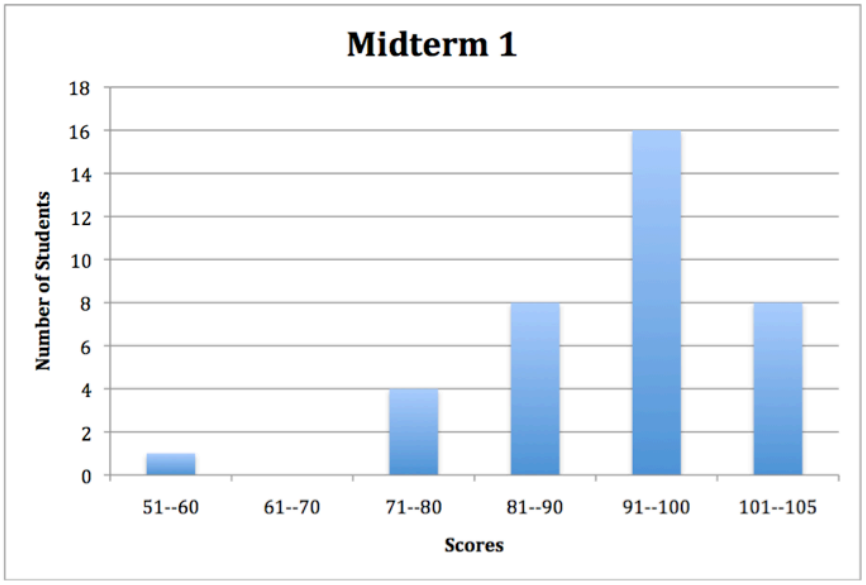
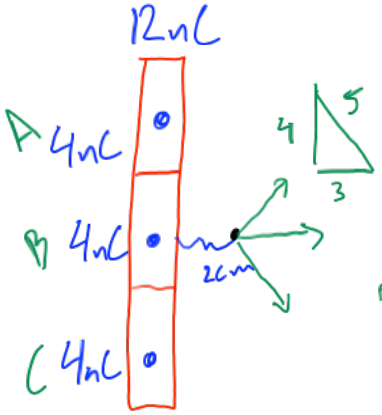
Jan 30

Finish VPython program or work on lab for 10 minutes



Mean: 89.2 (92.6 after bonuses)
Median: 91 (96 after bonuses)
Std Dev: 8.9 (10.0 after bonuses)

Tangible: Charged Nameblocks



12 nC on one block, others neutral
(each is 2 cm by 2 cm by 4 cm)
Bring them into contact,
ignore corners
Find electric field 2 cm to the right of center block's right edge

B: $d = 3\text{cm}$ $\quad E_{middle} = \frac{1}{4\pi\varepsilon_0}\frac{q}{d^2}\langle 1,0,0\rangle$

$= 9\times10^9 \frac{4\times10^{-9}}{(3\times10^{-2})^2}\langle 1,0,0\rangle = 4e4\frac{N}{C}\hat{x}$

A: $d = 5\text{cm}$ $\quad E_{top} = \frac{1}{4\pi\varepsilon_0}\frac{q}{d^2}\langle \frac{3}{5}, -\frac{4}{5}, 0\rangle$

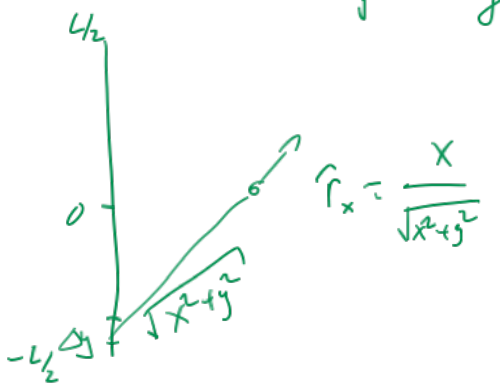
$= \langle 8.6e3, -1.2e4, 0\rangle N/C$

C: $E_{bottom} = \langle 8.6e3, +1.2e4, 0\rangle N/C$

$E_{net} = 5.7e4\frac{N}{C}\hat{x}$

Ponderable: Charges on a rod

Supercharge Me

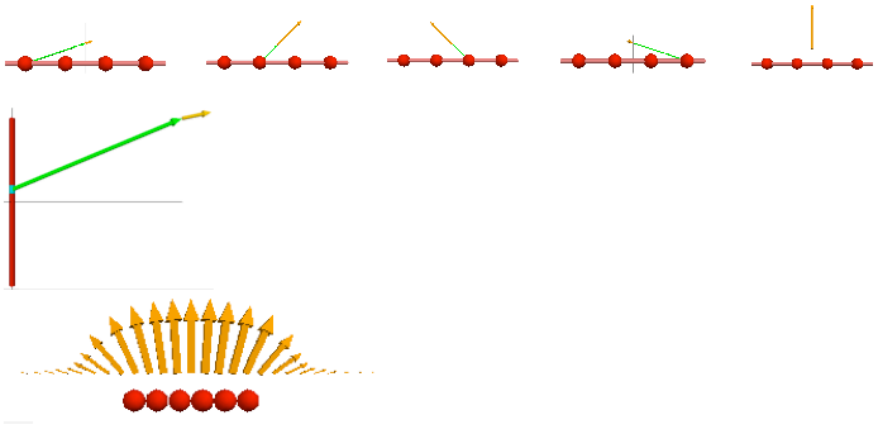


$$\Delta E_x = \frac{1}{4\pi\epsilon_0}\frac{Q}{L}\frac{\Delta y}{(x^2+y^2)}\frac{x}{\sqrt{x^2+y^2}}$$

