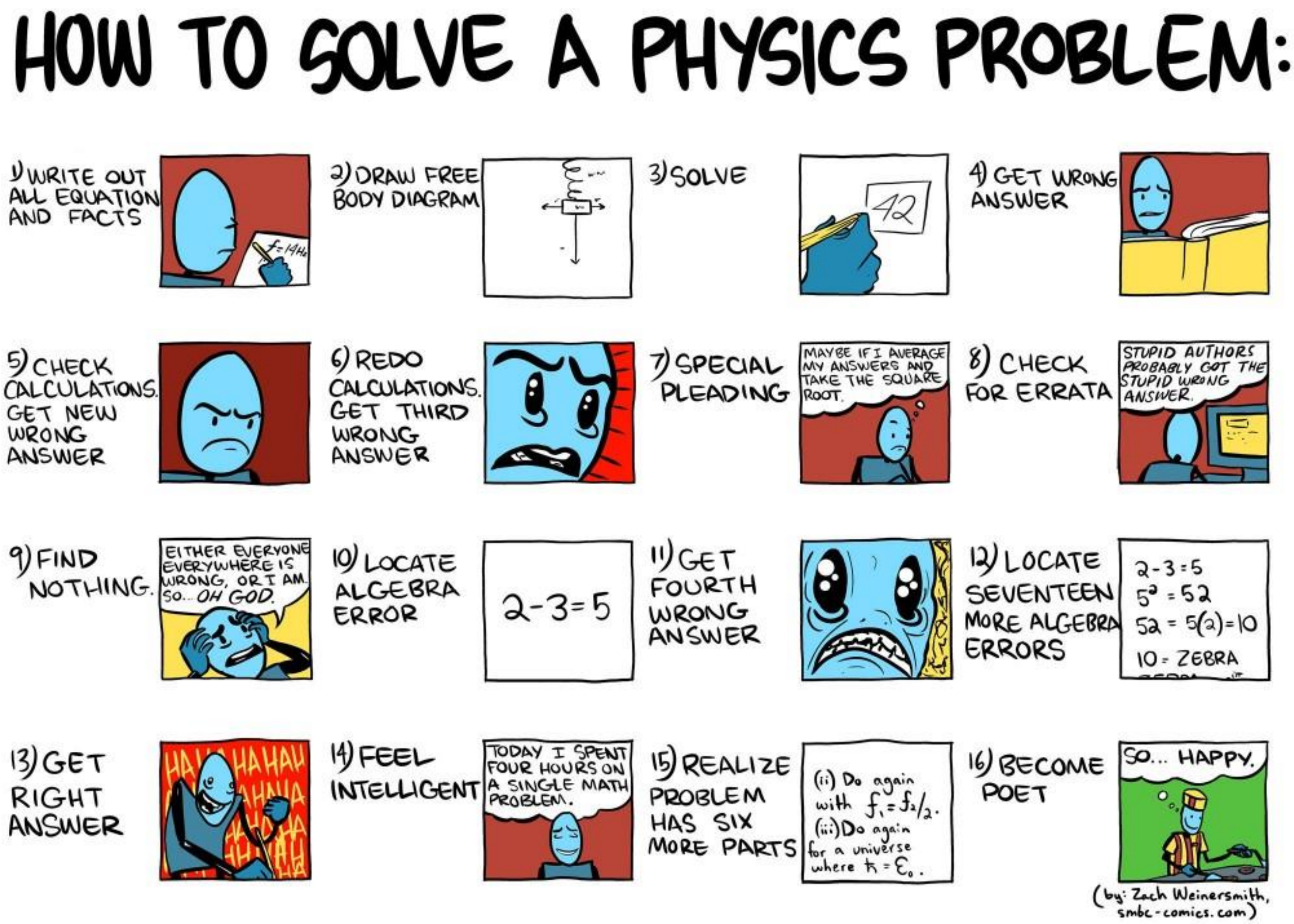
James M. Hill

Physics 112 Problem Set

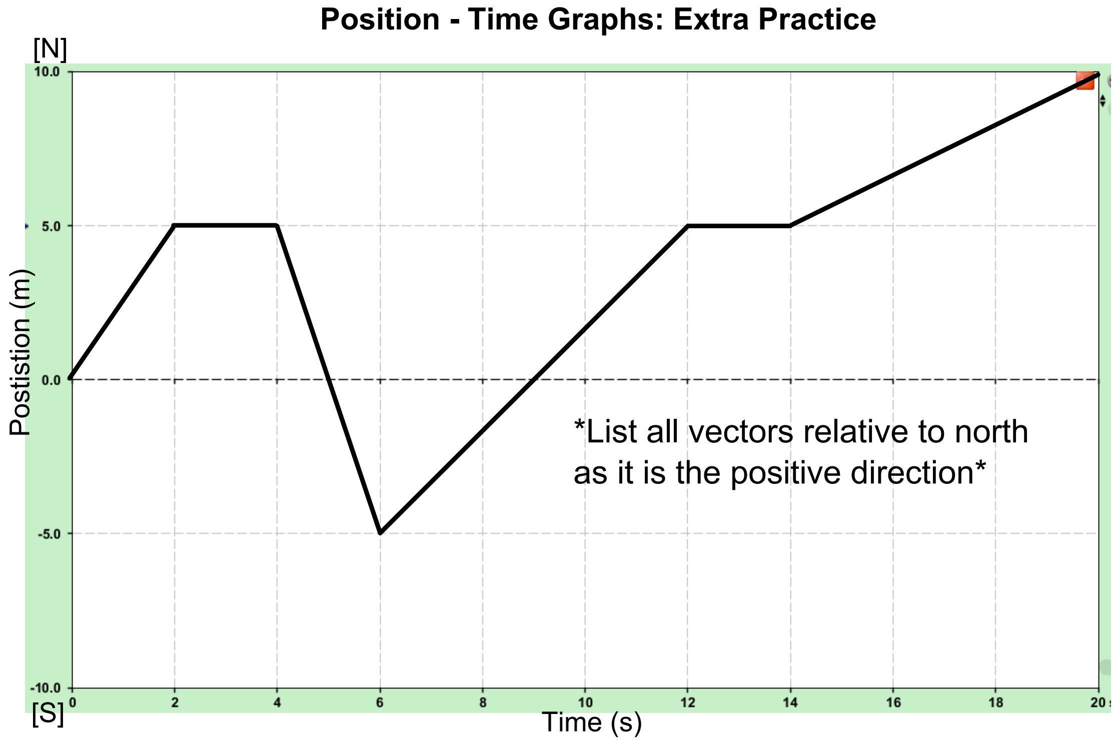


Mr. P. MacDonald

Motion: Position and Velocity

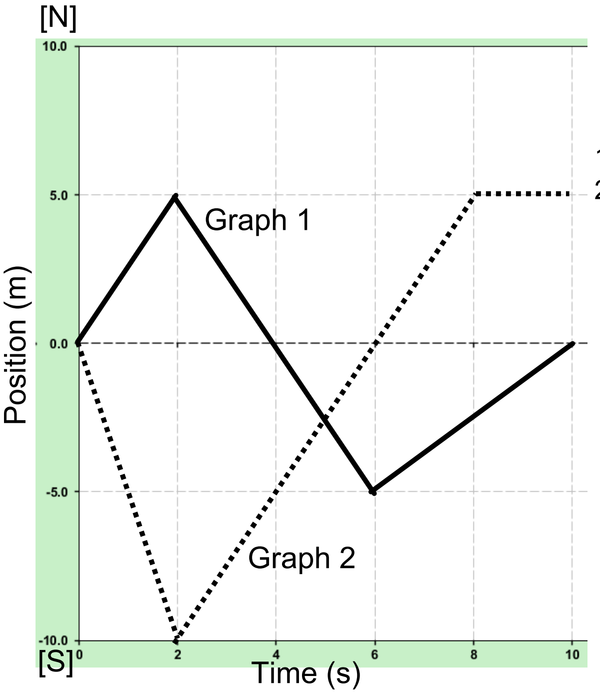
1. Describe why frame of reference is important and give two examples of how a choice of frame of reference can give two different results for the same object in motion.
2. Suppose you are in a car traveling 60 km/h East; relative to you, what is the velocity of the following cars (velocities given are relative to an observer on the side of the road)
   a. A bus is driving 35 km/h [E].
   b. A minivan is driving 50 km/h [E].
   c. A truck is driving 85 km/h [W].
   d. A police car is driving 100 km/h [W].
3. Define distance and displacement. In what situation are their magnitudes the same? Different?
4. What is the difference between position and displacement? Speed and Velocity?
5. In what situation are the magnitudes of speed and velocity the same? Different?
6. Give an example when an object's average velocity is zero but its average speed is not zero.
7. Suppose you drive between two cities called A and B (weird, I know) with an average velocity of ***v*** and it takes time ***t***.
   a. Now suppose you drive the same road between A and B but at twice the average velocity. Relative to the first trip how long did it take to drive?
   b. You have to drive one more time between A and B but this time it takes four times as long. Relative to the first trip what was your average velocity?
8. Sam is driving along the highway towards Saint John. He travels 150km in 3.00hrs. What is his average speed for his trip? (50 km/h)
9. A vehicle travels 2345 m [W] in 315 s toward the evening sun. What is its average velocity? (7.4 m/s [W])
10. What distance will a car, traveling 65 km/hr, cover in 3.0 hrs? (195 km)
11. How long will it take to go 150 km [E] traveling at 50 km/hr [E]? (3.0 hr)
12. What is the displacement of the Earth after one orbit about the Sun? What is the average velocity of the Earth after one orbit in m/s? (0 m; 0 m/s)
13. What is the average velocity of the Earth the instant it has traveled half of its circular orbit about the Sun in m/s? (v_{avg} = 19 025 m/s)
14. Calculate the average speed of the Earth about the Sun in m/s. (29 885 m/s)
15. How long will it take to travel 200 000 m [N] traveling 10 m/s [N]? (20 000 s)
16. A car drives 12 m/s [S] for 5.0 seconds, then 18 m/s [N] for 9.0 seconds, and finally 15 m/s [S] for 11 seconds. Calculate the average speed and average velocity. (v_{sp} = 15.5 m/s; v_{avg} = -2.5 m/s or 2.5 m/s [S])
17. A soccer ball is kicked 25 m [E], then 15 m [E], 8 m [W], and finally 12 m [E]. All this takes place in 45 seconds. Calculate the average speed and velocity of the ball. (v_{sp} = 1.3 m/s; v_{avg} = +0.98 m/s [E])

Position-Time Graphs Practice



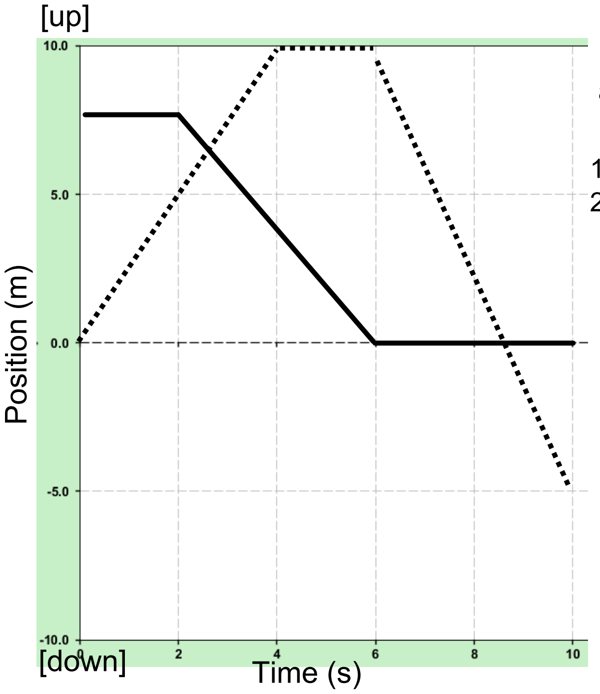
1. Calculate the velocity between 4 and 6 seconds.
2. Calculate the distance covered during the first 12 seconds.
3. Calculate the displacement from 2 to 6 seconds.
4. During which time interval was the highest speed obtained?
5. Other than the start, at what times was the object back at the origin?
6. Calculate the average speed between 6 and 20 seconds.
7. During what time interval(s) was the object traveling south?
8. Calculate the average speed and velocity during the first 6 seconds.
9. How long was the object not moving?
10. Calculate the average speed and velocity for the entire 20 seconds.

