Exam 9 March 2019, questions and answers

Fundamentals of Physics II (University of Ottawa)

Université d'Ottawa · University of Ottawa

Faculté des sciences Physique | Faculty of Science Physics

PHY1122A

March 9, 2019
Mid-Term Examination 2

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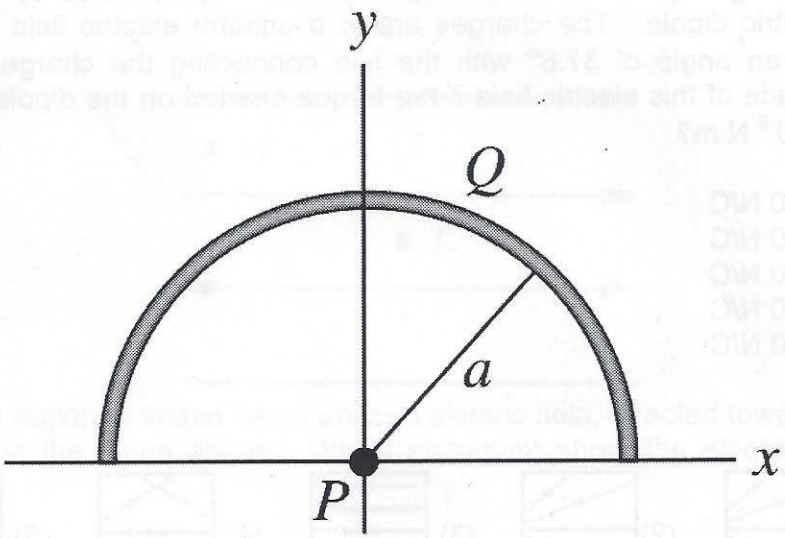
The answers should be entered carefully on a computer readable sheet using an HB pencil. When the exam time is over, you hand over only the computer sheet and keep this questionnaire for yourself.

Cellular phones, unauthorized electronic devices or course notes (unless an open-book exam) are not allowed during this exam. Phones and devices must be turned off and put away in your bag. Do not keep them in your possession, such as in your pockets. If caught with such a device or document, the following may occur: you will be asked to leave the exam immediately, and academic fraud allegations will be filed which may result in you obtaining a 0 (zero) for the exam.

1.



Positive charge Q is uniformly distributed around a semicircle of radius a as shown in the figure above. The resulting electric field at point P, the center of curvature of the semicircle, is

A) $\frac{1}{2\pi\varepsilon_0}\frac{Q}{a^2}\hat{\mathbf{j}}$.

B) $-\frac{1}{2\pi\varepsilon_0}\frac{Q}{a^2}\hat{\mathbf{j}}$.

C) $\frac{1}{2\pi\varepsilon_0}\frac{Q}{a^2}\hat{\mathbf{i}}$.

D) $-\frac{1}{2\pi\varepsilon_0}\frac{Q}{a^2}\hat{\mathbf{i}}$.

E) $-\frac{1}{2\pi\varepsilon_0}\frac{Q}{a^2}(\hat{\mathbf{i}}+\hat{\mathbf{j}})$.

2. Calculate the change of entropy of 257 g of water warmed slowly from 20.0°C to 80.0°C. The specific heat of water is 4186 J/(kg·K).

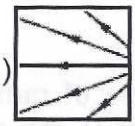
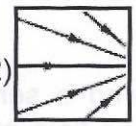
A) 1.49 kJ/K
B) −1.49 kJ/K
C) 200 J/K
D) −200 J/K
E) 312 J/K

3. A particle (mass = 5.0 g, charge = 40 mC) moves in a region of space where the electric field is given by $E_x = 2.5$ N/C, $E_y = E_z = 0$. If the velocity of the particle at $t = 0$ is given by $v_x = 80$ m/s, $v_y = v_z = 0$, what is the speed of the particle at $t = 2.0$ s?

