# PHY 2049 Review Problems

Let me know if you want me to add or fix anything!

# Exam 1 Material

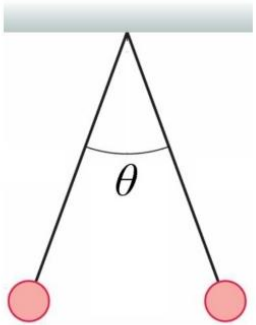
Chapter 21 - Chapter 25

# Chapter 21 - Add forces as vectors with Coulomb's law

1. Two point charges of $q_1 = 60$ nC and $q_2 = 80$ nC are held fixed on an $x$ axis, at the origin ($x_1 = 0$) and at $x_2 = 72$ cm, respectively. A particle with a charge of $q_0 = 0.60\ \mu$C is released from rest on the $x$ axis at $x_0 = 28$ cm. If the initial acceleration of the particle has a magnitude of 100 km/s$^2$, what is the particle's mass in kg?

(1) ♣ $1.9 \times 10^{-8}$ (2) $6.7 \times 10^{-7}$ (3) $4.4 \times 10^{-7}$ (4) $8.8 \times 10^{-8}$ (5) $9.9 \times 10^{-8}$

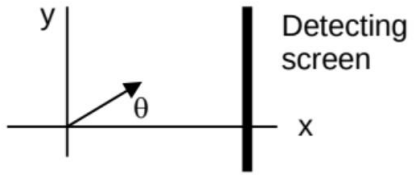
2. Two identical small spheres, each with mass 25 g and charge $q$, hang from very light strings, both of length 75 cm (see figure). If the angle $\theta$ between the strings is 60° at equilibrium, what is the magnitude of charge $q$ on each sphere?




(1) ♣ 3.0 $\mu$C
(2) 2.9 $\mu$C
(3) 1.4 $\mu$C
(4) 18 $\mu$C
(5) 9.9 $\mu$C

# Chapter 22 - Kinematics with a constant electric field

6. An electron is shot at an initial speed of $5 \times 10^6$ m/s at an angle $\theta = 30^o$ from the x-axis. It moves through a uniform electric field of $\vec{E} = 4\ \text{N/C}\ \hat{j}$. A screen detecting the electron is placed a distance $x = 3$ m away and parallel to the y-axis. What is the y-component of the electron's velocity when it arrives at the screen? The mass of an electron is $9.1 \times 10^{-31}$kg.




(1) ♣ $2.0 \times 10^6$ m/s (2) $2.5 \times 10^6$ m/s (3) $3.0 \times 10^6$ m/s (4) $1.5 \times 10^6$ m/s (5) $4.0 \times 10^6$ m/s

Question 7 of 10 < > 1 / 1

An electron with a speed of $4.39 \times 10^8$ cm/s in the positive direction of an *x* axis enters an electric field of magnitude $1.02 \times 10^3$ N/C, traveling along a field line in the direction that retards its motion. **(a)** How far will the electron travel in the field before stopping momentarily, and **(b)** how much time will have elapsed? **(c)** If the region containing the electric field is 6.38 mm long (too short for the electron to stop within it), what fraction of the electron's initial kinetic energy will be lost in that region?

**(a)** Number 0.0537 Units m

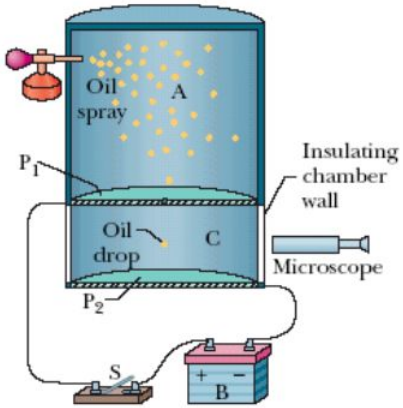
**(b)** Number 2.447e-8 Units s

**(c)** Number 0.119 Units This answer has no units

# Chapter 22 - Kinematics with a constant electric field

Question 6 of 10 < > 1 / 1

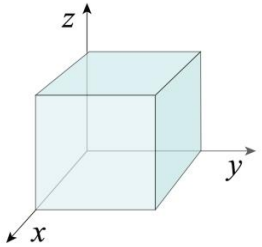
In Millikan's experiment, an oil drop of radius 1.70 μm and density 0.885 g/cm$^3$ is suspended in chamber C (see the figure) when a downward electric field of 1.59 × 10$^5$ N/C is applied. Find the charge on the drop, in terms of *e*.




Number -7.014 Units No units e

# Chapter 23 - Gauss' Law

9. A non-uniform electric field given by $\vec{E} = 5.5\hat{i} - 2.1\hat{j} + (4.6z^2 - 3)\hat{k}$ N/C pierces a cube with sides 3 m, as shown in the figure. The cube has its rear corner at the origin. What is the total charge inside the cube?

