Problems

Physics for the Life Sciences II

Sound
Electricity and Magnetism
Optics
Modern Physics

PHYS 106
Sections 01A
MTRF 12:30
PEngel 173

Text:
College Physics
with Enhanced WebAssign
By Open Stax

Fall 2020
Block D
Tom Kirkman

==> class1_19f.txt <==
2. What frequency sound has a 0.10-m wavelength when the speed of sound is 340 m/s?

3. Calculate the speed of sound on a day when a 1500 Hz frequency has a wavelength of 0.221 m.

5. Show that the speed of sound in 20.0 C air is 343 m/s, as claimed in the text.

7. Dolphins make sounds in air and water. What is the ratio of the wavelength of a sound in air to its wavelength in seawater? Assume air temperature is 20.0 C .

10. A physicist at a fireworks display times the lag between seeing an explosion and hearing its sound, and finds it to be 0.400 s. (a) How far away is the explosion if air temperature is 20.0 C and if you neglect the time taken for light to reach the physicist? (b) Calculate the distance to the explosion taking the speed of light into account. Note that this distance is negligibly greater.

==> class2_19f.txt <==
14. A sound wave traveling in 20 C air has a pressure amplitude of 0.5 Pa. What is the intensity of the wave?

15. What intensity level does the sound in the preceding problem correspond to?

18. (a) What is the decibel level of a sound that is twice as intense as a 90.0-dB sound? (b) What is the decibel level of a sound that is one-fifth as intense as a 90.0-dB sound?

30. (a) What frequency is received by a person watching an oncoming ambulance moving at 110 km/h and emitting a steady 800-Hz sound from its siren? The speed of sound on this day is 345 m/s. (b) What frequency does she receive after the ambulance has passed?

36. Two eagles fly directly toward one another, the first at 15.0 m/s and the second at 20.0 m/s. Both screech, the first one emitting a frequency of 3200 Hz and the second one emitting a frequency of 3800 Hz. What frequencies do they receive if the speed of sound is 330 m/s?

35. Can you perceive the shift in frequency produced when you pull a tuning fork toward you at 10.0 m/s on a day when the speed of sound is 344 m/s? To answer this question, calculate the factor by which the frequency shifts and see if it is greater than 0.300%.

==> class3_19f.txt <==
41. A piano tuner hears a beat every 2.00 s when listening to a 264.0-Hz tuning fork and a single piano string. What are the two possible frequencies of the string?

42. (a) What is the fundamental frequency of a 0.672-m-long tube, open at both ends, on a day when the speed of sound is 344 m/s? (b) What is the frequency of its second harmonic?

53. (a) Students in a physics lab are asked to find the length of an air column in a tube closed at one end that has a fundamental frequency of 256 Hz. They hold the tube vertically and fill it with water to the top, then lower the water while a 256-Hz tuning fork is rung and listen for the first resonance. What is the air temperature if the resonance occurs for a length of 0.336 m? (b) At what length will they observe the second resonance (first overtone)?

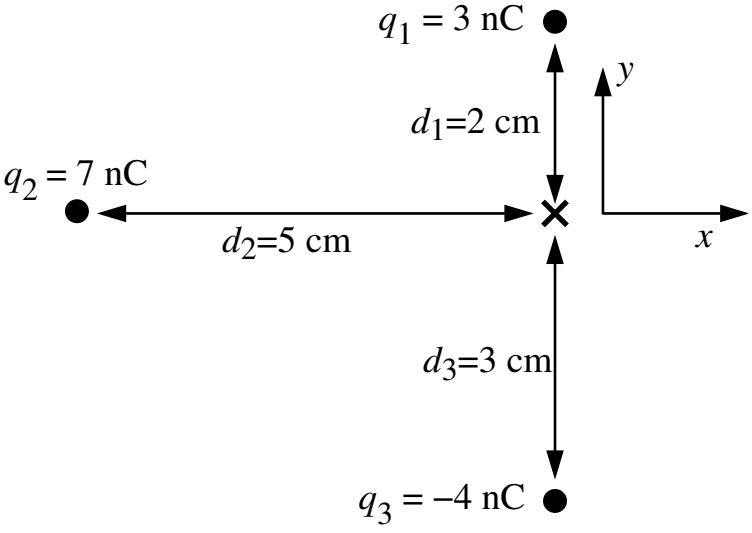
54. What frequencies will a 1.80-m-long tube produce in the audible range at 20.0 C if: (a) The tube is closed at one end? (b) It is open at both ends?

67. (a) What is the intensity in watts per meter squared of a just barely audible 200-Hz sound? (b) What is the intensity in watts per meter squared of a barely audible 4000-Hz sound?

==> class4_19f.txt <==
1. Common static electricity involves charges ranging from nanocoulombs to microcoulombs. (a) How many electrons are needed to form a charge of –2.00 nC (b) How many electrons must be removed from a neutral object to leave a net charge of 0.500 µC ?

Note: e= 1.6022 × 10-19 C

A charge q=-2 nC is placed at X in the below diagram. Find the magnitude and angle of the resulting force.

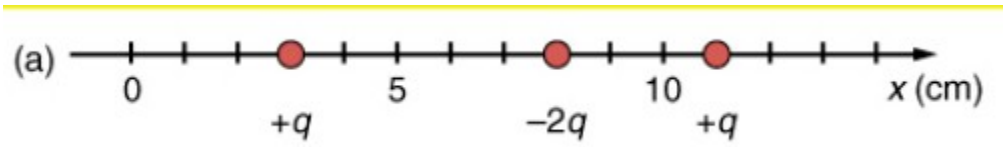


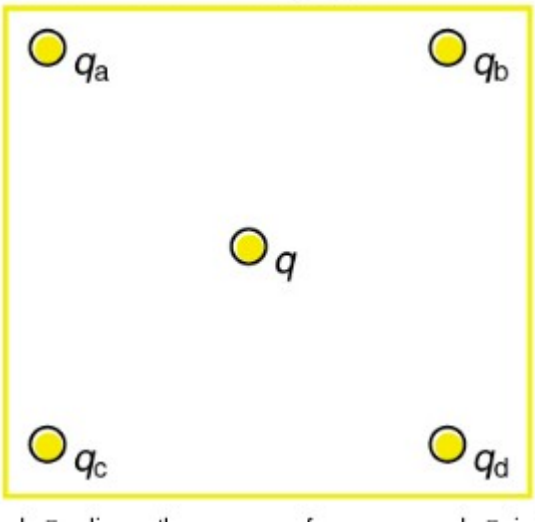
==> class5_19f.txt <==
27. What is the magnitude and direction of an electric field that exerts a 2.00×10^-5 N upward force on a –1.75 μC charge?

43. (a) Find the electric field at x = 5.00 cm in Figure 18.52(a), given that q = 1.00 μC . (b) At what position between 3.00 and 8.00 cm is the total electric field the same as that for –2q alone? (c) Can the electric field be zero anywhere between 0.00 and 8.00 cm? (e) At what position to the right of 11.0 cm is the total electric field zero, other than at infinity?

46. (a) Using the symmetry of the arrangement, determine the direction of the electric field at the center of the square in Figure 18.53, given that q a = q b = −1.00 μC and q c = q d =+1.00 μC . (b) Calculate the magnitude of the electric field at the location of q , given that the square is 5.00 cm on a side.

47. Find the electric field at the location of q a in Figure 18.53 given that q_b = q_c = q_d =+2.00 nC , q = −1.00 nC , and the square is 20.0 cm on a side.





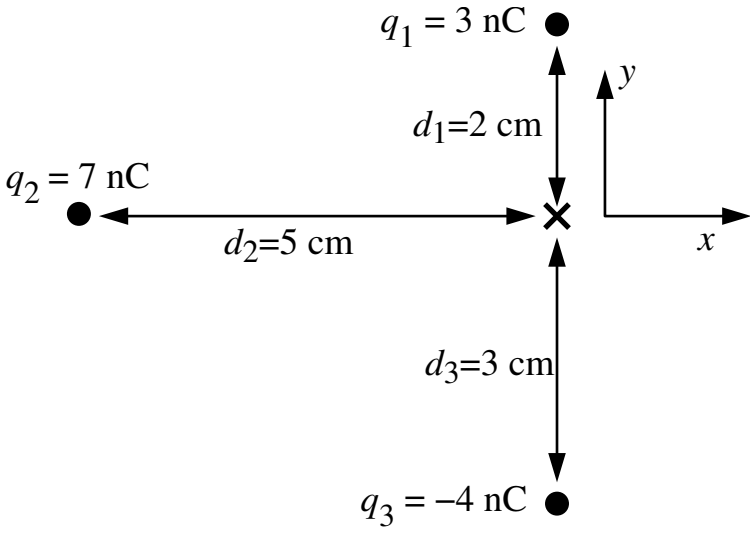
==> class6_19f.txt <==
1. Find the ratio of speeds of an electron and a negative hydrogen ion (one having an extra electron) accelerated through the same voltage, assuming non-relativistic final speeds.

mass of the hydrogen ion= 1.67 × 10-27 kg
mass electron= 9.11 × 10-31 kg
 e = 1.60 × 10-19 C

19. Membrane walls of living cells have surprisingly large electric fields across them due to separation of ions. What is the voltage
across an 8.00 nm–thick membrane if the electric field strength across it is 5.50 MV/m? You may assume a uniform electric field.

27. How far from a 1.00 μC point charge will the potential be 100 V? At what distance will it be 200 V ?

In the below diagram, find the voltage at the point marked X.



==> class7_19f.txt <==
54. (a)What is the capacitance of a parallel plate capacitor having plates of area 1.50 m^2 that are separated by 0.0200 mm of neoprene rubber? (K=6.7) (b) What charge does it hold when 9.00 V is applied to it?
epsilon0 = 8.8542 × 10^-12 F/m

60. Find the total capacitance of the combination of capacitors shown in **Figure 19.33**.

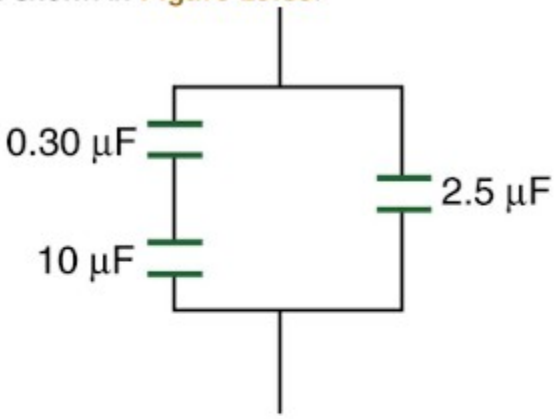


Figure 19.33 A combination of series and parallel connections of capacitors.

