Corinne Gulekson	dgd1	Thu 13:00 - 14:30	**MHN033**
Corinne Gulekson	dgd2	Mon 17:30 - 19:00	MNT203

LIST OF SUGGESTED DGD PROBLEMS

VERY IMPORTANT! **PLASE READ!**

1 NOT ALL OF THE PROBLEMS WILL BE SOLVED IN FULL.

SOME QUESTIONS WILL BY JUST ANALYSED AND THE PLAN OF ATTACK WILL BE PRESENTED DURING THE DGD.
STUDENTS SHOULD FINISH THESE PROBLEMS ON THEIR OWN.

2 If the the material in DGD will be getting ahead of the material studied and discussed in class, please inform the TA about it, and remain calm. TA might want to give you five minute intro into the material, and you will still benefit from the analysis of the problems.

3 Reading the assigned problems before DGD will surely help you in understanding what TA is doing.!

I recommend actually trying to solve these questions before the DGD!

4 **Two of the DGD sessions will be used for the midterm tests !**

DGD 1	**Jan 17**	**Jan 19**	**E1: Current, Resistance, and Circuits**
DGD 2	**Jan 24**	**Jan 26**	**M1 Oscillations I**
DGD 3	**Jan 30**	**Feb 2**	**M2 Acoustic Waves**
DGD 4	**Feb 6**	**Feb 9**	**O1 Laws of Geometric Optics**
DGD 5	**Feb 13**	**Feb 16**	**O2 Image Formation**
DGD 6	**Feb 27**	**Mar 2**	**O3 Wave Optics**
DGD 7	**Mar 6**	**Mar 9**	**Old Quantum Physics**
DGD 8	**Mar 13**	**Mar 16**	**Rutherford Experiment and Bohr's Atom**
DGD 9	**Mar 20**	**Mar 23**	**Nuclear Physics**
DGD 10	**Mar 27**	**Mar 30**	**E2 Electric Field and Gauss Law**
DGD 11	**Apr 3**	**Apr 6**	**E3 Electric Potential and Capacitance**

M **Mechanics: Vibrations and Mechanical Waves**
NP **Nuclear Physics**
E **Electricity**
O **Optics**
QP **Quantum Physics**

DGD # 1 REVIEW OF THE FALL SEMESTER: ROTATIONS

Rotational motion About a Fixed Axis

Angular speed $\omega = d\theta/dt$

Angular acceleration $\alpha = dw/dt$

Net torque $\sum \tau = I\alpha$

If $\alpha = const.$ $\begin{cases} \omega_f = \omega_i + \alpha_t \\ \theta_f = \theta_i + \omega_i t + \frac{1}{2}\alpha t^2 \\ \omega_f^2 = \omega_i^2 + 2\alpha(\theta_f - \theta_i) \end{cases}$

Work $W = \int_{\theta_i}^{\theta_f} \tau \ d\theta$

Rotational kinetic energy $K_R = \frac{1}{2} I\omega^2$

Power $P = \tau\omega$

Angular momentum $L = I\omega$

Net torque $\sum \tau = dL/dt$

Circular Hoop $I_{CM} = MR^2$

Hollow cylinder $I_{CM} = \frac{1}{2} M(R_1^2 + R_2^2)$

where R_1: inner radius, R_2: outer radius

Solid cylinder or disc $I_{CM} = \frac{1}{2} MR^2$

Thin Rectangle $I_{CM} = \frac{1}{12} M(a^2 + b^2)$

Long thin road with rotational axis through center $I_{CM} = \frac{1}{12} ML^2$

Long thin road with rotational axis through edge $I_{CM} = \frac{1}{3} ML^2$

Solid sphere $I_{CM} = \frac{2}{5} MR^2$

Thin spherical shell $I_{CM} = \frac{2}{3} MR^2$

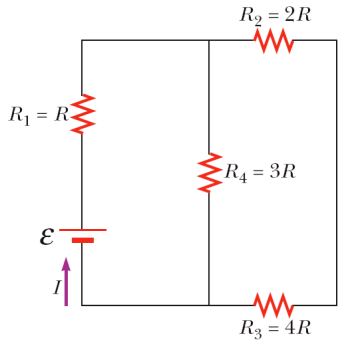
DGD 1: Current, Voltage, Resistance, Electric Circuits

2 An office worker uses an immersion heater to warm 250 g of water in a light, covered insulated cup from 20°C to 100°C in 4.00 min. In electrical terms, the heater is a Nichrome resistance wire connected to a 120-V power supply. Specify a diameter and a length that the wire can have. Can it be made from less than 0.5 cm^3 of Nichrome? You may assume that the wire is at 100°C throughout the time interval.

