James M. Hill

Physics 112 Problem Set

2013 – 2014

Mr. P. MacDonald

Physics 112

Solving Equations Review

Part I. Solve.

1. $17 = m + 8$
2. $z + 18 = 40$
3. $8 - y = -24$
4. $k + \frac{5}{6} = \frac{5}{18}$
5. $-\frac{3}{4} = w - \frac{11}{12}$
6. $\frac{9}{2}n = 36$
7. $\frac{5}{4} = -\frac{15}{4}a$
8. $0.03 = 3.5c - 1.02$
9. $\frac{k}{6} - 11 = -20$
10. $5x + 56 = 16$
11. $4r + 4 = \frac{2}{3}$
12. $\frac{7}{3} = 4 + \frac{5c}{2}$
13. $-14 = -(31 + p)$
14. $10(3r + 8) = 45$
15. $68 = -4(m + 9)$
16. $-10\left(\frac{2}{5} - f\right) = 86$
17. $-45 = 10(n + 3)$
18. $4(y + 8) = 7(y + 2)$
19. $5(3k - 6) = 6(2k - 3)$
20. $6(4 - 3j) = -2(3j - 5)$
21. $2(3x - 5) + 4 = 15 - (9x - 4)$
22. $7p - 2(3 - 4p) = 12p - (p + 4)$
23. $\frac{3}{10}y = 19 - \frac{1}{5}y$
24. $6a + 3 = \frac{5(4a + 1)}{3}$
25. $12c + 2.6 = 6.8c$
26. $0.55y - 4.5 = 0.05y + 5.5$
27. $-\frac{1}{2}(4w + 6) = \frac{1}{3}(9 - 3w)$
28. $7 + 3[4(2x - 3) - 8x] = 3x - 8$
29. $r + 4 = 4[2(8r - 7) + 5r] - 3r$

Part II. Solve for the indicated variable.

30. $C = K + 273$; for K
31. $V = Bh$; for B
32. $F = ma$; for a
33. $V = IR$; for I
34. $I = Prt$; for r
35. $i = \frac{1}{2}r^2w$; for w
36. $R = \frac{k\ell}{d^2}$; for ℓ
37. $F = \frac{gm_1m_2}{d^2}$; for m_1
38. $C = \frac{mv^2}{r}$; for r
39. $2c - 3d = 11$; for d
40. $3by - 2 = 2by + 1$; for y
41. $v = V + gt$; for t
42. $E = Ir + IR$; for r
43. $F = \frac{9}{5}C + 32$; for C
44. $t = \frac{n}{2}(a + 50)$; for a
45. $A = 2\pi r(r + h)$; for h

Physics 112 Solving Equations Review Mr. P. MacDonald 1/24/2012

Answer List

1.	9	2.	22	3.	32
4.	$-\frac{5}{9}$	5.	$\frac{1}{6}$	6.	8
7.	$-\frac{1}{3}$	8.	0.3	9.	-54
10.	-8	11.	$-\frac{5}{6}$	12.	$-\frac{2}{3}$
13.	-17	14.	$-\frac{7}{6}$	15.	-26
16.	9	17.	$-\frac{15}{2}$	18.	6
19.	4	20.	$\frac{7}{6}$	21.	$\frac{5}{3}$
22.	$\frac{1}{2}$	23.	38	24.	2
25.	-0.5	26.	20	27.	-6
28.	-7	29.	$\frac{3}{4}$	30.	$C-273$
31.	$\frac{V}{h}$	32.	$\frac{F}{m}$	33.	$\frac{V}{R}$
34.	$\frac{I}{Pt}$	35.	$\frac{2i}{r^2}$	36.	$\frac{Rd^2}{k}$
37.	$\frac{Fd^2}{gm_2}$	38.	$\frac{mv^2}{C}$	39.	$\frac{2c-11}{3}$
40.	$\frac{3}{b}$	41.	$\frac{v-V}{g}$	42.	$\frac{E-IR}{I}$
43.	$\frac{5}{9}(F-32)$	44.	$\frac{2t}{n}-50$	45.	$\frac{A-2\pi r^2}{2\pi r}$

Physics 112
Distance, Displacement, Speed, and Velocity Practice

1. 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)

2. A vehicle travels 2345 m [W] in 315 s toward the evening sun. What is its average velocity? (7.4 m/s [W])

3. What distance will a car, traveling 65 km/hr, cover in 3.0 hrs? (195 km)

4. How long will it take to go 150 km [E] traveling at 50 km/hr [E]? (3.0 hr)

5. 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)

6. 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)

7. Calculate the average speed of the Earth about the Sun in m/s. (29 885 m/s)

8. How long will it take to travel 200 000 m [N] traveling 10 m/s [N]? (20 000 s)

9. 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])

10. 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])

Acceleration Practice

1. 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)

2. 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)

3. 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)

4. 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)

5. 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)

6. 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)

7. 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)

8. 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)

9. 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)

10. 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])

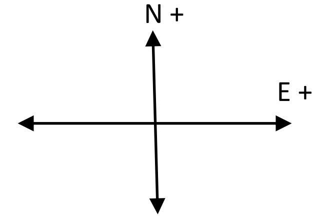
3. A ball is thrown straight up in the air. After 7.5 s the ball is on its way down and has a velocity of 14 m/s. Calculate the initial velocity of the ball. (+59.6 m/s or 59.6 m/s [up])

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])



Physics 112

1D Motion Equations

1. A car undergoes a constant acceleration from rest to 28 m/s in 9.5 s. What distance was covered in that time?

2. Not noticing a red light a drivers slams on the brakes squeeling to a halt in 3.75 s. Just before hitting the brakes the car was traveling 17 m/s and was 30 m from the light. **a)** What was the average acceleration of the car? **b)** Determine if the driver able to stop before reaching the traffic light by finding the distance required to stop.

3. An airplane lands with a speed of 70 m/s. After 3.5 s the airplane is traveling 17.5 m/s. **a)** What was the average acceleration of the airplane? **b)** What distance does the airplane need to stop?

4. During take off a Boeing 747 airplane accelerates at a constant $10.8\,\mathrm{m/s^2}$. The airplane accelerated, from rest, for 7.8 s before it left the ground. **a)** With what speed did the airplane leave the ground? **b)** What distance was required for take-off?

5. A ball is thrown upwards, on the Earth ($a_{gravity} = -9.81\,\mathrm{m/s^2}$, with an initial speed of 17 m/s. **a)** How long will the ball be traveling upwards? **b)** How high up will the ball travel?

6. A loonie dropped from the observation deck on the CN Tower in Toronto takes 8.35 s to hit the ground. **a)** Assuming no air resistance, with what speed is the loonie striking the ground? **b)** How high is the observation deck from the ground? (ta ke $a_{gravity} = -9.81\,\mathrm{m/s^2}$)

7. During its fall to Earth, hail stones from cumulonimbus clouds reach a terminal velocity (a constant speed) because of air resistance. **a)** Calculate at what speed a hail stone would strike the Earth if it continued to accelerate at $a_{gravity} = -9.8\,\mathrm{m/s^2}$ during its 20.2 s fall to the ground.

8. A ball is thrown straight up (assume no air resistance) at the surface of the Earth with $v_o = 25\,\mathrm{m/s}$. How long will the ball be in the air?

9. The upward velocity of a cannon ball is initially 142 m/s. How long after the cannon ball is fired will it be 51.0 m above the ground?

10. What is the instantaneous velocity of a ball (launched upwards) that has a displacement of 21 m above the ground if the initial velocity was 32 m/s?

11. Use $\Delta x = v_o t + \frac{1}{2}at^2$ and $a = \frac{v_f - v_o}{t}$ to derived ${v_f}^2 = {v_o}^2 + 2a\Delta x$

Physics 112 1D Motion Equations Mr. P. MacDonald 2/22/2012

Answer List

1. d=133 m
2. **a)** $a_{avg} = -4.5\,\mathrm{m/s^2}$, **b)** No, the driver needed 32 m to stop so the car ended up 2 m into the intersection.
3. **a)** $a_{avg} = -15\,\mathrm{m/s^2}$ **b)** $d = 163\,\mathrm{m}$
4. **a)** $v_f = 84\,\mathrm{m/s}$ **b)** $d = 330\,\mathrm{m}$
5. **a)** $t = 1.73\,\mathrm{s}$; **b)** $d = 15\,\mathrm{m}$
6. **a**)$v_f = -82\,\mathrm{m/s}$; **b**)$d = 342\,\mathrm{m}$
7. **a**)$v_f = -198\,\mathrm{m/s}$;
8. $t = 5.1\,\mathrm{s}$
9. $t = 0.364$ and 28.6 seconds
10. $v = +25\,\mathrm{m/s}$ or $-25 m/s$
11. **a**)$v_f = -198\,\mathrm{m/s}$;

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}

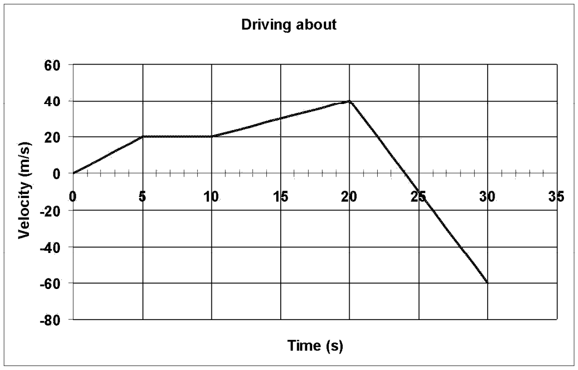
6. A fighter jet initially flying 250 m/s [E] turns to fly a supersonic 400 m/s [W]. This happens in 12 seconds.
    a. Calculate the acceleration of the plane. {$\vec{a}$ = –54.2 m/s^2}
    b. Calculate the displacement of the plane in that time. {$\vec{d}_f$ = 900 m}
    c. Calculate the distance traveled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

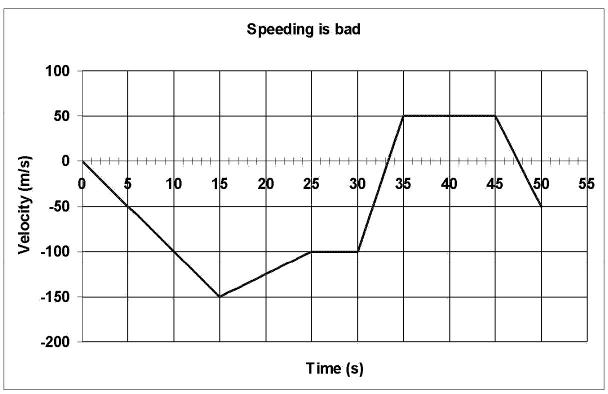
8. A car is driving around a circular track. The track has a radius of 100 m. Starting from rest it accelerates to 30 m/s in 12 seconds then holds a constant speed of 30 m/s.
    a. Calculate the distance moved along the track during the acceleration. {d = 180 m}
    b. Calculate the average speed and 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 }

Physics 112

Change in Velocity



1. Refer to the above image for the following v-t graph questions. **a)** What was the acceleration during the first five seconds? **b)** At what time(s) was there a change in direction? **c)** What was the displacement and distance for the entire 30 s? **d)** What was the average speed and velocity for the entire trip?



2. Refer to the above image for the following v-t graph questions. **a)** What was the magnitude of the greatest acceleration? **b)** What distance was traveled between 10 and 30 seconds? **c)** Calculate the average speed and velocity for the full 50 s.

3. A ball is thrown straight up with an initial velocity of 5.6 m/s. How long did it take to reach maximum height? Calculate the maximum height.

4. A car is traveling 30 m/s [E] when the brakes are applied creating an acceleration of $2.6\,\text{m/s}^2$ [W]. If the breaking lasted for 7.6 seconds, what was the final velocity of the car? Calculate the distance traveled in that time. Assuming the acceleration remains constant, what distance is needed to stop the car?

5. A glider is flying 11 m/s [E] when a head wind provides an acceleration of $1.5\,\text{m/s}^2$ [W]. What is the glider's new heading if the wind remains constant for 25 seconds? Calculate the distance and displacement of the glider at the end of the 25 seconds.

