

Physics 121 - Midterm 2

Last Name	First Name	Student Number	Signature
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Answer **ALL 8** questions. Show all your work and explain your reasoning for full credit. Neatness and clarity of presentation will be considered when assigning a grade. For multiple choice questions, circle one answer only. No aids other than the course calculator and the provided formula sheet may be used.

Useful Constants

elementary charge	$e = 1.602 \times 10^{-19} \text{ C}$
electron mass	$m_e = 9.11 \times 10^{-31} \text{ kg}$
proton mass	$m_p = 1.67 \times 10^{-27} \text{ kg}$
permittivity of free space	$\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{Nm}^2$
electrostatic constant	$K = 9.0 \times 10^9 \text{ Nm}^2/\text{C}^2$
speed of light in vacuum	$c = 2.998 \times 10^8 \text{ m/s}$

Useful P120 Formulae

$$\begin{aligned}
 f &= ma \\
 d &= vt \\
 v &= v_0 + at \\
 d &= v_0 t + \frac{1}{2} at^2
 \end{aligned}$$

Electricity

Coulomb's Law: $\vec{\mathbf{F}} = \frac{kq_1q_2}{r_{12}^2} \hat{\mathbf{r}} = \frac{1}{4\pi\epsilon_0} \frac{q_1q_2}{r_{12}^2} \hat{\mathbf{r}} = \vec{\mathbf{E}}q$

Electric Flux: $\phi = \vec{\mathbf{E}} \cdot \vec{\mathbf{A}}$

Gauss's Law: $\oint \vec{\mathbf{E}} \cdot d\vec{\mathbf{A}} = \frac{Q}{\epsilon_0}$

Electric Potential: $V = \frac{1}{4\pi\epsilon_0} \frac{q}{r}$

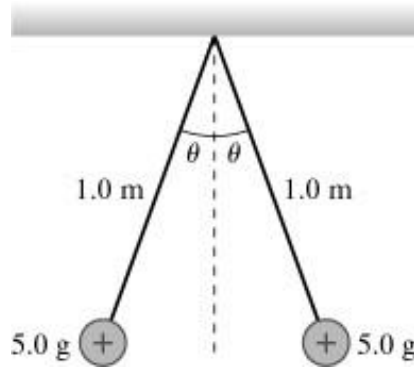
Problem	1	2	3	4	5	6	7	8	Total
Maximum	1	1	6	4	4	4	10	10	40
Grade									

1. (1pts) If two macroscopic objects are electrically attracted to each other,
 - a) One object must be negatively charged and the other must be positively charged.
 - b) both objects must be positively charged
 - c) both objects must be negatively charged
 - d) none of the above statements are absolutely true
2. (1pts) A positive test charge q is released near a positive fixed charge Q . As q moves away from Q it will move with
 - a) increasing acceleration
 - b) constant acceleration
 - c) constant velocity
 - d) decreasing acceleration
3. (6 pts) Please circle either True or False:
 - (a) Suppose you have two positive point charges and want to move them closer together. To do the least amount of work you should move them directly towards each other; any other path will require more work because the charges must move through a greater distance.
TRUE **FALSE**
 - (b) Two infinite parallel plastic sheets contain equal negative charge densities uniformly spread over the surfaces. The electric field is zero everywhere between the sheets, not just midway between them.
TRUE **FALSE**
 - (c) If one bag contains a charge $8Q$ and another one contains a charge Q , the $8Q$ -bag exerts 8 times as much force on the Q -bag as the Q -bag exerts on the $8Q$ -bag.
TRUE **FALSE**
 - (d) Two protons slightly separated from each other form an electric dipole.
TRUE **FALSE**
 - (e) Two unequal point charges q_1 and q_2 are held in place separated from each other. A point charge Q is placed somewhere between them at a point where it remains stationary when released. From this observation, we can conclude that q_1 and q_2 must either both be positive or both be negative.
TRUE **FALSE**
 - (f) If a Gaussian surface contains no charges, then the electric field at its surface must be zero.
TRUE **FALSE**

4. (4 pts) Three charges form the points of an equilateral triangle with 1.6cm long sides. One of the charges is +2nC, the other two are each -1nC. What is the electric potential at the center of the triangle?
5. (4 pts) A flat $1.0m^2$ surface is vertical at $x = 2.0m$ and parallel to the $y - z$ plane. What is the flux through the surface if it is located in a uniform electric field given by $\vec{E} = 25.0\hat{i} + 24.0\hat{j} + 62.0\hat{k}$?

6. (4 pts) What is the magnitude of an electric field that balances the weight of a plastic sphere of mass 6.4g that has been charged to $-3.0nC$?

7. (10 pts) The figure shows two 5.0g spheres suspended from 1.0m long threads. The spheres repel each other after being charged to $+91\text{nC}$. What is the angle θ ? (hint: assume the angle is small)



8. (10 pts) The figure shows two parallel plates that are 2.0cm apart. The electric field between them is $3.4 \times 10^4 \text{ N/C}$. An electron is launched at a 45° angle and with initial speed v_0 from the positive plate. What is the maximum v_0 such that the electron won't hit the negative plate?