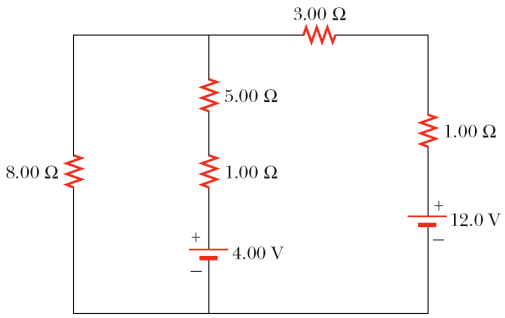
3 Suppose you wish to fabricate a uniform wire out of 1.00 g of copper. If the wire is to have a resistance of R = 0.500 **Ω** and if all the copper is to be used, what will be (a) the length and (b) the diameter of this wire?

4 A battery has an emf ε and internal resistance r. A variable load resistor R is connected across the terminals of the battery. (a) Determine the value of R such that the potential difference across the terminals is a maximum. (b) Determine the value of R so that the current in the circuit is a maximum. (c) Determine the value of R so that the power delivered to the load resistor is

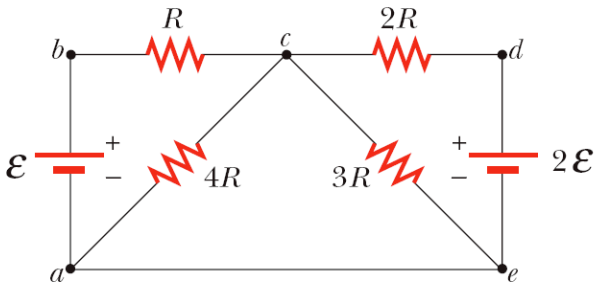
5 Four resistors are connected to a battery as shown in Figure P21.32. The current in the battery is I, the battery emf is ε, and the resistor values are $R_1 = R$, $R_2 = 2R$, $R_3 = 4R$, and $R_4 = 3R$. (a) Rank the resistors according to the potential difference across them, from largest to smallest. Note any cases of equal potential differences. (b) Determine the potential difference across each resistor in terms of ε. (c) Rank the resistors according to the current in them, from largest to smallest. Note any cases of equal currents. (d) Determine the current in each resistor in terms of I. (e) If R_3 is increased, what happens to the current in each of the resistors? (f) In the limit that $R_3 \to \infty$, what are the new values of the current in each resistor in terms of I, the original current in the battery?



6 Determine the current in each branch of the circuit shown in Figure P21.35.



7 Taking R = 1.00 k**Ω** and ε = 250 V in Figure P21.39, determine the direction and magnitude of the current in the horizontal wire between a and e.

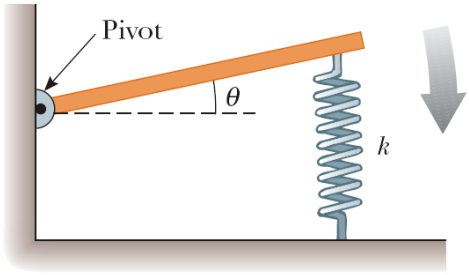


DGD2 MECHANICS: OSCILLATIONS I

1 A particle moves in simple harmonic motion with a frequency of 3.00 Hz and an amplitude of 5.00 cm. (a) Through what total distance does the particle move during one cycle of its motion? (b) What is its maximum speed? Where does this maximum speed occur? (c) Find the maximum acceleration of the particle. Where in the motion does the maximum acceleration occur?

2 A 1.00-kg glider attached to a spring with a force constant of 25.0 N/m oscillates on a horizontal, frictionless air track. At $t = 0$, the glider is released from rest at $x = -3.00$ cm (that is, the spring is compressed by 3.00 cm). Find (a) the period of its motion, (b) the maximum values of its speed and acceleration, and (c) the position, velocity, and acceleration as functions of time.

3 A horizontal plank of mass m and length L is pivoted at one end. The plank's other end is supported by a spring of force constant k (Fig. P12.49). The moment of inertia of the plank about the pivot is $\frac{1}{3}mL^2$. The plank is displaced by a small angle θ from its horizontal equilibrium position and released. (a) Show that it moves with simple harmonic motion with an angular frequency $\omega = \sqrt{3k/m}$. (b) Evaluate the frequency, assuming that the mass is 5.00 kg and that the spring has a force constant of 100 N/m.



4 A particle of mass m slides without friction inside a hemispherical bowl of radius R. Show that if it starts from rest with a small displacement from equilibrium, the particle moves in simple harmonic motion with an angular frequency equal to that of a simple pendulum of length R (that is, $\omega = \sqrt{g/R}$).

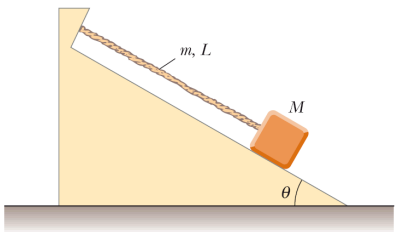
5 A bat can detect very small objects, such as an insect whose length is approximately equal to one wavelength of the sound the bat makes. If a bat emits chirps at a frequency of 60.0 kHz and the speed of sound in air is 340 m/s, what is the smallest insect the bat can detect?

