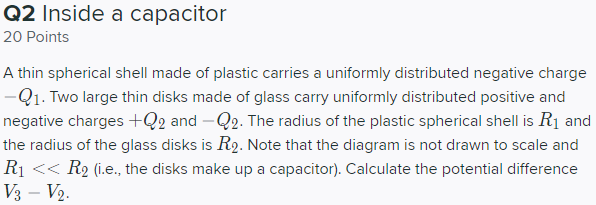
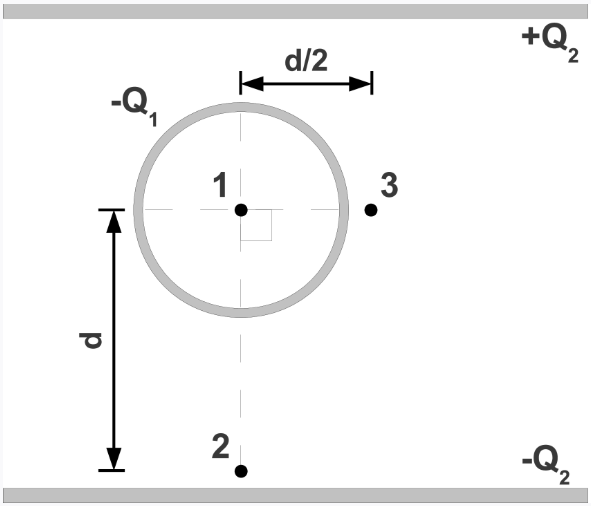
[2pt]



4

[8pt] Capacitor:   in direction

[10pt] Spherical shell (outside the shell): towards the center of the shell

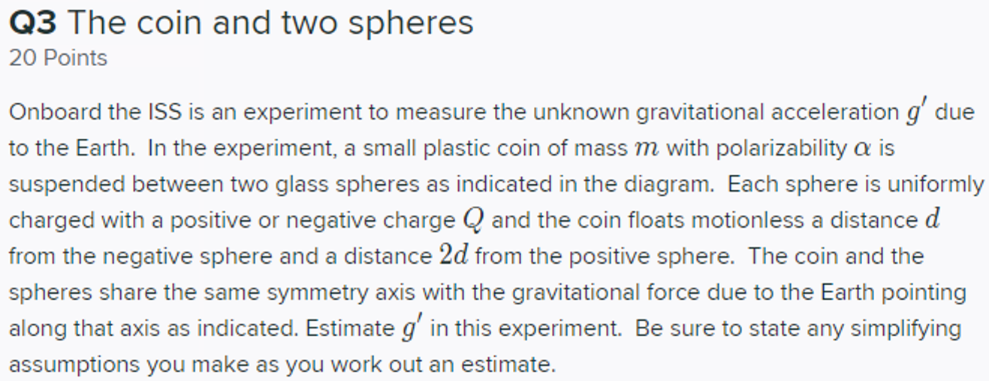
where point 4 is mid-point of line segment 12.

[Grading Rubric] for capacitor: -1 pt, clerical; -2 pt, minor; -4 pt, major; -8 pt, m.p.

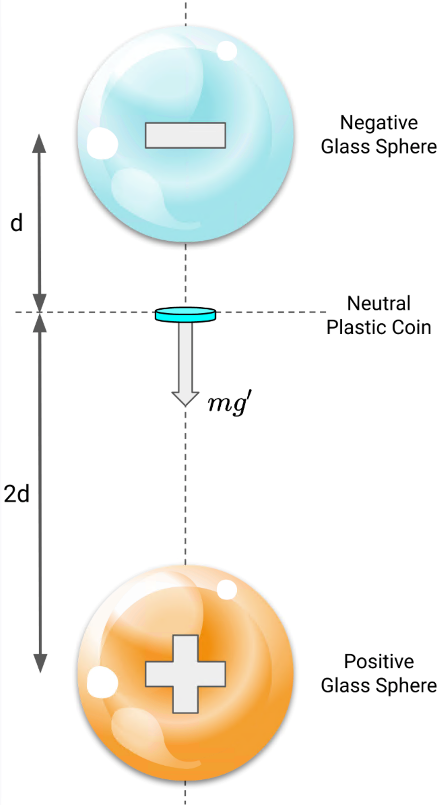
[Grading Rubric] for spherical shell: -1 pt, clerical; -2 pt, minor; -5 pt, major; -10 pt, m.p.