Physics 112 Change in Velocity Mr. P. MacDonald 2/22/2012

Answer List

1. a) $a = 4.0\,\text{m/s}^2$ b) $t = 24\,\text{s}$ c) $disp = 350\,\text{m}$, $dist = 710\,\text{m}$ d) $Speed = 24\,\text{m/s}$, $v_{avg} = 11.7\,\text{m/s}$
2. a) $30\,\text{m/s}^2$ b) $dist = 2375\,\text{m}$ c) $speed = 74\,\text{m/s}$, $v_{avg} = -50\,\text{m/s}$
3. a) $30\,\text{m/s}^2$ b) $dist = 2375\,\text{m}$ c) $speed = 74\,\text{m/s}$, $v_{avg} = -50\,\text{m/s}$
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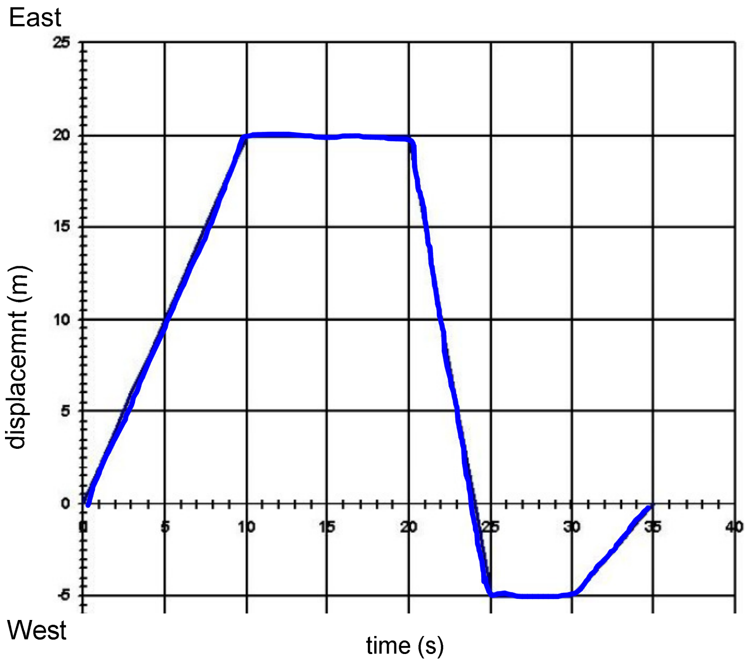
More Practice & Review

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?

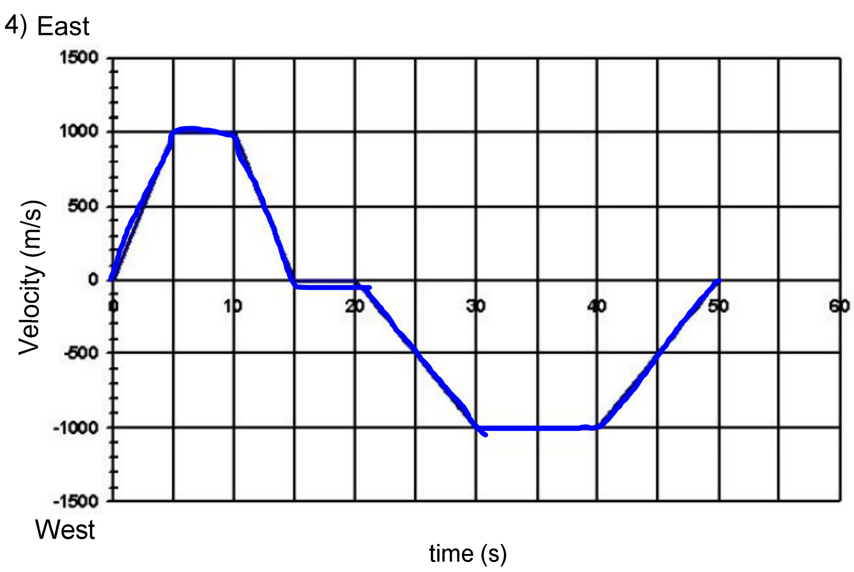
(c) What was the distance travelled during the 35 s trip?

(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)

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

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.

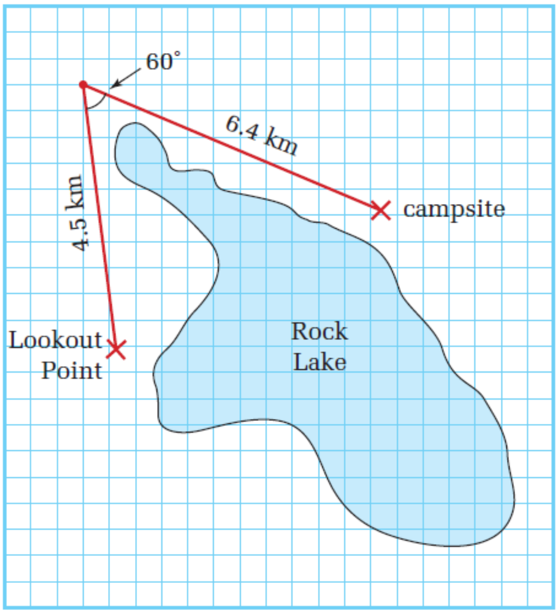
(b) In what direction will the plane have to fly in order to return directly to Sydney?

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.

PRACTICE PROBLEMS

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.

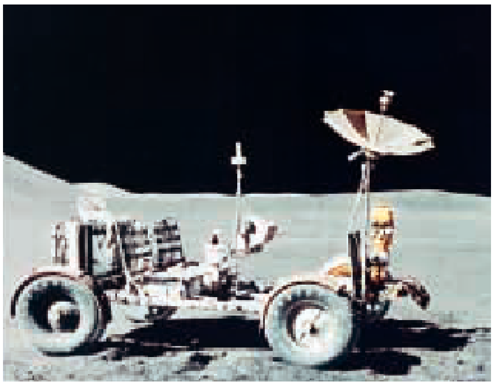


Table 4.3 Free-Fall Accelerations Due to Gravity on Earth

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

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)

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)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PRACTICE PROBLEMS

Pg. 485, 488, 489

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?

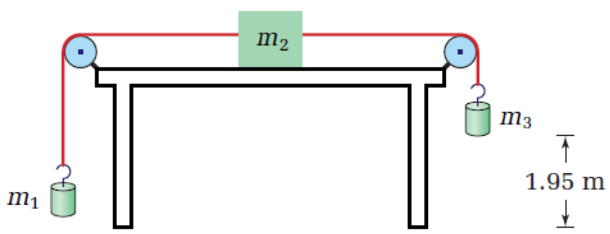
24. A Fletcher's trolley apparatus consists of a 1.90 kg cart on a level track attached to a light string passing over a pulley and holding a 0.500 kg mass suspended in the air. Neglecting friction, calculate

(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?



PRACTICE PROBLEMS

MHR: Pg. 341 # 1-4.

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.

PRACTICE PROBLEMS

Pg. 349 # 5 – 9.

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.

Problems for Understanding

Chapter Review Pg. 372 # 21 – 28.

21. A pendulum takes 1.0 s to swing from the rest line to it's highest point. What is the frequency of the pendulum?

22. By what factor will the wavelength change if the period of a wave is doubled?

23. A wave with an amplitude of 50.0 cm travels down a 8.0 m spring in 4.5 s. The person who creates the wave moves her hand through 4 cycles in 1 second. What is the wavelength?

24. A sound wave has a frequency of 60.0 Hz. What is its period? If the speed of sound in air is 343 m/s, what is the wavelength of the sound wave?

25. Water waves in a ripple tank are 2.6 cm long. The straight wave generator used to produce the waves sends out 60 wave crests in 42 s.
    (a) Determine the frequency of the wave.
    (b) Determine the speed of the wave.

26. A rope is 1.0 m long and the speed of a wave in the rope is 3.2 m/s. What is the frequency of the fundamental mode of vibration?

27. A tsunami travelled 3700 km in 5.2 h. If its frequency was 2.9×10^{-4} Hz, what was its wavelength?

28. A storm produces waves of length 3.5 m in the centre of a bay. The waves travel a distance of 0.50 km in 2.00 min.
    (a) What is the frequency of the waves?
    (b) What is the period of the waves?

Part I. Wave Problems. Take into account significant figures.

1. A woman jogger runs 25 complete laps in 5.0 min. a) What is her lap period in seconds? b) What is her frequency in Hertz?

2. A child on a swing completes 20.0 cycles in 25.0 s. Calculate a) the frequency and b) the period of the swing.

3. A stroboscope is flashing so that the time interval between flashes is 1.18×10^{-2} s. Calculate the frequency of the strobe lights flashes.

4. Calculate the frequency, in Hz, and the period, in seconds, of a tuning fork that vibrates 2.4×10^{4} times in 1.00 min.

5. Determine the frequency, in Hz, of each of the following:

   a) If 95 crests in a slinky pass a fixed point in 12.7 s.

   b) If the period of a tuning fork is 0.00462 s.

6. A swimmer notices that 30.0 waves strike a break water in 1.00 min. What is ther period of the waves in seconds?

7. Determine the frequency of each of the following:

   a) A basketball player who scores 36 points in 24 min.

   b) A roadrunner who escapes a coyote 27 times in 9 min.

   c) A fan that turns 170.0 times in 15.0 s.

8. Determine the period of each of the following:

   a) The pulse from a human heartbeat that is heard 24 times in 15 s.

   b) A tuning fork that vibrates 2048 times in 8.0 s.

   c) The Moon, which travels around the Earth 6.00 times in 163.8 days.

9. Calculate the frequency, in Hz, of each of the following periods:

   a) 5.0 s

   b) 0.80 s

   c) 2.50×10^{-2} s

   d) 0.40 min

10. Calculate the period, in seconds, of each of the following frequencies:

    a) 10.0 Hz

    b) 500.0 Hz

    c) 0.25 Hz

    d) 102.1 MHz

11. A source with a frequency of 25 Hz produces water waves that have a wavelength of 3.0 cm. What is the speed of the waves in cm/s? m/s?

12. An FM radio station broadcasts with a frequency of $f = 109.3$ MHz, the speed of the waves is 3.00×10^{8} m/s a) What is the period of the radio waves? b) What is the wavelength of the radio waves?

13. A pebble thrown in water creates waves with a wavelength, λ, of 14 cm and a frequency of 3.5 Hz. a) What is the velocity of the waves? b) How long will it take the waves to reach a shore 5.2 m away?

14. A hiker shouts towards a cliff 846 m away. He hears his echo 4.75 s later. What is the speed of sound in air?

15. A wave in a rope travels at a speed of 2.5 m/s. If the wavelength is 1.3 m, what is the period of the wave?

16. A sound wave travels at 350.0 m/s. What is the wavelength of a sound with a frequency of 1.4×10^{3} Hz?

17. 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 1.00 min?

18. The tine of a tuning fork, when struck, has an amplitude of 0.13 cm. If the frequency of the tuning fork is 200 Hz, what total distance will the tine travel in 1.00 min?

19. Water waves with a wavelength of 6.0 m approach a lighthouse at 5.6 m/s. a) What is the frequency of the waves? b) What is the period of the waves?

20. 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 1.0 min. At a time when one boat is on a crest, the other is in a trough, and there is one crest between the two boats. What is the speed of the waves in m/s?

21. The wavelength of a water wave is 3.7 m and its period is 1.5 s. Calculate:

    a) The speed of the wave.

    b) The time required for the wave to travel 100.0 m.

    c) The distance traveled by the wave in 1.00 min.

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

23. A television station broadcasts with a frequency of 90.0 MHz. If the speed of the electromagnetic wave emitted by the station tower is 3.00×10^8 m/s, what is the wavelength of the waves?

24. What are the wavelengths in air of the lowest and the highest audible frequencies if the range of human hearing is 20.0 Hz to 20.0 kHz. Assume the speed of sound is 342 m/s.

25. A source vibrates a string with a frequency of 103.6 Hz. The wavelengths produced are 2.70 cm. If the frequency is reduced by a factor of four, then what is the speed and wavelengths of the waves if the tension remains the same?

26. 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 medium the waves have a speed of 17.2 cm/s.

    a) What is the frequency of the waves in the second medium?

    b) What is the wavelength of the waves in the second medium?

    c) What is the orientation of the transmitted wave, erect or inverted?

    d) What is the orientation of the reflected wave, erect or inverted?

27. A standing wave interference pattern is produced in a rope by a vibrator with a frequency of 28.0 Hz. a) If the wavelength is 25.5 cm, what is the distance between successive nodes? b) What is the velocity of the wave in m/s?

28. The distance between the second and fifth nodes in a standing wave is 93.0 cm. a) What is the wavelength of the waves? b) What is the velocity if the source has a frequency of 12.5 Hz?

29. A string is vibrated such that a standing wave is produced.

    a) What is the wavelength of a vibrating string if the distance between adjacent nodes is 8.5 cm?

    b) What is the velocity of the waves if the frequency of the source is 21 Hz?

