(Circle the Correct Response, or Make a Sketch):

30) At what angle do you observe the 4th order maximum relative to the central maximum when 400 nm light is incident normally on two slits separated by 0.025 mm ?

I) 1.83^0
II) 2.75^0
III) 3.67^0
IV) 4.13^0
V) 39.8^0

31) You notice that for a material with work function of $\Phi = 2.20\ eV$, a stopping potential of 0.800 V is needed in order to prevent electrons from leaving the surface when you bombard the material with light from a laser of unknown wavelength. What is the wavelength of the laser?

I) $\lambda = 1550\ nm$
II) $\lambda = 886\ nm$
III) $\lambda = 564\ nm$
IV) $\lambda = 451\ nm$
V) $\lambda = 413\ nm$

32) Estimate the uncertainty in the transverse momentum of a photon with $\lambda = 500\ nm$ after it passes through a single slit of width $a = 0.005\ mm$. (I'll accept 2 of these answers depending on your reasons)

I) about 0.25 eV/c
II) about 0.020 eV/c
III) about 2.5 eV/c
IV) about 25.0 eV/c
V) about 0.0020 eV/c

33) An electron in a hyrogen atom in the $n = 3$ state makes a transition to the $n = 1$ state and a photon is emitted. What is the wavelength of this photon?

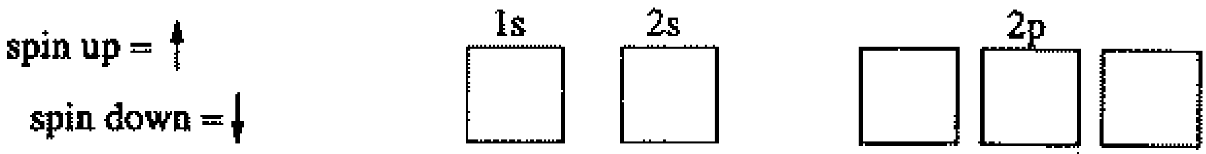
I) $\lambda = 91.2\ nm$
II) $\lambda = 103\ nm$
III) $\lambda = 137\ nm$
IV) $\lambda = 820\ nm$
V) $\lambda = 2480\ nm$

(Circle the Correct Response, or Make a Sketch):

34) Estimate the binding energy per nucleon for Zirconium. ($^{94}_{40}Zr$)

I) 8.665 MeV
II) 8.549 MeV
III) 8.448 MeV
IV) 814.5 MeV
V) 794.1 MeV

35) Please fill in a possible filling of the electronic states for Carbon(Z=6).



36) Which kind of radiation (assume an energy of about 1 MeV for each) is most likely to be absorbed quickly in air? (The quick absorbtion makes this kind of radiation useful for detecting changes in air density, like when there is smoke in the air...)

I) *alpha*
II) *beta*
III) *gamma*

37) On December 15, 1986, the physics department purchased a radioactive source with a half-life of 3.2 years and an activity of 10^5 Bq. What is the activity of this source today?

I) 10^5 Bq
II) 31000 Bq
III) 25000 Bq
IV) 6000 Bq
V) 60 Bq

Equations

$$\vec{F_{12}} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{r_{12}^2}\hat{r}_{12} \ (Point\ Charge) \ \vec{E} = \vec{F}/q_{test} = \frac{1}{4\pi\epsilon_0}\frac{q}{r_{12}^2}\hat{r}_{12}$$

$$\Phi = \oint \vec{E}\cdot d\vec{A} = \oint \vec{E}\cdot \hat{n} dA = \frac{q_{enclosed}}{\epsilon_0}, \qquad \Phi = E\,A\ (special\ cases)$$

$$(Sphere)\ A = 4\pi r^2, (Cylinder)\ A = 2\pi r L, (Sheet)\ A = L^2 + L^2 (two\ sides)$$

$$\vec{F} = m\vec{a}, \qquad x = x_0 + v_{0x}t + \frac{1}{2}a_x t^2, \qquad v_x = v_{0x} + a_x t$$

$$-\Delta U = W = \int \vec{F}\cdot d\vec{s}, \qquad Kinetic\ Energy = \frac{1}{2}mv^2$$

$$\vec{F}_{total} = \sum_i \vec{F}_i \qquad \vec{E}_{total} = \sum_i \vec{E}_i \qquad V_{total} = \sum_i V_i$$

$$Q = CV, \qquad U = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}, \qquad C = \kappa C_0, \quad E = \frac{E_0}{\kappa}, \quad \epsilon = \kappa\epsilon_0$$

