ID: C Name: Solutions

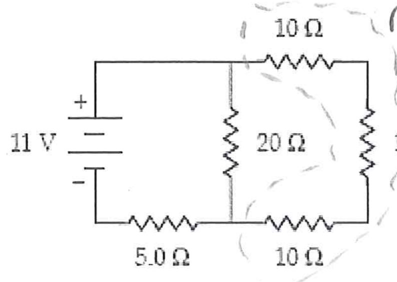
2049 EXAM 2 18 Questions

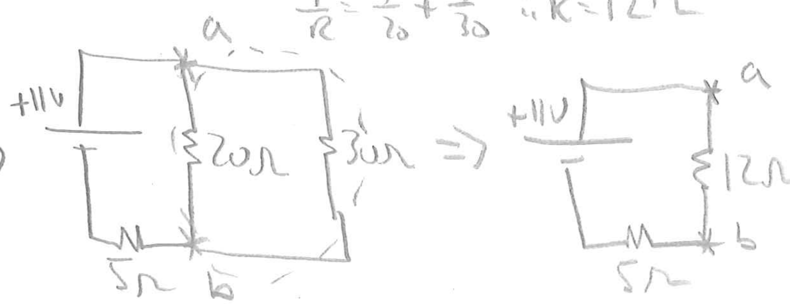
Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. What is the magnitude of the voltage across the 20-Ω resistor?

$\frac{1}{R} = \frac{1}{20} + \frac{1}{30}$ ∴ $R = 12\Omega$





a. 11 V
b. 5.0 V
c. 7.8 V ✓
d. 8.6 V
e. 3.2 V

$\Delta V_{a \to b} = -I(12) = -7.8V$

$+11V = I(12+5)$

$0.647A = I$

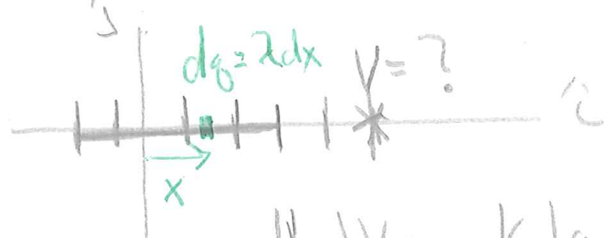
____ 2. A small bulb is rated at 7.5 W when operated at 125 V. Its resistance (in ohms) is ______.

a. 940
b. 2 100 ✓
c. 17
d. 7.5
e. 0.45

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

∴ $R = \frac{V^2}{P} = \frac{(125)^2}{7.5} = 2083\Omega$

____ 3. A charge of 10 nC is distributed uniformly along the *x* axis from *x* = –2 m to *x* = +3 m. Which of the following integrals is correct for the electric potential (relative to zero at infinity) at the point *x* = +5 m on the *x* axis?



a. $\int_{-2}^{3} \frac{90dx}{5+x}$

b. $\int_{-2}^{3} \frac{90dx}{x}$

c. $\int_{-2}^{3} \frac{18dx}{x}$

d. $\int_{-2}^{3} \frac{90dx}{5-x}$

e. $\int_{-2}^{3} \frac{18dx}{5-x}$ ✓

$dV = \frac{k\,dq}{r}$ ← distance from dq to observation point

$V = \int \frac{k\,dq}{r} = \int_{-2}^{3} \frac{k\lambda\,dx}{(5-x)} = \int_{-2}^{3} \frac{k\left(\frac{Q}{5}\right)dx}{(5-x)}$

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$\vec{F} = q\vec{E}$ ∴ moves in direction of $\vec{E}$

____ 4. A particle (charge = 50 μC) moves in a region where the only force on it is an electric force. As the particle moves 25 cm from point A to point B, its kinetic energy increases by 1.5 mJ. Determine the electric potential difference through which the charge has moved. Note that a negative sign in the answer means that the charge has moved to a lower voltage.

So its PE must decrease by 1.5 mJ

$\Delta PE = q\Delta V$

$-1.5\times10^{-3} = 50\times10^{-6}\,\Delta V$

$-30\text{V} = \Delta V$

a. -60 V
b. -50 V
c. $+15$ V
d. -40 V
e. -30 V

____ 5. Which one of the following is not an expression for electric charge?

Must accept either answer as correct

a. $\int_{area} \mathbf{E}\cdot d\mathbf{A}$

b. $\int_{line} \lambda d\ell$ → 1st definition $\lambda = \frac{Q}{d\ell}$

c. $\int_{area} \sigma dA$ → 2nd def. $\sigma = \frac{Q}{dA}$

d. $\int_{volume} \rho dV$ → 3rd def $\rho = Q/dV$

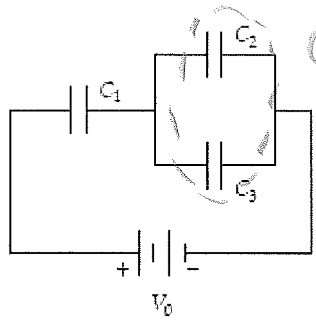
e. $\varepsilon_0 \int_{area} \mathbf{E}\cdot d\mathbf{A}$ → technically, does not specify "closed surface"

