Name: _____ **Class:** _____ **Date:** _____ **ID: A**

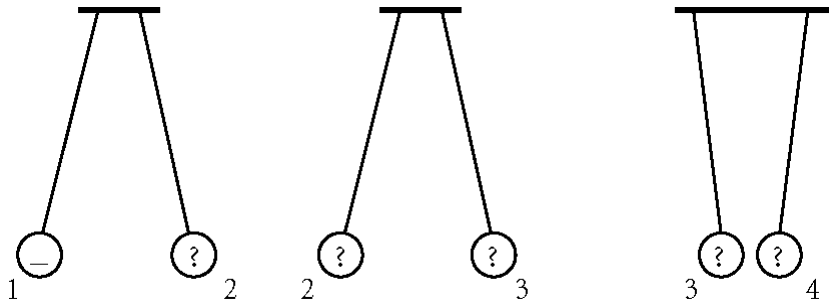
Cp physics Web Review ch 17 Electric Force

Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. An attracting force occurs between two charged objects when the charges are of
a. unlike signs.
b. like signs.
c. equal magnitude.
d. unequal magnitude.

____ 2. When a glass rod is rubbed with silk and becomes positively charged,
a. electrons are removed from the rod.
b. protons are removed from the silk.
c. protons are added to the silk.
d. the silk remains neutral.



____ 3. In the diagram shown above, the circles represent small balls that have electric charges. Ball 1 has a negative charge, and ball 2 is repelled by ball 1. Next, you see that ball 2 repels ball 3 and that ball 3 attracts ball 4. What is the electric charge on ball 4?
a. Ball 4 may have either a positive or negative charge.
b. Ball 4 has a negative charge.
c. Ball 4 has a positive charge.
d. It is not possible to determine the charge on ball 4.

____ 4. If the charge is tripled for two identical charges maintained at a constant separation, the electric force between them will be changed by what factor?
a. $\frac{1}{9}$
b. $\frac{2}{3}$
c. 9
d. 18

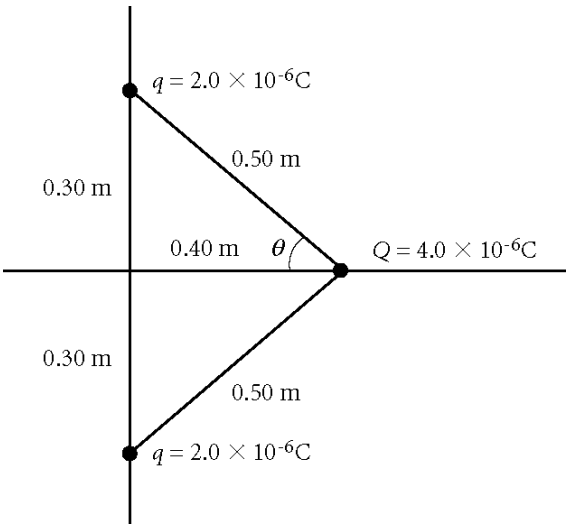
____ 5. Two point charges, initially 1 cm apart, are moved to a distance of 3 cm apart. By what factor do the resulting electric and gravitational forces between them change?
a. 9
b. 3
c. $\frac{1}{3}$
d. $\frac{1}{9}$

Problem

6. What is the electric force between a proton and an alpha particle (charge 2*e*) that are separated by a distance of 3.0×10^{-6} m? ($e = 1.60 \times 10^{-19}$ C, $k_C = 8.99 \times 10^9$ N•m^2/C^2)

7. An alpha particle (charge 2*e*) is sent at high speed toward a gold nucleus. The electric force acting on the alpha particle is 91.0 N when it is 2.00×10^{-14} m away from the gold nucleus. What is the charge on the gold nucleus, as a whole number multiple of *e*? ($e = 1.60 \times 10^{-19}$ C, $k_C = 8.99 \times 10^9$ N•m^2/C^2)

8. Charge A and charge B are 2.2 m apart. Charge A is 1.0 C, and charge B is 2.0 C. Charge C, which is 2.0 C, is located between them and is in electrostatic equilibrium. How far from charge A is charge C?