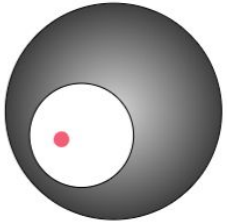



(1) +3.3 nC
(2) −2.4 nC
(3) +0.37 nC
(4) −5.2 nC
(5) +2.8 nC

6. A 9.5 cm radius hemisphere contains a total charge of $6.0 \times 10^{-7}$ C. The flux through the rounded portion of the surface is $7.9 \times 10^4$ Nm$^2$/C. The flux in Nm$^2$/C through the flat base is:

(1) $-1.1 \times 10^4$ (2) $+1.9 \times 10^4$ (3) $-5.3 \times 10^4$ (4) $-7.3 \times 10^4$ (5) $+8.8 \times 10^4$

7. A small ball, with a charge of $-2$ $\mu$C on it, is placed in a spherical cavity inside a spherical conductor, as illustrated in the figure. The net charge on the conductor is $-6$ $\mu$C. What is the amount of charge on the *outer* surface of the conductor?

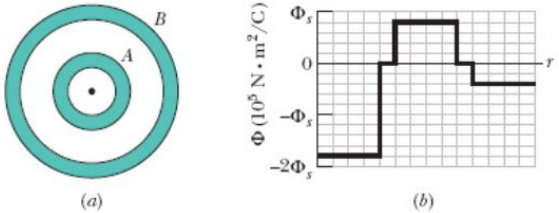


(1) ♣ $-8$ $\mu$C (2) 2 $\mu$C (3) 0 (4) $-4$ $\mu$C (5) 6 $\mu$C

# Chapter 23 - Gauss' Law

Question 3 of 10 < > 1 / 1

A charged particle is held at the center of two concentric conducting spherical shells. Figure (*a*) shows a cross section. Figure (*b*) gives the net flux Φ through a Gaussian sphere centered on the particle, as a function of the radius *r* of the sphere. The scale of the vertical axis is set by $\Phi_s = 6.0 \times 10^5\ \text{N}\cdot\text{m}^2/\text{C}$. What are **(a)** the charge of the central particle and the net charges of **(b)** shell A and **(c)** shell B?




(a) Number -9.558e-6 Units C

(b) Number 1.3806e-5 Units C

(c) Number -6.372e-6 Units C

# Chapter 24 - Electric field and electric potential

10. An electric field is given by equation $\vec{E}(x, y, z) = 2x\,\hat{i} + 3\,\hat{j} + 4z^2\,\hat{k}$, where the coordinates are in meters and the field is in N/C. What is the potential difference $V_B - V_A$ for two points $A(1, 2, 3)$ and $B(2, 2, 3)$?

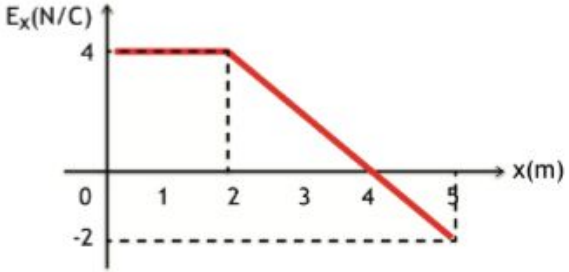
(1) ♣ $-3$ V (2) $-1$ V (3) 4 V (4) 2 V (5) 0 V

11. What is the magnitude of the electric field at the point $(-1, 2, 1)$ if the electric potential in the region is given by $V(x, y, z) = xz^2$? ($V$ is in volts and all coordinates are in meters.)

(1) ♣ 2.2 V/m (2) 1.4 V/m (3) 1.7 V/m (4) 2.6 V/m (5) 1.2 V/m

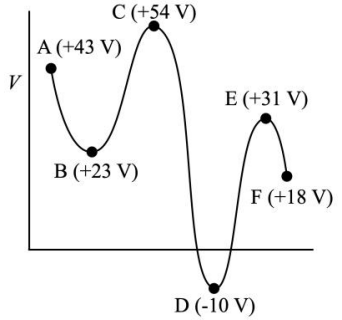
10. The $x$-component of electric field, $E_x$, changes with $x$-distance as shown in the graph. If potential at $x = 0$ is set to be zero, what is the potential at $x = 5$ m?

(1) $-11$ V
(2) $+11$ V
(3) $-13$ V
(4) $+13$ V
(5) 0 V



# Chapter 24 - Conservation of energy and electric potential

12. The figure shows the electric potential as a function of position. Consider now a particle with charge $-1\mu$C moving to the left from position E in the figure. How much kinetic energy does it need to reach B? (Note that the charge is negative!)




(1) ♣ 41 $\mu$J (2) 23 $\mu$J (3) 12 $\mu$J (4) 8 $\mu$J (5) 0

11. A proton located at $x = 1.5$ m is released along the positive $x$ direction in an electric potential of the form $V(x) = 6 - 1/x$ ($x$ in meters and $V$ in volts). What is the initial speed of the proton if it travels 1.0 m before turning back?