$$-(V_{s2} - V_{s1}) = \int_{s1}^{s2} \vec{E}\cdot d\vec{s}, \qquad E_x = -\frac{\partial V}{\partial x},\ E_y = -\frac{\partial V}{\partial y},\ E_z = -\frac{\partial V}{\partial z},$$

$$C = \frac{\epsilon_0 A}{d}\ Parallel\ Plate$$

$$C = \frac{2\pi\epsilon_0 L}{ln(b/a)}\ Cylindrical$$

$$C = 4\pi\epsilon_0\frac{ab}{a-b}\ Spherical$$

Constants

$\epsilon_0 = 8.85\times10^{-12}\ \frac{F}{m}$ $\qquad$ $\epsilon_0 = 8.85\times10^{-12}\ \frac{C^2}{Nm^2}$

$e = 1.60\times10^{-19}\ C$ $\qquad$ $M_{electron} = 9.11\times10^{-31}\ kg$

$M_{proton} = 1.67\times10^{-27}\ kg$ $\qquad$ $k = \frac{1}{4\pi\epsilon_0}$

Equations

$$I = \frac{dq}{dt}, \quad I = \int \vec{J} \cdot d\vec{A}, \quad V = IR, \quad R = \frac{\rho l}{A}, \quad \rho = \frac{1}{\sigma}$$

$$\rho - \rho_0 = \rho_0 \alpha (T - T_0), \quad \rho = \frac{m}{e^2 n \tau}, \quad P = IV$$

$$R = R_1 + R_2 + R_3 \ldots \; , \quad \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots$$

$$(charging) \quad Q = Q_0 (1 - e^{-\frac{t}{RC}}), \quad \tau = RC, \quad CV = Q, \quad I = \frac{V}{R} e^{-\frac{t}{RC}}$$

$$(discharging) \quad Q = Q_0 e^{-\frac{t}{RC}}, \quad I = -\frac{Q_0}{RC} e^{-\frac{t}{RC}}$$

$$\vec{F} = q\vec{v} \times \vec{B}, \quad n = \frac{BI}{Vle}, \quad qvB = \frac{mv^2}{r}, \quad \omega = 2\pi f, \quad \omega = \frac{v}{r}$$

$$\vec{F} = I\vec{l} \times \vec{B}, \quad d\vec{F} = Id\vec{l} \times \vec{B}, \quad \vec{\tau} = \vec{\mu} \times \vec{B}, \quad \vec{\tau} = \vec{r} \times \vec{F}$$

$$d\vec{B} = \left(\frac{\mu_0}{4\pi}\right) \frac{Id\vec{l} \times \vec{r}}{r^3} = \left(\frac{\mu_0}{4\pi}\right) \frac{Id\vec{l} \times \hat{r}}{r^2}, \qquad \oint \vec{B} \cdot \vec{ds} = \mu_0 I_{enclosed}$$

$$B = \frac{\mu_0 I}{2\pi r} \quad (infinite\ wire)$$

$$B = \frac{\mu_0 I \phi}{4\pi R} \quad (center\ of\ circular\ arc\ of\ angle = \phi)$$

$$B = \frac{\mu_0 I}{2R} \quad (center\ of\ whole\ loop)$$

$$B = \mu_0 n I \quad (solenoid)$$

$$B = \frac{\mu_0 N I}{2\pi r} \quad (toroid)$$

Constants

$\mu_0 = 4\pi \times 10^{-7} \frac{Tm}{A}$ $\qquad$ $\epsilon_0 = 8.85 \times 10^{-12} \frac{C^2}{Nm^2}$

$e = 1.60 \times 10^{-19}\ C$ $\qquad$ $M_{electron} = 9.11 \times 10^{-31}\ kg$

Equations

$$I = \frac{dq}{dt}, \quad I = \int \vec{J} \cdot d\vec{A}, \quad V = IR, \quad P = IV, \quad \vec{F} = m\vec{a}$$

$$\phi_B = \int \vec{B} \cdot d\vec{A}, \quad \epsilon = -\frac{d\phi_B}{dt}, \quad \phi_B = BA\ (sometimes), \quad \epsilon = -L\frac{dI}{dt}$$

$$(Increasing) \quad I = I_0(1 - e^{-t/\tau}), \quad \tau = L/R, \quad (decreasing) \quad I = I_0 e^{-t/\tau}$$