61. Find the total capacitance of the combination of capacitors shown in **Figure 19.34**.

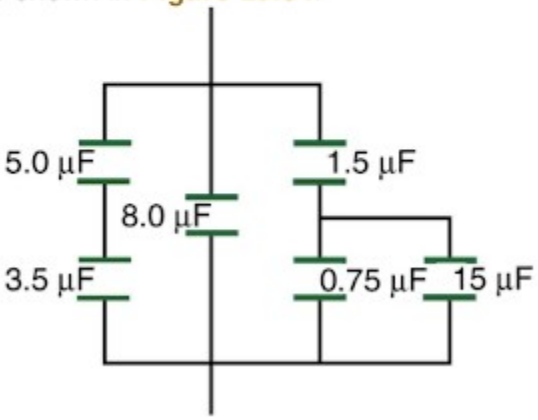


Figure 19.34 A combination of series and parallel connections of capacitors.

==> class8_19f.txt <==
19-66. Suppose you have a 9.00 V battery, a 2.00 µF capacitor, and a 7.40 µF capacitor. (a) Find the charge and energy stored if the capacitors are connected to the battery in series. (b) Do the same for a parallel connection.

20-2. A total of 600 C of charge passes through a flashlight in 0.500 h. What is the average current?

20-14. Repeat the above example on Example 20.3, but for a wire made of silver and given there is one free electron per silver atom.

Calculate the drift velocity of electrons in a 12-gauge silver wire (which has a diameter of 2.053 mm) carrying a 20.0-A current.

density Ag= 10.49 g/cm^3
e=1.6e-19 C

==> class9_19f.txt <==
21. How many volts are supplied to operate an indicator light on a DVD player that has a resistance of 140 Ω , given that 25.0 mA passes through it?

24. What is the resistance of a 20.0-m-long piece of 12-gauge copper wire having a 2.053-mm diameter?
resistivity Cu= 1.72e-8 Ω.m

28. What current flows through a 2.54-cm-diameter rod of pure silicon that is 20.0 cm long, when 1.00 × 10^3 V is applied to it? (Such a rod may be used to make nuclear-particle detectors, for example.)
resistivity Si= 2300 Ω.m

35. A wire is drawn through a die, stretching it to four times its original length. By what factor does its resistance increase?

==> class10_19f.txt <==
41. What power is supplied to the starter motor of a large truck that draws 250 A of current from a 24.0-V battery hookup?

43. How many watts does a flashlight that has 6.00×10^2 C pass through it in 0.500 h use if its voltage is 3.00 V?

51. With a 1200-W toaster, how much electrical energy is needed to make a slice of toast (cooking time = 1 minute)? At 9.0 cents/kW · h , how much does this cost?

74. A certain circuit breaker trips when the rms current is 15.0 A. What is the corresponding peak current?

77. In this problem, you will verify statements made at the end of the power losses for Example 20.10. (a) What current is needed to transmit 100 MW of power at a voltage of 25.0 kV? (b) Find the power loss in a 1.00 Ω transmission line. (c) What percent loss does this represent?

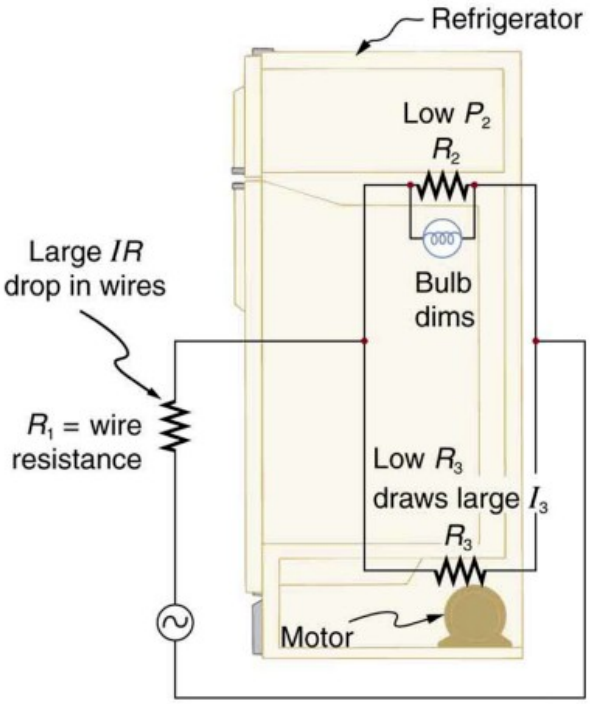
78. A small office-building air conditioner operates on 408 V AC and consumes 50.0 kW. (a) What is its effective resistance? (b) What is the cost of running the air conditioner during a hot summer month when it is on 8.00 h per day for 30 days and electricity costs 9.00 cents/kW · h ?

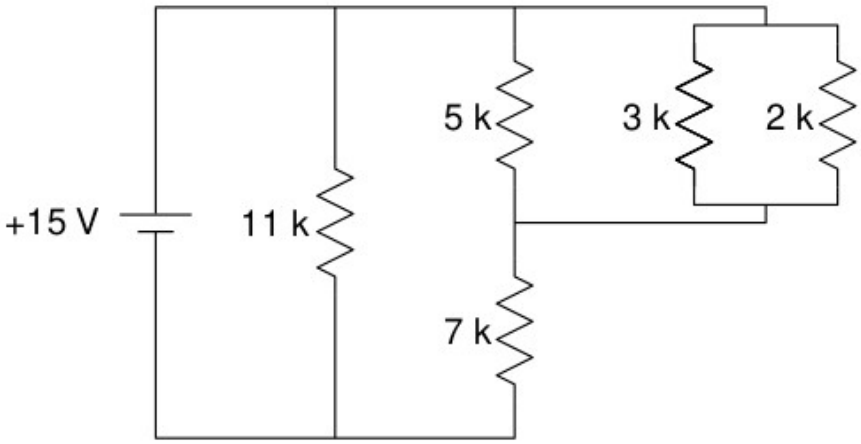
==> class11_19f.txt <==
3. What are the largest and smallest resistances you can obtain by connecting a 36 Ω , a 50 Ω , and a 700 Ω resistor together?

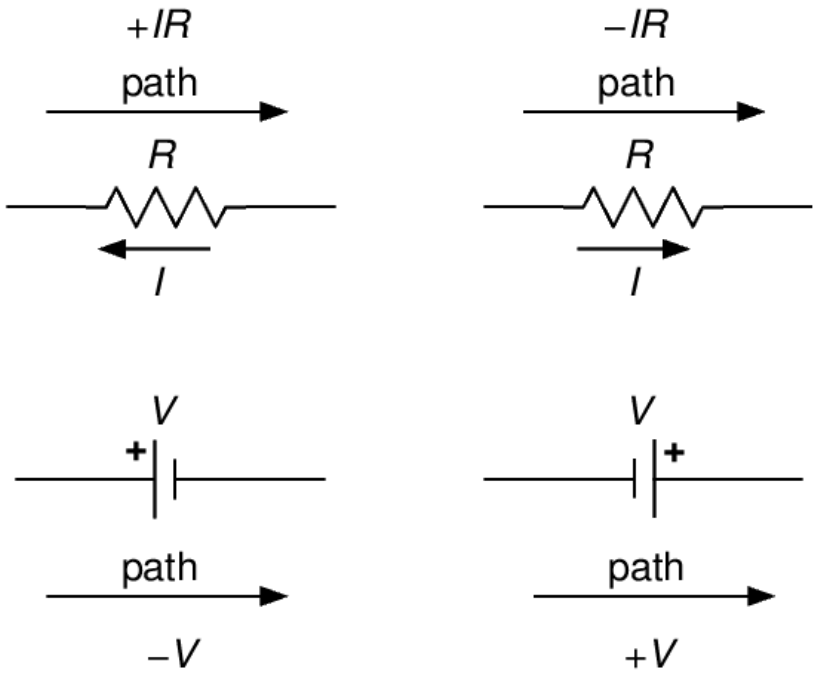
4. An 1800 W toaster, a 1400 W electric frying pan, and a 75 W lamp are plugged into the same outlet in a 15 A, 120 V circuit. (The three devices are in parallel when plugged into the same socket.). (a) What current is drawn by each device? (b) Will this combination blow the 15 A fuse?

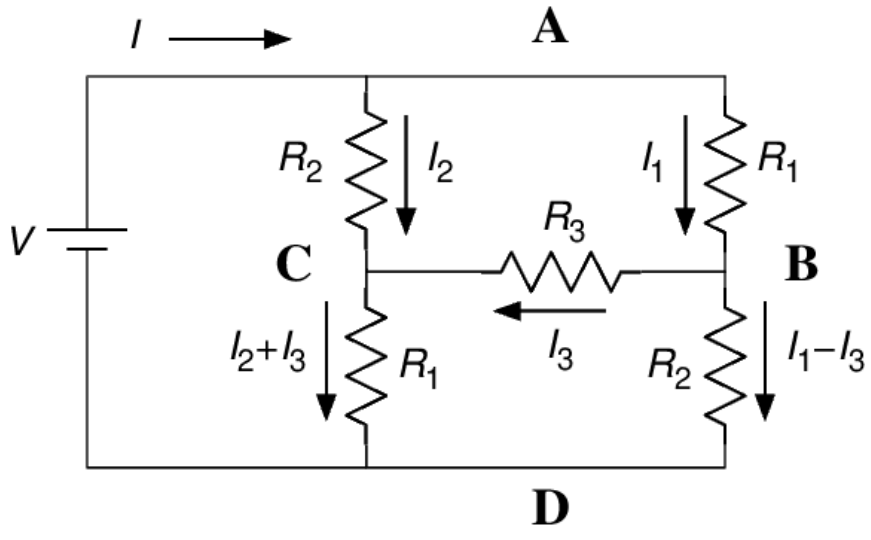
6. Given a 48 V battery and 24 Ω and 96 Ω resistors, find equivalent reistance when they are connected in series and parall; report the current and power for each resistor.

