Made available online by Prof. M. Jones 11-Dec-2015

219 Final Spr. 2015

Name_____ PUID (10 digits)_____

Calculator Used:_____Model No.: _____

PHYSICS 219
Exam III
TIME LIMIT: 120 minutes
May 8, 2015

Use the following values for constants in this test; other values may give results in slight disagreement with listed answers.

charge on electron = -1.602×10^{-19} C

charge on proton = $+1.602 \times 10^{-19}$ C

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

$\varepsilon_o = 8.85 \times 10^{-12}$ $C^2/(N \cdot m^2)$

$\mu_o = 4\pi \times 10^{-7}$ N/A^2

1 u $\equiv 1.660 \times 10^{-27}$ kg = 931.5 MeV/c^2

mass of electron = 9.11×10^{-31} kg = 0.000549 u

mass of proton = 1.673×10^{-27} kg = 1.00728 u

mass of neutron = 1.675×10^{-27} kg = 1.00867 u

mass of $^{1}_{1}H = 1.007825$ u

1 Ci= 3.7×10^{10} Bq

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

$h = 6.626 \times 10^{-34}$ J•s

$R_H = 1.097 \times 10^{7}$ m^{-1}

$a_o = 0.529 \times 10^{-10}$ m

$\pi = 3.14 \ldots$

Any use of cell phones and pagers during the exam is forbidden. No headphones are allowed. Check these items at the front of the room ***before*** *the exam begins.*

For questions that require a numerical answer, please show all your work in the space provided after each test question. Numerical answers without documented work may result in a reduction of your overall test score.

This test has 20 questions. Each correct answer is worth 5.00 points. All questions have equal weight. There will be no partial credit assigned. You should have a **ORANGE** Op-scan sheet with this exam.

Use soft pencils to fill in answer sheets. Be sure to enter name and ID number both in writing and in dot code on the answer sheet. The answer on the op-scan sheet is your ``official'' answer.

Cheating on this exam, no matter how minor, will lead to an immediate F in the course and possible dismissal from the University.

1. A concave spherical mirror produces an image that is 3 times as tall as the object. If the object is 25 cm in front of the mirror, where is the image?

a) 75 cm in front of the mirror
b) 75 cm behind the mirror
c) 25 cm in front of the mirror
d) 25 cm in behind the mirror
e) none of the above

2. Electromagnetic radiation of intensity 1200 W/m^2 is emitted by a monochromatic lamp designed to emulate solar radiation at a wavelength of 530 nm. What is the **amplitude** of the magnetic field in the electromagnetic wave emitted by this lamp?

a) 2.3×10^{-6} T
b) 951 T
c) 1.0×10^{-11} T
d) 3.2×10^{-6} T
e) none of the above

3. A possible fusion reaction can be written as

$$ {}_{1}^{2}H + {}_{2}^{3}He \rightarrow {}_{2}^{4}He + {}_{1}^{1}H + energy $$

Which choice listed below is closest to the energy released in this reaction? Use the known nuclear masses listed in the table provided.

Nucleus	Mass
${}_{1}^{2}H$	2.014102 u
${}_{1}^{1}H$	1.007825 u
${}_{2}^{4}He$	4.002603 u
${}_{2}^{3}He$	3.016029 u

a) 19.6 MeV
b) 12.0 MeV
c) 18.4 MeV
d) 4.3 MeV
e) none of the above

4. Light with a frequency of 1.5×10^{15} Hz strikes a metal surface. The maximum kinetic energy of the photoelectrons is measured to be 1.0 eV. What is the work function of the metal?

a) 1.8 eV
b) 3.7 eV
c) 5.2 eV
d) 6.2 eV
e) none of the above

5. If you have 10 grams of a radioactive material with a half-life of 21 days, how much will remain after 100 days?

a) 0.37 grams
b) 4.76 grams
c) 0.095 grams
d) 0.037 grams
e) none of the above

6. An applied magnetic field will **not** influence the trajectory of which of the nuclear decay products listed below?

a) proton
b) gamma ray
c) beta particle
d) alpha particle
e) electron

7. In the following nuclear reaction

$$ {}_{0}^{1}n + {}_{92}^{235}U \rightarrow {}_{54}^{139}Xe + Z + {}_{0}^{1}n + {}_{0}^{1}n $$

the nuclear decay product Z must have

a) 38 neutrons, 95 protons
b) 38 protons, 57 neutrons
c) 38 protons, 38 neutrons
d) 57 proton, 38 neutrons
e) none of the above

