Physics 202 Midterm Exam 1
February 22\textsuperscript{nd}, 2012

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Instructions:

1. Don’t forget to write down your name, student ID#, and section number. You need do this on (this page of) your test book and on your Scantron sheet as well.

2. Answer all multiple choice questions in this test book by indicating the best answer among choices. You must do this both on your test book and on your Scantron sheet. Follow instructions on the Scantron sheet on how to mark valid answers.

3. When you finish, you need to turn in both this test book and the Scantron sheet.

4. Use the blank side of question pages as additional draft spaces. An extra blank sheet is provided at the end of the test book.

5. Only one answer is allowed per problem/question. All problems have equal weight.

Constants: $k_c = 9 \times 10^9 \text{Nm}^2/\text{C}^2 = 1/(4\pi\varepsilon_0)$, \quad $\varepsilon_0 = 8.85 \times 10^{-12} \text{C}^2/(\text{Nm}^2)$

Please be very careful with the first question even though the answer will not count towards your grade:

1. ENTER THE ID CODE ABOVE IN THE UPPER RIGHT CORNER
   A. ID Code A
   B. ID Code B
   C. ID Code C
   D. ID Code D
   E. ID Code E
2. Two charged particles, Q₁ and Q₂, are of a distance r apart. If Q₂ = 5Q₁, which of the followings is true? (Denote \(\mathbf{F}_{21}\) as the force Q₂ exerts on Q₁ and \(\mathbf{F}_{12}\) is the force Q₁ exerts on Q₂.)

A. \(5\mathbf{F}_{21} = -\mathbf{F}_{12}\)
B. \(\mathbf{F}_{21} = -5\mathbf{F}_{12}\)
C. \(25\mathbf{F}_{21} = -\mathbf{F}_{12}\)
D. \(\mathbf{F}_{21} = -25\mathbf{F}_{12}\)
E. None of above

3. Three point charges, all have \(Q = 40\mu\text{C}\), are placed on the x axis at x = -1.0 m, 0.0 m, and +2.0 m, respectively. What is the magnitude of the electrostatic force on the charge at \(x = 0.0\text{ m}\)?

A. 18.0N
B. 14.4N
C. 10.8N
D. 3.6N
E. None of above is within 0.2N from the correct answer.

4. A charge of \(30\mu\text{C}\) at its center of an imagery cubic of side length 2.0m. What is the total electric flux through the surface of this cubic?

A. \(3.7 \times 10^6 \text{Nm}^2/\text{C}\)
B. \(4.9 \times 10^6 \text{Nm}^2/\text{C}\)
C. \(6.8 \times 10^6 \text{Nm}^2/\text{C}\)
D. \(9.9 \times 10^6 \text{Nm}^2/\text{C}\)
E. None of above is within 5% from the correct answer

5. In the previous setting, if a second point charge of \(Q = 60\mu\text{C}\) is now added at a position which is 0.5m from the first charge, what is the total electric flux through the surface of the same cubic?

A. same as before
B. twice as much
C. 3 times as much
D. Can’t be determined, as the question does not specify where exactly the 2\textsuperscript{nd} charge is placed with respect to the first one. (distance alone can not fix a position)
E. none of above
6. A total charge $q$ is distributed uniformly along the x axis from $x = 0$ to $x = L$ ($L > 0$). Which of the following integrals is correct for the magnitude of the electric field at $x = 2L$ on the x axis? (SI units implies)

A. $k_e \int_0^L \frac{q/L}{(2L-x)^2} dx$

B. $k_e \int_0^L \frac{q/L}{(2L+x)^2} dx$

C. $k_e \int_0^L \frac{(q/L)^2}{(2L-x)^2} dx$

D. $k_e \int_0^L \frac{(q/L)}{(2L-x)} dx$

E. None of above.

7. A point charge of $Q = -50 \mu C$ is released from rest at position A inside an electrostatic field. It then moves under the sole influence of the electric force to reach position B. At point B, its kinetic energy is 2.0 mJ. The distance between point A and B is 10 cm. What is the potential difference between point A and B, $V_B - V_A$?

A. 40 V
B. -40 V
C. -25 V
D. can not be determined as the electric field strength is not given.
E. None of above.

8. A circular ring of radius $R = 2.0 m$ has a charge $Q = 2.0 \mu C$ uniformly distributed along it. A test charge $q = 1.0 \mu C$ is placed at the center of the ring. What is the magnitude of the force on the test charge?

A. 0
B. 2.25 mN
C. 4.5 mN
D. 9.0 mN
E. None of above
9. The electric potential distribution of an electric field is described by expression 
\[ V = 3x^2 + 2xy - 9xyz. \] What is the magnitude of the force on a test charge of 1.0\(\mu\)C at location \((x,y,z) = (1.0, 1.0,1.0)\)? (SI units implied).

