Instructor: *Profs. Mitselmakher, Qiu*

PHYSICS DEPARTMENT

PHY 2054 Exam 1 February 11, 2015

Name (PRINT, last, first): _____ 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 answer sheet (use 76–80 for the 5-digit number)**. Code your name on your answer sheet. **DARKEN CIRCLES COMPLETELY**. 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) **Blacken the circle of your intended answer completely, using a #2 pencil or blue or black ink**. Do not make any stray marks or the answer sheet may not read properly.
(5) The answers are rounded off. Choose the closest to exact. There is no penalty for guessing.

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

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
$n_{H_2O} = 1.333$	micro $= 10^{-6}$	nano $= 10^{-9}$	pico $= 10^{-12}$

---

1. Three point charges are located on the x-axis. The first charge, $q_1 = 10.0\mu$C, is at $x = -1.00$ m; the second charge, $q_2 = 20.0\mu$C, is at the origin; and the third charge, $q_3 = -30.0\mu$C, is located at $x = 2.00$ m. What is the force on q_3?

   (1) 1.65 N in the negative x-direction
   (2) 3.15 N in the positive x-direction
   (3) 1.50 N in the negative x-direction
   (4) 4.80 N in the positive x-direction
   (5) 4.65 N in the negative x-direction

2. An electron gun sends electrons through a region with an electric field of 3.0×10^4 N/C for a distance of 1.8 cm. If the electrons start from rest, how fast are they moving after traversing the gun?

   (1) 1.4×10^7 m/s (2) 1.4×10^8 m/s (3) 1.5×10^7 m/s (4) 3.21×10^5 m/s (5) 2.5×10^{15} m/s

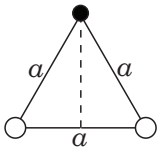
3. An electron gun sends electrons through a region with an electric field of 2.0×10^4 N/C for a distance of 3.2 cm. If the electrons start from rest, how fast are they moving after traversing the gun?

   (1) 1.5×10^7 m/s (2) 1.4×10^7 m/s (3) 1.5×10^8 m/s (4) 2.5×10^4 m/s (5) 2.3×10^{15} m/s

4. Two identical conducting spheres A and B carry charges Q amd $2Q$ respectively. They are separated by a 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 electrostatic force between A and B, which was originally F, becomes:

   (1) $5F/16$ (2) $F/8$ (3) $3F/16$ (4) $F/32$ (5) $7F/16$

5. Two particles with charges $2Q$ and Q are fixed at the vertices of an equilateral triangle with sides of length a. If $k = 1/4\pi\epsilon_0$, the work required to move a particle with a charge q from the other vertex to the center of the line joining the fixed charges is:



   (1) $3kQq/a$ (2) $2kQq/a$ (3) kQq/a^2 (4) 0 (5) $\sqrt{2}kQq/a$

6. A conducting sphere of radius 20 mm is charged so that the electric field reaches 3.0×10^5V/m at its surface. What is the potential at the surface of the sphere?

(1) 6.0×10^3 V (2) 1.5×10^5 V (3) 6.0×10^6 V (4) 3.0×10^4 V (5) 1.5×10^4 V

7. A conducting sphere of radius 30 cm is charged so that the electric field reaches 5.0×10^4V/m at its surface. What is the potential at the surface of the sphere?

(1) 1.5×10^4 V (2) 1.5×10^6 V (3) 1.7×10^6 V (4) 3.0×10^4 V (5) 1.7×10^3 V

8. If a 0.20 nF capacitor has a voltage of 80 V, how many more electrons are on the negative plate than on the positive plate?

(1) 2.0×10^{11} (2) 1.0×10^{11} (3) 1.0×10^{10} (4) 16.0×10^{13} (5) The electrons are in equal numbers on the plates.

9. If a 0.40 μF capacitor has a voltage of 80 V, how many more electrons are on the negative plate than on the positive plate?

(1) 4.0×10^{14} (2) 1.0×10^{14} (3) 1.0×10^{13} (4) 16.0×10^{13} (5) The electrons are in equal numbers on the plates.

10. A 10.0 V battery is placed across a 5.00 Ω resistor. If the current through the resistor is 1.60 A, what is the internal resistance of the battery?

(1) 1.25 Ω (2) 3.86 Ω (3) 6.25 Ω (4) 1.8 Ω (5) 3.4 Ω

11. A 18.0 V battery is placed across a 9.00 Ω resistor. If the current through the resistor is 1.40 A, what is the internal resistance of the battery?

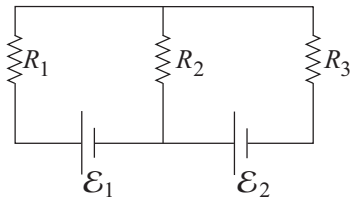
(1) 3.86 Ω (2) 5.32 Ω (3) 12.8 Ω (4) 7.6 Ω (5) 1.25 Ω

12. Four 6Ω resistors are connected together. Which of the following resistances cannot be formed using all 4 resistors?

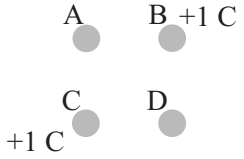
(1) 30 Ω (2) 24 Ω (3) 4.5 Ω (4) 6 Ω (5) 10 Ω

13. If $R_1 = 6\Omega$, $R_2 = 8\Omega$, $R_3 = 2\Omega$, $\mathcal{E}_1 = 8$ V, and $\mathcal{E}_2 = 28$ V, what is the current in R_2?

