Book Problems:

Chapter 13: 27, 45, 53, 59, 61

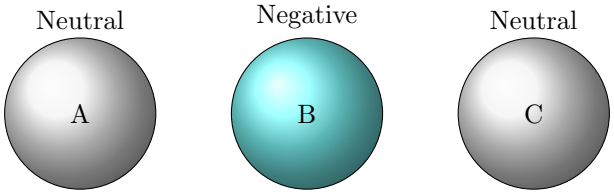
Chapter 14: 35, 47, 49, 53, 63

Chapter 15: 27, 37, 41, 50

- Solution to Ch 15.50 on last page

Sample Problems:

1. For each of the situations below, assume you start with the configuration of conducting metal balls below:



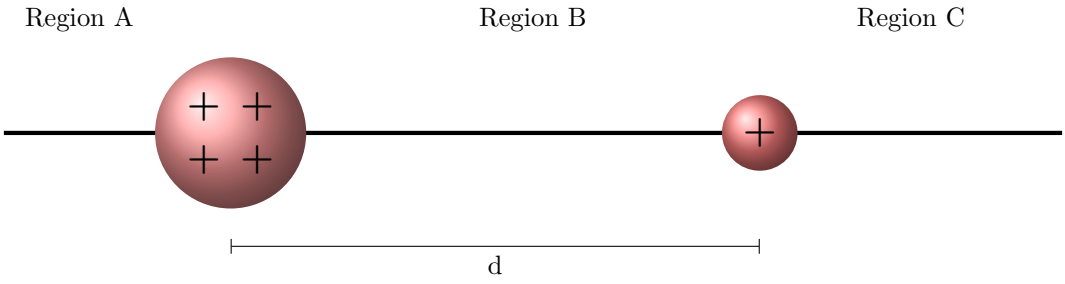
   (a) You bring all the balls together to touch and then separate them again. What is the net charge of each ball?

   (b) You bring the balls back together and then bring a negatively charged rod near (but not touching) Ball A. Then you:
      i. Take the rod away, then separate the balls. What is the net charge on each?

      ii. Ground Ball C momentarily, separate the balls, then take the rod away. What is the net charge on each ball?