A) 47 m/s.
B) 22 m/s
C) 64 m/s
D) 85 m/s
E) 180 m/s

4. Point charges $q_1 = -4.0$ nC and $q_2 = +4.0$ nC are separated by 3.7 mm, forming an electric dipole. The charges are in a uniform electric field whose direction makes an angle of 37.8° with the line connecting the charges. What is the magnitude of this electric field if the torque exerted on the dipole has magnitude 8.2×10^{-9} N·m?

A) 900 N/C
B) 860 N/C
C) 810 N/C
D) 770 N/C
E) 730 N/C

5. (1)  (2)  (3)  (4)  (5) 

Which one of the diagrams above is *not* a possible electric field configuration for a region of space which does *not* contain any charges?

A) (1)
B) (2)
C) (3)
D) (4)
E) (5)

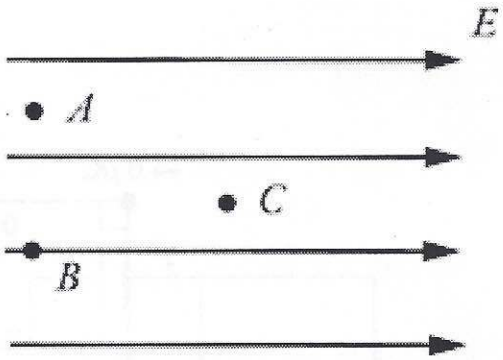
6. A neutral hollow spherical conducting shell of inner radius 1.00 cm and outer radius 3.00 cm has a +2.00-μC point charge placed at its center. Find the surface charge density on the inner surface of the shell and on the outer surface of the shell.

A) +177 $\mu C/m^2$, +1590 $\mu C/m^2$
B) −177 $\mu C/m^2$, +1590 $\mu C/m^2$
C) +1590 $\mu C/m^2$, −177 $\mu C/m^2$
D) +177 $\mu C/m^2$, −1590 $\mu C/m^2$
E) −1590 $\mu C/m^2$, +177 $\mu C/m^2$

7. You want to design an ideal Carnot heat engine that waste only 35.0% of the heat that goes into it. The lowest cold reservoir temperature available to you is +15.0°C. If 150.0 J of work is done per cycle, the heat input per cycle is

A) 203 J.
B) 231 J.
C) 248 J.
D) 429 J.
E) 760 J.

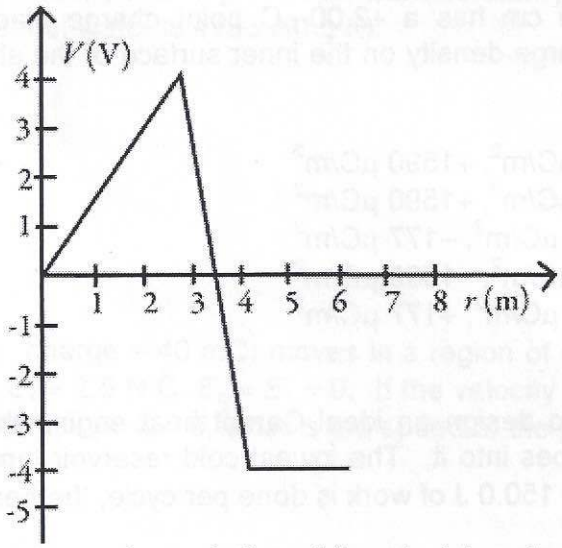
8.



Suppose a region of space has a uniform electric field, directed towards the right, as shown in the figure above. Which statement about the electric potential is true?

A) The potential at all three locations (*A*, *B*, *C*) is the same because the electric field is uniform.
B) The potentials at points *A* and *B* are equal, and the potential at point *C* is higher than the potential at point *A*.
C) The potentials at points *A* and *B* are equal, and the potential at point *C* is lower than the potential at point *A*.
D) The potential at point *A* is the highest, the potential at point *B* is the second highest, and the potential at point *C* is the lowest.

