Practice Exam, Physics 121 Common Exam 1

Name (Print): ___________________________________ **4 Digit ID:_________** **Section: ______**

Honors Code Pledge: For ethical and fairness reasons all students are pledged to comply with the provisions of the NJIT Academic Honor Code. You must answer the exam questions entirely by yourself. **Turn off all cell phones, pagers, or other communication devices**. Use only your own calculator.

Instructions:

- First, write your name and section number on **both** the Scantron card and this exam booklet.
- Use the formula sheet (last page of exam booklet) and no other materials.
- All questions, including the harder ones marked by (*), are worth 1 point each. You need to answer a total of 16 questions correctly for a 100% score on the exam. No partial credit.
- **Briefly show work on this set of exam sheets for problems which require calculations.** Use the backs of pages if necessary.
- **Answers are approximate.** Select the closest one.
- Answer each question on the Scantron card using #2 pencil. Also circle your answers on question papers.
- Do not hesitate to ask for clarification of any exam question, if needed, from your proctor or Professor.

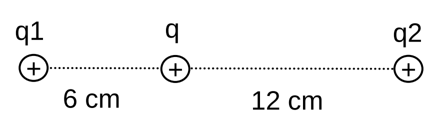
1. A point charge q = 1.45 nC is placed in the center of a spherical cavity of an isolated spherical conductor of inner radius 4 cm and outer radius 12 cm The area charge density on the inner surface is
A. -15.7nC/m^2
B. 28.4nC/m^2
C. -45.7nC/m^2
D. - 72.1nC/m^2
E. -152.7nC/m^2

2. The force acting on an electron 100 cm from a positive .1 μC point charge in a vacuum is:

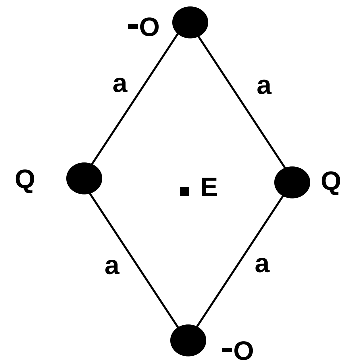
A) $2.8 \times 10^{+10}$ N. Repulsive
B) 1.0×10^{-19} N. Attractive
C) 1.4×10^{-12} N. Repulsive
D) **1.4×10^{-16} N. Attractive**
E) 1.6×10^{-16} N. Attractive

3. A positively charged particle with q= 2 μC is placed between two other positively charged particles with $q_1 = 9 \times 10^{-3}$ C and $q_2 = 3 \times 10^{-3}$ C as shown on the figure. The distance between q_1 and q is 6 cm and the distance from q to q_2 is 12 cm. What are the magnitude and direction of the total force acting on the middle particle?

A) $4.1 \times 10^{+4}$ N. right
B) $2.8 \times 10^{+9}$ N, right
C) $4.9 \times 10^{+4}$ N, left
D) $4.9 \times 10^{+4}$ N, right
E) $9.0 \times 10^{+9}$ N, left



4. The magnitude Q of the charge on four balls is 12 μC distributed uniformly on the surface of each one. Two are positive and tqo are negative as shown in the sketch. They are placed at the corners of the diamond as shown in the diagram. Each of the sides has length a = 3 cm. What are the magnitude and direction of the electric field at the center of the diamond shape?



A) 24.1 x 10^{13} N/C. Down
B) 1.6 x 10^{12} N/C. Up
C) 7.9 x 10^{19} N/C. Left
D) 1.4 x 10^{10} N/C. Right
E) **Zero**

5. For an isolated sphere of charge, which of the following statements about the electric field outside it is correct?

A) It is directly proportional to the distance from the sphere.
B**) It is inversely proportional to the square of the distance from the sphere.**
C) It is directly proportional to the square of the distance from the sphere.
D) It is inversely proportional to the distance from the sphere.
E) None of the above.