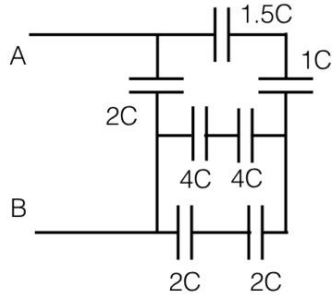
(1) 7.1 km/s (2) 24.8 km/s (3) 33.4 km/s (4) 2.0 km/s (5) 137.3 km/s

12. An electric field $\mathbf{E} = 4000\hat{\mathbf{i}} - 5000\hat{\mathbf{j}}$ V/m is created in a region. The potential at $(x, y) = (4, 5)$ is 25,000 V. What is the change in electric potential energy of a proton (in units of $10^{-15}$ J) as it moves from $(x, y) = (4, 5)$ to $(3, 2)$? (Units are meters)

(1) $-1.8$ (2) $-3.0$ (3) $+1.4$ (4) $+5.0$ (5) 0

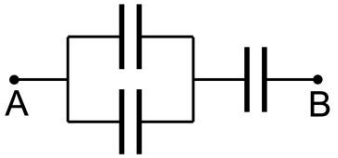
# Chapter 25 - Capacitors

15. Calculate the effective capacitance between points A and B in this multi-capacitor circuit. Use $C = 2\,\mu\text{F}$.




(1) ♣ 5 $\mu$F (2) 7.5 $\mu$F (3) 10 $\mu$F (4) 8 $\mu$F (5) 1.6 $\mu$F

16. In the figure at the right, all three capacitors have a capacitance of 1 $\mu$F. If the difference of potentials between points A and B is 9 V, what is the energy stored at the top-left capacitor in the circuit?



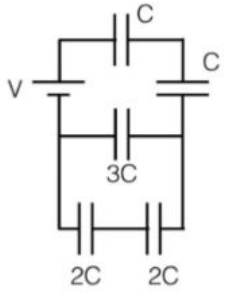

(1) ♣ 4.5 $\mu$J (2) 6.0 $\mu$J (3) 9.0 $\mu$J (4) 18 $\mu$J (5) 27 $\mu$J

# Chapter 25 - Capacitors

14. An air-filled parallel-plate capacitor has a capacitance of 3 pF. The plate separation is then tripled and a wax dielectric is inserted, completely filling the space between the plates. As a result, the capacitance becomes 6 pF. The dielectric constant of the wax is:

(1) 6.0 (2) 0.33 (3) 2.0 (4) 0.5 (5) 8.0

15. The figure shows an arrangement of five capacitors connected to a battery with a potential difference of $V$. What is the charge on the $3C$ capacitor?




(1) $\frac{1}{3}CV$
(2) $\frac{1}{9}CV$
(3) $\frac{4}{9}CV$
(4) $\frac{5}{9}CV$
(5) $\frac{2}{3}CV$

16. A parallel plate capacitor with capacitance $C = 20$ nF is charged by a battery to a potential difference of 20 V. The battery is now disconnected and the capacitor is filled with a dielectric with $\kappa = 8.0$. What is the final energy stored in the capacitor?

(1) 500 nJ (2) 250 nJ (3) 1.0 $\mu$J (4) 1.6 $\mu$J (5) 1.2 $\mu$J

17. Capacitors $C_1 = 5\,\mu$F and $C_2 = 10\,\mu$F are connected in series across a battery of $V = 100$ volts until fully charged. The battery is then carefully removed and $C_1$ and $C_2$ are connected together, + plate to + plate and − plate to − plate. After equilibrium is reached, what is the potential difference across $C_1$?

(1) 44 V (2) 67 V (3) 50 V (4) 100 V (5) 0 V

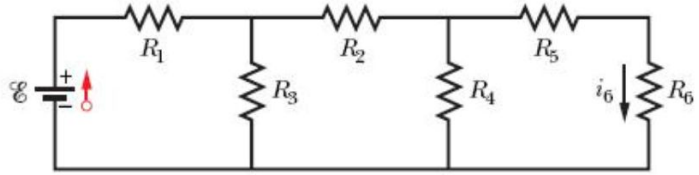
# Exam 2 Material

Chapter 27 - Chapter 31

# Chapter 27 - Resistors and Ohm's Law

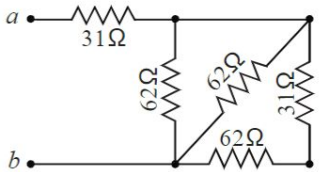
Question 4 of 10 ‹ › 1 / 1

In the figure the current in resistance 6 is $i_6 = 1.31$ A and the resistances are $R_1 = R_2 = R_3 = 1.71\ \Omega$, $R_4 = 16.6\ \Omega$, $R_5 = 8.53\ \Omega$, and $R_6 = 3.31\ \Omega$. What is the emf of the ideal battery?



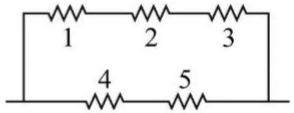

Number 41.74 Units V

1. Find the equivalent resistance in ohms of the five resistors connected as shown in the figure.




(1) 54
(2) 248
(3) 108
(4) 124
(5) 9

1. The figure shows a circuit of five resistors that are connected to a larger circuit. Resistors 1 and 2 are identical, as are resistors 4 and 5. The potential difference across resistor 1 is 1.3 V, and that across resistor 4 is 2.4 V. If the resistance of resistor 3 is 320 Ω and that of resistor 4 is 450 Ω, what is the resistance of resistor 1 (in Ω)?

