Purdue University
PHYS221
EXAM I
September 24,2002

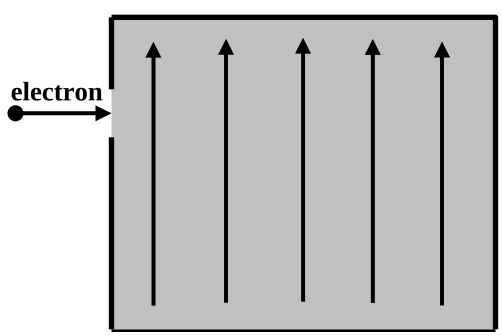
Please use a #2 pencil to fill in data for name, student ID #, and section on the computer sheet. Mark the correct answer for each problem on the same sheet. There will by no penalty for wrong answers. Please check to see that your exam has all 16 problems. All useful basic equations and constants are provided. Note that you will not need all of the equations and constants provided to do this exam.

(1) At which point (or points) is the electric field zero N/C for the two point charges shown on the x axis? (10 points)

a) The electric field is never zero in the vicinity of these charges.
b) The electric field is zero somewhere on the x axis to the left of the +4q charge.
c) The electric field is zero somewhere on the x axis to the right of the -2q charge. *
d) The electric field is zero somewhere on the x axis between the two charges, but this point is nearer to the -2q charge.
e) The electric field is zero at two points along the x axis; one such point is to the right of the -2q charge and the other is to the left of the +4q charge.

(2) An electron traveling horizontally enters a region where a uniform electric field is directed upward. What is the direction of the force exerted on the electron once it has entered the field? (5 points)

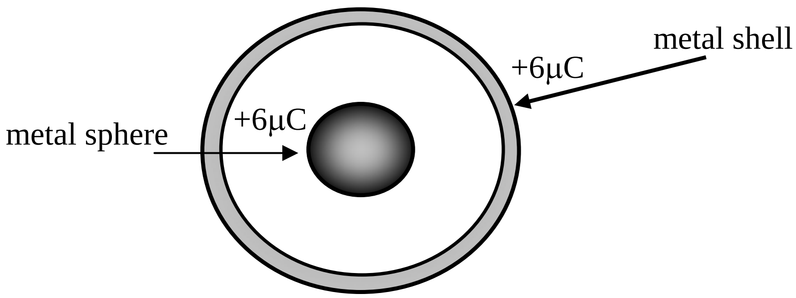
a) to the left
b) to the right
c) upward
d) downward *
e) out of the page, toward the reader



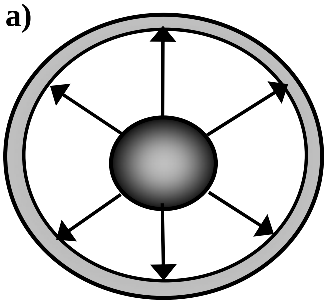
(3) A conducting sphere has a net charge of -4.8×10^{-17} C. What is the approximate number of excess electrons on the sphere? (5 points)

a) 100
b) 200
c) 300 *
d) 400
e) 500

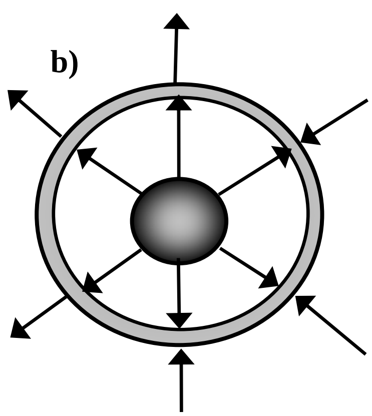
(4) Which one of the following figures shows a qualitatively accurate sketch of the electric field lines in and around this system? (5 points)



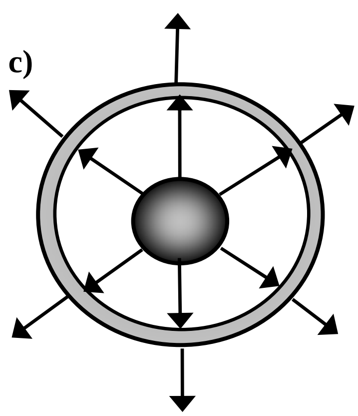
a)