6 A sinusoidal sound wave is described by the displacement wave function

$$s(x, t) = (2.00\ \mu\text{m}) \cos[(15.7\ \text{m}^{-1})x - (858\ \text{s}^{-1})t]$$

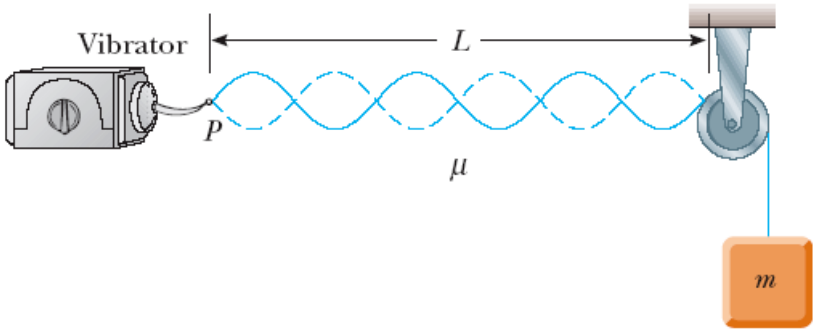
(a) Find the amplitude, wavelength, and speed of this wave.
(b) Determine the instantaneous displacement from equilibrium of the elements of the medium at the position $x = 0.050\ 0$ m at $t = 3.00$ ms.
(c) Determine the maximum speed of the element's oscillatory motion.

7 **Review problem.** A block of mass M, supported by a string, rests on a frictionless incline making an angle θ with the horizontal (Fig. P13.43). The length of the string is L and its mass is $m << M$. Derive an expression for the time interval required for a transverse wave to travel from one end of the string to the other.



DGD 3: MECHANICS: OSCILLATIONS II

1 In the arrangement below an object can be hung from a string (with linear mass density $\mu = 0.002\ 00$ kg/m) that passes over a light pulley. The string is connected to a vibrator (of constant frequency f), and the length of the string between point P and the pulley is $L = 2.00$ m. When the mass m of the object is either 16.0 kg or 25.0 kg, standing waves are observed, but no standing waves are observed with any mass between these values. (a) What is the frequency of the vibrator? (*Note:* The greater the tension in the string, the smaller the number of nodes in the standing wave.) (b) What is the largest object mass for which standing waves could be observed?



2 A flowerpot is knocked off a balcony 20.0 m above the sidewalk and falls toward an unsuspecting 1.75-m-tall man who is standing below. How close to the sidewalk can the flowerpot fall before it is too late for a warning shouted from the balcony to reach the man in time? Assume that the man below requires 0.300 s to respond to the warning.

3 The Bay of Fundy, Nova Scotia, has the highest tides in the world. Assume that in midocean and at the mouth of the bay, the Moon's gravity gradient and the Earth's rotation make the water surface oscillate with an amplitude of a few centimeters and a period of 12 h 24 min. At the head of the bay, the amplitude is several meters. Argue for or against the proposition that the tide is magnified by standing wave resonance. Assume that the bay has a length of 210 km and a uniform depth of 36.1 m. The speed of long-wavelength water waves is given by $\sqrt{gd}$, where d is the water's depth.

4 Two train whistles have identical frequencies of 180 Hz. When one train is at rest in the station and the other is moving nearby, a commuter standing on the station platform hears beats with a frequency of 2.00 beats/s when the whistles sound at the same time. What are the two possible speeds and directions that the moving train can have?

5 A family ice show is held at an enclosed arena. The skaters perform to music with level 80.0 dB. This is too loud for your baby, who yells at 75.0 dB.
(a) What total sound intensity engulfs you? (b) What is the combined sound level?

6 A fireworks rocket explodes at a height of 100 m above the ground. An observer on the ground directly under the explosion experiences an average sound intensity of 7.00×10^{-2} W/m^2 for 0.200 s.
(a) What is the total sound energy of the explosion? (b) What is the sound level in decibels heard by the observer?

7 The ocean floor is underlain by a layer of basalt that constitutes the crust, or uppermost layer, of the Earth in that region. Below this crust is found denser periodotite rock, which forms the Earth's mantle. The boundary between these two layers is called the Mohorovicic discontinuity ("Moho" for short). If an explosive charge is set off at the surface of the basalt, it generates a seismic wave that is reflected back out at the Moho. If the speed of this wave in basalt is 6.50 km/s and the two-way travel time is 1.85 s, what is the thickness of this oceanic crust?

