

Q12 [Fields] The key contains six statements about gravitational and electric fields. Choose the one WRONG statement in the key, and pencil across one cell in row 12.

KEY for Q12

- A No electric field line can ever originate or terminate at any point where there is no electric charge.
- B No two electric field lines can ever cross each other.
- C The electric field is an example of a vector field.
- D The gravitational field around a point mass can be represented by a set of radial lines pointing towards the mass.
- E The electric field around a point positive charge can be represented by a set of radial lines pointing away from the charge.
- F The magnitude of the electric field due to a point charge is inversely proportional to the distance from the point charge.

Q13 [Electrostatic potential energy] Figure 3 shows point charges of $+3\text{ C}$ (at position $0\text{ m}, 0\text{ m}$) and $+6\text{ C}$ (at position $3\text{ m}, 2\text{ m}$). Calculate the change in the electrostatic potential energy of the system if the 6 C charge is moved from $(3\text{ m}, 2\text{ m})$ to $(3\text{ m}, 0\text{ m})$ as indicated in the figure. Assume the charges are in a vacuum. Choose the option in the key nearest to your calculated value, and pencil across one cell in row 13.



FIGURE 3

KEY for Q13

- A 0 J
- B $9 \times 10^9\text{ J}$
- C $1.3 \times 10^{10}\text{ J}$
- D $4.2 \times 10^{10}\text{ J}$
- E $4.5 \times 10^{10}\text{ J}$
- F $5.4 \times 10^{10}\text{ J}$

Q14 [Electric field, Statics] A tiny ball at the end of a thread has a charge Q and is in a horizontal electric field of magnitude 700 NC^{-1} as shown in Figure 4. When it is in equilibrium in the position shown, the tension F_1 in the thread has a magnitude of $6.3 \times 10^{-3}\text{ N}$. Calculate the magnitude and the sign of the charge on the ball. Choose from the key one option from A-E for the magnitude and one option from F-H for the sign and pencil across two cells in row 14.

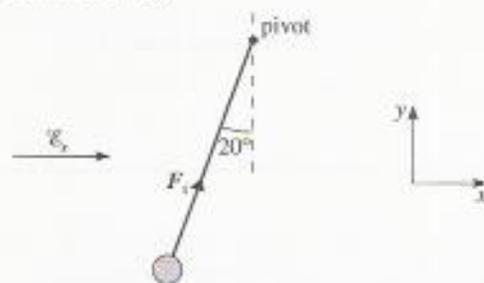


FIGURE 4

KEY for Q14

- A 0 C
- B $3.0 \times 10^{-6}\text{ C}$
- C $8.5 \times 10^{-6}\text{ C}$
- D $9.0 \times 10^{-6}\text{ C}$
- E $3.2 \times 10^6\text{ C}$
- F Positive
- G Neutral
- H Negative

Q15 [Electric field] In Millikan's oil drop apparatus, an electric field of magnitude $|\mathcal{E}|$ is maintained between the plates. Two oil drops A and B with weights of magnitude $w_A = 3.2 \times 10^{-13}\text{ N}$ and $w_B = 4.8 \times 10^{-13}\text{ N}$ are observed to remain stationary. Calculate the ratio (n_A/n_B) of the number of charges on drop A (n_A) to the number of charges on drop B (n_B). Choose one answer from the key that is closest to your own, and pencil across one cell in row 15.

KEY for Q15

- A 1.5×10^{-25}
- B $1.5 \times 10^{-25} \times |\mathcal{E}|$
- C 0.67
- D $0.67 \times |\mathcal{E}|$
- E 1.5
- G $1.5 \times |\mathcal{E}|$

$\sin \theta = \frac{n_1}{d}$

$= \frac{1450 \times 9}{10^{-2} / 6000}$

$$F = \frac{Q_1 Q_2}{4\pi \epsilon_0 r^2} = \frac{4^2 \times 10^{-12}}{16\pi \epsilon_0} + \frac{4^2 \times 10^{-12}}{64\pi \epsilon_0} = 16 \times 10^{-12} \left(\frac{9 \times 10^9}{4} + \frac{9 \times 10^9}{16} \right)$$

$$= 16 \times 10^{-12} \times \frac{45 \times 10^9}{16} = 5 \times 10^{-3}\text{ N}$$

$$E = \frac{Q_1 Q_2}{4\pi \epsilon_0 r^2} = \frac{18 \text{ C} \times 9 \times 10^9}{\sqrt{13}} = \frac{162 \times 10^9}{\sqrt{13}}$$

$$\frac{162 \times 10^9}{3} \quad 162 \times 10^9 \left(\frac{1}{\sqrt{13}} - \frac{1}{3} \right)$$