Describing the Motion of an Object from its Position - Time Graph



The graphs represent the position vs time analysis for two objects.

1. Write a description for the motion of object 1 and 2.
2. Calculate the average speed and velocity for each object for the full 10 seconds.



For this problem two objects move up and down and the time axis represents ground level.

1. Write a description for the motion of object 1 and 2.
2. Calculate the average speed and velocity for each object for the full 10 seconds.

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Acceleration Formula Practice

1. In words, what is the definition of acceleration? How do the units reflect this definition?
2. A car goes from 30 km/h [E] to 50 km/h [E]. What is the direction of the acceleration?
3. A truck goes from 90 km/h [E] to 45 km/h [E]. What is the direction of the acceleration?
4. Give two examples where an object has a non-zero acceleration but an instantaneous velocity of zero.
5. How does uniform acceleration differ from uniform motion?
6. Describe a situation where an object can have a constant speed and experience a non-zero acceleration?
7. A roller coaster car rapidly picks up velocity as it rolls down a slope. As it starts down the slope, its velocity is 4 m/s. But 3 seconds later, at the bottom of the slope, its velocity is 22 m/s. What is its average acceleration? (6.0 m/s^2)
8. A car accelerates at a rate of 3.0 m/s^2. If its original velocity is 8.0 m/s, how many seconds will it take the car to reach a final velocity of 25.0 m/s? (5.7 s)
9. A cyclist accelerates from 0 m/s to 8 m/s in 3 seconds. What is his acceleration? Is this acceleration higher than that of a car which accelerates from 0 to 30 m/s in 8 seconds? (2.7 m/s^2; No 3.75 m/s^2)
10. The final velocity of a car is 30m/s. The car is accelerating at a rate of 2.5m/s^2 over an 8 second period of time. What was the initial velocity of the car? (10 m/s)
11. If a Ferrari, with an initial velocity of 10 m/s, accelerates at a rate of 50 m/s^2 for 3 seconds, what will its final velocity be? (160 m/s)
12. A car traveling at a velocity of 30.0 m/s encounters an emergency and comes to a complete stop. How much time will it take for the car to stop if its rate of deceleration is -4.0 m/s^2? (7.5 s)
13. A cart rolling down an incline for 5.0 seconds has an acceleration of 4.0 m/s^2. If the cart has a beginning velocity of 2.0 m/s, what is its final velocity? (22 m/s)
14. A parachute on a racing dragster opens and changes the velocity of the car from 85 m/s to 45 m/s in a period of 4.5 seconds. What is the acceleration of the dragster? (-8.9 m/s^2)
15. A motorcycle traveling at 25 m/s accelerates at a rate of 7.0 m/s^2 for 6.0 seconds. What is the final velocity of the motorcycle? (67 m/s)
16. A skier accelerates at a rate of 4.6m/s^2 for 4.5s. What is his initial velocity if his final velocity is 21m/s? (0.3 m/s)

Acceleration: Taking into Account Direction

1. A car is initially driving 25 m/s up a large hill. On this hill it stalls and begins to coast. After 30 seconds its velocity is –13 m/s. Calculate the average acceleration acting on the car. (-1.27 m/s^2)

2. A glider is initially flying 62 m/s [N]. At head wind then blows and changes the gliders velocity to 45 m/s [S] in 65 seconds. Calculate the acceleration of the glider during that time. (-1.65 m/s^2 or 1.65 m/s^2 [S])

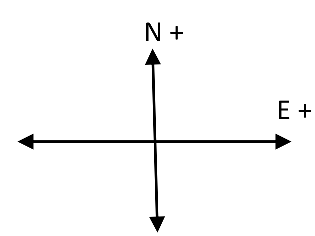
3. A ball is thrown straight up in the air. After 7.5 s the ball is on its way down and has a velocity of 14 m/s. Calculate the initial velocity of the ball. (+59.6 m/s or 59.6 m/s [up])

4. Calculate how long it takes for a car, undergoing an average acceleration of 5.6 m/s^2 [W], to change its velocity from 32 m/s [E] to 12 m/s [W]. (7.9 s)

5. A baseball is thrown with an initially velocity of 46 m/s [E]. After leaving the bat it is going 35 m/s [W]. Calculate the average acceleration of the ball if it was in contact with the bat for 0.34 seconds. (-240 m/s^2)

6. Standing atop a high building someone throws a coin straight up with an initial velocity of 26.5 m/s. Calculate is the coin's velocity after 1.5 seconds, 2.7 seconds, and 8.5 seconds. (11.8 m/s; 0.0 m/s; -57 m/s)

7. An electron is moving at 567 m/s [W] when a magnetic field is switch in. After 6.1 seconds the electron is now moving 241 m/s [W].
   a. Calculate the acceleration of the electron due to the magnetic field. (53 m/s^2 [E])
   b. If the acceleration stays constant, calculate the velocity of the electron after 22.6 seconds. (641 m/s [E])



1. A car accelerates from 15 m/s [E] to 25 m/s [W] in 26 seconds.
   a. Calculate the acceleration of the car. { $\vec{a}$ = –1.54 m/s^2}
   b. Calculate the displacement of the car during the above acceleration. {$\vec{d}_f$ = –130 m}
   c. Calculate the velocity of the car if it continues to accelerate for an additional 15 seconds. {$\vec{v}_f$ = –48.0 m/s^2}

2. A ball is kicked 20 m [E], 35 m [W], 50 m [E], and finally 10 m [W]. If all of this takes place in 52 seconds calculate:
   a. the average speed of the ball. {v_{sp} = 2.2 m/s}
   b. the average velocity of the ball. {$\vec{v}_{avg}$ = 0.48 m/s}

3. A person is standing atop a cliff that is 250 m high cliff overlooking the water below. Not happy with the new iPhone 5S she drops the phone. Hints: use the acceleration of gravity for the Earth; and when an object is dropped the initial velocity is zero.
   a. Calculate the time it takes for the iPhone to hit the water below. {t = 7.1 s}
   b. Calculate the velocity as it enters the water. {$\vec{v}_f$ = –70.0 m/s}
   c. Calculate the velocity of the iPhone 75 m above the water. {$\vec{v}_f$ = –58.6 m/s}

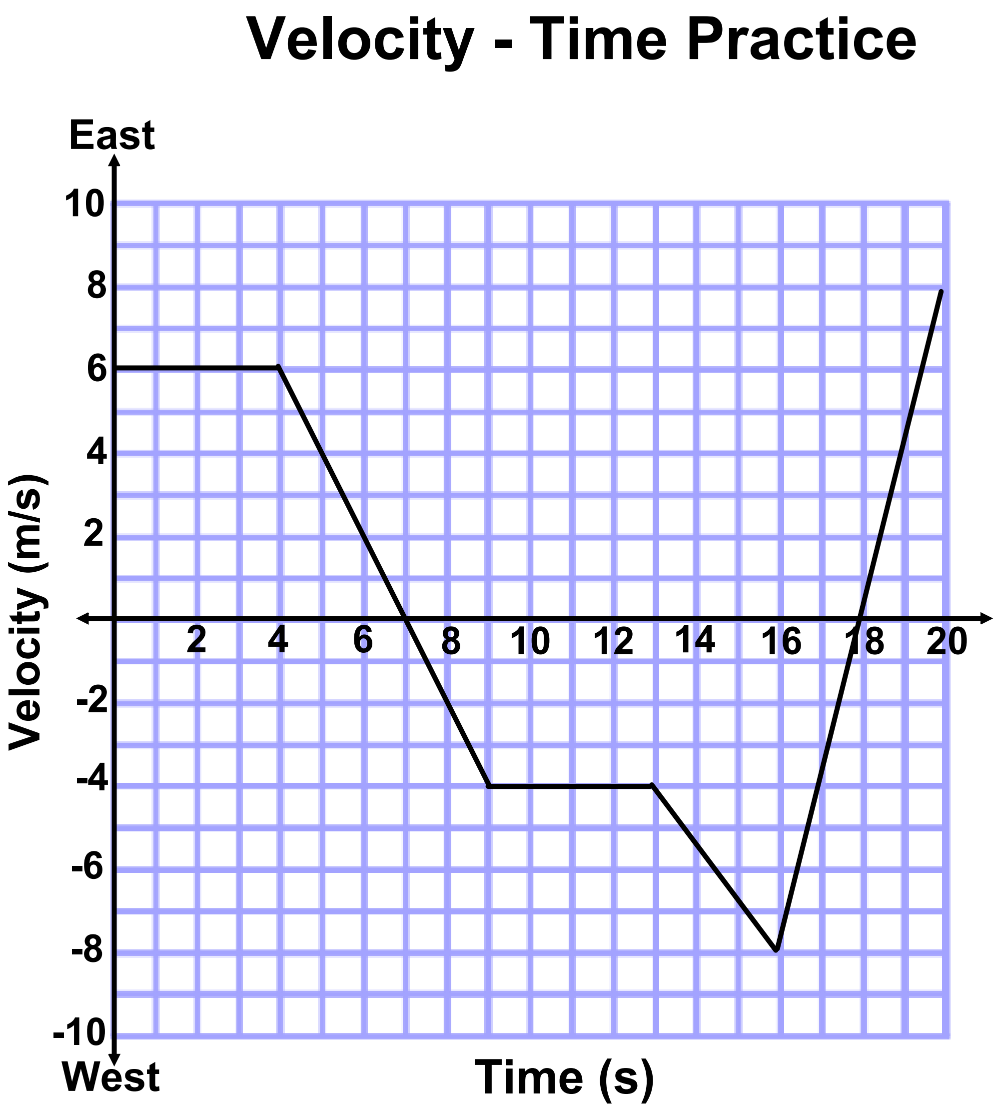
4. Standing on the ground a person throws a spear. It leaves his hand with an upward velocity of 21 m/s.
   a. Calculate the length of time the spear will be traveling upwards. {t = 2.1 s}
   b. Calculate the spear's maximum height. {$\vec{d}_f$ = 22.5 m}
   c. Calculate the velocity of the spear when it is 15 m above the ground. {$\vec{v}_f = \pm$12.1 m/s}

5. A plane changes its velocity from 215 m/s [S] to 300 m/s [N]. The acceleration was 5.72 m/s^2.
   a. Calculate the time it took for the plane to change its velocity. {t = 90.0 s}
   b. Calculate the displacement of the plane in that time. {$\vec{d}_f$ = 3830 m}
   c. Calculate the distance the plane traveled in that time. Hint: find the distance the plane traveled in both the South and Northern directions. {d = 11 900 m}