6. Determine the angle between **A** = 3.00**i** + 1.00**j** +0**k** and the **B** = -3.00**i** +3.00**j** + 0**k**.

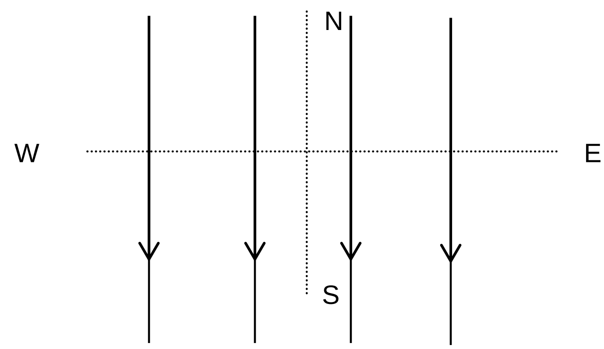
A) 26.6°
B) 30.0°
C) 88.1°
D) 117°
E) 45.2°

7. For an infinite line of charge, which of the following is true of the electric field?

A) It is directly proportional to the distance from the charged line.
B) It is a constant for all distances from the charged line.
C) It is directly proportional to the square of the distance from the charged line.
D) It is inversely proportional to the square of the distance from the charged line.
E) **None of the above.**

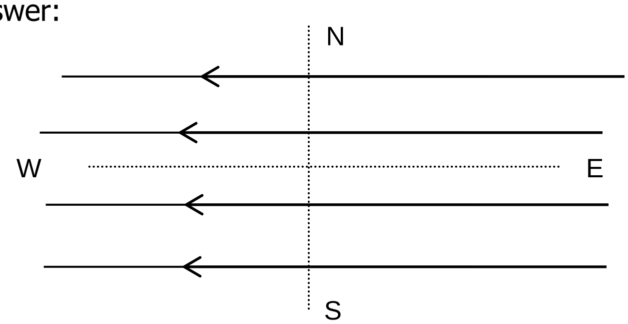
8. The field lines for a uniform electric field point south as shown. If a proton is released somewhere in the field, which way will it move?

A) West
B) East
C) **South**
D) North
E) Closer to the proton



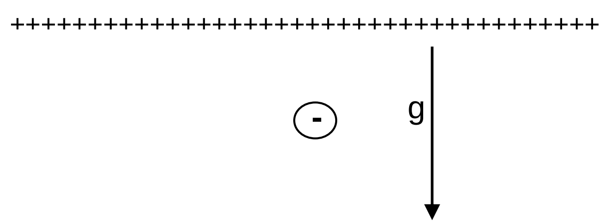
9. A negatively charged particle is placed in a uniform electric field directed West. What are the magnitude and direction of the particle's acceleration if its charge is q= -6 μC, its mass m = 2 grams, and the value of electric field E is 6 x10^{-6} N/C? Select the closest answer:

A) West. a = 1.8 x10^{-8} m/s^2
B) East. a = 1.8 x10^{-3} m/s^2
C) West. a = 1.8 x10^{+3} m/s^2
D) **East. a = 1.8 x10^{-8} m/s^2**
E) East. a = 1.8 x10^{-5} m/s^2



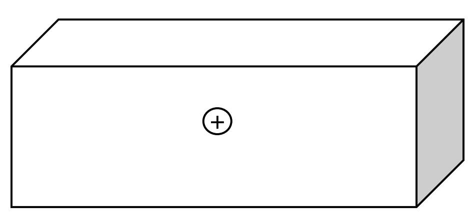
10. An electron with mass m = 9.11 x 10^{-31} kg is released at rest above very large positively charged non-conducting charged sheet lying horizontally as shown. What should the surface charge density σ on this sheet be to keep the electron balanced at rest above the ground?

