I. Optics

1) A convex spherical mirror has a focal distance |f|=1cm. An object is placed 3cm away. What is the image position, i? [5 points.]

(1) –1.5 cm

(2) –0.75 cm

(3) –1.2 cm

(4) 1.5 cm

(5) 0.75 cm

(6) –6 cm

(7) 6 cm

(8) 1.2 cm

(9) 3 cm

(10) None of the above

2) What is the magnification? [5 points.]

(1) -1
(2) 0.4
(3) 0.25
(4) –0.5
(5) –2
(6) –0.25
(7) 0.5
(8) –0.4
(9) 2
(10) None of the above

3) A plane mirror 1.5m tall stands vertically with its bottom 0.5m above the ground. A child stands 5m from the mirror with eye level at 1.2m above the ground. For objects placed 20m from the mirror, at what maximum height off the ground (for the object) will the child still be able to see (any part of) it through a reflection in the mirror? [10 points.]

(1) 4.4 m

(2) 4.8 m

(3) 2.4 m

(4) 1.5 m

(5) 20 m

(6) 1.2 m

(7) 3.2 m

(8) 2.8 m

(9) 5.2 m

(10) None of the above

4) A miniature pine tree is encased in a glass ball of index refraction, n=1.5. The radius of the ball is known to be 10cm. If viewed from the outside where n=1 the pine tree appears to be inside the glass ball at a distance of 8cm, what is its actual position, p? [10 points.]

(1) –8.57 cm

(2) 4.21 cm

(3) 20 cm

(4) 8.57 cm

(5) 40 cm

(6) –4.21 cm

(7) –20 cm

(8) –7.27 cm

(9) 7.27 cm

(10) None of the above

5) An object appears to reside on the bottom of a swimming pool at a depth of 2m when viewed at near normal incidence from above the water. If the index of refraction is 1.3, what is the actual depth of the object? [10 points.] Note that the air above the water has a refraction index of 1.

(1) 1.97 m

(2) 1.18 m

(3) 2 m

(4) 2.28 m

(5) 2.6 m

(6) 1.54 m

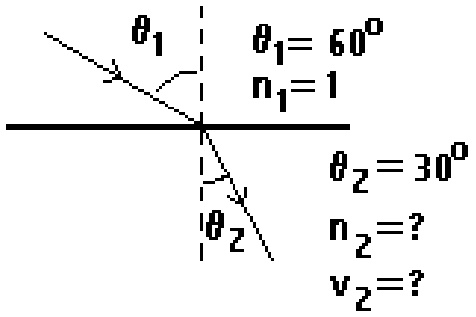
(7) 3.38 m

(8) 1.75 m

(9) 2.03 m

(10) None of the above

6) Light is incident at 60^o angle from normal from vacuum to an unknown medium. If the light travels at an angle of 30^o from normal in this medium, what is the speed of light in this medium? [10 points.]



(1) 1.73E8 m/s

(2) 3E8 m/s

(3) 1E8 m/s

(4) 6.9E8 m/s

(5) 9E8 m/s

(6) 2.1E8 m/s

(7) 5.2E8 m/s

(8) 1.3E8 m/s

(9) 1.5E7 m/s

(10) None of the above

7) For a double slit Young's experiment with a spacing, d, of 1.6mm, at a wavelength of 450nm what is the intensity relative to the central maximum intensity of the light at an angle of 0.002^{o} to the central maximum position? [5 points.]

(1) 0.925

(2) 6.81E−3

(3) 3.05E−4

(4) 0.506

(5) 0.017

(6) 0.856

(7) 0.42

(8) 1

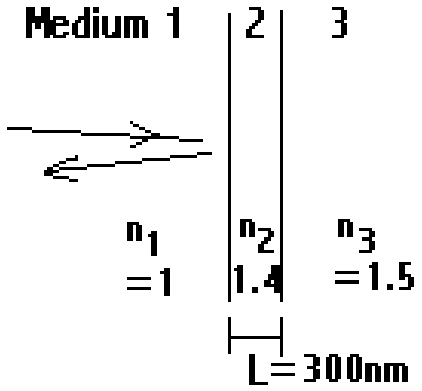
(9) 0.71

(10) None of the above

8) What is the wavelength of light which exhibits a 2^{nd} side maximum at this angle? [5 points.]