$$\vec{F} = I\vec{l} \times \vec{B}, \quad d\vec{F} = Id\vec{l} \times \vec{B}, \quad \phi_E = \int \vec{E} \cdot d\vec{A}$$

$$\oint \vec{E} \cdot d\vec{s} = -\frac{d\phi_B}{dt}, \quad \oint \vec{B} \cdot d\vec{s} = \mu_0\epsilon_0\frac{d\phi_E}{dt} + \mu_0 I_{enclosed}, \quad I_{Displacement} = \epsilon_0\frac{d\phi_E}{dt}$$

$$B = \mu_0 nI \quad (solenoid), \quad L = \mu_0 n^2 Al \quad (solenoid)$$

$$U_L = (1/2)\ LI^2, \quad U_C = (1/2)\ CV^2, \quad u_B = B^2/(2\mu_0), \quad u_E = \epsilon_0 E^2/2$$

$$c = E/B, \quad Pressure = S/c, \quad \vec{S} = (1/\mu_0)\ \vec{E} \times \vec{B}, \quad S_{av} = E_{max}B_{max}/(2\mu_0)$$

$$\vec{E} = \vec{E_0}\sin(kx - \omega t), \quad k = 2\pi/\lambda, \quad \omega = 2\pi f, \quad c_{vacuum} = \lambda f = 1/\sqrt{\epsilon_0\mu_0}$$

$$n_1 \sin\theta_1 = n_2 \sin\theta_2 \ \ (Snell's\ \ Law), \quad \sin\theta_c = n_2/n_1, \quad n = c/v, \quad n_1\lambda_1 = n_2\lambda_2$$

$$E = E_0 \cos\theta_{polarizer}, \quad I = I_0 \cos^2\theta_{polarizer}, \quad \theta_{polarizer} = \theta_E - \theta^{transmission}_{axis}$$

$$I_{unpolarized} \to I_{unpolarized}/2, \quad Work = \int \vec{F} \cdot d\vec{l} = Fl, \quad Power = \frac{dW}{dt} = Fv$$

Constants

$\mu_0 = 4\pi \times 10^{-7}\ \frac{Tm}{A}$
$\epsilon_0 = 8.85 \times 10^{-12}\ \frac{C^2}{Nm^2}$
$c = 3.0 \times 10^8\ m/s$
$g = 9.8\ m/s^2$

Equations

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{f}, \qquad M=-\frac{q}{p}=\frac{h'}{h}, \qquad M_{overall}=M_1\cdot M_2\cdot M_3...$$

$$|f|=|R/2|\ (mirror), \qquad \frac{n_1}{p}+\frac{n_2}{q}=\frac{n_2-n_1}{R}, \qquad \frac{1}{f}=(n-1)(\frac{1}{R_1}-\frac{1}{R_2})$$

$$d\sin(\theta) = m\lambda \quad Double\ slit$$

$$a\sin(\theta) = m\lambda \quad Single\ slit, \quad \theta_{res}=\frac{\lambda}{a}\ \ (slit), \quad \theta_{res}=1.22\,\frac{\lambda}{D}\ \ (hole)$$

$$d\sin(\theta) = m\lambda\ \ Diffraction\ grating, \quad Resolving\ Power,\ R=mN=\frac{\lambda}{\Delta\lambda}$$

$$\phi=0,2\pi,4\pi,6\pi... \quad Constructive\ Interference \quad \Delta x=0,\ \lambda,\ 2\lambda,\ 3\lambda...$$

$$\phi=\pi,3\pi,5\pi... \quad Destructive\ Interference \quad \Delta x=\lambda/2,\ 3\lambda/2,\ 5\lambda/2...$$

$$\phi=K_n\Delta x, \quad K_n=\frac{2\pi}{\lambda/n}, \qquad \phi=\pi\ \ (if\ n_1<n_2)\ \ \Delta x=\lambda/2$$

$$\lambda_{max}T=0.2898\times10^{-2}\ m\ K, \quad E=\frac{hc}{\lambda}=hf, \quad E_{threshold}=\Phi$$

$$KE_{max}=E_{photon}-\Phi, \qquad KE_{max}=eV_{stop}$$

$$\lambda_{scattered}-\lambda_{incident}=\frac{h}{m_ec}(1-\cos(\theta))$$

Constants

$h = 6.626\times10^{-34}\,J\ s$

$c = 2.9979\times10^{8}\ m/s$

$e = 1.6022\times10^{-19}\ C$

$m_e\,c^2 = 0.511\times10^{6}\ eV$

$hc = 1239.8\ eV\ nm$

$1\ eV = 1.6022\times10^{-19}J$

$M_{electron} = 9.11\times10^{-31}\ kg$

Equations

$$\Delta x \Delta p_x \geq \frac{h}{4\pi}, \quad \Delta E \Delta t \geq \frac{h}{4\pi}, \quad \lambda = \frac{h}{p} = \frac{h}{mv}(DeBroglie), \quad L = \frac{nh}{4\pi}(Bohr)$$