8. If a laser beam emits a 10 mJ pulse of radiation at a wavelength of 565 nm. How many photons are emitted in the laser pulse?

a) 5.65×10^{16}
b) 3.00×10^{8}
c) 4.84×10^{15}
d) 2.85×10^{16}
e) none of the above

9. As the mass of a nucleus increases beyond mass number 58, generally speaking,
   a) the diameter of the nucleus becomes smaller
   b) the number of neutrons tends to be more than the number of protons
   c) the nucleus becomes more stable
   d) the number of neutrons tends to be less than the number of protons
   e) none of the above are true

10. A golf ball with a 4.0 cm diameter is placed a distance of 20.0 cm from a convex lens having a focal length of 16.0 cm. The image of the golf ball will be

a) virtual, upright and 8.9 cm from the lens on the opposite side of the lens as the object
b) real, inverted and 80 cm from the lens on the opposite side of the lens as the object
c) real, upright and 4.0 cm from the lens on the same side of the lens as the object
d) virtual, upright and 20.0 cm from the lens on the opposite side of the lens as the object
e) none of the above

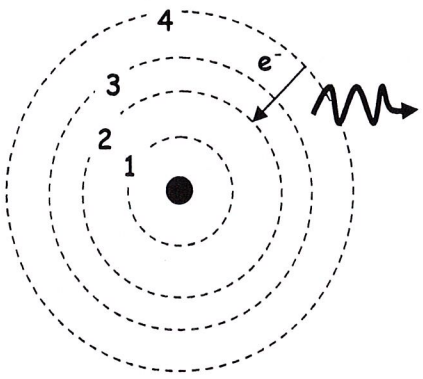
11. What is the energy in eV of electromagnetic radiation with a wavelength of 580 nm?

a) 2.14 eV
b) 3.21 eV
c) 5.82 eV
d) 12.34 eV
e) none of the above

12. What is the number of protons, electrons and neutrons in the neutral gold atom ${}^{197}_{79}Au$?

a) there are 118 protons, 118 electrons and 79 neutrons
b) there are 79 protons, 79 electrons and 197 neutrons
c) there are 79 protons, 79 electrons and 79 neutrons
d) there are 79 protons, 79 electrons and 118 neutrons
e) none of the above

13. The first few Bohr electron orbits for a H atom are sketched in the diagram to the right (not to scale). What is the wavelength of the photon emitted when an electron makes the transition from the 4^{th} to the 2^{nd} orbit as indicated schematically in this diagram?



a) 410 nm
b) 434 nm
c) 487 nm
d) 656 nm
e) none of the above

14. A diffraction grating has thin slits separated by 3.6 μm. The grating is illuminated by monochromatic light with a wavelength of 546 nm. At what angle will the third-order maximum appear on a viewing screen?

a) 27^o
b) 15^o
c) 10^o
d) 3^o
e) none of the above

15. If an electron has a velocity of 1×10^6 m/s, the de Broglie wavelength of this electron will be

a) 2.87×10^{-11} m
b) 7.27×10^{-10} m
c) 1.67×10^{-12} m
d) 2.53×10^{6} m
e) particles cannot have a wavelength

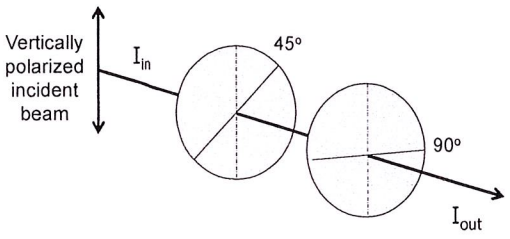
16. When light goes from air into water, what remains constant?

a) wavelength
b) speed
c) index of refraction
d) frequency
e) all of the above

17. What would be a reasonable estimate for the diameter of the $^{64}_{29}\mathrm{Cu}$ nucleus?

a) 1.2 fm
b) 3.7 fm
c) 4.8 fm
d) 5.4 fm
e) None of the above

18. Two polarizers are oriented at 45° and 90° with respect to a polarized incident beam of light as shown in the diagram. If the input intensity of the radiation is I_{in}=50 W/m^2, what is I_{out}?



