Exam 2

Name KEY

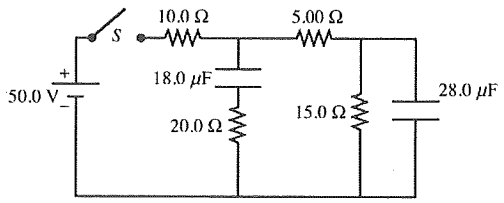
20 Questions

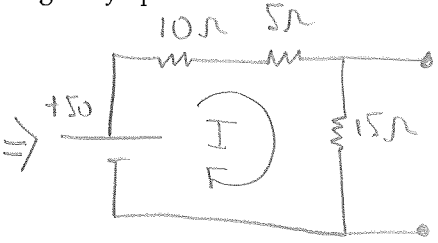
Select the one response that best answers each question.

1) For the circuit shown in the figure, the capacitors are all initially uncharged, the connecting leads have no resistance, the battery has no appreciable internal resistance, and the switch S is originally open.

$I = \frac{50}{(10+5+15)} = 1.67\,A$

$V_{15\Omega} = I(15) = 25\,V$

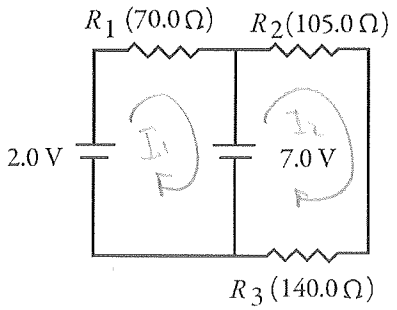




After the switch S has been closed for a very long time, what is the voltage across the 28.0-μF capacitor? SAME as across 15Ω

A) 37.5 V (B) 25.0 V ✓ C) 0.00 V D) 3.33 V E) 50.0 V

2) For the circuit shown in the figure, what is the current through resistor R_1?



loop #1

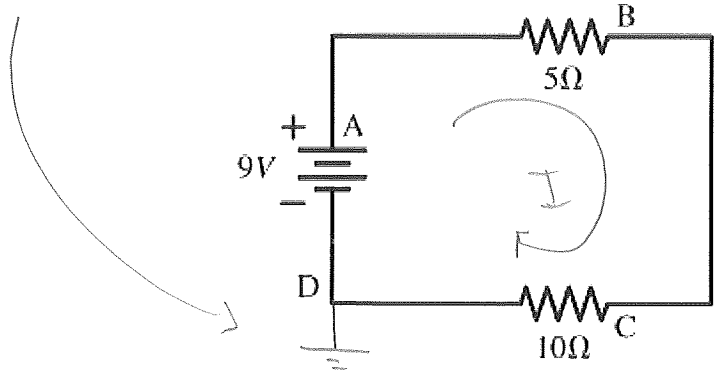
$+2 - 70I_1 - 7 = 0$

$\therefore I_1 = -0.071\,A$

picked wrong direction

(A) 0.071 A ✓ B) 0.029 A C) 0.13 A D) 0.016 A

3) A 9 Volt battery is hooked up to two resistors in series. One has a resistance of 5 ohms, and the other has a resistance of 10 ohms. Several locations along the circuit are marked with letters, as shown below. If the voltage is zero at the negative terminal of the battery, the voltage at location B is _____.

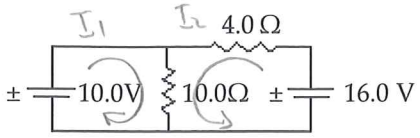


$I = \frac{9}{15} = 0.6\,A$

$V_B = +9 - 5(.6) = +6\,V$

A) zero.
(B) greater than 4.5 Volts. ✓
C) 4.5 Volts.
D) less than 4.5 Volts.

4) In the figure below, what is the current through the 4.0 Ω resistor?