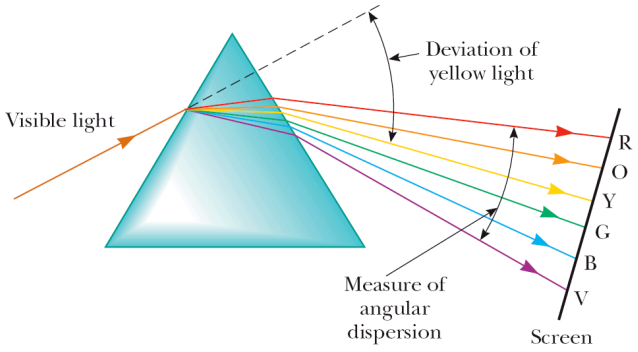
DGD 4: GEOMETRIC OPTICS, DISPERSION

1 The *Apollo 11* astronauts set up a panel of efficient cornercube retroreflectors on the Moon's surface. The speed of light can be found by measuring the time interval required for a laser beam to travel from Earth, reflect from the panel, and return to Earth. If this interval is measured to be 2.51 s, what is the measured speed of light? Take the center-tocenter distance from Earth to Moon to be 3.84×10^8 m, and do not ignore the sizes of the Earth and Moon.

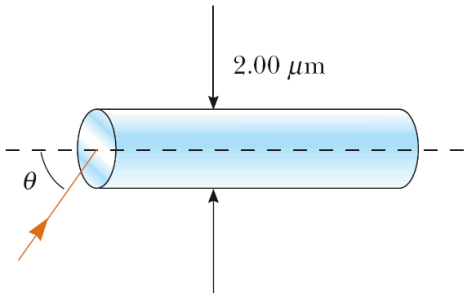
2. As a result of his observations, Roemer concluded that eclipses of Io by Jupiter were delayed by 22 min during a 6 month period as the Earth moved from the point in its orbit where it is closest to Jupiter to the diametrically opposite point where it is farthest from Jupiter. Using 1.50×10^8 km as the average radius of the Earth's orbit around the Sun, calculate

3 Use Huygens Principle to (and proper in-scale) geometric construction to obtain
Law of Reflection and Law of Refraction (Snell's Law)

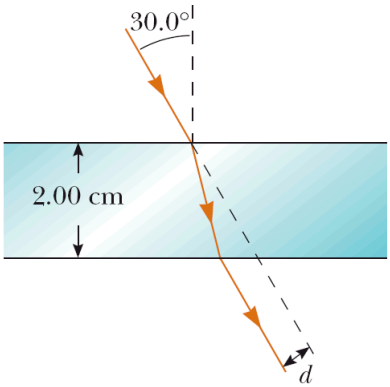
4 The index of refraction for violet light in silica flint glass is 1.66 and that for red light is 1.62. What is the angular dispersion of visible light passing through a prism of apex angle 60.0° if the angle of incidence is 50.0°?



5 Determine the maximum angle θ for which the light rays incident on the end of the pipe in Figure belwo are subject to total internal reflection along the walls of the pipe. Assume that the pipe has an index of refraction of 1.36 and that the outside medium is air. Your answer defines the size of the *cone of acceptance* for the light pipe.



6 When the light illustrated in Figure P25.17 passes through the glass block, it is shifted laterally by the distance d. Taking $n = 1.50$, find the value of d.



DGD5: Image formation

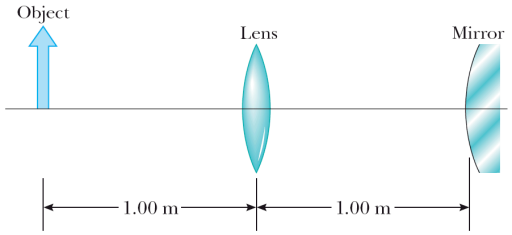
1 A cataract-impaired lens in an eye may be surgically removed and replaced by a manufactured lens. The focal length required for the new lens is determined by the lens-to-retina distance, which is measured by a sonarlike device, and by the requirement that the implant provide for correct distant vision. (a) Assuming the distance from lens to retina is 22.4 mm, calculate the power of the implanted lens in diopters. (b) Because no accommodation occurs and the implant allows for correct distant vision, a corrective lens for close work or reading must be used. Assume a reading distance of 33.0 cm and calculate the power of the lens in the reading glasses.

2 (a) A concave mirror forms an inverted image four times larger than the object. Find the focal length of the mirror, assuming that the distance between object and image is 0.600 m. (b) A convex mirror forms a virtual image half the size of the object. Assuming that the distance between image and object is 20.0 cm, determine the radius of curvature of the mirror.

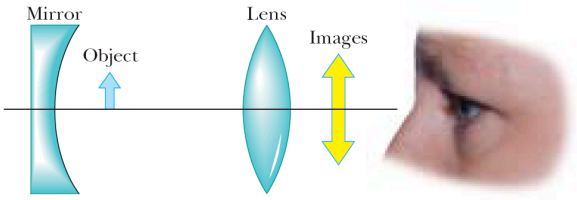
3 A flint glass plate (n = 1.66) rests on the bottom of an aquarium tank. The plate is 8.00 cm thick (vertical dimension) and is covered with a layer of water (n = 1.33) 12.0 cm deep. Calculate the apparent thickness of the plate as viewed from straight above the water.

4 In many applications, it is necessary to expand or to decrease the diameter of a beam of parallel rays of light. This change can be made by using a converging lens and a diverging lens in combination. Suppose you have a converging lens of focal length 21.0 cm and a diverging lens of focal length –12.0 cm. How can you arrange these lenses to increase the diameter of a beam of parallel rays? By what factor will the diameter increase.