(1) 1600 nm
(2) 279 nm
(3) 18.6 nm
(4) 223 nm
(5) 22.3 nm
(6) 15.9 nm
(7) 1067 nm
(8) 27.9 nm
(9) 186 nm
(10) None of the above

9) Sunlight is reflected off of a camera lens with an anti-reflection coating of thickness, 300nm, and index of refraction, n_2=1.4. Given that the index of refraction of air, n_1 equals 1 and the index of refraction of the lens, n_3, equals 1.5, what wavelength of visible light is reflected with the minimum amount of reflection? [10 points.]



(1) 500 nm

(2) 560 nm

(3) 630 nm

(4) 336 nm

(5) 1680 nm

(6) 400 nm

(7) 682 nm

(8) 239 nm

(9) 660 nm

(10) None of the above

10) Sunlight with intensity of $2kW/m^2$ shines on a totally absorbing flat surface of area, $A=5m^2$. If the normal of the area vector makes an angle of 60^o with respect to the direction of the sunlight, what is the force on the surface due to the absorption of the sunlight? [10 points.]

(1) 1.67E−5 N

(2) 6.66E−5 N

(3) 3.33E−5 N

(4) 2.89E−5 N

(5) 2.36E−5 N

(6) 6.66E−8 N

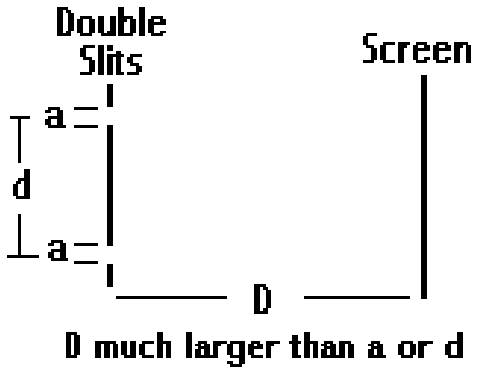
(7) 3.33E−8 N

(8) 4.71E−5 N

(9) 5.77E−5 N

(10) None of the above

11) A Young's double slit system consists of slit spacing, d=1mm, and slit width, a=0.8μm. What is the intensity of the light relative to the central maximum at an angle of 15^o from the central axis for 600nm light? [10 points.]



(1) 7.18E–3

(2) 0.064

(3) 3.03E–4

(4) 0.252

(5) 5.15E–5

(6) 0

(7) 0.112

(8) 1.57E–3

(9) 2.48E–6

(10) None of the above

12) A diffraction grating has a total width of 1mm and grating spacing of 2.5μm. What is the half width of the 2nd order diffraction line at a wavelength of 500nm? [5 points.]

(1) $5E{-}4^{o}$

(2) 0.0286^{o}

(3) 0.0313^{o}

(4) 12.5^{o}

(5) 1.15^{o}

(6) 11.4^{o}

(7) 2.18^{o}

(8) 2^{o}

(9) $5.46E{-}4^{o}$

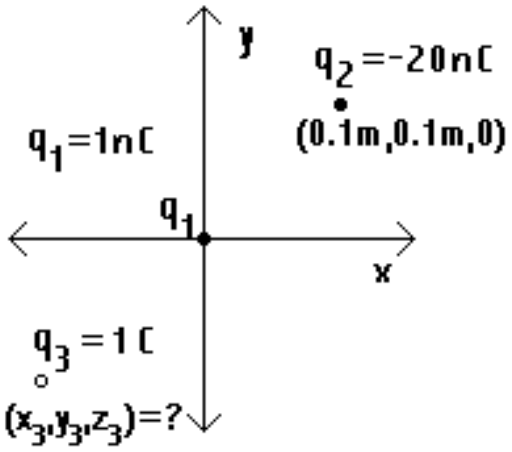
(10) None of the above

13) What is the resolving power of the grating for 2nd order diffraction? [5 points.]