A. 7.5 \(\mu\)N  
B. 17.0 \(\mu\)N  
C. 11.9 \(\mu\)N  
D. 13.4 \(\mu\)N  
E. None of above is within 0.2 \(\mu\)N of correct answer.

10. The electric potential distribution of an electric field is described by expression 
\[ V = 3x^2 + 2xy - 9xyz. \] A test charge of -1.0\(\mu\)C is moved from \((x,y,z) = (1.0, 1.0,1.0)\) to \((1.0,2.0,1.0)\), then to \((1.0,2.0,3.0)\), and then to \((2.0, 2.0,3.0)\) and finally to \((2.0,1.0,2.0)\). What is the total work done by the field to the test charge in the whole process? (SI units implied).

A. -20 \(\mu\)J  
B. 20 \(\mu\)J  
C. -16 \(\mu\)J  
D. 16 \(\mu\)J  
E. None of above
11. A point charge $Q>0$ is put as the center of a spherical conductor of inner radius $R$ and outer radius $2R$. Initially, the conductor is grounded. Which of the followings statements describes the charge on the conductor.

A. The total charge on the conductor is zero.
B. The total charge on the conductor is $-Q$, all on its inner surface
C. The total charge on the conductor is $+Q$, all on its inner surface
D. The total charge on the conductor is $-Q$, all on its outer surface
E. The total charge on the conductor is $+Q$, all on its outer surface

12. Now, the ground link of the above setting is cut off so the system is insulated from ground. Which of the followings statements describes the charge on the conductor.

A. The total charge on the conductor is zero.
B. The total charge on the conductor is $-Q$, all on its inner surface
C. The total charge on the conductor is $-Q$, all on its outer surface
D. The total charge on the conductor is $-Q$, half on the inner, half on the outer surfaces.
E. The total charge on the conductor is $-Q$, 1/5 on the inner and 4/5 on the outer surfaces.
13. The figure above illustrates the equipotential lines near two conductors. As indicated, the conductors have potential +15V and +10V respectively. What is the sign of the surface charge at point A, which is on the surface of the conductor at +10 V? (hint: what is the direction of the electric field near A?)
A. Positive
B. Negative
C. Zero
D. can not be determined

14. In the figure above, a test charge q of 1.0µC is placed at point C. What is the magnitude of the electric force on q? (ignore the effect of the test charge on the field).
A. 1.2µN
B. 1.0µN
C. 0.2 µN
D. Zero
E. can not be determined

15. In the above figure, a test charge q of charge 1.0µC is moved from point C to point B. Ignoring the effect of the test charge q on the field, what is the work done to q by the electric field in the process? (hint: pay attention to the sign.)
A. 2.0 µJ
B. - 2.0 µJ
C. - 3.0 µJ
D. + 3.0 µJ
E. none of above or can not be determined.
16. Still as shown in the same setting, an empty cavity completely enclosed by the conductor at +10V. What is the potential at location D that is inside the cavity?

A. 0V
B. 10 V
C. None zero but less than 10V
D. None zero but larger than 10 V
E. Can not be determined with given information.

17. The Marx Generator we have demoed in lecture is made of 10 capacitors, each with a capacitance of 0.02µF. Right before discharging, each capacitor is charged to 50KV and the capacitors are connected in series. What is the total energy stored in the capacitors in this configuration?

A. 25J
B. 125J
C. 250 J
D. 1250J
E. none of above is within 2J from the correct answer.
18. Three capacitors, $C_1=3.0 \, \mu F$, $C_2=6.0 \, \mu F$ and $C_3=4.0 \, \mu F$ are connected as shown $(\Delta V=4.0V)$:

![Diagram of capacitors connected in series](image)

The combined capacitance of capacitors is:

A. 6.0 $\mu F$
B. 13.0 $\mu F$
C. 2.8 $\mu F$
D. 7.2 $\mu F$
E. none of above is within 0.1 $\mu F$ from the correct answer.

19. In above setting, how much is the charge on $C_1$?

A. 2.0 $\mu C$
B. 4.6 $\mu C$
C. 6.7 $\mu C$
D. 8.0 $\mu C$
E. none of above is within 0.1 $\mu C$ from the correct answer.

20. Still in the above setting, what is the total energy stored in the three capacitors?

A. 24.0 $\mu J$
B. 48.0 $\mu J$
C. 16.0 $\mu J$
D. 22.4 $\mu J$
E. none of above is within 0.1 $\mu J$ from the correct answer.

21. Yet still in the above setting, what is the ratio of the energy stored in $C_1$ to that in $C_2$? (ie. $U_1:U_2$)

A. 1:2
B. 2:1
C. 1:1
D. 4:1
E. None of above