KEY

PHYSICS 241 FINAL EXAM Wednesday, May 7, 2003

This 23-question test is worth 150 points (most questions are worth approximately 6.82 points; there are a few half-credit questions.)

Please fill out the answer sheet with soft lead pencil. Be sure to give your name, student ID #, date, Course #, Test 3, and ****SIGN**** the answer sheet. Be prepared to present your Student picture ID card when handing in your answer sheet. You may keep the sheets with the questions and your work.

Pick the nearest value for your answer (there may be slight round-off errors). If your answer is significantly different from all possible answers, you have made some mistake.

Don't get hung up too long over any one question until you have tried all of them.

You are expected to bring your own sheet of equations and words explaining the equations. Here are a few possibly useful constants.

ϵ_o = = 8.85×10^{-12} $C^2/(Nm^2)$ or F/m

$k = 8.99 \times 10^9$ $Nm^2/C^2 = 1/4\pi\epsilon_o$

$\mu_o = 4\pi \times 10^{-7}$ Tm/A = 1.257×10^{-6} Tm/A

$e = 1.60 \times 10^{-19}$ C = $-q_{electron} = q_{proton}$

$c = 3.00 \times 10^8$ m/s

$g = 9.8$ m/ s^2

$G = 6.67 \times 10^{-11}$ Nm^2/kg^2

weight = mg

Phys 241 KEY

1.) How wide does the back face of a plastic cube (edge length = 77 cm, index of refraction = 1.39) look when viewed through the front face? [Treat the back face as if it were a square wire frame embedded in the plastic, and first find the location of its virtual image in the plastic as seen from the air, through the flat (zero-curvature, infinite radius of curvature) interface. Use the lens-like formula for an interface between two different media.]

a) 25.8 cm
b) 38.3 cm
c) 55.4 cm
d) 69.7 cm
e) 82.8 cm

2.) At what viewing angle through the front face of this cube(relative to normal incidence) is it no longer possible to see any of the back face of the cube?

a) 54.5^{o}
b) 60.0^{o}
c) 69.7^{o}
d) 79.4^{o}
e) 85.6^{o}

3.) A 10 metric ton (10^4 kg) space ship with a perfectly reflecting mirror is pushed by a laser beam from the Earth, with an acceleration of 0.3% of g (the Earth's surface gravity). What is the power of this laser beam? [Note: Intensity x A=Power]

a) 34.8 MW
b) 49.7 TW
c) 23.4 GW
d) 44.1 GW
e) 97.2 GW

4.)If the diameter of the mirror in the above example is 100 m, the diameter of the laser beam as it exits the laser is 1.8 m, and the radiation has wavelength 510 nm, how far from Earth can the space ship be and not have any of the central diffraction maximum spill off of the mirror? [Hint, match the first dark diffraction ring (the first zero of the Bessel function describing this diffraction pattern) to the RADIUS of the mirror.]

a) 97.5×10^6 km
b) 122×10^5 km
c) 3.78×10^5 km
d) 6.22×10^7 km
e) 1.45×10^5 km

5.) Light of wavelength 660 nm in air makes a bright reflection (at normal incidence) from a soap film which is ¼ of a wavelength thick (including the effect of the film's index of refraction on the wavelength.) What is a wavelength (in air) of EM radiation that will make zero (dark) normal-incidence reflection from this film?

a) 440 nm
b) 990 nm
c) 660 nm
d) 330 nm
e) 825 nm

6.) An LC circuit (negligible resistance) oscillates with a frequency f = 750 Hz. If C = 22 mF, what is the value of the inductance L in microHenrys?

a) 450
b) 0.00222
c) 2.05
d) 0.0228
e) 56.2

7.) In the above problem, if the total energy stored in the capacitor and inductor is 0.00010 J, what is the maximum charge, Q_{max}, that is stored in the capacitor?

a) 2.10 mC
b) 1.62 mC
c) 1.33 mC
d) 5.80 mC
e) 12.6 mC

8.) A slit of width 130 μm passes a plane wave of Infra Red radiation of wavelength 1020 nm to a screen which is 3.14 m away. What is the FULL width of the forward "bright" central maximum intensity stripe on the screen?

a) 1.64 cm
b) 3.28 cm
c) 4.93 cm
d) 6.88 cm
e) 17.5 cm

9.) In the above example, a second slit is added, its center is 1 mm from the center of the first slit. How "bright" is the 5^{th} bright fringe away from straight ahead, as a multiple of the peak Intensity of the forward, brightest, central maximum fringe? [Hint: you really want to set your calculator to radians for this one!]

a) 1.13
b) .980
c) .650
d) .190
e) .022

10.) A real image is formed by a converging lens. It is three times higher than the object (and inverted, of course). Object and image are 1.00 m apart. What is the focal length of the lens?.

a) 25 cm
b) 75 cm
c) 100 cm
d) 18.8 cm
e) 0.053 cm

11.) Compute the approximate inductance of a uniformly-wound toroid (with 2350 turns of wire) with a major radius of 1 m and a cross-sectional area of 1 cm^2 within the coil. [Think of the coil as wound around an oversized but extremely skinny bicycle tire on a wheel with spokes almost 1 m long and the cross sectional area of the inner tube is less than 1 cm^2]. Assume that B is approximately constant everywhere inside the coil, and evaluate it at the center of the coil, i.e. at r = 1.00 m.