5 The lens and mirror in Figure P26.44 have focal lengths of +80.0 cm and –50.0 cm, respectively. An object is placed 1.00 m to the left of the lens as shown. Locate the final image, formed by light that has gone through the lens twice. State whether the image is upright or inverted, and determine the overall magnification.



6 An observer to the right of the mirror–lens combination shown in Figure P26.52 sees two real images that are the same size and in the same location. One image is upright and the other is inverted. Both images are 1.50 times larger than the object. The lens has a focal length of 10.0 cm. The lens and mirror are separated by 40.0 cm. Determine the focal length of the mirror. Do not assume that the figure is drawn to scale.



7. Two lenses made of kinds of glass having different refractive indices n_1 and n_2 are cemented together to form what is called an *optical doublet*. Optical doublets are often used to correct chromatic aberrations in optical devices. The first lens of a doublet has one flat side and one concave side of radius of curvature R. The second lens has two convex sides of radius of curvature R. Show that the doublet can be modeled as a single thin lens with a focal length described by

$$\frac{1}{f} = \frac{2n^2 - n_1 - 1}{R}$$

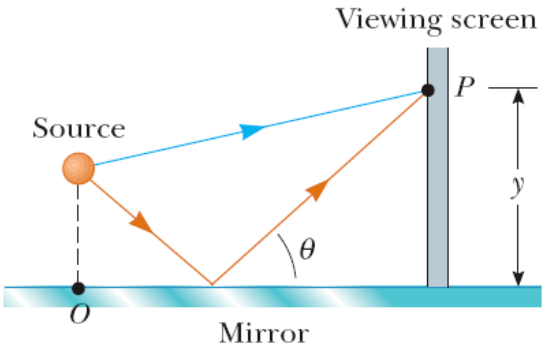
DGD 6: WAVE OPTICS,

1 Young's double-slit experiment is performed with 589-nm light and a distance of 2.00 m between the slits and the screen. The tenth interference minimum is observed 7.26 mm from the central maximum. Determine the spacing of the slits.

2 A beam of monochromatic green light is diffracted by a slit of width 0.550 mm. The diffraction pattern forms on a wall 2.06 m beyond the slit. The distance between the positions of zero intensity on both sides of the central bright fringe is 4.10 mm. Calculate the wavelength of the light.

3 The pupil of a cat's eye narrows to a vertical slit of width 0.500 mm in daylight. What is the angular resolution for horizontally separated mice? Assume that the average wavelength of the light is 500 nm.

4 Interference effects are produced at point *P* on a screen as a result of direct rays from a 500-nm source and reflected rays from the mirror as shown in. Assume that the source is 100 m to the left of the screen and 1.00 cm above the mirror. Find the distance *y* to the first dark band above the mirror.



5 The *Very Large Array* (VLA) is a set of 27 radio telescope dishes in Caton and Socorro counties, New Mexico (Fig P27.56). The antennas can be moved apart on railroad tracks, and their combined signals give the resolving power of a synthetic aperture 36.0 km in diameter. (a) If the detectors are tuned to a frequency of 1.40 GHz, what is the angular resolution of the VLA? (b) Clouds of hydrogen radiate at this frequency. What must be the separation distance of two clouds at the center of the galaxy, 26 000 lightyears away, if they are to be resolved? (c) As the telescope looks up, a circling hawk looks down. Find the angular resolution of the hawk's eye. Assume that that the hawk is most sensitive to green light having wavelength 500 nm and that it has a pupil of diameter 12.0 mm. (d) A mouse is on the ground 30.0 m below. By what distance must the mouse's whiskers be separated if the hawk can resolve them?

6 90nm oil slick (n_{oil}=1.4) covers the calm ocean (n_w=1.31). Perpendicular white light is reflected off the oiled covered ocean. Find the wavelengths in the range of 400nm to 670nm enhanced in (a) reflection and (b) transmission.

7 A parallel quadratic slab of glass (n=1.55 and thickness d=2cm, length L=21cm) rests on a large slab of glass (n=1.55). To prevent the "optical contact weld" forming between the two polished surfaces a small teflon ball (D=1cm) is inserted between the slabs on one side one cm away from the edge. 500nm light is incident (perpendicularly on this structure.

a) find the formula for the dark fringe position as the function of the distance from point of contact
b) find the number of bright fringes formed

DGD 6: "Old Quantum Physics"

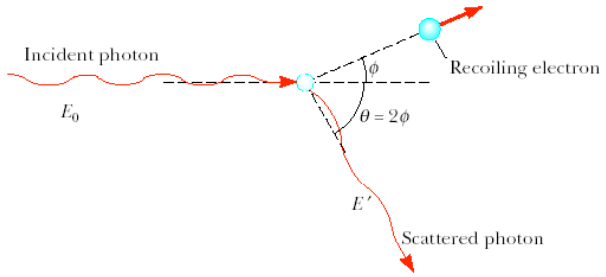
1 The average threshold of dark-adapted (scotopic) vision is 4.00×10^{-11} W/m^2 at a central wavelength of 500 nm. If light having this intensity and wavelength enters the eye and the pupil is open to its maximum diameter of 8.50 mm, how many photons per second enter the eye?

