P100 Spring 2009 – Recitation 9 (practice for exam 2)

Problem 1 :

Ernest Rutherford's experiments in which he (or his students) observed the scattering of alpha particles as they passed through a thin metal foil demonstrated that

a) light is a wave.
b) Light is made of particles
c) The atom has a tiny positive nucleus containing most of the atom's mass.
d) Electrons exist.
e) Neutrons exist.

Problem 2 :

A neutral atom's "atomic number" represents the

a) number of protons in the nucleus.
b) the number of neutrons in the nucleus.
c) the number of electrons orbiting the nucleus of the atom.
d) the number of quantum mechanical energy levels in the atom.
e) the number of protons and neutrons in the nucleus.
f) both (a) and (c).

Problem 3 :

The sun's energy comes from

a) nuclear decay.
b) nuclear fusion.
c) excessive amounts of jolt cola.
d) nuclear fission.
e) chemical reactions.

Problem 4 :

If two atoms are the same and are bound together in a molecule (such as H_2 or O_2) the chemical bond between them is

a) a quantum entanglement.
b) a covalent bond.
c) an example of the photoelectric effect.
d) an ionic bond.
e) all of the above

Problem 5 :

The alpha decay of an atom of $^{238}_{92}\mathrm{U}$ yields the atom

a) $^{234}_{90}\mathrm{U}$
b) $^{238}_{90}\mathrm{Th}$
c) $^{238}_{93}\mathrm{Np}$
d) $^{238}_{91}\mathrm{Pa}$
e) $^{234}_{90}\mathrm{Th}$

Problem 6 :

According to our scientific understanding of stars, most of the atoms of heavy elements (heavier than iron) that are spread throughout the dust in the universe were created

a) as dust clouds collapsed to form young stars
b) during the fusion process that powers the stars, and then released by a supernova explosion.
c) during a supernova explosion.
d) in the middle of hot white dwarf stars.
e) in Danforth and launched in to space by bottle rockets.

Problem 7 :

In quantum mechanics, if two photons are "entangled" it means

a) they always move in the same direction.
b) the two photons share the same quantum wavefunction and observations of one are reflected in the state of the other.
c) they are moving directly away from one another.
d) the two photons share the same quantum wavefunction and, consequently, observations of one have no bearing on the other.
e) they had a bit much to drink the night before.

Problem 8 :

One difference between electrons and photons is

a) electrons are particles while photons are waves.
b) electrons are a particle of matter and photons are a particle of light.
c) both of the above.
d) photons obey quantum theory while electrons obey Newtonian physics.
e) all of the above.

Problem 9 :

A neutron makes a much more effective "nuclear bullet" for fissioning a nucleus, e.g., in a chain reaction, than does a proton. Why?

Problem 10 :

Why is it that the spectrum of light emitted by an atom is often said to be a "fingerprint" for that atom?

Problem 11 :

If there are only approximately 100 different atomic elements (types of atoms) in our world, how is it that you can identify many, many more than 100 different types of substances in the world around you?

Problem 12:

Suppose we find a rock and geologists tell us that when that rock was formed in a volcano it would have contained an equal amount of Iridium-192 (Z=77, symbol = Ir) and Bismuth-209 (Z=83, symbol = Bi). Suppose that Iridium-192 and Bismuth-209 are both naturally radioactive. Also, suppose that Iridium-192 decays with a half-life of 500,000 years and Bismuth-209 decays with a half-life of 1 million years. If the rock is two million years old and you measure the amount of Iridium-192 and Bismuth-209 in the rock, what ratio for the amount of Iridium-192 to Bismuth-209 would you expect to measure?

Problem 13:

The strong force is mediated by gluons in the same way the electromagnetic force is mediated by

a) electrons.
b) neutrinos.
c) Z particles.
d) protons.
e) photons.

Problem 14:

A nucleus X decays into a nucleus Y and emits some form of radiation as shown by the reaction below.

$$^{50}_{21}X \rightarrow ^{50}_{20}Y + ?$$

The particle that is emitted (symbolized above as "?") is

a) an alpha particle.
b) a negative beta particle (electron)

c) a positive beta particle (positron).
d) a photon.
e) a neutron.

Problem 15

By each description on the left, put the letter of the answer on the right that best fits. There may be more than one answer on the right that works, in which case any of the correct answers is sufficient.

___ One type of quark found in neutrons

___ Force carrier (gauge boson) for electromagnetic interaction

___ Force carrier (gauge boson) for strong interaction

___ Only undiscovered particle predicted by the Standard Model of particle physics

___ Particle that can pass through light years of lead without interacting

___ One of the particles mediating the weak interaction (force carrier for weak interaction)

___ A particle made up of three quarks

___ An example of a meson

___ An example of a lepton

___ A massless particle

(3 pts) List below three of the five particles listed to the right which are known to be made of other particles (have constituents).

_____

a. electron
b. muon neutrino
c. proton
d. pion
e. charm (c) quark
f. W
g. gluon
h. higgs
i. Z
j. top (t) quark
k. muon
l. photon
m. up (u) quark
n. graviton
o. hydrogen atom
p. hadron
q. baryon