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PHYSICS

End of Term 1 Exam 2019 / 2020

- ☒ Where necessary use the constant in the table below.
- ☒ Answer all questions on the paper.



$g = 9.81 \text{ m/s}^2$	Electron charge $-1.6 \times 10^{-19} \text{ C}$	Proton charge $+1.6 \times 10^{-19} \text{ C}$
$k = 8.99 \times 10^9 \text{ N.m}^2/\text{C}^2$	$1.0 \mu = 1.0 \times 10^{-6}$	
$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N.m}^2$	$1.0 \text{ n} = 1.0 \times 10^{-9}$	Volume of a sphere $\frac{4}{3} \pi r^3$
	$1.0 \text{ m} = 1.0 \times 10^{-3}$	Surface area of a sphere $4\pi r^2$
	$1.0 \text{ p} = 1.0 \times 10^{-12}$	circumference of a circle $2\pi r$



1st Question

PART 1

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Place a tick (✓) inside the box to the left of the most appropriate answer for each of the following:

1- Two point charges (+ q) and (- q) have the same magnitude and the distance between them is (9.0 cm), if the electrostatic force between the two charges is (5.0 N).

What is the value of each charge?

☐ 7.1 nC

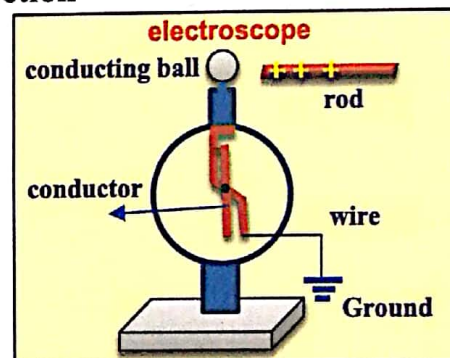
☐ 2.1 μC
☐ 7.1 μC
☐ 2.1 nC


2- In the figure, a rod carrying a positive charge is brought close to an uncharged electroscope without touching it. When the connection to the ground is removed, which of the following is true?

☐ a ball and conductor are both negatively charged.

☐ a ball and conductor are both positively charged.

☐ a ball is positively charged and conductor is negatively charged.

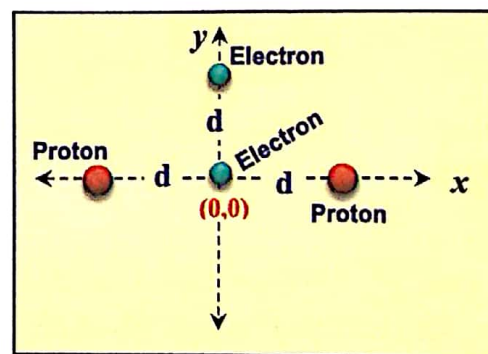
☐ a ball is positively charged and the conductor is uncharged.


3- The figure shows two protons and two electrons, which of the following represents the magnitude and direction of the electrostatic force on the electron at the point of origin (0, 0)?

☐ $k \times \frac{1.6 \times 10^{-19}}{d^2}$ to the positive y-axis

☐ $k \times \frac{(1.6 \times 10^{-19})^2}{d^2}$ to the positive y-axis

☐ $k \times \frac{1.6 \times 10^{-19}}{d^2}$ to the negative y-axis

☐ $k \times \frac{(1.6 \times 10^{-19})^2}{d^2}$ to the negative y-axis


4- Which of the following is correct for the unit of the D in the equation ($D = k \epsilon_0$) that links the Coulomb constant (k) to the electrical permittivity coefficient (ϵ_0)?