2 Electrons are ejected from a metallic surface with speeds ranging up to 4.60×10^5 m/s when light with a wavelength of 625 nm is used. (a) What is the work function of the surface? (b) What is the cutoff frequency for this surface?

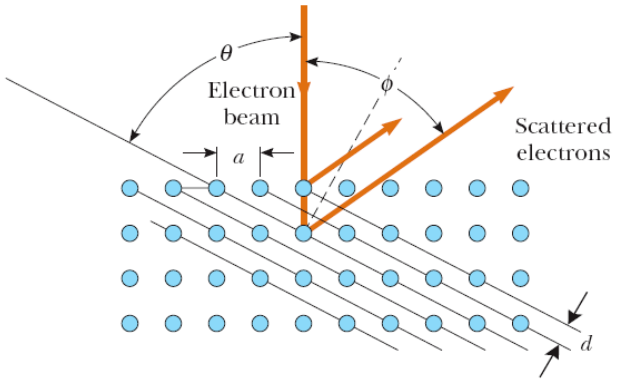
3 X-rays having an energy of 300 keV undergo Compton scattering from a target. The scattered rays are detected at 37.0° relative to the incident rays. Find (a) the Compton shift at this angle, (b) the energy of the scattered x-ray, and (c) the energy of the recoiling electron.

4. The radius of our Sun is 6.96×10^8 m, and its total power output is 3.77×10^{26} W.
(a) Assuming that the Sun's surface emits as a black body, calculate its surface temperature.
(b) Using the result of part (a), find λ_{max} for the Sun.

5 A 0.700-MeV photon scatters off a free electron such that the scattering angle of the photon is twice the scattering angle of the electron (Fig. P40.28). Determine (a) the scattering angle for the electron and (b) the final speed of the electron.



6 In the Davisson–Germer experiment, 54.0-eV electrons were diffracted from a nickel lattice. If the first maximum in the diffraction pattern was observed at $\phi = 50.0°$ (Fig. P28.22), what was the lattice spacing a between the vertical rows of atoms in the figure? (It is not the same as the spacing between the horizontal rows of atoms.)



DGD 7: EARLY ATOM MODELS. BOHR's ATOM

1. In the Rutherford scattering experiment, 4.00-MeV alpha particles (^{4}He nuclei containing 2 protons and 2 neutrons) scatter off gold nuclei (containing 79 protons and 118 neutrons). Assume that a particular alpha particle makes a direct head-on collision with the gold nucleus and scatters backward at 180°. Determine (a) the distance of closest approach of the alpha particle to the gold nucleus, and (b) the maximum force exerted on the alpha particle. Assume that the gold nucleus remains fixed throughout the entire process.

2 According to classical physics, a charge e moving with an acceleration a radiates at a rate

$$\frac{dE}{dt} = -\frac{1}{6\pi\varepsilon_0}\frac{e^2a^2}{c^3}$$

(a) Show that an electron in a classical hydrogen atom spirals into the nucleus at a rate

$$\frac{dr}{dt} = -\frac{e^4}{12\pi^2\varepsilon_0{}^2r^2m_e{}^2c^3}$$

(b) Find the time interval over which the electron will reach $r = 0$, starting from $r_0 = 2.00 \times 10^{-10}$ m.

3. Four possible transitions for a hydrogen atom are as follows:

(i) $n_i = 2$; $n_f = 5$ (ii) $n_i = 5$; $n_f = 3$

(iii) $n_i = 7$; $n_f = 4$ (iv) $n_i = 4$; $n_f = 7$

(a) In which transition is light of the shortest wavelength emitted? (b) In which transition does the atom gain the most energy?
(c) In which transition(s) does the atom lose energy?

4 A hydrogen atom is in its first excited state ($n = 2$). Using the Bohr theory of the atom, calculate (a) the radius of the orbit, (b) the linear momentum of the electron, (c) the angular momentum of the electron, (d) the kinetic energy of the electron, (e) the potential energy of the system, and (f) the total energy of the system.

5. How much energy is required to ionize hydrogen (a) when it is in the ground state? (b) when it is in the state for which $n = 3$?

6. Two hydrogen atoms collide head-on and end up with zero kinetic energy. Each atom then emits light with a wavelength of 121.6 nm ($n = 2$ to $n = 1$ transition). At what speed were the atoms moving before the collision?

7. A monochromatic beam of light is absorbed by a collection of ground-state hydrogen atoms in such a way that six different wavelengths are observed when the hydrogen relaxes back to the ground state. What is the wavelength of the incident beam?