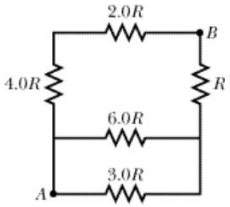



(1) 190 (2) 370 (3) 660 (4) 510 (5) 780

# Chapter 27 - Single loop circuit with Kirchhoff's law

Question 10 of 10 < > 1 / 1

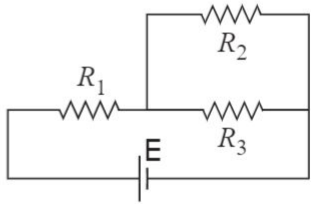
In the figure $R = 9.0\ \Omega$. What is the equivalent resistance between points A and B? (*Hint*: This circuit section might look simpler if you first assume that points A and B are connected to a battery.)




Number 18 Units Ω

1. In the figure, $\mathcal{E} = 18.0$ V, $R_1 = 2.0\ \text{k}\Omega$, $R_2 = 6.0\ \text{k}\Omega$, and $R_3 = 12.0\ \text{k}\Omega$. What is the power dissipated in $R_2$, in mW?

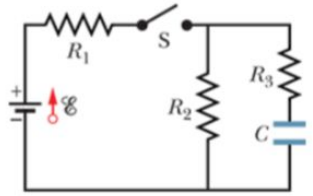
♣(1) 24
(2) 56
(3) 74
(4) 12
(5) 35



# Chapter 27/30 - RC or RL Circuit

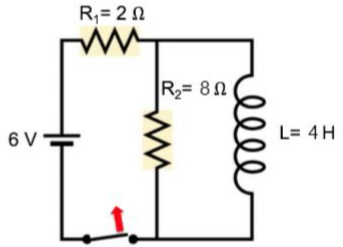
4. In the figure, $\mathcal{E} = 3.0$ V, $C = 500\mu$F, $R_1 = 1.0$ kΩ, $R_2 = 2.0$ kΩ and $R_3 = 5.0$ kΩ. At t = 0 the switch is closed. After a long enough time for the capacitor to become fully charged, what will be its final charge, in mC?

(1) 1
(2) 7
(3) 11
(4) 20
(5) 130



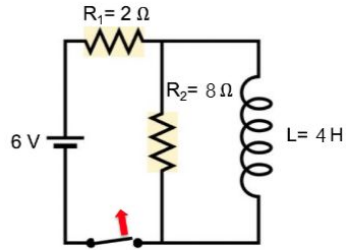

17. The switch in the circuit shown in the figure has been closed for a long time. What is the difference of potentials across resistor $R_2$ at the first instance after someone opens the switch?

♣(1) 24 V
(2) 12 V
(3) 6 V
(4) 2 V
(5) 0 V



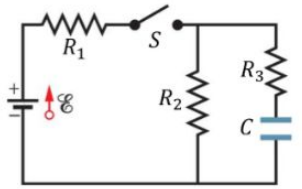

9. Consider the circuit shown in the figure. What is the voltage across resistor $R_2$ a long time after the switch is closed?

(1) 0 V
(2) 12 V
(3) 1.2 V
(4) 4.8 V
(5) 6.0 V



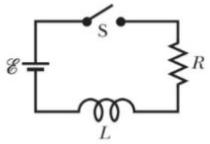
# Chapter 27/30 - RC or RL Circuit

1. In the figure, $\mathcal{E} = 6$ V, $R_1 = R_2 = R_3 = 100\ \Omega$, and $C = 50\ \mu$F. The capacitor is initially uncharged. What is the current through resistor $R_2$ instantaneously after switch $S$ is closed, in mA?




(1) 20 (2) 16 (3) 12 (4) 8 (5) 4

14. In the figure, $\mathcal{E} = 30$ V, $R = 1.0\ \Omega$, and $L = 1.0$ mH. How much energy, in joules, is stored in the inductor 1.0 ms after switch $S$ is closed?

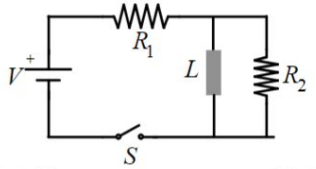



(1) 0.18 (2) 0.22 (3) 0.26 (4) 0.10 (5) 0.14

15. A series LR circuit includes a 9.0 V battery, a resistance of 0.5Ω, and an inductance of 0.800 H. What is the greatest energy stored by the inductor after the switch is closed?

(1) 130 J (2) 33 J (3) 162 J (4) 20 J (5) 15 J

16. In the RL circuit shown, $L = 7.0$ mH, $R_1 = 5.0\ \Omega$ and $R_2 = 10.0\ \Omega$ and $V = 18.0$ V (DC). After the switch $S$ has been closed for a very long time, it is opened. What is the voltage across $R_2$ immediately after $S$ is opened?

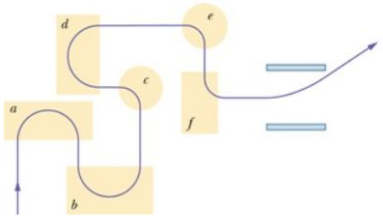



(1) 36 V (2) 12 V (3) 9.0 V (4) 6.0 V (5) 0

# Chapter 28 - Right hand rule for force

Question 1 of 10 < > 1 / 1

The figure shows the path of a particle through six regions of uniform magnetic field, where the path is either a half-circle or a quarter-circle.




