104ex2

Physics 104 Exam 2 March 27, 2003

Name DIL ID #_____

Section #_____ TA Name_____

Fill in your name, student ID # (not your social security #), and section # (under ABC of special codes) on the Scantron sheet. Fill in the letters given for the first 5 questions on the Scantron sheet. These letters determine which version of the test you took, and it is very important to get this right. Make sure your exam has questions 6—25.

1. B

2. C

3. A

4. D

5. E

6. A proton moving with a speed of 3.0×10^5 m/s perpendicular to a uniform magnetic field of 0.20 T will follow which of the paths described below? ($q_p = 1.6 \times 10^{-19}$ C and $m_p = 1.67 \times 10^{-27}$ kg)

$\vec{v} \perp$ TO $\vec{B}$ $\Rightarrow$ CIRCULAR PATH

$r = mv/qB$

$r = \frac{1.67 \times 10^{-27} \times 3 \times 10^5}{1.6 \times 10^{-19} \times 0.20} = 1.6 \times 10^{-2}$ M

   a. a straight line path
   b. a circular path of 3.1 cm radius
   c. a circular path of 0.78 cm radius
   (d.) a circular path of 1.6 cm radius
   e. a circular path of 16 cm radius

7. Two parallel conductors each of 0.50 m length, separated by 5.0×10^{-3} m and carrying 3.0 A in opposite directions, will experience what type and magnitude of mutual force? (magnetic permeability in empty space $\mu_0 = 4\pi \times 10^{-7}$ T·m/A)

OPPOSITE DIRECTIONS $\Rightarrow$ REPULSIVE

$\frac{F}{\ell} = \frac{\mu_0 I_1 I_2}{2\pi d}$

$F = \frac{\mu_0 I_1 I_2}{2\pi d} \ell = \frac{4\pi \times 10^{-7} \times 3 \times 3}{2\pi \times 5 \times 10^{-3}} \times 0.5 = \frac{9}{5} \times 10^{-4}$

   a. attractive, 0.06×10^{-4} N
   (b.) repulsive, 1.8×10^{-4} N
   c. repulsive, 0.60×10^{-4} N
   d. attractive, 1.8×10^{-4} N
   e. repulsive, 3.6×10^{-4} N

8. A solenoid with 500 turns, 0.10 m long, carrying a current of 4.0 A and with a radius of 10^{-2} m will have what strength magnetic field at its center? (magnetic permeability in empty space $\mu_0 = 4\pi \times 10^{-7}$ T·m/A)

   a. 31×10^{-4} T
   b. 250×10^{-4} T
   c. 62×10^{-4} T
   d. 125×10^{-4} T
   e. 500×10^{-4} T

$B = \mu_0 n I = 4\pi \times 10^{-7} \times \left(\frac{500}{0.1}\right) \times 4.0$

$B = 2.51 \times 10^{-2}$ T

9. The magnetic field of the Earth is believed responsible for which of the following?

   a. deflection of both charged and uncharged cosmic rays
   b. ozone in the upper atmosphere
   c. deflection of charged cosmic rays
   d. solar flares
   e. gravity

10. If an electron is released at the equator and falls toward the Earth under the influence of gravity, the magnetic force on the electron will be toward the:

   a. north
   b. south
   c. east
   d. Earth
   e. west

v (DOWN) (THUMB)

B (NORTH) (FINGERS)

BY RIGHT HAND RULE FORCE IS ⊗ (WEST)

(OUT OF BACK OF HAND FOR − CHARGE)

11. The basic function of the electric generator is which of the following conversion processes?

   a. electrical energy to mechanical
   b. low voltage to high voltage
   c. mechanical energy to electrical
   d. alternating current to direct
   e. high voltage to low voltage

(YOU TURN IT TO GENERATE ELECTRICITY.)

