Exam 2--PHYS 202--Spring 2016

Multiple Choice (20 pts)
Identify the choice that best completes the statement or answers the question.

1. These are two-dimensional cross sections through three-dimensional closed spheres and a cube. Rank order, from largest to smallest, the electric fluxes \(\Phi_a\) to \(\Phi_e\) through surfaces a to e.

\[
\begin{align*}
\text{(a)} &: q/R \\
\text{(b)} &: 2q/R \\
\text{(c)} &: q/2R \\
\text{(d)} &: q/2R \\
\text{(e)} &: q/2R \\
\end{align*}
\]

a. \(\Phi_a > \Phi_c > \Phi_b > \Phi_d > \Phi_e\)  

b. \(\Phi_b = \Phi_c = \Phi_d = \Phi_e\)  

c. \(\Phi_e > \Phi_d > \Phi_b > \Phi_c > \Phi_a\)  

d. \(\Phi_c > \Phi_a > \Phi_b > \Phi_d > \Phi_e\)  

e. \(\Phi_a = \Phi_b = \Phi_c = \Phi_d = \Phi_e\)

2. The amount of electric field passing through a surface is called

a. electric flux  

b. Gauss’ law  

c. electricity  

d. charge surface density  

e. none of the above

3. The vectors in this diagram represent the electric field; the 4 arrows are all the same length. What type of charge does the box contain?

\[
\begin{align*}
\end{align*}
\]

a. a net positive charge  

b. no net charge  

c. a net negative charge  

d. a positive charge  

e. a negative charge

4. Gauss’s law applies to

a. lines  

b. flat surfaces  

c. spheres  

d. closed surfaces

5. What is the equivalent capacitance of this circuit?

\[
\begin{align*}
\end{align*}
\]

a. 9 \(\mu\)F  

b. 5 \(\mu\)F  

c. 16 \(\mu\)F  

d. 2 \(\mu\)F
6. What is the voltage on the 6 µF capacitor?

\[ V = \frac{Q}{C} \]

\[ V = \frac{12 \text{ C}}{6 \times 10^{-6} \text{ F}} = 2 \times 10^6 \text{ V} \]

a. 12 V  
b. 8 V  
c. 4 V  
d. 6 V  
e. 2 V

7. This diagram shows a collection of charges. At which point is the potential equal to zero?

\[ \phi(a) = -2 \text{ C} + 1 \text{ C} = -1 \text{ C} \]
\[ \phi(b) = 1 \text{ C} + 1 \text{ C} = 2 \text{ C} \]
\[ \phi(c) = 2 \text{ C} + 3 \text{ C} = 5 \text{ C} \]
\[ \phi(d) = 3 \text{ C} + 3 \text{ C} = 6 \text{ C} \]

a. a  
b. b  
c. c  
d. d  
e. at all points

8. A parallel-plate capacitor initially has a potential difference of 10 V and is then disconnected from the charging battery. If the area of the plates is now doubled, what is the new value of the voltage?

\[ V = \frac{Q}{C} \]

As the area is doubled, the capacitance is also doubled, so the voltage remains the same.

a. 2.5 V  
b. 5 V  
c. 10 V  
d. 20 V  
e. 40 V

9. For this scenario, where is the electric potential the least?

\[ \phi(A) = -2 \text{ C} + 1 \text{ C} = -1 \text{ C} \]
\[ \phi(B) = 1 \text{ C} + 1 \text{ C} = 2 \text{ C} \]
\[ \phi(C) = 2 \text{ C} + 3 \text{ C} = 5 \text{ C} \]
\[ \phi(D) = 3 \text{ C} + 3 \text{ C} = 6 \text{ C} \]

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

10. Electric potential is a measure of:

a. energy/charge  
b. force/charge  
c. force  
d. momentum/charge
11. (7.5 pts) You have a potential described by this function:
\[ V = 3xy - 4yz^2 \]
What is the electric field, in vector notation, at the following coordinates:
\( (x=2, y=1, z=-2) \)

12. (7.5 pts) Beginning with Gauss’ Law, derive the equation for the electric field due to a point charge.
13. (15 pts) Consider this configuration of charges.

a) What is the potential at point A due to the three charges?

b) What is the potential energy of the configuration of 3 charges?

c) How much work would be required to place a +2 nC charge at point A?
14. (20 pts) Find the equivalent capacitance and the voltage & charge for each capacitor in this circuit.

\[
\begin{array}{c|c}
\text{Capacitor} & C_{eq}= \\
\hline
C_1 & 3.0 \mu F \\
C_2 & 3.0 \mu F \\
C_3 & 6.0 \mu F \\
C_4 & 6.0 \mu F \\
C_5 & 4.0 \mu F \\
C_6 & 4.0 \mu F \\
C_7 & 2.0 \mu F \\
\hline
V_1 & Q_1 = \\
V_2 & Q_2 = \\
V_3 & Q_3 = \\
V_4 & Q_4 = \\
V_5 & Q_5 = \\
V_6 & Q_6 = \\
V_7 & Q_7 = \\
\end{array}
\]
15. (20 pts) An electric field is given by:
\[ \vec{E} = 3x \hat{i} - 4 \hat{j} \]
This field is present in and around this gaussian surface, a rectangular prism 3m x 3m x 5m.

a) What is the electric flux through the gaussian surface?
b) What is the charge enclosed inside the surface?
MULTIPLE CHOICE

1. ANS: B PTS: 1
2. ANS: A PTS: 1
3. ANS: A PTS: 1
4. ANS: D PTS: 1
5. ANS: D PTS: 1 REF: S16
6. ANS: C PTS: 1 REF: S16
7. ANS: E PTS: 1 REF: S15-Final
8. ANS: B PTS: 1 REF: S15-Final
9. ANS: B PTS: 1 REF: S16
10. ANS: A PTS: 1 REF: S15

PROBLEM

11. ANS: 
   PTS: 1
12. ANS: 
   PTS: 1
13. ANS: 
   PTS: 1
14. ANS: 
   PTS: 1
15. ANS: 
   PTS: 1