Exam 1--PHYS 102--Spring 2011

Multiple Choice
Identify the choice that best completes the statement or answers the question.

1. This figure shows two charges and their electric field lines. If the charge on the left has a magnitude of 6 \( \mu \text{C} \), what is the sign and magnitude of the right charge?

   a. +12 \( \mu \text{C} \)  
   b. -3 \( \mu \text{C} \)  
   c. -6 \( \mu \text{C} \)

2. Which of these is not a valid charge?

   a. 7.0x10\(^{-19}\) \( \text{C} \)  
   b. -4 \( \text{C} \)  
   c. -1.6x10\(^{-19}\) \( \text{C} \)  
   d. 8.0x10\(^{-19}\) \( \text{C} \)
3. Consider this configuration of charges. Which vector best represents the net force acting on the rightmost charge?

![Diagram of charges]

- a. a
- b. b
- c. c
- d. d
- e. e

4. In this figure, 2 charges are separated by a distance d. The point A is equidistant between the two charges. The point B is a distance d/2 from the right charge. Where is the electric field the greatest in magnitude?

![Diagram of charges]

- a. A
- b. B
- c. both A & B have the same magnitude E
- d. not enough information; it depends on d
5. Which best describes the work required to move the charge along the dotted line in this figure?

a. zero work  
b. positive work  
c. negative work  
d. not enough information

6. This figure shows how particles a and b respond to one another and, separately, how a and c respond to one another. Which of these statements is true:

a. a & b are like charges  
b. a & c are opposite charges  
c. b & c are like charges  
d. b & c are opposite charges
7. A proton and electron are in a constant E-field as shown. You release an electron and proton at a point equidistant between the plates. Which particle has more kinetic energy when they strike the plates?

- a. electron
- b. not enough information
- c. proton
- d. neither, they have the same KE

8. In this figure, an electron sits between two charged plates. The electron moves to the right in response to the electric field. What is the direction of the electric field in between the plates?

- a. up
- b. to the right
- c. down
- d. to the left

9. In which of the following diagrams is the potential along the x-axis equal to zero?

- a. a
- b. b
- c. c
- d. none of these
- e. all of these
10. This figure shows a positive charge with concentric circles surrounding it. At what point(s) is the potential at its greatest value?

![Diagram showing a positive charge with concentric circles]

- a. A
- b. B
- c. C
- d. D
- e. C & D

11. These six charges are at the corner of an equilateral hexagon. What pair of statements best describes the electric field and potential at a point in the center of the hexagon, equidistant from each of the charges?

![Diagram showing six charges forming an equilateral hexagon]

- a. \( E \neq 0, V \neq 0 \)
- b. \( E \neq 0, V = 0 \)
- c. \( E = 0, V = 0 \)
- d. \( E = 0, V \neq 0 \)

12. A parallel-plate capacitor initially has a potential difference of 200 V and is then disconnected from the charging battery. If the plate area is now doubled (without changing \( Q \)), what is the new value of the voltage?

![Diagram showing a parallel-plate capacitor]

- a. 100 V
- b. 400 V
- c. 200 V
- d. 800 V
13. Consider this circuit. All three capacitors are identical. What is the voltage across \( C_1 \)?

\[ C_1 \quad C_2 \]
\[ \quad C_3 \]
\[ 12 \text{ V} \]

- a. 24 V
- b. 12 V
- c. 6 V
- d. 4 V

14. Consider this circuit; all 3 capacitors are identical. What happens to the equivalent capacitance if one of the capacitors is removed?

- a. \( C_{eq} \) decreases
- b. it depends on the value of C
- c. \( C_{eq} \) increases
- d. \( C_{eq} \) remains the same

15. What is the purpose of the dielectric in a capacitor?

- a. to prevent the plates of the capacitor from touching
- b. to increase the potential between the plates of the capacitor
- c. to allow for the flow of charge between the two plates of the capacitor
- d. there is no real purpose for the dielectric
Problem

16. (20 pts) a) What is the electric field in vector notation at the point (2.0 i - 3.0 j) meters if the electric potential is given by $V = 2xy^3 - 2x + 4x^2y$, where $V$ is in volts and $x$, $y$, and $z$ are in meters?

b) An electron is placed at the point (2.0 i - 3.0 j) and then released. What is the displacement, in vector notation, of the electron after $t=1\times10^{-5}$ s? (Assume that the electric field remains constant as the electron moves.)
(20 pts) In this figure a 20 V battery is connected across capacitors of capacitances \( C_1 = 4 \, \mu\text{F} \), \( C_2 = 4 \, \mu\text{F} \), \( C_3 = 2 \, \mu\text{F} \), \( C_4 = 8 \, \mu\text{F} \), \( C_5 = 8 \, \mu\text{F} \), and \( C_6 = 8 \, \mu\text{F} \).

a) What is the equivalent capacitance, \( C_{eq} \)?

\[
C_{eq} = \ldots
\]

b) What is the charge stored by \( C_{eq} \)?

\[
Q_{eq} = \ldots
\]

c) \( V_1 = \ldots \)

d) \( V_1 = \ldots \)

e) \( Q_2 = \ldots \)

f) \( V_3 = \ldots \)

g) \( V_4 = \ldots \)

h) \( Q_4 = \ldots \)

i) \( V_5 = \ldots \)
18. (15 pts) This figure shows three charges; the positions for each charge are given.

   a) What is the magnitude and direction of the net force acting on particle $Q_1$ (due to particles $Q_2$ and $Q_3$)?

   b) What are the x- and y-coordinates for a charge of $Q_4 = +3.0 \, \mu C$ placed such that the net force on $Q_1$ is zero?
19. (10 pts) Consider this configuration of charges.

a) What is the potential at point P?

b) How much work is required to move a charge of $Q=2.0 \ \mu C$ from an infinite distance way to point P?
20. (5 pts) A capacitor consists of 2 metal plates with an area of 0.4 m$^2$ each. The plates are separated by a distance of $1 \times 10^{-6}$ m. A piece of paper is between the two plates; this paper has a dielectric constant of 1.5. What is the capacitance of the capacitor?
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Answer Section

MULTIPLE CHOICE

1. ANS: A  PTS: 1
2. ANS: A  PTS: 1
3. ANS: E  PTS: 1
4. ANS: A  PTS: 1
5. ANS: A  PTS: 1
6. ANS: D  PTS: 1
7. ANS: D  PTS: 1
8. ANS: D  PTS: 1
9. ANS: D  PTS: 1
10. ANS: E  PTS: 1
11. ANS: B  PTS: 1
12. ANS: A  PTS: 1
13. ANS: C  PTS: 1
14. ANS: C  PTS: 1
15. ANS: A  PTS: 1

PROBLEM

16. ANS:
   .
   PTS: 1
17. ANS:
   .
   PTS: 1
18. ANS:
   .
   PTS: 1
19. ANS:
   .
   PTS: 1
20. ANS:
   .
   PTS: 1