Physics 203 Practice Midterm Exam 2

This is a practice exam for your use in preparing for the second midterm in PH203. My suggestion is that you take this test under similar circumstances to the actual exam.

I will give you the same ominous warning that my undergraduate professor always gave: doing well on this practice exam does not mean that you will do well on real exam, but doing poorly on this likely does mean you will do poorly on the exam. There may also be subjects not covered by this practice exam that will appear on the midterm. Consult the lecture notes, MP, boxsand, CHWs, recitation notes, etc. Have fun, work hard!

Constants:

$\mathbf{e = 1.602 \times 10^{-19} C}$, $\mathbf{m_e = 9.109 \times 10^{-31} kg}$, $\mathbf{m_p = 1.67 \times 10^{-27} kg}$

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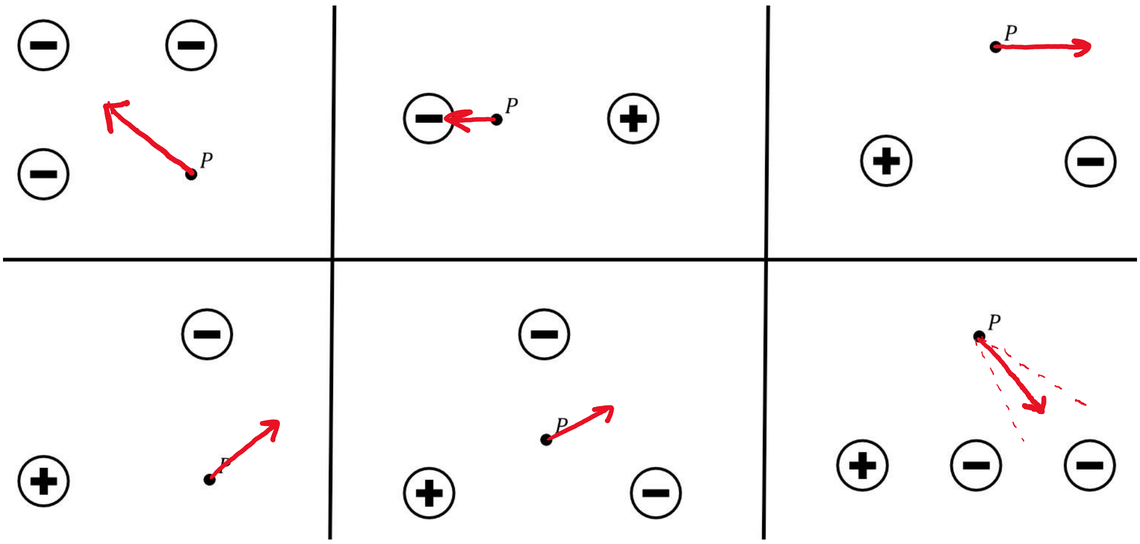
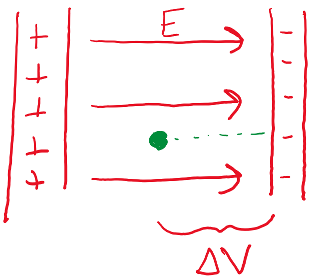
1. **(6 points)** For each of the following charge arrangements draw one clear arrow indicating the direction of the electric field at point **P**.



2. **(5 points)** A proton is released from rest at the midpoint between two parallel plate capacitors. If the proton hits the negative plate with $1 \times 10^{-18} J$ of energy, what is the voltage difference between the plates?



$E_b = q\Delta V \qquad E_a = \frac{1}{2}mv^2 = 1.0\times10^{-18} J$

$1.0\times10^{-18} = 1.6\times10^{-19}(\Delta V)$

$\Delta V = \frac{10}{1.6} = 6.25$

$\Delta V_{plates} = 2\Delta V = 12.5 V$

For questions 3 through 6 **fill in the square** next to all correct answers, a given problem may have more or less than one correct answer. Each correctly chosen answer will receive two points. There are 6 correct answers in this section and only the first 6 filled in answers will be graded. There is no partial credit.

