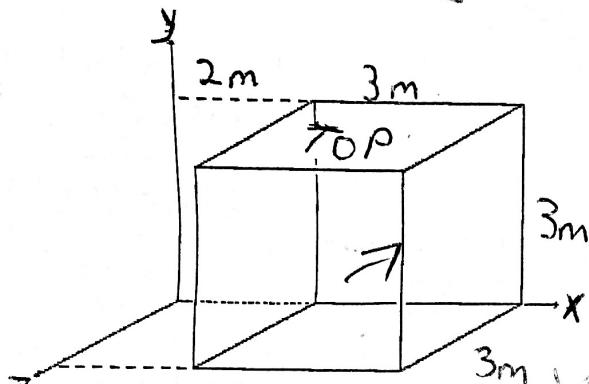


Exam 2

Multiple Choice

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

1. The electric field in the region of space shown is given by $\mathbf{E} = (8\mathbf{i} + 2x\mathbf{j}) \text{ N/C}$ where x is in meters. What is the magnitude of the electric flux through the bottom face of the cube shown?



$$\oint \mathbf{E} \cdot d\mathbf{x}$$

$$\begin{aligned} & \int_0^3 (8\mathbf{i} + 2x\mathbf{j}) \cdot \mathbf{k} dx \\ & 8(3) + 2 \int_0^3 x^2 dx \\ & 24 + \frac{2}{3} x^3 \Big|_0^3 \\ & 24 + \frac{2}{3}(27) \\ & 24 + 18 = 42 \end{aligned}$$

- a. $126 \text{ N} \cdot \text{m}^2/\text{C}$
- b. $54 \text{ N} \cdot \text{m}^2/\text{C}$
- c. $90 \text{ N} \cdot \text{m}^2/\text{C}$
- d. $12 \text{ N} \cdot \text{m}^2/\text{C}$
- e. $63 \text{ N} \cdot \text{m}^2/\text{C}$

2. A uniformly charged rod (length = 2.0 m, charge per unit length = 5.0 nC/m) is bent to form one quadrant of a circle. What is the magnitude of the electric field at the center of the circle?

NOTES: The radius of the arc is $4/\pi$. Recall that $S = R\theta$.

- a. 25 N/C
- b. 62 N/C
- c. 44 N/C
- d. 56 N/C
- e. 50 N/C

3. A uniform linear charge with a density of 4.0 nC/m is distributed along the entire x axis. Consider a spherical surface with a radius of 5.0 cm whose center is at the origin. What is the electric flux through this surface?

- a. $45 \text{ N} \cdot \text{m}^2/\text{C}$
- b. $23 \text{ N} \cdot \text{m}^2/\text{C}$
- c. $79 \text{ N} \cdot \text{m}^2/\text{C}$
- d. $62 \text{ N} \cdot \text{m}^2/\text{C}$
- e. $68 \text{ N} \cdot \text{m}^2/\text{C}$

$$\oint \mathbf{E} \cdot d\mathbf{S} = \frac{Q}{\epsilon_0}$$



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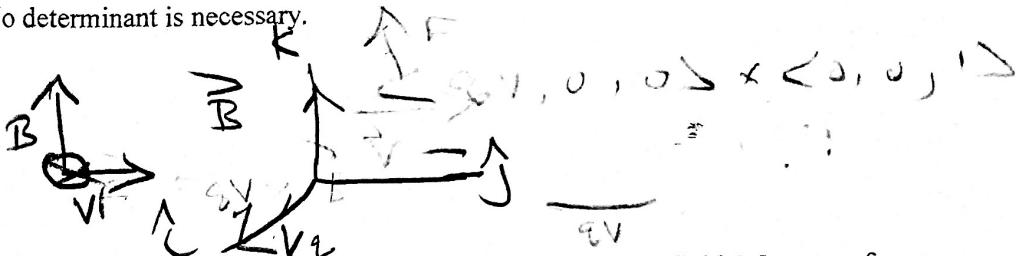
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electron

4. At one instant in time, an \checkmark moving in the positive x direction experiences a magnetic force in the positive z direction. If $B_x \approx 0$ what is the direction of the magnetic field?

HINT: Draw the picture. No determinant is necessary.

- a. positive z direction
 b. negative y direction
 c. negative x direction
 d. negative z direction
 e. positive y direction



5. A long straight wire carries a current of 40 A. What is the magnitude of the magnetic field 1.5 meters from the axis of the wire?

