

Homework #1

Phys 3344 Prof. Olness

Due: 26 Wednesday August 2020 on Canvas

Problem 1:

For the unit vectors $\{\hat{x}, \hat{y}, \hat{z}\}$ compute all possible

a) dot and b) cross products. (There are $3 \times 3 = 9$ of each.)

Problem 2:

For both $F_1 = x \hat{x} + y \hat{y}$ and $F_2 = -y \hat{x} + x \hat{y}$,

a) compute (div) $\nabla \cdot F$,

b) compute (curl) $\nabla \times F$, and

c) sketch F_1 and F_2 in the $\{x, y\}$ plane.

Problem 3:

For both $F_1 = r \hat{r}$ and $F_2 = \hat{r}/r^2$,

a) sketch F_1 and F_2 in the $\{r, \phi\}$ plane,

b) compute (div) $\nabla \cdot F$ and (curl) $\nabla \times F$ in cylindrical coordinates,

c) compute (div) $\nabla \cdot F$ and (curl) $\nabla \times F$ in spherical coordinates.

Problem 4:

a) For $F_1 = r \hat{\theta}$ compute $\nabla \cdot F$ and $\nabla \times F$ in cylindrical coordinates.

b) For $F_2 = r \sin \theta \hat{\phi}$ compute $\nabla \cdot F$ and $\nabla \times F$ in spherical coordinates.

(Hint: Take a look at the back cover page of the text book.)

Problem 5:

a) A projectile of mass m is launched from a cliff of height h with velocity v at an angle θ above the horizon. Find the a) range of the projectile, b) the time it is in the air, and c) the maximum height above the valley floor.

(Hint: This to refresh some of your skills from intro physics.)

Problem 6:

A proton of mass m and charge q circulates in a magnetic field of strength B with velocity $v \simeq c$ (where c is the speed of light).

a) Find the radius of the orbit.

b) At the LHC $B = 7.7$ Tesla. Compute r in meters. (Look up the values for m , c and q .)

(Hint: Recall the Lorentz force $\mathbf{F} = q\mathbf{v} \times \mathbf{B}$.)