a) 0 W/m^2, no light is transmitted
b) 12.5 W/m^2
c) 25 W/m^2
d) 50 W/m^2
e) none of the above

19. When an object is placed 37 cm to the left of a converging lens, the image is formed 15 cm to the right of the lens. What is the focal length of the lens?

a) 37 cm
b) 10.7 cm
c) 15 cm
d) -25.2 cm
e) none of the above

20. A chemical element has a nuclear isotope with 47 protons and 62 neutrons. Which of the following is a valid notation for the nucleus of this isotope?

a) ${}^{62}_{47}Ag$

b) ${}^{109}_{47}Ag$

c) ${}^{109}_{62}Sm$

d) ${}^{47}_{62}Sm$

e) none of the above answers match the conditions stated

END OF TEST!
THIS TEST HAS 20 QUESTIONS

When turning in your exam,
make sure your opscan answer sheet is
NOT
inserted into (or between) the test questions!

Equation Sheet
TEST III

$$n = \frac{c}{v} \qquad n_i \sin(\Theta_i) = n_r \sin(\Theta_r) \qquad \sin\Theta_c = \frac{n_2}{n_1} \quad (n_1 > n_2)$$

$$I = R + T + A \qquad \Theta_i = \Theta_r \qquad f = \pm\frac{R}{2} \qquad \frac{1}{f} = \frac{1}{s_i} + \frac{1}{s_o} \qquad m = \frac{h_i}{h_o} = -\frac{s_i}{s_o}$$

$$\text{phase} = 2\pi\frac{x}{\lambda} \qquad d\sin\Theta = m\lambda \qquad d\frac{y}{W} = m\lambda \qquad d\sin\Theta = \left(m + \frac{1}{2}\right)\lambda \qquad d\frac{y}{W} = \left(m + \frac{1}{2}\right)\lambda$$

$$2t = \frac{m}{2}\lambda_{film} = \frac{m}{2}\frac{\lambda_{air}}{n}; \quad m = 1,3,5,\ldots \qquad 2t = m\lambda_{film} = \frac{m\lambda_{air}}{n}; \quad m = 1,2,3\ldots \qquad \sin\Theta = \frac{m\lambda}{d}$$

$$c = f\lambda \qquad c = \frac{1}{\sqrt{\varepsilon_o \mu_o}} \qquad c = \frac{E}{B} \qquad |S| = \frac{EB}{\mu_o}$$

$$I = S_{avg} = \frac{E_{max}^2}{2\mu_o c} = \frac{E_{rms}^2}{\mu_o c} \qquad E_{rms} = \frac{E_{max}}{\sqrt{2}} \qquad I = \frac{P}{4\pi r^2}$$

$$u_{tot} = \frac{I}{c} = \frac{\varepsilon_o E_{max}^2}{2} = \frac{B_{max}^2}{2\mu_o} \qquad U = pc \qquad P_{radiation} = \frac{I}{c} \qquad I_{out} = I_{in}\cos^2\theta$$

$$E_y(x,t) = E_o \cos\left(2\pi\left(\frac{t}{T} \pm \frac{x}{\lambda}\right)\right) \qquad B_z(x,t) = B_o \cos\left(2\pi\left(\frac{t}{T} \pm \frac{x}{\lambda}\right)\right)$$

$$\frac{1}{\lambda} = R_H\left[\frac{1}{2^2} - \frac{1}{n^2}\right] \qquad \lambda = \frac{h}{p} \qquad \Delta x \Delta p_x \geq \frac{h}{4\pi}$$

$$E = hf \qquad E = pc \qquad E = KE_{max} + \varphi$$

$$E = -\frac{13.6\ eV}{n^2} \qquad r_n = n^2 a_o \qquad \Delta E = E_i - E_f$$

$$R = \left(1.2 \times 10^{-15}\right) A^{1/3} \qquad \Delta E = mc^2$$

$$N(t) = N_o\left[\frac{1}{2}\right]^{t/\tau_{1/2}} \qquad \lambda = \frac{0.693}{\tau_{1/2}} \qquad R = R_o e^{-\lambda t}$$