**Chapter 33**

1. A very long, thin rod carries electric charge with the linear density 35.0 nC/m. It lies along the *x* axis and moves in the *x* direction at a speed of 1.50 x 107 m/s. (a) Find the electric field the rod creates at the point (*x* = 0, *y* = 20.0 cm, *z* = 0). (b) Find the magnetic field it creates at the same point. (c) Find the force exerted on an electron at this point, moving with a velocity of (2.40 x 108) $\hat{i}$m/s.

**SOLUTION:**

2. The distance to the North Star, Polaris, is approximately 6.44 x 1018 m. (a) If Polaris were to burn out today, how many years from now would we see it disappear? (b) What time interval is required for sunlight to reach the Earth? (c) What time interval is required for a microwave signal to travel from the Earth to the Moon and back?

**SOLUTION:**

3. A 15.0-mW helium–neon laser emits a beam of circular cross section with a diameter of 2.00 mm. (a) Find the maximum electric field in the beam. (b) What total energy is contained in a 1.00-m length of the beam? (c) Find the momentum carried by a 1.00-m length of the beam.

**SOLUTION:**

**Solution for Chapter 33**

1. A very long, thin rod carries electric charge with the linear density 35.0 nC/m. It lies along the *x* axis and moves in the *x* direction at a speed of 1.50 x 107 m/s. (a) Find the electric field the rod creates at the point (*x* = 0, *y* = 20.0 cm, *z* = 0). (b) Find the magnetic field it creates at the same point. (c) Find the force exerted on an electron at this point, moving with a velocity of (2.40 x 108) $\hat{i}$m/s.

**Ans:**

(a) The very long rod creates the same electric field that it would if stationary. We apply Gauss’s law to a cylinder, concentric with the rod, of radius *r* = 20.0 cm and length 

 

 

**ANS. FIG. P33.2**

 

(b) The charge in motion constitutes a current of

 (35.0 × 10–9 C/m) × (15.0 × 106 m/s) = 0.525 A

 This current creates a magnetic field.

  

 

(c) The Lorentz force on the electron is 

 

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**Ans:**

(a) Since the light from this star travels at 3.00 × 108 m/s, the last bit of light will hit the Earth in



(b) From Table C.4 (in Appendix C of the textbook), the average Earth-Sun distance is *d* = 1.496 × 1011 m, giving the transit time as

 

(c) Also from Table C.4, the average Earth-Moon distance is *d* = 3.84 × 108 m, giving the time for the round trip as

 

3. A 15.0-mW helium–neon laser emits a beam of circular cross section with a diameter of 2.00 mm. (a) Find the maximum electric field in the beam. (b) What total energy is contained in a 1.00-m length of the beam? (c) Find the momentum carried by a 1.00-m length of the beam.

**Ans:**

(a) , and *r* =1.00 × 10–3 m:

 

(b) The beam carries power P. The amount of energy ∆*E* in the length of a beam of length  is the amount of power that passes a point in time interval 

 

 

(c) From Equation 33.34 and our result in part (b), the momentum and energy carried a light beam are related by

 