$$E_n = -\frac{Ke^2}{2a_o}\frac{1}{n^2}, \quad a_o = \frac{h^2}{(2\pi)^2 m_e K e^2}, \quad E_n = -\frac{13.6eV}{n^2}(Z-X)^2 (X\ for\ Screening)$$

$$\frac{1}{\lambda} = \frac{13.6eV}{hc}\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right), \quad \ell = 0, 1, 2, ...n-1, \quad m_\ell = -\ell, -\ell+1...\ell-1, \ell \quad m_s = \pm 1/2$$

$$r = r_o A^{1/3}, \quad A = Z + N, \quad {}^A_Z X, \quad E_{bind} = [Z \cdot M(H) + N \cdot M_n - M({}^A_Z X)]$$

$$\frac{dN}{dt} = -\lambda N, \quad R = \lambda N, \quad N = N_o e^{-\lambda t}, \quad R = R_o e^{-\lambda t}, \quad T_{1/2} = \ln(2)/\lambda$$

$$E = mc^2$$

Useful Masses of Particles and Isotopes

Quantity	Mass (u)
proton	1.007276
neutron	1.008665
electron	5.486×10^{-4}
${}^1_1H$	1.007825
${}^{12}_6C$	12.000000
${}^{94}_{40}Zr$	93.906450
${}^{140}_{58}Ce$	139.90532
${}^{197}_{79}Au$	196.966543
${}^{236}_{92}U$	236.045637

Constants

$a_o = 0.0528\ nm$
$1Ci = 3.7 \times 10^{10}\ decays/s$
$1Bq = 1\ decay/s$
$1u = 931.494\ MeV/c^2$

Physics 116b

Alternate Final Examination December 15,1999

Name:______________________________

I.D.#:______________________________

Please circle your section:

Section 5 6 7 8

Instructions

This is a two hour, closed book examination. Put answers in the boxes provided, circle the best answer, or draw a picture as indicated.

Any work needed to justify the answer you circled must be shown in the space provided. A correct answer circled without the necessary justifying work will receive only half credit! You may tear the formula sheets off the back of the exam.

Each problem is worth 2 points. Do what is easiest first. AVOID glancing at anyone else's paper during the exam!

Point Tallies for the Exam Problems

Max Score	Actual Score

I pledge that I have followed the honor code during this exam.

Signature:______________________________

(Circle the Correct Response, or Make a Sketch):

1) A +4.0 C (positive) charge and a -2.0 C (negative) charge are located 0.50 m apart from each other. What is the force on the +4.0 C (positive) charge due to the -2.0 C (negative) charge?

I) 7.2×10^{10} N and repulsive
II) 7.2×10^{10} N and attractive
III) 1.4×10^{11} N and repulsive
IV) 2.9×10^{11} N and attractive
V) 2.9×10^{11} N and repulsive

2) Two widely separated spheres, one with a radius of 1.0 cm and charge on its outer surface +q (Q_{small}=+q), and one sphere with a radius of 10.0 cm and *no* charge on its outer surface (Q_{big}=0), are connected by a thin wire, i.e. the wire forces them to be at the same potential. The charge on the big (r=10.0 cm) sphere *after* the spheres are connected by a thin wire is:

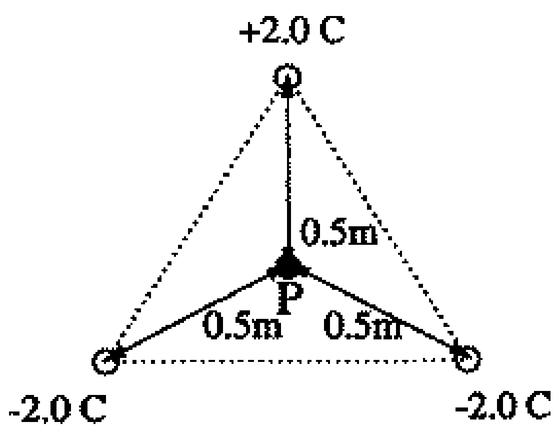
I) $Q_{big} = 0.50\ q$
II) $Q_{big} = 0.01\ q$
III) $Q_{big} = 1.0\ q$
IV) $Q_{big} = 0.91\ q$
V) $Q_{big} = 1.1\ q$