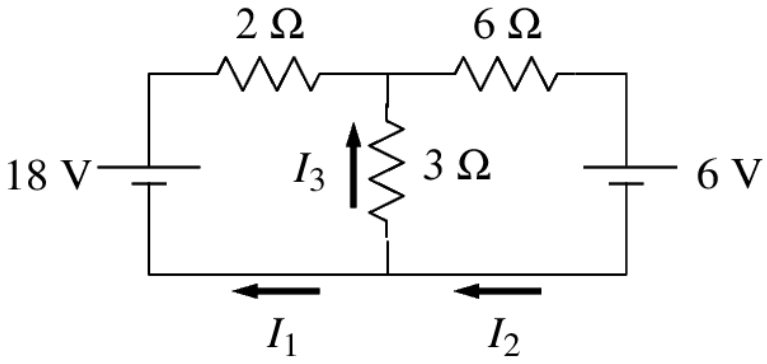
9. Refer to Figure 21.7 and the discussion of lights dimming when a heavy appliance comes on. (a) Given the voltage source is 120 V, the wire resistance is 0.400 Ω , and the bulb is nominally 75 W, what power will the bulb dissipate if a total of 15 A passes through the wires when the motor comes on? Assume negligible change in bulb resistance. (b) What power is consumed by the motor?

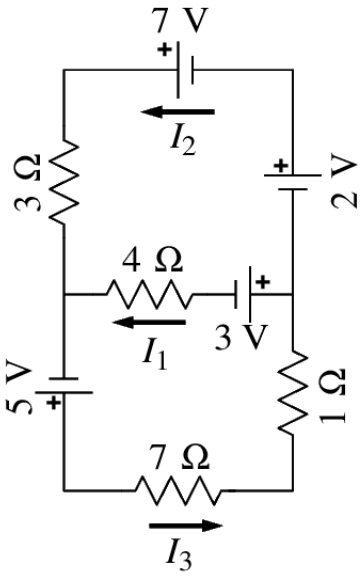


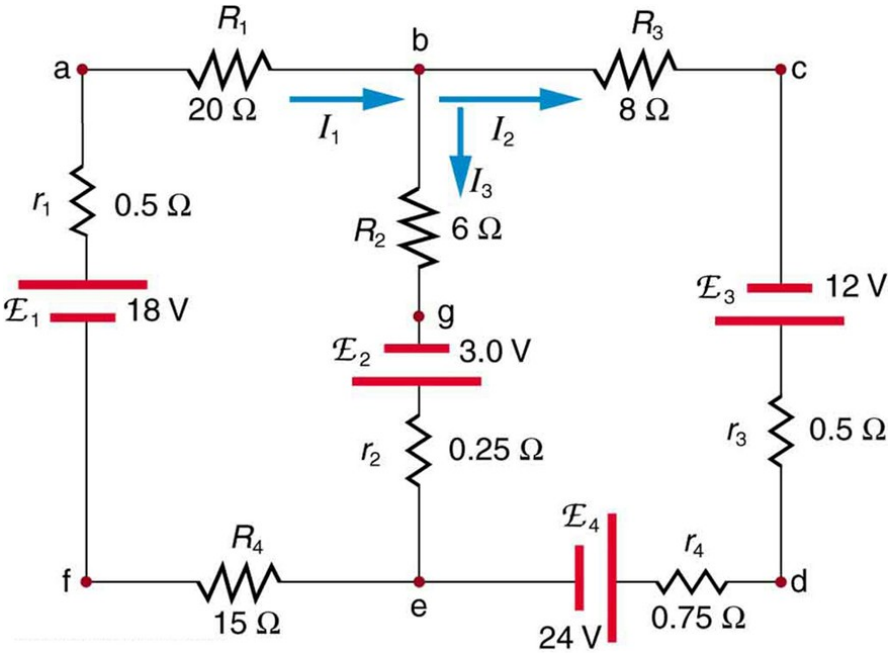

+15 V
11 k
5 k
3 k
2 k
7 k


+IR
path
R
I
−IR
path
R
I
V
+
path
−V
V
+
path
+V


I
A
R2
I2
I1
R1
R3
V
C
B
I2+I3
R1
I3
R2
I1−I3
D

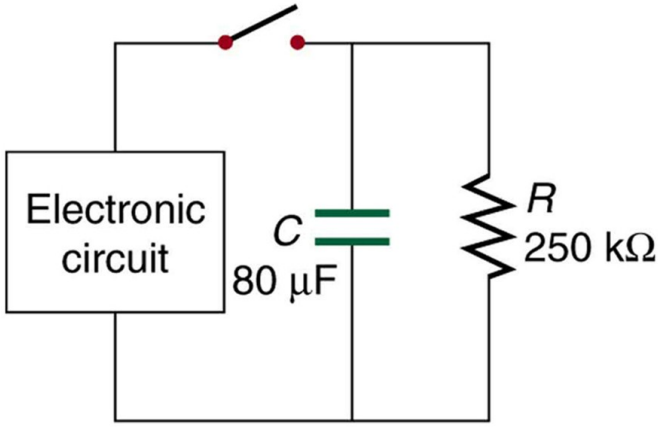

2 Ω
6 Ω
18 V
I_3
3 Ω
6 V
I_1
I_2


7 V
I_2
3 Ω
2 V
4 Ω
I_1
3 V
5 V
1 Ω
7 Ω
I_3


R_1
a
b
R_3
c
20 Ω
I_1
I_2
8 Ω
I_3
r_1
0.5 Ω
R_2
6 Ω
$\mathcal{E}_1$
18 V
g
$\mathcal{E}_3$
12 V
$\mathcal{E}_2$
3.0 V
r_3
0.5 Ω
r_2
0.25 Ω
$\mathcal{E}_4$
R_4
r_4
f
e
d
15 Ω
24 V
0.75 Ω

64. A heart pacemaker fires 72 times a minute, each time a 25.0-nF capacitor is charged (by a battery in series with a resistor) to 0.632 of its full voltage. What is the value of the resistance?

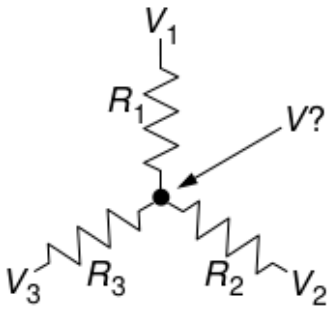
71. Figure 21.55 shows how a bleeder resistor is used to discharge a capacitor after an electronic device is shut off, allowing a person to work on the electronics with less risk of shock. (a) What is the time constant? (b) How long will it take to reduce the voltage on the capacitor to 0.250% (5% of 5%) of its full value once discharge begins? (c) If the capacitor is charged to a voltage V 0 through a 100-Ω resistance, calculate the time it takes to rise to 0.865V 0 (This is about two time constants.)



As shown right, a node is connected to three resistors (R_i). Each of the resistors connects to a known voltage (V_i). Show that the voltage at the node is:

$$V = \frac{\sum V_i G_i}{\sum G_i}$$

where the G_i are the conductances $G_i \equiv 1/R_i$. In short, the voltage at the node is the average of the voltages on the connections, weighted by conductances. (FYI: The result applies to any number of connections, not just three.)

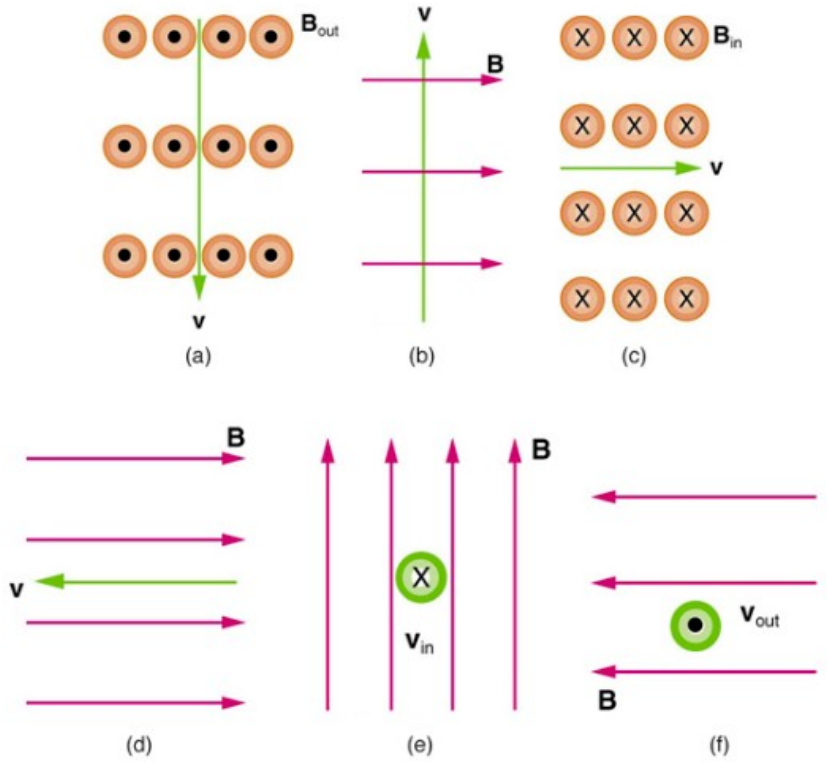


==> class15_19f.txt <==
14. (a) Viewers of Star Trek hear of an antimatter drive on the Starship Enterprise. One possibility for such a futuristic energy source is to store antimatter charged particles in a vacuum chamber, circulating in a magnetic field, and then extract them as needed. Antimatter annihilates with normal matter, producing pure energy. What strength magnetic field is needed to hold antiprotons, moving at 5.00×10^7 m/s in a circular path 2.00 m in radius? Antiprotons have the same mass as protons but the opposite (negative) charge. (b) Is this field strength obtainable with today's technology or is it a futuristic possibility?

proton mass=1.67 × 10^-27 kg ; charge= 1.60 × 10^-19 C

8. (a) Aircraft sometimes acquire small static charges. Suppose a supersonic jet has a 0.500-μC charge and flies due west at a speed of 660 m/s over the Earth's magnetic south pole (near Earth's geographic north pole), where the 8×10^−5 -T magnetic field points straight down. What are the direction and the magnitude of the magnetic force on the plane? (b) Discuss whether the value obtained in part (a) implies this is a significant or negligible effect.

1. What is the direction of the magnetic force on a positive charge that moves as shown in each of the six cases shown in **Figure 22.50**?