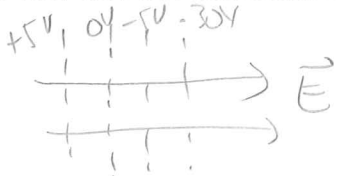
loop 1
$+10 - 10I_1 - 10I_2 = 0$
[1] $I_1 + I_2 = 1$

loop 2
$+16 - 4I_2 - 10I_2 - 10I_1 = 0$
$-10I_1 - 14I_2 = -16$
[2] $5I_1 + 7I_2 = 8$

[1] into [2] gives us:
$5 - 5I_2 + 7I_2 = 8$
$I_2 = 1.5$ A
This is current shown through 4 Ω

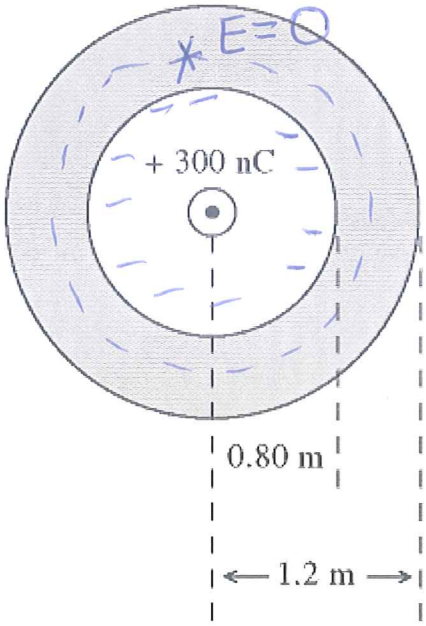
A) 0.43 A B) 1.1 A C) 1.5 A D) 4.0 A

5) If the voltage at a point in space is zero, then the electric field must be _____.



A) negative.
B) positive.
C) uniform.
D) zero.
E) it is impossible to determine based on the information given.

6) A hollow conducting spherical shell has radii of 0.80 m and 1.20 m, as shown in the figure. The sphere carries an excess charge of –500 nC. A point charge of +300 nC is present at the center. The surface charge density on the inner spherical surface is closest to _____. The surface area of a sphere is $4\pi r^2$.

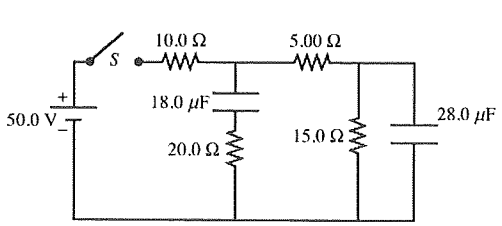


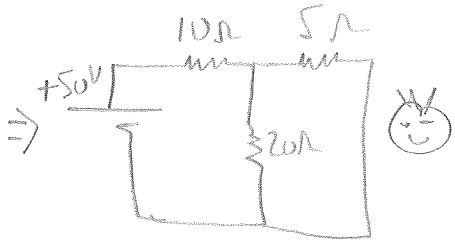
$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enclosed}}{\varepsilon_0}$
$\therefore Q_{enclosed} = 0$
So –300 nC must be on inner surface.

$\sigma = \frac{-300 \times 10^{-9}}{4\pi (0.8)^2}$
$= -3.7 \times 10^{-8}$ C/m²

A) zero.
B) $+4.0 \times 10^{-8}$ C/m^2.
C) -4.0×10^{-8} C/ m^2.
D) $+6.0 \times 10^{-8}$ C/ m^2.
E) -6.0×10^{-8} C/ m^2.

7) For the circuit shown in the figure, the capacitors are all initially uncharged, the connecting leads have no resistance, the battery has no appreciable internal resistance, and the switch *S* is originally open.



