2-26-14



solutions are circled

**1. The magnitude the electron's charge is $1.6 \times 10^{-19}$ Coulombs. True or False. (a) True (b) False**

**2. The polar water molecule has a net charge.
(a) True (b) False**

**3. A dipole does not have a net charge. (a) True (b) False**

**4. The gravitational force between two masses is never repulsive.
(a) True (b) False**

**5. If you were standing at arm's length to someone else and you each had one percent more electrons than protons, the repelling force you would each experience would be (a) very small compared to your own weight (b) larger than a weight of a two ton truck.**

**6. A positive charge placed in an electric field experiences a force in a direction opposite to that of the field. True or False. (a) True (b) False**

**7. A negative charge placed in an electric field experiences a force in a direction opposite to that of the field. True or False. (a) True (b) False**

**8. Electric flux is not a vector quantity i.e. it does not have magnitude and direction. True or False. (a) True (b) False**

**9. ~~The main difference between conductors and insulators is in terms of~~ (a) their mass densities (b) neutrons (c) outer valance or conduction electrons (d) protons**

**10. When the distance between two point charges is tripled, the magnitude of the electric force between them is (a) doubled
(b) quadrupled (c) reduced by a factor of $\frac{1}{3}$
(d) increased by a factor of $\sqrt{3}$ (e) reduced by a factor of $\frac{1}{9}$**

**11. When the distance between two point charges is reduced by a factor of $\frac{1}{3}$, the magnitude of the force between them is (a) doubled (b) quadrupled (c) increased by a factor of 3 (d) increased by a factor of $\sqrt{3}$ (e) increased by a factor of 9**

**12. When the magnitude of *each* of two interacting point charges is decreased by a factor of $\frac{1}{2}$, the magnitude of the force between them is**

**(a) doubled (b) quadrupled (c) reduced by a factor of $\frac{1}{2}$ (d) increased by a factor of $\sqrt{2}$ (e) reduced by a factor of $\frac{1}{4}$.**

**13. The magnitude of the electric field between two uniformly and oppositely** charged parallel plates (a) is a positive constant (b) increases linearly with distance from the positive plate (c) is zero

14. The electric field inside a solid, charged conductor in electrostatic equilibrium is (a) zero (b) a positive constant (c) increases linearly with distance inward from the surface.

15. The electric field at the surface a solid, charged conductor in electrostatic equilibrium (a) is zero (b) not zero and perpendicular to the surface (c) has magnitude that increases linearly with distance outward from the surface.

16. The electric field inside a solid, uniformly charged, spherically shaped insulator is (a) zero (b) a positive constant (c) increases linearly with distance outward from the center.

$\longrightarrow E = \frac{kr}{R^3} \propto r$

17. The electric field outside a solid, uniformly charged, spherically shaped insulator is (a) zero (b) a positive constant (c) decreases according to an inverse square law inputting the distance outward from the center.

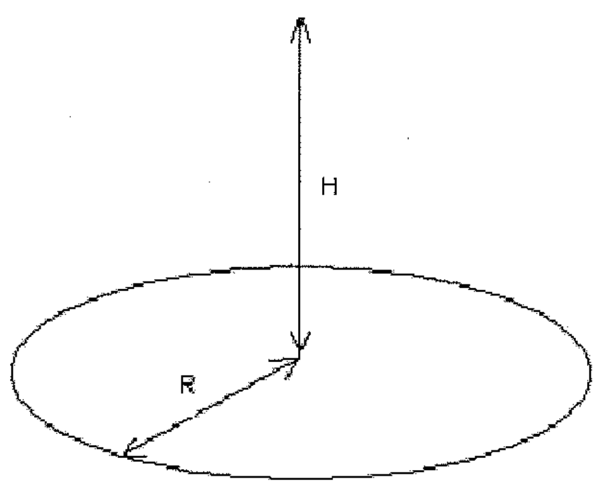
$E = \frac{kQ}{r^2}$, $Q$ = TOTAL CHARGE

**1. (31 points) CONSIDER A *UNIFORMLY* charged RING of radius R and points on the axis of symmetry of the ring shown. The ring's *CONSTANT* linear charge density is λ, a positive number.**