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==> class16_19f.txt <==
46. (a) At what angle θ is the torque on a current loop
90.% of maximum? (b) 50.% of maximum? (c) 10.% of maximum?
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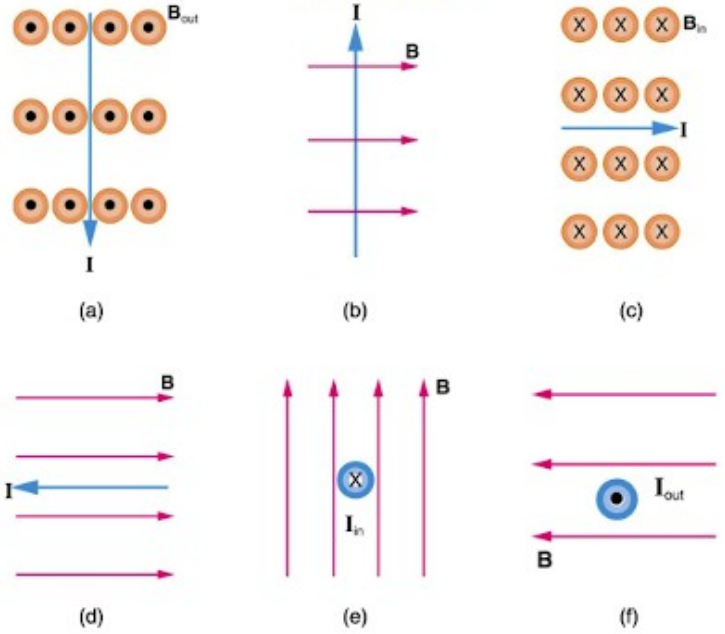
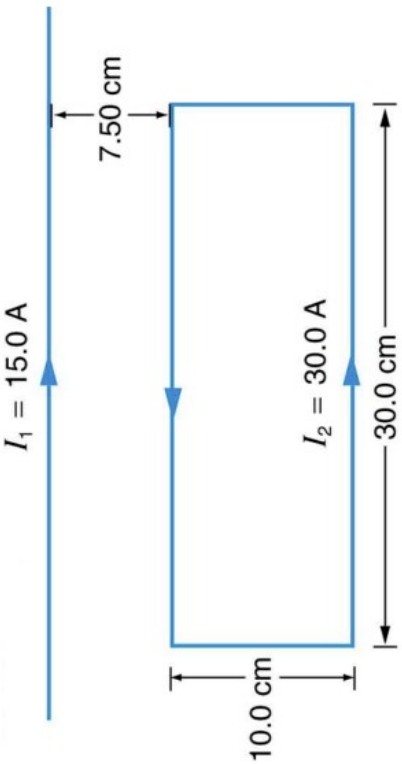
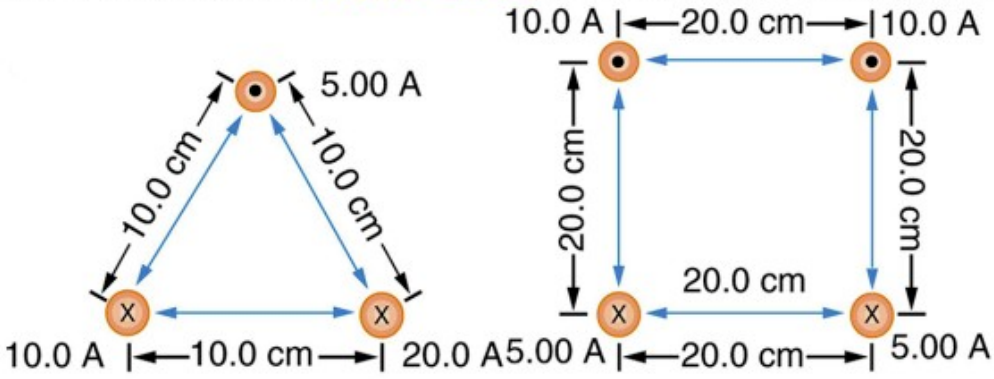
31. What is the direction of the magnetic force on the current in each of the six cases in **Figure 22.53**?



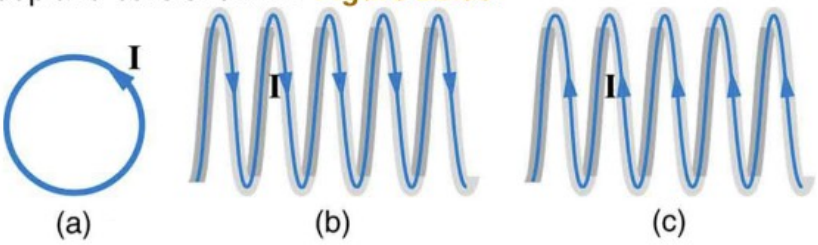
55. **Figure 22.57** shows a long straight wire near a rectangular current loop. What is the direction and magnitude of the total force on the loop?



56. Find the direction and magnitude of the force that each wire experiences in **Figure 22.58**(a) by, using vector addition.



59. What are the directions of the fields in the center of the loop and coils shown in **Figure 22.60**?

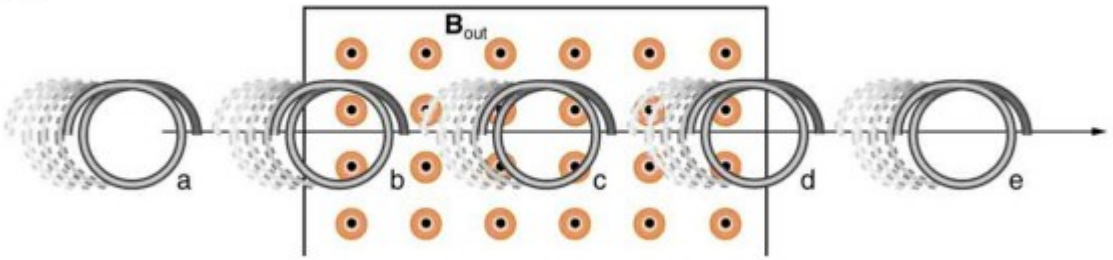


==> class17_19f.txt <==
9. (a) An MRI technician moves his hand from a region of very low magnetic field strength into an MRI scanner’s 2.00 T field with his fingers pointing in the direction of the field. Find the average emf induced in his wedding ring, given its diameter is 2.20 cm and assuming it takes 0.250 s to move it into the field. (b) Discuss whether this current would significantly change the temperature of the ring.

11. An emf is induced by rotating a 1000-turn, 20.0 cm diameter coil in the Earth’s 5.00×10^-5 T magnetic field. What average emf is induced, given the plane of the coil is originally perpendicular to the Earth’s field and is rotated to be parallel to the field in 10.0 ms?

27 Figure 23.59 A coil is moved into and out of a region of uniform magnetic field. The field is uniform inside the rectangle and zero outside. What is the direction of the induced current and what is the direction of the magnetic force on the coil at each position shown?

27.



==> class18_19f.txt <==
29. At what angular velocity in rpm will the peak voltage of a generator be 480 V, if its 500-turn, 8.00 cm diameter coil rotates in a 0.250 T field?

50. A large power plant generates electricity at 12.0 kV. Its old transformer once converted the voltage to 335 kV. The secondary of this transformer is being replaced so that its output can be 750 kV for more efficient cross-country transmission on upgraded transmission lines. (a) What is the ratio of turns in the new secondary compared with the old secondary? (b) What is the ratio of new current output to old output (at 335 kV) for the same power? (c) If the upgraded transmission lines have the same resistance, what is the ratio of new line power loss to old?

61. A large research solenoid has a self-inductance of 25 H. (a) What induced emf opposes shutting it off when 100 A of current through it is switched off in 80.0 ms? (b) How much energy is stored in the inductor at full current? (c) At what rate in watts must energy be dissipated to switch the current off in 80 ms? (d) In view of the answer to the last part, is it surprising that shutting it down this quickly is difficult?

66. How fast can the 150 A current through a 0.250 H inductor be shut off if the induced emf cannot exceed 75 V?

==> class19_19f.txt <==
74. (a) What is the characteristic time constant of a 25 mH inductor that has a resistance of 4 Ω ? (b) If it is connected to a 12.0 V battery, what is the current after 12.5 ms?

76. The 5 A current through a 1.5 H inductor is dissipated by a 2 Ω resistor in a circuit like that in Figure 23.44 with the switch in position 2. (a) What is the initial energy in the inductor? (b) How long will it take the current to decline to 5% of its initial value? (c) Calculate the average power dissipated, and compare it with the initial power dissipated by the resistor.

79. At what frequency will a 30 mH inductor have a reactance of 100 Ω ?

81. What capacitance should be used to produce a 2 MΩ reactance at 60 Hz?

==> class20_19f.txt <==
85. A 20 kHz, 16 V source connected to an inductor
produces a 2 A current. What is the inductance?

86. A 20 Hz, 16 V source produces a 2 mA current
when connected to a capacitor. What is the capacitance?

96. To receive AM radio, you want an RLC circuit that can be
made to resonate at any frequency between 500 and 1650 kHz.
This is accomplished with a fixed 1 μH inductor connected
to a variable capacitor. What range of capacitance
is needed?

101. An RLC series circuit has a 2.5 Ω resistor, a 100 μH
inductor, and an 80 μF capacitor.(a) Find the circuit's
impedance at 120 Hz. (b) Find the circuit's impedance at
5 kHz. (c) If the voltage source has Vrms = 5.6 V , what is
Irms at each frequency? (d) What is the resonant frequency
of the circuit? (e) What is Irms at resonance?

==> class21_19f.txt <==
3. What is the maximum electric field strength in an electromagnetic wave that has a maximum magnetic field strength of 5.00×10^−4 T (about 10 times the Earth’s)?

7. (a) Calculate the range of wavelengths for AM radio given its frequency range is 540 to 1600 kHz. (b) Do the same for the FM frequency range of 88.0 to 108 MHz.

12. Approximately what is the smallest detail observable with a microscope that uses ultraviolet light of frequency 1.20×10^15 Hz ?

32. Assume the helium-neon lasers commonly used in student physics laboratories have power outputs of 0.250 mW. (a) If such a laser beam is projected onto a circular spot 1.0 mm in diameter, what is its intensity? (b) Find the peak magnetic field strength. (c) Find the peak electric field strength.

