# List1

October 31, 2020

# 1 List 1

## 1.1 Q1

On the first case, we have $F_1$:

$$F_1 = \frac{kQ^2}{R^2}$$

soon after, there was reduction to the charge in half the value and distance was doubled, changing to the following:

$$F_2 = \frac{k(\frac{Q}{2})^2}{(2R)^2}$$

simplifying:

$$F_2 = \frac{1}{16}\frac{kQ^2}{R^2}$$

then the relation of forces after ($F_2$) and before ($F_1$) is:

$$F_2 = \frac{1}{16}F_1$$

the modulo of the new force is the reduction in 16 part of the former force.

## 1.2 Q2

first step:

$$Q < - - - - - -(d_1) - - - - - - > 2Q < - - - - - -(d_2) - - - - - - > 4Q$$

in order for $2Q$ to have resultant force null, the force of $Q$ in $2Q$ must be equal the force of $4Q$ in $2Q$, then:

$$F_{12} = F_{32}$$

developing equality, we've

$$\frac{K * Q * 2Q}{(d_1)^2} = \frac{K * 2Q * 4Q}{(d_2)^2}$$

then, the relation $d_1$ and $d_2$ is :

$$d_2 = 2d_1$$

## 1.3 Q4

### 1.3.1 a)

first step, we've to define the parameters

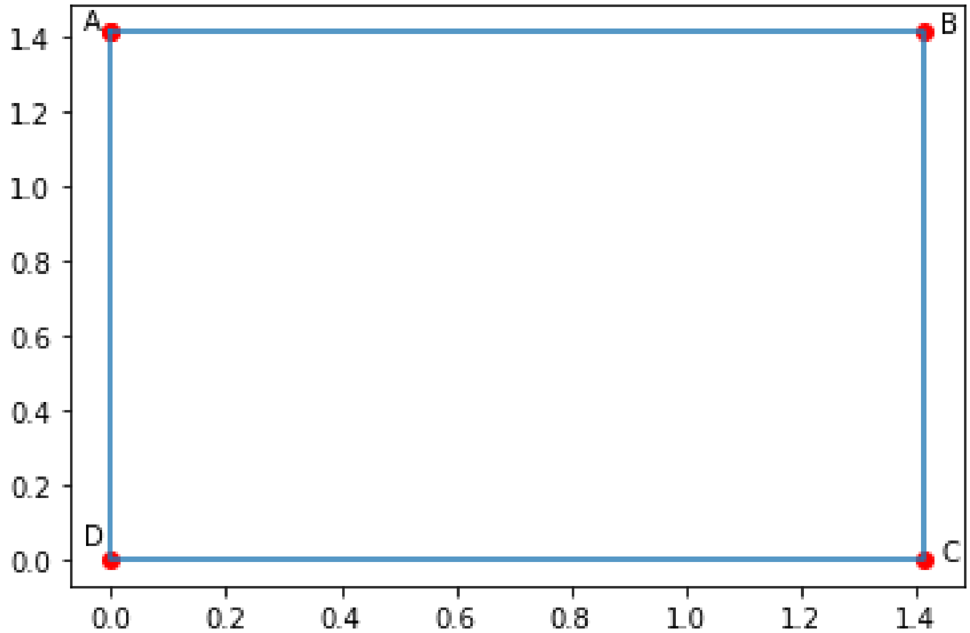
[26]:
```
from math import *
import numpy as np
import matplotlib.pyplot as plt

l = sqrt(2)

x = [0,1,1,0,0]
y = [1,1,0,0,1]


plt.plot(x,y,'ro')
plt.plot(x,y)
plt.annotate("A", xy=(-0.05,1+0.01))
plt.annotate("B", xy=(1+0.03,1))
plt.annotate("C", xy=(1+0.03,0))
plt.annotate("D", xy=(-0.05,0.04))
```

[26]:
```
Text(-0.05, 0.04, 'D')
```




second step is calculate to the force $B$ in $D$ :

$$\vec{F}_{BD} = \frac{kq^2}{(l\sqrt{2})^3}\vec{R}_{BD}$$

[27]:
```
k = 9e9
q = 1e-6

R_bd = (l*sqrt(2))
b = (k*q**2)/(R_bd**3) #escalar


r_bd = np.array([-1,-1])

F_bd = b*r_bd
print('F_bd = {:.2e}*i {:.2e}*j'.format(*F_bd))
```

```
F_bd = -1.59e-03*i -1.59e-03*j
```

third step, calculate the force $A$ in $D$:

$$\vec{F}_{AD} = \frac{kq^2}{l^3}\vec{R}_{AD}$$

[28]:
```
R_ad = l
r_ad = np.array([0,-1])
```

```
b = (k*q**2)/(R_ad**3) #escalar
F_ad = b*r_ad

print('F_ad = {:.2e}*i {:.2e}*j'.format(*F_ad))
```

```
F_ad = 0.00e+00*i -4.50e-03*j
```