30. Standing waves are produced in a string by two waves traveling in opposite directions at 6.0 m/s. The distance between the second and sixth node is 80.0 cm. Determine the wavelength and the frequency of the propagating waves.

31. A standing wave pattern in a string is observed to have eight antinodes (with a node at the beginning and end of the pattern). The distance between the second and seventh node is 12.5 cm. The speed of the waves is 2125 cm/s. What frequency must the string be vibrated at to observe three antinodes?

32. A standing wave pattern in a string is observed to have 12 antinodes (with a node at the beginning and end of the pattern). The distance between the third and nineth node is 46.1 cm. The speed of the waves is 1577 cm/s. What frequency must the string be vibrated at to observe six antinodes?

33. A standing wave pattern in a string is observed to have five antinodes (with a node at the beginning and end of the pattern). The distance between the first and fifth node is 33.6 cm. The speed of the waves is 7756 cm/s. What frequency must the string be vibrated at to observe two antinodes?

Part II. Sound Problems

34. What is the speed of sound on a hot summers day when the temperature is 35 °C?

35. What is the speed of sound on a cool 265 °K day?

36. What temperature, in °C, results in a speed of sound being $v = 376$ m/s?

37. What temperature, in °C, results in a speed of 1.2×10^3 km/h?

38. On a particular day the speed of sound is 321 m/s. Using the Kelvin temperature scale, What is the speed of sound if **a)** the temperature doubles. **b)** the temperature triples. **c)** the temperature drops by a factor of four.

39. What is the observed frequency of a 6.50×10^3 Hz source moving **a)** towards a stationary observer at 95.0 m/s? **b)** away from a stationary observer at 95.0 m/s? Take the speed of sound to be $v = 325$ m/s

40. A firetruck emitts a frequency of 7.85×10^3 Hz and travels at $v_s = 80.50$ km/h. A car is traveling at $v_o = 62.70$ km/h. The speed of sound is $v = 346.0$ m/s. What frequency is heard by the car's driver if **a)** the vehicles are approaching each other? **b)** the vehicles are receding from each other?

41. What is the speed of truck, in km/h, if the driver hears a frequency of a police car to be $f_o = 1.77 \times 10^4$ Hz? The police car is driving 139 km/h and its siren has a frequency of $f_s = 1.4 \times 10^4$ Hz. The speed of sound is 334 m/s.

42. The air temperature is 23 °C. What frequency will be heard by someone standing on a corner as a police car drives away at 135 km/h and emitts a frequency of 2.3×10^3 Hz?

43. A fighter plane is traveling at half the speed of sound and emitts a frequency of 614.0 Hz. A commercial aircraft is traveling at one-fifth the speed of sound. What frequency is detected by the commercial plane if **a)** the planes are approaching each other? **b)** the planes are receding from each other?

44. A stationary observer at an air show watches a fighter plane approach it at one-third the speed of sound. The plane emitts a sound frequency of 15 Hz. What is the wavelength of the sound detected by the observer if the air temperature is 27 °C?

45. Joe and Dave have nothing better to do with their time so they run towards each other yelling as they go. Joe can run at an impressive 250 m/s and Dave can run at a slow 95 m/s. Joe yells at 1.60×10^3 Hz and Dave shouts at 355 Hz. The air temperature is a cool 265 °K. **a)** What frequency does Joe hear Dave shout at? **b)** What frequecy does Dave hear Joe yell at?

46. How fast must a source be moving relative to a stationary observer such that the observer hears a frequency **a)** three times that of the source? **c)** one-fourth that of the source? Take the speed of sound to by 325 m/s.

47. What fraction of the speed of sound must a source by moving so that a stationary observer hears a frequecy four times greater than the source frequency?

48. What fraction of the speed of sound must a source by moving so that a stationary observer hears a frequency two-thirds that of the source?

49. Two fighter planes approach each other, one traveling North and the other traveling South. The North bound plane is traveling at two-fifths the speed of sound. The south bound plane detects a frequency three times that of the source. What fraction of the speed of sound is the South bound plane traveling?

50. A Saskatoon firetruck races towards a fire at 117 km/h while its sirens roars at 1.250×10^4 Hz. A stationary observer along the way hears a frequency of 1.395×10^4 Hz. What month is the fire occuring?

Part III. Wave Phenomena. Answer in complete sentences.

51. Suppose you and your lab partner were asked to measure the speed of a transverse wave in a giant slinky. How could you do it? List the equipment you would need.

52. 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?

53. If you pull on one end of a Slinky, does the pulse reach the other end instantaneously? What if you pull on a rope? Hit the end of a metal rod?

54. A pulse is sent along a spring. The spring is attached to a light thread that is tied to a wall. Sketch the problem, label the point where the spring and string are attached **A** and label the point where the string attaches to the wall point **B**. a) What happens when the pulse reaches point **A**? b) Is the pulse reflected from **A** erect of inverted? c) What happens when the transmitted pulse reaches **B**? d) Is the pulse reflected from **B** erect or inverted?

55. A long spring runs acros the floor of a room and out the door. A pulse is sent along the spring. After a few seconds, an inverted pulse returns. Is the spring attached to the wall in the next room or is it lying loose on the floor?

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

57. Rhonda sends a pulse along a rope. How does the position of a point on the rope, before the pulse comes compare to the position after the pulse has passed?

58. What is the difference between a pulse and a wave?

59. Suppose you produce a wave by shaking one end of a spring back and forth. How does the frequency of your hand compare to that of the wave?

60. Waves are sent along a spring of fixed length. a) Can the speed of the waves be changed? Explain. b) Can the frequency of a wave in the spring be changed? Explain.

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

62. When a wave reaches the boundary of a new medium, part of the wave is reflected and part is transmitted. What determines the amount of reflection?

63. What happens to the spring at nodes of a standing wave?

64. You repeatedly dip your finger into a sink full of water to make circular waves. What happens to the wavelength as you move your finger faster?

65. When a stone is dropped into water, the resulting ripples spread farther and farther out, getting smaller and smaller in amplitude. Why does the amplitude eventually decrease to zero?

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

67. 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.

Physics 20 Waves Phenomena Mr. MacDonald 31/02/2007

Answer List

1. a) $T = 12\,\text{s}$
   b) $f = 0.083\,\text{Hz}$
2. a) $f = 0.800\,\text{Hz}$
   b) $T = 1.25\,\text{s}$
3. $f = 84.7\,\text{Hz}$
4. $f = 4.0 \times 10^2\,\text{Hz}$, $T = 2.5 \times 10^{-3}\,\text{s}$
5. a) $7.5\,\text{Hz}$
   b) $216\,\text{Hz}$
6. $2.00\,\text{s}$
7. a) 1.5 points/min
   b) 3 escapes/min
   c) 11.3 rotations/s
8. a) $0.63\,\text{s}$
   b) $3.9 \times 10^{-3}\,\text{s}$
   c) 27.3 days/lunar cycle
9. a) $0.20\,\text{Hz}$
   b) $1.2\,\text{Hz}$
   c) $40.0\,\text{Hz}$
   d) $4.2 \times 10^{-2}\,\text{Hz}$
10. a) $0.100\,\text{s}$
    b) $2.000 \times 10^{-3}\,\text{s}$
    c) $4.0\,\text{s}$
    d) $9.794 \times 10^{-9}\,\text{s}$
11. $v = 75\,\text{cm/s},\ 0.75\,\text{m/s}$
12. a) $T = 9.149 \times 10^{-9}\,\text{s}$
    b) $\lambda = 2.74\,\text{m}$
13. a) $v = 49\,\text{cm/s}$
    b) $t = 11\,\text{s}$
14. $v = 356\,\text{m/s}$
15. $T = 0.52\,\text{s}$
16. $\lambda = 0.25\,\text{m}$
17. 15 waves
18. $62\,\text{m}$
19. a) $0.93\,\text{Hz}$
    b) $1.1\,\text{s}$
20. $5.0\,\text{m/s}$
21. a) $2.5\,\text{m/s}$
    b) $41\,\text{s}$
    c) $1.5 \times 10^2\,\text{m}$
22. $3.8\,\text{s}$
23. $3.33\,\text{m}$
24. $17\,\text{m}$ to $1.7 \times 10^{-2}\,\text{m}$
25. Speed remains the same. $v = 280.\,\text{cm/s}$ Wavelength becomes increased by a factor of four, $\lambda = 10.8\,\text{cm}$
26. a) $7.35\,\text{Hz}$
    b) $2.34\,\text{cm}$
    c) erect
    d) inverted
27. a) $\textit{node dist.} = 12.8\,\text{cm}$
    b) $v = 7.14\,\text{m/s}$
28. a) $\lambda = 62.0\,\text{cm}$
    b) $v = 775\,\text{cm/s}$
29. a) $17\,\text{cm}$
    b) $360\,\text{cm/s}$
30. $\lambda = 40.0\,\text{cm}$ and $f = 15\,\text{Hz}$
31. $f_3 = 159\,\text{Hz}$
32. $f_6 = 51.3\,\text{Hz}$
33. $f_2 = 185\,\text{Hz}$
34. $v = 352\,\text{m/s}$
35. $v = 326\,\text{m/s}$
36. $T = 73.8\,^\circ\text{C}$
37. $T = 3.8\,^\circ\text{C}$
38. **a)** $v = 454\,\text{m/s}$ **b)** $v = 556\,\text{m/s}$ **c)** $v = 161\,\text{m/s}$
39. **a)** $f_o = 9.185 \times 10^3\,\text{Hz}$ **b)** $f_o = 5158\,\text{Hz}$

40. **a)** $f_o = 8.813 \times 10^3$ Hz **b)** $f_o = 7.000 \times 10^3$ Hz
41. $v_o = 142$ km/h
42. $f_o = 2.0 \times 10^3$ Hz
43. **a)** $f_o = 1474$ Hz **b)** $f_o = 327$ Hz
44. $\lambda_o = 15$ m
45. **a)** $f = 889$ Hz **b)** $f = 8.86 \times 10^3$ Hz
46. **a)** 216 m/s approaching the observer. **b)** 975 m/s receding from the observer.
47. $\frac{v_s}{v} = \frac{3}{4}$
48. $\frac{v_s}{v} = \frac{1}{2}$
49. $\frac{v_o}{v} = \frac{4}{5}$
50. *Not going to make it that easy, check your answer with me.*
51. *short answer*
52. *short answer*
53. *short answer*
54. *short answer*
55. *short answer*
56. *Lower*
57. *Same position*
58. *short answer*
59. *Same frequency*
60. *short answer*
61. *The distance of maximum displacement fromt the equilibrium position. Represents the wave's energy*
62. *The difference in wave velocity of the new medium.*
63. *No motion*
64. *Wavelength get smaller*
65. *Short answer*
66. *short answer*
67. *Short answer*

Catalog List

1. 20P BA 1	2. 20P BA 5	3. 20P BA 7	4. 20P BA 8
5. 20P BA 20	6. 20P BA 22	7. 20P BA 23	8. 20P BA 24
9. 20P BA 25	10. 20P BA 26	11. 20P BA 9	12. 20P BA 2
13. 20P BA 3	14. 20P BA 4	15. 20P BA 10	16. 20P BA 12
17. 20P BA 29	18. 20P BA 28	19. 20P BA 35	20. 20P BA 38
21. 20P BA 39	22. 20P BA 41	23. 20P BA 44	24. 20P BA 46
25. 20P BA 48	26. 20P BA 49	27. 20P BA 16	28. 20P BA 17
29. 20P BA 52	30. 20P BA 57	31. 20P BA 58	32. 20P BA 59
33. 20P BA 60	34. 20P BA 61	35. 20P BA 62	36. 20P BA 63
37. 20P BA 64	38. 20P BA 65	39. 20P BA 66	40. 20P BA 67
41. 20P BA 68	42. 20P BA 69	43. 20P BA 70	44. 20P BA 71
45. 20P BA 72	46. 20P BA 73	47. 20P BA 74	48. 20P BA 75
49. 20P BA 76	50. 20P BA 77	51. 20P BB 1	52. 20P BB 2
53. 20P BB 3	54. 20P BB 6	55. 20P BB 7	56. 20P BB 8
57. 20P BB 10	58. 20P BB 11	59. 20P BB 13	60. 20P BB 14
61. 20P BB 15	62. 20P BB 16	63. 20P BB 19	64. 20P BB 21
65. 20P BB 37	66. 20P BB 39	67. 20P BB 40	

Physics 112

Light

Part I. Sources of light questions. Use compete sentences.

