

NUMBER _____

PHYSICS 135bL

Professor Shakeshaft
Professor Nemeschansky

Spring 1998
Tuesday, May 5
8-10 a.m.

FINAL EXAMINATION

NAME (printed) _____
Last First Initial

NAME (signed) _____

SOCIAL SECURITY NUMBER _____

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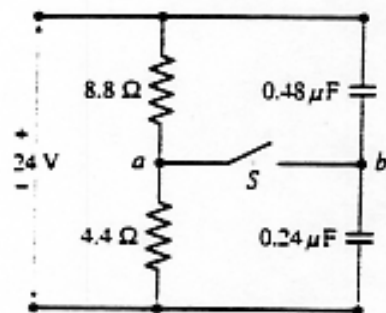
8. _____

TOTAL _____

1. (25 pts) A $3.0 \mu\text{C}$ charge and a $-2.0 \mu\text{C}$ charge are separated by a distance of 45.0 cm. Where is the electric field produced by these charges zero? Sketch roughly the lines of force.

2. (25 pts) Two resistors and two uncharged capacitors are arranged as shown in the figure. The potential difference across the combination is 24 V.

- (a) What are the potentials at points a and b when the switch S is open?
- (b) What is the potential at point b when S is closed?
- (c) How much charge flows through S when it is closed?



3. (25 pts) A horizontal compass is placed 20 cm due south from a straight vertical wire carrying a 30-A current downward. The horizontal component of the Earth's field at this point is 0.45×10^{-4} T and the magnetic declination is 0° . In what direction does the compass needle point?

4. (25 pts) An object of height 0.2 mm stands 12 cm before a converging lens of focal length 10 cm. Behind this lens is another converging lens of focal length 20 cm. Determine the position and size of the final image. Is it real or virtual, upright or inverted?

5. (25 pts) The nearest star to earth, Proxima Centauri, is 4.3 light-years away.

(a) At what velocity must a spacecraft travel from Earth if it is to reach the star in 4.0 light-years as measured by the travelers on the spacecraft? ($c = 3 \times 10^8$ m/s)

(b) How long does the trip take according to an observer on the Earth?

6. (25 pts) A photon with wavelength 0.100-nm strikes a free electron (mass 9.11×10^{-31} kg) in a head-on collision and knocks it into the forward direction. The photon recoils directly backward. Treating the electron nonrelativistically, and noting that $1 \text{ eV} = 1.60 \times 10^{-19} \text{ J}$,
- (a) what is the final kinetic energy of the electron, and
 - (b) what is the wavelength of the recoiling photon?

7. (25 pts) In September 1991, a German tourist made a startling discovery while walking in the Italian Alps. He found the Iceman, a Stone Age traveler whose body had become trapped in the ice of a glacier. Material found within the body had a ^{14}C activity of 0.12 decays per second. Knowing that the half-life of ^{14}C is 5730 years and that the ratio of ^{14}C to ^{12}C in living organisms has been approximately constant and equal to 1.3×10^{-12} for many thousand years, determine how long ago the Iceman lived.

8. (25 pts) Neutral ${}^6_{12}\text{C}$ decays to ${}^5_{11}\text{B}$ by emitting a β^+ particle (a positron) and a neutrino (which has zero rest mass). Using the table below, determine the maximum and minimum energies that the β^+ particle can have. Note that the electron mass is $5.48579903 \times 10^{-4}$ u, and that $1 \text{ u} \equiv 931.5 \text{ MeV}/c^2$.

(1) Atomic Number Z	(2) Element	(3) Symbol	(4) Mass Number A	(5) Atomic Mass	(6) % Abundance (or Radioactive Decay Mode)	(7) Half-life (if radioactive)
5	Boron	B	10	10.012936	19.9%	
			11	11.009305	80.1%	
6	Carbon	C	11	11.011433	β^- , EC	20.385 min
			12	12.000000	98.90%	
			13	13.003355	1.10%	

Formulas and Constants

$$k = 9.0 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$$

$$\text{electron mass} = 9.11 \times 10^{-31} \text{ kg}$$

$$p = mv$$

$$E = mv^2/2$$

$$E = mc^2$$

$$t = t_0/\sqrt{1 - v^2/c^2}$$

$$L = L_0\sqrt{1 - v^2/c^2}$$

$$p = mv/\sqrt{1 - v^2/c^2}$$

$$E^2 = p^2c^2 + m^2c^4$$

$$E = hf \text{ (photon)}$$

$$v = f\lambda$$

$$p = h/\lambda$$

$$\mathbf{E} = (kq/r^2)\hat{r}$$

$$\mathbf{F} = q\mathbf{E}$$

$$V = kq/r$$

$$\text{Work} = q\Delta V$$

$$Q = CV$$

$$V = IR$$

$$\bar{P} = IV \text{ or } I_{\text{rms}}V_{\text{rms}}$$

$$R_{\text{series}} = R_1 + R_2$$

$$1/R_{\text{para.}} = 1/R_1 + 1/R_2$$

$$1/C_{\text{series}} = 1/C_1 + 1/C_2$$

$$C_{\text{para.}} = C_1 + C_2$$

$$F = IlB \sin \theta$$

$$F = qvB \sin \theta$$

$$\mathcal{E} = -N\Delta\Phi/\Delta t$$

$$\mathcal{E} = -L\Delta I/\Delta t$$

$$V_s/V_p = N_s/N_p \text{ (transformer)}$$

$$1/f = (1/d_o) + (1/d_i)$$

$$m = -d_i/d_o$$

$$\lambda_2/\lambda_1 = n_1/n_2$$

$$d \sin(\theta) = m\lambda \text{ (maximum)}$$

$$d \sin(\theta) = (2m + 1)\lambda/2 \text{ (minimum)}$$

$$D \sin(\theta) = m\lambda, m \neq 0 \text{ (minimum)}$$

$$N = N_0e^{-\lambda t}$$

$$\text{Activity} = \Delta N/\Delta t = -\lambda N$$

$$T_{1/2} = 0.693/\lambda$$

$$\ln(e^x) = x$$

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This is a closed book exam. No notes or other materials are allowed. Your signature represents that you understand these rules and that you agree neither to give nor receive help during this exam.

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