fourth step, calculate the force $C$ in $D$ :

$$\vec{F}_{CD} = \frac{kq^2}{l^3}\vec{R}_{CD}$$

[29]:
```
R_cd = l
r_cd = np.array([-l,0])

b = (k*q**2)/(R_cd**3) #escalar

F_cd = b*r_cd

print('F_cd = {:.2e}*i {:.2e}*j'.format(*F_cd))
```

```
F_cd = -4.50e-03*i 0.00e+00*j
```

fiveth and last step, calculate the result force in $D$ :

$$\vec{F_D} = \vec{F}_{BD} + \vec{F}_{CD} + \vec{F}_{AD}$$

[30]:
```
F_d = F_bd+F_cd+F_ad

print('F_d = {:.2e}*i {:.2e}*j'.format(*F_d))
```

```
F_d = -6.09e-03*i -6.09e-03*j
```

### 1.3.2 b)

the components of the force in the square's center are going to annul, with it the result of the force will be zero.

## 1.4 Q5

first step, setting the parameters:

[31]:
```
q1 = 2e-6
q2 = -300e-6

P1 = np.array([0,1,2])
P2 = np.array([2,0,0])
```

```
R21 = np.array([P1 - P2][0]) #vector P21

r21 = sqrt(sum(R21**2)) #modulo

print('R21 = {:.2e}*i {:.2e}*j {:.2e}*k'.format(*R21))
```

```
R21 = -2.00e+00*i 1.00e+00*j 2.00e+00*k
```

knowing that

$$\vec{F_{21}} = \frac{k * q1 * q2}{R_{21}^3}\vec{R}_{21}$$

we have:

[32]:
```
F21 = ((k*q1*q2)/r21)*R21
print('F21 = {:.2e}*i {:.2e}*j {:.2e}*k'.format(*F21))
```

```
F21 = 3.60e+00*i -1.80e+00*j -3.60e+00*k
```

## 1.5 Q6

### 1.5.1 a)

first step, putting on the input

[33]:
```
Qa = 200e-6
Qb = 500e-6
A = np.array([26,4,7])
B = np.array([5,8,-2])

Rab = np.array([B-A][0])


print('Rab = {:.2e}*i {:.2e}*j {:.2e}*k'.format(*Rab))
```

```
Rab = -2.10e+01*i 4.00e+00*j -9.00e+00*k
```

### 1.5.2 b)

Calculating the absolute value of vector, $\vec{R}_{AB}$

[34]:
```
rab = sqrt(sum(Rab**2))
rab
```

[34]: 23.194827009486403

the force is:

$$\vec{F}_{AB} = \frac{Q_A * Q_B}{4 * \pi * \epsilon_0 * R_{AB}^3}\vec{R}_{AB}$$

[35]:
```
Fab = ((Qa*Qb)/(4*pi*(1e-9/(36*pi)*rab)))*Rab

print('Fab = {:.2e}*i {:.2e}*j {:.2e}*k'.format(*Fab))
```

```
Fab = -8.15e+02*i 1.55e+02*j -3.49e+02*k
```

### 1.6 Q7

putting on the input:

[36]:
```
q = 2e-6
F = 0.1
```

$$d = \sqrt{\frac{k * Q^2}{F}}$$

[37]:
```
d = sqrt((k*q**2)/F)
d
```

[37]:
```
0.6
```

soon:

$$d = 0.6m$$

### 1.7 Q3

first step:

$$Q_1 <-------(x)-------->Q_3 <-------(d-x)-------->Q_2$$

in order to have a balanced system we have $\vec{F}_{13} = \vec{F}_{23}$

$$\frac{k * q_1 * q_2}{x^2} = \frac{k * q_2 * q_3}{(d-x)^2}$$

simplifying:

$$\frac{d-x}{x} = \sqrt{\frac{q_2}{q_1}}$$

[38]:
```
q1 = -9e-6
q2 = -36e-6

b = sqrt(q2/q1) + 1 #b = d/x
b
```

[38]: 3.0

soon we stay with: $\frac{d}{x} = 3 \rightarrow d = 3x$, we've always that the proportion of 1 to 3

looking now for the balanced system in $Q_2$:

$$\vec{F}_{32} = \vec{F}_{12}$$

$$\frac{k * q_3 * q_2}{(d-x)^2} = \frac{k * q_1 * q_2}{d^2}$$

$$q_3 = q_1 \frac{(d-x)^2}{d^2}$$

[39]:
```
x = 1 # arbitrary value for calculate
d=3*x
q3 = q1*(((d-x)**2)/(d**2))
q3
```

[39]: -4e-06

$$q_3 = -4\mu C$$