1. Sound doesn't travel through a vacuum; how do we know light does?

2. What is the wavelength, from shortest to longest, the human eye can detect?

3. What colour of light has the shortest wavelength?

4. What colour of light has the shortest frequency?

5. Distiguish between a luminous body and an illuminated body.

6. Explain how we can see ordinary nonluminous classroom objects.

7. What happens to the wavelength of light as the frequency increases?

8. To what is the illumination of a surface by a light source directly proportional? Inversely proportional?

9. A point source of light is 2.0 m from screen **A** and 4.0 m from screen **B**. How does the illumination of screen **B** compare with the illumination of screen **A**?

10. Convert 700.0 nm, the wavelength of red light, to metres.

11. The Sun is 1.5×10^8 km from the Earth. How many minutes does it take for its light to reach us?

12. Radio stations are usually identified by their frequency. What is the radio wavelength λ of a station that broadcasts with a frequency of 99.0 MHz?

13. What is the wavelength of electromagnetic radiation that has a frequency of 4.8×10^{14} Hz? Convert your answer to nanometres.

14. How many minutes does it take light to travel 3.30×10^{12} m?

15. What is the wavelength of light that has a frequency of 7.23×10^{14} Hz? What is the colour of this light?

16. Assuming Jupiter is at its closest approach to Earth, how many minutes does it take a radio signal from Earth to reach Jupiter if Jupiter is 5.2 AU from the Sun? (AU is an astronomical unit, 1 AU is the distance between the Earth and the Sun.)

Physics 112 Light Mr. MacDonald Fall 2012

Answer List

1. *short answer*
2. *short answer*
3. violet
4. red light
5. *short answer*
6. *short answer*
7. wavelength decreases
8. Directly proportional to the luminous flux. Inversely proportional to the square of the distance from the source.
9. Screen **A** is four times brighter than screen **B**.
10. 7.000×10^{-7} m
11. 8.3 min
12. 3.03 m
13. 6.3×10^{-7}, or 630 nm
14. 183 min
15. $\lambda = 415$ nm, it is violet/blue light.
16. 35 min

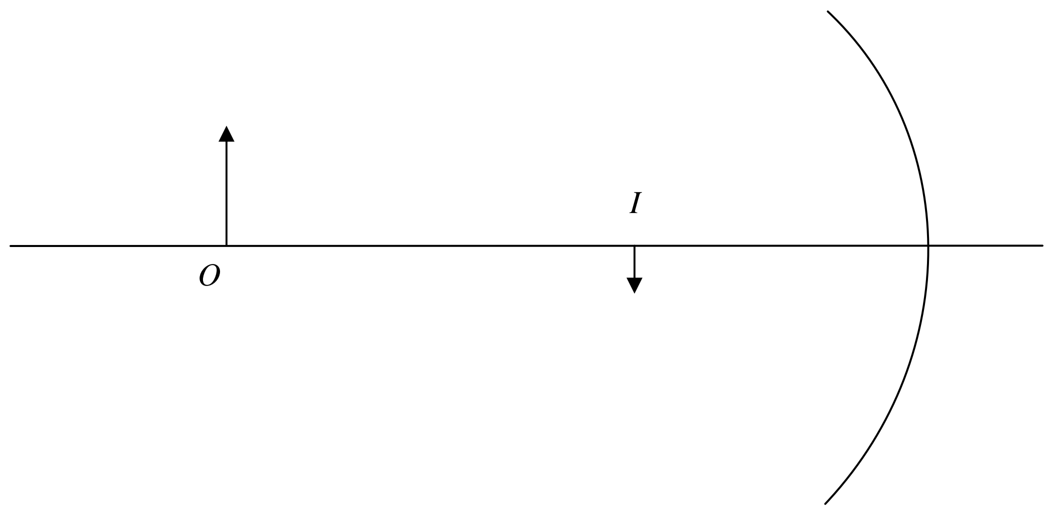
Catalog List

1. 20P CA 1
2. 20P CA 2
3. 20P CA 3
4. 20P CA 4
5. 20P CA 5
6. 20P CA 6
7. 20P CA 7
8. 20P CA 8
9. 20P CA 9
10. 20P CA 11
11. 20P CA 13
12. 20P CA 14
13. 20P CA 16
14. 20P CA 17
15. 20P CA 18
16. 20P CA 19

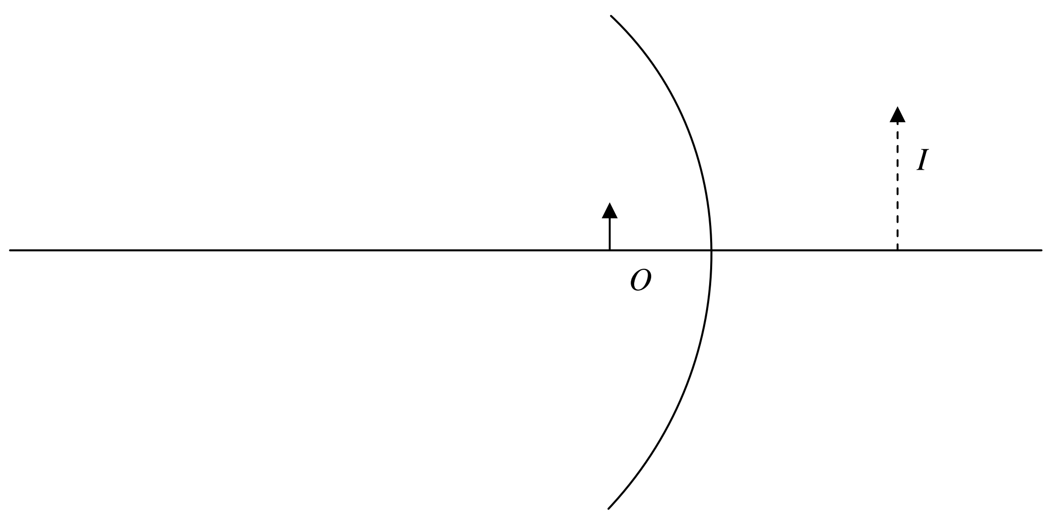
Converging Mirror Problems

1. Locate the centre of curvature.

    a.

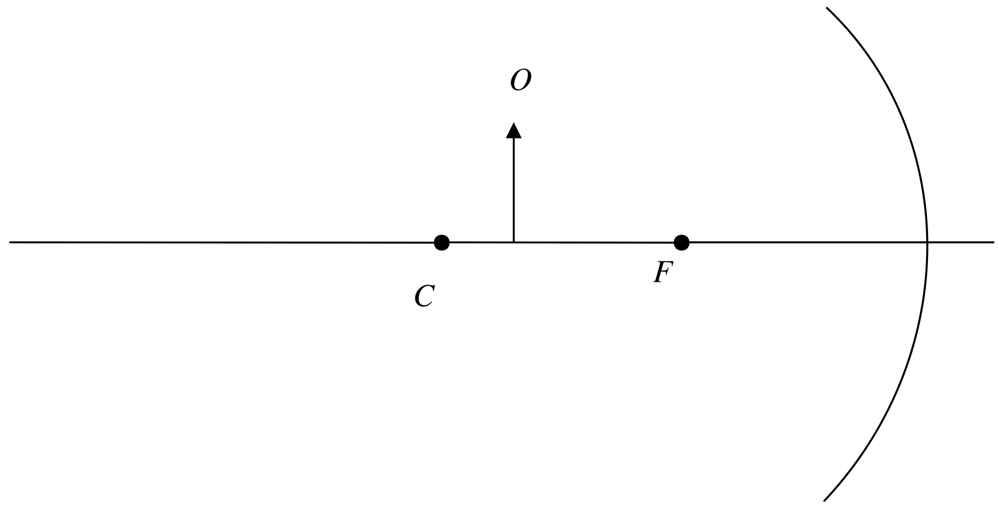


    b.

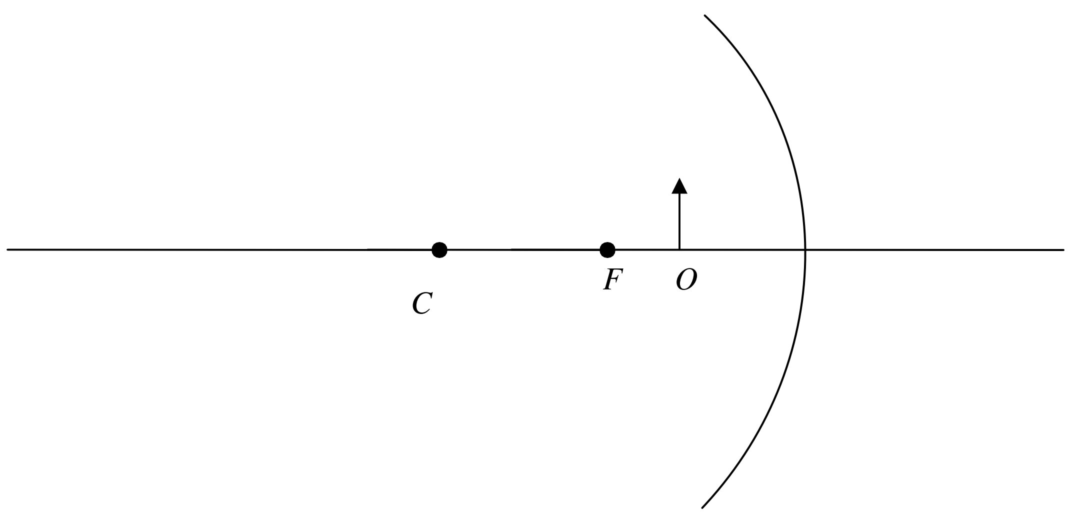


2. Locate the image of the object.

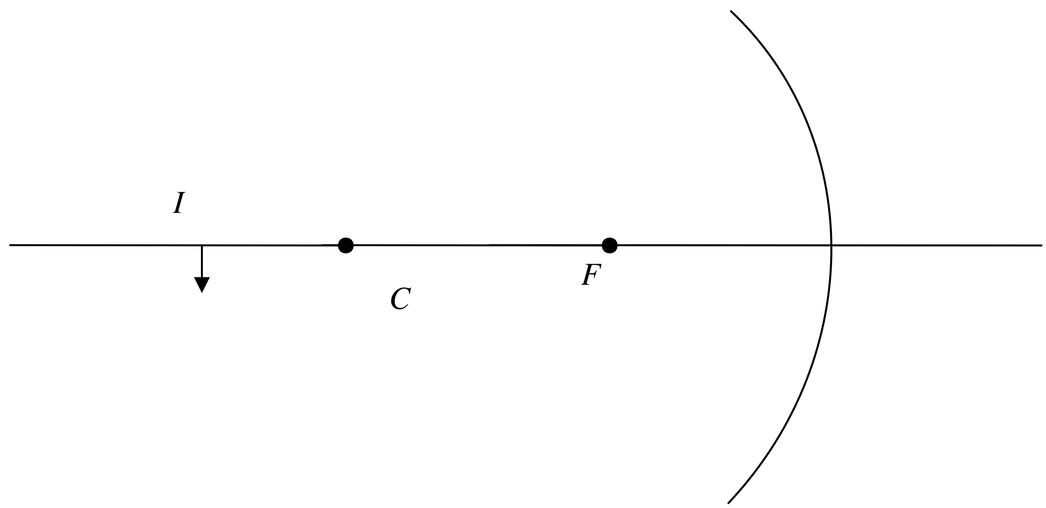
a.



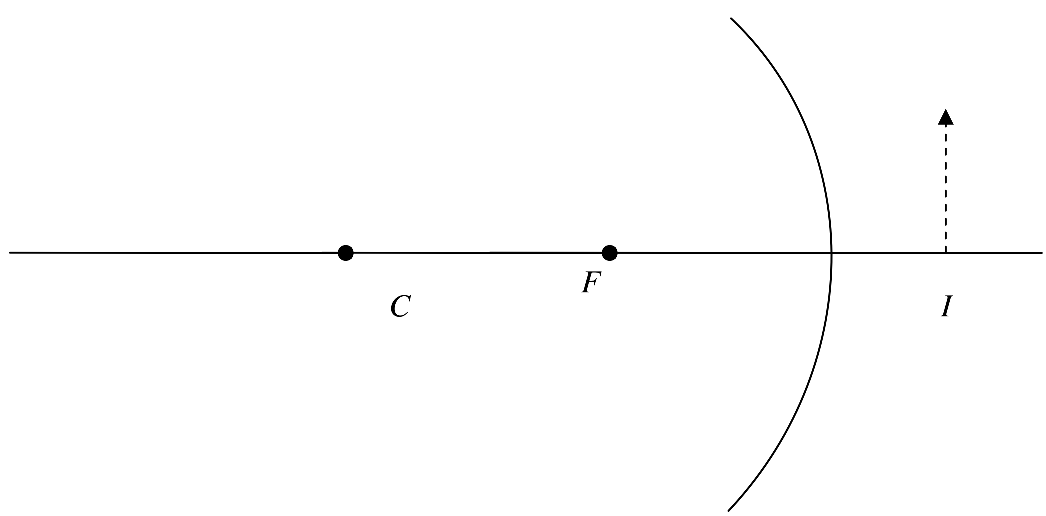
b.