3. Which of the following are scalar fields?

a) A map of the world's ocean currents

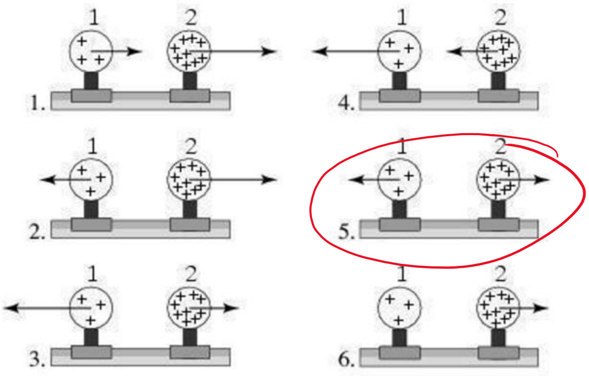
b) The electric potential near a point charge

c) The electric field between two parallel plate capacitor plates

d) A map of the elevation surrounding Mary's Peak

e) A map of the current at every point in the Willamette River

4. Which of the images on the right correctly display the forces on each of the two charged spheres?



1)

2)

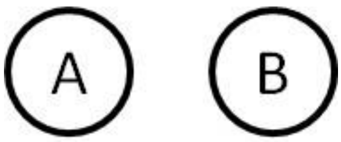
3)

4)

5)

6)

5. You start with two identical neutral, conducting, spheres labeled A and B. Sphere A always stays to the left of sphere B as pictured. Which of the following procedures results in a negatively charged sphere B?



a) Touch both spheres together. Bring a positive rod close (no touching!) to the left side of sphere A. Pull the two spheres apart.

b) Touch both spheres together. Bring a negative rod close (no touching!) to the left side of sphere A. Pull the two spheres apart.

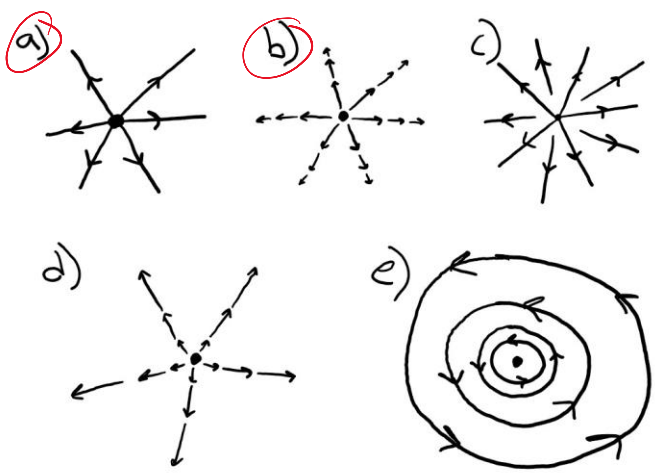
c) Touch both spheres together. Touch a positive conducting rod to sphere A. Pull the two spheres apart.

d) Touch both spheres together. Touch a positive insulating rod to sphere A. Pull the two spheres apart.

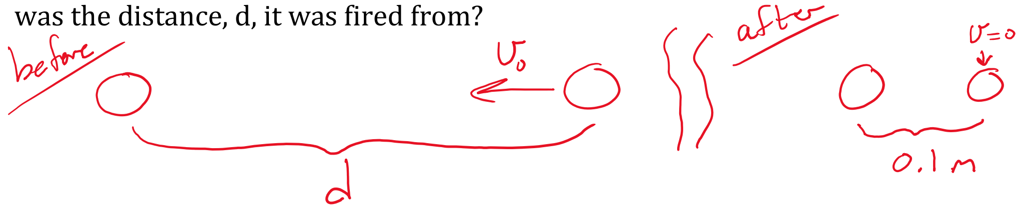
e) It is not possible to get a negatively charged sphere B unless both spheres are insulating spheres.

6. Which of the following diagrams could represent an electric field who's magnitude is decreasing with distance from the center dot?

(a) (circled)
(b) (circled)
c)
d)
e)



7. **(8 points)** Two identical point charges have mass 1.0 kg and charge +0.0030 C. One is fixed to the origin and cannot move. The other is fired towards the origin from a cannon located a distance d away. The speed of the moving charge is 900.0 m/s immediately after it is fired from the cannon. The closest it gets to the origin is 0.10 meters. What was the distance, d, it was fired from?



$$E_{before} = \frac{1}{2} m v_0^2 + k \frac{q_1 q_2}{d}$$

$$E_{after} = k \frac{q_1 q_2}{0.1}$$

$$E_{before} = E_{after} \Rightarrow \frac{1}{2} m v_0^2 + k\frac{q^2}{d} = k\frac{q^2}{0.1}$$

$$k\frac{q^2}{d} = k\frac{q^2}{0.1} - \frac{1}{2} m v_0^2$$

$$d = \frac{kq^2}{k\frac{q^2}{0.1} - \frac{1}{2} m v_0^2}$$

$$d = \frac{9\times10^9 (3\times10^{-3})^2}{\frac{9\times10^9 (3\times10^{-3})^2}{10^{-1}} - \frac{1}{2}(1.0)(900)^2}$$

$$d = \frac{81\times10^3}{81\times10^4 - 40.5\times10^4} = \frac{81}{40.5}\times10^{-1}$$

$$\boxed{d = 0.2\,m}$$

← 900 m/s & it only gets 10 cm closer!