☐ $\text{N} \cdot \text{m}^2 \text{C}^2$
☐ $\text{N} \cdot \text{m}^2 \text{C}^{-2}$
☐ $\text{N} \cdot \text{m}^{-2} \text{C}^2$
☐ constant without unit


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5- Two charges are placed on the y-axis. One has a charge of $(+e)$ and is located at the origin, the other has a charge of $(-4e)$ and is located at $y = +r$, where $r > 0$. **Where on the y-axis is the net electric field equal to zero?**

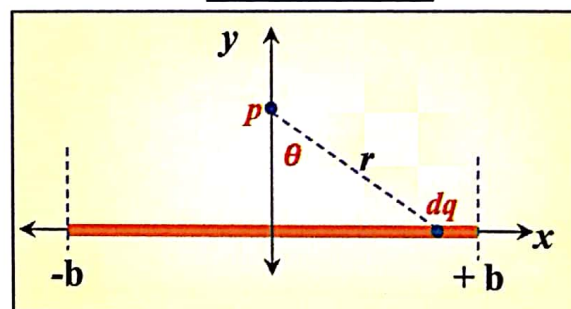
- ☐ $y = +2r$
- ☐ $y = -r$
- ☐ $y = -2r$
- ☐ $y = +r$



6- In the figure, a straight wire is located along the x-axis between points $(-b$ and $+b)$ and carries a charge with linear charge density (λ) , assume that the wire is positioned with its midpoint at $x = 0$. Which of the following is **correct** for the magnitude of the electric field, at point p located on the y-axis?

	E_y	E_x
☐	$2k \int_0^b \frac{dq}{r^2} \cos\theta$	0
☐	0	$2k \int_0^b \frac{dq}{r^2} \cos\theta$
☐	$2k \int_0^b \frac{dq}{r^2} \sin\theta$	$2k \int_0^b \frac{dq}{r^2} \cos\theta$
☐	$2k \int_0^b \frac{dq}{r^2} \sin\theta$	0

hint
 $dq = \lambda dx$

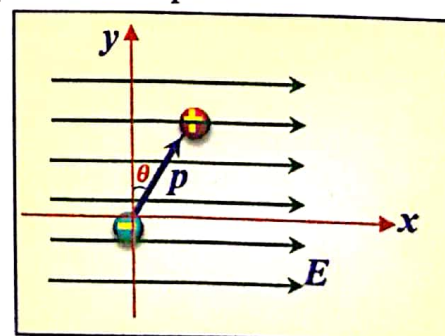


7- A point charge sits at the center of a cube. The electric flux through one side of the cube is $(6.0 \times 10^{10} \text{ Nm}^2/\text{C})$. What is the **charge** at the center of the cube?

- ☐ 0.53 C
- ☐ 3.2 C
- ☐ 1.6 C
- ☐ 2.1 C

8- In the figure, an electric dipole with dipole moment of magnitude $(2.0 \times 10^{-12} \text{ C m})$ is placed in a uniform electric field of magnitude (500 N/C) . At some instant (in time) the angle $\theta = 15^\circ$. What is the **magnitude** and **direction** of the torque on the dipole

- ☐ $2.6 \times 10^{-10} \text{ N m}$ in the positive z-direction
- ☐ $2.6 \times 10^{-10} \text{ N m}$ in the negative z-direction
- ☐ $9.7 \times 10^{-10} \text{ N m}$ in the positive z-direction
- ☐ $9.7 \times 10^{-10} \text{ N m}$ in the negative z-direction



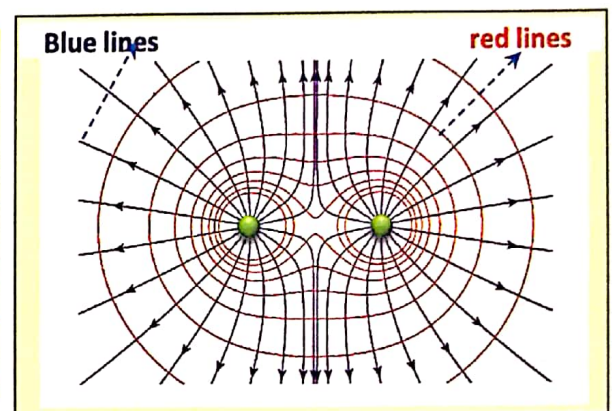
9- An infinite conducting sheet in the xz -plane is uniformly charged with a charge surface density of $(+7.0 \mu\text{C}/\text{m}^2)$. If a charge of $(-2.0 \mu\text{C})$ is moved from position $(y_1 = +21 \text{ cm})$ away from the sheet to position $(y_2 = +6.0 \text{ cm})$ away from the sheet. How much **work** is done by electric field on the charge ?