(1) 50
(2) 4
(3) 900
(4) 2
(5) 100
(6) 2000
(7) 400
(8) 800
(9) 1000
(10) None of the above

II. Electricity and Magnetism

14) Two point charges, q_1=1nC and q_2=−20nC are located at (0,0,0) and (0.1m, 0.1m,0). A third point charge, q_3=1C, is placed in a position where it experiences no net force from the charges q_1 and q_2. What is its position? [10 points.]



(1) (5.26E−3m, −5.26E−3m,0)

(2) (−5.26E−3m, −5.26E−3m,0)

(3) (5.26E−3m, 5.26E−3m,0)

(4) (−0.082m, −0.082m,0)

(5) (−0.029m, −0.029m,0)

(6) (0.029m,0.029m,0)

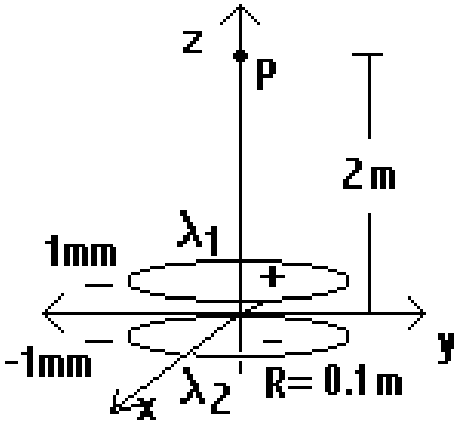
(7) (−5.26E−3m, 5.26E−3m,0)

(8) (0,−0.029m, −0.029m)

(9) (0.082m, 0.082m,0)

(10) None of the above

15) Two circular rings of radius R=0.1m containing uniform line charge densities λ_1=5mC/m and λ_2=–5mC/m reside parallel to the x-y plane at z_1=1mm and z_2=-1mm respectively, each centered about the z-axis. What is the electric field at point P on the z-axis where z=2m? [10 points.] Note that for a ring residing *in the x-y plane* centered about the z-axis, $\mathbf{E}=(zq)/\{4\pi\varepsilon_o[z^2+R^2]^{3/2}\}\ \mathbf{k}$ for a point at z on the z-axis.



(1) –2.23E4 V/m **k**

(2) 7.06E3 V/m **k**

(3) –1.40E4 V/m **k**

(4) 1.40E4 V/m **k**

(5) 7.06E3 V/m **k**

(6) 1.12E4 V/m **k**

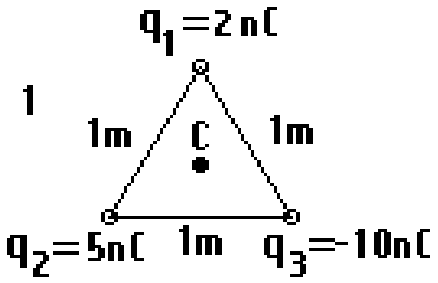
(7) 2.23E4 V/m **i**

(8) –1.12E4 V/m **k**

(9) 2.23E4 V/m **k**

(10) None of the above

16) Three point charges are placed at the corners of an equilateral triangle of sides 1m. q_1=2nC, q_2=5nC, and q_3=−10nC. What is the electric potential at the center? Note that the potential is taken to be zero infinitely far away. [10 points.]



(1) −265 V

(2) 9E−9 V

(3) −46.7 V

(4) −9E−9 V

(5) 5.19E−9 V

(6) −5.19E−9 V

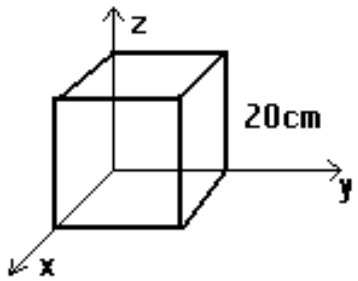
(7) −80.9 V

(8) 80.9 V

(9) 46.7 V

(10) None of the above

17) Given that the electric field is $\mathbf{E}=E_o(x/a)\mathbf{i}$ where $E_o=100$V/m and a=1cm. Find the net electric charge enclosed by a cubic box of sides 20cm residing with one corner at the origin as shown in diagram. [10 points.]