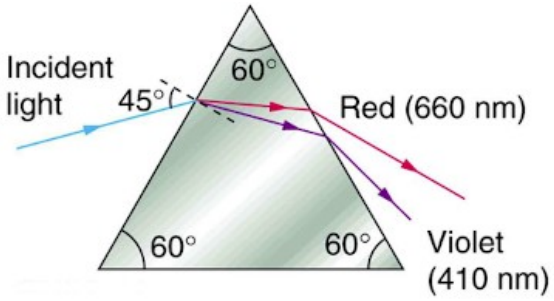
35. A 2.5 m diameter university communications satellite dish receives TV signals that have a maximum electric field strength (for one channel) of 7.5 μV/m . (See Figure 24.28.) (a) What is the intensity of this wave? (b) What is the power received by the antenna? (c) If the orbiting satellite broadcasts uniformly over an area of 1.5×10^13 m^2 (a large fraction of North America), how much power does it radiate?

==> class22_19f.txt <==
12. (a) Given that the angle between the ray in the water and the perpendicular to the water is 25.deg , and using information in Figure 25.53, find the height of the instructor’s head above the water. (b) Find the apparent depth of the diver’s head below water as seen by the instructor.

13. Suppose you have an unknown clear substance immersed in water, and you wish to identify it by finding its index of refraction. You arrange to have a beam of light enter it at an angle of 45.0 deg , and you observe the angle of refraction to be 40.3 deg . What is the index of refraction of the substance and its likely identity?
Table 25.1 says fused quartz n=1.458

24. Suppose you are using total internal reflection to make an efficient corner reflector. If there is air outside and the incident angle is 45. deg , what must be the minimum index of refraction of the material from which the reflector is made?

35. A narrow beam of white light enters a prism made of crown glass at a 45. deg incident angle, as shown in Figure 25.57. At what angles, θR and θV , do the red (660 nm) and violet (410 nm) components of the light emerge from the prism?
nR=1.512 nV=1.530 p. 905



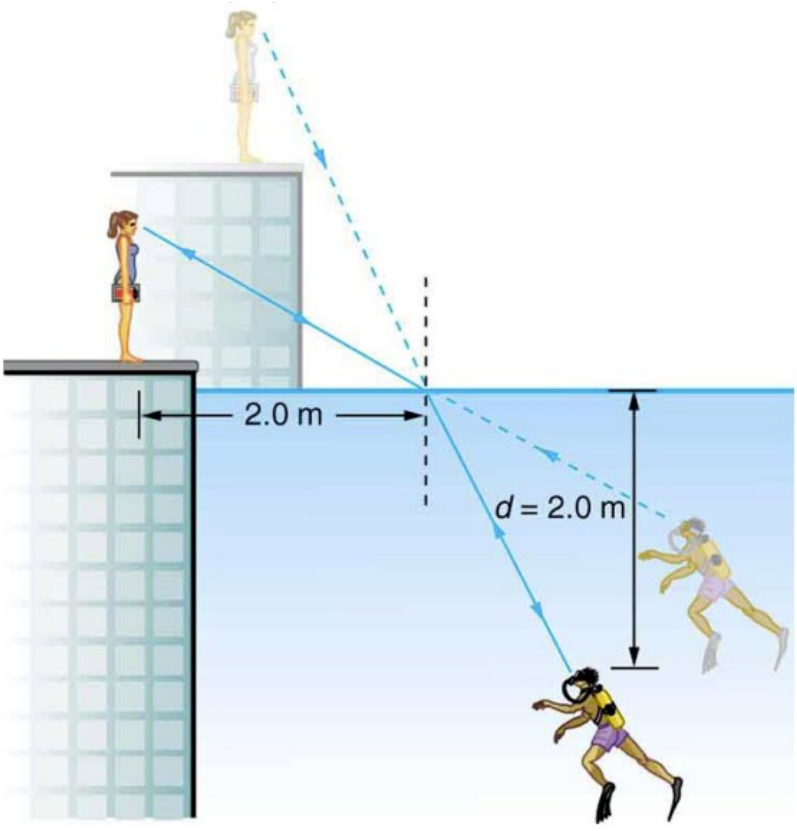
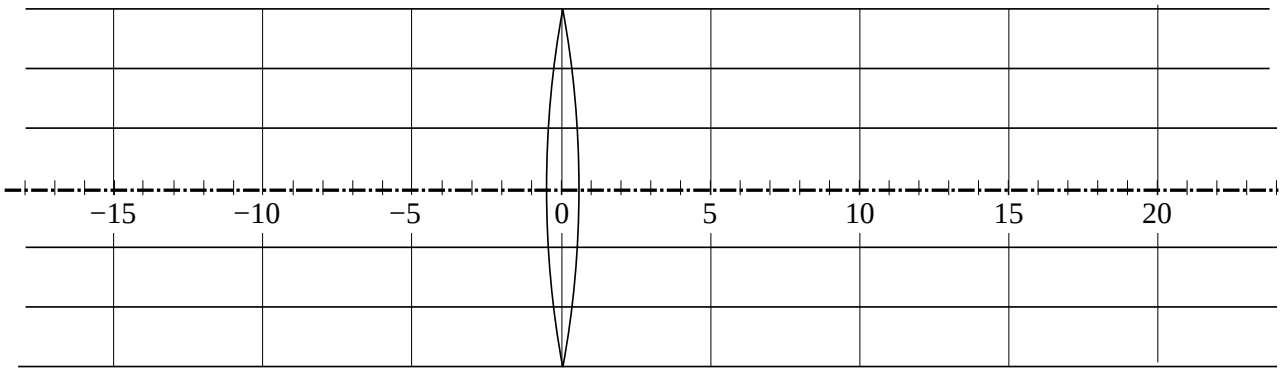


Figure 25.53 A scuba diver in a pool and his trainer look at each other.

==> class23_19f.txt <==
40. How far from the lens must the film in a camera be, if the lens has a 35.0 mm focal length and is being used to photograph a flower 75.0 cm away? If the flower has a diameter of 15 cm, what is the diameter of the flower's image on the film?

42. A doctor examines a mole with a 15.0 cm focal length magnifying glass held 13.5 cm from the mole (a) Where is the image? (b) What is its magnification? (c) How big is the image of a 5.00 mm diameter mole?