(1) 2 A
(2) 1 A
(3) 3 A
(4) 4 A
(5) 5 A



14. Four charges are at the corners of a square, with B and C on opposite corners. Charges A and D, on the other two corners, have equal charge, while both B and C have a charge of +1.0 C. What is the charge on A so that the force on B is zero?



(1) −0.35 C (2) −0.50 C (3) −1.0 C (4) −0.71 C (5) −0.25 C

15. Charge A and charge B are 3.00 m apart, charge A is +2.00 C and charge B is +3.00 C. Point C is located between them, and the electric field at this point is zero. How far from charge A is the point C?

(1) 1.35 m (2) 0.555 m (3) 0.667 m (4) 1.50 m (5) none of these

16. A closed surface contains the following point charges: 4 C, 6 C, −2 C, −6 C. The electric flux coming out of the surface is:

(1) $2C/\epsilon_0$ (2) $-2C/\epsilon_0$ (3) $18C/\epsilon_0$ (4) $-18C/\epsilon_0$ (5) $7C/\epsilon_0$

17. A closed surface contains the following point charges: 2 C, 10 C, −3 C, −2 C. The electric flux coming out of the surface is:

(1) $7C/\epsilon_0$ (2) $-7C/\epsilon_0$ (3) $17C/\epsilon_0$ (4) $-17C/\epsilon_0$ (5) $2C/\epsilon_0$

18. 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

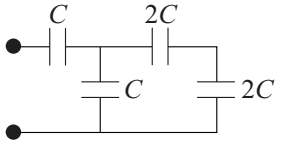
19. When charges q_a, q_b, and q_c are placed respectively at the corners a, b, and c of a right triangle, the potential at the midpoint of the hypotenuse is 20 V. When the charge q_a is removed, the potential at the midpoint becomes 15 V. When, instead, the charge q_b is removed (q_a and q_c both in place), the potential at the midpoint becomes 12 V. What is the potential at the midpoint if both charges q_a and q_c are removed?

(1) 8 V (2) 5 V (3) 7 V (4) 13 V (5) 0

20. Increasing the separation of the two charged parallel plates of a capacitor, which are disconnected from a battery, will produce what effect on the capacitor?

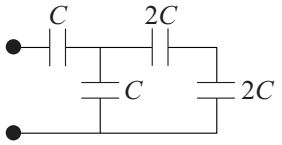
(1) decrease capacitance (2) increase capacitance (3) increase charge (4) decrease charge (5) none of these

21. If $C = 48\mu$F, determine the equivalent capacitance for the combination shown.



(1) 32μF (2) 24μF (3) 48μF (4) 16μF (5) 8μF

22. If $C = 12\mu$F, determine the equivalent capacitance for the combination shown.

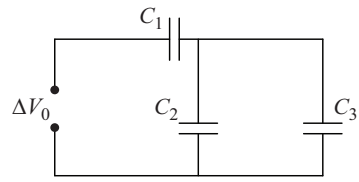


(1) 8μF (2) 12μF (3) 6μF (4) 32μF (5) 48μF

23. Using a 1-mF capacitor, a 2-mF capacitor, and a 3-mF capacitor, which of the following capacitances cannot be made by a combination that uses all three? (Hint: At most only 2 combinations must be considered to determine the correct answer.)

(1) 5/11 mF (2) 6/11 mF (3) 11/3 mF (4) 6 mF (5) 0

24. If $C_1 = 25\mu F$, $C_2 = 20\mu F$, $C_3 = 10\mu F$, and $\Delta V_0 = 21V$, determine the energy stored by C_2.



(1) 0.91 mJ
(2) 0.72 mJ
(3) 0.32 mJ
(4) 0.40 mJ
(5) 0

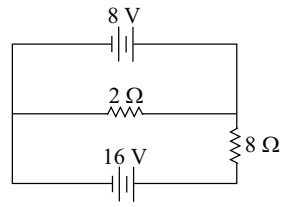
25. A high voltage transmission line of diameter 2 cm and length 200 km carries a steady current of 1000 A. If the conductor is copper with a free charge density of 16×10^{28} electrons/m^3, how long does it take for one electron to travel the full length of the cable? ($e = 1.6 \times 10^{-19}$ C)

(1) 1.6×10^9 s (2) 4.0×10^8 s (3) 1.6×10^5 s (4) 1.6×10^4 s (5) 0

26. A high voltage transmission line of diameter 2 cm and length 200 km carries a steady current of 2000 A. If the conductor is copper with a free charge density of 8×10^{28} electrons/m^3, how long does it take for one electron to travel the full length of the cable? ($e = 1.6 \times 10^{-19}$ C)

(1) 4.0×10^8 s (2) 1.6×10^9 s (3) 4.0×10^5 s (4) 4.0×10^6 s (5) 0

27. What is the current flowing through the 2-Ω resistor?



(1) 4 A
(2) 3 A
(3) 2 A
(4) 6 A
(5) 0 A

FOLLOWING GROUPS OF QUESTIONS WILL BE SELECTED AS ONE GROUP FROM EACH TYPE
TYPE 1
Q# S 2
Q# S 3
TYPE 2
Q# S 6
Q# S 7
TYPE 3
Q# S 8
Q# S 9
TYPE 4
Q# S 10
Q# S 11
TYPE 5
Q# S 16
Q# S 17
TYPE 6
Q# S 21
Q# S 22
TYPE 7
Q# S 25
Q# S 26