(1) –4.25 nC

(2) 42.5 μC

(3) 7.08 μC

(4) 6.76 mC

(5) –708 pC

(6) 708 pC

(7) 4.25 nC

(8) –7.08 μC

(9) –42.5 μC

(10) None of the above

18) A wire of rectangular cross section with sides 3mm by 8mm and 20m long has a total resistance of 2ohms. What is the resistivity of the wire material? [10 points.]

(1) 9.6E–4 Ω-m^3

(2) 6E–6 Ω/m

(3) 2.4 Ω-m

(4) 960 Ω-m^3

(5) 4.2E5 Ω^{-1}-m^{-1}

(6) 6 m/Ω

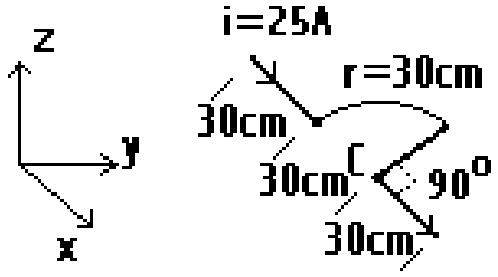
(7) 1.67E5 Ω^{-1}-m^{-1}

(8) 3.72E–5 Ω-m

(9) 2.4E–6 Ω-m

(10) None of the above

19) For the wire with the 3 straight segments and quarter-circular arc shown, where the radius of the arc is 30cm, what is the magnitude of the magnetic field at the arc "center", C, if a current of 25A passes through the wire? [10 points.]



(1) 1.31E−5 T

(2) 9.33E−3 T

(3) 6.5E−6 T

(4) 3.78E−3 T

(5) 2.27 T

(6) 4.54E−5 T

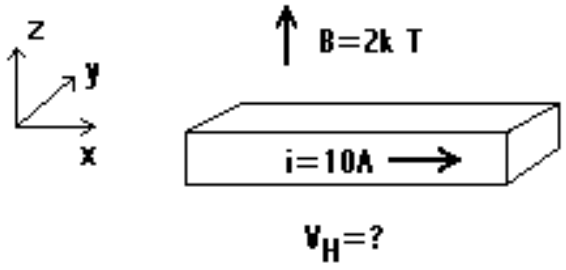
(7) 2.27E−5 T

(8) 2.27E−7 T

(9) 4.54E−7 T

(10) None of the above

20) What is the Hall voltage which develops in a conductor with a rectangular cross section of width 2mm (y-drection) and thickness 1mm (z-direction) when a current, i=10A passes through it in the +**i** (+x) direction along the wire in the presence of a magnetic field B=2**k** T? The conductor contains current carriers of charge –2e and carrier density of $4x10^{26}m^{-3}$. [10 points.]



(1) 3.13E–4 V; Hall voltage more positive in the +**j** direction.

(2) 3.13E–4 V; Hall voltage more positive in the – **j** direction.

(3) 1.56E–4 V; Hall voltage more positive in the + **j** direction.

(4) 1.56E–4 V; Hall voltage more positive in the – **j** direction.

(5) 3.13E–4 V; Hall voltage more positive in the +**k** direction.

(6) 3.13E–4 V; Hall voltage more positive in the –**k** direction.

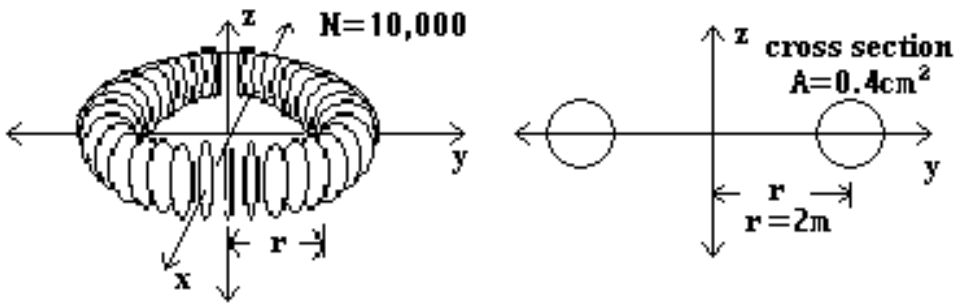
(7) 1.56E–4 V; Hall voltage more positive in the +**k** direction.