A) 8.55 x 10^{-1} C/m^2
B) 2.35 x 10^{-6} C/m^2
C) 1.8 x 10^{-18} C/m^2
D**) 9.88 x 10^{-22} C/m^2**
E) 1.84 C/m^2

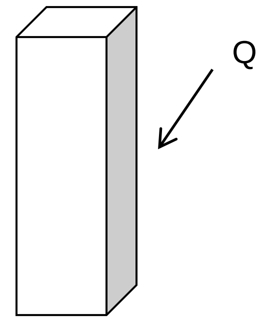


11. Find the electric flux through the surface of a rectangular Gaussian surface with a charge of 3.1 C. placed at it's center. The ends of the box are squares whose sides are 4.0 cm. The length is 8.0 cm.

A) 4.5 x 10^{+11} N m^2/C
B) **3.5 x 10^{+11} N m^2/C**
C) 0.1 x 10^{-16} N m^2/C
D) 4.4 x 10^{-10} N m^2/C
E) Insufficient information

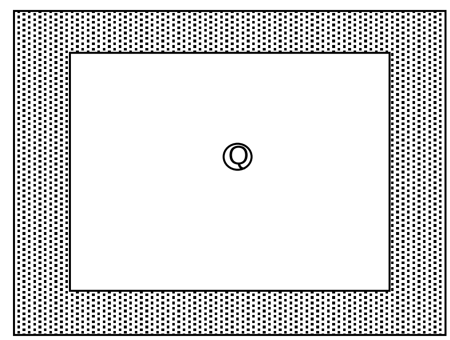


12. A charge Q is placed on an isolated, hollow metal rectangular solid with closed ends as shown. How will this charge be distributed after a while?



A) The charge will be distributed uniformly over the volume of the solid.
B) The charge will continuously move along the surface, creating a constant current.
C) The charge will be concentrated as a point charge at the center of the solid.
D) **The charge will be distributed over the outer surface of the solid.**
E) The charge will be distributed over the outer and inner surfaces of the solid.

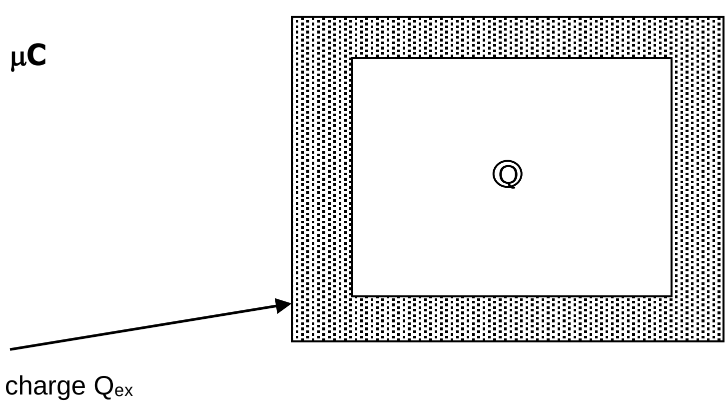
13. A negative charge Q = - 2 μC is placed inside a neutral cubical conducting box with a cavity in it. The length of the side of the inner cavity is a and the outer box's side length is b. What charges will be induced at the inner and outer surfaces of the box?



A) Inner charge = –2 μC. Outer charge = +2 μC
B**) Inner charge = +2 μC. Outer charge = -2 μC**
C) Inner charge = 0 μC. Outer charge = -2 μC
D) Inner charge = +2 μC. Outer charge = 0 μC
E) Inner charge = 0 μC. Outer charge = 0 μC

14. The same negative charge Q = - 2 μC is placed inside the same box in the problem above, but now in addition, an extra negative charge of Q_{ex} = - 4 μC. is initially placed on the the inner surface of the cavity. What will the charges be on the inner and outer surfaces of the box after some time has passed?