3) If a 10.0 kg particle with charge 3.0 C is placed in an electric field, $\vec{E} = 2.0\ (N/C)\ \hat{x}$, and then released, how fast is the particle moving after 5.0 s?(at $t = 0$ the particle is at rest)

I) $v = 3.0\ m/s$
II) $v = 9.0\ m/s$
III) $v = 15\ m/s$
IV) $v = 33\ m/s$
V) $v = 0.33\ m/s$

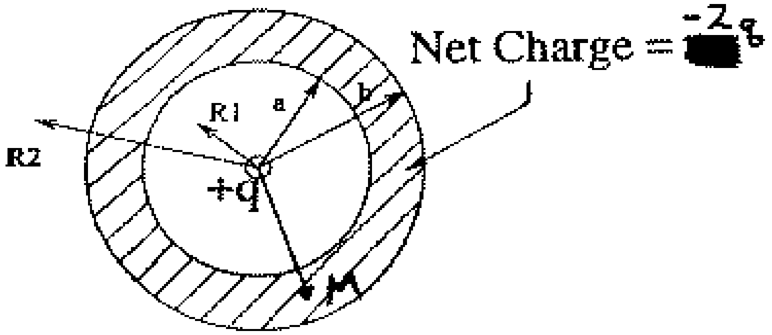
4) What is the electric potential at point P for the three charges in the figure, each of which is placed at one point of an equilateral triangle?

I) $V = 0.0\ Volts$
II) $V = -3.6 \times 10^{10}\ Volts$
III) $V = -7.2 \times 10^{10}\ Volts$
IV) $V = -1.1 \times 10^{11}\ Volts$
V) $V = -1.8 \times 10^{10}\ Volts$



(Circle the Correct Response, or Make a Sketch):

A charge of +q is in the center of a conducting spherical shell of inner radius a and outer radius b. This conducting shell has a net charge of -2q.



charge inside shell = +q
conducting shell net charge = -2q

5) What is the magnitude of the electric field at R_1, between the center and the inner surface of the shell? (Hint: How much charge would be enclosed by a Gaussian surface of radius R_1?)

I) $E = \frac{1}{4\pi\epsilon_0}\frac{-2q}{R_1^2}$
II) $E = 0$
III) $E = \frac{1}{4\pi\epsilon_0}\frac{2q}{R_1^2}$
IV) $E = \frac{1}{4\pi\epsilon_0}\frac{-q}{R_1^2}$
V) $E = \frac{1}{4\pi\epsilon_0}\frac{q}{R_1^2}$

6) What is the magnitude of the electric field at point M, inside the shell? (Hint: What is the electric field inside a conductor if there is NO changing B field?)

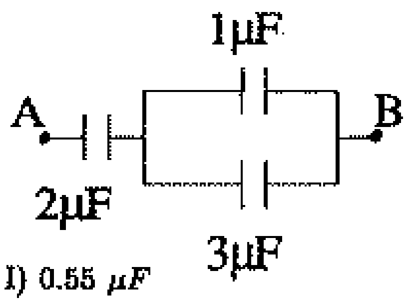
I) $E = \frac{1}{4\pi\epsilon_0}\frac{-2q}{M^2}$
II) $E = 0$
III) $E = \frac{1}{4\pi\epsilon_0}\frac{2q}{M^2}$
IV) $E = \frac{1}{4\pi\epsilon_0}\frac{-q}{M^2}$
V) $E = \frac{1}{4\pi\epsilon_0}\frac{q}{M^2}$

7) What is the magnitude of the electric field at R_2, outside the shell?(Hint: How much charge would be enclosed by a Gaussian surface of radius R_2? Try it, add them up!)

I) $E = \frac{1}{4\pi\epsilon_0}\frac{-2q}{R_2^2}$
II) $E = 0$
III) $E = \frac{1}{4\pi\epsilon_0}\frac{2q}{R_2^2}$
IV) $E = \frac{1}{4\pi\epsilon_0}\frac{-q}{R_2^2}$
V) $E = \frac{1}{4\pi\epsilon_0}\frac{q}{R_2^2}$

(Circle the Correct Response, or Make a Sketch):

8) Calculate the capacitance between points A and B.