Upon leaving the last region, the particle travels between two charged, parallel plates and is deflected toward the plate of higher potential. What is the direction of the magnetic field in each of the six regions?

a: Into the page

b: Out of the page

c: Out of the page

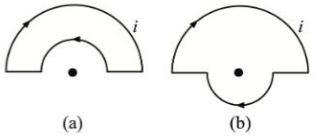
d: Into the page

e: Into the page

f: Out of the page

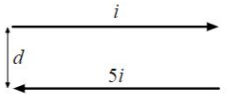
# Chapter 29 - Magnetic Field for Loops and Wires of Current

9. The figure shows two configurations of loops with identical currents. Each loop consists of a larger semicircle of radius 20 cm, a smaller concentric semicircle of radius 13.3 cm, and two straight segments. The magnitude of the magnetic field produced at the center marked by the dot is 25 $\mu$T in configuration (b). What is the magnitude of the magnetic field at the center marked by the dot in configuration (a)?



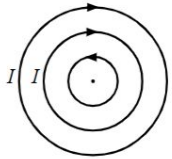

(1) 5.0 $\mu$T (2) 10.0 $\mu$T (3) 2.0 $\mu$T (4) 25 $\mu$T (5) 50 $\mu$T

10. Two long parallel wires separated by $d = 12$ cm are shown with the currents indicated. Where does the net B field from both wires have the same magnitude but opposite direction as the B field from the upper wire alone?




(1) 8 cm above upper wire
(2) 4 cm above upper wire
(3) 4 cm below upper wire
(4) 4 cm above lower wire
(5) 3 cm above upper wire

11. Three concentric circular current loops of radius $r$, $2r$ and $3r$ carry currents in the directions shown. The total B field at the center is 0. If the current in each of the outermost loops is $I = 30$ A, what is the magnitude of the current in the innermost loop?

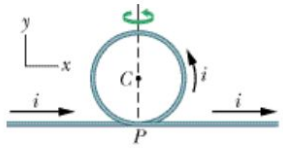



(1) 25 A (2) 20 A (3) 10 A (4) 5.0 A (5) 30 A

# Chapter 29 - Magnetic Field for Loops and Wires of Current

Question 3 of 10 < > 1 / 1

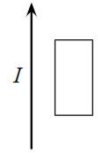
In the figure, part of a long insulated wire carrying current $i$ = 8.87 mA is bent into a circular section of radius $R$ = 1.32 cm. What are **(a)** the $x$-component, **(b)** the $y$-component, and **(c)** the $z$-component of the magnetic field at the center of curvature $C$ if the circular section lies in the plane of the page as shown? What are **(d)** the $x$-component, **(e)** the $y$-component, and **(f)** the $z$-component of the magnetic field at the center of curvature $C$ if the circular section is perpendicular to the plane of the page after being rotated 90° counterclockwise as indicated?




| | | | | | | | |
|---|---|---|---|---|---|---|---|
| (a) | Number | 0 | Units | T | (c) | Number | 5.566e-7 | Units | T |
| (b) | Number | 0 | Units | T | (d) | Number | 4.222e-7 | Units | T |
| | | | | | (e) | Number | 0 | Units | T |
| | | | | | (f) | Number | 1.344e-7 | Units | T |

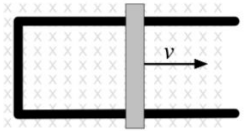
# Chapter 30 - Induction

13. A conductive loop is placed next to a wire carrying current $I$ as shown. If the current is decreasing, what is the direction of the force on the loop?



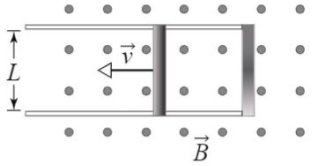

(1) left
(2) right
(3) up
(4) down
(5) The net force is zero.

16. A rod of length $L$ with resistance $R$ lies across frictionless conducting rails in a constant uniform magnetic field B, as shown. Assume the rails have negligible resistance. The rod is pulled to the right by a person with constant power P . After a long time, what is the resulting speed of the rod?



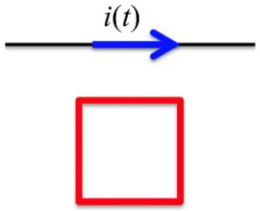

(1) $\sqrt{RP}/BL$ (2) $P/RBL$ (3) $P/RB^2L^2$ (4) $R/PBL$ (5) $\sqrt{BP}/RL$

15. In the figure shown, a metal rod is pulled at a constant velocity along two parallel metal rails, connected with a strip of metal at one end. A magnetic field of magnitude $\vec{B} = 1.0$ T points out of the page. If the metal rod has a length $L = 0.25$ m and a resistance of 0.3 Ω, what is the force necessary (in N) to pull the rod with a velocity of 2 m/s? The rails and connector have negligible resistance.




♣(1) 0.4 (2) 0.25 (3) 0.8 (4) 0.03 (5) 2.0

16. A square loop made of conductive material is placed near a wire carrying a current as shown in the figure. The current in the wire flows to the right and decreases. What is the direction of the net force on the loop?

