EXAM INSTRUCTIONS

- **PROCTORS WILL BE AVAILABLE DURING THE EXAM TO ANSWER QUESTIONS IF NECESSARY.**

- **KEEP THE AISLE CLEAR OF ALL PERSONAL ITEMS – PLACE CLOSED BOOKBAGS, ETC. UNDER THE CHAIR NEXT TO YOU.**

- **NO IPODS, SMART WATCHES, ETC. ON YOUR DESK. ALL CELL PHONES TURNED OFF AND PUT AWAY.**

- **ALL HATS EITHER OFF OR TURNED BACKWARDS.**

- **ON YOUR DESK YOU SHOULD ONLY HAVE AN APPROVED CALCULATOR, NXT OR QT CLICKER, PEN/PENCIL/ERASER AND YOUR STUDENT ID. SEE CANVAS FOR EXAMPLES OF CALCULATORS.**

- **SCRATCH PAPER IS AVAILABLE FROM THE PROCTORS – ONLY USE PAPER PROVIDED TO YOU.**

- **TURN IN ALL PAPERS AND SHOW ID AS YOU LEAVE.**

EXAMS WILL BE RETURNED NEXT FRIDAY
&
GRADES WILL BE POSTED BY
TUESDAY AFTERNOON ON CANVAS

SAMPLE EXAM #2 Chapters 21-24 – PH112

See Canvas Calendar for All Exam Dates

THE IN-CLASS EXAM WILL INCLUDE 20 QUESTIONS SIMILAR TO THESE AND TO HOMEWORK/CLASS EXERCISES. ALL 20 QUESTIONS WILL HAVE MULTIPLE-CHOICE ANSWERS. SOME ANSWERS MAY BE WORTH PARTIAL CREDIT, SO DO NOT LEAVE ANY QUESTION BLANK!

USE NXT OR QT CLICKER TO ENTER ANSWERS TO EXAM. See Canvas for details.

EXAM BEGINS PROMPTLY AT 2:15 AND ENDS AT 3:40. MAKE ARRANGEMENTS WITH OTHER INSTRUCTORS IF YOU THINK YOU'LL BE LATE TO THEIR CLASS.

Instructions:

1. Write your name in the blank above.
2. Circle one answer for each problem; do not leave any problems blank.
3. Enter answers on NXT or QT clicker.
4. Turn in exam and all scratch paper used during exam.

EQUATIONS BELOW WILL BE ON YOUR IN-CLASS EXAM:

$$V = -\int \vec{E} \cdot d\vec{s}$$

$$U = W_{\text{ext}} = \Delta K = \frac{1}{4\pi\varepsilon_0}\left\{\frac{q_1 q_2}{r_{12}} + \frac{q_2 q_3}{r_{23}} + \frac{q_1 q_3}{r_{13}} + \frac{q_2 q_4}{r_{24}} + \ldots\right\} \text{ or } qV$$

$$\Delta V = V_f - V_i = \frac{-W_{if}}{q} = \frac{W_{ext}}{q}$$

$$\varepsilon_0 \Phi = \varepsilon_0 \oint \vec{E} \cdot d\vec{A} = q_{enclosed} \qquad \vec{F} = q\vec{E} = m\vec{a}$$

For point charges and charge distributions:

$$\left|\vec{E}\right| = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2} \Rightarrow \frac{1}{4\pi\varepsilon_0}\int \frac{dq}{r^2}$$

$$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r} \Rightarrow \frac{1}{4\pi\varepsilon_0}\sum_{i=1}^{n}\frac{q_i}{r_i} \Rightarrow \frac{1}{4\pi\varepsilon_0}\int \frac{dq}{r}$$

Constants and conversions

$\varepsilon_0 = 8.85\times10^{-12}\ \mathrm{C^2/N\cdot m^2}$

$1\,\mathrm{eV} = 1.6\times10^{-19}\ \mathrm{J} =$ work to move one electron through ΔV of $1\,\mathrm{V}$

mass of electron, 9.1×10^{-31} kg

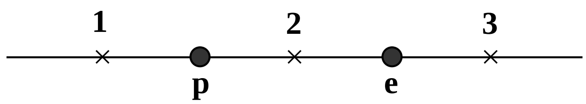
mass of proton, 1.67×10^{-27} kg

magnitude of charge of electron or proton, 1.6×10^{-19} C

1. The magnitude of the electric field at a distance of 10 cm from an isolated point charge of 2.0 $\times 10^{-9}$ C is:

A. 1.8 N/C
B. 180 N/C
C. 18 N/C
D. 1800 N/C
E. none of these

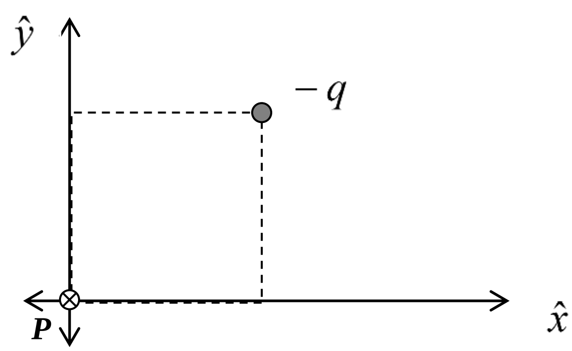
2. A proton **p** and an electron **e** are on the x axis. The directions of the electric field at points 1, 2, and 3 respectively, are:



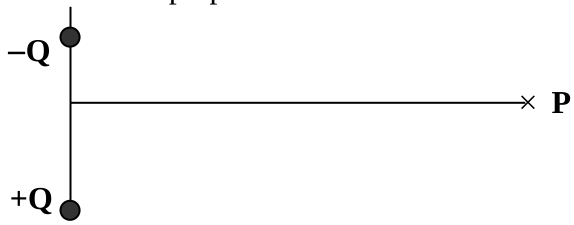
A. $\rightarrow,\leftarrow,\rightarrow$
B. $\leftarrow,\rightarrow,\leftarrow$
C. $\leftarrow,\rightarrow,\rightarrow$
D. $\leftarrow,\leftarrow,\leftarrow$
E. none of the above

3. A charge is placed at the corner of a square of side *d* as shown in the diagram below. Using the *xy*-axis given, what is the electric field at point *P*?

A. $\left(\sqrt{2}q/16\pi\varepsilon_0 d^2\right)\hat{\mathbf{i}}$
B. $\left(q/4\pi\varepsilon_0 d^2\right)\hat{\mathbf{i}}$
C. $\left(\sqrt{2}q/16\pi\varepsilon_0 d^2\right)\left(\hat{\mathbf{i}}+\hat{\mathbf{j}}\right)$
D. $\left(q/4\pi\varepsilon_0 d^2\right)\left(\hat{\mathbf{i}}+\hat{\mathbf{j}}\right)$
E. $\left(\sqrt{2}q/8\pi\varepsilon_0 d^2\right)\left(\hat{\mathbf{i}}+\hat{\mathbf{j}}\right)$

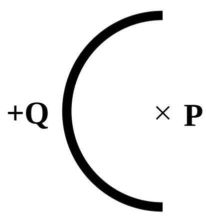


4. The diagram shows a positive charge Q and a negative charge $-Q$ with the same magnitude. The electric field at point P on the perpendicular bisector of the line joining them is:



A. ↑
B. ↓
C. →
D. ←
E. zero

5. Positive charge Q is uniformly distributed on a semicircular rod. What is the direction of the electric field at point P, the center of the semicircle?



A. ↑
B. ↓
C. ←
D. →
E. ↗

6. A point charge of 0.02 C is placed in an electric field of $400\ \mathrm{N/C}\,\hat{\mathbf{i}}$. What is the force on the charge?

A. $8.0\ \mathrm{N}\,\hat{\mathbf{i}}$
B. $-8.0\ \mathrm{N}\,\hat{\mathbf{i}}$
C. $8.0\times10^{-6}\ \mathrm{N}\,\hat{\mathbf{i}}$
D. $2.0\times10^{4}\ \mathrm{N}\,\hat{\mathbf{i}}$
E. $-2.0\times10^{4}\ \mathrm{N}\,\hat{\mathbf{i}}$

7. A charged oil drop with a mass of 3.0×10^{-3} kg is held suspended by a downward electric field of 60 N/C. The charge on the drop is:

A. 2.0×10^{3} C
B. -2.0×10^{3} C
C. 4.9×10^{-4} C
D. -4.9×10^{-4} C
E. 1.8 C

8. A total charge of 6.3×10^{-8} C is distributed uniformly throughout a 2.7 cm radius sphere. The volume charge density is:

A. 3.7×10^{-7} C/m^3
B. 6.9×10^{-6} C/m^3
C. 6.9×10^{-6} C/m^2
D. 2.5×10^{-4} C/m^3
E. 7.6×10^{-4} C/m^3

9. When a piece of paper is held with one face perpendicular to a uniform electric field the flux through it is 25 N · m^2/C. When the paper is turned so that the field makes an angle of 25° with the normal to the paper, the flux through the paper is:

A. 0
B. 12 N · m^2/C
C. 21 N · m^2/C
D. 23 N · m^2/C
E. 25 N · m^2/C

10. A 5.0 μC point charge is placed within the confines of a cube. The total electric flux through all sides of the cube is:

A. 0
B. 7.1×10^4 N · m^2/C
C. 9.4×10^4 N · m^2/C
D. 1.4×10^5 N · m^2/C
E. 5.6×10^5 N · m^2/C

11. 10 C of charge is placed on a spherical conducting shell. A –3 C point charge is placed at the center of the shell's cavity, isolated from the shell. The net charge on the inner surface of the shell is:

A. –7 C
B. –3 C
C. 0 C
D. +3 C
E. +7 C

12. Charge is distributed uniformly along a long straight wire. The electric field 2.0 cm from the wire is 20 N/C. The electric field 4.0 cm from the wire is:

A. 120 N/C
B. 80 N/C
C. 40 N/C
D. 10 N/C
E. 5.0 N/C

13. A long line of charge with λ_l charge per unit length runs along the axis of a conducting cylindrical shell that carries a charge per unit length of λ_c. The charge per unit length on the inner and outer surfaces of the shell, respectively are:

A. λ_l and λ_c
B. $-\lambda_l$ and $\lambda_c+\lambda_l$
C. $-\lambda_l$ and $\lambda_c-\lambda_l$
D. $\lambda_l+\lambda_c$ and $\lambda_c-\lambda_l$
E. $\lambda_l-\lambda_c$ and $\lambda_c+\lambda_l$

14. Positive charge Q is placed on a conducting spherical shell with inner radius R_1 and outer radius R_2. A point charge q is placed at the center of the cavity. The magnitude of the electric field at a point outside the shell, a distance r from the center, is:

A. $Q/\left(4\pi\varepsilon_0 R_1^2\right)$
B. $Q/\left\{4\pi\varepsilon_0\left(R_1^2-r^2\right)\right\}$
C. $q/\left(4\pi\varepsilon_0 r^2\right)$
D. $(q+Q)/\left(4\pi\varepsilon_0 r^2\right)$
E. $(q+Q)/\left\{4\pi\varepsilon_0\left(R_1^2-r^2\right)\right\}$

15. A 5.0-cm radius conducting sphere has a charge density of 2.0×10^{-6} C/m^2 on its surface. The electric potential at its surface, relative to the potential far away, is:

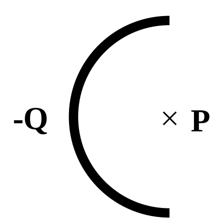
A. 1.1×10^4 V
B. 2.2×10^4 V
C. 2.3×10^5 V
D. 3.6×10^5 V
E. 7.2×10^6 V

16. A non-conducting ring of radius 1.0 m is charged with 2.0 nC on one-third of its circumference and –8.0 nC on the other two-thirds. If *V* at infinity is zero, find the potential at a point 2.0 meters above the ring on the central axis.

A. +8.0 V
B. +32 V
C. -24 V
D. -54 V
E. -72 V

17. A circular arc of plastic rod has a radius of 0.50 m and a uniform negative charge distribution of –5.0 pC/m. What is the electric potential at point *P*?