48. What magnification will be produced by a lens of power −4.00 D (such as might be used to correct myopia) if an object is held 25.0 cm away?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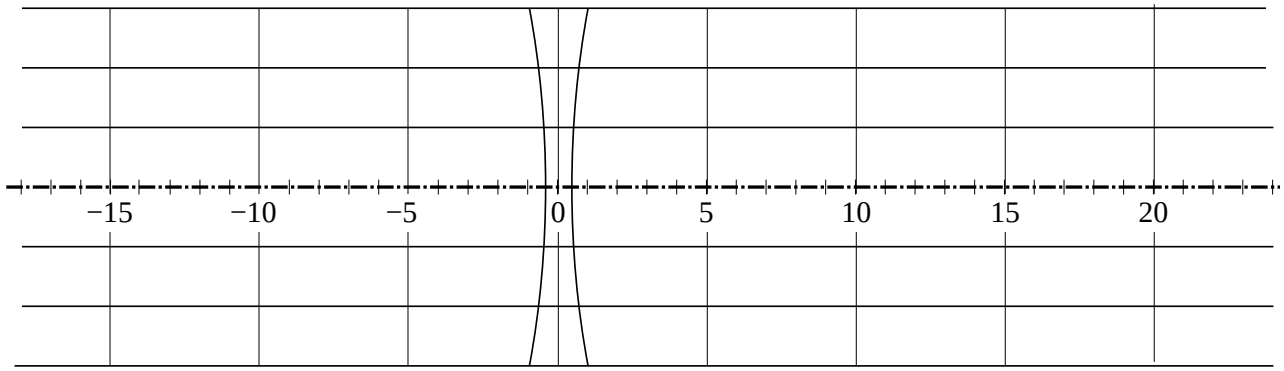
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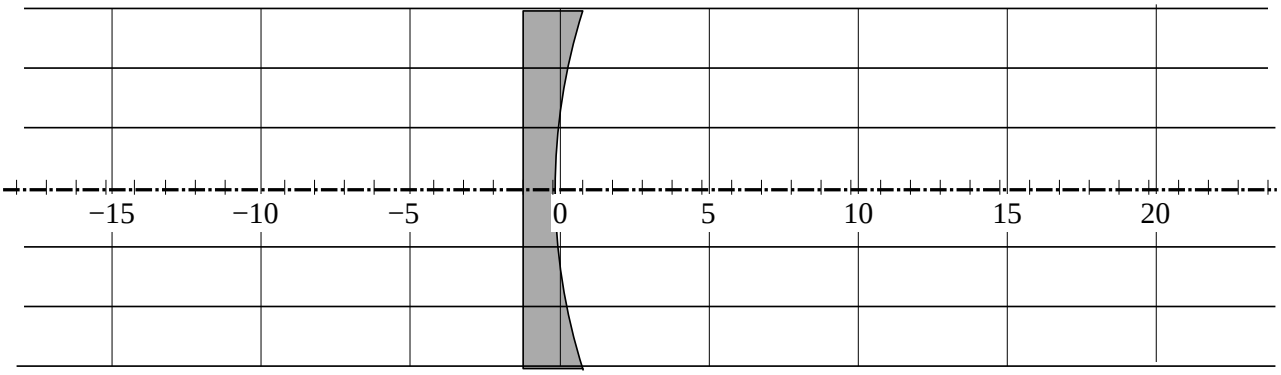
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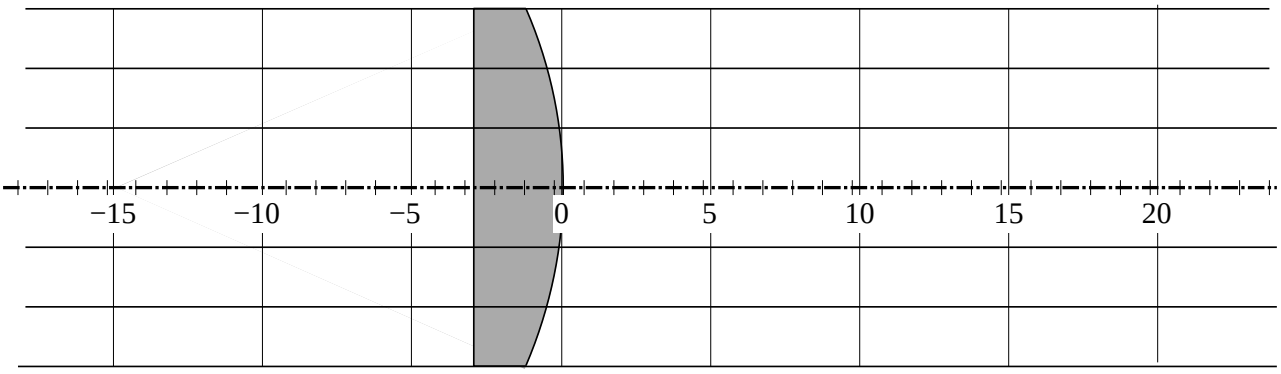
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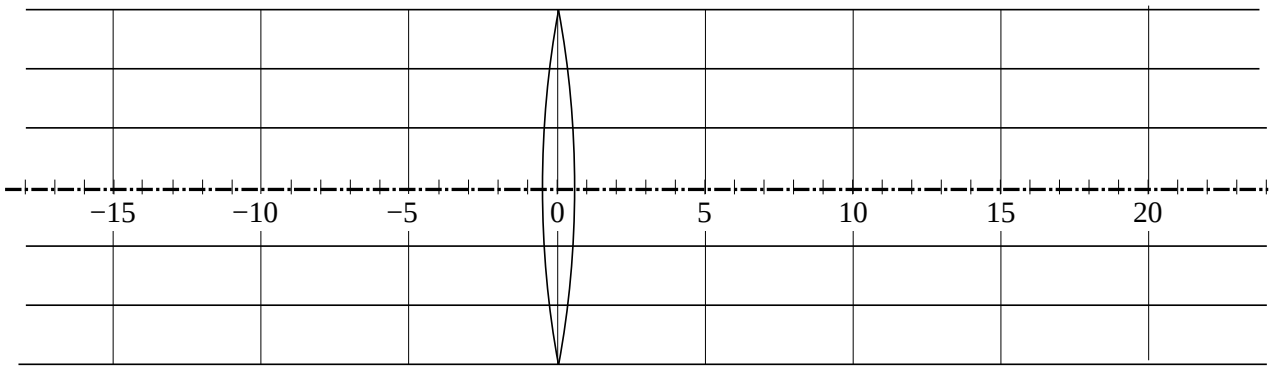
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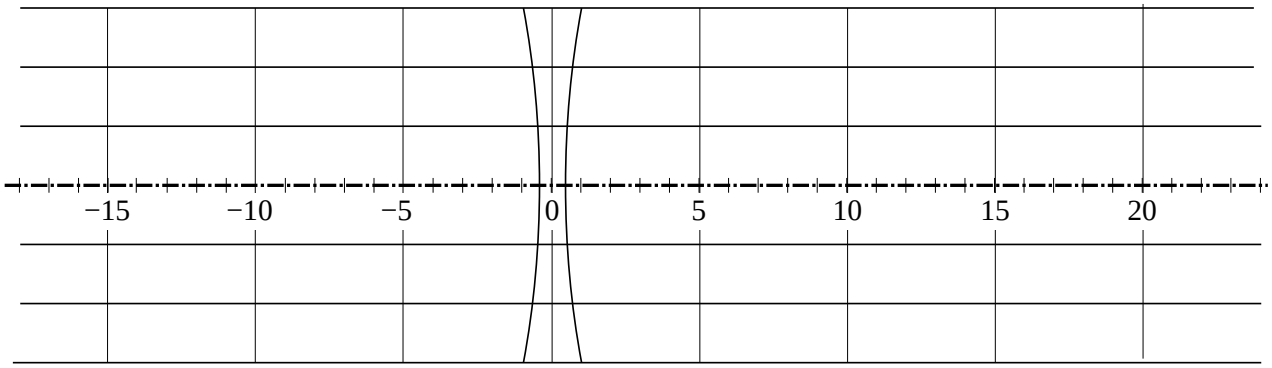
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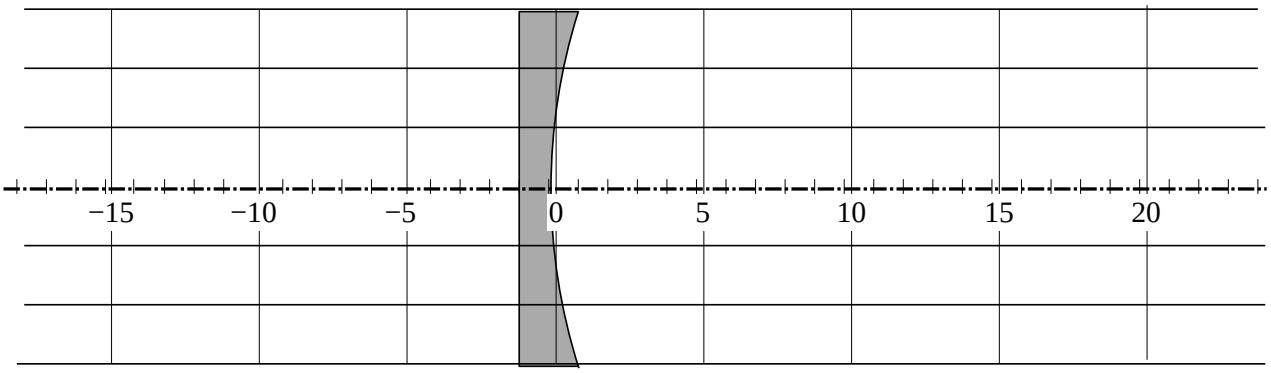
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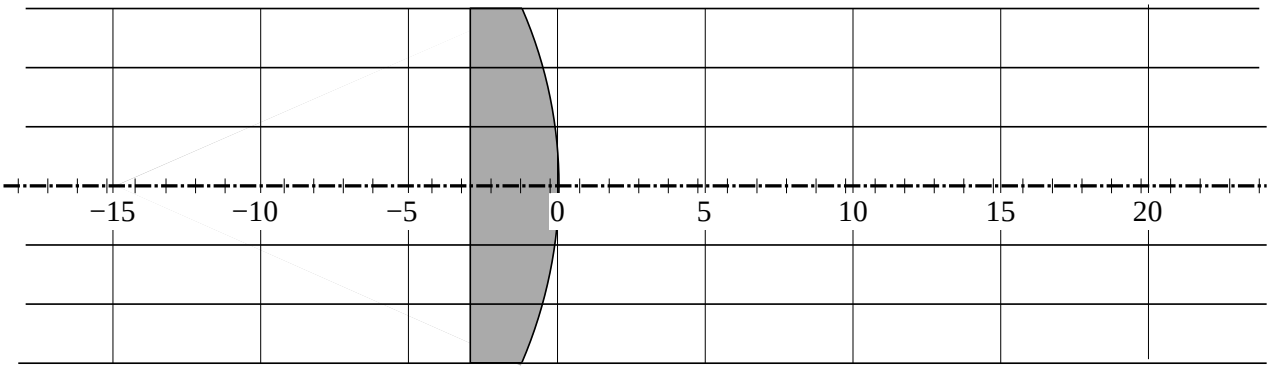
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3. A photographic image of a building is 0.092 0 m high. The image was made with a lens with a focal length of 52.0 mm. If the lens was 100 m from the building when the photograph was made, determine the height of the building.

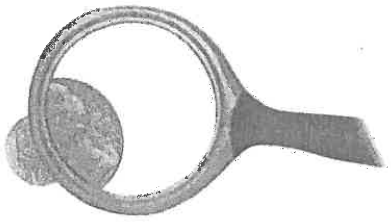
5. A camera is being used with a correct exposure at *f*/4 and a shutter speed of $\frac{1}{15}$ s. In addition to the *f*-numbers listed in Section 25.1, this camera has *f*-numbers *f*/1, *f*/1.4, and *f*/2. To photograph a rapidly moving subject, the shutter speed is changed to $\frac{1}{125}$ s. Find the new *f*-number setting needed on this camera to maintain satisfactory exposure.

10. BIO GP A patient can't see objects closer than 40.0 cm and wishes to clearly see objects that are 20.0 cm from his eye. (a) Is the patient nearsighted or farsighted? (b) If the eye–lens distance is 2.00 cm, what is the minimum object distance *p* from the lens? (c) What image position with respect to the lens will allow the patient to see the object? (d) Is the image real or virtual? Is the image distance *q* positive or negative? (e) Calculate the required focal length. (f) Find the power of the lens in diopters. (g) If a contact lens is to be prescribed instead, find *p*, *q*, and *f*, and the power of the lens.

11. BIO M The accommodation limits for Nearsighted Nick's eyes are 18.0 cm and 80.0 cm. When he wears his glasses, he is able to see faraway objects clearly. At what minimum distance is he able to see objects clearly?

20. A lens that has a focal length of 5.00 cm is used as a magnifying glass. (a) To obtain maximum magnification and an image that can be seen clearly by a normal eye, where should the object be placed? (b) What is the angular magnification?

36. The nickel's image in Figure P23.36 has twice the diameter of the nickel when the lens is 2.84 cm from the nickel. Determine the focal length of the lens.



7. A convex spherical mirror, whose focal length has a magnitude of 15.0 cm, is to form an image 10.0 cm behind the mirror. (a) Where should the object be placed? (b) What is the magnification of the mirror?

10. QC While looking at her image in a cosmetic mirror, Dina notes that her face is highly magnified when she is close to the mirror, but as she backs away from the mirror, her image first becomes blurry, then disappears when she is about 30 cm from the mirror, and then inverts when she is beyond 30 cm. Based on these observations, what can she conclude about the properties of the mirror?

11. A 2.00-cm-high object is placed 3.00 cm in front of a concave mirror. If the image is 5.00 cm high and virtual, what is the focal length of the mirror?

18. QC A concave mirror has a radius of curvature of 24.0 cm. (a) Determine the object position for which the resulting image is upright and larger than the object by a factor of 3.00. (b) Draw a ray diagram to determine the position of the image. (c) Is the image real or virtual?

64. A certain Christmas tree ornament is a silver sphere having a diameter of 8.50 cm. (a) If the size of an image created by reflection in the ornament is three-fourth's the reflected object's actual size, determine the object's location. (b) Use a principal-ray diagram to determine whether the image is upright or inverted.