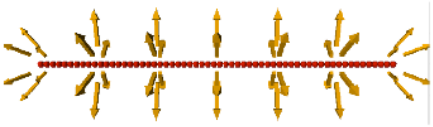
$$E_x = \frac{1}{4\pi\epsilon_0}\frac{Q}{L}\int_{-L/2}^{L/2}\frac{x}{(x^2+y^2)^{3/2}}\,dy$$

$\frac{Q}{L}\Delta y$ ~ amount of charge in length Δy

Demo: Visualizing field from rod



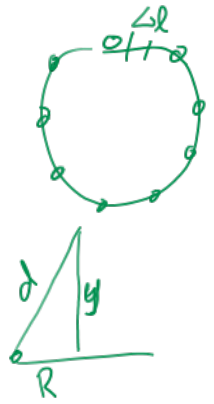
```
#constants
L = 2
N = 6
Q = 3e-8
oofpez = 9e9
scalefactor = 1.0/569.0
deltax = L/N
deltaQ = Q/N

#initial values
x = (L/6)/2
xobs = -L
xobsfinal = 2*L
delta_xobs = L/10.

#first loop to create objects representing pieces of rod
while x < L:
    sphere(pos = vector(x,0,0),radius = deltax/2,color=color.red)
    x = x + deltax

while xobs < xobsfinal:

    #second loop to calculate net E field at one spot
    obslocation = vector(xobs,0.4,0)
    Enet = vector(0,0,0)
    x=(L/6)/2
    while x < L:
        sourcelocation = vector(x,0,0)
        r = obslocation-sourcelocation
        rhat = r/mag(r)
        deltaE = oofpez*deltaQ/(mag(r)**2)*rhat
        Enet = Enet + deltaE
        x = x + deltax

    print "Enet = ", Enet, "  mag(Enet) = ",mag(Enet)
    arrow(pos = obslocation,axis = scalefactor*Enet, color = color.orange)
    xobs = xobs + delta_xobs
```



Tangible: Charged Up Table Occupants

Everyone has $+5\,\mu C$ (spread them around edge of table)

What is field above center of table measured at ceiling?



$$\Delta E_y = \frac{1}{4\pi\varepsilon_0}\frac{Q}{2\pi R}\Delta l\,\frac{y}{(R^2+y^2)^{3/2}}$$

$$E_y = \frac{1}{4\pi\varepsilon_0}\frac{Q}{2\pi R}\frac{y}{(R^2+y^2)^{3/2}}\int \Delta l = \frac{1}{4\pi\varepsilon_0}\frac{Q\,y}{(R^2+y^2)^{3/2}}$$

Ponderable: Parallel computing of field due to ring of charge

E field from a uniform ring of charge

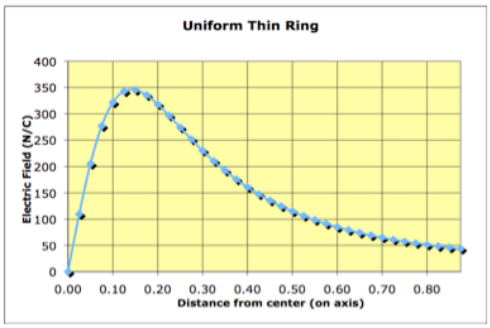
q = 4 nC
R = 20 cm

$$E = \frac{1}{4\pi\varepsilon_0}\frac{Qz}{(R^2+z^2)^{3/2}}$$

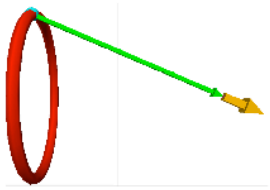
	Given Distance			Calculated Field		
Group	**1**	**2**	**3**	1	2	3
1a	**0.000**	**0.325**	**0.650**			
1b	**0.025**	**0.350**	**0.675**			
1c	**0.050**	**0.375**	**0.700**			
2a	**0.075**	**0.400**	**0.725**			
2b	**0.100**	**0.425**	**0.750**			
2c	**0.125**	**0.450**	**0.775**			
3a	**0.150**	**0.475**	**0.800**			
3b	**0.175**	**0.500**	**0.825**			
3c	**0.200**	**0.525**	**0.850**			
4a	**0.225**	**0.550**	**0.875**			
4b	**0.250**	**0.575**	**0.900**			
5a	**0.275**	**0.600**	**0.925**			
5b	**0.300**	**0.625**	**0.950**			