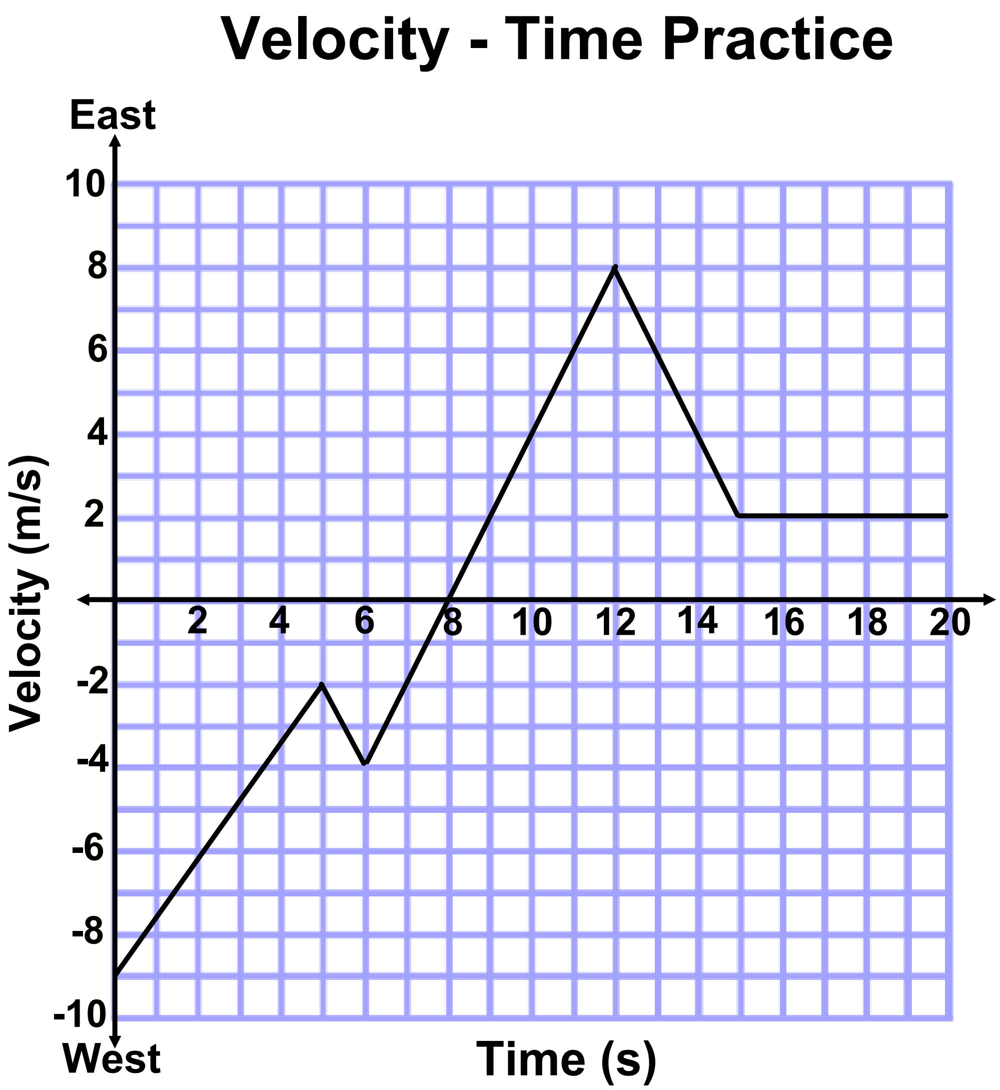
6. A fighter jet initially flying 250 m/s [E] turns to fly a supersonic 400 m/s [W]. This happens in 12 seconds.
   a. Calculate the acceleration of the plane. {$\vec{a}$ = –54.2 m/s^2}
   b. Calculate the displacement of the plane in that time. {$\vec{d}_f$ = –900 m}
   c. Calculate the distance traveled by the plane in that time. {d = 2050 m}

7. A cannonball is fired from a 250 m high cliff towards a galleon. Its vertical, upward, velocity is 75 m/s.
   a. Calculate the maximum height above the water the cannonball reaches. {$\vec{d}_f$ = 536 m}
   b. Calculate the vertical velocity with which the cannonball strikes the galleon. {$\vec{v}_f$ = –103 m/s}
   c. Calculate the length of time the cannonball takes to travel from the cannon to the galleon. {t = 18.1 s}

8. A car is driving around a circular track. The track has a radius of 100 m. Starting from rest it accelerates to 30 m/s in 12 seconds then holds a constant speed of 30 m/s.
   a. Calculate the distance moved along the track during the acceleration. {d = 180 m}
   b. Calculate the average speed and velocity when the car is half way around the track. {v_{sp} = 19.0 m/s; $\vec{v}_{avg}$ = 12.1 m/s}
   c. Calculate the average speed and velocity when the car has returned to its starting position. {v_{sp} = 23.3 m/s; $\vec{v}_{avg}$ = 0.0 m/s }
   d. **Challenge**: Calculate the average velocity during the car's first 12 and 20 seconds of motion. {$\vec{v}_{avg}$ = 6.5 m/s; $\vec{v}_{avg}$ = 4.3 m/s }



1. What is the instantaneous velocity at the 14.5 second mark?
2. Calculate the distance traveled during the first 4 seconds.
3. During what time interval(s) was the acceleration opposite the direction of motion?
4. Calculate the displacement between 4 and 9 seconds.
5. Calculate the average speed between 4 and 9 seconds.
6. Calculate the total distance traveled during the 20 seconds.
7. Calculate the position of the object at the 20 second mark.
8. Calculate the average speed and velocity for the full 20 seconds.
9. Assume the object started at position (0,0). Without extensive calculations, estimate at what point in time the object had instantaneously returned to its starting position.

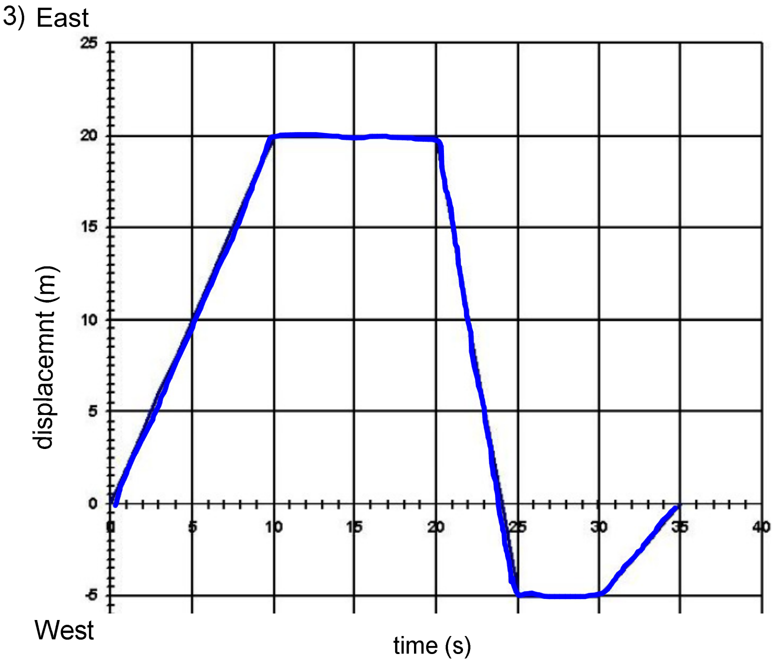


1. What is the instantaneous velocity at the 14.5 second mark?
2. Calculate the distance traveled during the first 5 seconds.
3. During what time interval(s) was the acceleration opposite the direction of motion?
4. Calculate the displacement between 6 and 12 seconds.
5. Calculate the average speed between 6 and 12 seconds.
6. Calculate the total distance traveled during the 20 seconds.
7. Calculate the position of the object at the 20 second mark.
8. Calculate the average speed and velocity for the full 20 seconds.
9. Assume the object started at position (0,0). Without extensive calculations, estimate at what point in time the object had instantaneously returned to its starting position.

More Practice & Review

1) Use a scale diagram to find the resultant of 90 km [W35°S], 60 km [E], and 70km [W75°N]

2) Calculate the resultant of 58 m [N], 12 m [S], 45 m [E], and 112 m [W].

3)


(a) What was the instantaneous velocity at *t* = 7.25 s?

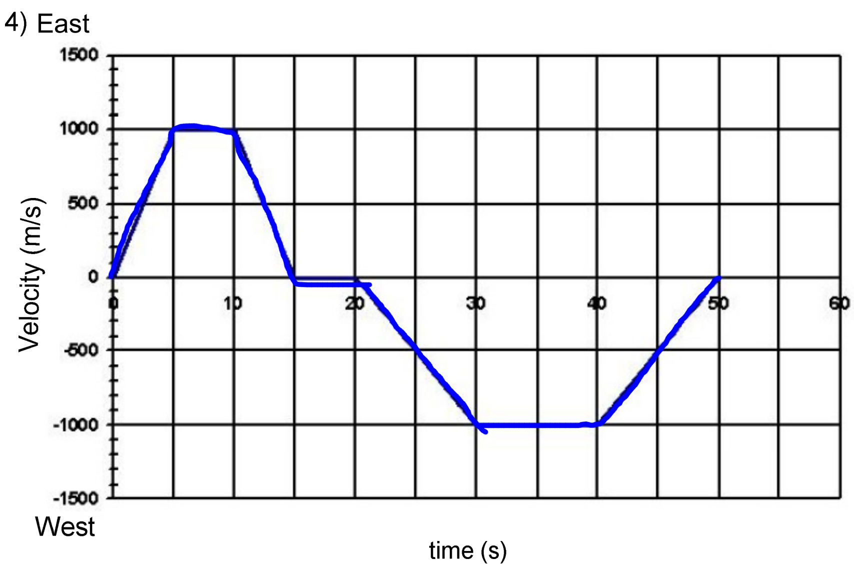
(b) What was the displacement at t = 35 s?

(c) What was the distance travelled during the 35 s trip?

(d) What was the average speed for the entire trip? Average velocity?

(e) What was the instantaneous velocity at *t* = 21.83 s?

(f) What was the average velocity for the first 25 s?

4)


(a) Determine the displacement and distance traveled.

(b) Determine the average speed and velocity.

(c) What was the instantaneous acceleration at *t* = 42.3 s? at *t* = 24.8 s?

5) A car accelerates from rest to 32 m/s [E] in 12.5 s. (a) Find the average acceleration. (b) What distance is does this car cover in that time?

6) A plane lands with a velocity of 47 m/s [E]. It takes 17 s to stop. (a) What was the average acceleration of the plane? (b) What distance was required to stop?

7) A police car initially at 100 km/h [E] accelerates at 5 km/h/s [E] (your speed increases by 5 km/h each second) for 8.9 s. (a) What is the final velocity of the car? (b) What distance was covered during the acceleration?

8) A car traveling at 25 m/s [E] accelerates to 10 m/s in 5.0 s. (a) What is the acceleration of the car? (b) What distance was covered in that time? (c) What distance is need to come to a stop? (hint: find the time needed to come to a stop first)

Introduction to Forces

1. Define inertia.

2. Describe inertial and gravitational mass.

3. Suppose a baseball and a table-tennis ball were traveling with the same velocity and you caught one in each hand – which would hurt more and why?

4. Forces break down in to which two groups? Give three examples of each.

5. Define and compare an object's weight and mass.

6. In the formula for the force of gravity, how is the distance between masses accounted for?

7. Is the force of gravity acting on objects in Earth's orbit?

8. Suppose you are on the ISS (which would be awesome), would you need to push a 50 kg object with a different force than a 100 kg object? Explain.

1. Find the weight of a 2.3 kg bowling ball on Earth.
2. You have a weight of 652.58 N[down] while standing on a spring scale on Earth near the equator.
   (a) Calculate your mass.
   (b) Determine your weight on Earth near the North Pole.
   (c) Determine your weight on the International Space Station. Why would this value be impossible to verify experimentally?
3. The lunar roving vehicle (LRV) pictured here has a mass of 209 kg regardless of where it is, but its weight is much less on the surface of the Moon than on Earth. Calculate the LRV's weight on Earth and on the Moon.
4. A 1.00 kg mass is used to determine the acceleration due to gravity of a distant, city-sized asteroid. Calculate the acceleration due to gravity if the mass has a weight of 3.25×10^{-2} N[down] on the surface of the asteroid.