9. Two equal positive charges, both $q = 2.0 \times 10^{-6}$ C, interact with a third charge, $Q = 4.0 \times 10^{-6}$ C, as shown in the figure above. What is the magnitude of the electric force on *Q*? ($k_C = 8.99 \times 10^9$ N•m^2/C^2)

10. Two point charges are 4.0 cm apart and have values of 30.0 μC and –30.0 μC, respectively. What is the electric field at the midpoint between the two charges? ($k_C = 8.99 \times 10^9$ N•m^2/C^2)

Cp physics Web Review ch 17 Electric Force
Answer Section

MULTIPLE CHOICE

1. A
2. A
3. C
4. C
5. D

PROBLEM

6. 5.1×10^{-17} N

Given

$q_p = +e = +1.60 \times 10^{-19}$ C

$q_\alpha = +2e = +3.20 \times 10^{-19}$ C

$r = 3.0 \times 10^{-6}$ m

$k_C = 8.99 \times 10^{9}$ N•m^2/C^2

Solution

$$F_{electric} = k_C \frac{q_p q_\alpha}{r^2} = \left(8.99 \times 10^{9} \text{ Nm}^2/\text{C}^2\right)\left(\frac{\left(+1.60 \times 10^{-19} \text{ C}\right)\left(+3.20 \times 10^{-19} \text{ C}\right)}{\left(3.0 \times 10^{-6} \text{ m}\right)^2}\right)$$

$F_{electric} = 5.1 \times 10^{-17}$ N

7. $79e$

Given

$e = 1.60 \times 10^{-19}$ C

$q_\alpha = 2e = 3.20 \times 10^{-19}$ C

$F_{electric} = 91.0$ N

$r = 2.00 \times 10^{-14}$ m

$k_C = 8.99 \times 10^9$ N•m^2/C^2

Solution

$$F_{electric} = k_C \frac{q_\alpha q_{Gold}}{r^2}$$

Rearrange to solve for q_{Gold}.

$$q_{Gold} = \frac{\left(F_{electric}\right) r^2}{(k_C) q_\alpha} = \frac{(91.0\,\text{N})(2.00 \times 10^{-14}\,\text{m})^2}{(8.99 \times 10^9\,\text{Nm}^2/\text{C}^2)(3.20 \times 10^{-19}\,\text{C})} = 1.27 \times 10^{-17}\,\text{C}$$

$$\frac{q_{Gold}}{q_e} = \frac{1.27 \times 10^{-17}\,\text{C}}{1.60 \times 10^{-19}\,\text{C}} = 79.4$$

The charge on the gold nucleus must be an integer multiple of e.
Integer $(79.4)e = 79e$

8. 0.91 m

Given
$r_{A,B} = 2.2 \text{ m}$
$r_{C,A} = d$
$r_{C,B} = 2.2 \text{ m} - d$
$q_A = 1.0 \text{ C}$
$q_B = 2.0 \text{ C}$
$q_C = 2.0 \text{ C}$
$F_{C,A} = F_{C,B} = 0 \text{ N}$

Solution
$F_{C,A} = F_{C,B}$

$$k_C\left(\frac{q_C q_A}{(r_{C,A})^2}\right) = k_C\left(\frac{q_C q_B}{(r_{C,B})^2}\right)$$

$$\frac{q_A}{d^2} = \frac{q_B}{(2.2 \text{ m} - d)^2}$$

$$\left(d^2\right)\left(q_B\right) = (2.2 \text{ m} - d)^2\left(q_A\right)$$

$$d\sqrt{q_B} = (2.2 \text{ m} - d)\sqrt{q_A}$$

$$d\left(\sqrt{q_B} + \sqrt{q_A}\right) = \sqrt{q_A}(2.2 \text{ m})$$

$$d = \frac{\sqrt{q_A}(2.2 \text{ m})}{\sqrt{q_B} + \sqrt{q_A}} = \frac{\sqrt{1.0 \text{ C}}(2.2 \text{ m})}{\sqrt{2.0 \text{ C}} + \sqrt{1.0 \text{ C}}} = 0.91 \text{ m}$$

$d = 0.91 \text{ m}$

9. 0.46 N

Given

$q_1 = 2.0 \times 10^{-6}$ C

$q_2 = 2.0 \times 10^{-6}$ C

$Q = 4.0 \times 10^{-6}$ C

$r_{q_1,Q} = r_{q_2,Q} = 0.50$ m

$\theta = \tan^{-1}(0.30 \text{ m}/0.40 \text{ m}) = 37°$

$k_C = 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2$

Solution

$$F_{q_1,Q} = F_{q_2,Q} = k_C \frac{qQ}{\left(r_{q,Q}\right)^2} = \left(8.99 \times 10^9 \text{ Nm}^2/\text{C}^2\right)\left(\frac{\left(2.0 \times 10^{-6} \text{ C}\right)\left(4.0 \times 10^{-6} \text{ C}\right)}{(0.50 \text{ m})^2}\right) = 0.29 \text{ N}$$