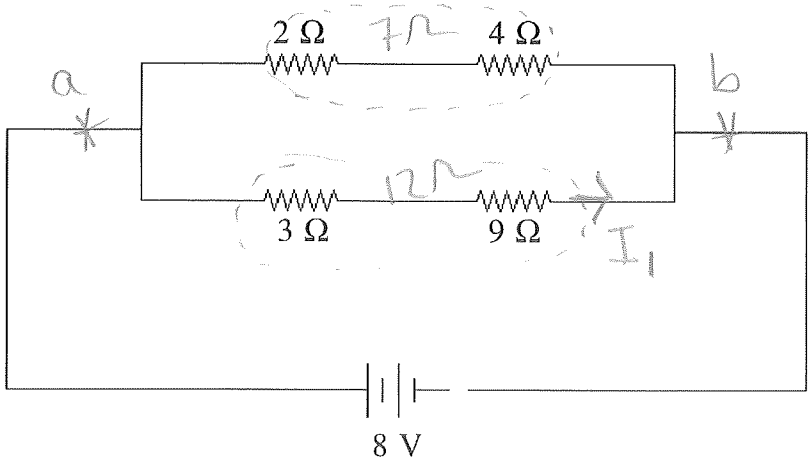


Just after closing the switch *S*, what is the current in the 15.0-Ω resistor?

A) 1.67 A (B) 0.00 A C) 3.33 A D) 5.00 A E) 2.50 A

"Shunted"

8) Four resistors are connected across an 8V battery as shown in the figure. The current through the 9-Ω resistor is closest to



$\Delta V_{ab} = 8$ volts

$I_1 = \frac{\Delta V_{ab}}{12\Omega} = 0.67\,A$

A) 0.5 A. B) 0.9 A. (C) 0.7 A. D) 1 A. E) 2 A.

9) A device with a resistance of 200.0 kΩ is connected to a 9.0 V battery. How much power does the device use?

A) 1800 kW (B) 0.41 mW C) 0.045 mW D) 16,000 kW

$P = \frac{V^2}{R} = 4.05 \times 10^{-4}$ watts

10) In a certain region, the electric potential due to a charge distribution is given by the equation $V(x,y,z) = 3x^2y^2 + yz^3 - 2z^3x$. The units are SI. What is the y-component of the electric field at the point x=4, y=3, z=2 ?

$E_y = -\frac{\partial V}{\partial y} = -6x^2y - z^3$

@(4,3,2) this is $[-6(4)^2 3 - 2^3]$

-296 V

A) 296 V/m
B) 392 V/m
C) -392 V/m
D) No way to tell with out defining the zero voltage point.
(E) -296 V/m

11) If the potential in a region is given by $V(x,y,z) = xy - 3yz^{-2} + 4$, then the *y* component of the electric field in that region is _____.

Again, $E_y = -\frac{\partial V}{\partial y} = -x + 3z^{-2}$

A) $x - 3z^{-2}$ (B) $3z^{-2} - x$

C) $-xy^2/2 + 3y^2/z^2 - 4y$ D) $-xy + 3yz^{-2}$

☹ "MOVES" is a better word

12) A negative charge is moved from point *A* to point *B* along a path where the voltage is constant. Which of the following statements must be true for this case?

OMIT

$\Delta PE_{elec} = q\Delta V$ ↑ ✗ No change in voltage

BEST ANSWER →

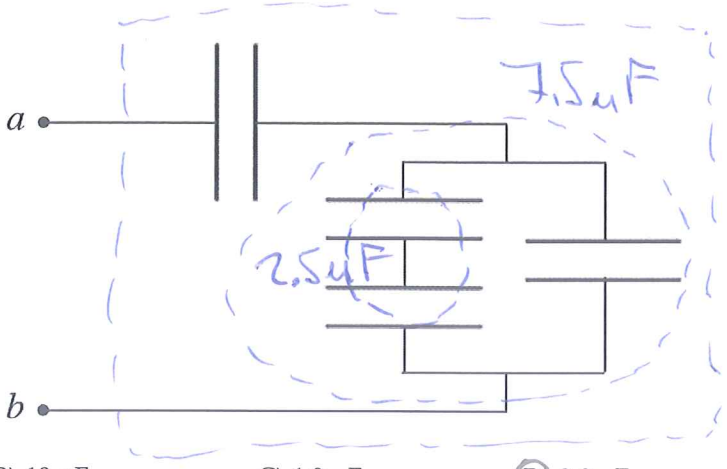
A) Work is required to move the negative charge from point *A* to point *B*.
B) The negative charge performs work in moving from point *A* to point *B*.
C) No work is required to move the negative charge from point *A* to point *B*.
D) The work done on the charge depends on the distance between *A* and *B*.
E) Work is done in moving the negative charge from point *A* to point *B*.

