Exercise 1. Surface Area

What is the surface area of a sphere? A cylinder? A box?

(a) sphere $2\pi rx+2\pi r^2$, cylinder $4\pi r^2$, box $2(ab+bc+ac)$

(b) sphere $2\pi rx+2\pi r^2$, cylinder $2(ab+bc+ac)$, box $4\pi r^2$

(c) sphere $4\pi r^2$, cylinder $2\pi rx+2\pi r^2$, box $2(ab+bc+ac)$

(d) sphere $4\pi r^2$, cylinder $2(ab+bc+ac)$, box $2\pi rx+2\pi r^2$

(e) sphere $2(ab+bc+ac)$, cylinder $4\pi r^2$, box $2\pi rx+2\pi r^2$

(f) sphere $2(ab+bc+ac)$, cylinder $2\pi rx+2\pi r^2$, box $4\pi r^2$

Exercise 2. Cone I

Find the surface area of a cone with a circular base of radius r and a height of h.

Exercise 3. Cone II

Find the volume of a cone with a circular base of radius r and a height of h.

Exercise 4. Two Charges I

What is the electric field $E(x, y)$ on the xy plane given by two charges q located at $(0, 0, 1)^T$ and $(0, 0, -1)^T$.

(a) 0 ***

(b) kq

(c) $-kq$

(d) $2kq/(1 + x^2 + y^2)$

Exercise 5. Two Charges II

Is there any flux through the xy plane? Justify your answer.

Exercise 6. Gauss Law I

Suppose that we are given a distribution of charge, $\rho(z) = \rho_0 z$ in a cone with its base of radius r at the origin, and height h in the z direction. What is the total charge enclosed in the cone?

(a) 0

(b) $\pi r^2 h^2 \rho_0/12$ ***

(c) $\pi r^2 h \rho_0/3$

(d) $\pi r^2 h \rho_0$

Exercise 7. Gauss Law II

What is the net flux through a cylinder of radius r at the origin and with height in the z direction of h.

(a) 0

(b) $\pi r^2 h^2 \rho_0/32\epsilon_0$

(c) $\pi r^2 h^2 \rho_0/12\epsilon_0$ ***

(d) $\pi r^2 h \rho_0/3\epsilon_0$

Exercise 8. Gauss Law III

What is the net flux through a cylinder of radius r at the origin and with height in the z direction of $2h$.

(a) 0

(b) $\pi r^2 h^2 \rho_0/32\epsilon_0$

(c) $\pi r^2 h^2 \rho_0/12\epsilon_0$ ***

(d) $\pi r^2 h \rho_0/3\epsilon_0$

Exercise 9. Gauss Law IV

What is the net flux through a cylinder of radius r at the origin and with height in the z direction of $h/2$.

(a) 0

(b) $\pi r^2 h^2 \rho_0/32\epsilon_0$ ***

(c) $\pi r^2 h^2 \rho_0/12\epsilon_0$

(d) $\pi r^2 h \rho_0/3\epsilon_0$

Exercise 10. Flux I

Find the electric field at the point $P = (1, 3, 1)^T$ from a particle of charge $+q$ at $(1, 2, 1)^T$.

(a) kq ***
(b) $kq/9$
(c) kq^2
(d) $kq^2/9$

Exercise 11. Flux II

Find the electric field at the point $P = (1, 3, 1)^T$ from a particle of charge $-q$ at $(1, 1, 1)^T$.

(a) $-kq$
(b) $-kq/4$ ***
(c) kq^2
(d) $kq^2/4$

Exercise 12. Flux III

Find the net field at $P = (1, 3, 1)^T$.

Exercise 13. Flux IV

What is the total flux given by the rectangular box that has corners at $(0, 0, 0)^T$ and $(2, 3, 2)^T$. Hint: don't do an integral.

(a) 0 ***
(b) $2kq$
(c) $4kq$
(d) $8kq$

Exercise 14. Disc I

By evaluating the following integral, show that the circumference of a circle is $2\pi r$:

$$C = \int r \, d\theta$$

Exercise 15. Disc II

From the result of the last problem and the following integral, show that the area of a disc is πr^2:

$$A = \int r' C \, dr'$$