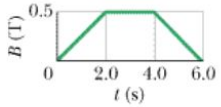



♣(1) up
(2) down
(3) right
(4) left
(5) the net force is zero

# Chapter 30 - Induction

Question 1 of 10 < > 1 / 1

A wire loop of radius 17 cm and resistance 7.4 Ω is located in a uniform magnetic field that changes in magnitude as given in the figure. The loop's plane is perpendicular to the magnetic field. What is the magnitude of the emf in volts induced in the loop during the time intervals **(a)** $t$ = 0 to 2.0 s; **(b)** 2.0 s to 4.0 s; and **(c)** 4.0 s to $t$ = 6.0 s?




(a) Number 0.0227 Units V

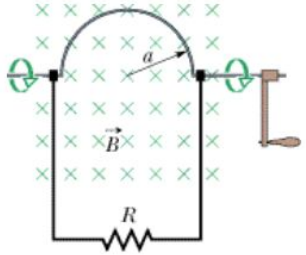
(b) Number 0 Units V

(c) Number 0.0227 Units V

# Chapter 30 - Induction

Question 4 of 10 < > 1 / 1

In the figure, a stiff wire bent into a semicircle of radius $a$ = 5.4 cm is rotated at constant angular speed 50 rev/s in a uniform 14 mT magnetic field. What are the **(a)** frequency and **(b)** the amplitude of the emf induced in volts in the loop?




**(a)** Number 50 Units Hz

**(b)** Number 2.01458e-2 Units V

# Chapter 31 - LC Circuit

17. A $15\,\mu$F capacitor in an oscillating LC circuit stores a maximum energy of $20\,\mu$J. If the resonance frequency of the circuit is $f_0 = 3\,$kHz, what is the maximum current in mA through the inductor?

(1) 462 (2) 624 (3) 327 (4) 57 (5) 212

18. An $LC$ circuit has a capacitance of 30 $\mu$F and inductance of 60 mH. At time $t = 0$ the charge on the capacitor is 10 $\mu$C and the current is 20 mA. The maximum charge on the capacitor is:

♣(1) 29 $\mu$C (2) 10 $\mu$C (3) 12 $\mu$C (4) 19 $\mu$C (5) 24 $\mu$C

Question 2 of 10 < > 1 / 1

An oscillating *LC* circuit consisting of a 0.94 nF capacitor and a 3.9 mH coil has a maximum voltage of 4.1 V. What are **(a)** the maximum charge on the capacitor, **(b)** the maximum current through the circuit, **(c)** the maximum energy stored in the magnetic field of the coil?

**(a)** Number 3.854 Units nC

**(b)** Number 0.0020129 Units A

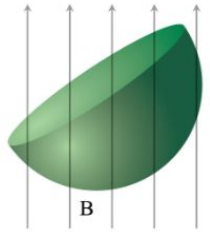
**(c)** Number 7.9 Units nJ

# Exam 3 New Material

Chapter 32 - Chapter 36

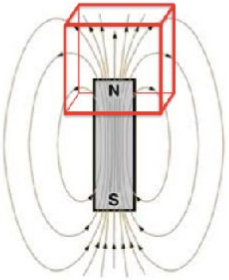
# Chapter 23/32 - Magnetic and electric flux through a surface (Gauss' Law)

11. A hemispherical volume of diameter 80 cm is placed in a constant B field of magnitude 3.0 T pointing vertically upward as shown. The flat face normal is 40° from vertical. What is the magnetic flux through the curved surface?




(1) $-1.16\ \mathrm{T{\cdot}m^2}$
(2) $-0.97\ \mathrm{T{\cdot}m^2}$
(3) $+2.31\ \mathrm{T{\cdot}m^2}$
(4) $-1.94\ \mathrm{T{\cdot}m^2}$
(5) $+0.97\ \mathrm{T{\cdot}m^2}$

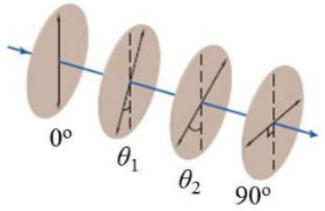
11. The north pole of a magnet is enclosed by a Gaussian surface in the form of a cube. The magnetic flux is $0.5\,\mathrm{Tm^2}$ through the top face of the cube and $-2.5\,\mathrm{Tm^2}$ through the bottom face. If the fluxes through each of the four side faces are identical to each other, what is the magnetic flux (in $\mathrm{Tm^2}$) through one of those side faces?




(1) 0.5
(2) 2.0
(3) $-2.0$
(4) 3
(5) $-3$

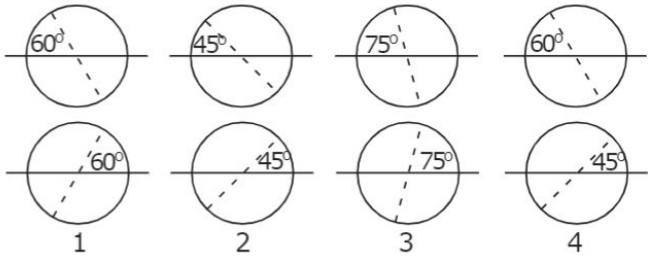
# Chapter 33 - Polarization

14. Unpolarized light is incident on four polarizing sheets with their transmission axes oriented as shown in the figure, where $\theta_1 = 25°$ and $\theta_2 = 45°$. All angles are between the transmission axis and the vertical, and are not necessarily drawn to scale. What percentage of the initial light intensity is transmitted through this set of polarizers?