No change in PE. No work required

13) The capacitors in the network shown in the figure all have a capacitance of 5.0 μF. What is the equivalent capacitance, C_{ab}, of this capacitor network?

$\frac{1}{C} = \frac{1}{7.5} + \frac{1}{5}$

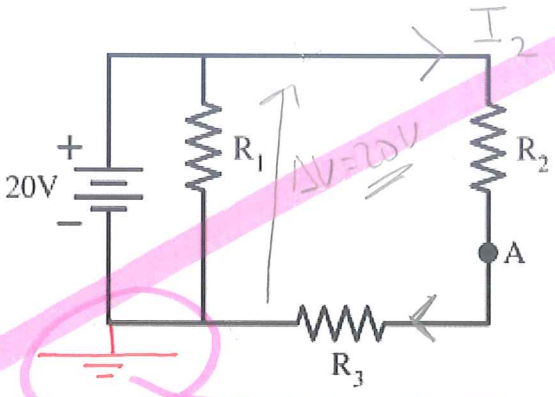
$\therefore C = 3\mu F$



A) 20 μF B) 10 μF C) 1.0 μF D) 3.0 μF E) 5.0 μF

14) In the circuit below, the resistor R_2 is adjustable. As its resistance is made larger, the voltage at point A _____.

PROBLEM: "Voltage @ A" with respect to where?



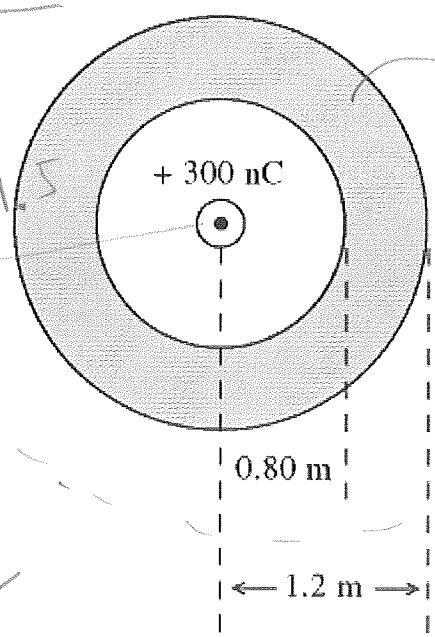
A) decreases. B) does not change. C) increases.

Already had student complete early exam. Too Late to fix

OMIT QUESTION

With this ground we can answer the question. If R_2 gets larger, I_2 gets smaller. $V_A = +I_2R_3$. This will get smaller.

15) A hollow conducting spherical shell has radii of 0.80 m and 1.20 m, as shown in the figure. The sphere carries a net excess charge of -500 nC. A point charge of +300 nC is present at the center. The radial component of the electric field at a point that is 1.50 m from the center is closest to _____.



Spherical Symmetry!

Looks like a point charge of (-200 nC).

$q_{sphere} = -500\,nC$

$\vec{E} = ?$ $r = 1.5$

$|\vec{E}| = \frac{8.99\times10^{9}\,(200\times10^{-9})}{1.5^2} = 799\ N/m$ Radially IN

A) -2000 N/C. B) -800 N/C. C) +1200 N/C. D) -1600 N/C. E) +2000 N/C.

16) Consider a vertical, infinite sheet of positive charge. Parallel to this sheet and to its right is an infinite sheet of negative charge. An electron is in between these sheets and moving to the right, towards the negative charge. Which statement is true?

high ↑ $-q\vec{E}$ ↓ low $\vec{F} = -q\vec{E}$ is to left ⇒ Lower PE. So to right is Higher PE.