==> class26_19f.txt <==
30. An amoeba is 0.305 cm away from the 0.300 cm focal length objective lens of a microscope. (a) Where is the image formed by the objective lens? (b) What is this image’s magnification? (c) An eyepiece with a 2.00 cm focal length is placed 20.0 cm from the objective. Where is the final image? (d) What magnification is produced by the eyepiece? (e) What is the overall magnification? (See Figure 26.16.)

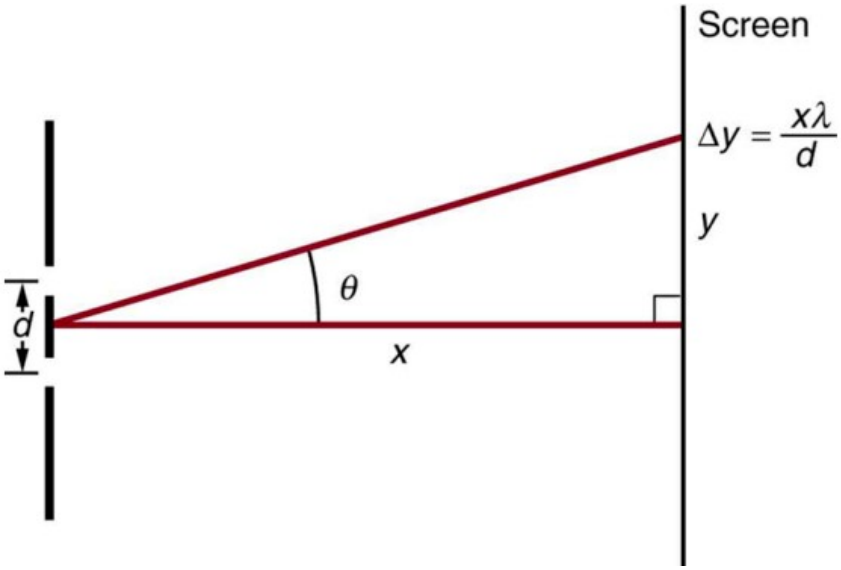
==> class29_19f.txt <==
6. At what angle is the first-order maximum for 450-nm wavelength blue light falling on double slits separated by 0.0500 mm?

12. At what angle is the fourth-order maximum for the situation in Exercise 27.6?

8. What is the separation between two slits for which 610-nm orange light has its first maximum at an angle of 30 deg?

10. Calculate the wavelength of light that has its third minimum at an angle of 30 deg when falling on double slits separated by 3.00 μm .

18. Figure 27.56 shows a double slit located a distance x from a screen, with the distance from the center of the screen given by y. When the distance d between the slits is relatively large, there will be numerous bright spots, called fringes. Show that, for small angles (where sin θ ≈ θ with θ in radians), the distance between fringes is given by Δy = xλ /d .



==> class30_19f.txt <==
21. A diffraction grating has 2000 lines per centimeter. At what angle will the first-order maximum be for 520-nm-wavelength green light?

22. Find the angle for the third-order maximum for 580-nm-wavelength yellow light falling on a diffraction grating having 1500 lines per centimeter.

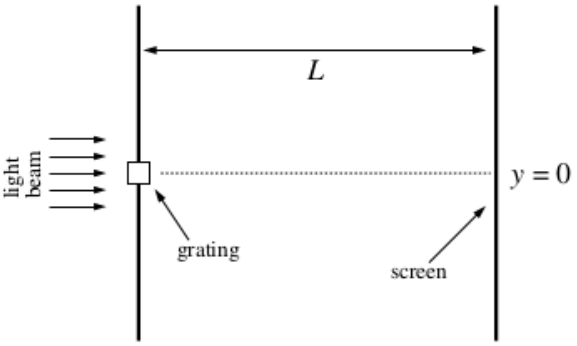
53. (a) If a single slit produces a first minimum at 14.5 deg at what angle is the second-order minimum? (b) What is the angle of the third-order minimum? (c) Is there a fourth-order minimum?

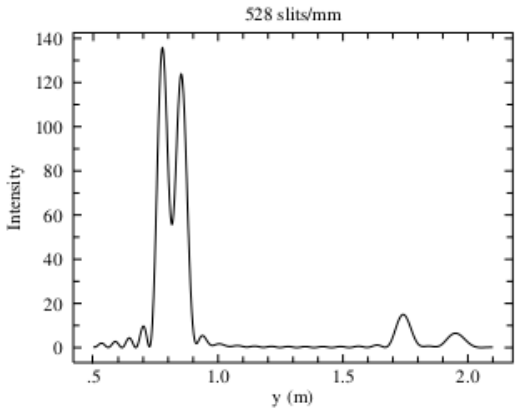
57. The 300-m-diameter Arecibo radio telescope pictured in Figure 27.28 detects radio waves with a 4.00 cm average wavelength. (a) What is the angle between two just-resolvable point sources for this telescope?

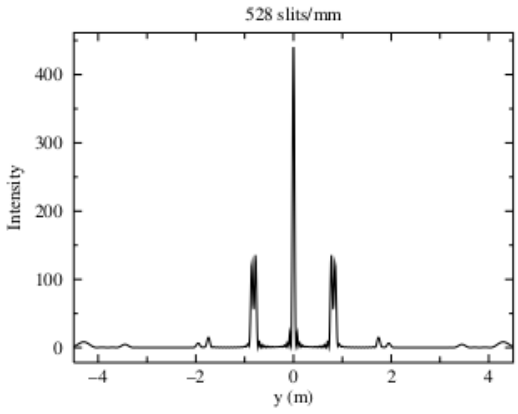
62. The limit to the eye's acuity is actually related to diffraction by the pupil.
(a) What is the angle between two just-resolvable points of light for a 3.00-mm-diameter pupil, assuming an average wavelength of 550 nm?

(b) Take your result to be the practical limit for the eye. What is the greatest possible distance a car can be from you if you can resolve its two headlights, given they are 1.30 m apart?

11. A beam of light, consisting of a mixture of two wavelengths, is normally incident on a diffraction grating with 528 slits/mm. The light intensity on a screen $L = 3$ m from the slit is plotted below as a function of the distance, y, along the screen with origin at the bright central maximum. The plot on the left is an expanded-scale version of a portion of the plot on the right. (A) Directly on the below right plot, label each peak pair with its corresponding order m. Repeat for the expanded plot below left. (B) Using the second order maximums, calculate the two wavelengths in the incident light.







==> class31_19f.txt <==
70. A soap bubble is 100 nm thick and illuminated by white light incident perpendicular to its surface. What wavelength and color of visible light is most constructively reflected, assuming the same index of refraction as water?

76. Suppose you have a lens system that is to be used primarily for 700-nm red light. What is the second thinnest coating of fluorite (magnesium fluoride) that would be non-reflective for this wavelength? (n MgF2=1.38)

89. Show that if you have three polarizing filters, with the second at an angle of 45 deg to the first and the third at an angle of 90 deg to the first, the intensity of light passed by the first will be reduced to 25% of its value. (This is in contrast to having only the first and third, which reduces the intensity to zero, so that placing the second between them increases the intensity of the transmitted light.)

95. Light reflected at 55.6 deg from a window is completely polarized. What is the window’s index of refraction and the likely substance of which it is made?

==> class32_19f.txt <==
89. Show that if you have three polarizing filters, with the second at an angle of 45 deg to the first and the third at an angle of 90 deg to the first, the intensity of light passed by the first will be reduced to 25% of its value. (This is in contrast to having only the first and third, which reduces the intensity to zero, so that placing the second between them increases the intensity of the transmitted light.)

95. Light reflected at 55.6 deg from a window is completely polarized. What is the window's index of refraction and the likely substance of which it is made?
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13. How fast would a 6.0 m-long sports car have to be going past you in order for it to appear only 5.5 m long?

16. (a) How long does it take the astronaut in Example 28.2 to travel 4.30 ly at 0.99944c (as measured by the Earth-bound observer)? (b) How long does it take according to the astronaut? (c) Verify that these two times are related through time dilation with γ=30 as given.

20. Suppose a spaceship heading straight towards the Earth at 0.75c can shoot a canister at 0.50c relative to the ship. (a) What is the velocity of the canister relative to the Earth, if it is shot directly at the Earth? (b) If it is shot directly away from the Earth?

==> class33_19f.txt <==
1. A LiBr molecule oscillates with a frequency of
1.7×10^13 Hz. (a) What is the difference in energy in eV
between allowed oscillator states? (b) What is the
approximate value of n for a state having an energy of 1.0
eV? (c) What is the wavenumber (cm^-1) for this oscillation?
h=4.136e-15 eV Hz^-1

7. Calculate the binding energy in eV of electrons in
aluminum, if the longest-wavelength photon that can eject
them is 304 nm.

8. What is the maximum kinetic energy in eV of electrons
ejected from sodium metal by 450-nm EM radiation, given
that the binding energy is 2.28 eV?

23. (a) What is the wavelength of a 1-eV photon? (b) Find
its frequency in hertz. (c) Identify the type of EM radiation.

36. Assuming that 10.0% of a 100-W light bulb’s energy
output is in the visible range (typical for incandescent bulbs)
with an average wavelength of 580 nm, and that the photons
spread out uniformly and are not absorbed by the
atmosphere, how far away would you be if 500 photons per
second enter the 3.00-mm diameter pupil of your eye? (This
number easily stimulates the retina.)

45. (a) Find the momentum of a 100-keV x-ray photon.
(b) Find the equivalent velocity of a neutron with the same
momentum. (c) What is the neutron’s kinetic energy in keV?
h=6.626e−34 J·s, 1eV=1.602E−19 J

==> class34_19f.txt <==
50. What is the wavelength of an electron moving at 3% of the speed of light? me = 9.1094 × 10^-31 kg

57. What is the kinetic energy of an electron in a TEM having a 0.01-nm wavelength? eV = 1.6022 × 10^-19 J

64. Suppose the velocity of an electron in an atom is known to an accuracy of 2.0×10^3 m/s (reasonably accurate compared with orbital velocities). What is the electron’s minimum uncertainty in position, and how does this compare with the approximate 0.1-nm size of the atom?

