Final Examination
Time: 2 hours

Name: _____ Physics 222 (TAMU)

UIN: _____ Spring 2019

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1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	Total

1. (4 pts) A rocket ship blasts off to go from New York to Los Angeles, a distance of about 5000 km. How fast must the rocket ship go to have its length shortened by 1%?

a. v = 2.1c
b. v = .05c
c. v = 0.21c
d. v = 0.14c
e. v = 0.09c

2. (4 pts) The kinetic energy of a proton is 2/3 of its rest energy. What is the speed of the proton as a fraction of c?

a. 0.5
b. O.6
c. 0.7
d. 0.8
e. 0.9

3. (4 pts) Consider the photoelectric effect when one increases only the frequency of the incoming light onto the emitter, one measures

a. An increased current
b. A decrease in the necessary stopping voltage
c. No change in either current or stopping voltage
d. An increase in the necessary stopping voltage
e. Either a or c. You cannot determine which from the information given.

4. (4 pts) The de Broglie wavelength of which of the following objects would be the largest if the objects had the same velocity?

a. Electron
b. Proton
c. Tennis ball
d. Hydrogen atom
e. All the same wavelength

5. (4 pts) Which of the following is an important difference between the infinite square-well potential and the finite square-well potential?

a. Particles can exist in classically forbidden regions outside the finite square-well potential.
b. The number of energy levels is limited in the infinite square-well potential, but not limited to the finite square-well potential.
c. The infinite square-well potential utilizes Schrödinger's equation to describe particle motion while the finite square-well potential does not.
d. The energy levels are quantized only in the finite square-well potential.
e. Only the energy levels in the finite square-well potential depend on Planck's constant.

6. (4 pts) Consider the Franck-Hertz experiment and select the correct statement.

a. The electron makes an inelastic collision and excites the Hg atom to the first excited state.
b. The collector current versus stopping voltage has maxima for each energy value of the Hg atom.
c. An electron energy of 4.88 eV is needed before the electron can gain its energy in an elastic collision with the Hg atom.
d. The collector current versus stopping voltage has minima for each energy value of the Hg atom.

7. (4 pts) Which of the following states of the hydrogen atom is allowed?

a. $n = 3, l = 3, m_l = 0$
b. $n = 2, l = 2, m_l = 0$
c. $n = 5, l = 2, m_l = 3$
d. $n = 4, l = 2, m_l = 1$

8. What atom has the electron configuration $1s^2\ 2s^2\ 2p^6$
(4 pts)

a. fluorine
b. magnesium
c. calcium
d. sodium
e. neon

9. Which is the correct electron configuration of $^{40}_{20}Ca$, which has 20 protons and 20
(4 pts) neutrons in its nucleus

a. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s$
b. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$
c. $1s^2\ 2s^2\ 2p^4\ 3s^2\ 3p^4\ 4s^2$
d. $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4\ 4s$
e. $1s^2 2s^2 2p^6 3s^2 3p^6 3d$

10. Choose the proper isotopic symbol for an isotope of lithium with three neutrons.
(4 pts)

a. $^{5}_{3}Li$

b. $^{6}_{3}Li$

c. $^{7}_{3}Li$

d. $^{8}_{3}Li$

e. $^{9}_{3}Li$

11. Choose the proper nuclear radius of ^{238}U.
(4 pts)

a. $5.1 \times 10^{-14}_{m}$
b. 3 fm
c. 1.5 fm
d. 7.4 fm
e. $6.1 \times 10^{-15}_{m}$
f.

12. (4 pts) Hundreds of nuclides are known to decay by alpha emission. Why is decay by ^{3}He emission never observed?

a. ^{3}He has a higher binding energy per nucleon than the alpha-particle.
b. ^{3}He has a lower binding energy per nucleon than ^{4}He.
c. ^{3}He has a larger surface effect than ^{4}He.
d. ^{3}He has more protons than the alpha-particle.
e. For ^{3}He to total Coulomb energy is larger than for ^{4}He.

13. (4 pts) Calculate the binding energy per nucleon for $^{56}_{26}Fe$ and chose the correct answer. (use m_n = 1.008665u and M(^{1}H) = 1.007825u) and $\frac{931.5MeV}{c^2u}$

a. 8.79 MeV/nucleon
b. 9.10 MeV/nucleon
c. 5.54 MeV/nucleon
d. 7.57 MeV/nucleon
e. 4.53 MeV/nucleon

14. (4 pts) A radioactive sample of mass 2mg has a half life of 2 hours. What amount decays in 6 hours?

a. 0.5 mg
b. 0.75 mg
c. 1.00 mg
d. 1.50 mg
e. 1.75 mg

15. (4 pts) Select the correct answer:

a. Isotones are nuclei with the same proton number.
b. Isobars are nuclei with the same neutron number.
c. Isotopes are nuclei with the same neutron number.
d. Isobars are nuclei with the same value of A.
e. Isotopes are nuclei with the same proton and neutron number.