12. A square coil, enclosing an area with sides 2.0 cm long, is wrapped with 250 turns of wire. A uniform magnetic field perpendicular to its plane is turned on and increases to 0.25 T during an interval of 1.0 s. What average voltage is induced in the coil?

a. 25 mV
b. 12 mV
c. 200 mV
d. 250 mV
e. 20 mV

$B_\perp$ TO PLANE OF LOOP SO $B = B_\perp$

$\Phi = B_\perp A$ AND $\Delta\Phi = (\Delta B_\perp) A$

$\frac{\Delta\Phi}{\Delta t} = \frac{\Delta B_\perp A}{\Delta t} = \frac{0.25\,(2\times10^{-2})^2}{1.0} = 1\times10^{-4}$

MULTIPLY BY $N = 250$ TO GET $\mathcal{E} = 250 \times 10^{-4} = 25$ mV

13. An airplane with a wingspan of 60.0 m flies parallel to the Earth's surface at a point where the downward component of the Earth's magnetic field is 0.400×10^{-4} T. If the induced potential between wingtips is 0.900 V, what is the plane's speed?

a. 250 m/s
b. 338 m/s
c. 417 m/s
d. 300 m/s
e. 375 m/s

$\mathcal{E} = B\ell v$ SO $v = \frac{\mathcal{E}}{B\ell}$

$v = \frac{0.900}{0.4\times10^{-4} \times 60.0} = 375$ m/s

14. A 12-V battery is connected in series with a switch, resistor and inductor. If the circuit's time constant is 2.0×10^{-4} s and the final steady current after the switch is closed becomes 1.0 A, what is the value of the inductance?

a. 1.2 mH
b. 9.6 mH
c. 48 mH
d. 2.4 mH
e. 4.8 mH

$R = \mathcal{E}/I_{FINAL} = 12/1.0\,A = 12\,\Omega$

$\tau = L/R = 2\times10^{-4} \Rightarrow L = \tau R$

$L = 2\times10^{-4} \times 12 = 24\times10^{-4} = 2.4$ mH

15. If a bar magnet is falling through a loop of wire, the induced current in the loop of wire sets up a field which exerts a force on the magnet. This force between the magnet and the loop will be attractive when:

a. the magnet enters the loop
b. the magnet is halfway through
c. never
d. always
e. the magnet is leaving the loop

THE FIELD CREATED BY THE INDUCED EMF IN THE LOOP WILL MAKE AN INDUCED FIELD THAT OPPOSES THE CHANGE IN THE FIELD FROM THE FALLING BAR.

THIS WILL BE OPPOSITE THE BAR'S FIELD WHEN THE BAR IS ENTERING THE LOOP AND THE SAME AS THE BAR'S FIELD WHEN IT IS LEAVING, AND THE FORCE IS ATTRACTIVE WHEN THE FIELD IS THE SAME.

16. An AC series circuit has 12 Ω resistance, 15 Ω inductive reactance and 10 Ω capacitive reactance. If an effective (rms) voltage of 120 V is applied, what is the effective (rms) current value?

$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{12^2 + (15-10)^2} = 13\,\Omega$

$I_{rms} = V_{rms}/Z = 120/13 = 9.23\ A$

a. 5.31 A
b. 10.8 A
c. 26.0 A
d. 9.23 A
e. 18.5 A

17. Resonance occurs in an AC series circuit when which of the following conditions is met?

a. capacitive reactance equals inductive reactance
b. resistance equals capacitive reactance
c. resistance equals inductive reactance
d. capacitive reactance equals zero
e. inductive reactance equals zero

18. A 200-Ω resistor is connected in series with a 10-μF capacitor and a 60-Hz, 120-V (rms) line voltage. If electrical energy costs 5.0¢ per kWh, how much does it cost to leave this circuit connected for 24 hours?

$X_C = \frac{1}{2\pi fC} = \frac{1}{2\pi \times 60 \times 10\times10^{-6}} = 265\,\Omega$

$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{200^2 + 265^2} = 332\,\Omega$

$I = V/Z = 120/332 = 0.361\ A$; ONLY THE RESISTOR DISSIPATES POWER: $P = I^2R = 26.1$ WATTS

$26.1\ W \times 24\ h = 626$ WATT-HOURS $= 0.626$ kWH $\quad 5¢ \times 0.626 = 3.13¢$

a. 62¢
b. 31¢
c. 5.2¢
d. 8.6¢
e. 3.1¢

19. Which condition of motion must be met with regard to a charged particle if it is in the process of emitting electromagnetic waves?

