Solution to HW Problems

Chapter 25

104 Phys

Prof. *Nasser S. Alzayed*

3. (a) Calculate the speed of a proton that is accelerated from rest through a potential difference of 120 V. (b) Calculate the speed of an electron that is accelerated through the same potential difference.

Chapter 25 3/25

$\Delta V = 120V$ $m_p = 1.67\times10^{-27}$ kg

a) potential energy of the proton $U = qV \rightarrow K.E.$

$\therefore qV = \frac{1}{2} m_p v^2$

$\rightarrow 1.6\times10^{-19} \times 120 = \frac{1}{2} \times 1.67\times10^{-27} \times v^2 \Rightarrow v = 1.5\times10^{5}$ m/s

b) the only difference is mass:

$1.6\times10^{-19} \times 120 = \frac{1}{2} \times 9.1\times10^{-31} \times v^2$

$\rightarrow v = 6.5\times10^{6}$ m/s ###

13. An insulating rod having linear charge density $\lambda = 40.0\ \mu C/m$ and linear mass density $\mu = 0.100$ kg/m is released from rest in a uniform electric field $E = 100$ V/m directed perpendicular to the rod (Fig. P25.13). (a) Determine the speed of the rod after it has traveled 2.00 m. (b) **What If?** How does your answer to part (a) change if the electric field is not perpendicular to the rod? Explain.

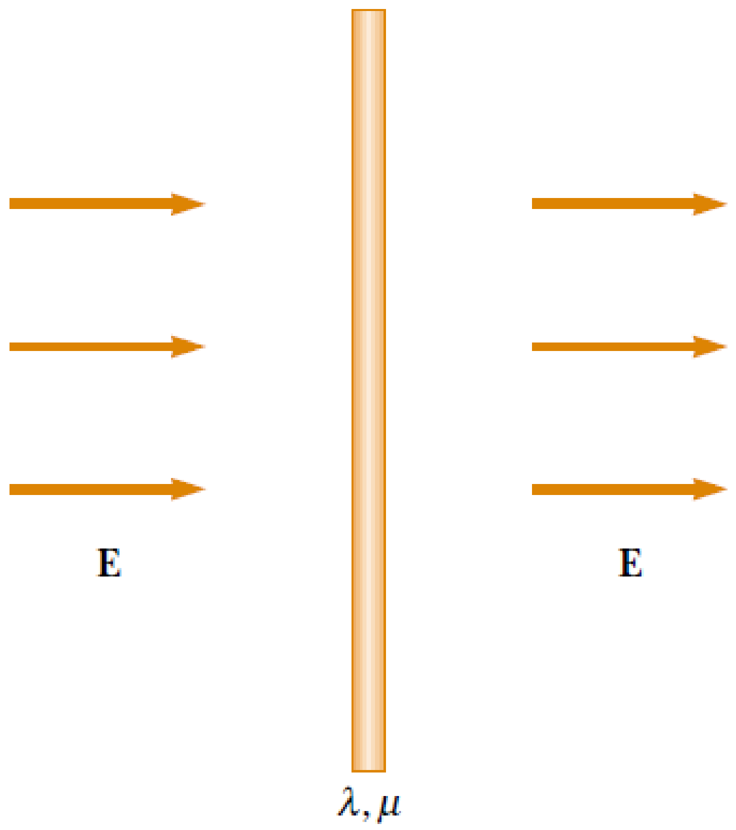


Figure P25.13

Chapter 25, 13/25:

$\lambda = 40\ \mu C/m$, $\mu = 0.1\ kg/m$, $E = 100\ V/m$, $d = 2\ m$

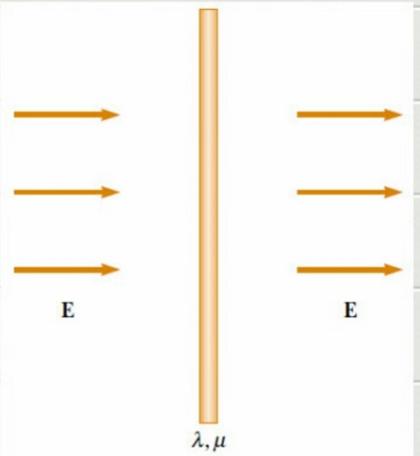


Figure P25.13

a) Same as in #3:

$U \rightarrow KE$ ∴ $qV \rightarrow \frac{1}{2} m v^2$

$q = \lambda L$, $V = Ed$, $m = \mu L$

∴ $\lambda \cancel{L} E d = \frac{1}{2} \mu \cancel{L} v^2$

$\rightarrow v = \sqrt{\frac{2 \lambda E d}{\mu}} = \sqrt{\frac{2 \times 40 \times 100 \times 2}{0.1}} = 0.4\ m/s$

لاحظ أننا هنا اعتبرنا أن هناك شحنة = λL تتحرك في مجال
كهربائي منتظم.

(b) بحسب القانون المذكور أعلاه لم يتغير شيء لأن ال
نفس الشحنة تتحرك في نفس المجال.

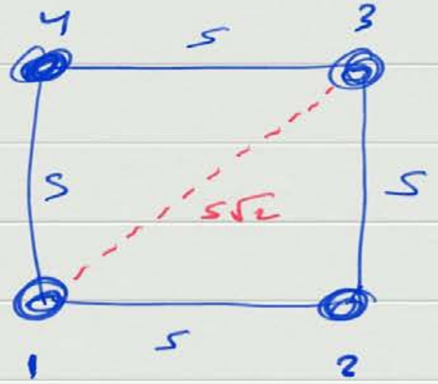
∴ Same → $v = 0.4\ m/s$ ※

23. Show that the amount of work required to assemble four identical point charges of magnitude Q at the corners of a square of side s is $5.41 k_e Q^2/s$.

Chapter 25 Q23/25:

المطلوب هنا حساب طاقة الوضع U.

كما تم توضيحه سابقا، لما نأخذ كل شحنتين مختلفتين تتفاعل مع بعضها.



Total $U = U_{11} + U_{12} + U_{13} + U_{14} + U_{23} + U_{24} + U_{34}$

$\therefore U = K \frac{Q_1 Q_2}{r} \equiv K \frac{Q^2}{s}$

$\therefore U_{total} = 0 + K\frac{Q^2}{s} + K\frac{Q^2}{s\sqrt{2}} + K\frac{Q^2}{s} + K\frac{Q^2}{s} + K\frac{Q^2}{s\sqrt{2}} + K\frac{Q^2}{s}$

$= K\frac{Q^2}{s}\left[\frac{1}{1} + \frac{1}{\sqrt{2}} + \frac{1}{1} + \frac{1}{1} + \frac{1}{\sqrt{2}} + \frac{1}{1}\right] = K\frac{Q^2}{s}\left[4 + \frac{2}{\sqrt{2}}\right]$

$\therefore U_{tot} = 5.4 \cdot K\frac{Q^2}{s}$ #

24. *Compare this problem with Problem 23 in Chapter 23.* Five equal negative point charges $-q$ are placed symmetrically around a circle of radius R. Calculate the electric potential at the center of the circle.

chapter 25 24/25 ?

$\because V = k\frac{q}{r}$

$\therefore V = -5k\frac{q}{R}$ #