Minor: wrong -direction or wrong sign

Major: wrong , wrong , wrong integration, missing

Assumption: The coin is very thin and can be modeled as a dipole.

-field at the center of the plastic coin



- - - -q

+ + + +q

Dipole moment of the coin (surface charges shown in the diagram)

Electric force on the coin due to the negative sphere (in direction)

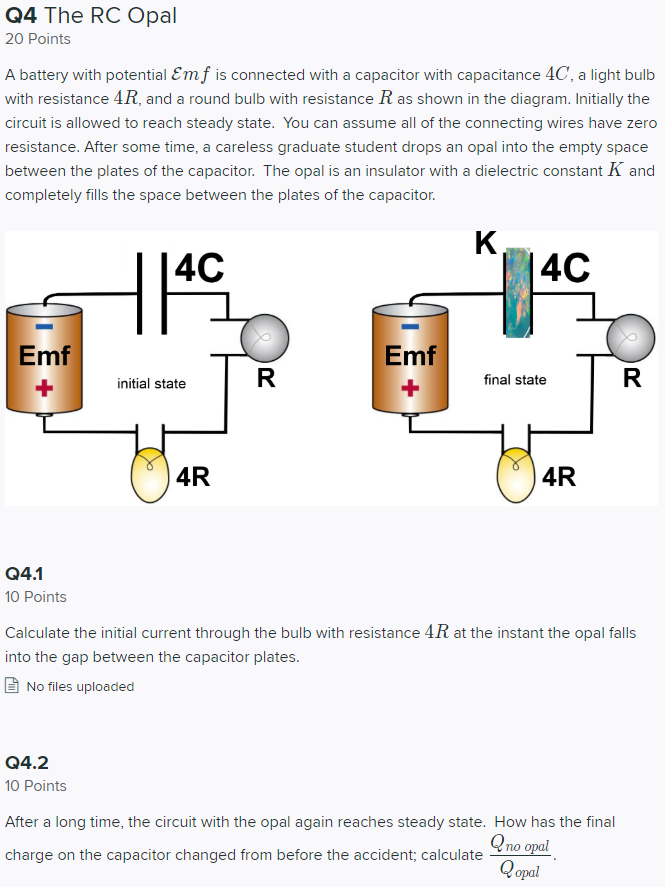
Similarly, electric force on the coin due to the positive sphere (in direction)

Coin floating:

[Grading Rubric]: -2 pt, clerical; -4 pt, minor; -8 pt, major; -16 pt, m.p.

Minor: sign errors

Major: not using superposition for -field, not searching for , not using force balance

[10 pt] Q4.1

At steady state,

When the opal falls in,

Loop rule

[10 pt] Q4.2

After a long time, the potential difference across the capacitor becomes again.

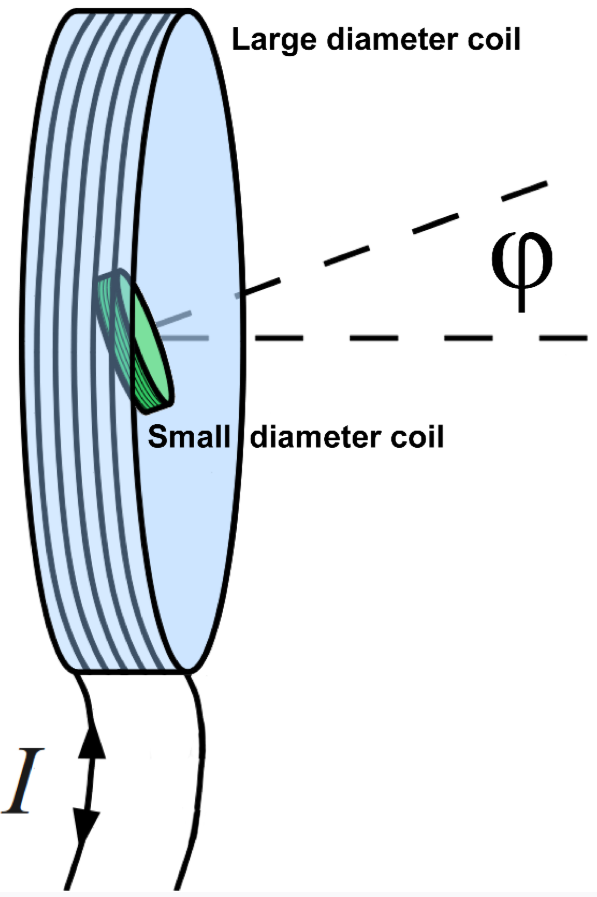
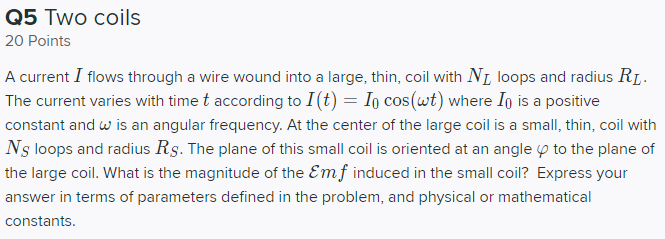
The applied -field

