 31111

PHYSICS DEPARTMENT

PHY 2054 | Practice Exam #1 | September 20, 2001

B. Whiting

Name (print): ______________________________ Signature: ______________________________

On my honor, I have neither given nor received unauthorized aid on this examination.

YOUR TEST NUMBER IS THE 5-DIGIT NUMBER AT THE TOP OF EACH PAGE.

DIRECTIONS

(1) **Code your test number on your green answer sheet (use 76–80 for the 5-digit number)**. Code your name on your answer sheet. **Darken circles completely (errors can occur if too light)**. Code your student number on your answer sheet.
(2) Print your name on this sheet and sign it also.
(3) Do all scratch work anywhere on this exam that you like. At the end of the test, this exam printout is to be turned in. No credit will be given without both answer sheet and printout with scratch work most questions demand.
(4) Work the questions in any order. Incorrect answers are not taken into account in any way; you may guess at answers you don't know if you feel that a correct answer is listed. Guessing on all questions will most likely result in failure.
(5) If none of the answers is correct, please leave the answer sheet blank. It is not our intention to omit the right answer, but in case of a mistake, please leave the answer sheet blank.
(6) **Blacken the circle of your intended answer completely, using a number 2 pencil**. Do not make any stray marks or the answer sheet may not read properly.
(7) As an aid to the examiner (and yourself), in case of poorly marked answer sheets, please circle your selected answer on the examination sheet.
(6) Good luck!!!

>>>>>>>>**WHEN YOU FINISH** <<<<<<<<
Hand in the green answer sheet separately.

Constants

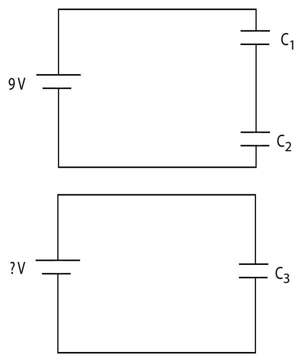
$k = 1/(4\pi\epsilon_0) = 9.0 \times 10^9\,\mathrm{N\,m^2/C^2}$		$\epsilon_0 = 8.85 \times 10^{-12}\mathrm{C^2/(N\,m^2)}$	$e = 1.6 \times 10^{-19}$ C
$1\mu\mathrm{C} = 10^{-6}$ C	$g = 9.8$ m/s^2	electron mass: $m_e = 9.11 \times 10^{-31}$kg	proton mass: $m_p = 1.67 \times 10^{-27}$kg
Avogadro's number: 6.023×10^{23}		Atomic mass of Al = 27 g	

---

1. A parallel plate capacitor with a dielectric material (κ) between its plate is connected to a battery and charged to a voltage V and charge Q. The battery is then disconnected from the capacitor and the dielectric material is removed. Which of the following statements is true?

(1) The voltage across the capacitor is constant; the charge decreases.
(2) The voltage across the capacitor increases; the charge is constant.
(3) The voltage across the capacitor is constant; the charge is constant.
(4) The voltage across the capacitor decreases; the charge is constant.
(5) The voltage across the capacitor is constant; the charge increases.

2. A 9V battery is connected across two series-connected capacitors, $C_1 = 50\mu$F and $C_2 = 100\mu$F (see figure). What voltage (in V) would be required to separately charge a third capacitor, $C_3 = 200\mu$F, so that it would have the same stored energy as C_1? (Select the closest answer.)



(1) 4.5 (2) 1.5 (3) 3.75 (4) 12 (5) 3

3. Which statement is **false**?

(1) The electric potential energy difference in going from point A to point B is independent of the path taken.
(2) At equilibrium, any excess charge on a conductor resides on the surface.
(3) The electric field obeys the principle of superposition.
(4) Negative charges are sources of electric field lines, while positive charges are sinks of electric field lines.
(5) The electric force is a conservative force.