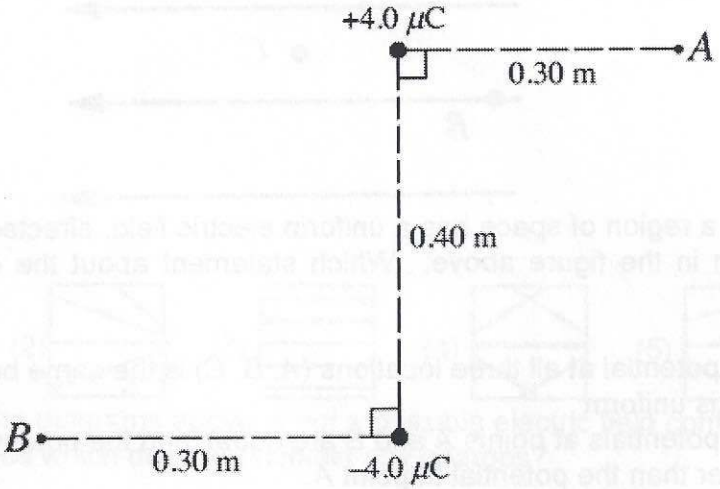
9.



The graph in the figure shows the variation of the electric potential V (measured in volts) as a function of the radial direction r (measured in meters). For which range or value of r is the magnitude of the electric field the largest?

A) From $r = 0$ m to $r = 3$ m
B) From $r = 3$ m to $r = 4$ m
C) From $r = 4$ m to $r = 6$ m
D) At $r = 3$ m
E) ~~At $r = 3$ m~~
At $r = 4$ m

10.



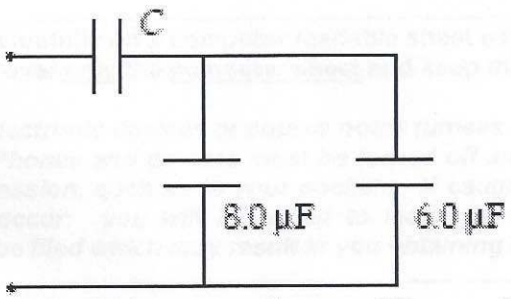
A +4.0-μC point charge and a –4.0-μC point charge are placed as shown in the figure above. What is the potential difference, $V_A - V_B$, between points A and B?

A) 48 V
B) 96 V
C) 0.00 V
D) 96 kV
E) 48 kV

11. An electron is released from rest at a distance of 9.00 cm from a proton. If the proton is held in place, how fast will the electron be moving when it is 3.00 cm from the proton?

A) 75.0 m/s
B) 106 m/s
C) 130 m/s
D) 1.06×10^3 m/s
E) 4.64×10^5 m/s

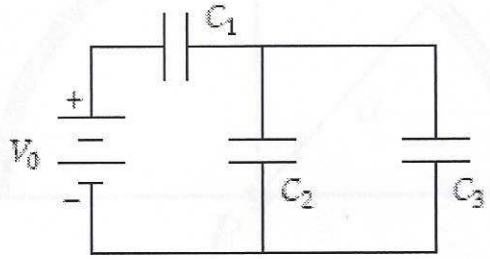
12.



If $C = 10$ μF, what is the equivalent capacitance of the combination shown?

A) 7.5 μF
B) 6.5 μF
C) 7.0 μF
D) 5.8 μF
E) 13 μF

13.



Determine the energy stored in C_2 when $C_1 = 15$ μF, $C_2 = 10$ μF, $C_3 = 20$ μF, and $V_0 = 18$ V.

A) 1.6 mJ
B) 0.18 mJ
C) 0.50 mJ
D) 0.32 mJ
E) 0.72 mJ

14. A parallel plate capacitor of capacitance C_0 has plates of area A with separation d between them. When it is connected to a battery of voltage V_0, it has charge of magnitude Q_0 on its plates. It is then disconnected from the battery and the plates are pulled apart to a separation $2d$ without discharging them. After the plates are $2d$ apart, the magnitude of the charge on the plates and the potential difference between them are

A) $Q_0/2$, $V_0/2$.
B) Q_0, $V_0/2$.
C) Q_0, V_0.
D) Q_0, $2V_0$.
E) $2Q_0$, $2V_0$.