**NAME (Please Print)**_____

***Part 1.***
***Please c*ircle the correct answer, to the nearest number for the quantitative questions**. ***Each Question worth's 1 point.***

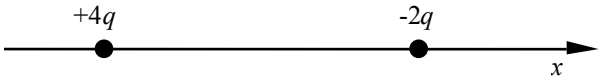
**1.** Electrical and gravitational forces follow similar equations with one main difference:

(A) Electrical forces obey the inverse square law and gravitational forces do not.
(B) Gravitational forces obey the inverse square law and electrical forces do not.
(C) Electrical forces attract and gravitational forces repel.
(D) Electrical forces repel and gravitational forces attract.
(E) Gravitational forces are always attractive but electrical forces can be attractive or repulsive.

**2.** Two charges, $\boldsymbol{Q_1}$ and $\boldsymbol{Q_2}$, are separated by a certain distance $\boldsymbol{R}$. If the magnitude of their charges is **halved**, and their separation is **doubled**, then what happens to the electrical forces between these charges?

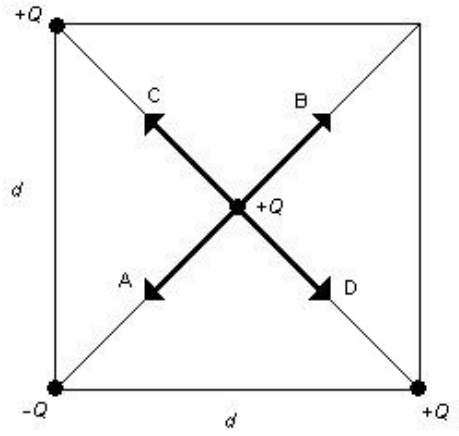
(A) It decreases by a factor of 2.
(B) It decreases by a factor of 4.
(C) It decreases by a factor of 8.
(D) It remains the same.
(E) It decreases by a factor of 16.

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




(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 +4*q* charge.
(C) The electric field is zero somewhere on the *x* axis to the right of the –2*q* charge.
(D) The electric field is zero somewhere on the *x* axis between the two charges, but this point is nearer to the –2*q* charge.
(E) The electric field is zero at two points along the *x* axis; one such point is to the right of the –2*q* charge and the other is to the left of the +4*q* charge.

**4**. Four point charges of equal magnitudes but with varying signs are arranged on three of the corners and at the center of the square of side *d* as shown in the figure. Which of the arrows shown represents the net force acting on the center charge?

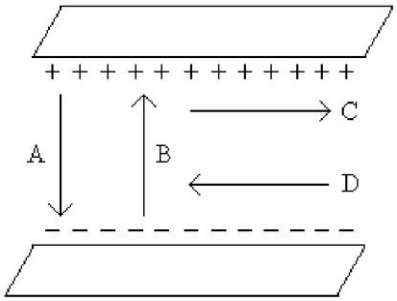



(A) C (B) A (D) B (C) D
(E) None of the above.

**5**. What is the electric flux passing through a Gaussian surface that surrounds a **+0.075 C** point charge?

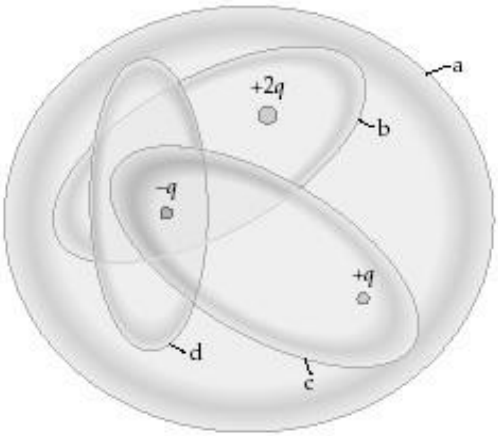
(A) $8.5 \times 10^9$ N·m$^2$/C (B) $1.3 \times 10^7$ N·m$^2$/C (C) $7.2 \times 10^5$ N·m$^2$/C
(D) $6.8 \times 10^8$ N·m$^2$/C (E) $4.9 \times 10^6$ N·m$^2$/C

**6**. Which of the arrows shown in the figure represents the correct direction of the electric field between the two metal plates?




(A) D
(B) C
(C) B
(D) A
(E) None of the above.

**7**. The figure shows four Gaussian surfaces surrounding a distribution of charges. Which Gaussian surfaces have no electric flux through them?