(8) 1.56E–4 V; Hall voltage more positive in the –**k** direction.

(9) 1.56E–4 V; Hall voltage more positive in the + **i** direction.

(10) None of the above

21) What is the inductance of a toroidal solenoid with a total of 10,000 turns and a circular cross sectional area of 0.4cm^2 and a toroid radius r of 2m? Note find the closest approximate answer. [10 points.]



(1) 251 nH

(2) 77.3 mH

(3) 28.3 nH

(4) 31.8 nH

(5) 2.51 mH

(6) 40 nH

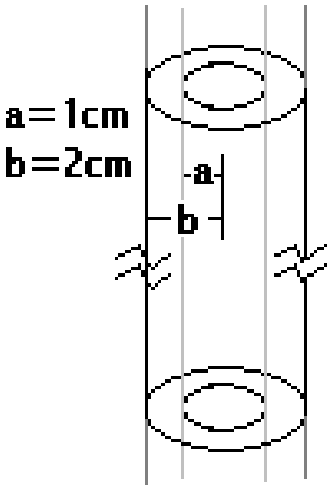
(7) 400 μH

(8) 318 H

(9) 283 μH

(10) None of the above

22) Two very long, concentric metallic cylinders form the electrodes of a capacitor. The cylinders have radii of 1cm and 2cm, respectively. What is the capacitance per meter in length? [5 points.]

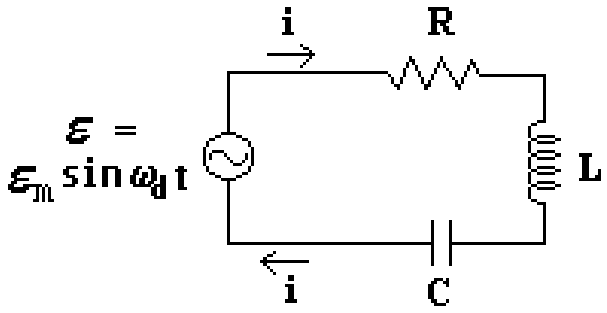


(1) 9.06 F/m
(2) 44.3 μF/m
(3) 33.5 nF/m
(4) 111 pF/m
(5) 55.6 pF/m
(6) 80.2 pF/m
(7) 8.12 mF/m
(8) 13.4 F/m
(9) 85.6 pF/m
(10) None of the above

23) A potential of 10V is applied to the conductors. What is the electric field energy density at a radius of 1.5cm, situated in between the cylinders? [5 points.]

(1) 1 mJ/m^3
(2) 4.09 $\mu J/m^3$
(3) 8.2 $\mu J/m^3$
(4) 8.1 mJ/m^3
(5) 8.5 nJ/m^3
(6) 4.26 nJ/m^3
(7) 7.7 $\mu J/m^3$
(8) 2.4 pJ/m^3
(9) 6.6 J/m^3
(10) None of the above

24) The series RLC circuit shown is driven to resonance. What is the amplitude of the current, I_m, given that the driving amplitude E_m=5V? R=10Ω, L=100μH, C=10μF. [10 points.]



(1) 0.354 A

(2) 0.423 A

(3) 1.26 A

(4) 500 A

(5) 0.5 A

(6) 0.043 A

(7) 36.1 A

(8) 0.645 A

(9) 0.306 A

(10) None of the above

Phys241 Final Exam KeyB
1) 2*
2) 3*
3) 9
4) 4
5) 5
6) 1
7) 6*
8) 8*
9) 2
10) 1
11) 7
12) 3*
13) 8*
14) 5
15) 4
16) 3
17) 6
18) 9
19) 1
20) 3
21) 7
22) 6*
23) 2*
24) 5