3. Find the location and size of the object.
   a.

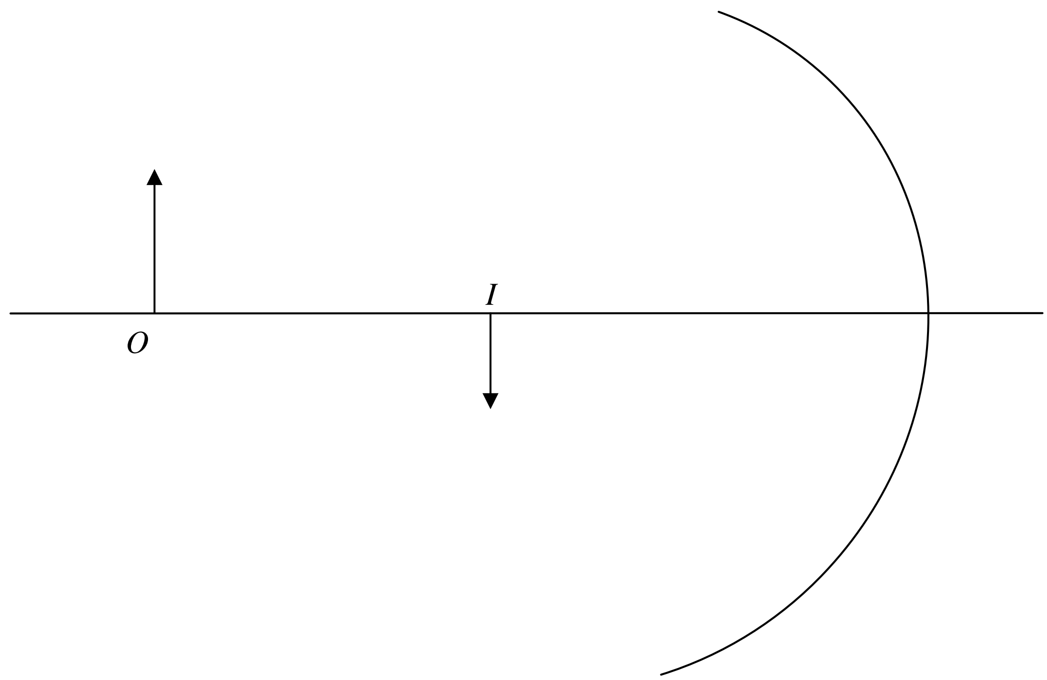


   b.

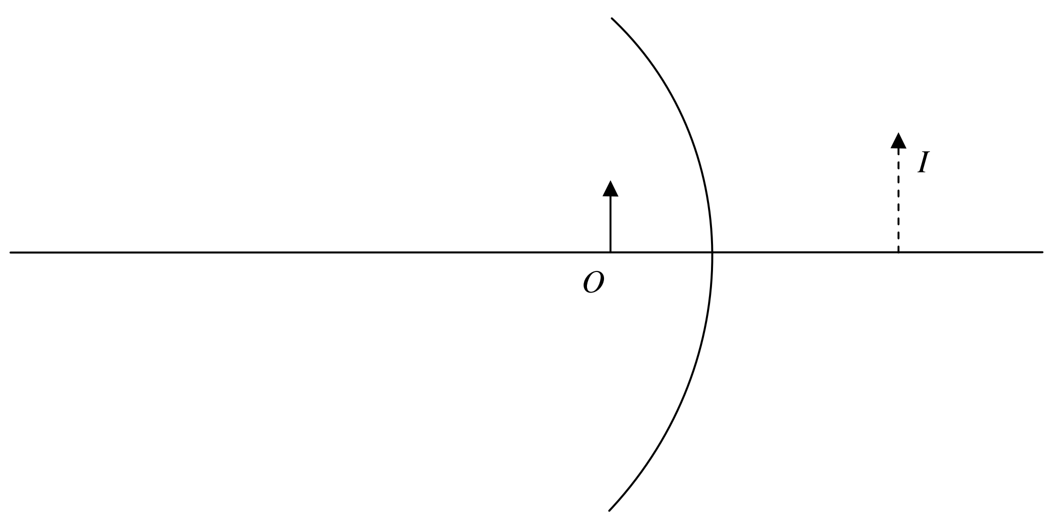


4. Determine the location of the principal focus.

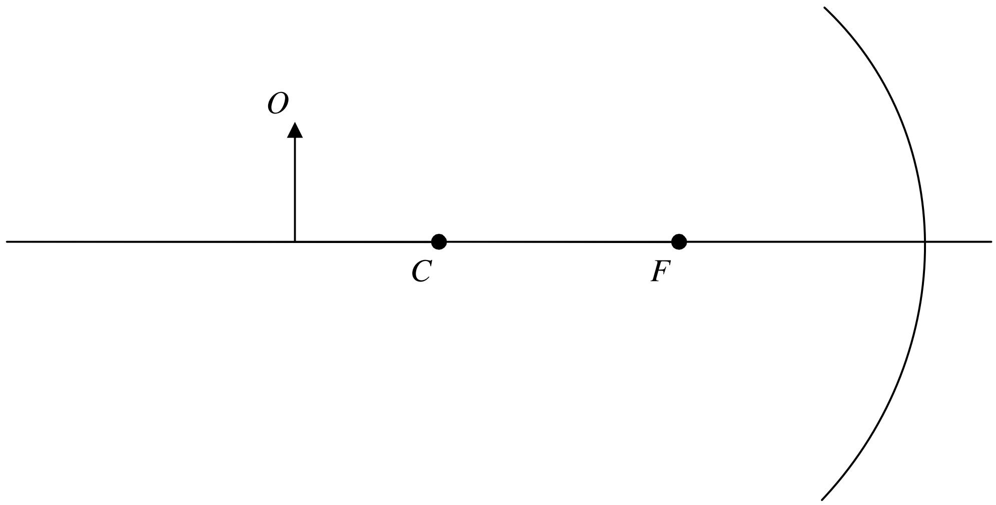
a.



b.



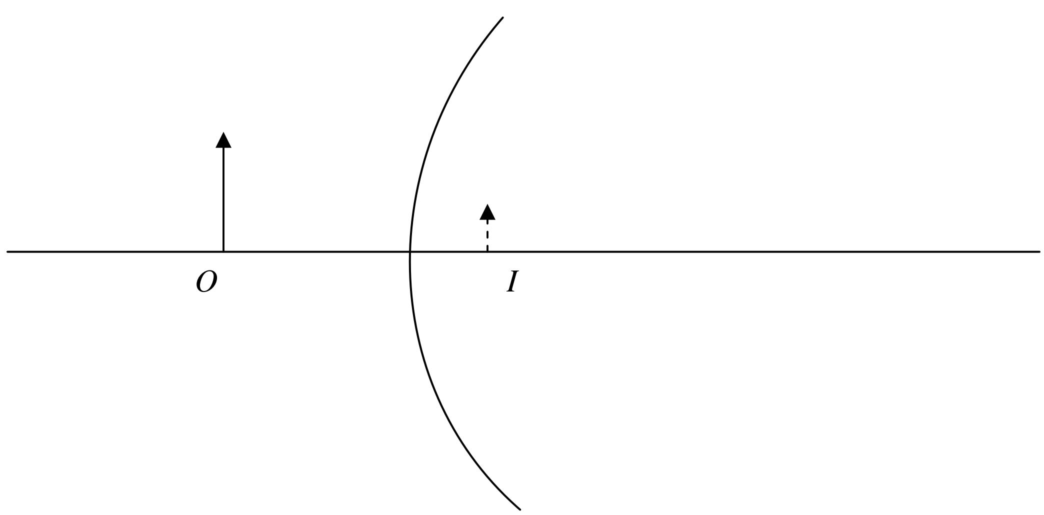
5. Locate the image in the following mirrors. List the characteristics of the image.



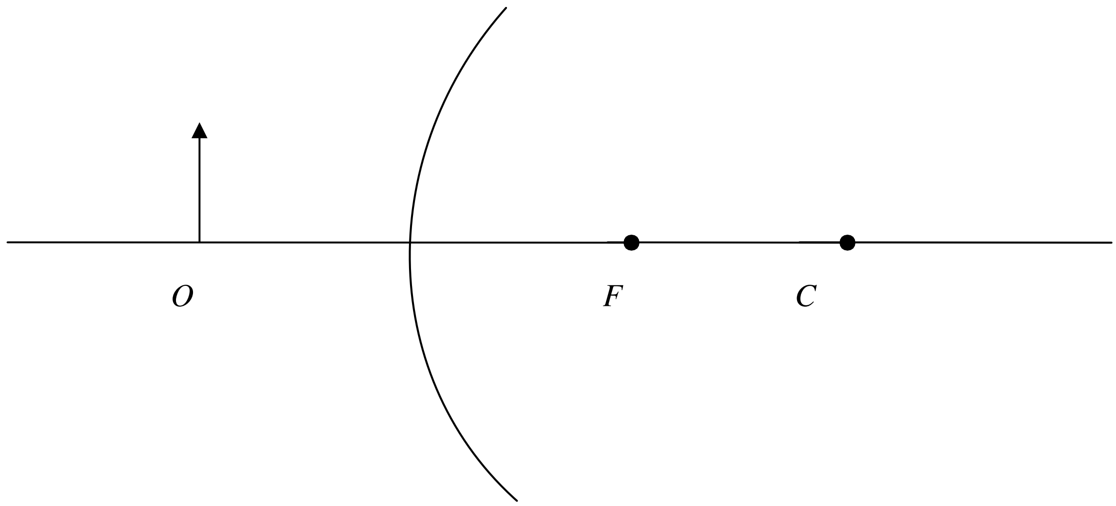
Characteristics:

Diverging Mirror Problems

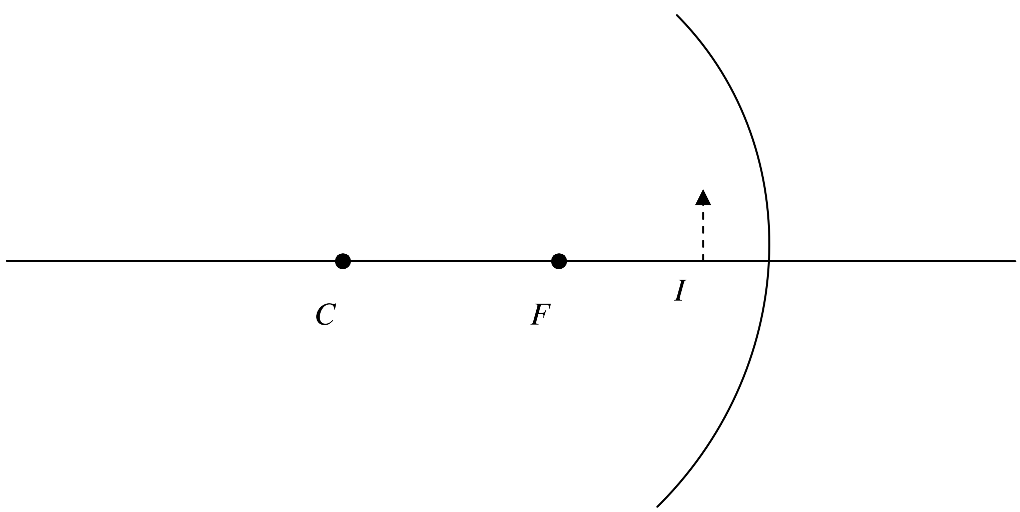
6. Locate the centre of curvature.