2. Explain why a positively charged wand attracts a neutral piece of insulating paper.

3. Use the situation below to answer the following questions:

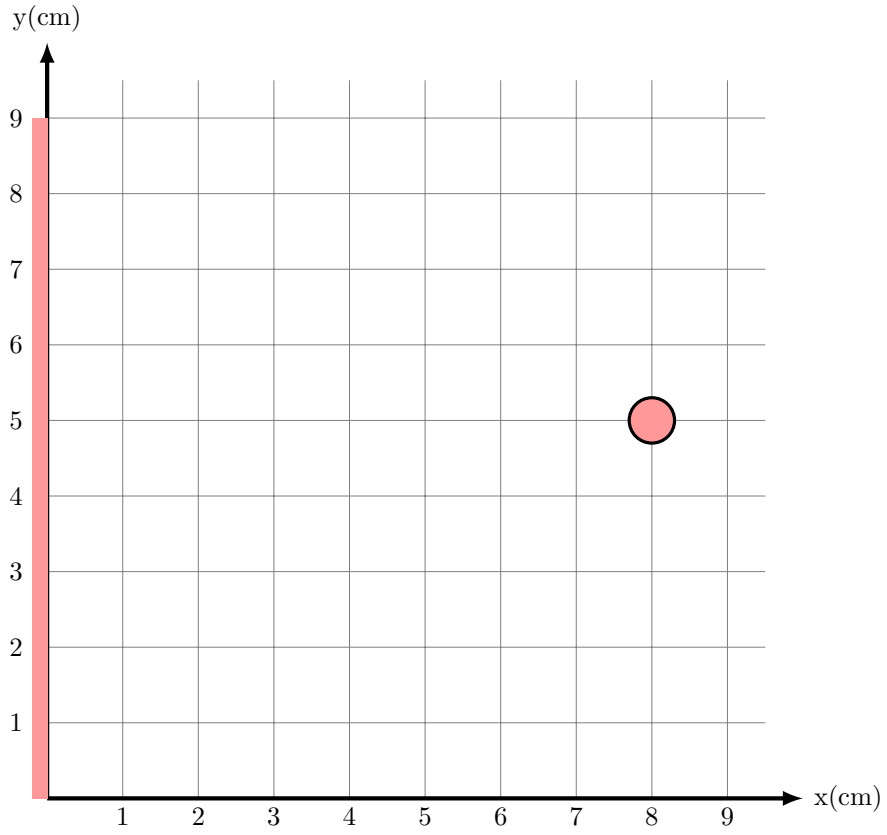


   (a) In what region would a point with zero net electric field exist?

   (b) How far from the left charge would such a point exist? (Your answer will depend on d.)

4. A 60 kg ice skater coasts onto a patch of ice traveling at 20 m/s. Her wool clothing has picked up some serious charge, and thus she has a total charge of 20 µC. 40 meters in front of her looms an immense wall that happens to possess a surface charge density of 300 µC/m^2 (weird!). Will she hit the wall? If yes, how much slower would she need to be going to turn around before hitting the wall? If no, how close to the wall will she get?

5. An infinite line charge ($\lambda = 75\,\text{nC/m}$) and a point charge ($q = 10\,\text{nC}$) are hanging out on top of an insulated table. I want to place down a negative charge such that it has zero net force. At what x and y position do I place the charge? The picture below shows a top down view of the situation.



6. The below parts are some examples of the types of questions that might be asked that concern some aspect of computation or Glowscript.

   (a) You'd like to simulate a line charge in Glowscript. The line starts at the point $\langle 1, 2, 3\rangle$ m and stretches 3 m in the z-direction. The total charge on the line is 10 µC and you'd like to break it into 20 chunks. Fill in the missing blanks in the code below to correctly set up a list of charges for this simulation.

```
Q = 10E-6
L = 3
N = _ _ _ _ _ _

list_of_charges = []
for z in range(_ _ _ _ _ _):
        list_of_charges.append(sphere(pos=vec( _ _ _ _ _ _ ),
                                       radius=L/N/2,
                                       color=color.red,
                                       q = _ _ _ _ _ _ ))
```

   (b) You have either been given an existing list of charges or you have already calculated it as done above, and the list is accurately called `list_of_charges`. Fill in the missing blanks below to calculate the net electric field at a particular location due to all charges in the list.

```
oofpez = 9E9
Q = 10E-6
N = 20
dq = Q/N

# List of charges is generated and returned to you as list_of_charges

obsloc = vec(2,2,2)

Enet = vec(0,0,0)

for charge in list_of_charges:
        # I'm not telling you there are necessarily just two lines
        # to fill in below, just that there might be more than 1
        _ _ _ _ _ _
        _ _ _ _ _ _

print(Enet)
```

Solutions:

1.
   - Each is negative
   - Each is negative
   - Ball A is positive, Balls B and C are neutral
2. The charged wand induces the molecular dipoles in the paper to align, such that the negative ends are closer to the wand than the positive ends. Since the electric field of a charged wand has a $\frac{1}{r}$ dependence, the positive ends of the dipoles feel a smaller force than the negative ends. Added up over each dipole, the net force is enough for the paper to be picked up by the charged rod.
3.
   - Region B
   - $\frac{2}{3}d$
4. No, 4.6 m
5. $x = 3.3\,\text{cm}$, $y = 5\,\text{cm}$
6.
   - Part A
     - `20`
     - `3, 3+L, L/N`
     - `1, 2, z`
     - `Q/N`
   - Part B
     - `r = obsloc - charge.pos`
     - `dE = oofpez*Q*r.hat/r.mag**2`
     - `Enet = Enet + dE`

Ch 15.50: Uniformly charged rod, uniformly charged disk, a dipole, a point charge or hollow sphere