77 (a) What is γ for an electron emerging from the Stanford Linear Accelerator with a total energy of 50 GeV? (b) Find its momentum. (c) What is the electron’s wavelength?
h = 4.1357 × 10^-15 eV·s = 6.6261 × 10-34 J·s

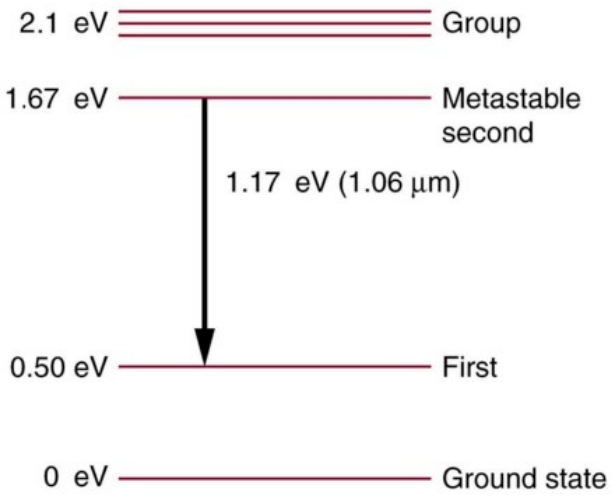
==> class35_19f.txt <==
11. If a hydrogen atom has its electron in the n=4 state
how much energy in eV is needed to ionize it?

19. A wavelength of 4.653 μm is observed in a hydrogen
spectrum for a transition that ends in the n=5 level.
What was n for the initial level of the electron?

22. Atoms can be ionized by thermal collisions, such as at the
high temperatures found in the solar corona. One such ion is
C^+5 , a carbon atom with only a single electron.
(a) By what factor are the energies of its hydrogen-like levels
greater than those of hydrogen?
(b) What is the wavelength of the first line in this ion's
Paschen series?
(c) What type of EM radiation is this?

34. Some of the most powerful lasers are based on the
energy levels of neodymium in solids, such as glass, as
shown in Figure 30.64. (a) What average wavelength light
can pump the neodymium into the levels above its metastable
state? (b) Verify that the 1.17 eV transition produces
1.06 μm radiation.

Figure 30.64 Neodymium atoms in glass have these energy levels, one
of which is metastable. The group of levels above the metastable state
is convenient for achieving a population inversion, since photons of
many different energies can be absorbed by atoms in the ground state.

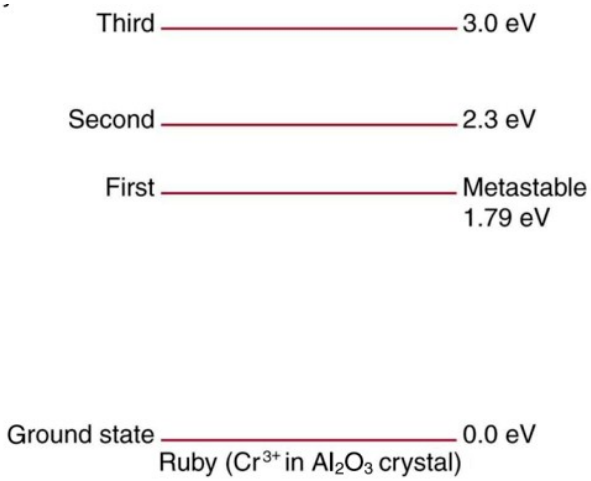


==> class36_19f.txt <==
25. (a) What is the shortest-wavelength x-ray radiation that can be generated in an x-ray tube with an applied voltage of 50.0 kV? (b) Calculate the photon energy in eV. (c) Explain the relationship of the photon energy to the applied voltage.
h= 4.1357 × 10^-15 eV·s c = 2.9979 × 10^8 m/s

29. What are the approximate energies of the K α and K β x-rays for copper? Z=29 (A=63.55)

32. Ruby lasers have chromium atoms doped in an aluminum oxide crystal. The energy level diagram for chromium in a ruby is shown in Figure 30.63. What wavelength is emitted by a ruby laser?

33. (a) What energy photons can pump chromium atoms in a ruby laser from the ground state to its second and third excited states? (b) What are the wavelengths of these photons? Verify that they are in the visible part of the spectrum.

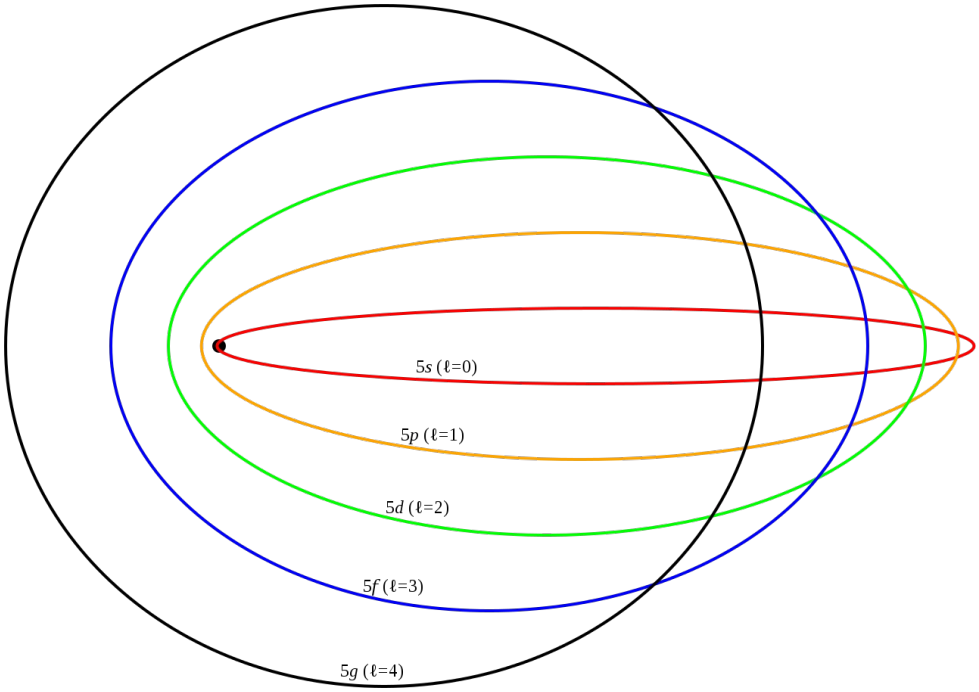


==> class37_19f.txt <==
35. If an atom has an electron in the n=5 state with m_l=3 , what are the possible values of l ?

42. (a) How many angles can L make with the z-axis for an l=2 electron? (b) Calculate the value of the smallest angle.

48. Which of the following spectroscopic notations are not allowed? (a) 5s1 (b) 1d1 (c) 4s3 (d) 3p7 (e) 5g15 . State which rule is violated for each that is not allowed.

Report the electron configuration of: P, Y, Au, Am



==> class38_19f.txt <==
12. If a 1.5-cm-thick piece of lead can absorb 90% of the γ rays from a radioactive source, how many centimeters of lead are needed to absorb all but 0.1% of the γ rays?

16. (a) What is the kinetic energy in MeV of a β ray that is traveling at 0.998c ? This gives some idea of how energetic β ray must be to travel at nearly the same speed as a γ ray. (b) What is the velocity of the γ ray relative to the β ray?

18. β− decay of 40K , a naturally occurring rare isotope of potassium responsible for some of our exposure to background radiation.
40K= 39.963999 u
40Ca= 39.962591 u

40. (a) Write the complete β+ decay equation for 11C
(b) Calculate the energy released in the decay. (Careful)
11C= 11.011433 u
11B= 11.009305 u
β=   .000549 u
931.5 MeV/c^2 = 1 u

21. Electron capture by 7Be
42. (b) Calculate the energy released.
7Be= 7.016928 u
7Li= 7.016003 u

41. (a) Calculate the energy released in the α decay of 238U .
4He=   4.002603 u
234Th= + 234.043593 u.
238U=   238.050784 u.

==> class39_19f.txt <==
45. A 60Co source is labeled 4.00 mCi, but its present
activity is found to be 1.85e7 Bq. (a) What is the present
activity in mCi? (b) How long ago did it actually have a
4.00-mCi activity?
60Co: β−, T½=5.271 y; 1 Ci=3.70e10 Bq

47. Show that the activity of the 14C in 1.00 g of
12C found in living tissue is 0.250 Bq.
14C β−, T½=5730 y, fraction=1.3e-12

48. Mantles for gas lanterns contain thorium, because it forms
an oxide that can survive being heated to incandescence for
long periods of time. Natural thorium is almost 100% 232Th ,
with a half-life of 1.405e10 y . If an average lantern
mantle contains 300 mg of thorium, what is its activity?
232Th α, T½=1.41e10 y

64. The Galileo space probe was launched on its long journey
past several planets in 1989, with an ultimate goal of Jupiter.
Its power source is 11.0 kg of 238Pu , a by-product of
nuclear weapons plutonium production. Electrical energy is
generated thermoelectrically from the heat produced when
the 5.59-MeV α particles emitted in each decay crash to a
halt inside the plutonium and its shielding. The half-life of
238Pu is 87.7 years. (a) What was the original activity of the
238Pu in becquerel? (b) What power was emitted in
kilowatts? (c) What power was emitted 30 y after launch?
You may neglect any extra energy from daughter nuclides
and any losses from escaping γ rays
238Pu α, T½=87.7 y, 1 eV= 1.60e-19 J

==> class42_19f.txt <==
7. (a) Neutron activation of sodium, which is 100% 23Na produces 24Na , which is used in some heart scans, as seen in Table 32.1. The equation for the reaction is
23Na + n → 24Na + γ .
Find its energy output, given masses:
23Na=22.989767 u
24Na=23.990962 u
n= 1.008665 u
u= 931.5 MeV/c^2
(b) What mass of 24Na produces the needed 5.0-mCi activity, given its half-life is 15.0 h?

21. Large amounts of 65Zn are produced in copper exposed to accelerator beams. While machining contaminated copper, a physicist ingests 50.0 μCi of 65Zn. Each 65Zn decay emits an average γ-ray energy of 0.550 MeV, 40.0% of which is absorbed in the scientist's 75.0-kg body. What dose in mSv is caused by this in one day? Forever?

43. (a) Calculate the energy released in the neutron-induced fission (similar to the spontaneous fission in Example 32.3)
n + 238U → 96Sr + 140Xe + 3n,
238U = 238.050784 u
140Xe= 139.92164 u
96Sr = 95.921750 u
n= 1.008665 u

33. (a) Calculate the number of grams of deuterium in an 80,000-L swimming pool, given deuterium is 0.0150% of natural hydrogen.
(b) Find the energy released in joules if this deuterium is fused via the reaction 2H + 2H → 3He + n .
2H = 2.014102 u
3He= 3.016030 u