16. (4 pts) From the following nuclei ^{6}Li, ^{13}C, ^{7}Li, ^{18}F, ^{19}F which ones have integer spins?

a. ^{6}Li, ^{18}F
b. ^{13}C, ^{19}F
c. ^{6}Li, ^{19}F
d. ^{18}F, ^{19}F

17. (4 pts) What fraction of the original number of nuclei remains in a radioactive sample after three half-lives?

a. $\frac{1}{2}$
b. $\frac{1}{5}$
c. $\frac{1}{8}$
d. $\frac{1}{16}$
e. $\frac{1}{24}$

18. (4 pts) The Bohr radius is $0.5x10^{-10}m$. What is the radius of the stationary state with n=2?

a. $2x10^{-10}m$
b. $1x10^{-10}m$
c. $6x10^{-10}m$
d. $8x10^{-10}m$
e. $4x10^{-10}m$

19. (4 pts) The k_{α}-xray comes from transition of an electron:

a. From the L-shell to a vacancy in the captive K-shell
b. From the M-shell to a vacancy in the K-shell
c. From the M-shell to a vacancy in the L-shell
d. From the O-shell to a vacancy in the K-shell
e. From the N-shell to a vacancy in the M-sh

20. (4 pts) A typical diameter of a nucleus is about 10^{-14}m. Use the infinite square-well potential to calculate the transition energy from the first excited state to the ground state for a proton confined to the nucleus. Chose the correct answer:

a. 10 MeV
b. 8 MeV
c. 6 MeV
d. 4 MeV
e. 2 MeV

21. (4 pts) Which of the following statements describes best the line of stability?

a. It has N=Z when A=240
b. It has Z>N at A=240
c. N always tends to be greater than Z
d. N tends to be greater than Z, especially for masses greater than calcium
e. N always tends to be smaller than Z

22. (4 pts) Find the degeneracy of the second, third, fourth, and fifth levels for the three-dimensional cubical box.

a. 3 fold, 3 fold, 2 fold, not degenerate
b. Not degenerate, 2 fold, 3 fold, 4 fold
c. 3 fold, 3 fold, 3 fold, not degenerate
d. 2 fold, 2 fold, 2 fold, not degenerate

23. (4 pts) A particle in an infinite square well potential has a ground state energy of 4eV. What are the energies in the next 2 levels?

a. 8eV, 16 eV
b. 16eV, 36 eV
c. 24eV, 48 eV
d. 12eV, 16 eV
e. 8eV, 12 eV

24. (4 pts) An unknown radioactive sample is observed to decrease in activity by a factor of five in a two-hour period. What is the half-live t_{12}?

a. 13 minutes
b. 26 minutes
c. 52 minutes
d. 65 minutes
e. 78 minutes

25. (4 pts) Using only A and Z values, calculate the number of α and β particles produced from a decay of $^{235}_{92}U$ to $^{207}_{82}Pb$?