(1) 18.1% (2) 36.2% (3) 30.1% (4) 10.3% (5) 20.5%

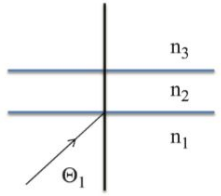
14. The diagrams show four pairs of polarizing sheets, with the polarizing directions indicated by dashed lines. The two sheets of each pair are placed one behind the other and the front sheet is illuminated by unpolarized light. The incident intensity is the same for all pairs of sheets. Rank the pairs according to the intensity of transmitted light, least to greatest.




(1) 2, 4, 1, 3 (2) 4, 2, 1, 3 (3) 2, 4, 3, 1 (4) 1, 2, 3, 4 (5) 3, 1, 4, 2

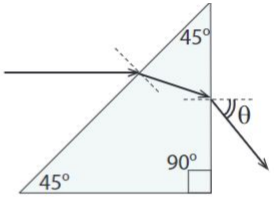
# Chapter 33 - Refraction

16. A light ray traveling in a material with index of refraction of $n_1$ is incident onto a stack of two other materials with indices of refraction $n_2$ and $n_3$, respectively, as shown in the diagram. The light ray has an angle of incidence of $\theta_1 = 45°$ in material $n_1$. What angle does the light ray make relative to the normal when it is inside material $n_3$? ($n_1 = 1.1$, $n_2 = 1.3$, $n_3 = 1.4$).




(1) 34° (2) 30° (3) 37° (4) 84° (5) 73°

18. A ray of light traveling horizontally enters a prism as shown in the figure. The index of refraction of the prism is $n = 1.4$, and the prism is surrounded by air. What is the value of the angle $\theta$ between the horizontal and the direction of the ray leaving the prism?

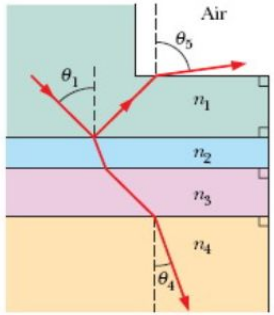



(1) 21° (2) 31° (3) 69° (4) 59° (5) 49°

# Chapter 33 - Refraction

Question 3 of 10 < > 1 / 1

In the figure, light is incident at angle $\theta_1 = 38^\circ$ on a boundary between two transparent materials. Some of the light travels down through the next three layers of transparent materials, while some of it reflects upward and then escapes into the air. If $n_1 = 1.28$, $n_2 = 1.42$, $n_3 = 1.32$ and $n_4 = 1.45$, what is the value of **(a)** $\theta_5$ and **(b)** $\theta_4$?




**(a)** $\theta_5$ = Number 52 Units ° (degrees)

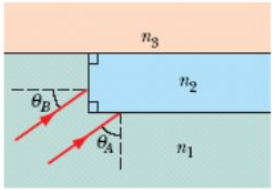
**(b)** $\theta_4$ = Number 32.9 Units ° (degrees)

# Chapter 33 - Refraction

Question 4 of 10 < > 1 / 1

In the figure, light from ray *A* refracts from material 1 ($n_1 = 1.66$) into a thin layer of material 2 ($n_2 = 1.80$), crosses that layer, and is then incident at the critical angle on the interface between materials 2 and 3 ($n_3 = 1.52$). **(a)** What is the value of incident angle $\theta_A$? **(b)** If $\theta_A$ is decreased, does part of the light refract into material 3?

Light from ray *B* refracts from material 1 into the thin layer, crosses that layer, and is then incident at the critical angle on the interface between materials 2 and 3. **(c)** What is the value of incident angle $\theta_B$? **(d)** If $\theta_B$ is decreased, does part of the light refract into material 3?




(a) Number 66.3 Units ° (degrees)

(b) yes

(c) Number 36.2 Units ° (degrees)

(d) no

# Chapter 34 - Single mirror

15. A dental hygienist uses a concave mirror to see the back of her patient's teeth. When the mirror is 2.5 cm from a tooth, the image is upright and 3.5 times as large as the tooth. What is the radius of curvature of the mirror?

(1) 7.0 cm (2) 3.7 cm (3) 2.0 cm (4) 3.5 cm (5) 4.0 cm

15. A makeup mirror has radius of curvature 54 cm. How far is the upright image from your face if it is 6 times larger?

(1) 158 cm (2) 45 cm (3) 315 cm (4) 22.5 cm (5) 135 cm

# Chapter 34 - Single mirror

Question 9 of 10 < > 1 / 1

*Spherical mirrors.* Object *O* stands on the central axis of a spherical mirror. For this situation object distance is $p_s$ = +20 cm, the type of mirror is concave, and then the distance between the focal point and the mirror is 11 cm (without proper sign). Find **(a)** the radius of curvature *r* (including sign), **(b)** the image distance *i*, and **(c)** the lateral magnification *m*. Also, determine whether the image is **(d)** real or virtual, **(e)** inverted from object *O* or noninverted, and **(f)** on the *same* side of the mirror as *O* or on the *opposite* side.