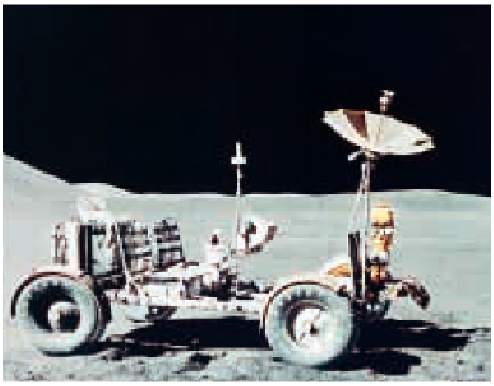


Table 4.3 Free-Fall Accelerations Due to Gravity on Earth

Location	Acceleration due to gravity (m/s^2)	Altitude (m)	Distance from Earth's centre (km)
North Pole	9.8322	0 (sea level)	6357
equator	9.7805	0 (sea level)	6378
Mt. Everest (peak)	9.7647	8850	6387
Mariana Ocean Trench* (bottom)	9.8331	11 034 (below sea level)	6367
International Space Station*	9.0795	250 000	6628

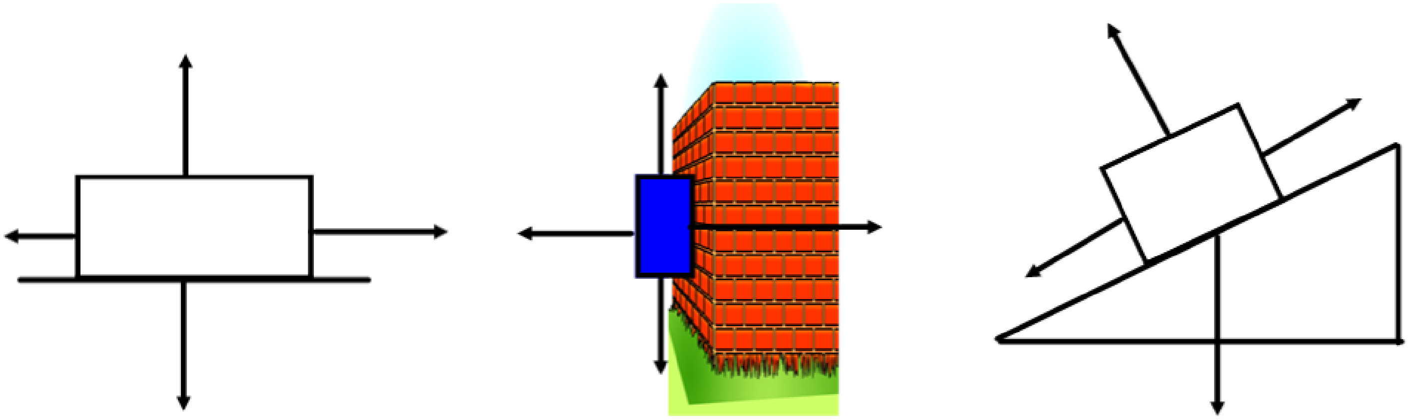
*These values are calculated.

Table 4.4 Free-Fall Accelerations Due to Gravity in the Solar System

Location	Acceleration due to gravity (m/s^2)
Earth	9.81
Moon	1.64
Mars	3.72
Jupiter	25.9

Force of Friction Review Questions

1. In the diagrams below, label the force of friction and normal force by the appropriate arrows.



2. Summarize what physical process causes friction.

3. How does friction depend on surface area between the two objects rubbing together? Think of a case where surface area could play a significant role in the force of friction.

4. Summarize the three situations when basic surface friction theory will not be applied.

5. Why will two identical pieces of smooth metals not fuse together?

6. What are the two types of friction? For two given surfaces which force of friction is greater?

7. Suppose you apply a force to a heavy object. Describe how the two forces of friction affect the object’s motion.

8. A textbook is sitting on a desk. Is there a force of friction present? Provide an explanation.

9. In what direction does friction always act?

10. Describe how heat is created when two surfaces are rubbed together.

Physics 112: Force Practice

1. A 25 kg crate is pulled at a constant velocity with an applied force of 125 N.
   a. Calculate the force of friction. (-125 N)
   b. Calculate the normal force on the crate. (245 N)
   c. Calculate the coefficient of kinetic friction. (0.51).

2. A sled has a weight of 75 N and is being pulled with a net force of 15 N. The coefficient of kinetic friction is 0.19.
   a. What is the mass of the sled? (7.6 kg)
   b. What is the force of friction? (14.25 N)
   c. What is the applied force? (29.25 N)

3. A 55 kg box is moved with a net force of 28 N. The applied force necessary is 185 N.
   a. What is the force of friction? (-157 N)
   b. What is the normal force? (540 N)
   c. What is the coefficient of kinetic friction? (0.29)

4. A box is being pulled across the floor at a constant velocity with an applied force of 184 N. The coefficient of kinetic friction is 0.26.
   a. What is the force of friction? (-184 N)
   b. What is the force of gravity on the box? (708 N)
   c. What is the mass of the box? (72.2 kg)

5. A 46 kg object is being pulled with an applied force of 200 N. The coefficient of kinetic friction is 0.18.
   a. What is the force of gravity on the object? (451 N)
   b. What is the force of friction acting on the object? (81 N)
   c. What is the net force acting on the object? (119 N)

6. A box is being pulled across the floor at a constant velocity with an applied force of 250 N. The coefficient of kinetic friction is 0.16. What is the mass of the box? (159 kg)

7. A 37 kg crate is pulled at a constant velocity with an applied force of 145 N. Calculate the coefficient of kinetic friction. (0.40)

8. A 39 kg object is being pulled with an applied force of 133 N. The coefficient of kinetic friction is 0.25. What is the net force acting on the object? (37 N)

9. A 42 kg box is moved with a net force of 52 N. The applied force necessary is 210 N. What is the coefficient of kinetic friction? (0.38)

10. A sled has a weight of 166 N and is being pulled with a net force of 27 N. The coefficient of kinetic friction is 0.24. What is the applied force? (67 N)

11. A 6.2 kg book is pressed against the wall. The coefficient of static friction between the book and wall is 0.16. Calculate the minimum applied force necessary to keep the book from slipping down. (380 N)

12. A 14.7 kg box is pressed up against the wall using an applied force of 600 N. For the box not to fall, calculate the minimum coefficient of static friction necessary between the wall and the box. (0.24)

13. A 22 kg box held up against a wall. The coefficients of friction are μ_s = 0.39 and μ_k = 0.27. Calculate the minimum applied force necessary to support the box on the wall. After a period of time the applied force is 300 N, calculate the vertical net force on the crate. (554 N; 135 N [down])

14. A 15 kg box is pressed on a wall. The net force acting on the box is 294 N [down] when the horizontal pushing force is 275 N. Calculate the coefficient of kinetic friction. (0.32)

Physics 112: Force Practice #2

1. A box is being pulled across the floor at a constant velocity with an applied force of 333 N. The coefficient of kinetic friction is 0.26. What is the mass of the box? (130 kg)

2. A 22 kg crate is pulled at a constant velocity with an applied force of 161 N. Calculate the coefficient of kinetic friction. (0.75)

3. A 28 kg object is being pulled with an applied force of 188 N. The coefficient of kinetic friction is 0.12. What is the net force acting on the object? (155 N)

4. A 31 kg box is moved with a net force of 32 N. The applied force necessary is 174 N. What is the coefficient of kinetic friction? (0.47)

5. A sled has a weight of 425 N and is being pulled with a net force of 17 N. The coefficient of kinetic friction is 0.16. What is the applied force? (85 N)

Newton's First & Third Laws

5.1 Section Review

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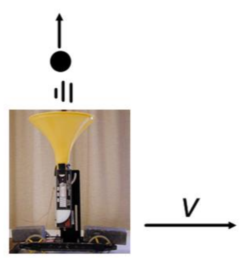
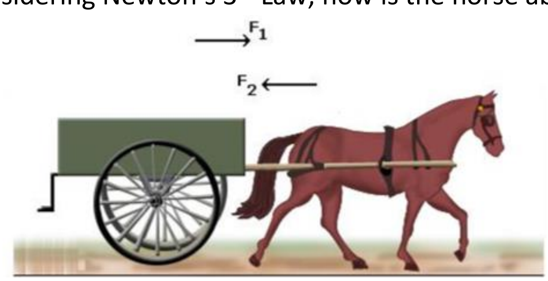
1. K/U State Newton's first law in two different ways.
2. C Identify the two basic situations that Newton's first law describes and explain how one statement can cover both situations.
3. MC A stage trick involves covering a table with a smooth cloth and then placing dinnerware on the cloth. When the cloth is suddenly pulled horizontally, the dishes "magically" stay in position and drop onto the table.
   (a) Identify all forces acting on the dishes during the trick.
   (b) Explain how inertia and frictional forces are involved in the trick.
4. K/U Give an example of an unusual frame of reference used in a movie or a television program. Suggest why this viewpoint was chosen.
5. K/U Identify the defining characteristic of inertial and non-inertial frames of reference. Give an example of each type of frame of reference.
6. C In what circumstances is it necessary to invoke ficticious forces in order to explain motion? Why is this term appropriate to describe these forces?
7. Is the Earth an inertial frame of reference? If not, why are we still able to accurately use Newton's laws of motion?
8. Give two examples of objects that cannot be analyzed with Newtonian mechanics.
9. Is the ball in the image below likely to land in the funnel if the cart is maintaining a constant velocity? What about if the cart has a constant acceleration? Provide an explanation for your answers.



10. Describe how the floor pushes you forward and that you do not push the floor.
11. How could an astronaut lost in space with a fire extinguisher move around?
12. Considering Newton's 3rd Law, how is the horse able to move the cart?



13. Describe how Newton's 3rd Law applies to rocket launches.

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/s^2 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)

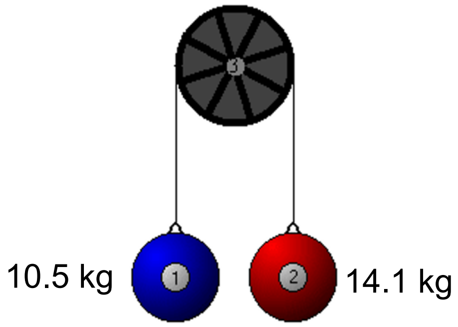
15. A force of –9000 N is used to stop a 1500 kg car traveling 20 m/s. What breaking distance is needed to bring the car to a halt? (d = 33 m)

16. A 65 kg diver jumps of a 10 m high platform.
    a. Find the swimmer's velocity the instant he reaches the water. (v = –14 m)
    b. 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)

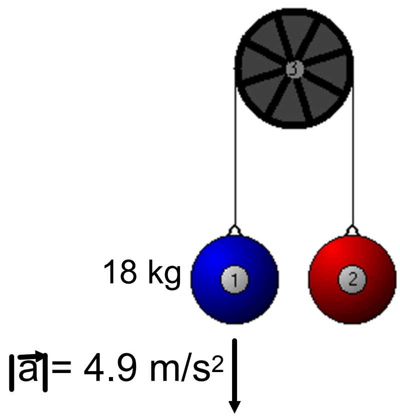
17. A 825 kg car goes from 62 m/s [E] to 25 m/s [W] in 9.5 s.
    a. Calculate the average force acting on the car. (-7555 N)
    b. Calculate the final position of the car assuming the initial position is zero. (175 m [E])
    c. Assuming a constant acceleration, calculate the instantaneous velocity 21 seconds (from when the acceleration first started).
    d. Calculate the final position of the car from part ***c***.
    e. Calculate the displacement of the car from the result of part ***b*** to ***d***.

Connected Masses Practice

Calculate the acceleration of the masses and the magnitude of tension in the string in the diagram below.

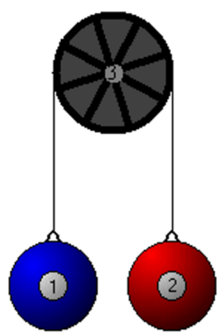


Given the information in the diagram, calculate M_2 and the magnitude of tension in the string.



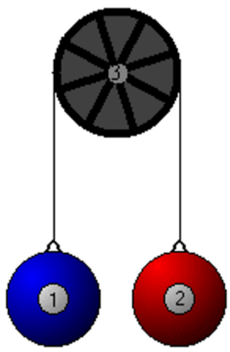
A counter weight of 13.5 kg is used to help a person of mass 62.4 kg do chin ups.

1. Calculate the force applied by the person if he accelerates at 1.9 m/s^2.
2. Calculate the magnitude of tension in the wire.

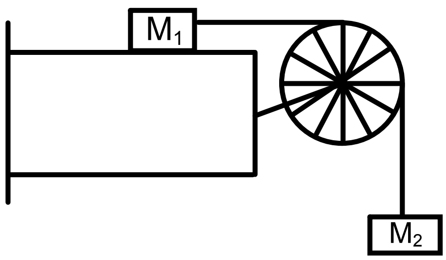


Connected Masses Practice

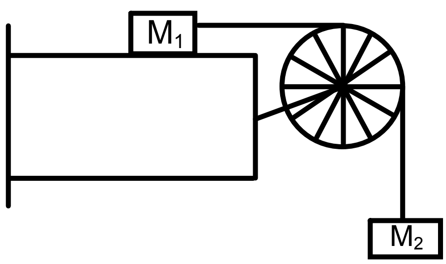
Suppose the maximum mass a person can lift is 21 kg. A counterbalance is set up to help that person lift other objects. Calculate the minimum mass of the counter weight for the person to lift a 60 kg object with an acceleration of 1.75 m/s^2



Calculate the acceleration of the masses if M_1 = 5.2 kg, M_2 = 4.5 kg, and μ_k = 0.22. Then calculate the tension in the wire.