a) 110 μH
b) 89 μH
c) 0.36 μH
d) 1.12 μH
e) 2.85 μH

12.) A conducting circular loop has a radius which is contracting at a rate of 1 cm/s, It lies in a magnetic field of 4.8 T, with its area normal parallel to the field. The resistance of this loop is 17 Ohms. What current, in Amperes, flows in this loop at the instant that its radius is 90 cm? [Hint: be careful to work in meters. Also, what's the time derivative of πr^2 ?]

a) 0
b) 1.8 mA
c) 3.6 mA
d) 6.4 mA
e) 16 mA

13.) [half-credit] You look at the above circular loop against the direction of the magnetic field, i.e. the field points at your eyeball. The induced current (if any) circulates:

a) clockwise
b) zero
c) counterclockwise
d) none of the above

14.) Two infinitely long parallel wires, one carrying 117 A and the other carrying 432 A in the opposite direction, are 7 cm apart. For a section along the wires of length 75 cm, what is the force between that portion of the two wires, in Newtons?

a) 0.72
b) 0.55
c) 0.11
d) 108
e) 680

15.) [half credit] The force between these two wires is:

a) perpendicular to the plane defined by the two wires
b) along the direction of the current in the first wire
c) along the direction of the current in the second wire
d) attractive between the two wires
e) repulsive between the two wires

16.) Charges $Q_1 = +10$nC and $Q_2 = +30$nC are placed on the x axis at $x = 0$ and $x = 60$ cm, respectively. The electric field vector is zero at $y = 0$ and $x = ?$ (in cm). [Hint, check your answer carefully by plugging in the distances to the two charges and seeing that the two fields cancel. Be particularly careful even in your checking -- there are some easy-to-get wrong answers below!!]

a) 38
b) 22
c) –82
d) 142
e) -142

17.) Given an electric field: $E_x = ax + by$
$E_y = bx + ay$
$E_z = 3abxy$

What is the change in electric potential in going from the origin to a point (x, y, z) = (10 m, 0, 0)?

a) $5(a + b)$
b) $50b + 62.5a$
c) $50a^2 - 12.5\ b^2$
d) $-50a$
e) $-50b$

18.) The flux of the uniform electric field E = (17 , 43 , 61)N/C through a rectangular portion of the xz plane with corners at (3m, 0, 5m) and (9m, 0, 7.2m) is:

a) 266 N m^2/C
b) 325 N m^2/C
c) 920 N m^2/C
d) 1173 N m^2/C
e) 568 N m^2/C

19.)Two charges of 4 μC each are placed on diagonally opposite corners of a 20 cm x 20 cm square, and a –3 μC charge is placed on a third corner. What is the magnitude of their NET force on a charge of –5 μC placed at the fourth corner of the square?

a) 2.99 N
b) 4.68 N
c) 6.66 N
d) 1.27 N
e) 8.56 N

20.)What is the electric potential at the fourth corner of the square, if the –5 μC charge is removed to infinity?

a) 553 V
b) 264 kV
c) 179 MV
d) 93 GV
e) 1.32 mV

21.) What is the total potential energy of the three assembled charges in the previous problem?

a) –1.08 J
b) 0.509 J
c) –0.570 J
d) 509 J
e) –1.08 kJ

22.) A matching pair of circular metal sheets of radius 1.3 m are separated in air (face to face) by 0.05 mm and charged to 17 mC. What is the voltage difference between the two plates?

a) 0.940 μV
b) 17.0 mV
c) 901 V
d) 18.1 kV
e) 256 kV

23.) What is the electric field between these two plates?

a.) 362 MV/m
b.) 18.1 MV/m
c.) 256 kV/m
d.) 0.905 V/m
e.) 16.1 V/m

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SEE IMPORTANT MARKING INSTRUCTIONS ON SIDE 2

LAST NAME	FIRST NAME	MI
KEY		

PURDUE UNIVERSITY CIS-11

[redacted]

COMPLETE ALL INFORMATION AS DIRECTED

SECTION NUMBER	TEST/QUIZ NUMBER	STUDENT IDENTIFICATION NUMBER
	03	[redacted]

SIGNATURE ______________________

USE A #2 PENCIL ONLY

Question	Marked answer
1	C
2	D
3	D
4	E
5	D
6	C
7	A (T)
8	C
9	D
10	D
11	A (T)
12	E
13	C
14	C
15	E
16	B (F)
17	D
18	E
19	B (F)
20	B (F)
21	C
22	D
23	A (T)
24	
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26	
27	
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30	

INSTRUCTOR V. Barnes

COURSE Phys 241

DATE 7 May 2023

SIDE 2

IMPORTANT DIRECTIONS FOR MARKING ANSWERS

- Use black lead pencil only (#2 or softer).

1 T F WRONG

2 T F WRONG

T F WRONG