

# PHYSICS 241

EXAM I

Feb. 20, 2001

Name: \_\_\_\_\_ ID#: \_\_\_\_\_

This is a closed book exam. Print and encode your name, student ID number, and recitation number on the answer sheet. Answers to all the questions are to be recorded on the answer sheet. There are 10 multiple choice questions for a total of 100 points. Do not do the problems in the order in which they are given. Do the easy problems first. There is only one correct answer to each question. No penalty for a wrong answer. However, all credit for a question will be lost if more than one choice is marked for that question. You may use your crib sheet and calculator. Fill out the op-scan card gradually, as soon as you finish a problem. Do not wait filling out the op-scan card during the last hectic five minutes!

## USEFUL CONSTANTS:

$$k_e \equiv 1/(4\pi\epsilon_0) = 8.99 \times 10^9 \text{ (Nm}^2\text{/C}^2\text{)}$$

$$\epsilon_0 = 8.85 \times 10^{-12} \text{ (C}^2\text{/Nm}^2\text{)}$$

$$e = 1.60 \times 10^{-19} \text{ (C)}$$

$$m_e = 9.11 \times 10^{-31} \text{ (kg)}$$

$$g = 9.81 \text{ (m/s}^2\text{)}$$

$$m_p = 1.67 \times 10^{-27} \text{ (kg)}$$

proton charge = electron charge (in magnitude).

$$\mu_0/4\pi = 10^{-7}$$

$$c = 3.00 \times 10^8 \text{ m/s}$$

$$\text{Atomic Mass Unit (AMU)} = 1.66 \times 10^{-27} \text{ Kg}$$

1. (10 points) A  $2\text{-}\mu\text{C}$  charge is placed at the origin, an identical charge is placed 2 m from the origin on the  $x$  axis, and a third identical charge is placed 2 m from the origin on the  $y$  axis. The magnitude of the force on the charge at the origin is:

(A) ( )  $9.0 \times 10^{-3} \text{ N}$

(B) ( )  $6.4 \times 10^{-3} \text{ N}$

(C) ( )  $1.3 \times 10^{-2} \text{ N}$

(D) ( )  $1.8 \times 10^{-2} \text{ N}$

(E) ( )  $3.6 \times 10^{-2} \text{ N}$

2. (10 points) An electric field exerts a torque on a dipole only if:

- (A) ( ) the field is parallel to the dipole moment
- (B) ( ) the field is not parallel (or anti-parallel) to the dipole moment
- (C) ( ) the field is perpendicular to the dipole moment
- (D) ( ) the field is not perpendicular to the dipole moment
- (E) ( ) the field is uniform

3. (10 points) A uniform electric field of  $300 \text{ N/C}$  makes an angle of  $64^\circ$  with the dipole moment of an electric dipole. If the moment has a magnitude of  $2 \times 10^{-9} \text{ C} \cdot \text{m}$ , the torque exerted by the field has a magnitude of:

(A) ( )  $6.7 \times 10^{-12} \text{ N} \cdot \text{m}$

(B) ( )  $2.5 \times 10^{-7} \text{ N} \cdot \text{m}$

(C) ( )  $5.4 \times 10^{-7} \text{ N} \cdot \text{m}$

(D) ( )  $6.0 \times 10^{-7} \text{ N} \cdot \text{m}$

(E) ( )  $2.8 \times 10^{-7} \text{ N} \cdot \text{m}$

4. (10 points) A  $5.0\text{-}\mu\text{C}$  point charge is placed at the center of a cube. The electric flux in  $\text{N}\cdot\text{m}^2/\text{C}$  through one side of the cube is:

- (A) ( ) 0
- (B) ( )  $7.1 \times 10^4$
- (C) ( )  $9.4 \times 10^4$
- (D) ( )  $1.4 \times 10^5$
- (E) ( )  $5.6 \times 10^5$

5. (10 points) A parallel-plate capacitor has a plate area of  $0.2 \text{ m}^2$  and a plate separation of  $0.1 \text{ mm}$ . If the charge on each plate has a magnitude of  $4 \times 10^{-6} \text{ C}$  the potential difference across the plates is approximately:

- (A) ( ) 0
- (B) ( )  $4 \times 10^{-2} \text{ V}$
- (C) ( )  $1 \times 10^2 \text{ V}$
- (D) ( )  $2 \times 10^2 \text{ V}$
- (E) ( )  $4 \times 10^8 \text{ V}$

6. (10 points) A 5 cm radius conducting sphere is charged until the electric field just outside its surface is 2000 V/m. The electric potential of the sphere, relative to the potential far away, ( $V_\infty = 0$ ) is:

- (A) ( ) 0
- (B) ( ) 5 V
- (C) ( ) 100 V
- (D) ( )  $4 \times 10^4$  V
- (E) ( )  $8 \times 10^5$

7. (10 points) Two identical capacitors (capacitance =  $C$ ) are connected in parallel and the combination is connected in series to a third identical capacitor (capacitance =  $C$ ). The equivalent capacitance of this arrangement is:

- (A) ( )  $2C/3$
- (B) ( )  $C$
- (C) ( )  $3C/2$
- (D) ( )  $2C$
- (E) ( )  $3C$



8. (10 points) Two capacitors are identical except that one is filled with air and the other with oil. Both capacitors carry the same charge. The ratio of the electric fields  $E_{\text{air}}/E_{\text{oil}}$  is:

- (A)  between 0 and 1
- (B)  0
- (C)  1
- (D)  between 1 and infinity
- (E)  infinite

9. (10 points) A 10 ohm resistor has a constant current of 5 A. How many coulombs of charge flow through this resistor in 4 minutes?

- (A) ( ) 20
- (B) ( ) 40
- (C) ( ) 200
- (D) ( ) 1200
- (E) ( ) 2400

10. (10 points) An air-filled parallel-plate capacitor has a capacitance of 1 pF. The plate separation is then doubled and a wax dielectric is inserted, completely filling the the space between the plates. As a result, the capacitance becomes 2 pF. The dielectric constant of the wax is:

- (A) ( ) 0.25
- (B) ( ) 0.5
- (C) ( ) 2.0
- (D) ( ) 4.0
- (E) ( ) 8.0

Exam 1

- 1) C
- 2) B
- 3) C
- 4) C
- 5) D
- 6) C
- 7) A
- 8) D
- 9) D
- 10) D