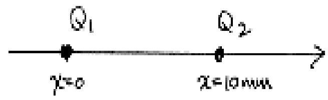
4. An aluminum wire with a cross-sectional area of 4.0×10^{-6} m^2 carries a current of 5.0 A. Find the drift speed of the electrons in the wire. The density of aluminum is 2.7 g/cm^3. (Assume that one electron is supplied by each atom.)

(1) 0.77 km/s (2) 7.7 m/s (3) 19 km/s (4) 0.13 mm/s (5) 0.13 km/s

5. What size downward electric field (in N/C) is required to balance the gravitational pull on an electron?

(1) 5.9×10^{-5} (2) 3.2×10^{2} (3) 9.3×10^{-20} (4) 5.6×10^{-11} (5) 5.7×10^{-12}

6. Two charges are fixed in place on the x-axis, as shown. Charge $Q_1 = +4$ nC, and $Q_2 = -1$ nC. At what x-axis position (in m) should an electron be placed so there is zero net force acting upon it? (Ignore gravity.) Select the closest answer.



(1) 0.013 (2) 0.035 (3) 0.007 (4) −0.01 (5) 0.02

7. Which of the following statements is **false**:

(1) For most conductors, the mobile charge carriers are electrons.
(2) If the electric flux through a Gaussian surface is zero, then the electric field must be zero everywhere on the surface.
(3) The electrical potential midway between two oppositely charged point charges is exactly zero.
(4) The electric field midway between two identical point charges is exactly zero.
(5) Neutrons have mass but no charge.

8. An aluminum wire and a silver wire have identical resistances and lengths. What is the ratio of the radius of the aluminum wire to that of the silver wire? The resistivities of aluminum and silver are $2.82 \times 10^{-8}\Omega$ m and $1.59 \times 10^{-8}\Omega$ m, respectively.

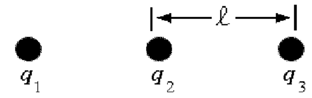
(1) 2.11 (2) 1.33 (3) 0.56 (4) 1.77 (5) 0.75

9. A spherical rubber (insulating) balloon has charge uniformly distributed on its surface. The balloon is then inflated to three times its original size. Which of the following statements is correct? Assume the balloon begins and ends as a sphere.

(1) At a point very near the outer surface of the balloon, the electric field increases
(2) At a point far away from the balloon, the electric field decreases
(3) At a point very near the outer surface of the balloon, the electric field remains constant
(4) At a point far away from the balloon, the electric field increases
(5) At a point far away from the balloon, the electric field doesn't change

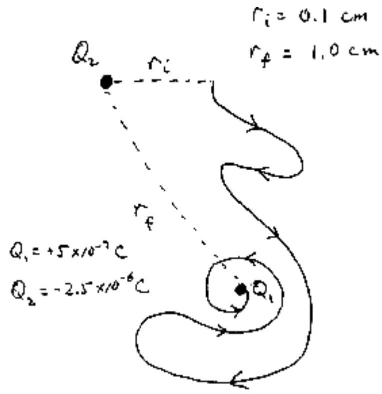
 31111

10. Three charges q_1, q_2 and q_3 lie along a straight line as shown in the figure. The charges q_2 and q_1 are opposite in sign and $|q_3| = 3|q_2| = 6|q_1|$. The distance between q_2 and q_3 is ℓ. What is the distance between q_1 and q_2 when the electrostatic force on q_1 vanishes?



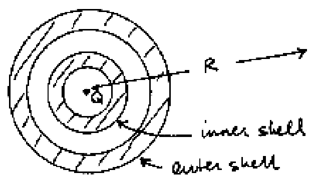
(1) 1.37ℓ (2) 0.54ℓ (3) 0.98ℓ (4) 0.76ℓ (5) 1.11ℓ

11. A point charge $Q_1 = +5 \times 10^{-7}$ C is initially located 0.1 cm from a second (fixed) point charge $Q_2 = -2.5 \times 10^{-6}$ C. If Q_1 follows the path shown such that its final position is 1 cm from Q_2, what is the change in its electric potential energy (in J)?