[Note: there are different ways to solve Q4.2.]

[Grading Rubric] for both parts: -1 pt, clerical; -2 pt, minor; -5 pt, major; -10 pt, m.p.

Minor: sign errors in loop rule

Major: not describing steady state correctly, not applying K correctly, not using loop rule

Magnetic field generated at the center of the large coil

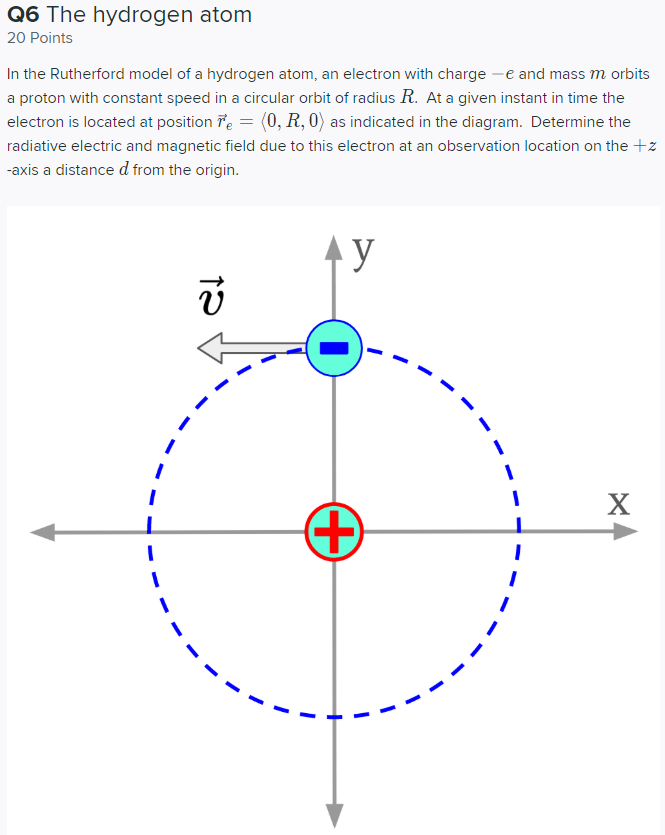
Magnetic flux through the small coil

Faraday’s Law

[Grading Rubric]: -2 pt, clerical; -4 pt, minor; -8 pt, major; -16 pt, m.p.

Minor: completely missing , … (copy errors between lines are clerical)

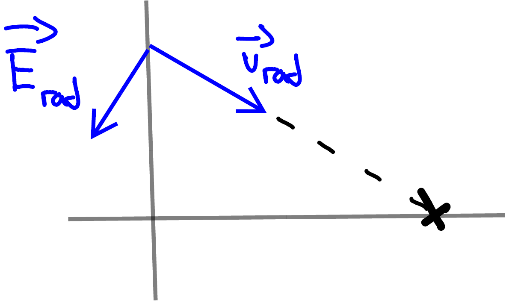
Major: missing an important component such as area and , wrong derivative, mixing and

[15 pt] Centripetal acceleration

along the direction.

Radiative -field of the electron ()

where and



and

[5 pt] into the page

[Grading Rubric]: should match ; check for POE

[Grading Rubric] for -field: -1 pt, clerical; -3 pt, minor; -6 pt, major; -12 pt, m.p.

Minor: sign errors, wrong expression for and

Major: wrong acceleration, wrong , wrong