a. 6 α, 4 β
b. 5 α, 7 β
c. 4 α, 6 β
d. 7 α , 4 β
e. 8 α, 2 β

The Periodic Table

Periodic Table of Elements

Closed shells	Groups: 1 (Alkalis)	2 (Alkaline earths)	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Rare Halogens gases 18
	1 **H** $1s$		Transition elements															2 **He** $1s^2$
$1s^2$	3 **Li** $2s^1$	4 **Be** $2s^2$											5 **B** $2s^2\ 2p^1$	6 **C** $2s^2\ 2p^2$	7 **N** $2s^2\ 2p^3$	8 **O** $2s^2\ 2p^4$	9 **F** $2s^2\ 2p^5$	10 **Ne** $2s^2\ 2p^6$
$2s^2 2p^6$	11 **Na** $3s^1$	12 **Mg** $3s^2$											13 **Al** $3s^2\ 3p^1$	14 **Si** $3s^2\ 3p^2$	15 **P** $3s^2\ 3p^3$	16 **S** $3s^2\ 3p^4$	17 **Cl** $3s^2\ 3p^5$	18 **Ar** $3s^2\ 3p^6$
$3s^2 3p^6$	19 **K** $4s^1$	20 **Ca** $4s^2$	21 **Sc** $3d^1\ 4s^2$	22 **Ti** $3d^2\ 4s^2$	23 **V** $3d^3\ 4s^2$	24 **Cr** $3d^5\ 4s^1$	25 **Mn** $3d^5\ 4s^2$	26 **Fe** $3d^6\ 4s^2$	27 **Co** $3d^7\ 4s^2$	28 **Ni** $3d^8\ 4s^2$	29 **Cu** $3d^{10}\ 4s^1$	30 **Zn** $3d^{10}\ 4s^2$	31 **Ga** $3d^{10}\ 4s^2\ 4p^1$	32 **Ge** $3d^{10}\ 4s^2\ 4p^2$	33 **As** $3d^{10}\ 4s^2\ 4p^3$	34 **Se** $3d^{10}\ 4s^2\ 4p^4$	35 **Br** $3d^{10}\ 4s^2\ 4p^5$	36 **Kr** $3d^{10}\ 4s^2\ 4p^6$
$3d^{10} 4s^2 4p^6$	37 **Rb** $5s^1$	38 **Sr** $5s^2$	39 **Y** $4d^1\ 5s^2$	40 **Zr** $4d^2\ 5s^2$	41 **Nb** $4d^4\ 5s^1$	42 **Mo** $4d^5\ 5s^1$	43 **Tc** $4d^6\ 5s^1$	44 **Ru** $4d^7\ 5s^1$	45 **Rh** $4d^8\ 5s^1$	46 **Pd** $4d^{10}$	47 **Ag** $4d^{10}\ 5s^1$	48 **Cd** $4d^{10}\ 5s^2$	49 **In** $4d^{10}\ 5s^2\ 5p^1$	50 **Sn** $4d^{10}\ 5s^2\ 5p^2$	51 **Sb** $4d^{10}\ 5s^2\ 5p^3$	52 **Te** $4d^{10}\ 5s^2\ 5p^4$	53 **I** $4d^{10}\ 5s^2\ 5p^5$	54 **Xe** $4d^{10}\ 5s^2\ 5p^6$
$4d^{10} 5s^2 5p^6$	55 **Cs** $6s^1$	56 **Ba** $6s^2$	57 **La** $5d^1\ 6s^2$	72 **Hf** $4f^{14}\ 5d^2\ 6s^2$	73 **Ta** $4f^{14}\ 5d^3\ 6s^2$	74 **W** $4f^{14}\ 5d^4\ 6s^2$	75 **Re** $4f^{14}\ 5d^5\ 6s^2$	76 **Os** $4f^{14}\ 5d^6\ 6s^2$	77 **Ir** $4f^{14}\ 5d^9\ 6s^1$	78 **Pt** $4f^{14}\ 5d^9\ 6s^1$	79 **Au** $4f^{14}\ 5d^{10}\ 6s^1$	80 **Hg** $4f^{14}\ 5d^{10}\ 6s^2$	81 **Tl** $4f^{14}\ 5d^{10}\ 6s^2\ 6p^1$	82 **Pb** $4f^{14}\ 5d^{10}\ 6s^2\ 6p^2$	83 **Bi** $4f^{14}\ 5d^{10}\ 6s^2\ 6p^3$	84 **Po** $4f^{14}\ 5d^{10}\ 6s^2\ 6p^4$	85 **At** $4f^{14}\ 5d^{10}\ 6s^2\ 6p^5$	86 **Rn** $4f^{14}\ 5d^{10}\ 6s^2\ 6p^6$
$4f^{14} 5d^{10} 6s^2 6p^6$	87 **Fr** $7s^1$	88 **Ra** $7s^2$	89 **Ac** $6d^1\ 7s^2$	104 **Rf** $5f^{14}\ 6d^2\ 7s^2$	105 **Db** $5f^{14}\ 6d^3\ 7s^2$	106 **Sg** $5f^{14}\ 6d^4\ 7s^2$	107 **Bh** $5f^{14}\ 6d^5\ 7s^2$	108 **Hs** $5f^{14}\ 6d^6\ 7s^2$	109 **Mt** $5f^{14}\ 6d^7\ 7s^2$	110 **Ds** $5f^{14}\ 6d^9\ 7s^1$	111 **Rg** $5f^{14}\ 6d^{10}\ 7s^1$	112 **Cn** $5f^{14}\ 6d^{10}\ 7s^2$						

Lanthanides	58 **Ce** $4f^2\ 6s^2$	59 **Pr** $4f^3\ 6s^2$	60 **Nd** $4f^4\ 6s^2$	61 **Pm** $4f^5\ 6s^2$	62 **Sm** $4f^6\ 6s^2$	63 **Eu** $4f^7\ 6s^2$	64 **Gd** $4f^7\ 6s^2\ 5d^1$	65 **Tb** $4f^9\ 6s^2$	66 **Dy** $4f^{10}\ 6s^2$	67 **Ho** $4f^{11}\ 6s^2$	68 **Er** $4f^{12}\ 6s^2$	69 **Tm** $4f^{13}\ 6s^2$	70 **Yb** $4f^{14}\ 6s^2$	71 **Lu** $4f^{14}\ 5d^1\ 6s^2$
Actinides	90 **Th** $6d^2\ 7s^2$	91 **Pa** $5f^2\ 6d^1\ 7s^2$	92 **U** $5f^3\ 6d^1\ 7s^2$	93 **Np** $5f^4\ 6d^1\ 7s^2$	94 **Pu** $5f^6\ 7s^2$	95 **Am** $5f^7\ 7s^2$	96 **Cm** $5f^7\ 6d^1\ 7s^2$	97 **Bk** $5f^8\ 6d^1\ 7s^2$	98 **Cf** $5f^{10}\ 7s^2$	99 **Es** $5f^{11}\ 7s^2$	100 **Fm** $5f^{12}\ 7s^2$	101 **Md** $5f^{13}\ 7s^2$	102 **No** $5f^{14}\ 7s^2$	103 **Lr** $5f^{14}\ 6d^1\ 7s^2$