General Physics A (II) – Spring Semester 2019 Homework Set 3

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1.

Total E-flux outward the box of dxdydz

$$\left(\frac{dE_x}{dx} + \frac{dE_y}{dy} + \frac{dE_z}{dz}\right) dx\,dy\,dz = 0$$

$$\Rightarrow \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2} = 0$$

$$V(x_0 + \delta x, y_0, z_0)$$

$$= V(x_0 + y_0, z_0) + \frac{\partial V}{\partial x}\Big|_{x_0, y_0, z_0} \delta x + \frac{1}{2}\frac{\partial^2 V}{\partial x^2}\delta x^2 + O \ldots$$

$$V(x_0 - \delta x, y_0, z_0)$$

(higher order)

$$= V(x_0, y_0, z_0) + \frac{\partial V}{\partial x}\Big|_{x_0, y_0, z_0} (-\delta x) + \frac{1}{2}\frac{\partial^2 V}{\partial x^2}\delta x^2 + \ldots$$

$$V(x_0 + \delta x, y_0, z_0) + V(x_0 - \delta x, y_0, z_0) + V(x_0, y_0 + \delta y, z_0)$$

$$+ \ldots V \ldots V \ldots V$$

$$\approx 6V(x_0, y_0, z_0) + \underbrace{\left(\frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}\right)}_{=0}\delta^2$$

$$\Rightarrow V(x_0, y_0, z_0) = \overline{V(\text{neighbor})}$$

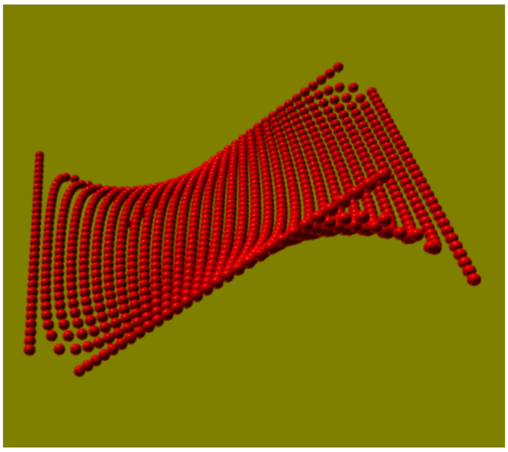
2.

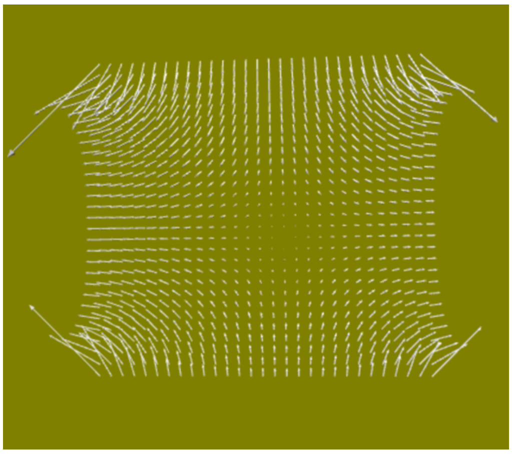
When we set V1,V2,V3,V4 as following:

V[(0, 0)] = 5V V[(0, 30)] = -10V V[(30, 30)] = -15V V[(30, 0)] = 0V

The right profile represents the potential distribution within the hollow region.

The left profile represents the field distribution within the hollow region.





Code explanation:

```
for x in range (0, 31):
    for y in range (0, 31):
        z = 0
        spheres[(x, y)] = sphere(radius = size, color=color.red)
        spheres[(x, y)].pos = vec(x,y,z)
        location[(x, y)] = z  ##initialize the array
location[(0, 0)] = 5  ##set the potential value of boundary
location[(0, 30)] = -10
location[(30, 30)] = -15
location[(30, 0)] = 0
for x in range (1, 30):
        location[(x, 0)] = location[(30,0)]
        location[(x, 30)]= location[(0,30)]
for y in range (1, 30):
        location[(0, y)] = location[(0,0)]
        location[(30, y)] = location[(30,30)]
##start find out potential of each point by average the potential value of its neighbors.
for c in range (1,1000):
    for x in range (1, 30):
        for y in range (1, 30):
            tmp = ((location[(x+1,y)] + location[(x-1,y)] + location[(x,y+1)]
                  + location[(x,y-1)]))/4
            location[(x, y)]= tmp
    for x in range (0, 31):
        for y in range (0, 31):
            z = 0
            spheres[(x, y)].pos = vec(x,y,location[(x,y)])
```

```
for c in range (1,1000):
    for x in range (1, 30):
        for y in range (1, 30):##compute field value of each point.
            tmpvx =(location[(x+1,y)] - location[(x-1,y)])/2/d
            tmpvy =(location[(x,y+1)] - location[(x,y-1)])/2/d
            tmp = ((location[(x+1,y)] + location[(x-1,y)] +
                  location[(x,y+1)] + location[(x,y-1)]))/4
            location[(x, y)]= tmp
            arrows[(x, y)].axis= vec(-tmpvx,-tmpvy,0)
```