- a. 3.0×10^{-6} T
 b. 8.0×10^{-6} T
 c. 5.3×10^{-6} T
 d. 12×10^{-6} T
 e. 7.4×10^{-6} T

$$I = 40$$

$$\vec{B} = \frac{\mu_0 (40)}{4\pi (1.5)^2} \hat{r}$$

6. A 2.0 C charge moves with a velocity of $(2.0\mathbf{i} + 4.0\mathbf{j} + 6.0\mathbf{k}) \text{ m/s}$ and experiences a magnetic force of $(4.0\mathbf{i} - 20\mathbf{j} + 12\mathbf{k}) \text{ N}$. The x component of the magnetic field is equal to zero. Determine the y component of the magnetic field.

HINT: Using what is given, expand the determinant for the vector cross product. Then look at the vector components of the relevant equation.



- a. $+3.0 \text{ T}$
 b. -3.0 T
 c. $+5.0 \text{ T}$
 d. $+6.0 \text{ T}$
 e. -5.0 T

$$\vec{F} = 192 \mathbf{i} - 48 \mathbf{j} + 12 \mathbf{k} \times \langle 4, -20, 12 \rangle$$

$$\vec{F} = \langle -72, 0, 56 \rangle \quad \begin{vmatrix} \mathbf{i} & \mathbf{j} & \mathbf{k} \\ 4 & -20 & 12 \\ 2 & 4 & 6 \end{vmatrix} = \frac{1}{4-20-12} (48-120)\mathbf{i} - (24-24)\mathbf{j} + (-40-16)\mathbf{k}$$

$$\langle -72, 0, 56 \rangle$$

7. Appliances are often rated in terms of the power they consume. A cook plugs a 500 watt crockpot and a 1000 watt tea kettle into a 240 V power supply. Treat the crockpot and the kettle as two resistors in parallel, each connected to the power supply. When we compare the two devices, we find that _____.

- a. $I_{crockpot} < I_{kettle}$ and $R_{crockpot} > R_{kettle}$
 b. $I_{crockpot} = I_{kettle}$ and $R_{crockpot} = R_{kettle}$
 c. $I_{crockpot} > I_{kettle}$ and $R_{crockpot} < R_{kettle}$
 d. $I_{crockpot} > I_{kettle}$ and $R_{crockpot} > R_{kettle}$
 e. $I_{crockpot} < I_{kettle}$ and $R_{crockpot} < R_{kettle}$

$$\frac{500}{R_1} = \frac{(240)^2}{16}, \quad \frac{1000}{R_2} = \frac{(240)^2}{4}$$

$$R_1 = 115.2 \Omega, \quad R_2 = 57.2 \Omega$$

8. Point A is at $x = 2, y = 3$. Point B is at $x = 5, y = 7$. The electric field in this region of space is given by $\vec{E} = 4\mathbf{i} + 3\mathbf{j}$. All units are SI. What is the magnitude of voltage between these points?

- a. 27 V
 b. 24 V
 c. 33 V
 d. 30 V
 e. 11 V

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

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

$$= -(51.5)(\sqrt{2}) \quad \vec{E} = \langle 4, 3 \rangle$$

$$= -25(\sqrt{2}) \quad r = \sqrt{3^2 + 4^2} = 5$$

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9. A segment of wire of total length 3.0 m carries a 15-A current and is formed into a semicircle. To be clear, that is one half of a circle. What is the magnitude of the **magnetic field** at the center of the semicircle?
NOTES: The radius is $3/\pi$. Also recall that $S = R\theta$.

- a. $4.9 \mu\text{T}$
- b. $1.0 \mu\text{T}$
- c. $1.6 \mu\text{T}$
- d. $15 \mu\text{T}$
- e. $9.8 \mu\text{T}$

- B 10. By using a compass to measure the magnetic field direction at various points adjacent to a long straight wire, you can show that the wire's magnetic field lines are _____.
Recall that we did this demonstration in class!

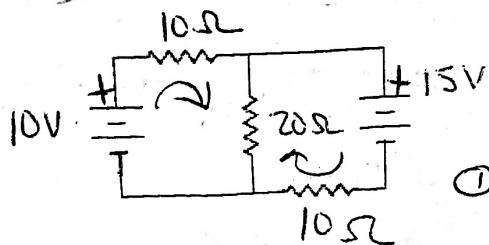


- a. straight lines in space that are parallel to the wire.
- b. straight lines in space that are perpendicular to the wire.
- c. straight lines in space that go from one magnetic charge to another.
- d. circles that have their centers on the wire and lie in planes perpendicular to the wire.
- e. circles that have the wire lying along a diameter of the circle.

11. A long conducting rod with a square cross section ($3.0 \text{ cm} \times 3.0 \text{ cm}$) carries a current of 60 A that is uniformly distributed across the cross section. What is the magnitude of the line integral, $\oint \mathbf{B} \cdot d\mathbf{s}$, around a square path ($1.5 \text{ cm} \times 1.5 \text{ cm}$) if the path is centered on the center of the rod and lies in a plane perpendicular to the axis of the rod? NOTE: This path defines a square cross section that is contained within the cross section of the rod.

