Phys 112
Spring 2013

# General Physics: Class Exam I v1 10am

15 February 2013

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## Instructions

- There are 7 questions on 5 pages.
- Show your reasoning and calculations and always justify your answers.

## Physical constants and useful formulae

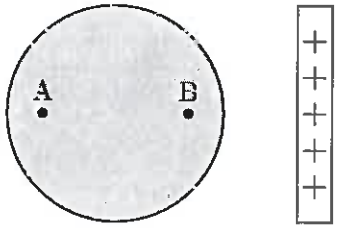
Coulomb's constant: $k = 9.0 \times 10^9\,\mathrm{Nm^2/C^2}$

Electron charge: $q_{\mathrm{electron}} = -1.60 \times 10^{-19}\,\mathrm{C}$ Electron mass: $m_e = 9.11 \times 10^{-31}\,\mathrm{kg}$

Proton charge $q_{\mathrm{proton}} = +1.60 \times 10^{-19}\,\mathrm{C}$ Proton mass: $m_p = 1.67 \times 10^{-27}\,\mathrm{kg}$

## Question 1

A positively charged rod is held next to a solid sphere made of a perfect conducting material. The sphere and rod are held fixed.




a) Is the negative charge in the sphere evenly distributed throughout the sphere? Explain your answer.

b) Is the electric potential at point A the same, larger, or smaller than that at point B? Explain your answer.

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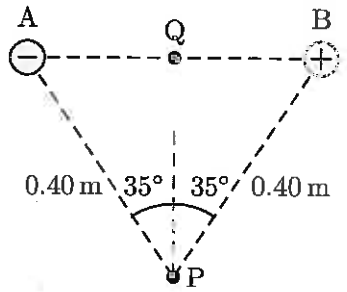
## Question 2

Two fixed charged particles are situated as illustrated. The charges of these particles are

$$q_A = -16.0 \times 10^{-9}\,\text{C} \quad \text{and}$$
$$q_B = +16.0 \times 10^{-9}\,\text{C}.$$




a) Determine the electric field produced by the entire charge distribution at the location labeled P. Describe the direction of the electric field.

Question 2 continued ...

b) A student considers teh point Q midway between the charges and states that, "The potential at point Q is zero and this means that the electric field at point Q is zero." Is this claim true or false? Explain your answer.

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## Question 3

Two oppositely charged particles, A and B, are held fixed near to each other. A has charge $+8\,\mathrm{C}$ and B has charge $-4\,\mathrm{C}$. How does the *magnitude* of the force exerted by A on B, $F_{\text{A on B}}$, compare to the magnitude of the force exerted by B on A, $F_{\text{B on A}}$ (choose one)?


a) $F_{\text{A on B}} = \frac{1}{2} F_{\text{B on A}}$.

b) $F_{\text{A on B}} = F_{\text{B on A}}$.

c) $F_{\text{A on B}} = 2\, F_{\text{B on A}}$.

d) $F_{\text{A on B}} = 4\, F_{\text{B on A}}$.

e) $F_{\text{A on B}} = 8\, F_{\text{B on A}}$.

By Newton's 3rd Law

$\vec{F}_{A\text{ on }B} = F_{B\text{ on }A}$

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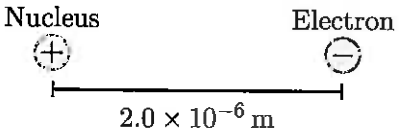
## Question 4

An electron and a nucleus, consisting of *two protons*, are separated by a distance of $2.0 \times 10^{-10}\,\mathrm{m}$. Determine the electric potential produced by the nucleus at the location of the electron **and** the electric potential energy of the electron in this configuration.

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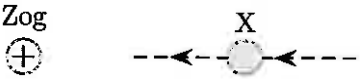
## Question 5




A positvely charged particle, Zog, is held fixed. Another charged particle, X, is given a brief kick and moves toward Zog. Consider the motion of X after the kick.

a) Which of the following (choose one) is true regarding the change in electric potential seen by X?

i) $\Delta V > 0$ is X is positive, $\Delta V < 0$ is X is negative,
ii) $\Delta V < 0$ is X is positive, $\Delta V > 0$ is X is negative,
iii) $\Delta V > 0$ regardless of X's charge.
iv) $\Delta V < 0$ regardless of X's charge.

b) Which of the following (choose one) is true regarding the change in electric potential energy seen by X?

i) $\Delta U_{\text{elec}} > 0$ is X is positive, $\Delta U_{\text{elec}} < 0$ is X is negative,
ii) $\Delta U_{\text{elec}} < 0$ is X is positive, $\Delta U_{\text{elec}} > 0$ is X is negative,
iii) $\Delta U_{\text{elec}} > 0$ regardless of X's charge.
iv) $\Delta U_{\text{elec}} < 0$ regardless of X's charge.

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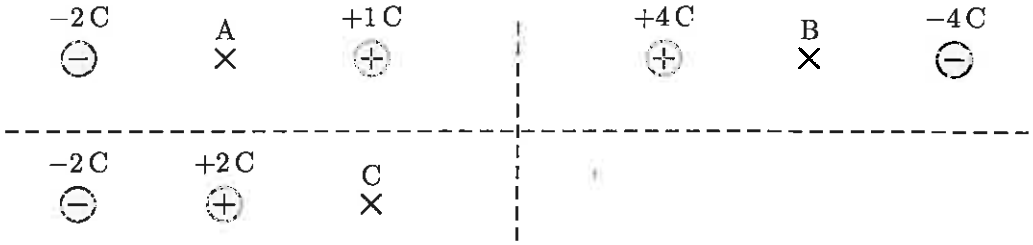
## Question 6

Separate arrangements of fixed charged particles are illustrated. Note that the magnitudes of the charges are not the same.




Which of the following (choose one) represents the rank of the electric potential at points A, B, and C? Note that negative always ranks lower than positive.

a) $V_B = V_C > V_A$
b) $V_C > V_A > V_B$
c) $V_C > V_B = V_A$
d) $V_C > V_B > V_A$
e) $V_A > V_B > V_C$

$V = V_{\text{from left}} + V_{\text{from right}}$

$\Rightarrow V = 0$ at B

$V < 0$ at A since $-2C$ dominates

$V > 0$ at C since $+2C$ dominates

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## Question 7

A proton passes an initial location, moving with speed $8.0 \times 10^3$ m/s at that instant. It is only affected by an electric field, reaching a speed of $4.0 \times 10^3$ m/s at a final location.

a) Determine the difference in electric potential between the initial and final locations.

Energy conserved!

$\Delta K + q\Delta V = 0 \Rightarrow \Delta K = -q\Delta V$ (+2)

$\Rightarrow \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2 = -q\Delta V$ (+4)

$\Rightarrow \frac{1}{2}m(v_f^2 - v_i^2) = -q\Delta V$

$\Rightarrow \frac{1}{2}(1.67\times10^{-27}\,kg)[(4.0\times10^3\,m/s)^2 - (8.0\times10^3\,m/s)^2] = -1.6\times10^{-19}\,C\,\Delta V$

correct (+2)

$\Rightarrow -4.0\times10^{-20}\,CV = -1.6\times10^{-19}\Delta V$

$\Rightarrow \Delta V = \frac{-4.0\times10^{-20}}{-1.6\times10^{-19}} = +0.25V$ (+3)

Only get $\Delta U_{elec}$, not $\Delta V$ (-3)

b) Is the electric potential at the final location higher or lower than that at the initial location?

$\Delta V > 0 \Rightarrow$ higher at final location (+3)

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