Calculate the mass necessary to hang over the pulley that will result in an acceleration of masses at 2.3 m/s^2 if M_1 = 7.3 kg and μ_k = 0.15. Then calculate the tension in the wire.



PRACTICE PROBLEMS Pg. 485, 488, 489 Chapter 10

19. An Atwood machine consists of masses of 3.8 kg and 4.2 kg. What is the acceleration of the masses? What is the tension in the rope?

20. The smaller mass on an Atwood machine is 5.2 kg. If the masses accelerate at 4.6 m/s^2, what is the mass of the second object? What is the tension in the rope?

21. The smaller mass on an Atwood machine is 45 kg. If the tension in the rope is 512 N, what is the mass of the second object? What is the acceleration of the objects?

22. A 3.0 kg counterweight is connected to a 4.5 kg window that freely slides vertically in its frame. How much force must you exert to start the window opening with an acceleration of 0.25 m/s^2?

23. Two gymnasts of identical 37 kg mass dangle from opposite sides of a rope that passes over a frictionless, weightless pulley. If one of the gymnasts starts to pull herself up the rope with an acceleration of 1.0 m/s^2, what happens to her? What happens to the other gymnast?

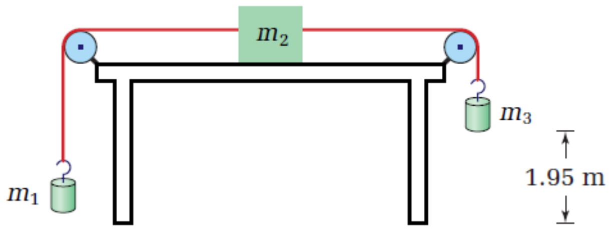
24. A Fletcher's trolley apparatus consists of a 1.90 kg cart on a level track attached to a light string passing over a pulley and holding a 0.500 kg mass suspended in the air. Neglecting friction, calculate

(a) the tension in the string when the suspended mass is released

(b) the acceleration of the trolley

25. A 40.0 g glider on an air track is connected to a 25.0 g mass suspended by a string passing over a frictionless pulley. When the mass is released, how long will it take the glider to travel the 0.85 m to the other end of the track? (Assume the mass does not hit the floor, so there is constant acceleration during the experiment.)

26. The objects in the diagram have the following masses: $m_1 = 228$ g, $m_2 = 615$ g, and $m_3 = 455$ g. The coefficient of kinetic friction between the block and the table is 0.260. Mass m_3 is 1.95 m above the floor. What will be the time interval between the instant that the masses start to move and the instant when mass m_3 hits the floor?



Part I - Find the resultant, $\vec{R}$, graphically.

1. From home a car drives 16 km [E], and then 24 km [S].
2. A person runs 2.0 m/s [N] then 4.0 m/s [E30.°N].
3. A ball is kicked 25 m [W20.0°S] then kicked again 35 m [W60.0°N].
4. A basketball is passed 15 m due West, then 20. m due North, and finally 8.0 m due East.
5. A police car drives 70. km due North, then 80. km [E40.°N], and finally 50. km [E50.0°S].
6. A laser beam travels 1500 km [W30.°S], 2100 km [E20.°S], and finally 2700 km [W10.°S].

Part II - Find the indicated vector graphically.

1. A rescue boat is located 150 km [E30°N] from port. A call for help comes in from a boat located 225 km [E20°S] from the same port. What bearing should the captain of the rescue boat set?
2. While hiking from base camp you walk 75 m [E], then 55 m [E60°N], and finally 60 m [W35°N]. You then receive a snap-chat from your friends who are located 40 m [E20°S] of base camp. Determine the direction and distance you must walk to meet up with your friends.
3. A strong wind of 45 m/s [W15°N] is blowing on an airplane. The pilot wants the resulting velocity of her plane to be 70 m/s [E42°N]. What velocity must the pilot fly the plane? (85 m/s [E21°N])

PRACTICE PROBLEMS

Chapter 3 Pg 93-94

8. An airplane flies with a heading of [N58°W] from Sydney, NS to Newcastle, NB, a distance of 618 km. The airplane then flies 361 km on a heading of [E35°S] to New Glasgow, NS.

(a) Determine the airplane's displacement for the trip.

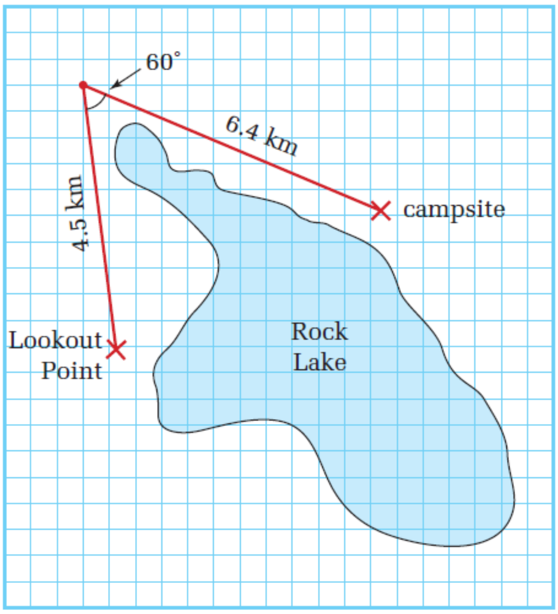
(b) In what direction will the plane have to fly in order to return directly to Sydney?

9. A canoeist starts from her campsite, paddles 3.0 km due north, and then 4.0 km due west.

(a) Determine her displacement for the trip.

(b) In what direction would she have to head her canoe in order to paddle straight home?

10. From a lookout point, a hiker sees a small lake ahead of her. In order to get around it, she walks 4.5 km in a straight line toward the end of the lake. She turns right making a 60° angle with her original path, and walks to a campsite that is 6.4 km in the new direction. Determine her displacement from the lookout point when she has reached the campsite. (See the map on the right.)



11. A boat heads out from port for a day's fishing. It travels 21.0 km due north to the first fishing spot. It then travels 30.0 km[W30.0°S] to a second spot. Finally, it turns and heads [W10.0°N] for 36.0 km.

(a) Determine the boat's displacement for the entire journey.

(b) In what direction should the boat point so as to head straight to its home port?

19. A person walks 3.0 km[S] and then 2.0 km[W], to go to the movie theatre.

(a) Draw a vector diagram to illustrate the displacement.

(b) What is the total displacement?

20. A person in a canoe paddles 5.6 km[N] across a calm lake in a time of 1.0 h. He then turns west and paddles 3.4 km in 30.0 minutes.

(a) Calculate the displacement of the canoeist from his starting point.

(b) Determine the average velocity for the trip.

21. A cyclist is moving with a constant velocity of 5.6 m/s[E]. He turns a corner and continues cycling at 5.6 m/s[N].

(a) Draw a vector diagram to represent the change in velocity.

(b) Calculate the change in velocity.

22. A cyclist travels with a velocity of 6.0 m/s[W] for 45 minutes. She then heads south with a speed of 4.0 m/s for 30.0 minutes.

(a) Calculate the displacement of the cyclist from her starting point.

(b) Determine the average velocity for the trip.

27. A jogger runs 15 km[N35°E], and then runs 7.5 km[N25°W]. It takes a total of 2.0 hours to run.

(a) Determine the displacement of the jogger.

(b) Calculate the jogger's average velocity.

Use the given scale to find the resultant in each of the following questions. Remember to draw arrows to represent the vectors and label your diagrams.

1. Calculate the displacement of a car drives 26 km [E], then 42 km [E30°N], and finally 35 [E75°S]. Use a scale of 1 cm = 7.0 km. (73km[E10°S])

2. Calculate the resultant displacement of a plane that flies 250 km [W25°N], then 175 km [E75°N], and finally 425 km [E85°S]. Use a scale of 1 cm = 50 km. (207 km [W46°S])

3. A river flows 7.5 m/s directly east. To cross the river a boat is sailed 10 m/s [W60°N]. Calculate the resulting velocity of the boat using a scale of 1 cm = 1 m/s. (9.0 m/s [E74°N])

4. A plane is attempting to land on a runway that is lined up with north; however, there exists a 35 m/s crosswind blowing west. To compensate the pilot flies the plane 75 m/s [E65°N] in the air. Use a scale of 1 cm = 8.0 m/s to calculate the resulting velocity of the plane relative to someone watching from the ground. (68 m/s [E87°N])

5. Take the situation from question 4. The crosswind is 25 m/s and the pilot wants the plane's resultant velocity is 60 m/s [N]. Calculate, graphically, what velocity the pilot must make the plane in the air. Use a scale of 1 cm = 6 m/s. (65 m/s [E67°N])

6. Two people start from the same spot and walk different paths. Person 1 walks 20 m [E], 40 m [W55oN], and finally 30 m [W10oS]. Person 2 walks 15 m [W], 50 m [E25oS], and finally 35 m [E40oN].
    a. Calculate the resultant of each person from the starting point.
    b. Calculate the displacement of Person 2 relative to Person 1.

Waves Review Questions

Period & Frequency

1. A woman jogger runs 25 complete laps in 300 seconds. Calculate her period and frequency.

2. A strobe light flashes such that the time interval between flashes is 0.018 s. Calculate the frequency of the strobe light.

3. Calculate the frequency of each of the following periods:
   a. 5.0 s
   b. 0.80 s
   c. 0.0025 s
   d. 750 s

4. Calculate the period of each of the following frequencies:
   a. 10.0 Hz
   b. 500 Hz
   c. 0.25 Hz
   d. 102.1 MHz

PRACTICE PROBLEMS

Chapter 8 Pg 341 & 343

1. A metronome beats 54 times over a 55 s time interval. Determine the frequency and period of its motion.

2. Most butterflies beat their wings between 450 and 650 times per minute. Calculate in hertz the range of typical wing-beating frequencies for butterflies.

3. A watch spring oscillates with a frequency of 3.58 Hz. How long does it take to make 100 vibrations?

4. A child swings back and forth on a swing 12 times in 30.0 s. Determine the frequency and period of the swinging.

8.1 Section Review

1. K/U Give three examples of periodic motion. What makes them periodic?

2. C Explain in your own words the meaning of the terms "cycle," "period," and "frequency."

3. K/U If a simple pendulum is lengthened, what happens to its frequency? To its period?

4. K/U Sketch diagrams illustrating
   (a) two masses on springs vibrating in phase
   (b) two pendulums vibrating out of phase

5. K/U Period is typically measured in units of seconds and frequency in units of hertz. How are these two units related to each other? Why are they related in this manner?

6. C Describe what happens when resonance occurs in an object. Explain how this is produced.

7. MC Provide two examples of resonance in everyday life.

Waves Review Questions

Wave Equation Questions

PRACTICE PROBLEMS Chapter 8 Pg 349 - 350

5. A longitudinal wave in a 6.0 m long spring has a frequency of 10.0 Hz and a wavelength of 0.75 m. Calculate the speed of the wave and the time that it would take to travel the length of the spring.

7. Tsunamis are fast-moving ocean waves typically caused by underwater earthquakes. One particular tsunami travelled a distance of 3250 km in 4.6 h and its wavelength was determined to be 640 km. What was the frequency of this tsunami?

8. An earthquake wave has a wavelength of 523 m and travels with a speed of 4.60 km/s through a portion of Earth's crust.

(a) What is its frequency?

(b) If it travels into a different portion of Earth's crust, where its speed is 7.50 km/s, what is its new wavelength?

6. Interstellar hydrogen gas emits radio waves with a wavelength of 21 cm. Given that radio waves travel at 3.00×10^8 m/s, what is the frequency of this interstellar source of radiation?

(c) What assumption(s) did you make to answer part (b)?

