Name KEY

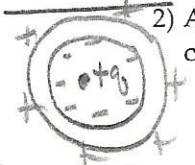
Exam 2 20 questions

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) A light bulb is connected to a 110-V source. What is the resistance of this bulb if it is a 100-W bulb?

A) 240 Ω (B) 120 Ω ✓ C) 100 Ω D) 6.0 mΩ E) 8.0 mΩ

2) A hollow spherical conductor of inner radius 2.0 cm has a 2.0 C point charge at its center. Find the surface charge density at the outer surface of the sphere. The thickness of the sphere is 1.0 mm.



A) $-0.50\ C/m^2$ B) $-360\ C/m^2$ (C) $360\ C/m^2$ ✓ D) $0.50\ C/m^2$

3) Why is it that electrons rather than positive ions flow in a solid, condusting wire?

A) Either kind of charge will flow in a solid conductor
(B) The positive ions are locked into the crystalline structure. ✓ SEE NOTES
C) Ben Franklin randomly chose eectrons as the moving particles
D) The electrons have less mass, and are thus more easily moved

4) Two concentric conducting spherical shells produce a radially outward electric field of magnitude 49,000 N/C at a point 4.10 m from the center of the shells. The outer surface of the larger shell has a radius of 3.75 m. If the inner shell contains an excess charge of -5.30 μC, find the amount of charge on the outer surface of the larger shell.

A) 96.9 μC (B) 91.6 μC C) 5.3 μC D) 86.3 μC

5) Two concentric conducting spherical shells produce a radially outward electric field of magnitude 49,000 N/C at a point 4.10 m from the center of the shells. The outer surface of the larger shell has a radius of 3.75 m. If the inner shell contains an excess charge of -5.30 μC, find the total charge on the outer shell.

(A) 96.9 μC B) 5.3 μC C) 86.3 μC D) 91.6 μC

6) A resistor has 4.0 V across it while a current of 4.0 mA flows through it. How much power does it dissipate?

(A) 16 mW ✓ B) 1.0 kW C) 4.0 kW D) 64 μW

7) Consider a spherical Gaussian surface of radius R centered at the origin. A charge Q is placed inside the sphere. To maximize the magnitude of the electric flux through the Gaussian surface, the charge should be located ____.

A) at $x = 0, y = R/2, z = 0$.
B) at $x = R/2, y = 0, z = 0$.
C) at the origin.
D) at $x = 0, y = 0, z = R/2$.
(E) The charge can be located anywhere, since flux does not depend on the position of the charge as long as it is inside the sphere.

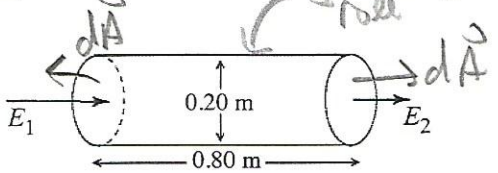
$P = IV \;\therefore\; I = \frac{P}{V} = \frac{1200}{110} = 10.9\,A$

8) A 110-V hair dryer is rated at 1200 W. What current will it draw when operating from a 110-V electrical outlet?

A) 5.0 A B) 90 mA C) 11 A ✓ D) 1.0 A E) 14 A

9) A nonuniform electric field is directed along the x-axis at all points in space. This magnitude of the field varies with x, but not with respect to y or z. The axis of a cylindrical surface, 0.80 m long and 0.20 m in diameter, is aligned parallel to the x-axis, as shown in the figure. The electric fields E_1 and E_2, at the ends of the cylindrical surface, have magnitudes of 6000 N/C and 1000 N/C respectively, and are directed as shown. What is the net electric flux passing through the cylindrical surface?

$\vec{E} \parallel \hat{n}$ ± $\hat{i}$. * $\Phi_{side} = 0$ *



Area of left surface $\approx$

$\Phi_{left} = \int_{left} \vec{E}\cdot d\vec{A} = 6000\cos(180)\left[\pi\left(\frac{0.2}{4}\right)^2\right] = -188.4$

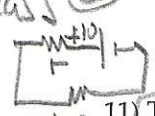
$\Phi_{right} = \int_{right} \vec{E}\cdot d\vec{A} = 1000\cos(0)\left[\pi\left(\frac{0.2}{4}\right)^2\right] = +31.4$

$\Phi_{TOTAL} = 0 - 188.4 + 31.4 = -157$

A) -350 N · m²/C
B) -160 N · m²/C ✓
C) 0.00 N · m²/C
D) +160 N · m²/C
E) +350 N · m²/C

10) A 4.0 Ω resistor is connected across the terminals of a 10.0 V battery. If 0.50 A of current flows, what is the internal resistance of the battery?