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

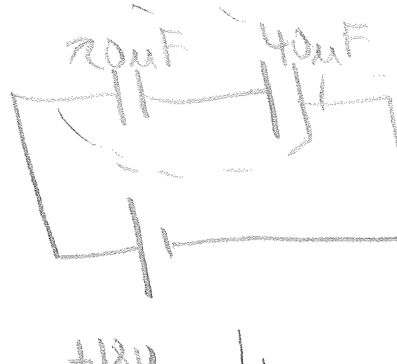
$\varepsilon_0 \oint \vec{E}\cdot d\vec{A} = Q_{enc}$

intended

____ 6. Determine the charge stored by C_1 when $C_1 = 20\ \mu$F, $C_2 = 10\ \mu$F, $C_3 = 30\ \mu$F, and $V_0 = 18$ V.

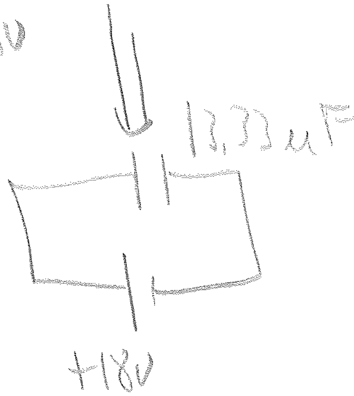


$C = 40\mu F$



$\frac{1}{C} = \frac{1}{20} + \frac{1}{40}$

∴ $C = 13.33\mu F$



a. 0.50 mC
b. 0.32 mC
c. 0.40 mC
d. 0.24 mC
e. 0.37 mC

$Q = 13.33\times10^{-6} \times 18$
$= 2.4\times10^{-4}$ C

"... in series have the same charge."

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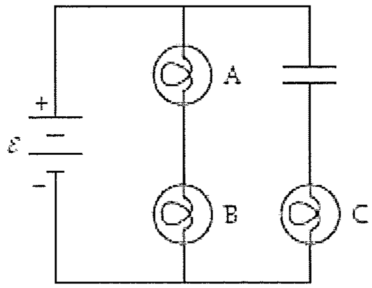
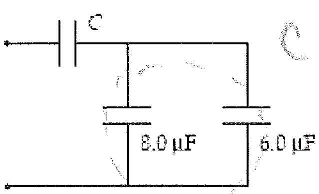
7. The circuit below contains three 100-watt light bulbs and a capacitor. The emf $\varepsilon = 110V$. The capacitor has been in the circuit for a long time and is fully charged. Which light bulb(s) is(are) dimmest?



↳ Acts like an open circuit.
⇒ No current through C.

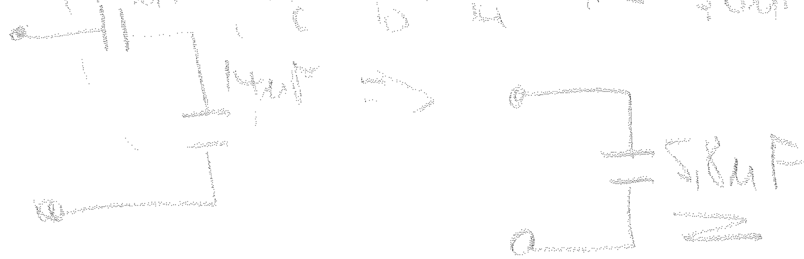
a. A
b. B
c. C ✓
d. A and B
e. All three are equally bright (or dim).

8. If $C = 10\ \mu F$, what is the equivalent capacitance for the combination shown?



C = 14μF ⇒

$\frac{1}{C} = \frac{1}{10} + \frac{1}{14}$ ∴ C = 5.8μF



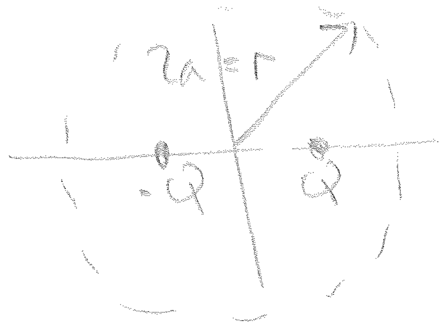
a. 13 μF
b. 7.0 μF
c. 5.8 μF ✓
d. 6.5 μF
e. 7.5 μF

