PHYSICS

PHY 2054 Exam 1

Name (PRINT, last, first): ______________________ Signature: ______________________

Constants			
$\epsilon_0 = 8.85 \times 10^{-12}$ F/m	$m_e = 9.11 \times 10^{-31}$ kg	$m_p = m_n = 1.67 \times 10^{-27}$ kg	$e = 1.6 \times 10^{-19}$ C
$k = 9 \times 10^9$ N m^2/C^2	$\mu_0 = 12.56 \times 10^{-7}$ H/m	$N_A = 6.02 \times 10^{23}$ atoms/mole	$c = 3 \times 10^8$ m/s
$n_{H_2O} = 1.333$	k="kilo"$=10^3$	M="mega"$=10^6$	$g = 9.8$ m/s^2
m="milli"$=10^{-3}$	μ="micro"$=10^{-6}$	n="nano"$=10^{-9}$	p="pico"$=10^{-12}$

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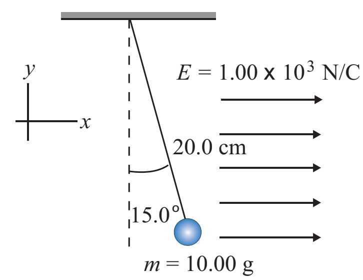
1. A small 10 g plastic ball is suspended by a 20 cm long string in a uniform electric field. If the ball makes an angle 15° with the vertical, what is the net charge on the ball?

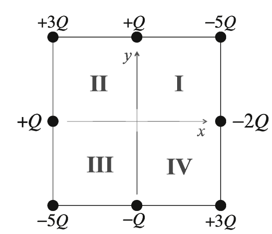


(1) 26.8μC
(2) 5.26μC
(3) 50μC
(4) 13.4μC
(5) 10.5μC

2. Four charges of magnitude q are placed at the corners of a square with sides of length L. What is the magnitude of the force acting on any of the charges?

(1) $1.91kq^2/L^2$ (2) kq^2/L^2 (3) $2.50kq^2/L^2$ (4) $1.41kq^2/L^2$ (5) $3.00kq^2/L^2$

3. Charges are arranged on a square of side d as shown in the diagram. In what direction does the electric field at the center of the square point? (The quadrants are numbered counterclockwise starting from the positive x-axis.)

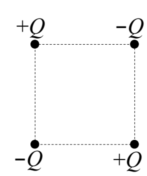


(1) Fourth quadrant
(2) First quadrant
(3) Second quadrant
(4) Third quadrant
(5) $E = 0$

4. Two charged particles are fixed to the x-axis: particle 1 of charge $q_1 = 20\,\mu$C at $x = 0$ m, and particle 2 of charge $q_2 = -80\,\mu$C at $x = 0.6$ m. At what coordinate along the x axis is the net electric field produced by the particles equal to zero?

(1) −0.6 m (2) +0.2 m (3) +1.2 m (4) +1.8 m (5) −1.0 m

5. Four charges of magnitude $Q = 3.0\,\mu$C (but different signs, as in the figure) are arranged on the corners of a square of side 25 cm. Find the potential energy of the system of the four charges (in J).



(1) −0.84 (2) −0.34 (3) +1.75 (4) +1.30 (5) 0

6. A 1 gram particle with a charge of 2 mC starts from rest in a uniform electric field. If the particle travels 20 meters in 2 seconds, what is the magnitude of the uniform electric field (in N/C)?

(1) 5 (2) 10 (3) 15 (4) 2 (5) 20

7. The electric field at the surface of solid spherical conductor with a radius of 2 meters points radially away from the conductor and has a magnitude of 899 N/C. What is the net charge on the conductor (in μC)?

(1) 0.4 (2) 0.9 (3) 1.6 (4) 0.2 (5) 2.0

8. If a 2.0 pF capacitor has a voltage of 20 mV, how many more electrons are on the negative plate than on the positive plate?

(1) 0.5×10^6 (2) 2.5×10^5 (3) 4.0×10^{14} (4) 2.0×10^3 (5) none, the electrons are in equal numbers on the plates.

9. Two equipotential surfaces lying near the middle of the space between the plates of a parallel-plate capacitor are 2.0 mm apart and have a potential difference of 0.0012 volt. The area of each plate is 7.5 cm^2. What is the magnitude of the charge on each plate, (in units of 10^{-15} C)?