As in class (5)

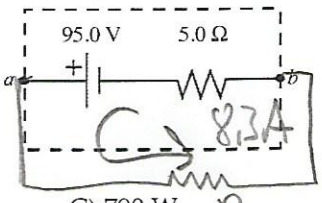


$+10 = (0.5)(4 + r)$

$\therefore r = 16\,\Omega$

A) 16 Ω ✓ B) -5.0 Ω C) 20 Ω D) 24.0 Ω

11) The emf and the internal resistance of a battery are as shown in the figure. If a current of 8.3 A is drawn from the battery when a resistor R is connected across the terminals ab of the battery, what is the power dissipated by the resistor R? Note that R is not shown in this diagram. Hint: You must first solve for R.



$95 = 8.3(5 + R)$

$\therefore R = 6.45\,\Omega$

$P_R = I^2R = 444\,\Omega$

A) 620 W B) 700 W C) 790 W D) 530 W E) 440 W ✓

12) An uncharged conductor has a hollow cavity inside of it. Within this cavity there is a charge of +10 μC that does not touch the conductor. There are no other charges in the vicinity. Which statement about this conductor is true?

Gauss → $E_{inside} = 0$

A) The inner and outer surfaces of the conductor each contain charges of -5 μC. ✗
B) The inner surface of the conductor carries a charge of -10 μC and its outer surface carries no excess charge. ✗
C) Both surfaces of the conductor carry no excess charge because the conductor is uncharged. ✗
D) The outer surface of the conductor contains +10 μC of charge and the inner surface contains -10 μC.
E) The net electric field within the material of the conductor points away from the +10 μC charge. ✗ → $= 0$

SEE NOTES. (apply Gauss ☺)

Same configuration as question 2.

13) A flat 1.0 m^2 surface is vertical at $x = 2.0$ m and parallel to the yz-plane. What is the magnitude of the flux through the surface if it is located in a uniform electric field given by $\vec{E} = 25.0\,\hat{i} + 42.0\,\hat{j} + 62.0\,\hat{k}$ N/C?

A) 44 N·m^2/C (B) 25 N·m^2/C ✓ C) 69 N·m^2/C D) 110 N·m^2/C

14) A certain electric furnace consumes 24 kW when it is connected to a 240-V line. What is the resistance of the furnace?

A) 1.0 kΩ (B) 2.4 Ω ✓ C) 0.42 Ω D) 10 Ω E) 100 Ω

15) A rectangular surface has an area of 2.00 m^2. The surface is horizontal. The electric flux through the surface is 836 Nm^2/C. The electric field is uniform and makes an angle of 60° with respect to the horizontal. What is the magnitude of the electric field?

A) 210 N/C B) 840 N/C (C) 480 N/C ✓ D) 420 N/C

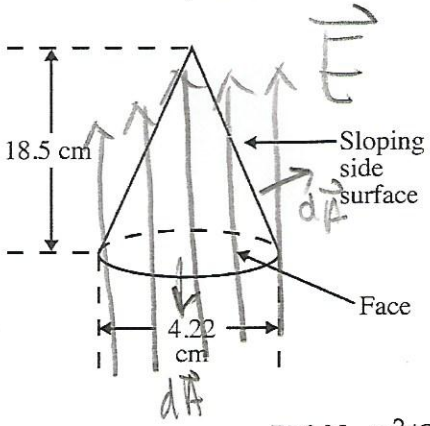
16) A spherical conductor with radius 4.0 mm carries a charge of 6.0 μC. What is the magnitude of the electric field 6.0 mm from the center of the conductor?

A) 34 x 10^9 N/C (B) 1.5 x 10^9 N/C ✓ C) 300 x 10^9 N/C D) 2700 x 10^9 N/C

17) A charge $q = 2.00$ μC is placed at the origin in a region of space where there is already a uniform electric field $\vec{E} = 100\,\hat{i}$ N/C. This field is in addition ot the field produced by the 2.00 μC charge. Calculate the electric flux through a Gaussian sphere of radius $R = 10.0$ cm centered at the origin.