9. The speed of sound in air at room temperature is 343 m/s. The sound wave produced by striking middle C on a piano has a frequency of 256 Hz.

(a) Calculate the wavelength of this sound.

(b) Calculate the wavelength for the sound produced by high C, one octave higher than middle C, with a frequency of 512 Hz.

1. A pebble thrown in water creates waves with a wavelength of 14 cm and frequency of 3.5 Hz.
   a. Calculate the velocity of the waves.
   b. How long will it take the waves to reach a shore 5200 cm away?

2. A sound wave travels at 350 m/s. Calculate the wavelength of a sound with a frequency of 1400 Hz.

3. A wave in a rope travels at a speed of 2.5 m/s. If the wavelength is 1.3 m calculate the period of the wave.

4. The wavelength of a water wave is 8.0 m and its speed is 2.0 m/s. How many waves will pass a fixed point in the water in 60 seconds?

5. A rock thrown in the water creates wave with a frequency of 9.4 Hz and a wavelength of 1.9 cm. In the same water a different rock creates waves with a wavelength of 0.6 cm. Calculate the speed and frequency of the waves created by the second rock.

6. Two people are fishing from small boats located 30 m apart. Waves pass through the water and each person's boat bobs up and down 15 times in 60 seconds. At a time when one boat is on a crest the other is in a trough and there is one crest between the boats. Calculate the speed of the waves.

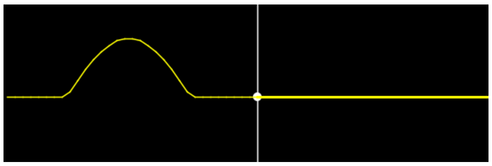
7. A boat at anchor is rocked by waves whose crests are 30.0 m apart and speed is 8.0 m/s. Calculate the time interval between crests striking the boat.

Waves Review Questions

Transmission & Reflection

1. Define and compare free-end and fixed-end reflection.

2. The image below shows a wave pulse traveling to the right. It is going from a thin to thicker medium. Describe the properties of the reflected and transmitted wave.



3. Describe the properties of a transmitted wave in the scenario of going from thick to thin.

4. You send a pulse down a string that is attached to a second string with unknown properties. The pulse returns to you inverted and with a smaller amplitude. Is the speed of the waves faster or slower in the second string? Explain your reasoning.

5. Waves traveling on a piece of string encounter a second piece of string tied to the first. The original waves have a speed of 43.8 cm/s and a frequency of 7.35 Hz. In the second string the waves have a speed of 17.2 cm/s.
    a. What is the frequency of the waves in the second string?
    b. Calculate the wavelength of the waves in the second string.
    c. What is the orientation of the transmitted wave?
    d. What is the orientation of the reflected wave?

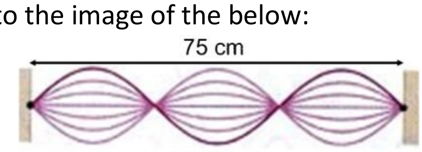
Wave Interference & Standing Waves

1. What must take place for waves to interfere constructively? Destructively?

2. What is meant by wave superposition?

3. What is a standing wave? What circumstances are necessary for its creation?

4. Refer to the image of the below:



    a. How many antinodes?
    b. How many nodes?
    c. Calculate the wavelength.
    d. Calculate the frequency.
    e. Calculate the fundamental frequency.
    f. Calculate the frequency to observe 10 antinodes.

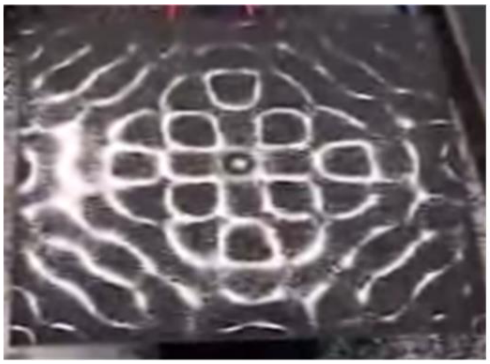
5. The distance between the second and fifth nodes in a standing wave is 93.0 cm.
    a. Calculate the wavelength of the waves.
    b. Calculate the velocity if the source has a frequency of 120 Hz.

Waves Review Questions

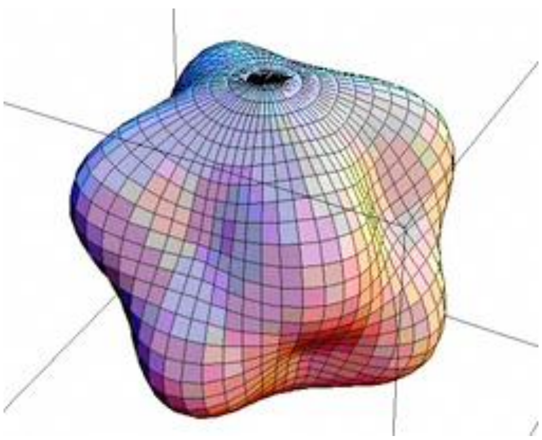
6. Standing waves are produced in a string with a velocity of 6.0 m/s. The distance between the 2nd and 6th node is 80.0 cm. Calculate the wavelength and frequency of the propagating waves.

7. Describe, using proper physics terminology, how the Tacoma Narrows Bridge was destroyed.

8. Describe, in detail, as the wave phenomenon that results in the following image:



9. Briefly explain what this image represents:



Wave Characteristics and Phenomena Review

1. You are creating waves in a rope by shaking your hand back and forth. Without changing the distance your hand moves you begin to shake it faster and faster. What happens to the amplitude, frequency, period and velocity of the wave?

2. If you pull on the end of a slinky does the pulse reach the other end instantly? What if you pull on a rope? Hit the end of a metal rod?

3. If you want to increase the wavelength of waves in a rope, should you shake it at a higher or lower frequency? Will the speed of the waves change?

4. What is the amplitude of a wave and what does it represent?

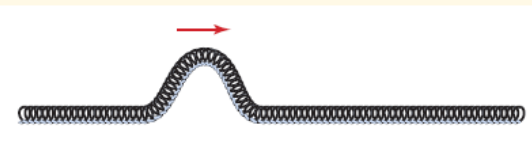
5. What happens to the string at nodes of a standing wave? Are waves still passing through that point?

6. What happens when two pool balls collide head on? How does this differ from two waves or pulses that collide head on?

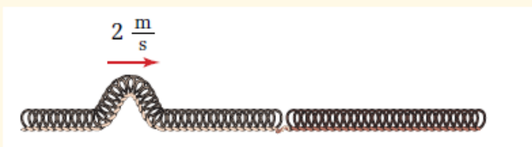
8.2 Section Review

Chapter 8 Pg 353

1. K/U What are the essential characteristics of a wave?
2. K/U How do transverse and longitudinal waves differ? Give an example of each.
3. C Sketch a diagram of a transverse wave. Mark the amplitude and wavelength of the wave on your diagram. Also, mark two points, P1 and P2, that are in phase.
4. C Do the following:
   (a) State the wave equation relating the speed, frequency, and wavelength of a wave.
   (b) Explain how the wave equation can be derived from the fact that a wave travels a distance of one wavelength in a time of one period.
5. K/U A wave pulse is travelling down a spring from left to right as shown. Sketch what the spring would look like after the pulse had been reflected if
   (a) the opposite end of the spring was firmly held to the floor by another student.
   (b) the opposite end of the spring was held by a light thread so that it was free to move.



6. K/U After a transverse wave pulse has travelled 2.5 m through a medium, it has a speed of 0.80 m/s. How would this speed have differed if
   (a) the pulse had been twice the size?
   (b) the pulse had had twice the energy?
   (c) the pulse had travelled twice the distance?
7. C Explain the meaning of the statement, "The speed of a wave is a characteristic property of the medium through which it is travelling."
8. K/U A wave pulse is travelling down a spring with a speed of 2 m/s toward a second spring attached to its opposite end. Sketch what the two springs would look like after the pulse has passed into the second spring if
   (a) the speed of a wave in the second spring is 1 m/s.
   (b) the speed of a wave in the second spring is 4 m/s.
   (c) the speed of a wave in the second spring is 2 m/s.



Sound Waves: Practice Questions

9.1 Section Review

Ch. 9 Pg 384

1. K/U The amplitude of a sound wave represents what property of sound?
2. C Describe the motion of a molecule or particle as a sound wave passes.
3. C Explain the meaning of the "quality" of sound.
4. K/U The amplitude of an electromagnetic wave represents what property of the space through which it travels?
5. C Describe two significant differences between sound and electromagnetic waves.
6. MC Imagine that you are in a completely dark cave or room. How might you estimate the size of the space in which you are standing?
7. C Explain the relationship between a wavefront and a ray.
8. I Design a demonstration using billiard balls that you could use to explain the difference between regular and diffuse reflection to a grade six class.

PRACTICE PROBLEMS

Ch. 9 Pg 390

1. What is the speed of sound in air at each of the following temperatures?
   (a) −15°C
   (b) 15°C
   (c) 25°C
   (d) 33°C
2. For each speed of sound listed below, find the corresponding air temperature.
   (a) 352 m/s
   (b) 338 m/s
   (c) 334 m/s
   (d) 319 m/s
3. A ship's horn blasts through the fog. The sound of the echo from an iceberg is heard on the ship 3.8 s later.
   (a) How far away is the iceberg if the temperature of the air is −12°C?
   (b) How might weather conditions affect the accuracy of this answer?
4. An electronic fish-finder uses sound pulses to locate schools of fish by echolocation. What would be the time delay between the emission of a sound pulse and the reception of the echo if a school of fish was located at a depth of 35 m in a lake? Assume the temperature of the water is 20°C.
5. You want to estimate the length of a large sports complex. You generate a loud noise at one end of the stadium and hear an echo 1.2 s later. The air temperature is approximately 12°C. How far away is the far wall of the stadium from your position?
6. (a) How long does it take for sound to travel 2.0 km in air at a temperature of 22°C?
   (b) The speed of light is 3.0×10^8 m/s. How long does it take for light to travel 2.0 km?
   (c) The rumble of thunder is heard 8.0 s after a flash of lightning hits a church steeple. The temperature is 22°C. How far away is the church?

9.2 Section Review

Ch. 9 Pg. 414

1. C Provide a logical reason for the increase in the speed of sound in air with a rise in the temperature of the air.
2. K/U Define Mach number.
3. C Given that the speed of any wave obeys the wave equation, $v = \lambda f$, and the speed of light is much greater than the speed of sound, comment on the values of wavelength and frequency for light compared to sound.
4. C An ambulance is not moving when it turns on its siren. As the ambulance starts moving, you hear the pitch of the siren rise. How is the ambulance moving relative to you?
5. K/U What causes sonic boom?
6. MC Why do supersonic aircraft fly extremely high?

Sound Waves: Practice Questions

Doppler Shift Problems

1. Calculate the observed frequency of a 6500 Hz source moving **a)** away from a stationary observer at 95 m/s and **b)** towards a stationary observer. Take the speed of sound to be 325 m/s. (9200 Hz; 5200 Hz)

2. A fire truck emits a frequency of 7850 Hz and travels 22.4 m/s. An observer in a car is traveling at 17.4 m/s on the same road. The speed of sound is 346 m/s. Calculate the frequency heard by the observer if the vehicles are **a)** approaching and **b)** receding. (8800 Hz; 7000 Hz)

3. Calculate the speed of a truck if the driver hears a frequency of a police car to be 17700 Hz. The police car is driving 38.6 m/s and its siren emits a frequency of 14000 Hz. The speed of sound is 334 m/s. (39.4 m/s)

4. A fighter plane is traveling at half the speed of sound and emits a frequency of 614 Hz. A passenger plane is traveling at one-fifth the speed of sound. Calculate the frequency detected by the passenger plane if they are **a)** approaching and **b)** receding. (1474 Hz; 327 Hz)

5. A stationary observer at an air show watches a fighter plane approach at one-third the speed of sound. The plane emits a sound frequency of 315 Hz. Calculate the wavelength of the sound observed by the person. (λ = 0.73 m)

6. What fraction of the speed of sound must a source be moving so that a stationary observer hears a frequency four times greater than the source? ($v = \frac{3}{4}v_s$)

7. What fraction of the speed of sound must a source be moving so that a stationary observer hears a frequency two-thirds that of the source? ($v = \frac{1}{2}v_s$)

Electromagnetic Spectrum & Light: Practice and Review

1. Light travels as an electromagnetic wave. How are these waves similar and different to transverse waves?

2. List the electromagnetic spectrum in order of decreasing wavelength. Would that order change for decreasing frequency? Decreasing energy?