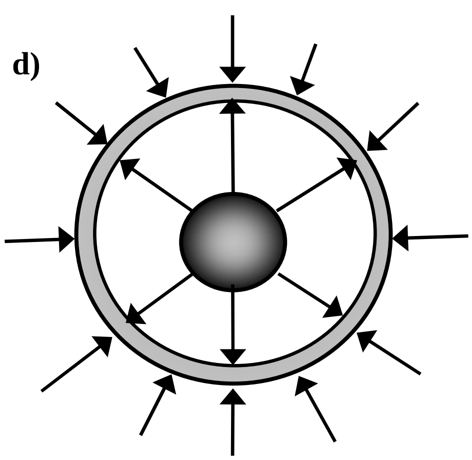
b)



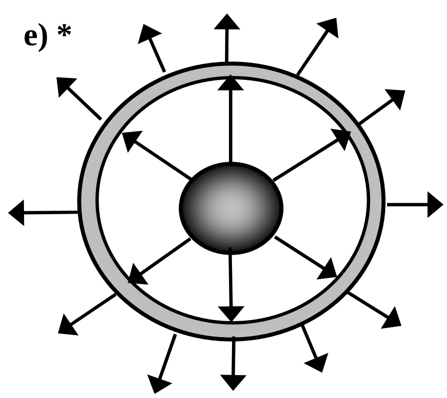
c)



d)



e) *

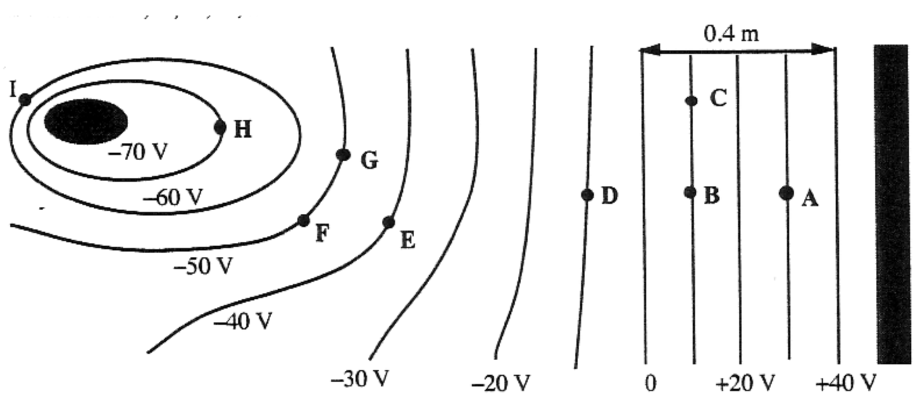


(5) Is the voltage in a U.S. domestic electrical outlet AC or DC, and roughly how many volts (rms) does it put out? (5 points)

a) AC 220V
b) DC 120V
c) AC 120V *
d) DC 170V
e) AC 170V

Questions 6 through 8 refer to the statement and figure below:

The sketch below shows cross sections of equipotential surfaces between two charged conductors that are shown in solid black. Various points on the equipotential surfaces near the conductors are labeled A, B, C, …, I.



(6) At which of the labeled points will an electron have the greatest potential of energy? (5 points)

a) A
b) D
c) G
d) H *
e) I

(7) What is the potential difference between points B and E? (5 points)

a) 10 V
b) 30 V
c) 40 V
d) 50 V *
e) 60 V

(8) What is the direction of the electric field at B? (5 points)

a) toward A
b) toward D *
c) toward C
d) into the page
e) up and out of the page

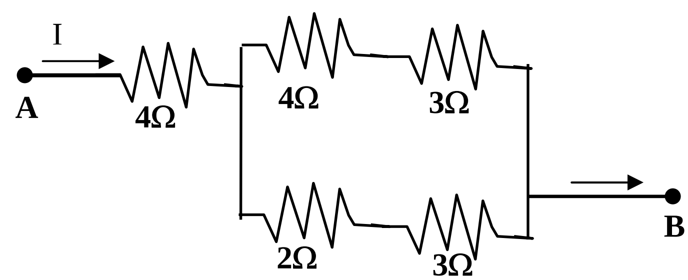
(9) The potential difference across the ends of a wire is doubled in magnitude. If Ohm's law is obeyed, which one of the following statements concerning resistance of the wire is true? (5 points)

a) The resistance is one half of its original value.
b) The resistance is twice its original value.
c) The resistance is not changed. *
d) The resistance increases by a factor of four.
e) The resistance decreases by a factor of four.