(A) 2.26 x 10^5 N · m^2/C ✓ B) zero
C) 1.13 x 10^5 N · m^2/C D) 5.52 x 10^5 N · m^2/C

18) A cone is resting on a tabletop as shown in the figure with its face horizontal and pointing down. A uniform electric field of magnitude 4550 N/C points vertically upward. What is the electric flux through the sloping, side surface of the cone? In choosing your direction for d**A**, recall that the cone forms a closed surface.



A) −6.36 N · m^2/C B) 0 N · m^2/C
C) more information is needed (D) 6.36 N · m^2/C ✓

19) The cube of insulating material shown in the figure has one corner at the origin. Each side of the cube has length 0.080 m. The top face of the cube is parallel to the xz-plane and is at $y = 0.080$ m. It is observed that there is an electric field $\vec{E} = (3280\, y)\,\hat{j}$ N/C everywhere, including along the surfaces of the cube. Notice that this is in the $+y$ direction and depends on y. What is the charge inside the cube?

Since $\vec{E}$ is only $\hat{j}$, only surfaces w/ flux passing through are Top and bottom. $d\vec{A}$ is $\perp$ to $\vec{E}$ on others.

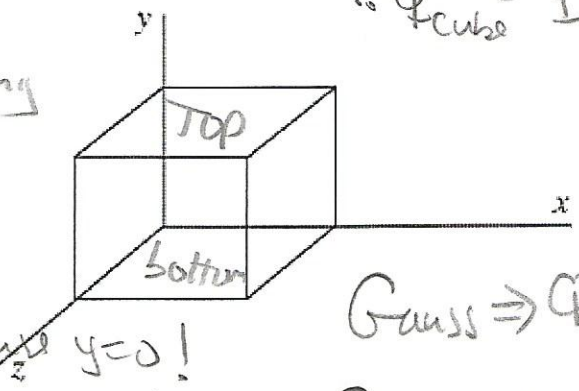
On Bottom, $\vec{E} = 0$ because $y = 0$!

$\therefore \Phi_{cube} = \Phi_{Top} = \int_{Top} \vec{E} \cdot d\vec{A}_{Top}$

$= 3280(0.08)[0.08 \times 0.08]$

$= 1.67936$

Gauss $\Rightarrow Q_{encl.} = \Phi_{cube} * \varepsilon_0 = 1.5 * 10^{-11}$



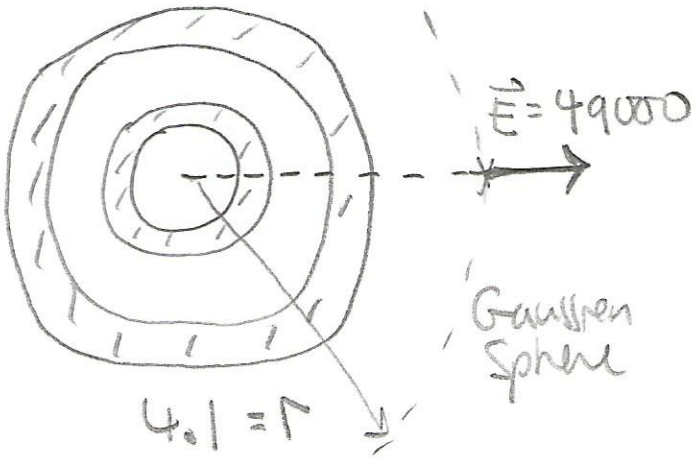
A) 262 C B) 2.32×10^{-9} C C) 1.5×10^{-11} C ✓ D) 0 C

20) An electric field is pushing a current through a conductor. The charges carrying the current _____.

A) never gain or lose energy since energy is conserved
B) lose energy when they collide with other particles ← READING and Monday Notes.
C) gain energy from the electric field, setting them in motion., but do not lose it until they return to their starting point in the circuit
D) nothing can be said about the energy without knowing the voltage

---

4 and 5]



$q_{inner\ shell} = -5.3 * 10^{-6}$

$q_{outer\ shell} = ?$

$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enclosed}}{\varepsilon_0}$

$49000(4\pi(4.1)^2) = \frac{-5.3 * 10^{-6} + q_{outer}}{8.854 * 10^{-12}}$

$9.69 * 10^{-5}\ C = q_{outer}$

Answer Question #5

#4] $q_{outer} = q_{inner\ surface} + q_{outer\ surface}$

↑ Must be $+5.3\mu C$ (GAUSS → Keeps E=0 in metal)

$\therefore q_{outer\ surface} = q_{outer} - q_{inner\ surface} = 9.69 * 10^{-5} - 5.3 * 10^{-6} = 9.16 * 10^{-5}\ C$

Answer Question #4