PHYS 223 University Physics III

GRADES 91
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Exam 2
February 9, 2023

Name J.C. Daly

1. Consider the parallel conducting plates shown in Figure 1. A battery maintains the upper plate at 10 volts relative to the lower plate. An electron starts at rest on the lower plate.

   What is its speed when it strikes the upper plate? 1.88×10^6 m/s

Figure 1

$\frac{1}{2}mv^2 = qV$

$v = \sqrt{\frac{2qV}{m}} = \sqrt{\frac{2 \times 1.6 \times 10^{-19} \times 10}{9.1 \times 10^{-31}}}$

$v = \sqrt{\frac{2 \times 1.6 \times 10 \times 10^{+12}}{9.1}}$

$= \sqrt{\frac{20 \times 1.6}{9.1} \times 10^{12}}$

$v = 1.88 \times 10^6$ m/s

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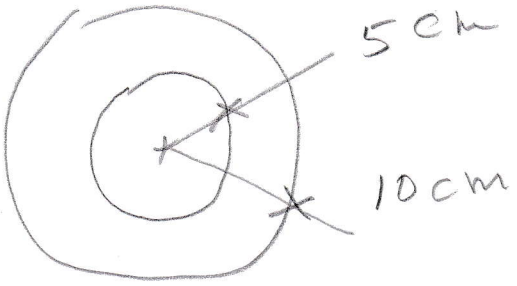
2. Two charged concentric spherical shells have radii 5.0 cm and 10.0 cm. The charge on the inner shell is 5.00×10^{-8} C, and that on the outer shell is -6.00×10^{-8} C. Find the electric field at

a. r = 4.0 cm 0 $Q_{enc} = 0$

b. r = 8.0 cm 7.02×10^4 N/C

c. r = 15.0 cm 0.399×10^4 N/C



a) for $r = 4.0$ cm

$Q_{enc} = 0$

b) $r = 8$ cm $Q_{enc} = 5 \times 10^{-8}$ C

Spherical Symmetry $E = \frac{Q_{enc}}{4\pi\varepsilon_0 r^2}$

$r = 0.08$ $Q_{enc} = 5 \times 10^{-8}$ C

$$E = \frac{5 \times 10^{-8}}{4\pi\, 8.854 \times 10^{-12} \times (0.08)^2}$$

$$E = \frac{5}{4\pi\, 8.854 \times (0.08)^2} \times 10^4 = 7.02 \times 10^4 \text{ N/C}$$

c) $Q_{enc} = 5 \times 10^{-8} - 6 \times 10^{-8} = -1 \times 10^{-8}$ C

$r = 0.15$ m

$$E = \frac{Q_{enc}}{4\pi\varepsilon_0 r^2} = \frac{-1 \times 10^{-8}}{4\pi\, 8.854 \times 10^{-12} \times (0.15)^2} =$$

$$E = \frac{-10^4}{4\pi\, 8.854} = 0.399 \times 10^4 \text{ N/C} = E$$

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Exam 1
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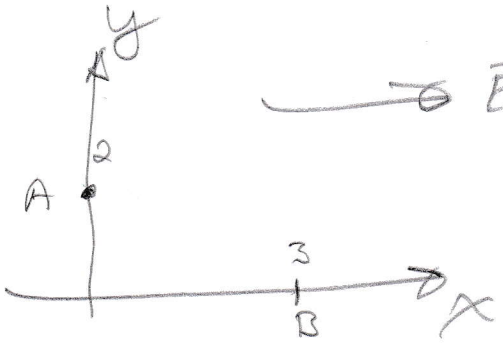
3. The electric field in a region of space has components $E_y = E_z = 0$ and $E_x = 4.00\ x^2$. Point A is on the y axis at y = 2.00 m, and point B is on the x axis at x = 3.00 m. What is the potential difference $V_B - V_A$?



$\vec{E} = 4x^2\hat{x}$

$$\Delta V = V_B - V_A = -\int \vec{E}\cdot d\vec{s}$$

$E = 4x^2$

$\vec{ds} = \hat{x}\,dx + \hat{y}\,dy$

$\vec{E}\cdot\vec{ds} = 4x^2\hat{x}\cdot(\hat{x}\,dx + \hat{y}\,dy) = 4x^2\,dx$

$$V_B - V_A = -\int_A^B E\cdot ds = -\int_0^3 4x^2\,dx = -\frac{4x^3}{3}\Big|_0^3$$

$V_B - V_A = -4*9 = -36\ V$

Physical Constants

Constant	Symbol	Magnitude
Avogadro's Number	N_A	6.022×10^{23} molecules/mole
Boltzmann's constant	k	1.38×10^{-23} J/K = 8.62×10^{-5} eV/K
Stefan-Boltzmann constant	s	5.67×10^{-8} J/(s*m^2*K^4)
Electronic charge	q	1.6×10^{-19} C
Electronvolt	eV	1.6×10^{-19} J
Planks constant	h	6.625×10^{-34} J-s
Thermal voltage, kT, at 300 ^oK	V_t	25.8 mV
Velocity of light	c	3×10^8 m/s
Permeability of free space	u_o	1.257×10^{-6} H/m
Permittivity of free space	e_o	8.854×10^{-12} F/m
Electron mass	m_e	9.1×10^{-31} kg
Proton mass	m_p	1.673×10^{-27} kg

Atomic Masses

Element	Symbol	Atomic Mass	Atomic Number
Hydrogen	H	1.00794 u	1
Helium	He	4.00260 u	2
Lithium	Li	6.941 u	3
Beryllium	Be	9.0122 u	4
Boron	B	10.811 u	5
Carbon	C	12.0107 u	6
Nitrogen	N	14.0067 u	7
Oxygen	O	15.9994 u	8
Fluorine	F	18.9984 u	9
Neon	N	20.1797 u	10
Sodium	Na	22.9897 u	11
Magnesium	Mg	24.305 u	12
Aluminum	Al	26.9815 u	13
Silicon	Si	28.0855 u	14
Phosphorus	P	30.9738 u	15