A) Inner charge = 0 μC. Outer charge = -6 mC
B**) Inner charge = + 2 μC. Outer charge = -6 μC**
C) Inner charge = -6 μC, Outer charge = -2 μC
D) Inner charge = – 4 μC. Outer charge = +2 μC
E) Inner charge = +2 μC, Outer charge = -2 μC

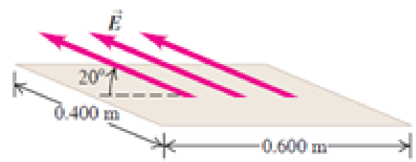


15. Charge is distributed uniformly on the surface of large, flat plate. The electric field 8 cm from the plates is 40 N/C. The electric field 12 cm from the plate is:

A. 20 N/C
B. 25 N/C
C. 30 N/C
D. 35 N/C
E. 40 N/C

16. A flat sheet is in the shape of a rectangle with sides of lengths 0.400 m and 0.600 m. The sheet is immersed in a uniform electric field of magnitude 60.0 N/C that is directed at 20° from the plane of the sheet as it is shown in the figure. Find the magnitude of the electric flux through the sheet.

A) 9.2 N·m²/C
B) 5.3 N·m²/C
C) 2.3 N·m²/C
D) 2.8 N·m²/C
E) 4.9 N·m²/C



Formulas PHYS 121- exam1

Units: SI system: kg (kilogram), m (meter), s (second), C (coulomb); $\mathcal{A}$ (ampere)=C/s. $1\,\mathrm{mm} = 10^{-3}\,\mathrm{m}$, $1\,\mathrm{cm} = 10^{-2}\,\mathrm{m}$, $1\,\mathrm{km} = 10^3\,\mathrm{m}$; 1 N (newton)=kg·m/s^2, 1 J (joule)=N · m = kg · m^2/s^2, 1 W (watt)=J/s; prefixes: m (milli) 10^{-3}, μ (micro) 10^{-6}, n (nano) 10^{-9}, p(pico) 10^{-12}, k (kilo) 10^3, M (mega) 10^6.
Constants: $g = 9.8\,\mathrm{m/s^2}$, $k_e = 9 * 10^9\,\mathrm{N\ m^2/C^2} = 1/(4\pi\epsilon_0)$, $\epsilon_0 = 8.85 * 10^{-12}\,\mathrm{C^2/(N\ m^2)}$. $e = -1.6 * 10^{-19}\,\mathrm{C}$, $m_e = 9.11 * 10^{-31}\,\mathrm{kg}$, $m_p \simeq m_n = 1.67 * 10^{-27}\,kg$
Volumes. Cylinder: $\pi R^2 h$, sphere: $\frac{4}{3}\pi R^3$, cone: $\frac{1}{3}\pi R^2 h$. **Areas:** Sphere: $4\pi R^2$
Quadratic equation. $ax^2 + bx + c = 0\,,\ x = \left(-b \pm \sqrt{b^2 - 4ac}\right)/(2a)$
Derivatives/integrals. $\frac{d}{dt}t^n = nt^{n-1}\,,\ \int r^n\,dr = \frac{1}{n+1}r^{n+1}$
Vectors. If $\vec{c} = \vec{a}+\vec{b}$, then $c_x = a_x+b_x\,,\ c_y = a_y+b_y\,,\ c_z = a_z+b_z$ and $c = \sqrt{c_x^2 + c_y^2 + c_z^2}$. Dot product: $\vec{a}\cdot\vec{b} = a_x b_x + a_y b_y + a_z b_z = ab\cos\alpha$. Cross product: $\hat{i}\times\hat{j} = \hat{k}\,,\ \hat{j}\times\hat{k} = \hat{i}\,,\ \hat{k}\times\hat{i} = \hat{j}$.