A. 0.14 V
B. -0.14 V
C. 0.090 V
D. -0.090 V
E. 0 V



18. A 2.0-meter stick is parallel to a uniform 200 N/C electric field. The magnitude of the potential difference between its ends is:

A. 0
B. 1.6×10^{-17} V
C. 3.2×10^{-17} V
D. 100 V
E. 400 V

19. An electron is accelerated from rest through a potential difference of 100V. Its final speed is:

A. 100 m/s
B. 3.0×10^{6} m/s
C. 5.9×10^{6} m/s
D. 3.5×10^{13} m/s
E. 1.5×10^{16} m/s

20. If 500 J of work are required to carry a 40 C charge from one point to another, the magnitude of the potential difference between these two points is:

A. 12.5 V
B. 20,000 V
C. 0.08 V
D. 500 V
E. depends on the path

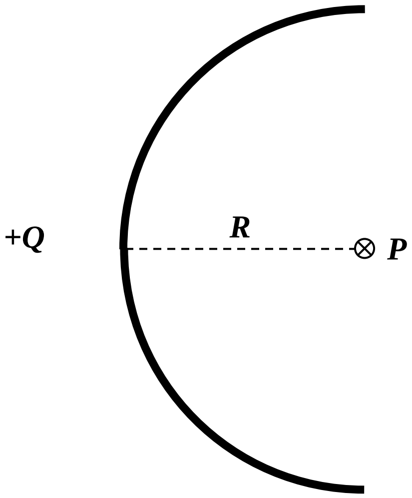
21. A 5.5×10^{-8} C charge is fixed at the origin. A -2.3×10^{-8} C charge is moved from x = 3.5 cm on the x axis to y = 3.5 cm on the y axis. The change in potential energy of the two-charge system is:

A. 3.2×10^{-4} J
B. -3.2×10^{-4} J
C. 9.3×10^{-3} J
D. -9.3×10^{-3} J
E. 0

22. Three charges lie on the *x* axis: 1×10^{-8} C at $x=1\,\mathrm{cm}$, 2×10^{-8} C at $x=2\,\mathrm{cm}$, and 3×10^{-8} C at $x=3\,\mathrm{cm}$. (Assume 2 significant digits of accuracy.) The potential energy of this arrangement, relative to the potential energy for infinite separation, is:

A. 7.9×10^{-2} J
B. 8.5×10^{-4} J
C. 1.7×10^{-3} J
D. 0.16 J
E. zero

1.



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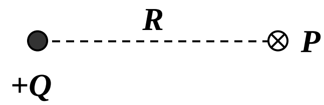

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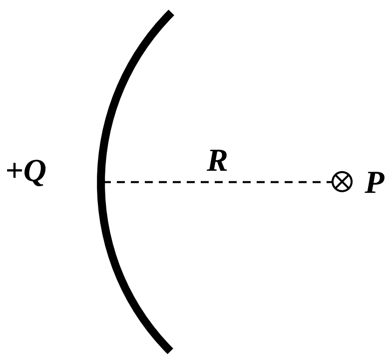

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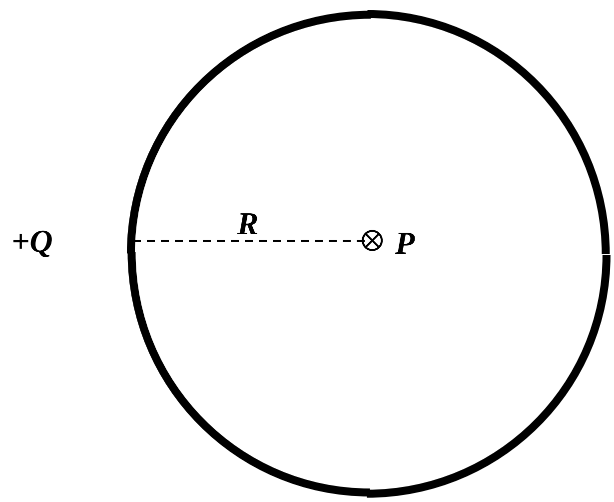

23. Rank the arrangements above according to the magnitude of the electric potential at the center of curvature, largest first.

A. 1, 2, 3, 4
B. 4, 1, 3, 2
C. 2, 3, 1, 4
D. all arrangements are the same
E. none of the above

Answers:

1. D
2. B
3. C
4. A
5. D
6. A
7. D
8. E
9. D
10. E
11. D
12. D
13. B
14. D
15. A
16. C
17. B
18. E
19. C
20. A
21. E
22. B
23. D