8 (a) Construct an energy-level diagram for the He^+ ion, for which $Z = 2$. (b) What is the ionization energy for He^+

DGD 8: Nuclear Physics

1 A π^0 meson is an unstable particle produced in high-energy particle collisions. Its rest energy is about 135 MeV, and it exists for an average lifetime of only 8.70×10^{-17} s before decaying into two gamma rays. Using the uncertainty principle, estimate the fractional uncertainty $\Delta m/m$ in its mass determination.

2 In a Rutherford scattering experiment, alpha particles having kinetic energy of 7.70 MeV are fired toward a gold nucleus. (a) Use energy conservation to determine the distance of closest approach between the alpha particle and gold nucleus. Assume that the nucleus remains at rest. (b) Calculate the de Broglie wavelength for the 7.70-MeV alpha particle and compare it with the distance obtained in part (a). (c) Based on this comparison, why is it proper to treat the alpha particle as a particle and not as a wave in the Rutherford scattering experiment?

3 Identify the missing nuclide or particle (X):

(a) $\mathrm{X} \rightarrow {}^{65}_{28}\mathrm{Ni} + \gamma$

(b) ${}^{215}_{84}\mathrm{Po} \rightarrow \mathrm{X} + \alpha$

(c) $\mathrm{X} \rightarrow {}^{55}_{26}\mathrm{Fe} + \mathrm{e}^{+} + \nu$

(d) ${}^{109}_{48}\mathrm{Cd} + \mathrm{X} \rightarrow {}^{109}_{47}\mathrm{Ag} + \nu$

(e) ${}^{14}_{7}\mathrm{N} + {}^{4}_{2}\mathrm{He} \rightarrow \mathrm{X} + {}^{17}_{8}\mathrm{O}$

4 Europeans named a certain direction in the sky as between the horns of Taurus the Bull. On the day they named as A.D. July 4, 1054, a brilliant light appeared there. Europeans left no surviving record of the supernova, which could be seen in daylight for some days. As it faded it remained visible for years, dimming for a time with the 77.1-day half-life of the radioactive cobalt-56 that had been created in the explosion. (a) The remains of the star now form the Crab Nebula. (See Fig. 10.23 and the opening photographs of Chapter 24.) In it, the cobalt-56 has now decreased to what fraction of its original activity? (b) Suppose an American, of the people called the Anasazi, made a charcoal drawing of the supernova. The carbon-14 in the charcoal has now decayed to what fraction of its original activity?

5 To destroy a cancerous tumor, a dose of gamma radiation totaling an energy of 2.12 J is to be delivered in 30.0 days from implanted sealed capsules containing palladium-103. Assume that this isotope has half-life 17.0 d and emits gamma rays of energy 21.0 keV, which are entirely absorbed within the tumor. (a) Find the initial activity of the set of capsules. (b) Find the total mass of radioactive palladium that these "seeds" should contain.

6 **Review problem.** Singly ionized carbon is accelerated through 1 000 V and passed into a mass spectrometer to determine the isotopes present (see Chapter 29). The *Note:* Atomic masses are listed in Table A.3 in Appendix A. magnitude of the magnetic field in the spectrometer is 0.200 T. (a) Determine the orbit radii for the ^{12}C and the ^{13}C isotopes as they pass through the field. (b) Show that the ratio of radii may be written in the form

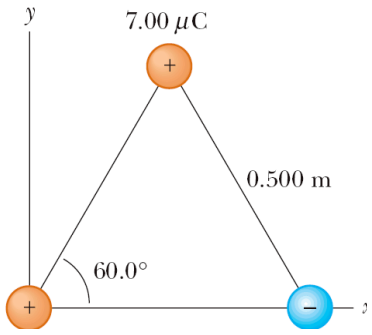
$$\frac{r_1}{r_2} = \sqrt{\frac{m_1}{m_2}}$$

and verify that your radii in part (a) agree with this.

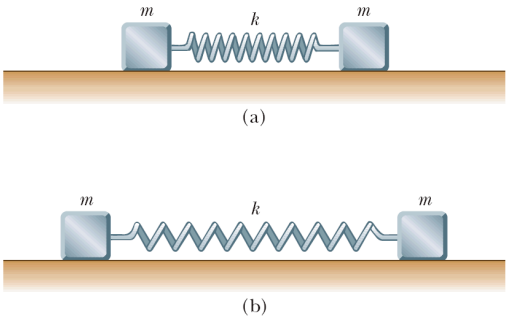
7 (a) Use the semi-empirical binding-energy formula to compute the binding energy for ${}^{56}_{26}\mathrm{Fe}$. (b) What percentage is contributed to the binding energy by each of the four terms

DGD 9/10 ELECTRICITY II

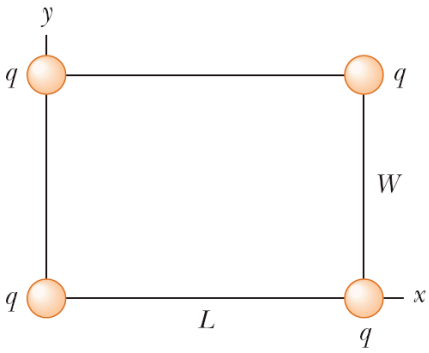
1 Three point charges are located at the corners of an equilateral triangle as shown in Figure P19.5. Calculate the resultant electric force on the 7.00-μC charge.