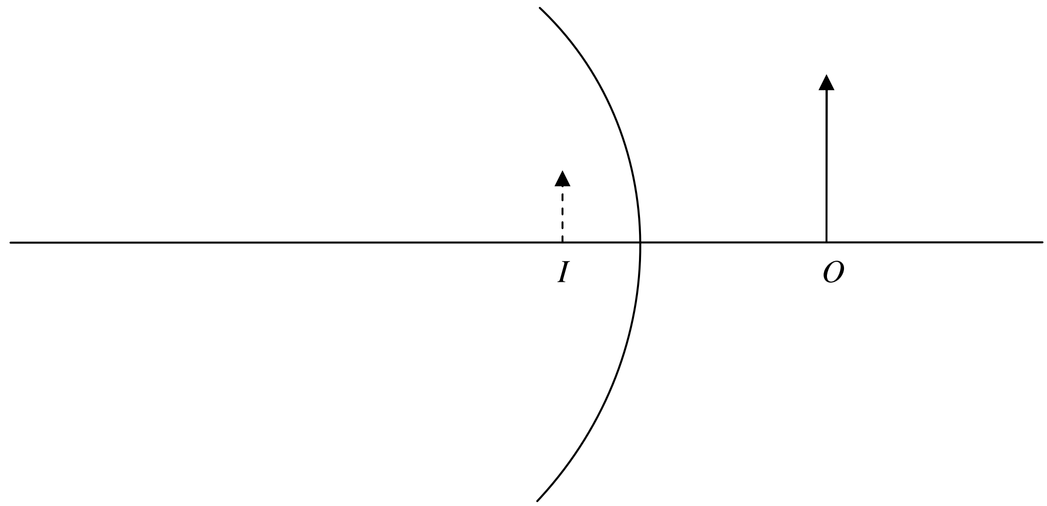
7. Locate the image of the object.



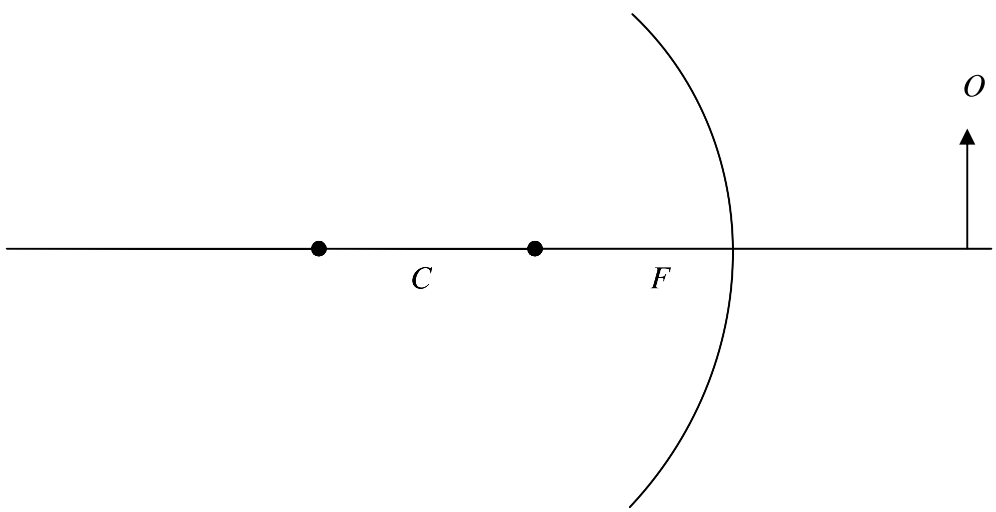
8. Find the location and size of the object.



9. Determine the location of the principal focus.



10. Locate the image in the diverging mirror.



Characteristics:

Physics 112

Mirrors Problems

Part I. Mirrors and Reflection Problems.

1. A converging mirror has a focal length of 15.0 cm. a) Where is the image if the object is 58.0 cm from the vertex? b) What is the height of the image if the original object was 75.0 cm high?

2. A 2.5 m tall person stands 1.5 m in front of a large diverging mirror. a) What is the focal length of the mirror if the mirror has a magnification of $M = +0.65$? b) What is the height of the image?

3. An image of a person's face is located a distance of $d_i = -25.0$ cm from the vertex of a converging mirror. The person is 11.0 cm from the vertex. a) What is the focal length of the mirror? b) What is the magnification of the mirror? c) What is the height of the image if the face is 26.0 cm high?

4. How far from the vertex is an image in a diverging mirror if it has a focal length of $f = -49.0$ cm and the object is 33.0 cm from the vertex?

5. Determine the image distance for a converging mirror with a focal length of $f = 44$ cm if the object is placed 62 cm from the screen. What are the four characteristics of the image?

6. A 15 cm pencil is placed 35 cm from a diverging mirror. If the focal length is $f = -25$ cm, find the image distance and height. What are the four characteristics of the image?

7. Determine the image distance in in a converging mirror that has a focal length of 15.0 cm when the object is placed a) 40.0 cm from the mirror; and b) 10.0 cm from the mirror.

8. Determine the image distance in a diverging mirror that has a focal length of −20.0 cm when the object is placed a) 10.0 cm from the mirror; and b) 30.0 cm from the mirror.

9. A candle 3.0 cm high is placed 30.0 cm from a converging mirror with a focal length of 20.0 cm. Find the location and height of the image. What are the images characteristics?

10. A woman looks at herself in a magnifying converging mirror whose focal length is 20.0 cm. If her face is 10.0 cm from the mirror, at what distance from the mirror is her image? what is the magnification of her face?

11. A 2.0 cm high candle is placed 15 cm in from of a converging mirror with a focal length of 30.0 cm. How far behind the mirror does the candle appear, and how large is it?

12. A dentist holds a converging mirror with a focal length of 20.0 mm a distance of 15 mm from a tooth. What is the magnification of a filling in the tooth?

13. A trucker sees the image of a car passing her truck in her diverging rear-view mirror whose focal length is −60.0 cm. If the car is 1.5 m high and 6.0 m away, what is the size and location of the image?

14. Where is an image formed with a converging mirror of focal length 25 cm if the object is placed a) 45 cm from the vertex? b) 15 cm from the vertex?

15. A converging mirror has a focal length of 42 cm. Where should an object be placed to produce a *real* image one third the size of the object?

16. A converging mirror has a focal length of 42 cm. Where should an object be placed to produce a *virtual* image three times the size of the object?

17. Where is the centre of curvature of a diverging mirror that produces an image three quarters as high as the original object? The original object is 24.0 cm from the vertex of the mirror.

18. A converging mirror has a focal length of 30.0 cm. Where must an object be placed to produce a real image five times the size of the object?

19. A child looks at his reflection in a spherical Christmas tree ornament 8.0 cm in diameter, and sees that the image of his face is reduced by a factor of half. How far is his face from the ornament?

20. A converging mirror has a focal length of 15 cm. Where would you place an object in order to produce a virtual image two times as tall as the object?

21. A converging mirror has a focal length of 24 cm. Where would you place an object: a) to produce a real image one-third the size of the object? b) to produce a real image 3.00 times the size of the object? c) to produce a virtual image 3.00 times the size of the object?

22. A converging mirror has a focal length of $f = 15.0$ cm. The distance between the object and its real, enlarged image is 40.0 cm. Determine the magnification.

23. A converging mirror has a focal length of $f = 12.0$ cm. The distance between the object and its real, reduced image is 55.0 cm. Determine the magnification.

24. You are given either a converging or diverging mirror with a known focal length f. Using the mirror and magnification equations, show that to obtain a desired magnification M, the object should be placed a distance of, $d_o = \dfrac{f(M-1)}{M}$.

Physics 112 Mirrors Problems Mr. MacDonald Fall 2012

Answer List

1. a) $d_i = 20.2\,\text{cm}$
   b) $h_i = -26.1\,\text{cm}$
2. a) $f = -2.8\,\text{m}$
   b) $h_i = 1.6\,\text{m}$
3. a) $f = 19.6\,\text{cm}$
   b) $M = 2.27$
   c) $h_i = 59.1\,\text{cm}$
4. $d_i = -19.7\,\text{cm}$
5. $d_i = 1.5 \times 10^2\,\text{cm}$. Image is real, inverted, beyond C, and larger than the object.
6. $d_i = -15\,\text{cm}$; $h_i = 6.3\,\text{cm}$. Image is virtual, between V and F, smaller than the object, and erect.
7. a) $d_i = 24.0\,\text{cm}$
   b) $d_i = -30.0\,\text{cm}$
8. a) $d_i = -6.70\,\text{cm}$
   b) $d_i = -12.0\,\text{cm}$
9. $d_i = 60.0\,\text{cm}$; $h_i = -6.0\,\text{cm}$. The image is real, inverted, beyond C, and larger than the object.
10. $d_i = -20.0\,\text{cm}$; $M = +2.0$
11. $d_i = -30.0\,\text{cm}$; $h_i = 4.0\,\text{cm}$
12. $M = +4.0$
13. $h_i = 14\,\text{cm}$; $d_i = -0.55\,\text{m}$
14. a) $d_i = 56\,\text{cm}$
    b) $d_i = -38\,\text{cm}$
15. $d_o = 1.7 \times 10^2\,\text{cm}$
16. $d_o = 28\,\text{cm}$
17. $C = -144$
18. $d_o = 36\,\text{cm}$
19. $d_o = 2.0\,\text{cm}$
20. $d_o = 7.5\,\text{cm}$
21. a) $d_o = 96\,\text{cm}$
    b) $d_o = 32\,\text{cm}$
    c) $d_o = 16\,\text{cm}$
22. $d_o = 20.0\,\text{cm}$, $d_i = 60.0\,\text{cm}$, $M = -3.00$
23. $d_o = 69.5\,\text{cm}$, $d_i = 14.5\,\text{cm}$, $M = -0.209$
24. *proof*

Catalog List

1. 20P CB 1	2. 20P CB 2	3. 20P CB 3	4. 20P CB 4
5. 20P CB 5	6. 20P CB 6	7. 20P CB 8	8. 20P CB 9
9. 20P CB 11	10. 20P CB 12	11. 20P CB 13	12. 20P CB 14
13. 20P CB 15	14. 20P CB 17	15. 20P CB 19	16. 20P CB 20
17. 20P CB 21	18. 20P CB 24	19. 20P CB 26	20. 20P CB 27
21. 20P CB 28	22. 20P CB 31	23. 20P CB 32	24. 20P CB 40

Part I. Review of trigonometric properties and right triangles.

1. Find $\tan 40^\circ$ to three decimal places.

2. Find $\sin 40^\circ$ to three decimal places.

3. Find $\tan 80^\circ$ to four decimal places.

4. Find $m\angle \mathbf{C}$ to the nearest degree given $\sin C = 0.5784$.

5. Find $m\angle \mathbf{A}$ to the nearest degree given $\tan A = 3.2452$.

6. Find $\angle \mathbf{A}$ to the nearest tenth of a degree if $\cos A = 0.906$

7. Find $\angle \mathbf{P}$ to the nearest tenth of a degree of $\sin A = 0.457$

8. Find $\angle \phi$ to the nearest degree given $\sin \phi = 0.423$

9. Find $\angle \theta$ to the nearest degree given $\tan \theta = 9.094$.

10. Find $m\angle \beta$ to the nearest degree given $\sin \beta = \frac{4}{7}$.

11. Find $\angle \beta$ to the nearest degree given $\tan \beta = \dfrac{\sqrt{5}}{3}$.

Part II. Refraction of light problems.

12. What is the speed of light in flint glass?

13. Light travels from air into ruby. What is the speed of light in ruby?

14. How long will it take light to travel through a piece of fused quartz 1.35 m thick?

15. How many times faster does light travel in glycerin than in zircon?

16. What is the index of refraction of a liquid in which the speed of light is 2.50×10^8 m/s?

17. What is the speed of light in sodium chloride?

18. Zircon is often used as an imitation diamond in costume jewelry. Calculate how much the speed of light decreases when it passes from air into zircon.

19. What is the wavelength of blue light in ruby if it travels from a vacuum where its wavelength is $\lambda = 455$ nm?

20. Someone claims to have invented a material with an index of refraction of $n = 0.85$. What is the speed of light in that material? What argument can you provide against such a material existing?

21. A piece of fused quartz of a length 25 cm is placed next to a 55 cm piece of zircon (there is no gap between the two). How long will it take light to travel through both materials? Be careful with the units.

22. How does the frequency of a radio wave, $\lambda = 2.8$ m, traveling through air compare to the frequency of the radio wave after entering water? What is the wavelength and frequency of this radio wave in the water?

23. Light travels from air into flint glass. a) What is the speed of light in flint glass? b) If the incident angle is 25°, what is the angle of refraction?

24. Light is traveling from an unknown medium into diamond. The angle of incidence is 42° and the angle of refraction is 28°. What is the index of refraction of the unknown medium?

