Exam 2
Nov 8, 2018

In addition to this page, I will include the "purple equation sheet" from Griffiths.

No phones or other device that connects to the internet.

You may use a calculator, though I don't think you'll need it.

Present clear and complete answers:

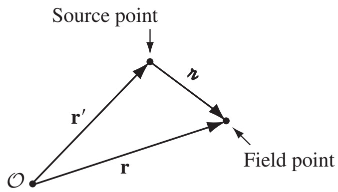
Explain your answers clearly but briefly. You want to aim for a level of solution that someone taking this class would be able to understand. A diagram and a few words may help.

Start calculations with first principles: things like definitions ($\vec{E} \equiv \frac{\vec{F}}{Q}$) or empirical laws (like Coulomb's Law or Newton's Laws) or conservation laws.

Check time:

The point values for each problem are shown next to the question number. Time yourself accordingly. The total value of the exam is 100 points. **Good luck!**

Some definitions:



Helpful Integrals:

$$\int \sqrt{1-x^2}dx = \frac{1}{2}[x\sqrt{1-x^2} + \sin^{-1} x]$$

$$\int \frac{dx}{\sqrt{1-x^2}} = \sin^{-1} x$$

$$\int \frac{xdx}{\sqrt{1-x^2}} = -\sqrt{1-x^2}$$

$$\int \frac{x^2dx}{\sqrt{1-x^2}} = -\frac{x}{2}\sqrt{1-x^2} + \frac{1}{2}\sin^{-1} x$$

Some more math:

$$\mathscr{r}^{\,2} = r^2 + r'^2 - 2rr'\cos\alpha$$

$$V_s = \frac{4}{3}\pi R^3$$

Helpful Equations:

$$\vec{F} = \frac{qQ}{4\pi\epsilon_0 \mathscr{r}^{\,2}}\hat{\mathscr{r}}$$

$$\oint \vec{E}\cdot d\vec{a} = \frac{q_{enc}}{\epsilon_0}$$

$$V(r) = -\int_{ref}^{r} \vec{E}\cdot d\vec{\ell}$$

Helpful Taylor series expansions (for small ϵ):

$$e^{\epsilon} \approx 1 + \epsilon + \ldots$$

$$\ln(1+\epsilon) \approx \epsilon + \ldots$$

$$(1+\epsilon)^n \approx 1 + n\epsilon + \ldots$$

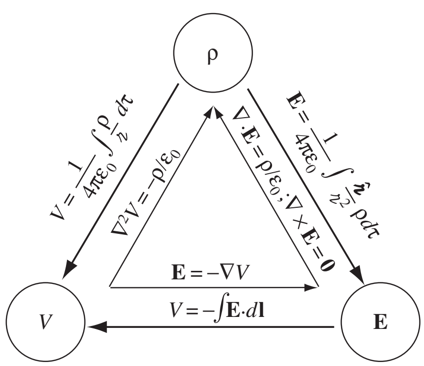


FIGURE 2.35

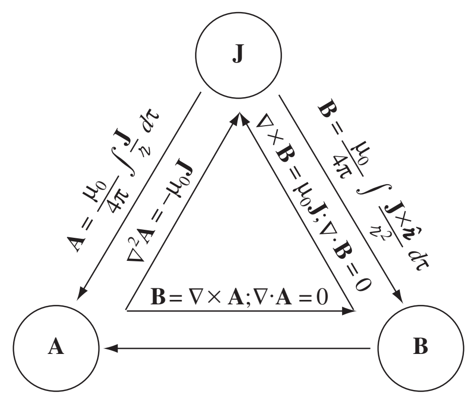


FIGURE 5.48

$$W = \frac{\epsilon_0}{2}\int E^2 d\tau$$

$$\vec{F} = Q\vec{E} + Q\vec{v}\times\vec{B} \qquad \vec{F} = \int I d\vec{\ell}\times\vec{B}$$

$$\vec{B}(\vec{r}) = \frac{\mu_0 I}{4\pi}\int \frac{d\vec{\ell}\times\hat{\mathscr{r}}}{\mathscr{r}^{\,2}} \qquad \oint \vec{B}\cdot d\vec{\ell} = \mu_0 I_{enc}$$

1. Four equal charges q are on the corners of a square. The square has sides of length d. Calculate how much work it took to assemble this arrangement of charges, assuming you brought each charge in from infinity, one at a time.

2. item A very long straight wire lies in the plane of the paper, as shown. It carries a current, I. A square wire loop lies in the plane of the paper also. The square has sides of length a and carries a current I in the clockwise direction. Find the force on the square loop due to the long straight wire.

3. Find the magnetic field a distance z above the center of a circular loop of radius R that carries current I in the clockwise direction, as you look down (from above, from $+z$ to the origin)