(10) Which one of the following statements concerning resistors in series is true? (5 points)

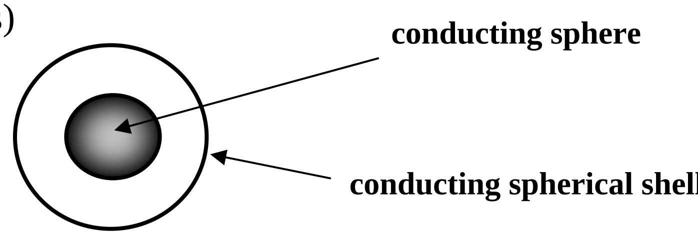
a) The voltage across each resistor is the same.
b) The current through each resistor is the same. *
c) The power dissipated by each resistor is the same.
d) The rate at which charge flows through each resistor depends on its resistance.
e) The total current through the resistors is the sum of the current through each resistor.

(11) Five resistors are connected as shown. What is the equivalent resistance between points A and B? (10 points)



a) 6.9 Ω *
b) 9.2 Ω
c) 3.4 Ω
d) 2.1 Ω
e) 16 Ω

(12) A conducting sphere carries a net charge of -6 μC. The sphere is located at the center of a conducting spherical shell that carries a net charge of +2 μC. Determine the excess charge on the outer surface of the spherical shell. (5 points)

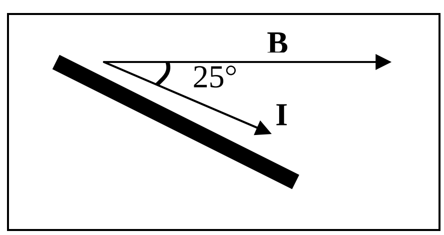


a) -4 μC *
b) +4 μC
c) -8 μC
d) +8 μC
e) +6 μC

(13) Which one of the following statements concerning permanent magnets is false? (5 points)

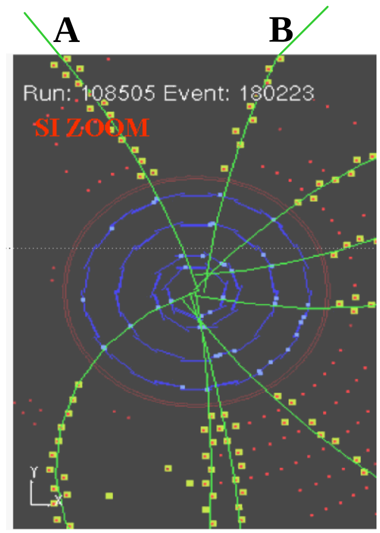
a) The north pole of a permanent magnet is attracted to a south pole.
b) All permanent magnets are surrounded by a magnetic field.
c) The direction of a magnetic field is indicated by the north pole of a compass.
d) Magnetic field lines outside a permanent magnet originate from the north pole and end on the south pole.
e) When a permanent magnet is cut in half, one piece will be a north pole and one piece will be a south pole. *

(14) A 0.150-m wire carries a direct current of 12.5 A. The wire in magnetic field. The angle between the direction of the current and that of the magnetic field is 25.0°. If the magnetic field strength is 0.625 T, what is the magnitude and direction of the magnetic force on the wire? (10 points)



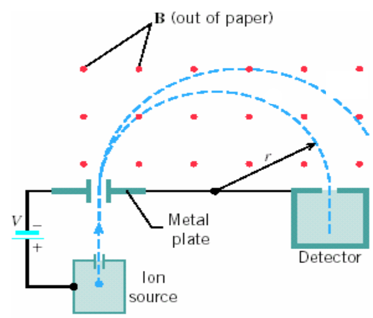
a) 1.17 N, upward
b) 3.30 N, downward
c) 1.17 N, downward
d) 0.495 N, perpendicular to the page and outward *
e) 0.495 N, perpendicular to the page an inward

(15) The picture below shows the trajectories of particles produced in a particle physics experiment. The particles are moving from the center of the picture outward to the edges of the picture. There is a magnetic field present directed into the page. What are the signs on the charges of particles A and B? (5 points)



(a) + + (b) + - * (c) - + (d) - - (e) 0 0

(16) In a mass spectrometer (see figure below), a magnetic field causes the trajectories of charged particles (typically ions) of various masses, to curve. For two iron isotopes with the same electric charge: ^{57}Fe & ^{56}Fe, which of the following statements is true? (Note: an Fe nucleus has 26 protons. The number preceding Fe is the total number of neutrons and protons in the nucleus.) (10 points).



a) ^{57}Fe will follow a trajectory with a slightly larger radius than ^{56}Fe. *
b) ^{56}Fe will follow a trajectory with a slightly larger radius than ^{57}Fe
c) Both isotopes will follow trajectories with the same radius because they are the same element.
d) ^{57}Fe will follow a trajectory with a radius twice as large as ^{56}Fe.
e) ^{56}Fe will follow a trajectory with a radius twice as large as ^{57}Fe.