- ☐ 0.12 J
- ☐ 0.24 J
- ☐ 0.34 J
- ☐ 0.43 J



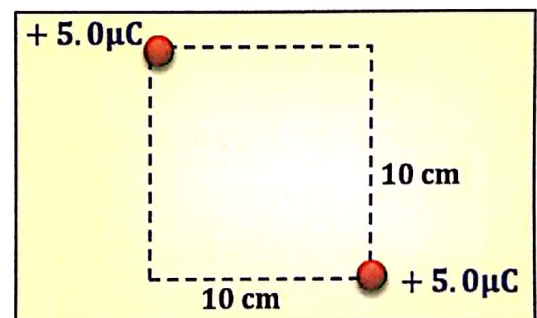
10- The figure shows the electric field lines and equipotential surfaces of two point charges. Which of the following is **correct**?

	point charges	red lines
☐	identical and positive	electric field lines
☐	identical and positive	equipotential surfaces
☐	identical and negative	electric field lines
☐	identical and negative	equipotential surfaces



11- Two $(+5.0 \mu\text{C})$ point charges arranged at the corners of a square with side length (10 cm) as shown in the figure. What is the **potential energy** of a system of two charges ?

- ☐ 0.0 J
- ☐ 0.80 J
- ☐ 1.6 J
- ☐ 2.3 J



12- An electric potential is described in volts by $V(x, y, z) = 3x^2 + 2y - 5z$.

What is the magnitude of **an electric field** at the point $(+4.0 \text{ m}, -2.0 \text{ m}, -1.0 \text{ m})$?

hint

$$E_s = -\frac{\partial V}{\partial s}$$

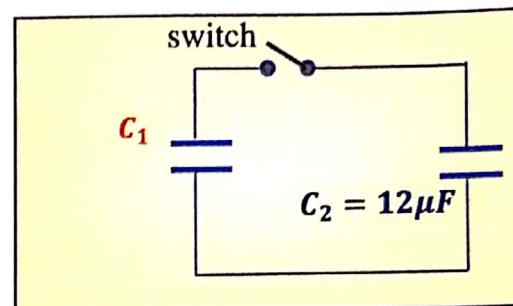
- ☐ 27.0 V/m
- ☐ 31.0 V/m
- ☐ 24.6 V/m
- ☐ 8.16 V/m



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13- In the circuit shown, a capacitor C_2 initially has a voltage of (6.0 V) and a capacitor C_1 is initially uncharged. When the switch is closed, the voltage on capacitor C_2 drops to (4.0 V) . What is the **capacitance** of capacitor C_1 ?

- ☐ $6.0\ \mu\text{F}$
- ☐ $9.0\ \mu\text{F}$
- ☐ $12\ \mu\text{F}$
- ☐ $18\ \mu\text{F}$



14- A parallel plate capacitor with a dielectric material having a dielectric constant of (4) is connected to a battery. Each plate acquired a charge (Q) and the energy stored in the capacitor is (U) . When the dielectric material between the two plates is removed, what **happens** to both the energy and the charge?

	Charge Q	Energy U
☐	remains Q	remains U
☐	becomes $\frac{Q}{4}$	becomes $\frac{U}{4}$
☐	becomes $4Q$	becomes $\frac{U}{4}$
☐	remains Q	becomes $\frac{U}{4}$

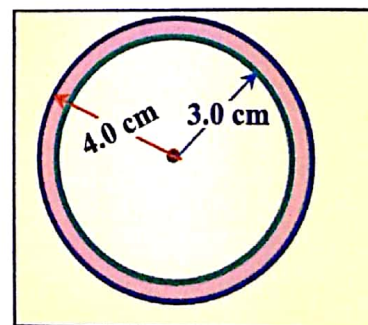


15- In the figure shown, a spherical capacitor, the volume between the spherical conductors filled with a material has a dielectric constant $(\kappa = 7)$. What is the **capacitance** of the spherical capacitor?