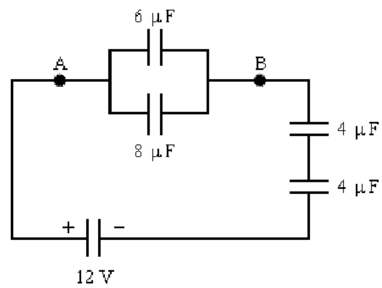
(1) 13.5
(2) -2.03×10^7
(3) 2.03×10^7
(4) -43.8
(5) 10.1

12. Two hollow conducting shells surround a point charge $Q = +5$ nC, as shown. At a radius $R = 0.6$m from Q (i.e., outside the outer shell) the electric field is directed inward with magnitude 100 N/C. The total charge on the inner shell is -10 nC. What is the net charge (in nC) on the outer shell? (Pick the closest answer.)



(1) $+1$ (2) -4 (3) $+9$ (4) $+4$ (5) $+6$

13. The four capacitors in the diagram are arranged as shown and are charged by a 12-volt battery. What is the equivalent capacitance of the system of capacitors?



(1) $7/2\mu$F (2) 22μF (3) 6μF (4) $7/4\mu$F (5) $29/2\mu$F

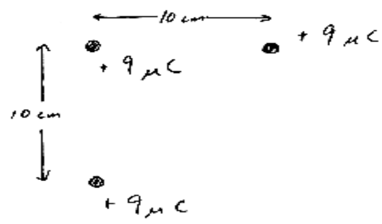
14. A capacitor has plate area of 0.01 m^2 and separation distance (gap) of 0.5 mm. What is maximum energy (in J) the capacitor can store if its breakdown voltage is 300 V? (The breakdown voltage is the voltage at which the charge is able to jump across the gap; i.e., the maximum voltage the capacitor can have.)

(1) 2.1×10^{-3} (2) 1.77×10^{-10} (3) 2.1×10^{-5} (4) 8.0×10^{-6} (5) 5.3×10^{-8}

15. A high-voltage transmission line of length 150 km carries a current of 500A. The voltage drop from one end of the line to the other is 10^4Volts. If 1 percent of the power carried by the line is lost due to the resistance of the line, what is the power input into the line?

(1) 3×10^9W (2) 7×10^6W (3) 4×10^{10}W (4) 5×10^8W (5) 2×10^3W

16. Three $+9.0\mu$C charges are arranged as shown. If the charges were brought in from an infinite distance, how much did their potential energy increase (in J)? Assume that charges at infinity have zero potential energy.



(1) 167.9 (2) 182.3 (3) 2.3 (4) 145.9 (5) 19.7

17. A wire with an original resistance of 8-Ω is melted down and from the same volume reformed into a wire that is one fourth as long as the original wire. What is the resistance (in Ω) of the new wire?

(1) 32 (2) 0.5 (3) 4 (4) 2 (5) 128

18. A metal wire has radius 1 mm and length 10m. The resistivity of the metal is $1 \times 10^{-6}\Omega$-m. What is the resistance (in Ω) of the wire? (Select the closest answer.)

(1) 1×10^{-5} (2) 3×10^{-3} (3) 3×10^{6} (4) 1×10^{-9} (5) 3

19. A particular wire has a resistivity of $3.0 \times 10^{-8}\Omega\cdot$m and a cross-sectional area of 4.0×10^{-6}m^2. A length of this wire is to be used as a resistor that will develop 48 W of power when connected across a 20-V battery. What length of wire is requried?

(1) 16 m (2) 1.1 km (3) 0.32 km (4) 56 m (5) 0.9 mm

20. Two electrons are placed at a distance of 10^{-2}m from each other and are then simultaneously released while each is at rest. What is the final speed of each electron in m/s as it approaches infinite separation from the other electron?

(1) 4.3×10^{1} (2) 8.3×10^{1} (3) 1.6×10^{2} (4) 0.41×10^{-1} (5) 2.5×10^{1}