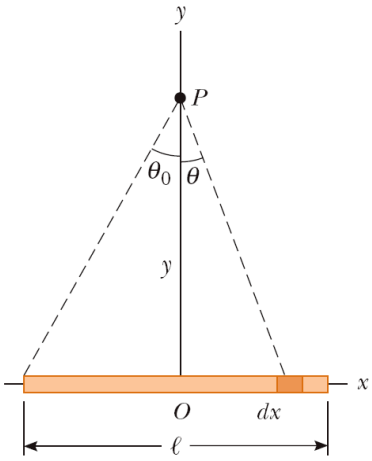
2 Two identical metallic blocks resting on a frictionless horizontal surface are connected by a light metallic spring having the spring constant 100 N/m and an un-stretched length of 0.300 m as shown in Figure P19.57a. A total charge of Q is slowly placed on the system, causing the spring to stretch to an equilibrium length of 0.400 m as shown in Figure P19.57b. Determine the value of Q , assuming that all the charge resides on the blocks and modeling the blocks as point charges



3 Four identical point charges (q = +10.0 μC) are located on the corners of a rectangle as shown. The dimensions of the rectangle are L = 60.0 cm and W = 15.0 cm. Calculate the magnitude and direction of the resultant electric force exerted on the charge at the lower left corner by the other three charges.



4 A thin rod of length ℓ and uniform charge per unit length λ lies along the x axis as shown in Figure P19.22. (a) Show that the electric field at P, a distance y from the rod along its perpendicular bisector, has no x component and is given by $E = 2k_e\lambda \sin\theta_0/y$. (b) Using your result to part (a), show that the field of a rod of infinite length is $E = 2k_e\lambda/y$. (*Suggestion:* First, calculate the field at P due to an element of length dx, which has a charge $\lambda\, dx$. Then, change variables from x to θ, using the relationships $x = y \tan\theta$ and $dx = y \sec^2\theta\, d\theta$, and integrate over θ.)



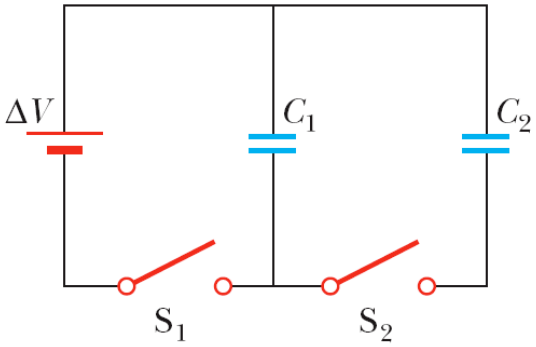
5 Detailed demonstration of the differential volume surface and length elements in the Cartesian, polar, cylindrical and spherical coordinates, in 2D and 3D. (30 minutes)(this is a repeat exercise from class)

DGD10: ELECTRICITY III

1 Obtain the expressions for the electric potential and electric field for the following high-symmetry charge distributions (*) start with the ones which were not reviewed in class:

a) point charge
b) infinite line of charge
c) infinite plane of charge
d) ring
e) disk
f) rod
g) fully charged sphere
h) spherical shell

2 Consider the circuit shown in Figure P20.43, where $C_1 = 6.00\ \mu F$, $C_2 = 3.00\ \mu F$, and $\Delta V = 20.0$ V. Capacitor C_1 is first charged by the closing of switch S_1. Switch S_1 is then opened, and the charged capacitor is connected to the uncharged capacitor by the closing of S_2. Calculate the initial charge acquired by C_1 and the final charge on each capacitor.



3 Two capacitors, $C_1 = 25.0\ \mu F$ and $C_2 = 5.00\ \mu F$, are connected in parallel and charged with a 100-V power supply. (a) Draw a circuit diagram and calculate the total energy stored in the two capacitors. (b) What potential difference would be required across the same two capacitors connected in series so that the combination stores the same energy as in part (a)? Draw a circuit diagram of this circuit.

a maximum. Choosing the load resistance for maximum power transfer is a case of what is called *impedance matching* in general. Impedance matching is important in shifting gears on a bicycle, in connecting a loudspeaker to an audio amplifier, in connecting a battery charger to a bank of solar photoelectric cells, and in many other applications.

4 Two conductors having net charges of +10.0 μC and –10.0 μC have a potential difference of 10.0 V between them. (a) Determine the capacitance of the system. (b) What is the potential difference between the two conductors if the charges on each are increased to +100 μC and –100 μC?

5 A 50.0-m length of coaxial cable has an inner conductor that has a diameter of 2.58 mm and carries a charge of 8.10 μC. The surrounding conductor has an inner diameter of 7.27 mm and a charge of –8.10 μC. (a) What is the capacitance of this cable? (b) What is the potential difference between the two conductors? Assume that the region between the conductors is air.