8. An electrically charged bowling ball of mass = 5.0 kg and charge = – 0.05 C slides to the right across a flat frictionless surface. It slides through an electric field which starts at x = 2.0 m and ends at x = d.

a. **(3 pts)** If the bowling ball feels a force of 2 N to the left, what is the magnitude and direction of the electric field?

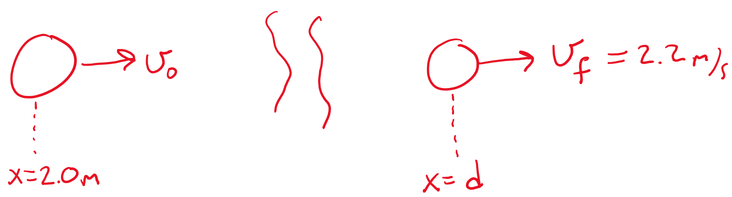
$\vec{F} = -q\vec{E}$ ($\vec{F}$: left; $\vec{E}$: right or $\langle 1,0,0\rangle$)

$\vec{E} = \frac{\vec{F}}{q} = -\frac{2\,N}{0.05\,C} = -40\,\frac{N}{C}$

$\boxed{\vec{E} = 40\ \frac{N}{C}\ \langle 1,0,0\rangle}$

b. **(5 pts)** If the bowling ball has a speed of 3.0 m/s at x = 0.0 m, and a speed of 2.2 m/s after it exits the field, what is d?

$v_0 = 3.0\ m/s$



$KE_b = \frac{1}{2}mv_0^2$
$KE_a = \frac{1}{2}mv_f^2$
$\Delta KE = W$

$W = -F\Delta x = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_0^2$

$-2(d-2) = \frac{1}{2}(5)(2.2^2 - 3^2)$

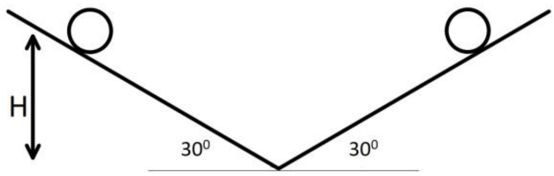
$\boxed{d = 7.2\ m}$

c. **(2 pts)** Through what electric potential difference, delta V, did the bowling ball travel?

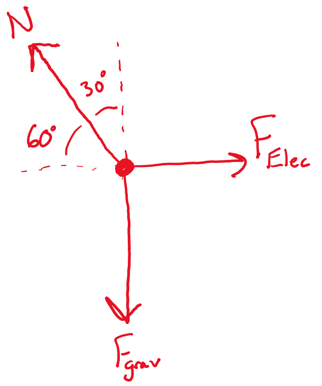
$\Delta V = E\,\Delta x = 40(7.2 - 2.0) = 208\ V$

$\boxed{\Delta V = 208\ V}$

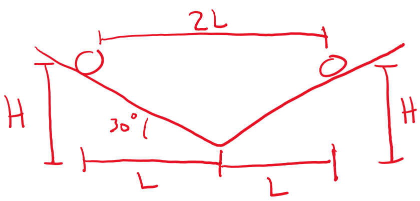
9. Two positively charged spheres are at rest in equilibrium on the pictured diagram. They each have a mass of 1.0 kg, and a charge of 3.0 x Coulombs.



a. **(2 pts)** Draw a free body diagram for the charge on the right.



b. **(8 pts)** What is their height, H?



$\tan 30° = \frac{H}{L}$

$L = \frac{H}{\tan 30°}$

$mg = N \cos 30°$

$N = \frac{mg}{\cos 30°}$

$F_{Elec} = N \sin 30° = mg \tan(30°)$

$k \frac{q^2}{(2L)^2} = mg \tan(30°)$

$\frac{kq^2}{mg \tan 30°} = 4L^2 = 4 \frac{H^2}{\tan(30°)^2}$

$\Rightarrow H^2 = \frac{kq^2 \tan 30°}{4mg} = \frac{(9 \times 10^9)(3.0)^2 \frac{1}{\sqrt{3}}}{4(1.0)(9.81)}$

$H = 34.5$ km

!!! (it turns out 1C is a HUGE charge!)