3. A girl reading a book needs to buy a brighter bulb. What information should she look for on the package?

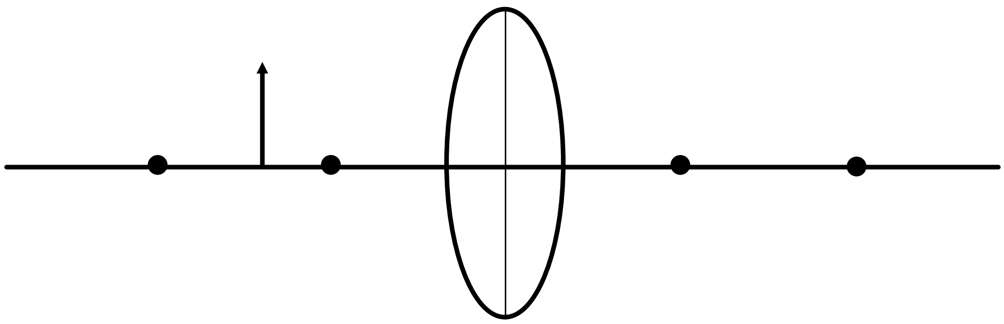
4. Starting at a position of 20 m from a light source; describe by what factor the illuminance will change as you go to the following positions: 15 m, 10m, 5m, 1m, 25m, 30m, 40m, 100m.

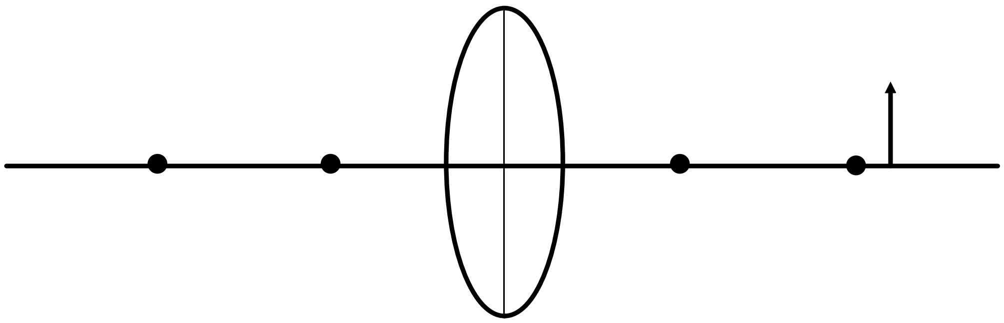
Electromagnetic Waves

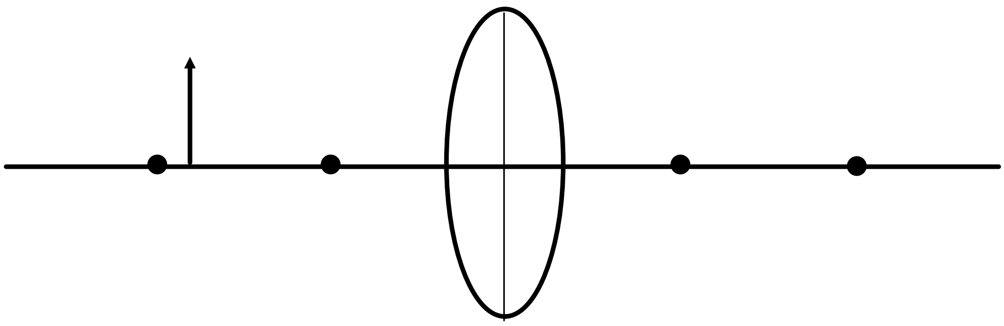
1. Gamma-ray bursters are objects in the universe that emit pulses of gamma rays with high energies. The frequency of the most energetic bursts has been measured at around 3.0×10^{21} Hz. What is the wavelength of these gamma rays?
2. What is the wavelength range for the FM radio band (88 MHz–108 MHz)?
3. Shortwave radio is broadcast between 3.50 and 29.7 MHz. To what range of wavelengths does this correspond? Why do you suppose this part of the spectrum is called shortwave radio?
4. What is the frequency of an electromagnetic wave if it has a wavelength of 1.0 km?
5. The portion of the visible spectrum that appears brightest to the human eye is around 560 nm in wavelength, which corresponds to yellow-green. What is the frequency of 560 nm light?
6. What is the frequency of highly energetic ultraviolet radiation that has a wavelength of 125 nm?

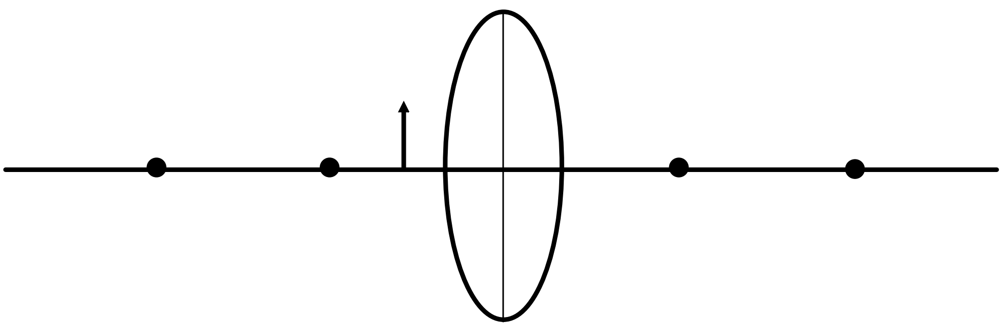
1. Identify which portions of the electromagnetic spectrum are used in each of the devices listed.
   a. a microwave oven
   b. a television set
   c. a single-lens reflex camera
2. If an electromagnetic wave has a frequency of 7.57×10^{14} Hz, what is its wavelength? To what part of the spectrum does this wave belong?
3. Galileo performed an experiment to measure the speed of light by timing how long it took light to travel from a lamp he was holding to an assistant about 1.5 km away and back again. Why was Galileo unable to conclude that light had a finite speed?

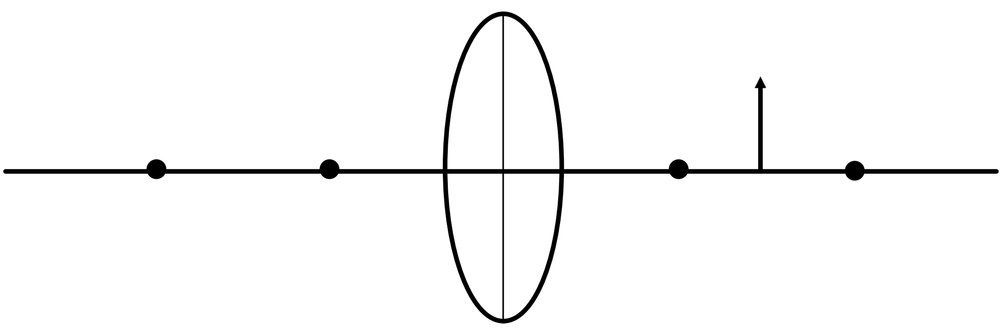
Find the image location and size.



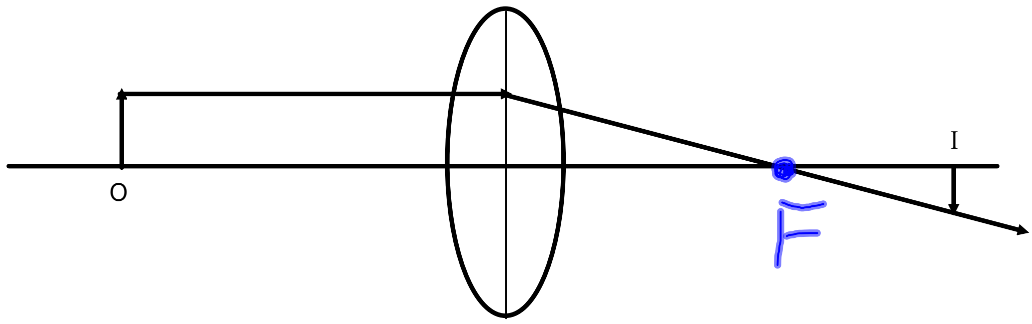


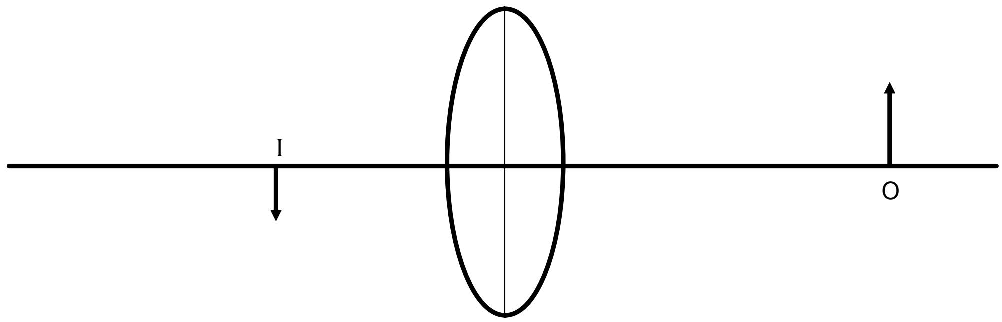


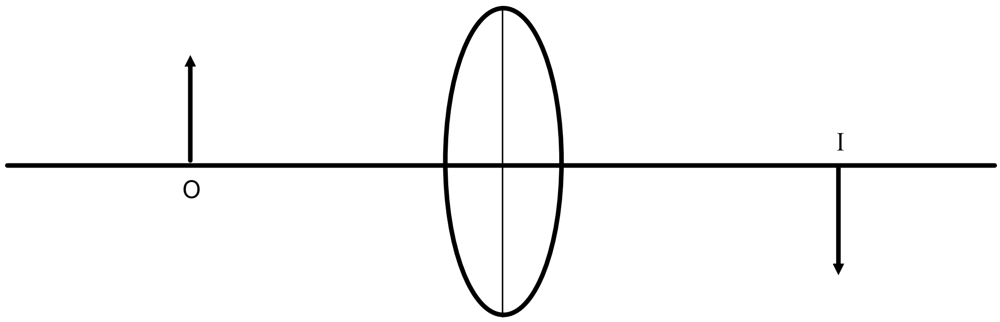


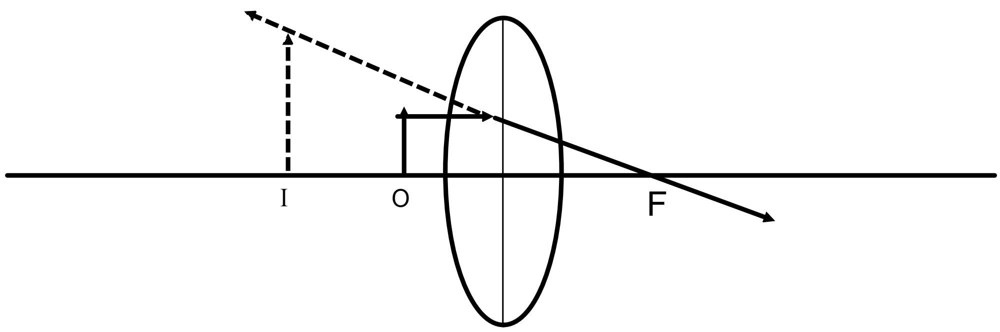


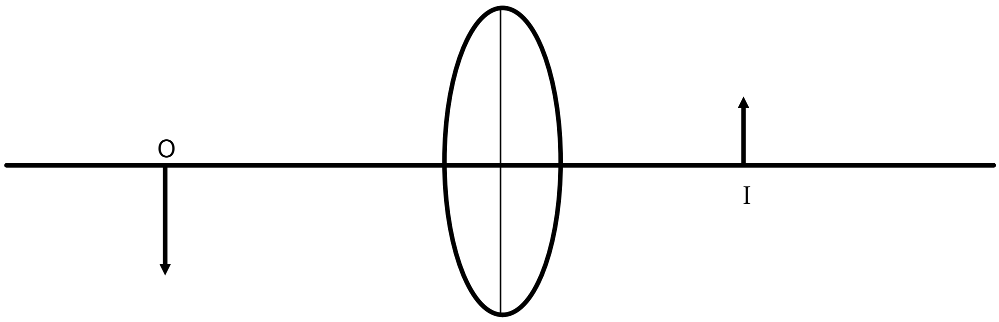
Given the location and size of the object and image, find the principle focus by drawing a light ray from the object that is parallel to the principle axis.