I) 0.55 μF
II) 6.0 μF
III) 0.75 μF
IV) 2.75 μF
V) 1.33 μF

9) What is the gap between the plates of a parallel plate capacitor in air if the Area of the gap is 0.5 m^2 and the capacitance is 2.5×10^{-10} F?

I) 1.1×10^{-23} cm
II) 0.58 cm
III) 0.14 cm
IV) 1.8 cm
V) 7.1 cm

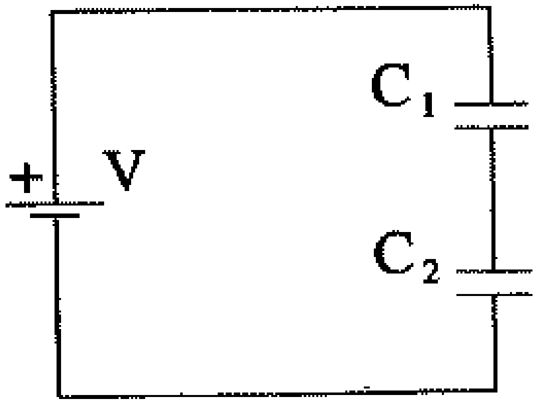
10) An isolated capacitor in air has a stored energy of 1.0×10^{-9} J. If we now insert a dielectric material of dielectric constant $\kappa = 1.3$ into the gap of the capacitor, what is the new stored energy of the capacitor? (Hint: Use charge conservation.)

I) 1.3×10^{-9} J
II) 0.77×10^{-9} J
III) 1.7×10^{-9} J
IV) 0.59×10^{-9} J
V) 1.0×10^{-9} J

11) What is the charge on C_2?

$C_1 = 10 \times 10^{-12} F$
$C_2 = 20 \times 10^{-12} F$
$V = 6.0 volts$

I) 6.0×10^{11} C
II) 3.0×10^{11} C
III) 1.2×10^{-10} C
IV) 6.0×10^{-11} C
V) 4.0×10^{-11} C

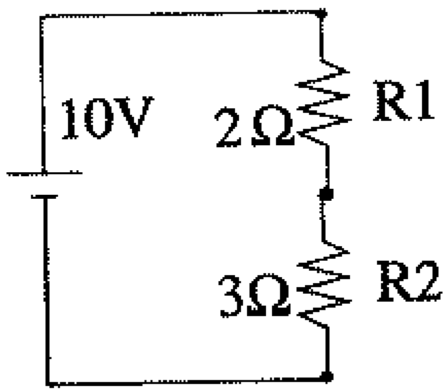


(Circle the Correct Response, or Make a Sketch):

12) What is the *resistivity* of a conducting wire of length 2.0 m, cross-sectional area of 1.0 mm^2, and resistance of 1.0Ω?

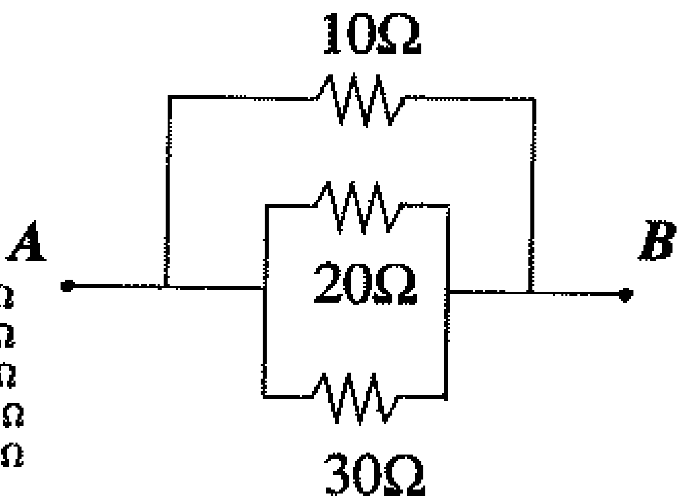
I) $20\ \Omega \cdot m$
II) $2.0 \times 10^{6}\ \Omega \cdot m$
III) $0.50 \times 10^{-6}\ \Omega \cdot m$
IV) $2.0 \times 10^{7}\ \Omega \cdot m$
V) $2.0\ \Omega \cdot m$

13) How much current passes through R2?



I) 1 A
II) 2 A
III) 3 A
IV) 4 A
V) 5 A

14) Calculate the resistance between points A and B.



I) 60 Ω
II) 17 Ω
III) 10 Ω
IV) 8.3 Ω
V) 5.5 Ω

15) A 12 Ω resistor dissipates 100 *Watts* when current flows through it. This resistor has how much voltage across it?