9. A point charge $+Q$ is located on the x axis at $x = a$, and a second point charge $-Q$ is located on the x axis at $x = -a$. A spherical Gaussian surface with radius $r = 2a$ is centered at the origin. The flux through this Gaussian surface is __________.

a. zero because the flux exiting the sphere (produced by the +Q) will exactly cancel the flux entering the sphere (produced by the -Q).
b. zero because the electric field is zero at every point on the surface.
c. greater than zero.
d. zero because at every point on the surface the electric field has no component perpendicular to the surface.
e. more than one answer is correct

$(+Q - Q) \Rightarrow 0$

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



$\vec{E} = -\frac{\partial}{\partial x}V\hat{i} - \frac{\partial}{\partial y}V\hat{j} - \frac{\partial}{\partial z}V\hat{k} = -3y^2\hat{i} - 6xy\hat{j} - 4\hat{k}$

____ 10. A region of space has an electric potential given by the function $V(x,y,z) = 3xy^2 + 4z - 2$. The electric field vector at the point (1, 2, 3) is ______________.

$E(1,2,3) = -3(2)^2\hat{i} - 6(1)(2)\hat{j} - 4\hat{k}$

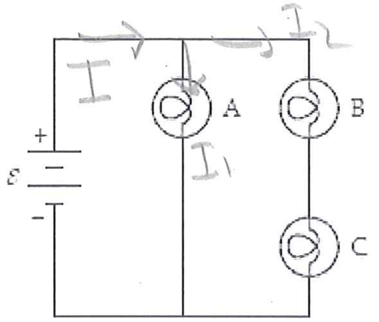
a. 22 N/C
b. -12**i**^ - 12**j**^ -4**k**^ ✓
c. -12**i**^ -6**j**^ +12**k**^
d. - 22 N/C

____ 11. Two charges of 15 pC and –40 pC are inside a cube with sides that are of 0.40-m length. Determine the net electric flux through the surface of the cube. NOTE: pico is 10^{-12}.

$\underbrace{\oint \vec{E}\cdot d\vec{A}}_{\Phi_E} = \frac{Q_{enc}}{\varepsilon_0} = \frac{(15\times10^{-12} - 40\times10^{-12})}{8.854\times10^{-12}}$

a. –2.8 N · m²/C ✓
b. –1.1 N · m²/C
c. –0.47 N · m²/C
d. +1.1 N · m²/C
e. +2.8 N · m²/C

____ 12. The circuit below contains three 100-W light bulbs. The emf ε = 110 V. Which light bulb(s) is(are) brightest?



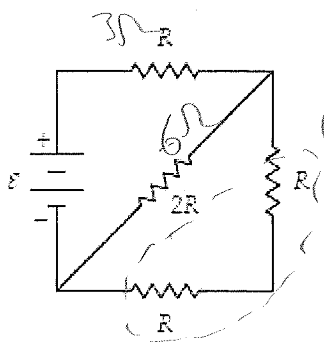
$I = I_1 + I_2$

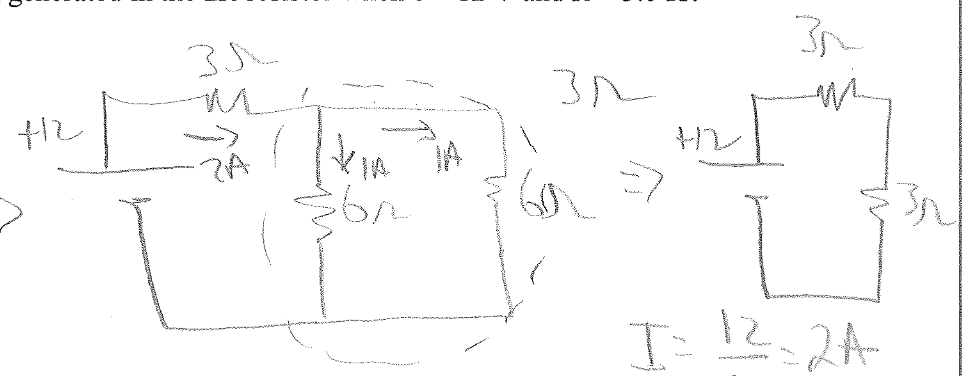
More current will pass through the lower resistance.

a. A ✓
b. B
c. C
d. B and C
e. All three are equally bright.

OVER →

____ 13. At what rate is thermal energy being generated in the $2R$-resistor when $\varepsilon = 12$ V and $R = 3.0\ \Omega$?