- a. $19 \mu\text{T} \cdot \text{m}$
- b. $38 \mu\text{T} \cdot \text{m}$
- c. $14 \mu\text{T} \cdot \text{m}$
- d. $75 \mu\text{T} \cdot \text{m}$
- e. $57 \mu\text{T} \cdot \text{m}$

12. What is the current delivered by the 10 V battery?



$$\begin{aligned} ① \quad 10 - 10I_1 - 20I_2 + 20I_3 &= 0 \\ -15 + 10I_2 - 20I_2 + 20I_3 &= 0 \\ ② \quad 10 = 10I_1 + 20I_2 - 20I_2 \\ 15 = -10I_2 - 20I_2 + 20I_3 \end{aligned}$$

$$I_1 = 0$$

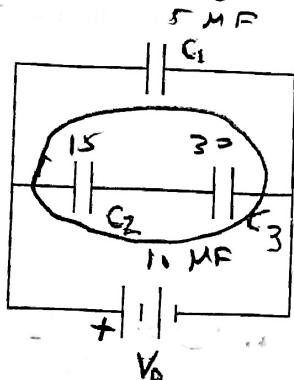
$$I_2 = -0.5$$

$$P =$$

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

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13. What is the voltage across C_2 when $C_1 = 5.0 \mu\text{F}$, $C_2 = 15 \mu\text{F}$, $C_3 = 30 \mu\text{F}$, and $V_0 = 24 \text{ V}$?



$$C_{(2,3)} = \left(\frac{1}{15} + \frac{1}{30} \right)^{-1} = 10 \mu\text{F}$$

$$C_{(2,3),1} = 10 + 5 = 15 \mu\text{F}$$

$$Q = 15(24)$$

$$Q = 360$$

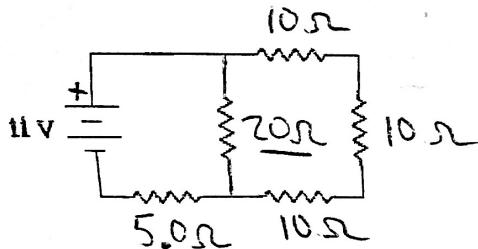
$$360 = 15(I)$$

$$\frac{360}{15} = V \approx 24$$

- a. 8.0 V
- b. 19 V
- c. 21 V
- d. 16 V
- e. 24 V

✓

14. What is the magnitude of the voltage across the 20Ω resistor?



$$\begin{aligned} \textcircled{1} \quad 11 - 20I_2 + 20I_2 &\sim I_1 = 0 \\ \textcircled{2} \quad -10I_2 - 20I_2 + 20I_2 - 10I_2 &\sim 0 \end{aligned}$$

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

$$\left. \begin{aligned} \textcircled{1} \quad 11 &= 20I_2 - 20I_2 + 5I_1 \\ &\sim 5I_1 \\ \textcircled{2} \quad -40I_2 + 20I_2 &\sim 0 \end{aligned} \right\}$$

$$I_1 = 0.733$$

$$I_{20\Omega} = 0.36$$

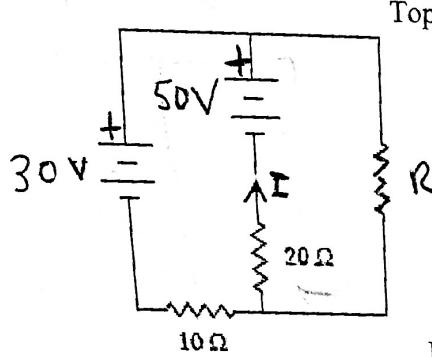
$$11 = 20(0.733) - 20(0.36)$$

$$11.66 - 7.2$$

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$$V = IR \quad V = (20)(1.5) \rightarrow 30$$

15. What is the voltage across the resistor 'R' if the current through the 20Ω resistor is 1.5 amps in the direction shown on the figure?



$$\textcircled{1} \quad 30 - 50 - 20I_1 + 20I_2 - 10I_1 = 0$$

$$\textcircled{2} \quad 30 - RI_2 - 20I_2 + 20I_1 = 0$$

$$\textcircled{1} \quad -20 = 20I_1 - 20I_2 + 10I_1$$

$$\textcircled{2} \quad 50 = RI_2 + 20I_2 - 20I_1$$

- a. 20 V with the top of R at the higher voltage
b. 20 V with the bottom of R at the higher voltage
 c. 80 V with the top of R at the higher voltage
d. 80 V with the bottom of R at the higher voltage
e. There is no way of knowing unless we are given a value for R

$$I_1 = 0$$

$$20(1.5)$$

$$I_2 = 1$$

$$30V - 50 = 20V$$