I) 4.0 *Volts*
II) 8.3 *Volts*
III) 35 *Volts*
IV) 49 *Volts*
V) 2400 *Volts*

(Circle the Correct Response, or Make a Sketch):

16) A magnetic field of 0.52 T makes an angle with respect to the velocity of a particle with charge 1.0×10^{-12} C traveling at 1000 m/s. If the magnitude of the force on the particle due to the magnetic field is $1.0 \times 10^{-10} N$, which of these angles best describes the angle of the magnetic field with respect to the particle velocity?

I) 1^0
II) 5^0
III) 11^0
IV) 20^0
V) 34^0

17) An electron is in a circular orbit in a magnetic field of 0.0000010 T. What is the magnitude of the angular frequency(ω) with which this particle rotates?

I) 6.0×10^{10} $rads/sec$
II) 0.11 $rads/sec$
III) 8.8 $rads/sec$
IV) 1.0×10^{-6} $rads/sec$
V) 1.8×10^{5} $rads/sec$

18) At what location from a very long wire is the magnetic field 0.000040 T if the wire carries a current of 10.0 A?

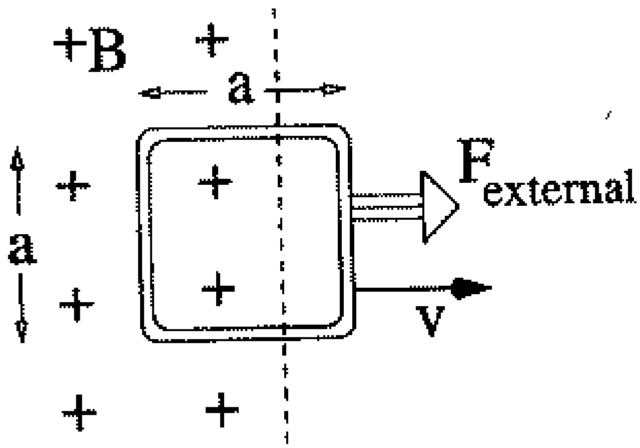
I) $r = 0.05$ m
II) $r = 0.31$ m
III) $r = 20$ m
IV) $r = 2000$ m
V) $r = 0.016$ m

19) What is the self inductance of a solenoid of length 2.0 m, area 0.01 m^2 and 10000 turns?

I) 100 $milli - Henrys$
II) 630 $milli - Henrys$
III) 310 $Henrys$
IV) 2.0 $micro - Henrys$
V) 25000 $Henrys$

(Circle the Correct Response, or Make a Sketch):

In the figure below, an external force is used to move a conducting loop of sides a and a resistance R through a magnetic field at a constant velocity v as shown. This produces an induced Emf in the loop, and a resulting current. If $R = 2.0\ \Omega$, $a = 0.5\ m$, $v = 10\ m/s$, and $B = 0.2\ T$ (into the page):



20) What direction is the current moving?

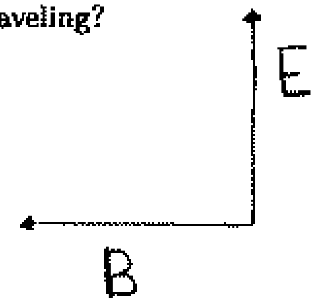
I) Clockwise
II) Counter-Clockwise
III) Out of the paper
IV) Into the paper
V) No Current!

21) What is the value of this current?

I) 0.5 *Amps*
II) 1 *Amps*
III) 2 *Amps*
IV) 10 *Amps*
V) 0 *Amps*

(Circle the Correct Response, or Make a Sketch):

22) In which direction is this ElectroMagnetic wave traveling?

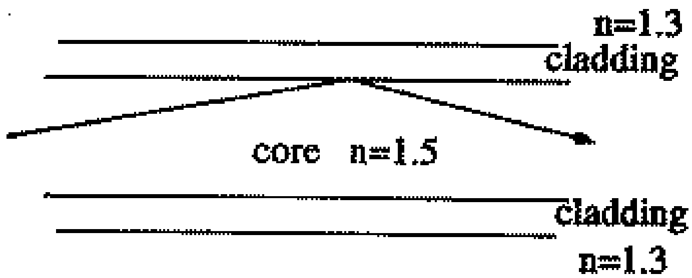


I) Up
II) Down
III) Into the Page
IV) Out of the Page

23) Light that has passed through a polarizer with its transmission axis oriented at 10^0 from the vertical direction has an intensity of I_1. This light then passes through a second polarizer oriented at 40^0 from the vertical direction. What is the intensity of the light after this second polarizer (I_{new})?