**(a) (28 points) In terms of λ, R, H and *other* relevant symbols, what is the magnitude and direction of the electric field at the point shown below?**

**(b) (3 points) What is the formula for the total charge *on the ring* ? Write your answer in terms of R, λ and any other relevant symbols.**

**Note: You must *derive* all formulas that you use in this problem; you will lose points if you do not do so, so for full credit, you must show every step, including any *integrations* .**



**2. (37 points) A point charge of mass *m*, and charge Q > 0 "floats" a height H above the surface of a UNIFORMLY charged disk of radius R and thus CONSTANT charge density σ. The point charge Q is located on the axis of symmetry of the disk, as shown.**

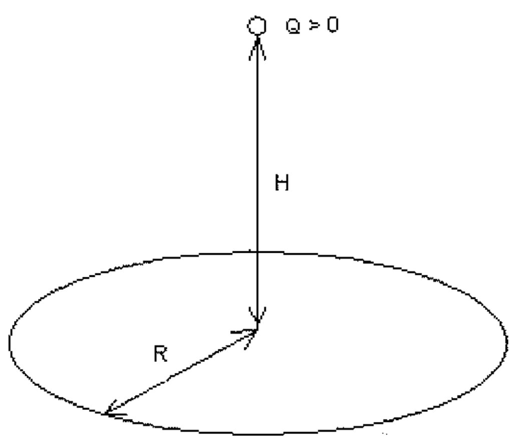
**(a) (28 points) In terms of σ, R, H and *other* relevant symbols, what is the magnitude of the electric field at the point shown below DUE TO THE DISK?**

**(b) (3 points) In terms of Q, σ, g, R, H and *other* relevant symbols, what is the mass of the *floating* charge ? The *formula* for the mass you derive will be in terms of these symbols. Represent the mass value by letter *m*.**

**(c) (3 points) Is σ positive or negative ? EXPLAIN.**

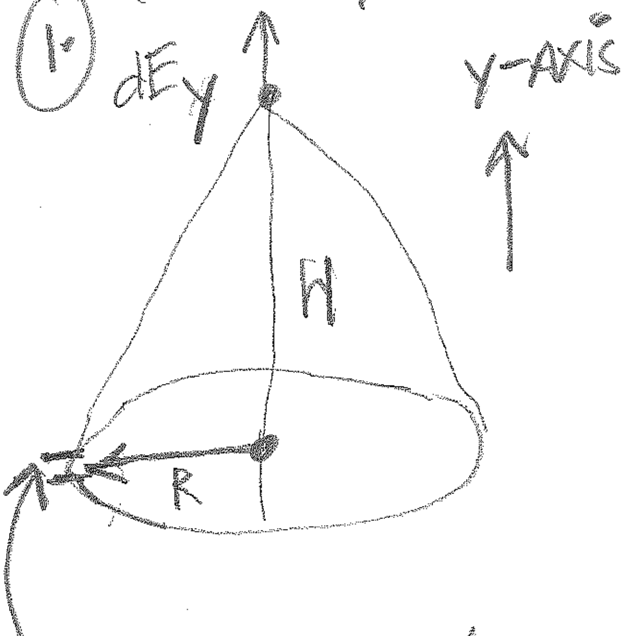
**(d) (3 points) What is the formula for the total charge *on the disk* ? Write your answer in terms of R , σ and any other relevant symbols.**

**Note: You must *derive* all formulas that you use in this problem; you will lose points if you do not do so, so for full credit, you must show every step, including any *integrations* .**



413 sp'14 Test 1 follow solutions

1.




$$dq = \lambda \cdot R\,d\phi$$

$$dE_x = \frac{k\,\lambda \cdot R\,d\phi \cdot H}{(R^2+H^2)^{3/2}}$$

Integrating $d\phi$ from 0 to $2\pi$:

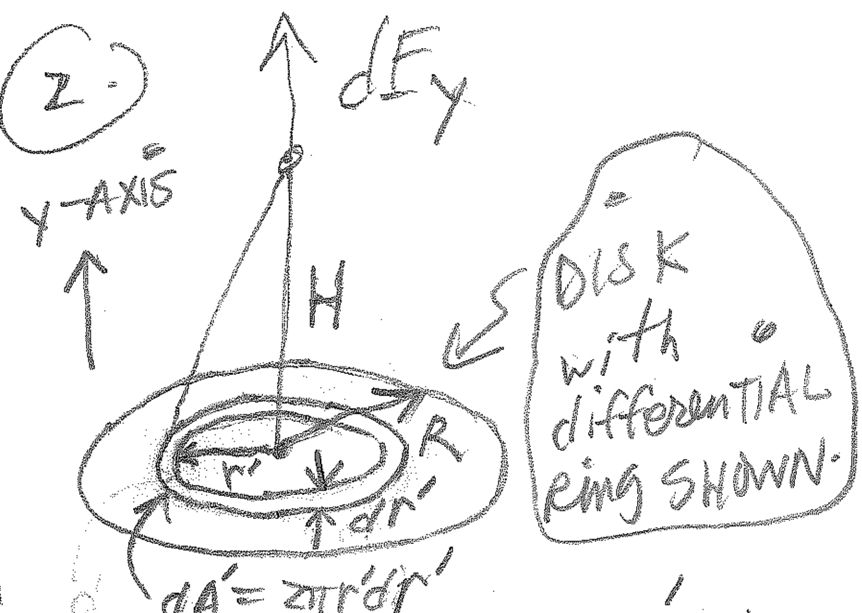
$$E_y = \frac{k \cdot \lambda(2\pi R) \cdot H}{(R^2+H^2)^{3/2}}$$

$$E_y = \frac{k \cdot \overset{*}{Q} \cdot H}{(R^2+H^2)^{3/2}};$$

b. *

$$Q = \lambda \cdot (2\pi R).$$

2.




$$dE_y = \frac{k \cdot \sigma(2\pi r')dr' \cdot H}{(r'^2+H^2)^{3/2}}$$

$$E_y = k\sigma 2\pi H \cdot \int_0^R \frac{r'dr'}{(r'^2+H^2)^{3/2}}$$

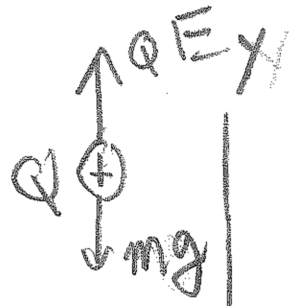
$$= k\sigma(2\pi)H\left[-\int_0^R du\right]$$

$$u = (r'^2+H^2)^{-1/2}$$

$$du = -\frac{r'dr}{(r'^2+H^2)^{3/2}}$$

$$E_y = k \cdot \sigma \cdot 2\pi H\left[\frac{1}{|H|} - \frac{1}{\sqrt{R^2+H^2}}\right]$$

2 (b.)




$$mg = Q \cdot E_y$$

$$mg = K \cdot Q \cdot \sigma 2\pi \left[1 - \frac{H}{\sqrt{R^2+H^2}}\right]$$

$$m = \frac{K Q \cdot \sigma \cdot 2\pi}{g}\left[1 - \frac{H}{\sqrt{R^2+H^2}}\right]$$

(c.) $\sigma > 0$

(d.) $Q = \sigma \cdot \pi R^2$

2-26-14 supplement

sample VCB level problem:

2 PROTONS at REST at initial DISTANCE $r_i$

FIND speeds AT $\infty$

(i.)

$+e$ $\oplus \leftarrow r_i \rightarrow \oplus$ $+e$ (rest)

(f.)

$$U_f = \frac{ke^2}{r_f} = \frac{ke^2}{\infty} = 0$$

$v_\infty \leftarrow \oplus \leftarrow r_f = \infty \rightarrow \oplus \rightarrow v_\infty$ $+e$

FIND $v_\infty = ?$

$$KE_i + U_i = KE_f + U_f$$

$$0 + \frac{ke^2}{r_i} = 2\cdot\left(\tfrac{1}{2} m_p v_\infty^2\right) + 0$$

$\rightarrow$ FIND $v_\infty$ given $r_i$