25. Light travels from Plexiglass into ruby. What is the angle of incidence if the angle of refraction is measured to be 16.8°?

26. Light passes from air into diamond with an angle of incidence of 60.0°. What will be the angle of refraction?

27. A transparent substance has a refractive index of $n = 1.30$. What is the angle of incidence in air when the angle of refraction in the substance is 45°?

28. What is the index of refraction of a material if the angle of incidence in air is 50.0° and the angle of refraction in the material is 40.0°?

29. A ray of light passes from water into carbon disulphide, $n_{cs_2} = 1.63$, with an angle of incidence of 30.0°. What is the angle of refraction in the carbon disulfide?

30. A ray of light in air strikes diamond and another strikes a piece of fused quartz, in each case at an angle of incidence of 40.0°. What is the difference between the angles of refraction?

31. Light travels from water into an unknown material. If the angle of incidence is 35.5° and the measured angle of refraction is 17.4°, what is the speed of light in the unknown material?

32. The speed of light in a certain material is 9.68×10^7 m/s. If light enters that material from crown glass with an angle of incidence of 33.5°, what will be the angle of refraction?

33. Light is traveling from air into glycerin. What is the largest possible angle of refraction?

34. Light is traveling from water into crown glass. What is the largest possible angle of refraction?

35. What is the critical angle in crystal glass if light travels from it into air?

36. A ray of light travels from diamond into Plexiglas. What is the critical angle in the diamond?

37. What is the critical angle in flint glass when light passes from flint glass into air?

38. For each of the following light travels into water. Calculate the critical angle for (a) zircon (b) sodium chloride, and (c) ethyl alcohol.

39. The critical angle for a medium is 40.5°. What is the index of refraction for that medium if the light travels into air?

40. What is the difference between the critical angle light traveling from ruby-to-air and the critical angle for light traveling from water-to-air?

41. In a certain substance, light travels 3.15 m in 16.5 ns. What is the critical angle of the substance if light travels from that substance into ethyl alcohol?

42. In a certain medium, light will travel 1.75 m in 11.0 ns. What is the critical angle of the substance if light is traveling from that substance into air?

Physics 20 Refraction of Light Mr. MacDonald 31/02/2007

Answer List

1. 0.839
2. 0.643
3. 5.6713
4. 35°
5. 73°
6. 25.0°
7. 27.2°
8. 25°
9. 83.7°
10. 35°
11. 37°
12. $v = 1.82 \times 10^8$ m/s
13. $v_{ruby} = 1.95 \times 10^8$ m/s
14. $t = 6.57$ ns
15. $v_{glycerin} = 1.31 v_{zircon}$
16. $n = 1.20$
17. $v_{s.chloride} = 1.96 \times 10^8$ m/s
18. Light decreases 1.44×10^8 m/s.
19. $\lambda_{ruby} = 295$ nm
20. $v_{material} = 3.53 \times 10^8$ m/s
21. $t = 4.74$ ns
22. The wavelength decreases in water. The frequency is $f = 1.1 \times 10^8$ Hz and $\lambda = 2.11$ m in the water.
23. a) $v = 1.82 \times 10^8$ m/s
    b) $\theta_R = 15°$
24. $n_{unknown} = 1.7$
25. $\theta_i = 17.1°$
26. $\theta_R = 21.0°$
27. $\theta_i = 67°$
28. $n = 1.19$
29. $\theta_R = 24.0°$
30. The difference is 11°.
31. $v_{material} = 1.16 \times 10^8$ m/s
32. $\theta_R = 15.7°$
33. 42.9°
34. 61.0°
35. $\theta_C = 40.5°$
36. $\theta_C = 38.6°$
37. $\theta_C = 37.3°$
38. a) $\theta_C = 43.8°$
    b) $\theta_C = 60.4°$
    c) $\theta_C = 77.9°$
39. $n = 1.54$
40. The difference is 8.3°.
41. $\theta_C = 59.5°$
42. $\theta_C = 31.9°$

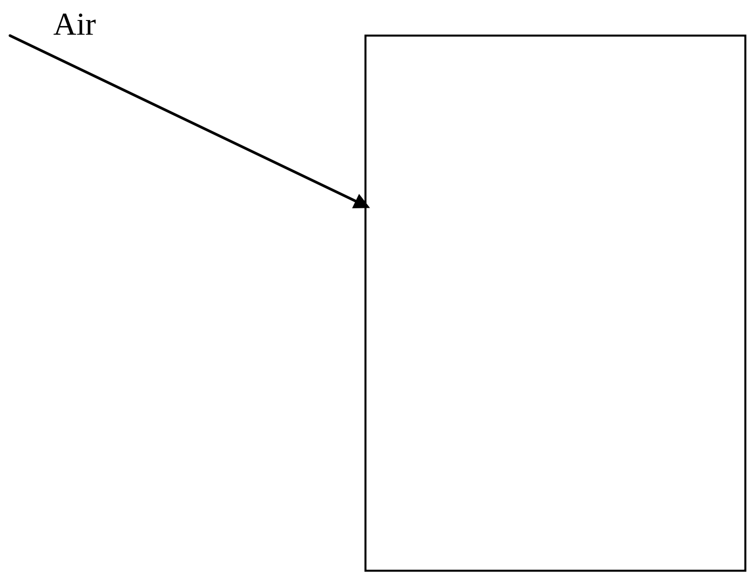
Catalog List

1. CM2 JA 85
2. CM2 JA 86
3. CM2 JA 88
4. CM2 JA 89
5. CM2 JA 90
6. CM2 JA 91
7. CM2 JA 92
8. CM2 JA 93
9. CM2 JA 94
10. CM2 JA 95
11. CM2 JA 96
12. 20P CC 1
13. 20P CC 2
14. 20P CC 5
15. 20P CC 6
16. 20P CC 9
17. 20P CC 10
18. 20P CC 11
19. 20P CC 13
20. 20P CC 15
21. 20P CC 16
22. 20P CC 17
23. 20P CC 19
24. 20P CC 20
25. 20P CC 22
26. 20P CC 23
27. 20P CC 24
28. 20P CC 25
29. 20P CC 27
30. 20P CC 29
31. 20P CC 30
32. 20P CC 33
33. 20P CC 47
34. 20P CC 48
35. 20P CC 34
36. 20P CC 35
37. 20P CC 38
38. 20P CC 39
39. 20P CC 40
40. 20P CC 42
41. 20P CC 43
42. 20P CC 45

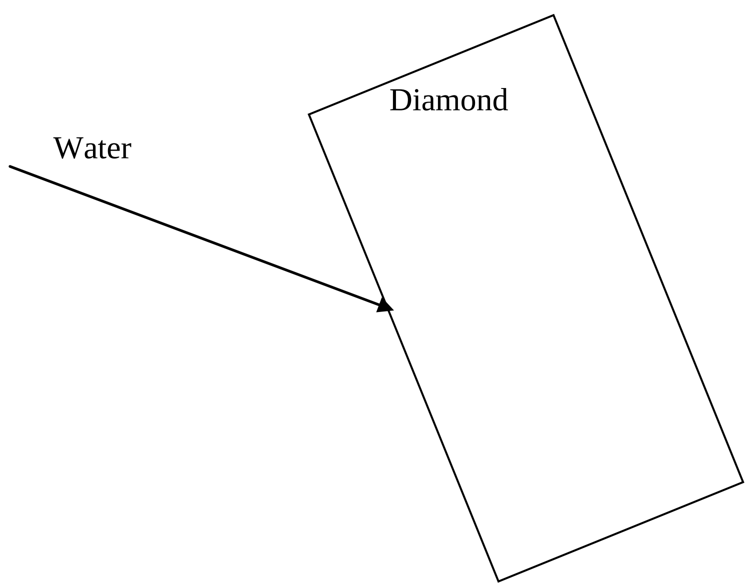
Displacement & Deviation Practice

→ *Use a protractor, ruler, and calculator to trace the path of light.*

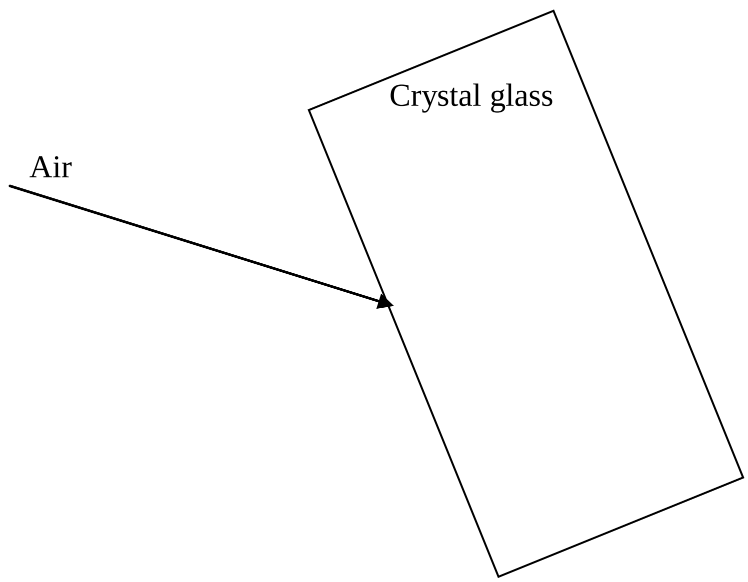
41. Find the lateral displacement in mm for the rectangular piece of crown glass.



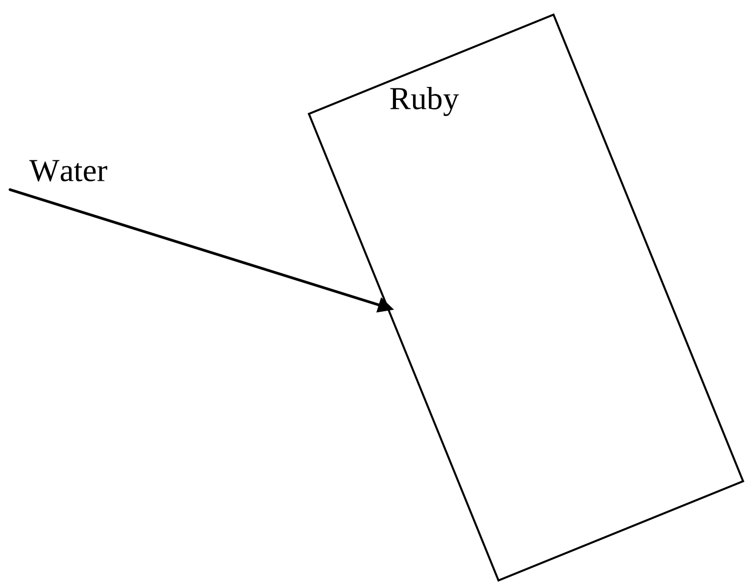
42. Find the lateral displacement in mm for light traveling from water into diamond.



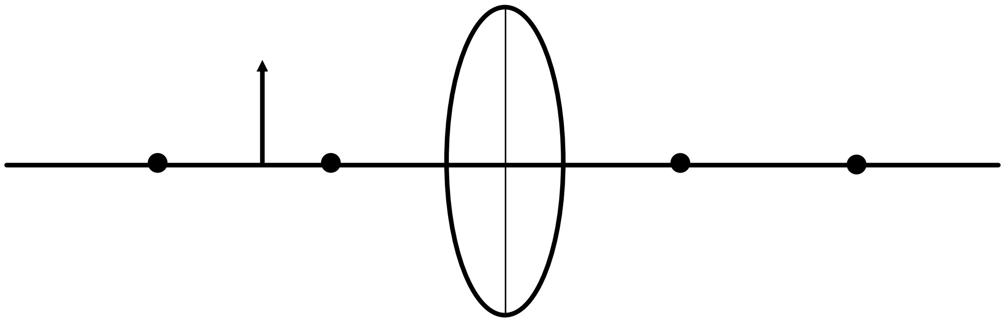
43. Using a protractor, ruler, and calculator, calculate the lateral displacement in mm.