I) $I_{new} = 0.87\ I_1$
II) $I_{new} = 0.75\ I_1$
III) $I_{new} = 0.50\ I_1$
IV) $I_{new} = 0.25\ I_1$
V) $I_{new} = I_1$

24) What is the critical angle for total internal reflection for light traveling in the core (inner part) of an optical fiber if the core has an index of refraction of $n = 1.5$ and the cladding (outer covering) of the fiber has an index of refraction of $n = 1.3$?



I) $\theta = 30^0$
II) $\theta = 40^0$
III) $\theta = 42^0$
IV) $\theta = 50^0$
V) $\theta = 60^0$

25) A flying fish, under water (n=1.33), sees the sun at an apparent angle of 45^0 from the vertical. At what angle from the vertical does this fish see the sun when it "flies" above (n=1.00) the water?

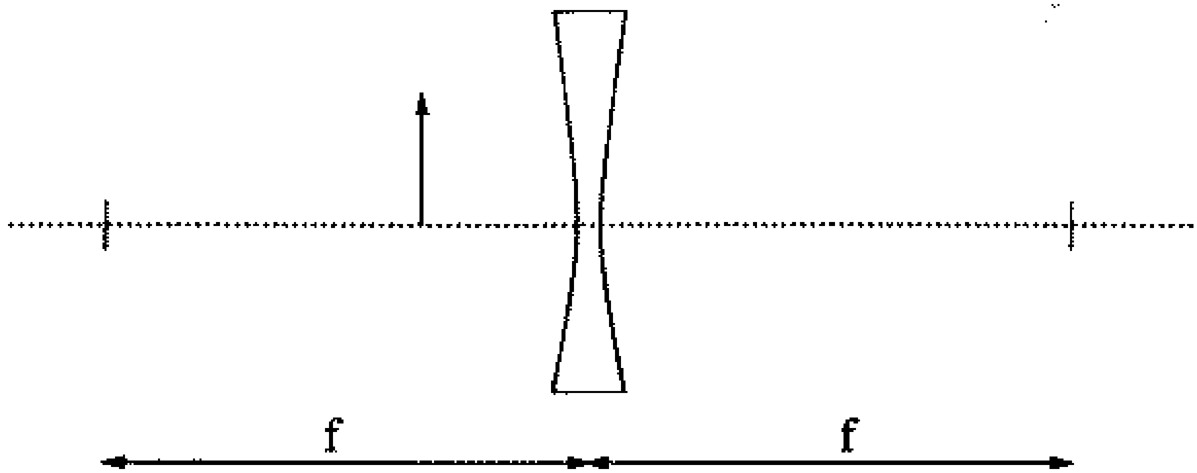
I) $\theta = 20^0$
II) $\theta = 32^0$
III) $\theta = 49^0$
IV) $\theta = 60^0$
V) $\theta = 70^0$

(Circle the Correct Response, or Make a Sketch):

26) What is the focal length of the lens in your eye when you can focus an object at your near point? (Assume that the distance from your lens to the back of your eye is 2.0 *cm*, that your near point is 15 *cm* in front of your lens, and that the liquid behind your lens has $n = 1.00$ just like the air in front of your lens.)

I) 2.0 *cm*
II) 23 *cm*
III) 17 *cm*
IV) 2.3 *cm*
V) 1.8 *cm*

27) Please find the image produced by the object and the diverging lens shown in the figure below using graphical methods(your ruler).



28) An object, 6.0 *m* in height, is located 25.0 *m* in front of a convex (diverging) mirror with radius of curvature $|R| = 20.0$ *cm*. What is the apparent size and orientation of the image produced by the mirror?

I) 210 *cm* erect
II) 2.4 *cm* erect
III) 2.4 *cm* inverted
IV) 4.8 *cm* erect
V) 4.8 *cm* inverted

29) At what distance are you theoretically able to just distinguish the two headlights from a car? Treat your eye like a pinhole camera. Assume your pupil has a diameter of 4.0 *mm*, the headlights are separated by 2.0 *m*, and the wavelength of light that comes from the headlights is 550 *nm*.

I) $L = 8200$ *m*
II) $L = 12000$ *m*
III) $L = 10000$ *m*
IV) $L = 18000$ *m*
V) $L = 2.00$ *m*