$I = \frac{12}{6} = 2A$

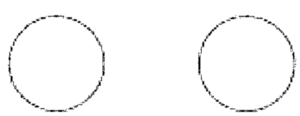
a. 24 W
b. 1.5 W
c. 12 W
d. 6.0 W ✓
e. 3.0 W

$P_{2R} = I^2(2R) = 1^2 * 6 = \underline{6W}$

____ 14. When a capacitor is fully charged, the current through the capacitor in a direct-current circuit is ________.

a. zero. ✓ NOTES
b. greater than the current in a resistor that is farther from the battery than the capacitor.
c. equal to the current in a resistive circuit in parallel with the capacitor circuit.
d. zero if it is the only capacitor, but maximum if there is another capacitor in series with it.
e. at its maximum value.

____ 15. The electric flux through the two adjacent spherical surfaces shown below is known to be the same. REQUIRED



It is also known that there is no charge inside either spherical surface. We can conclude that ________.

a. there is no electric field present in this region of space.
b. there is a constant E field present in this region of space.
c. the electric flux has a constant value of zero.
d. any of the above may be correct.
e. only (a) and (b) above may be correct.

None are exclusively true, but all would satisfy requirement.

$\vec{F} = \overset{(-)}{q}\vec{E}$ || electron moves in opposite direction of $\vec{E}$

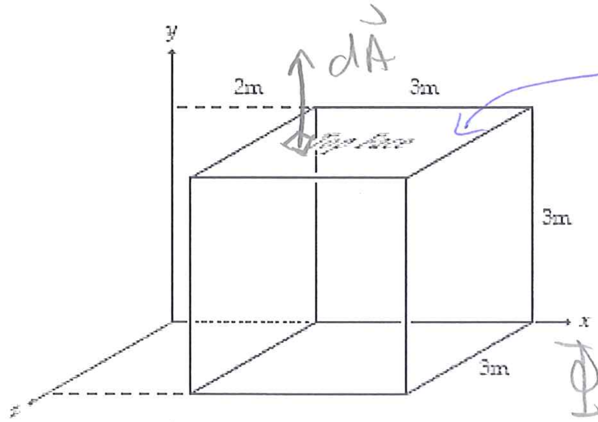
____ 16. An electron is released from rest in a region of space where a uniform electric field is present. The electric force is the only force acting on the electron. Which of the following statements is correct?

Not Relevant (and flux requires a surface) — $\vec{E}$ points from high voltage to low voltage

a. The electric flux produced by the electron is constant.
b. Nothing can be said about the kinetic energy of the electron without knowing its mass.
c. The kinetic energy increases while the electron moves to a point at higher voltage and higher potential energy.
d. The kinetic energy increases while the electron moves to a point at lower voltage and lower potential energy.
e. The kinetic energy increases while the electron moves to a point at a higher voltage but lower potential energy.

Gain in KE, Must Correspond to loss in PE.

____ 17. The electric field in the region of space shown is given by $\vec{\mathbf{E}} = (8\hat{\mathbf{i}} + 2y\hat{\mathbf{j}})$ N/C ,where y is in meters. What is the magnitude of the electric flux through the top face of the cube shown?



$d\vec{A} = +dz\,dx\,\hat{j}$

$\Phi_{Top} = \int_{Top} \vec{E} \cdot d\vec{A} = \int_{Top} 2y\, dz\, dx$

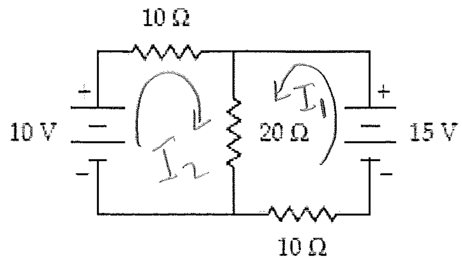
3 over top Surface

$= 6 \underbrace{\int_{Top} dz\,dx}_{\text{Area of top}} = 6 \times 9 = \underline{54}$

a. 126 N · m²/C
b. 90 N · m²/C
c. 12 N · m²/C
d. 6.0 N · m²/C
e. 54 N · m²/C

OVER

____ 18. What is the magnitude of the current in the 20-Ω resistor?



a. 1.00 A
b. 0.25 A
c. 0.75 A
d. 0.00 A
e. 0.50 A ✓

for loop 1

$+15 - 20I_1 - 20I_2 - 10I_1 = 0$

(1) $\boxed{-30I_1 - 20I_2 = -15}$

for loop 2

$+10 - 10I_2 - 20I_2 - 20I_1 = 0$

(2) $\boxed{-20I_1 - 30I_2 = -10}$

Consider $-3 * (2) + 2 * (1)$:

$+50I_2 = 0$

$I_2 = 0$

So from (1) $\Rightarrow -30I_1 = -15$

$I_1 = \frac{15}{30} = 0.5A$

Current through 20Ω is $I_1 + I_2 = 0.5A$