(1) 4 (2) 16 (3) 5310 (4) 6.6 (5) 3320

10. A certain parallel plate capacitor with capacitance 12 μF is connected to a source of EMF with potential 3 V. A dielectric material with $\kappa = 4$ is then inserted between the plates of the capacitor with the capacitor still connected to the circuit. By how much does the energy stored in the capacitor *change*?

(1) 1.6×10^{-4} J (2) 5.4×10^{-5} J (3) 1.2×10^{-5} J (4) 1.4×10^{-6} J (5) 0 J

11. An electric car has a battery voltage of 200 V. After 130 km of driving, the battery needs 2×10^8 J of electrical energy restored to fully recharge the battery. How many Coulombs have to be put into the positive terminal of the car battery (which remains at 200 V during the recharging process) by the battery charger? (units of Coulombs)

(1) 10^6 (2) 10^3 (3) 10^4 (4) 10^5 (5) 10^7

12. An electron is released from rest at the negative plate of a parallel-plate capacitor. If the distance across the plate is 5.0 mm and the potential difference across the plate is 5.0 V, with what velocity does the electron hit the positive plate? ($e = 1.6 \times 10^{-19}$ C, $m_e = 9.1 \times 10^{-31}$ kg)

(1) 1.3×10^6 m/s (2) 5.3×10^6 m/s (3) 1.0×10^5 m/s (4) 2.6×10^5 m/s (5) 0 m/s

13. A material shaped as a cylinder has a resistance R measured from one end of the cylinder to the other. If the material is now stretched to form a cylinder 4 times longer (with the same volume) what is the resistance of the new shape?

(1) $16R$ (2) $4R$ (3) $2R$ (4) R (5) $8R$

14. A 9 V battery is connected to a 3 Ω resistor. How much charge passes through the resistor in 3 hours?

(1) 32400 C (2) 540 C (3) 3600 C (4) 60 C (5) 13000 C

15. A copper cable with resistivity $\rho = 1.7 \times 10^{-8}\Omega$-m is designed to carry a current of 200 Amps with a power loss of 2.0 W/m. What is the required radius of this cable (in cm)?

(1) 1.04 (2) 2.08 (3) 0.52 (4) 1.56 (5) 0.66

16. Two identical conducting spheres A and B carry charges $2Q$ and $3Q$, respectively. They are separated by a constant distance much larger than their diameters. A third identical conducting sphere C is uncharged. Sphere C is first touched to A, then to B and finally removed. As a result, the magnitude of the electrostatic force between A and B, initially F, becomes

(1) $F/3$ (2) $3F/8$ (3) $F/2$ (4) $F/16$ (5) 0

17. Two protons approach one another head-on from a great distance. Initially each proton has kinetic energy 1.2 MeV (1 MeV $= 1.6 \times 10^{-13}$ J). What is the closest distance in fm (1 fm $= 10^{-15}$ m) the protons will approach one another?

(1) 0.6 (2) 2.4 (3) 1.2 (4) 0.3 (5) 4.8

18. A capacitor is charged by a battery in a circuit and then disconnected from the circuit, leaving it with charges $+Q$ and $-Q$ on the plates and a total energy U. A person then moves the capacitor plates to 1/5 of their original separation. What is the work done by the person?

(1) $-4U/5$ (2) $+U/5$ (3) $-U/5$ (4) $-4U$ (5) $+4U$

19. A uniform electric field of 5,000 V/m is directed along the negative y-axis. A proton is projected upward from the origin at an angle of 60 degrees above the horizontal. The proton's initial speed is 800,000 m/s. How much time (in μs) is required for the proton to return to the x-axis? (Ignore gravitational forces.)

(1) 2.9 (2) 1.45 (3) 1.1 (4) 2.2 (5) 3.5

20. A 2.5-mC charge is on the y-axis at $y = 3.0$ m and a 6.3-mC charge is on the x-axis at $x = 3.0$ m. What is the direction of the potential at the origin?

(1) potential has no direction (2) 168° (3) 292° (4) 332° (5) 22°

21. An air-filled 3.0 nF capacitor is charged to 8.0 V. If the plate separation is 100μm, what is the energy density in the electric field?

(1) 28 mJ/m^3 (2) 280 J/m^3 (3) 57 mJ/m^3 (4) 57 J/m^3 (5) more than 50 J/m^3