# ÇANKAYA UNIVERSITY

# PHYS 132 – PHYSICS II

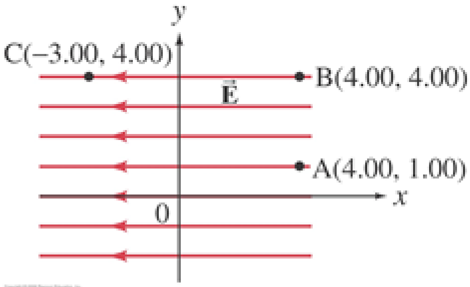
**CHAPTER 24**

**ELECTRIC POTENTIAL**

**PROBLEM SET**

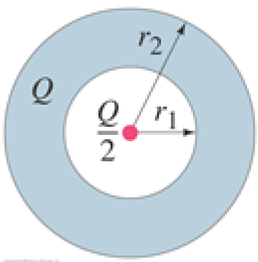
**1)** A uniform electric field $\vec{E} = -4.20\ N/C\ \hat{\mathbf{i}}$ points in the negative *x* direction as shown in Fig. 23–25. The *x* and *y* coordinates of points A, B, and C are given on the diagram (in meters). Determine the differences in potential (*a*) $V_{BA}$, (*b*) $V_{CB}$, and (*c*) $V_{CA}$.

**[Answer: a) $V_{BA} = 0$, b) $V_{CB} = -29.4\ V$, c) $V_{CA} = -29.4\ V$]**




**2)** *** A hollow spherical conductor, carrying a net charge +Q, has inner radius $r_1$ and outer radius $r_2 = 2r_1$ (Fig. 23–26). At the center of the sphere is a point charge +Q/2. (*a*) Write the electric field strength *E* in all three regions as a function of *r*. Then determine the potential as a function of *r*, the distance from the center, for (*b*) $r > r_2$, (*c*) $r_1 < r < r_2$, and (*d*) $0 < r < r_1$.

**[Answer: a) For $r > r_2$, $E = \frac{3Q}{8\pi\varepsilon_0 r^2}$; For $r_1 < r < r_2$, E=0; For $0 < r < r_1$, $E = \frac{Q}{8\pi\varepsilon_0 r^2}$ b) $V = \frac{3Q}{8\pi\varepsilon_0 r}$ c) $V = \frac{3Q}{8\pi\varepsilon_0 r_2}$ d) $V = \frac{Q}{8\pi\varepsilon_0}\left(\frac{1}{r_2}+\frac{1}{r}\right)$]**



**3)** Two point charges, 3.4 μC and -2.0μC are placed 5.0 cm apart on the $x$ axis. At what points along the $x$ axis is ($a$) the electric field zero and ($b$) the potential zero? Let $V = 0$ at r =infinite.**[Answers: a) 16 cm left of $q_2$, b) 1.9 cm from the negative charge towards the positive charge, and 7.1 cm from the negative charge away from the positive charge.]**

**4)** A +25 μC point charge is placed 6.0 cm from an identical +25 μC point charge. How much work would be required by an external force to move a +0.18 μC test charge from a point midway between them to a point 1.0 cm closer to either of the charges? **[Answer: 0.34 J]**

**5)** *** A total charge $Q$ is uniformly distributed on a thread of length $l$. The thread forms a semicircle. What is the potential at the center? (Assume $V = 0$ at large distances.)

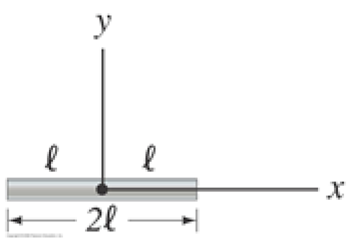
**[Answer:**

$\frac{Q}{4\varepsilon_0 \ell}$ **]**

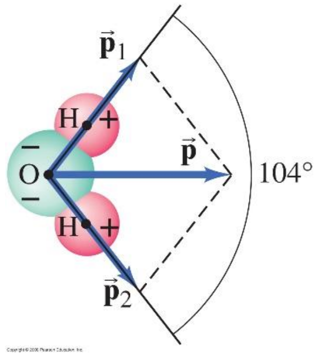
**6)** A thin rod of length ***2l*** is centered on the $x$ axis as shown in Fig. 23–31. The rod carries a uniformly distributed charge $Q$. Determine the potential $V$ as a function of $y$ for points along the $y$ axis. Let $V = 0$ at infinity.

**[Answer:**

$$\frac{Q}{8\pi\varepsilon_0 \ell}\left[\ln\left(\frac{\sqrt{\ell^2+y^2}+\ell}{\sqrt{\ell^2+y^2}-\ell}\right)\right]$$ **]**



**7)** The dipole moment, considered as a vector, points from the negative to the positive charge. The water molecule, Fig. 23–32, has a dipole moment $\vec{\mathbf{p}}$ which can be considered as the vector sum of the two dipole moments $\vec{\mathbf{p}}_1$ and $\vec{\mathbf{p}}_2$ as shown. The distance between each H and the O is about $0.96 \times 10^{-10} m$ ;the lines joining the center of the O atom with each H atom make an angle of 104° as shown, and the net dipole moment has been measured to be $p = 6.1 \times 10^{-30}\ C \cdot m$ . Determine the effective charge $q$ on each H atom.
**[Answer: $\mathbf{5.2 \times 10^{-20}\ C}$ ]**

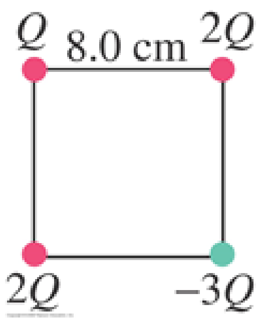



**8)** *** The electric potential in a region of space varies as $V = by/\left(a^2 + y^2\right)$. Determine $\vec{\mathbf{E}}$.
**[Answer:**

$$\vec{\mathbf{E}} = \boxed{\frac{\left(y^2 - a^2\right)b}{\left(a^2 + y^2\right)^2}\hat{\mathbf{j}}}$$
**]**

**9)** Four point charges are located at the corners of a square that is 8.0 cm on a side. The charges, going in rotation around the square, are $Q$, $2Q$, -3Q and $2Q$, where $Q$ =3.1μC (Fig. 23–35). What is the total electric potential energy stored in the system, relative to $U = 0$ at infinite separation?

**[Answer: -7.9 J]**



**10)** In a television picture tube (CRT), electrons are accelerated by thousands of volts through a vacuum. If a television set is laid on its back, would electrons be able to move upward against the force of gravity? What potential difference, acting over a distance of 3.5 cm, would be needed to balance the downward force of gravity so that an electron would remain stationary? Assume that the electric field is uniform. **[Answer: $2.0 \times 10^{-12}$ V, the thousands of volts in a television set move electrons upward against the force of gravity.]**