Physics 201-031
Final Exam

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A. MULTIPLE CHOICES

1.A The quantization of energy, $E = nhf$, is not important for an ordinary pendulum because:
A) the formula applies only to mass-spring oscillators
B) the allowed energy levels are too closely spaced
C) the allowed energy levels are too widely spaced
D) the formula applies only to atoms
E) the value of h for a pendulum is too large

2.A In a photoelectric effect experiment the stopping potential is:
A) the energy required to remove an electron from the sample
B) the kinetic energy of the most energetic electron ejected
C) the potential energy of the most energetic electron ejected
D) the photon energy
E) the electric potential that causes the electron current to vanish

3.A In Compton scattering from stationary particles the maximum change in wavelength can be made smaller by using:
A) higher frequency radiation
B) lower frequency radiation
C) more massive particles
D) less massive particles
E) particles with greater charge

4.A Consider the following:
I. A photoelectric process in which some emitted electrons have kinetic energy greater than hf, where f is the frequency of the incident light.
II. A photoelectric process in which all emitted electrons have energy less than hf.
III. Compton scattering from stationary electrons for which the emitted light has a frequency that is greater than that of the incident light.
IV. Compton scattering from stationary electrons for which the emitted light has a frequency that is less than that of the incident light.

The only possible processes are:
A) I
B) III
C) I and III
D) I and IV
E) II and IV

5.A The probability that a particle is in a given small region of space is proportional to:
A) its energy
B) its momentum
C) the frequency of its wave function
D) the wavelength of its wave function
E) the square of the magnitude of its wave function

6.A Of the following which has the smallest rest energy?
A) A neutron
B) An electron
C) An ion
D) A proton
E) An atom

7.A The binding energy of a nucleus is the energy that must be supplied to:
A) remove a nucleon
B) remove an alpha particle
C) remove a beta particle
D) separate the nucleus into its constituent nucleons
E) separate the nucleus into a collection of alpha particles

8.A The greatest binding energy per nucleon occurs for nuclides with masses near that of:
A) helium
B) sodium
C) iron
D) mercury
E) uranium

9.A The energies of electrons emitted in β^- decays have a continuous spectrum because:
A) the original neutron has a continuous spectrum
B) the neutrino can carry off any energy up to a certain maximum
C) free electrons always have a continuous spectrum
D) more than one electron is emitted in each decay
E) the daughter nucleus may have any energy

10.A Bombardment of ^{28}Si (Z = 14) with alpha particles may produce:
A) a proton and ^{31}P (Z = 15)
B) hydrogen and ^{32}S (Z = 16)
C) a deuteron and ^{27}Al (Z = 13)
D) helium and ^{31}P (Z = 15)
E) ^{35}Cl (Z = 17)

11.A Consider the following energies:

1. minimum energy needed to excite a hydrogen atom
2. energy needed to ionize a hydrogen atom
3. energy released in ^{235}U fission
4. energy needed to remove a neutron from a ^{12}C nucleus

Rank them in order of increasing value.

A) 1, 2, 3, 4
B) 1, 3, 2, 4
C) 1, 2, 4, 3
D) 2, 1, 4, 3
E) 2, 4, 1, 3

12.A An explosion does not result from a small piece of ^{235}U because:

A) it does not fission
B) the neutrons released move too fast
C) ^{238}U is required
D) too many neutrons escape, preventing a chain reaction from starting
E) a few neutrons must be injected to start the chain reaction

13.A In the uranium disintegration series:

A) the emission of a β^- particle increases the mass number A by one and decreases the atomic number Z by one
B) the disintegrating element merely ejects atomic electrons
C) the emission of an α particle decreases the mass number A by four and decreases the atomic number Z by two
D) the nucleus always remains unaffected
E) the series of disintegrations continues until an element having eight outermost orbital electrons is obtained

14.A High temperatures are required in thermonuclear fusion so that:

A) some nuclei are moving fast enough to overcome the barrier to fusion
B) there is a high probability some nuclei will strike each other head on
C) electrons are boiled off from the atoms
D) fused nuclei are in high energy states
E) the Pauli exclusion principle does not prohibit fusion

15.A For a controlled nuclear fusion reaction, one needs:

A) high number density n and high temperature T
B) high number density n and low temperature T
C) low number density n and high temperature T
D) low number density n and low temperature T
E) high number density n and temperature $T = 0$ K

16.A The figure shows an emf ξ_L induced in a coil. Which of the following can describe the current through the coil (there could be more than one correct answer):

a) Constant right ward
b) Constant leftward
c) Increasing rightward
d) Decreasing right ward
e) Increasing and leftward
f) Decreasing and leftward

B. EXPLANATIONS

1.B The table lists the number of turn per unit length, current, and cross-sectional area for three solenoids. Rank the solenoids according to the magnetic energy density within them, greatest first. Explain.

Solenoid	Turns per Unit Length	Current	Area
a	$2n_1$	i_1	$2A_1$
b	n_1	$2i_1$	A_1
c	n_1	i_1	$6A_1$

2.B Light of uniform intensity shines perpendicularly on a totally absorbing surface, fully illuminating the surface. If the area of the surface is decreased, do.

a) the radiation pressure and
b) the radiation force on the surface increase, decrease or stay the same
Explain.

3.B A thin lens provides an image of a fingerprint with a magnification of +0.2 when the fingerprint is at a distance 1.0 cm less than the focal point of the lens. What are the types and orientation of the image, and what is the type of the lens? Explain

4.B The light waves of the rays in Fig. Have the same wavelength and amplitude and are initially in phase. If 7.6 wavelengths fit within the length of the top material and 5.50 wavelength fit within that of the bottom material, which material has the greater index of refraction? Explain.

5.B The kinetic energy and the total energy of 1 G eV electron more than, less than or equal to those of a 1 G eV proton ? Explain.

C. PROBLEM SOLVING

1.C The work function for a certain sample is 2.3 eV. The stopping potential for electrons ejected from the sample by 7.0×10^{14}-Hz electromagnetic radiation is:

2.C The half-life of radium is about 1600 years. If a rock initially contains 1 g of radium, the amount left after 8000 years will be about:

3.C A capacitor in an LC oscillator has a maximum potential difference of 17 V and a maximum energy of 160 μ J. When the capacitor has a potential difference of 5 V and an energy of 10 μ J, what are

a) The emf across the inductor
b) The energy stored in the magnetic filed

4.C What is the de Broglie wavelength of an electron with a kinetic energy of 120 eV?

5.C An electron and a proton can have the same (a) kinetic energy, (b) momentum, or (c) speed. In each case which particle has the shorter de Broglie wavelength?

6.C Assume that an electron is moving along an x axis and that you measure its speed to be 2.05×10^6 m/s, which can be known with a precision of 0.50 %. What is the minimum uncertainty (as allowed by the uncertainty principle in quantum theory) with which you can simultaneously measure the position of the electron along the x axis?

7.C Find the critical angle for a water-air boundary if the index of refraction of water is 1.33

8.C Find the disintegration energy Q for the fission event of Eq.1 Some needed atomic and particle masses are

$$^{235}U + n \rightarrow .....^{140}Ce + {}^{94}Zr + 2n \qquad (1)$$

^{235}U	235.0439 u	^{140}Ce	139.9054 u
n	1.008 67 u	^{94}Zr	93.9063 u

9.C A diffraction grating 20.0mm wide has 6000 rulings. (a) calculate the distance d between adjacent rulings (b) at what angles θ (the three smallest) will intensity maxima occur or a viewing screen if the radiation on the grating has a wavelength of 589 nm ?