Coulombs Law: $F = k_e \frac{q_1 q_2}{r^2}$, r-distance between charges; in vector form $\vec{F} = k_e \frac{q_1 q_2}{r^2}\hat{r}$, $\hat{r} = \vec{r}/r$ - unit vector from charge q_1 to q_2, $k_e = 9 * 10^9$... Superposition: if charge q_1 acts on q_0 with $\vec{F}_{01}$, charge q_2 acts on q_0 with $\vec{F}_{02}$, etc., then $\vec{F}_{\text{net on } q_0} = \vec{F}_{01} + \vec{F}_{02} + \ldots$

Electric field. Definition: $\vec{E} = \vec{F}_0/q_0$ (charge q_0 is a "probe"). Field from a charge q: $E = k_e\frac{q}{r^2}$, r-distance between charge and observation point; in vector form $\vec{E} = k_e\frac{q}{r^2}\hat{r}$, $\hat{r} = \vec{r}/r$ - unit vector from charge q to the observation point, $k_e = 9 * 10^9$... Superposition: consider charges q_1, q_2, etc. and the observation point. If q_1 creates field $\vec{E}_1$ at the observation point, q_2 creates field $\vec{E}_2$, etc., then $\vec{E} = \vec{E}_1 + \vec{E}_2 + \ldots$.
Force on a charge placed in external field $\vec{E}$: $\vec{F} = q\vec{E}$.

Gauss Law. Elementary flux (definition): $\Delta\Phi = \vec{E}\cdot\Delta\vec{A}$. Flux through a closed surface: $\oint \vec{E}\cdot d\vec{A} = q_{\text{enc}}/\epsilon_0$. Field $E(r)$ from a uniformly charged spherical shell with radius R and charge Q: $E(r < R) = 0$, $E(r > R) = k_e Q/r^2$. Field $E(r)$ from a uniformly charged infinite line with linear charge density λ: $E(r) = \lambda/(2\pi\epsilon_0 r)$. Field E from a uniformly charged infinite non-conducting plane with surface charge density σ: $E = \sigma/(2\epsilon_0)$.

Conductors. Inside the body of a conductor: $\vec{E} = 0$, no charge. Extra charge - goes to outer surface. Field near the surface of a conductor, *outside*, is $E = \sigma/\epsilon_0$. Inner surfaces (surfaces of cavities) - uncharged, unless charge inside cavities.

From Phys 111:

Kinematics: $v = dx/dt$, $a = dv/dt = d^2x/dt^2$. Constant a: $v - v_0 = at$, $x - x_0 = \frac{v_0+v}{2}t = v_0 t + \frac{1}{2}at^2 = \frac{v^2 - v_0^2}{2a}$.

Circular motion with constant speed: $\omega = v/R$, $a_c = v^2/R = \omega^2 R$, towards center.

The three Laws of motion: (1) If $\vec{F}_{net} = 0$ then $\vec{v} = const$; (2) $\vec{F}_{net} = m\vec{a}$; (3) $\vec{F}_{21} = -\vec{F}_{12}$

Specific forces. Gravity: $m\vec{g}$ (down). Normal $\vec{N}$ - perpendicular to surface; tension T - constant along the string.

Centripetal motion: $F_{net} = mv^2/R$; direction of $\vec{F}_{net}$ - towards center of revolution.

Work and power. Constant force $W = \vec{F}\cdot(\vec{r}_2 - \vec{r}_1) = F_x\Delta x + F_y\Delta y + F_z\Delta z$ (or, $W = F\Delta r\cos\alpha$); general: $W_{AB} = \int_A^B \vec{F}\cdot d\vec{r}$. Power: $P = W/\Delta t = \vec{F}\cdot\vec{v}$. Work by specific forces: gravity: $W_g = -mg\Delta y$ (and Δx does not matter); normal: $W_N = 0$.

Kinetic energy and work-energy theorem: $K = \frac{1}{2}mv^2$, $\Delta K = W$ where W is the *net* work (i.e. work by all forces).

Potential energy. For conservative forces (with path-independent work) introduce $U(\vec{r})$ so that $W_{AB} = U_A - U_B = -\Delta U$. For specific forces: gravity: $U_g = mgh$. If *only* conservative forces, then energy conservation: $K + U = const$.