(A) c (B) b (C) a (D) b and d
(E) b and c

**8**. Consider three identical metal spheres, ***A, B***, and ***C***. Sphere ***A*** carries a charge of ***-2.00 μC***; sphere ***B*** carries a charge of ***-6.00 μC***; and sphere ***C*** carries a charge of ***+5.00 μC***. Spheres ***A*** and ***B*** are touched together and then separated. Spheres ***B*** and ***C*** are then touched and separated. Does sphere ***C*** end up with an excess or a deficiency of electrons and how many electrons is it?

(A) deficiency, 3.12 x $10^{13}$ (B) excess, 3.12 x $10^{13}$ (C) excess, 1.87 x $10^{13}$
(D) excess, 3.13 x $10^{12}$ (E) deficiency, 3.13 x $10^{12}$

**9**. A total charge of ***-6.50 μC*** is uniformly distributed within a sphere that has a radius of ***0.150 m***. What is the **magnitude** and **direction** of the electric field at ***0.300 m*** from the surface of the sphere?

(A) 9.38 x $10^5$ N/C, radially outward (B) 6.49 x $10^5$ N/C, radially outward
(C) 2.89 x $10^5$ N/C, radially inward (D) 4.69 x $10^5$ N/C, radially inward
(E) 1.30 x $10^6$ N/C, radially inward

**10**. Three point charges of magnitudes **+ 4.0 μC, – 5.0 μC**, and **– 9.0 μC** are placed on the ***x*–axis** at ***x* = 0 cm**, ***x* = 40 cm**, and ***x* = 120 cm**, respectively. What is the force on the **– 9.0 μC** charge due to the other two charges?

(A) −0.55 N (B) 0.55 N (C) 0.64 N (D) – 0.41 N (E) 0.41 N

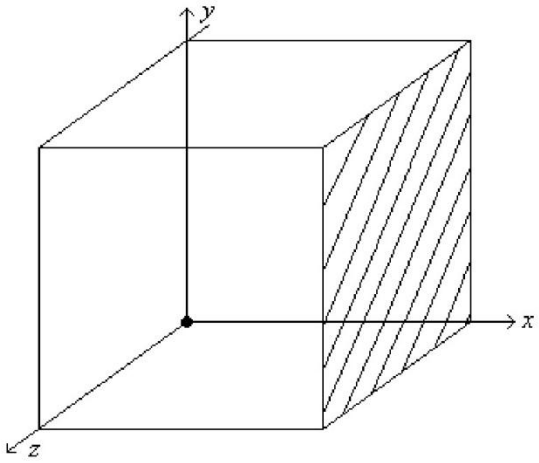
**11**. A particle with a charge of **4.0 μC** has a mass of $\mathbf{5.0 \times 10^{-3}\ kg}$. What electric field directed upward will exactly balance the weight of the particle?

(A) $4.1 \times 10^2$ N/C (B) $8.2 \times 10^2$ N/C (C) $4.4 \times 10^4$ N/C
(D) $5.1 \times 10^6$ N/C (E) $1.2 \times 10^4$ N/C.

***Part 2 . Please show your work in the space provided.***

**1**. A uniform electric field with a magnitude of $\mathbf{6 \times 10^6\ N/C}$ is applied to a cube of edge length **0.1 m** as shown in the figure. If the direction of the ***E*–field** is along the ***+x–axis***, what is the electric flux passing through the shaded face of the cube?

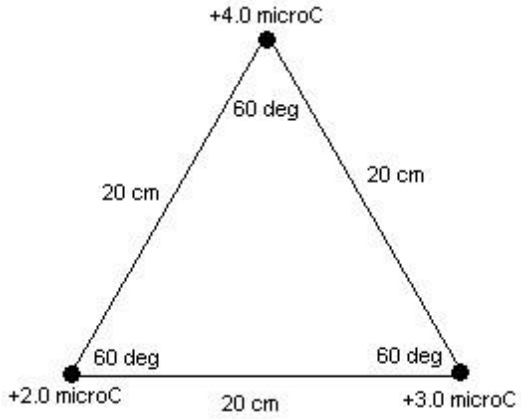
***( 3 points)***




***Answer with units:_____***

**2**. Three point charges of magnitude **+2.0 μC, +3.0 μC, +4.0 μC** are located at the corners of a triangle as shown in the figure. What is the resultant electric force (magnitude and direction) acting on the **+4.0 μC** charge?

***(3 points)***




***Answer (magnitude) with units:*** _____

***Direction:*** _____

***Some useful constants:*** $e^{-} = 1.60 \times 10^{-19}$ C., $\varepsilon_0 = 8.85 \times 10^{-12}\ C^2/(N.m^2)$, $k = (1/4\pi\varepsilon_o) = 8.99 \times 10^{9}\ N.m^2/C^2$, $m_e = 9.11 \times 10^{-31}$ kg, $m_p = 1.67 \times 10^{-27}$ kg.

*Good Luck*