a. moves at constant velocity } NO
b. moves at the speed of light }
c. oscillates periodically } BOTH OF THESE WILL EMIT BUT THIS KIND OF MOTION IS NOT REQUIRED, ACCELERATION IS WHAT IS REQUIRED, AND ANY ACCELERATED MOTION WILL CAUSE EMISSION.
d. moves in a circle }
e. accelerates

20. A radio wave transmits 1.2 W/m^2 average power per unit area. What is the peak value of the associated magnetic field? ($\mu_0 = 4\pi \times 10^{-7}$ T·m/A and $c = 3.00 \times 10^8$ m/s)

a. 8.4×10^{-3} T
b. 1.0×10^{-7} T
c. 1.2 T
d. 30 T
e. 7.1×10^{-8} T

$\frac{\langle P \rangle}{AREA} = \frac{c B_{MAX}^2}{2\mu_0}$ (PAGE 671 IN TEXT)

$1.2 = \frac{c B_{MAX}^2}{2\mu_0}$ $\quad B_{MAX} = \sqrt{\frac{2\mu_0 \times 1.2}{c}}$

$B_{MAX} = \sqrt{\frac{2 \times 4\pi \times 10^{-7} \times 1.2}{3 \times 10^8}} = 1 \times 10^{-7}$ T

21. A container of flint glass ($n = 1.66$) holds a small quantity of benzene ($n = 1.501$). What is the critical angle for internal reflection of a ray in the glass when it is incident on the glass-to-liquid surface?

a. 89.5°
b. 41.1°
c. 37.0°
d. 64.7°
e. 0°

$\sin\theta_c = \frac{n_1}{n_2}$ WITH $n_2 > n_1$

$\sin\theta_c = \frac{1.501}{1.66}$ $\quad \theta_c = 64.7°$

22. A monochromatic beam of light in air has a wavelength of 589 nm in air. It passes through glass ($n = 1.52$) and then through carbon disulfide ($n = 1.63$). What is its wavelength in the carbon disulfide?

a. 387.5 nm
b. 895 nm
c. 960 nm
d. 589 nm
e. 361 nm

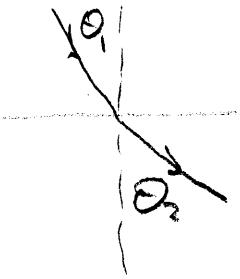
$f\lambda = c$ OR IN A MEDIUM $f\lambda_{MED} = c/n_{MED}$

f DOES NOT CHANGE SO

$\frac{f\lambda_{MED}}{f\lambda} = \frac{c/n_{MED}}{c} = \frac{1}{n_{MED}}$ $\quad \lambda_{CS_2} = \frac{\lambda}{n_{CS_2}} = \frac{589}{1.63}$

23. A ray of light passing through a liquid is incident on a liquid-to-glass interface at an angle of 35°. Indices of refraction for the liquid and glass are, respectively, 1.63 and 1.52. What is the angle of refraction for the ray moving through the glass?

a. 23°
b. 30°
c. 46°
d. 35°
e. 38°



$n_1 = 1.63$

$n_2 = 1.52$

$\theta_1 = 35°$ $\quad 1.63 \sin 35° = 1.52 \sin\theta_2$

$\theta_2 = \sin^{-1}\left\{\frac{1.63 \sin 35°}{1.52}\right\} = 38°$

24. Dispersion occurs when:

a. some materials bend light more than other materials.
b. a material changes some frequencies more than others.
c. light has different speeds in different materials.
d. a material slows down some wavelengths more than others.
e. light is scattered in all different directions.

DISPERSION IS SOMETHING THAT HAPPENS WHEN DIFFERENT WAVELENGTHS PASS THRU THE SAME STUFF.

25. Helium-neon laser light has a wavelength in air of 632.8 nm. What is the energy of a single photon in the beam? ($h = 6.626 \times 10^{-34}$ J·s and $c = 3.00 \times 10^{8}$ m/s).

a. 5.40×10^{-19} J
b. 3.14×10^{-19} J
c. 7.62×10^{-19} J
d. 1.15×10^{-18} J
e. 6.28×10^{-19} J

$E = hf \quad f\lambda = C \quad$ SO $f = C/\lambda$

$$E = \frac{hc}{\lambda} = \frac{6.626 \times 10^{-34} \times 3 \times 10^{8}}{632.8 \times 10^{-9}}$$