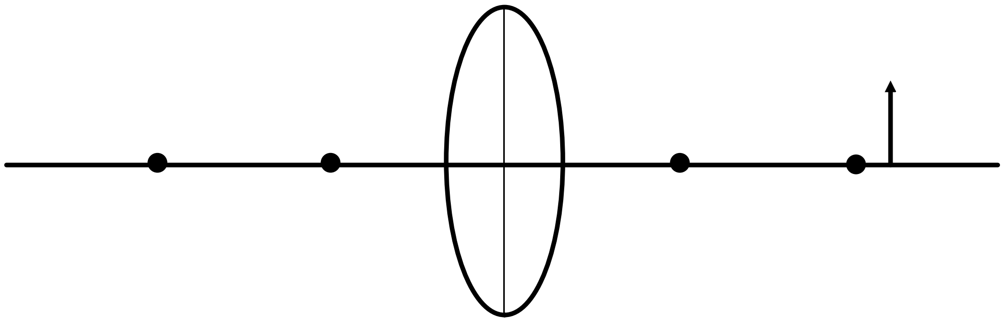


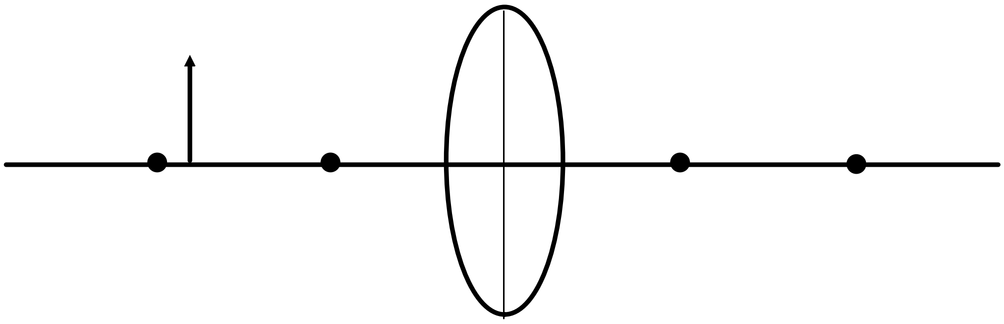
44. Find the lateral displacement in mm for light traveling from water into ruby.
(Displacement ≈ 6.5 mm)

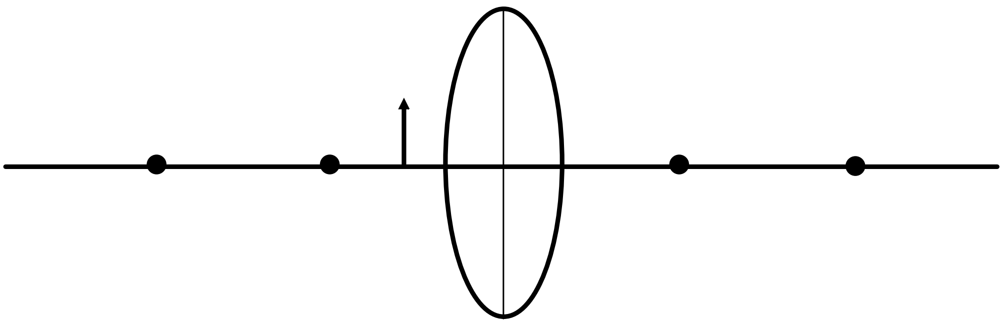


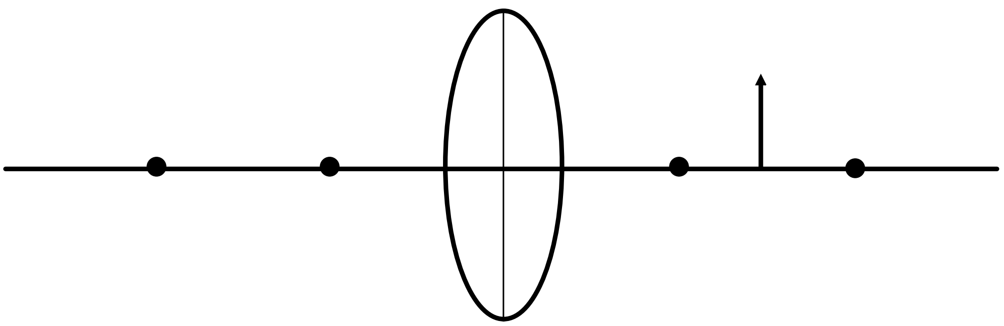
Find the image location and size.



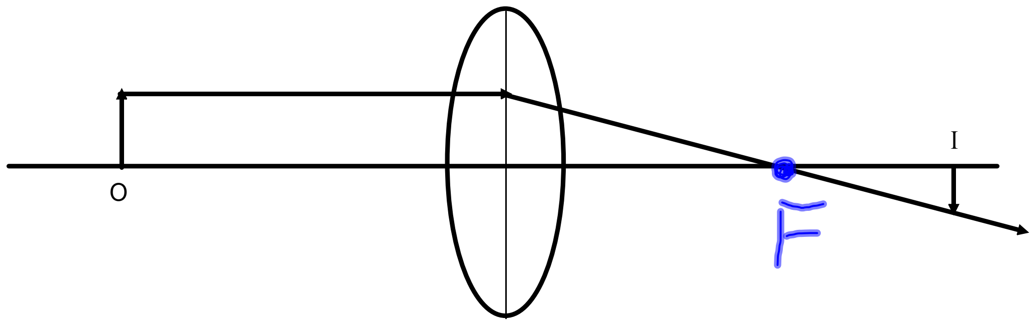


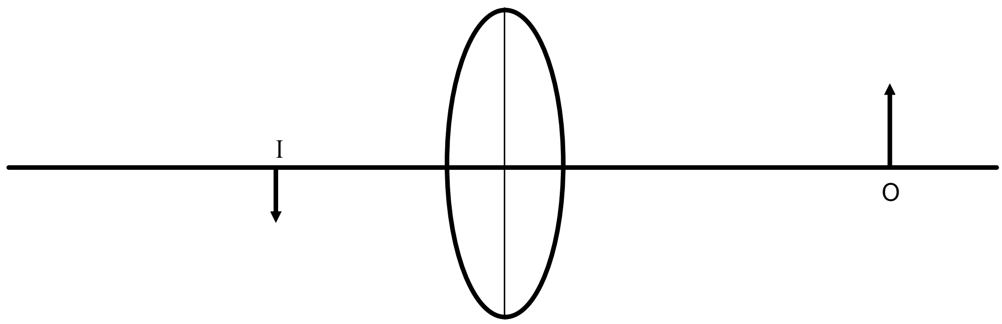


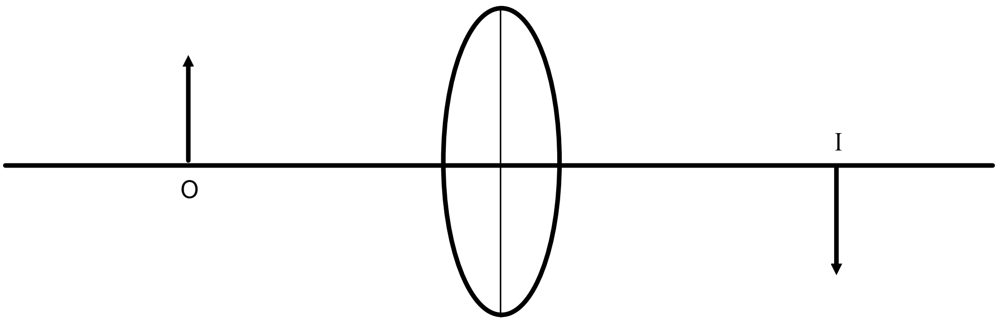


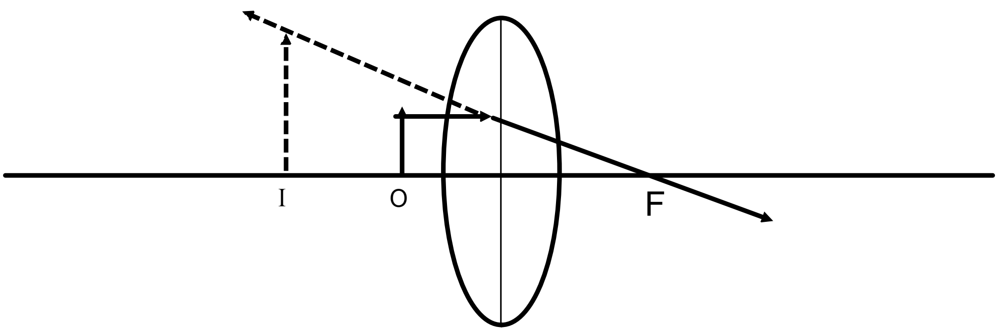


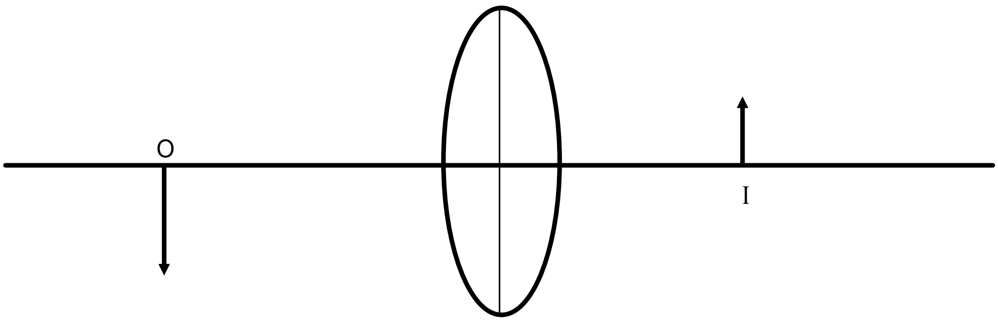
Given the location and size of the object and image, find the principle focus by drawing a light ray from the object that is parallel to the principle axis.











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?

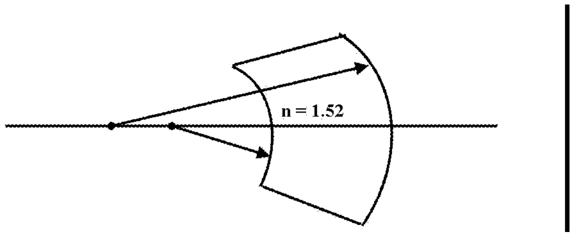
29. a) What is the focal length of a double convex glass lens ($R_1 = R_2$) of radius 20.0 cm for violet light? The index of refraction for violet light is 1.532.
b) What is the focal length of the same lens for red light? The index of refraction for red light is 1.513.

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?

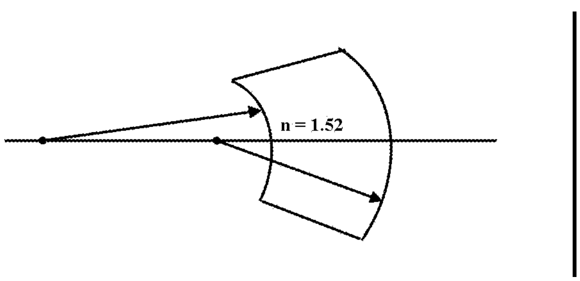
31. The focal length of a lens in a box camera is 10.0 cm. The fixed distance between the lens and the film is 11.0 cm. If the object is to be clearly focussed on the film, how far must it be from the lens?

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) $k = 2.2 \times 10^3$ N/m
(b) 0.98 s
7. 1.3 s
8. 4.0 m
9. 0.25 m
10. 0.88 s

Chapter 13 Review

Problems for Understanding

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

Unit 5 Review

33. 15 N[E19°S]
34. 1.4 m/s^2
35. (a) 7×10^3 N
(b) $9.15 \times$ 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; $1 \times$ weight
(b) 2.0×10^2 N; $0.45 \times$ weight
(c) 4.4×10^2 N; $1 \times$ weight
(d) 6.8×10^2 N; $1.5 \times$ 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. $1.86 \times 10^{-9}\ kg = 2.04 \times 10^{21} \times m_{actual}$

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. $R_{coil} = 6.00\ \Omega$, $R_{bulb} = 20.0\ \Omega$, $R_S = 4.62\ \Omega$

34. $R_{unknown} = 8.00\ \Omega$, $R_S = 4.80\ \Omega$

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 × 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 × 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 × 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 × 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) $v_{\text{He}} = 1.520 \times 10^{7}$ m/s;
$v_{\text{Rn}} = 2.740 \times 10^{5}$ 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) $^{\text{D}}N = {}^{\text{P}}N_0\left(1 - \left(\frac{1}{2}\right)^{\frac{\Delta t}{T_{\frac{1}{2}}}}\right)$, where $^{\text{D}}N$ is the number of daughter nuclei at any time t, $^{\text{P}}N_0$ 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)** $\frac{N_{\text{U}}}{N_{\text{Pb}}} = \frac{\left(\frac{1}{2}\right)^{\frac{\Delta t}{T_{\frac{1}{2}}}}}{1 - \left(\frac{1}{2}\right)^{\frac{\Delta t}{T_{\frac{1}{2}}}}}$
(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