- ☐ $93\ \mu\text{F}$
- ☐ $13\ \mu\text{F}$
- ☐ $93\ \text{pF}$
- ☐ $13\ \text{pF}$

hint

$$C_{\text{air}} = 4\pi\epsilon_0 \frac{r_1 r_2}{(r_2 - r_1)}$$



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3rd Question

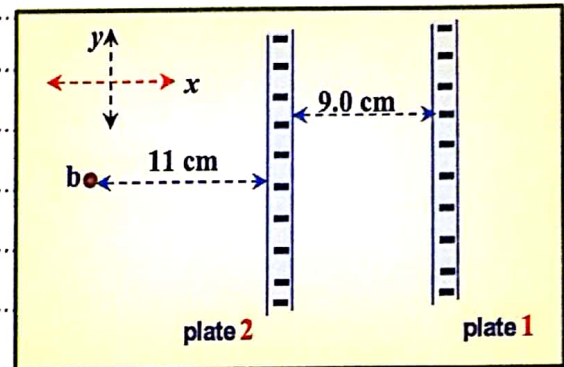
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18- Two parallel infinite nonconductive plates were placed in air, as shown in the figure. Each plate carries a uniform charge distribution. Plate 1 has a surface charge distribution of $(-5.0 \mu\text{C}/\text{m}^2)$ and plate 2 has a surface charge distribution of $(-6.0 \mu\text{C}/\text{m}^2)$.

- Calculate the total electric field at point b.

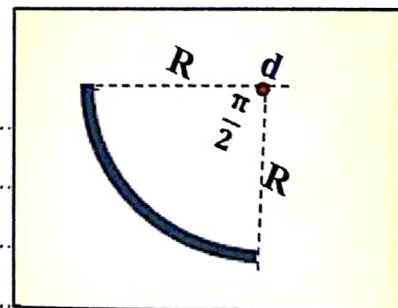


19- A particle charge of $(+3.0 \mu\text{C})$ is released from rest at a point on the x- axis, $(x = 5.0 \text{ cm})$. It begins to move due to the presence of $(+8.0 \mu\text{C})$ a charge that remains fixed at the origin $(x = 0.0)$.

- Calculate the kinetic energy of the particle at the instant it passes the point $(x = +12 \text{ cm})$.

20- In the figure, a line of charge is uniformly distributed with a linear charge density of $(+2.5 \mu\text{C}/\text{m})$ on arc $(\frac{\pi}{2})$ with a radius (R) .

- Calculate the magnitude of the electric potential at point d.



hint

$$V = \int_{\theta_i}^{\theta_f} k \frac{dq}{R}$$

$$dq = \lambda dl = \lambda R d\theta$$



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4th Question

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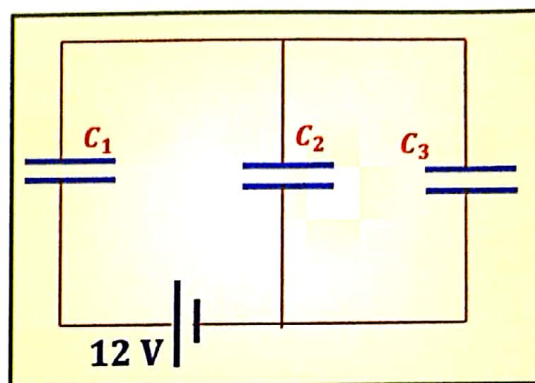


In circuit shown :

$$C_1 = 5.0 \mu F$$

$$C_2 = 6.0 \mu F$$

$$C_3 = 9.0 \mu F$$



21- Calculate the **equivalent capacitance** for the three capacitors.

6

22- Calculate the **charge** on capacitor (C_1).

4

23- Calculate the **energy** stored in the capacitor ($C_3 = 9.0 \mu F$).

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The End