(a) Number 22 Units cm

(b) Number 24.4444 Units cm

(c) Number -1.2222 Units This answer has no units

(d) real

(e) inverted

(f) same

# Chapter 34 - Single mirror

Question 10 of 10 < > 1 / 1

*Spherical mirrors.* Object *O* stands on the central axis of a spherical mirror. For this situation object distance is $p_s$ = +18 cm, the type of mirror is convex, and then the distance between the focal point and the mirror is 34 cm (without proper sign). Find **(a)** the radius of curvature *r* (including sign), **(b)** the image distance *i*, and **(c)** the lateral magnification *m*. Also, determine whether the image is **(d)** real or virtual, **(e)** inverted from object *O* or noninverted, and **(f)** on the *same* side of the mirror as *O* or on the *opposite* side.

**(a)** Number -68 Units cm

**(b)** Number -11.77 Units cm

**(c)** Number 0.654 Units This answer has no units

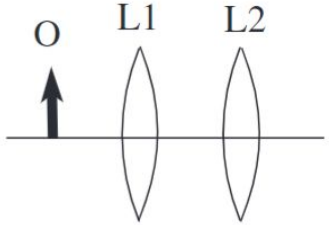
**(d)** virtual

**(e)** noninverted

**(f)** opposite

# Chapter 34 - System of two lenses

16. In the figure shown (not to scale), the focal lengths of the thin converging lenses, L1 and L2, are 20 cm and 10 cm, respectively. When object O is placed 30 cm to the left of L1, its image forms at 30 cm to the right of L2. What is the distance between the two lenses?

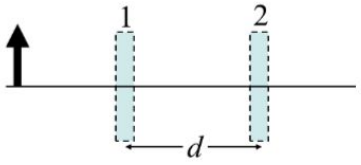



(1) 75 cm
(2) 30 cm
(3) 20 cm
(4) 50 cm
(5) 40 cm

16. Two identical converging lenses with a focal distance of $f = 8$ cm are separated by a distance of 16 cm. An object of 1-cm height is placed 2 cm in front of the two-lens package. What is the absolute value of the image height formed by the two lenses?

(1) 1 cm (2) 0.7 cm (3) 1.4 cm (4) 0.5 cm (5) 2 cm

43. Lens 1 (a converging lens) is placed $d = 15$ cm to the left of lens 2 (a diverging lens) such that the two lenses share their principal axes, as shown in the figure. The focal lengths of the lenses are 30 cm and 40 cm, respectively. If an object is placed 60 cm to the left of lens 1, where will the image form? Choose the closest answer. The figure is not to scale.




(1) 345 cm to the left of lens 1
(2) 85 cm to the left of lens 1
(3) halfway between the two lenses
(4) 20 cm to the right of lens 2
(5) 160 cm to the right of lens 2

# Chapter 35 - Interference with two slits

18. Two slits of width 0.5 $\mu$m and separation 0.12 mm are illuminated by a coherent beam of light of wavelength 600 nm. What is the linear separation of the bright interference fringes observed on a screen that is a distance 5 m away?

(1) 25 mm (2) 0.04 mm (3) 2.0 mm (4) 10 mm (5) 5.0 mm

Question 8 of 10 < > 1 / 1

The distance between the first and fifth minima of a single-slit diffraction pattern is 0.350 mm with the screen 37.0 cm away from the slit, when light of wavelength 540 nm is used. **(a)** Find the slit width. **(b)** Calculate the angle $\theta$ of the first diffraction minimum.

**(a)** Number 0.00228 Units m

**(b)** Number 0.0002368 Units rad

# Chapter 36 - Single slit diffraction

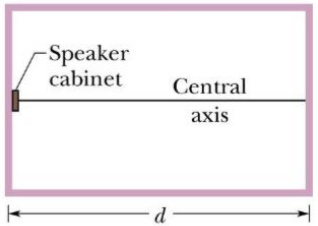
20. A single slit diffracts laser light of 612 nm onto a screen 3.0 m away. The distance between the third order minima (located on opposite sides of the central peak) is 8.0 mm. How wide is the slit?

(1) 1.4 mm (2) 0.92 mm (3) 0.69 mm (4) 1.1 mm (5) 0.46 mm

20. A slit 1.00 mm wide is illuminated by light of wavelength 450 nm. We see a diffraction pattern on a screen 2.00 m away. What is the distance between the first two diffraction minima on the same side of the central diffraction maximum?

(1) 0.90 mm (2) 0.45 mm (3) 1.35 mm (4) 1.80 mm (5) 2.25 mm

19. Sound waves with frequency 3000 Hz and speed 343 m/s diffract through the rectangular opening of a speaker cabinet and into a large auditorium of length $d = 100\,\text{m}$. The opening, which has a horizontal width of $W = 30\,\text{cm}$, faces a wall 100 m away. Along that wall, how far from the central axis will a listener be at the first diffraction minimum and thus have difficulty hearing the sound? (Neglect reflections.)




(1) 40 m (2) 25 m (3) 30 m (4) 20 m (5) 10 m

# Good luck!

I recommend studying additional problems; no promises that these questions will be exactly like the exam. Just make sure you know the material.