Part I.

1. A converging lens has a focal length of 20.0 cm If it is placed 50 cm from an object, at what distance from the lens will the image be?

2. The focal length of a lens in a box camera is 10.0 cm. The fixed distance between the lens and the film is 11.0 cm. If the object is to be clearly focussed on the film, how far must it be from the lens?

3. An object 8.0 cm high is placed 80.0 cm in front of a converging lens of focal length 25 cm. a) Using the lens and magnification equations, determine the image position and its height. b) By means of a scale ray diagram, locate the image and determine its height.

4. A lamp 10.0 cm high is placed 60.0 cm in front of a diverging lens of focal length $f = 20.0$ cm. a) Using the appropriate equations, calculate the image position and the height of the image. b) By means of a scale ray diagram, locate the image and determine its height.

5. A typical single lens reflex (SLR) camera has a converging lens with a focal length of 50.0 mm. What is the position and size of the image of a 25 cm candle located 1.0 m from the lens?

6. A converging lens with a focal length of 20.0 cm is used to create an image of the Sun on a paper screen. How far from the lens must the paper be placed to produce a clear image?

7. The focal length of a slide projector's converging lens is 10.0 cm.

   a) If a 35.0 mm slide is positioned 10.2 cm from the lens, how far away must the screen be placed to create a clear image?

   b) If the height of a dog on the slide film in 12.5 mm, how tall will the dogs image be on the screen?

   c) If the screen is then removed to a position 15 m from the lens, by how much will the separation between film and lens have to change from part **(a)**?

8. A candle is placed 36 cm from a screen. Where between the candle and the screen should a converging lens with a focal length of 8.0 cm be placed to produce a sharp image on the screen?

9. An object 5.00 cm height is placed at the 20.0 cm mark on a metre stick. A converging lens with a focal length of 20.0 cm is mounted at the 50.0 cm mark. What are the position and size of the image?

10. A camera lens has a focal length of 6.0 cm and is located 7.0 cm from the film. How far from the lens is the object positioned if a clear image has been produced on the film?

11. A lens with a focal length of 20.0 cm is held 12.0 cm from a grasshopper 7.00 mm high. What is the position and size of the image of the grasshopper?

12. A projector is required to make a real image, 0.5 m tall, of a 5.0 cm object placed on a slide. Within the projector, the object is to be placed 10.0 cm from the lens. What must be the focal length of the lens?

13. A 3.0 cm flower is placed 40.0 cm from a lens with a focal length of 10.0 cm. What is the position, size, and type of image?

14. An object 7.9 cm high is placed at the 35 cm mark on a metre stick. A converging lens with a focal length of $f = 25$ cm is mounted at the 95 cm mark. a) What is the distance of the image from the optical centre? b) What is the size of the image?

15. A child wants to magnifiy and ant by a factor of 15.0. The magnifying glass she holds has a focal length of $f = 75.0$ mm. To get this magnification, how far from the ant should she hold the magnifying glass?

16. A projector, with a focal length of $f = 14.4\,\text{mm}$ produces an inverted, enlarged image of a squirrel. If the squirrel is to be enlarged by a factor of 25.0, what must be the separation between the lense and the slide of the squirrel?

17. What is the focal length of lens which has a radius of curvature of 6.00 cm on one side and 12.0 cm on the other side? Both sides are convex and the index of refraction is 1.60.

18. What is the focal length of a plano-convex lens with a radius of curvature of 12.0 cm? The index of refraction of the lens is 1.40.

19. What is the focal length of a plano-concave lens with a radius of curvature of 12.0 cm? The index of refraction of the lens is 1.40.

20. What is the focal length for a lens if both radii are 20.0 cm, the index of refraction is 1.20, and:
a) both sides are convex.
b) both sides are concave.
c) one side is convex and the other is concave.

21. A double convex lens ($n = 1.50$) has radii of curvatures of 18.0 cm.
a) What is the focal length in air?
b) What is the focal length in water?

22. A converging meniscus flint glass lens has a focal length of 26.5 cm. What is its convex radius if its concave radius measures 8.0 cm?

23. What are the radii of curvature of a double convex Plexiglas lens ($R_1 = R_2$) that has a focal length of 30.0 cm?

24. What is the radius of curvature of a double concave Plexiglas lens ($R_1 = R_2$) that has a focal length of −30.0 cm?

25. Someone has two double convex lenses ($R_1 = R_2$). One is made of crown glass and the other is made of diamond, and each have a focal length of 10.0 cm. What is the radii of curvatures for each lens?

26. What is the index of refraction of a diverging meniscus lens of focal lenth −15.5 cm, and has a concave radius of 5.0 cm and a convex radius of 12 cm

27. A person has two identically shaped lenses, one is made of Plexiglas and the other zircon. Which lens has the greater focal length and by what factor?

28. A plano-concave flint glass lens has a focal length of −16.0 cm in air. Material of what index of refraction should the lens be placed into to have a focal length of +16.0 cm?

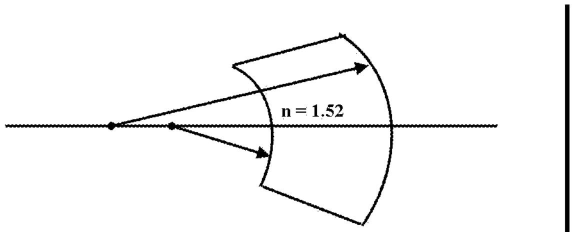
29. a) What is the focal length of a double convex glass lens ($R_1 = R_2$) of radius 20.0 cm for violet light? The index of refraction for violet light is 1.532.
b) What is the focal length of the same lens for red light? The index of refraction for red light is 1.513.

30. A converging lens has a focal length of 20.0 cm If it is placed 50 cm from an object, at what distance from the lens will the image be?

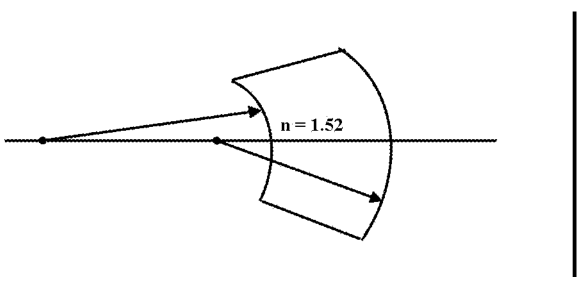
31. The focal length of a lens in a box camera is 10.0 cm. The fixed distance between the lens and the film is 11.0 cm. If the object is to be clearly focussed on the film, how far must it be from the lens?

32. An object 2.0 cm high is placed 8.0 cm from the focal point of a double convex lens made of quartz. The lens has a radii of curvature of 20.0 cm and 5.0 cm. Calculate the position and size of the image.

33. What is the focal length of the following lens? Is it converging or diverging?



34. What is the focal length of the following lens? Is it converging or diverging?



Physics 112 Lenses Problems Mr. MacDonald Fall 2012

Answer List

1. $d_i = 33.3\,\text{cm}$
2. $d_o = 110\,\text{cm}$
3. a) $d_i = 36\,\text{cm}$; $h_i = -3.6\,\text{cm}$
4. a) $d_i = -15\,\text{cm}$; $h_i = 2.5\,\text{cm}$
5. $d_i = 5.3\,\text{cm}$; $h_i = -1.3\,\text{cm}$
6. $d_i = 20.0\,\text{cm}$
7. a) $d_i = 5.10\,\text{m}$
   b) $h_i = -62.5\,\text{cm}$
   c) $0.13\,\text{cm}$
8. $d_i = 12\,\text{cm}$ and $d_o = 24\,\text{cm}$; or $d_i = 24\,\text{cm}$ and $d_o = 12\,\text{cm}$
9. $d_i = 60.0\,\text{cm}$; $h_i = -10.0\,\text{cm}$
10. $d_o = 42\,\text{cm}$
11. $d_i = -30.0\,\text{cm}$; $h_i = 1.75\,\text{cm}$
12. $f = 9.1\,\text{cm}$
13. $d_i = 13.3\,\text{cm}$; $h_i = -1.00\,\text{cm}$; real image
14. a) $d_i = 43\,\text{cm}$
    b) $h_i = -5.6\,\text{cm}$
15. $d_o = 70.0\,\text{mm}$
16. $d_o = 15.0\,\text{mm}$
17. $f = 6.7\,\text{cm}$
18. $f = 30.0\,\text{cm}$
19. $f = -30\,\text{cm}$
20. a) $50\,\text{cm}$
    b) $-50\,\text{cm}$
    c) $f = \infty$
21. a) $f_{air} = 18\,\text{cm}$
    b) $f_{water} = 70\,\text{cm}$
22. $R_{convex} = 5.5\,\text{cm}$
23. $R = 30.6\,\text{cm}$
24. $R = -30.6\,\text{cm}$
25. $R_{crown} = 10.4\,\text{cm}$, $R_{diamond} = 28.4\,\text{cm}$
26. $n = 1.55$
27. Plexiglas has the greater focal length by a factor of $f_{plex} = 1.80 f_{zircon}$
28. $n_{material} = 4.71$
29. a) $f_{violet} = 18.8\,\text{cm}$
    b) $f_{red} = 19.5$
30. $d_i = 33.3\,\text{cm}$
31. $d_o = 110\,\text{cm}$
32. $d_i = 18.1\,\text{cm}$
33. $f = -4.13\,\text{cm}$. It is a diverging lens.
34. $f = 19.7\,\text{cm}$. It is a converging lens.

Diffraction Problems

1. In Young's double slit experiment, a monochromatic (only one wavelength) source of wavelength 550 nm illuminates slits that are 4.0×10^{-6} m apart. What angle does the first order magnitude occur? Second order? Third order? Is there a mathematical pattern?

2. Given that the second-order maximum occurs at 22^{o} and the light of wavelength 600 nm is used, what is the double slit separation? [3.2 µm]

3. Two slits are 0.015 mm apart and the second-order maximum is 7.8 mm away from the centre line. If that maximum is 1.1 m from the slits, what is the wavelength of light used? [5.3×10^{-6} m]

4. In an interference experiment, yellow light of wavelength 580 nm illuminates a double slit. If the screen is 1.3 m away and the distance between the centre line and the 9^{th} maximum is 38.5 cm, find the slit separation. [1.83 mm]

5. A diffraction grating with 2000 slits per centimeter is used with red light of wavelength 650 nm. Find the order number of the maximum occurring at 15.1^{o}. [n=2]

6. What is the distance to the n=2 maximum for a diffraction grating with 20000 slits per meter if the screen is 0.90 m away and orange light with wavelength 600 nm is used? (assume $\theta \leq 15^{o}$) [0.022 m]

7. The distance between the central line and the 5^{th} maximum is 65 cm when the grating is 92 cm from the screen. What is the wavelength of the light if the diffraction grating has 250 lines per millimeter? [447 nm]

8. Two identical diffraction gratings are set up the same distance from a screen. A red laser of wavelength 675 nm is aimed at one grating and a green laser of wavelength 515 nm at the other. The distance to the first maximum for the red laser is 3.7 cm, what is the distance for the first maximum for the green laser? (assume $\theta \leq 15^{o}$ for both gratings) [2.8 cm]

9. What is the value of θ for the n = 2 maximum if an orange laser beam of wavelength 615 nm is fired through a diffraction grating with 2×10^{4} lines per millimeter?

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 = 2.2×10^3 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. ±14 μC

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 ≤ λ ≤ 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 × rest mass energy
(c) 2.1×10^{-30} kg or 2.3 × 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