Ponderable: Parallel computing of field due to ring of charge

	Given Distance			Calculated Field		
Group	**1**	**2**	**3**	1	2	3
1a	**0.000**	**0.325**	**0.650**	0	210	74
1b	**0.025**	**0.350**	**0.675**	110	192	70
1c	**0.050**	**0.375**	**0.700**	205	176	65
2a	**0.075**	**0.400**	**0.725**	277	161	61
2b	**0.100**	**0.425**	**0.750**	322	148	58
2c	**0.125**	**0.450**	**0.775**	343	136	54
3a	**0.150**	**0.475**	**0.800**	345	125	51
3b	**0.175**	**0.500**	**0.825**	335	115	49
3c	**0.200**	**0.525**	**0.850**	318	106	46
4a	**0.225**	**0.550**	**0.875**	297	99	44
4b	**0.250**	**0.575**	**0.900**	274	92	41
5a	**0.275**	**0.600**	**0.925**	252	85	39
5b	**0.300**	**0.625**	**0.950**	230	80	37



Demo: Visualizing E field from disk and ring



Ponderable: Parallel computing of field due to disk of charge

	Given Distance		
Group	a	b	c
1a	0.00001	0.001	0.10
1b	0.00002	0.002	0.20
1c	0.00003	0.003	0.30
2a	0.00004	0.004	0.40
2b	0.00005	0.005	0.50
2c	0.00006	0.006	0.60
3a	0.00007	0.007	0.70
3b	0.00008	0.008	0.80
3c	0.00009	0.009	0.90
4a	0.00010	0.010	1.00
4b	0.00011	0.011	1.10
5a	0.00012	0.012	1.20
5b	0.00013	0.013	1.30

R = 20 cm

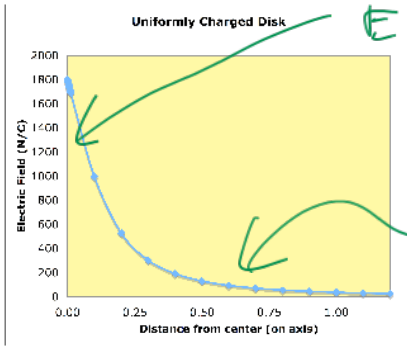
$Q = 4\,nC$

$\epsilon_0 = 8.85e{-12}$

$$\vec{E}_z = \frac{\sigma/A}{2\epsilon_0}\left[1 - \frac{z}{\sqrt{R^2+z^2}}\right]$$

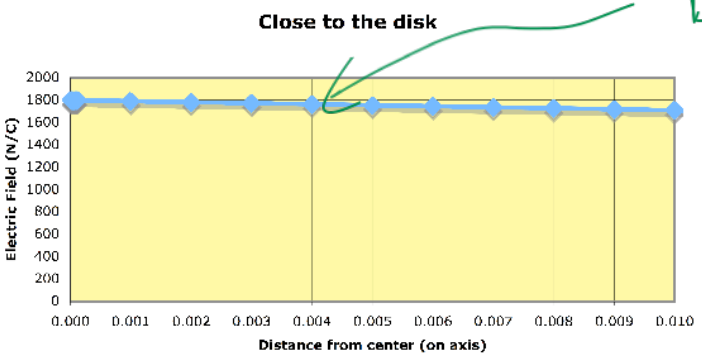
Ponderable: Parallel computing of field due to disk of charge

	Given Distance			Calculated Field		
Group	a	b	c	a	b	c
1a	0.00001	0.001	0.10	1798	1789	994.1
1b	0.00002	0.002	0.20	1798	1780	526.7
1c	0.00003	0.003	0.30	1798	1771	302.0
2a	0.00004	0.004	0.40	1798	1762	189.9
2b	0.00005	0.005	0.50	1798	1753	128.6
2c	0.00006	0.006	0.60	1798	1744	92.3
3a	0.00007	0.007	0.70	1798	1735	69.2
3b	0.00008	0.008	0.80	1798	1726	53.7
3c	0.00009	0.009	0.90	1798	1718	42.8
4a	0.00010	0.010	1.00	1797	1709	34.9
4b	0.00011	0.011	1.10	1797	1700	29.0
5a	0.00012	0.012	1.20	1797	1691	24.5
5b	0.00013	0.013	1.30	1797	1682	20.9



$$E = \frac{Q/A}{2\epsilon_0}\left[1 - \frac{z}{R}\right]$$

$$E = \frac{Q/A}{2\epsilon_0}\left[1 - \frac{z}{\sqrt{R^2+z^2}}\right]$$



$$E = \frac{Q/A}{2\epsilon_0}$$

$$F_z = \frac{Q/A}{2\epsilon_0}\left[1 - \frac{z}{\sqrt{R^2+z^2}}\right]$$