For $F_{q_1,Q}$: $F_{x,q_1,Q} = (F_{q_1,Q})(\cos 37°) = (0.29 \text{ N})(\cos 37°) = 0.23$ N

$F_{y,q_1,Q} = (F_{q_1,Q})(\sin 37°) = (0.29 \text{ N})(\sin 37°) = 0.17$ N

For $F_{q_2,Q}$: $F_{x,q_1,Q} = (F_{q_2,Q})(\cos 37°) = (0.29 \text{ N})(\cos 37°) = 0.23$ N

$F_{y,q_2,Q} = -(F_{q_2,Q})(\sin 37°) = -(0.29 \text{ N})(\sin 37°) = -0.17$ N

$F_{x,tot} = F_{x,q_1,Q} + F_{x,q_2,Q} = 0.23 \text{ N} + 0.23 \text{ N} = 0.46$ N

$F_{y,tot} = F_{y,q_1,Q} + F_{y,q_2,Q} = 0.17 \text{ N} + (-0.17 \text{ N}) = 0$ N

$$F_{Q,tot} = \sqrt{\left(F_{x,tot}\right)^2 + \left(F_{y,tot}\right)^2} = \sqrt{(0.46 \text{ N})^2 + 0} = 0.46 \text{ N}$$

$F_{Q,tot} = 0.46$ N

10. 1.3×10^{9} N/C

Given

$r_1 = r_2 = 2.0 \text{ cm} = 2.0 \times 10^{-2} \text{ m}$

$\theta_1 = 0°$

$\theta_2 = 180°$

$q_1 = 30 \ \mu\text{C} = 3.0 \times 10^{-5} \text{ C}$

$q_2 = -30 \ \mu\text{C} = -3.0 \times 10^{-5} \text{ C}$

$k_C = 8.99 \times 10^{9} \text{ Nm}^2/\text{C}^2$

Solution

$$E_1 = k_C \frac{q_1}{r_1^{\,2}} = \left(8.99 \times 10^{9} \text{ Nm}^2/\text{C}^2\right)\left(\frac{3.0 \times 10^{-5} \text{ C}}{\left(2.0 \times 10^{-2} \text{ m}\right)^2}\right) = 6.7 \times 10^{8} \text{ N/C}$$

$$E_2 = k_C \frac{q_2}{r_2^{\,2}} = \left(8.99 \times 10^{9} \text{ Nm}^2/\text{C}^2\right)\left(\frac{-3.0 \times 10^{-5} \text{ C}}{\left(2.0 \times 10^{-2} \text{ m}\right)^2}\right) = -6.7 \times 10^{8} \text{ N/C}$$

For E_1 : $E_{x,1} = (E_1)(\cos 0°) = (6.7 \times 10^{8} \text{ N/C})(\cos 0°) = 6.7 \times 10^{8} \text{ N/C}$

$E_{y,1} = 0 \text{ N/C}$

For E_2 : $E_{x,2} = (E_2)(\cos 180°) = (-6.7 \times 10^{8} \text{ N/C})(\cos 180°) = 6.7 \times 10^{8} \text{ N/C}$

$E_{y,2} = 0 \text{ N/C}$

$E_{x,tot} = E_{x,1} + E_{x,2} = 6.7 \times 10^{8} \text{ N/C} + 6.7 \times 10^{8} \text{ N/C} = 1.3 \times 10^{9} \text{ N/C}$

$E_{y,tot} = E_{y,1} + E_{y,2} = 0 \text{ N/C} + 0 \text{ N/C} = 0 \text{ N/C}$

$$E_{tot} = \sqrt{\left(E_{x,tot}\right)^2 + \left(E_{y,tot}\right)^2} = \sqrt{\left(1.3 \times 10^{9} \text{ N/C}\right)^2 + 0} = 1.3 \times 10^{9} \text{ N/C}$$

$E_{tot} = 1.3 \times 10^{9} \text{ N/C}$