A) The potential energy of the electron is increasing and it is moving to a region having a lower voltage.
B) The potential energy of the electron is increasing and it is moving to a region having a higher voltage.
C) The potential energy of the electron is decreasing and it is moving to a region having a higher voltage.
D) The potential energy of the electron is decreasing and it is moving to a region having a lower voltage.

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

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

$P = \frac{V^2}{R}$

$\therefore R = \frac{V^2}{P} = \frac{(240)^2}{24\times10^3} = 2.4\,\Omega$

18) 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 so the top face of the cube is parallel to the xz-plane and is at $y = 0.080$ m. Everywhere in this region of space there is an electric field given by $\vec{E} = (3280\ y)\ \hat{j}$. Note that the field is constant but not uniform. Use Gauss's law to calculate the net charge enclosed by the cube.

all $\hat{j}$, so only surfaces w/ Φ_E passing through are TOP and Bottom. But, $y=0$ on bottom so $E=0$ on bottom. Left only w/ TOP, where $y = 0.08$.

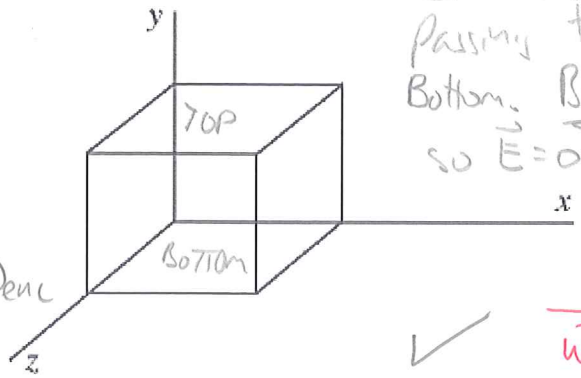
$\oint \vec{E} \cdot d\vec{A} = \frac{Q_{enclosed}}{\varepsilon_0}$

CUBE

$\int 3280(.08)\, dA = \frac{Q_{enc}}{\varepsilon_0}$

TOP

$3280(0.08)[0.08 * 0.08] * \varepsilon_0 = Q_{enc}$



We don't have to imagine what the charge must look like to produce this $\vec{E}$.

A) 1.9×10^{-10} C B) 0 C C) 1.5×10^{-11} C D) 262 C

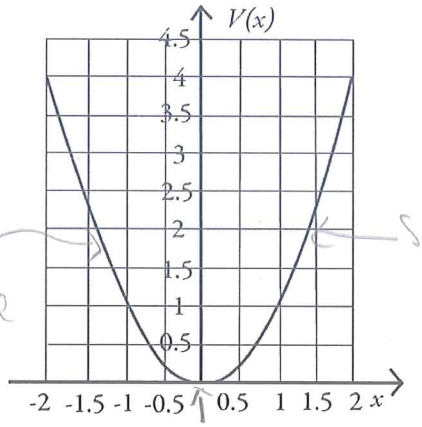
19) The graph in the figure shows the variation of the electric potential $V(x)$ (in arbitrary units) as a function of the position x (also in arbitrary units). Which of the choices below correctly describes the orientation of the x-component of the electric field along the x-axis?

Gauss DEMANDS that this be the charge enclosed.

$E_x = -\frac{\partial}{\partial x} V(x)$

Slope

Negative



So E_x is Positive

So E_x is Negative.

E_x is zero.

A) E_x is negative from $x = -2$ to $x = 2$.
B) E_x is positive from $x = -2$ to $x = 2$.
C) E_x is positive from $x = -2$ to $x = 0$, and negative from $x = 0$ to $x = 2$.
D) E_x is negative from $x = -2$ to $x = 0$, and positive from $x = 0$ to $x = 2$.

20) A 9.0 V battery is connected to two resistors in series. If the resistors have resistances of 570.0 Ω and 730.0 Ω, what is the voltage drop across the 730.0 Ω resistor?

A) 12 V B) 4.0 V C) 7.0 V D) 5.1 V

$I = \frac{9}{1300} = 6.92 * 10^{-3}$

$\Delta V_{730} = I * 730 = 5.05$ V