ISP209 Fall 2012

Exam #3

Name:_____

Student #:_____

Please write down your name and student # on both the exam and the scoring sheet. After you are finished with the exam, please place the scoring sheet inside the exam and turn in at the front of the lecture room. **No section # or form ID is needed.**

Do not begin working on the exam before permission is given. Keep your eyes on your own exam and no talking. Violation of this policy will result in a grade of 0 for the exam. No cell phones visible.

Some useful constants:

$e = 1.6X10^{-19}$ C

$c= 3 X 10^{8}$ m/s

$G=6.67X10^{-11}N.m^2/kg^2$

$h= 6.63X10^{-34J}.S$

$m_{electron}=9.1X10^{-31}$ kg

$m_{proton}=1.67X10^{-27}$ kg

$m_{neutron}=1.67X10^{-27}$ kg

$M_{Earth}=5.98X10^{24}$ kg

$R_{Earth}=6.37X10^{6}$ m

1) The Michelson-Morley experiment was designed to measure

a) the mass of the electron

b) the mass of the proton

c) the velocity of the Earth with respect to the ether

d) the acceleration of gravity on the Earth's surface

e) the acceleration of gravity on the Moon

2) A fast spaceship is travelling with a speed of 0.80c. How fast would an observer at rest with respect to the spaceship see light travelling from headlights on the ship?

a) 0.20 c

b) 0.80c

c) 0.9c

d) 1.0c

e) 1.8c

light always travels at c in vacuum

3) How much mass is lost during a nuclear reaction when $1.7X10^{8}$ MeV is released?

a) $1.8X10^{-8}$ kg

b) $5.7X10^{-9}$kg

c) $1.9X10^{-17}$ kg

d) $3.0X10^{-22}$ kg

e) $4.8X10^{-24}$kg

$$E = mc^2$$

$$m = \frac{E}{c^2} = \frac{1.7X10^{14} ev * 1.6X10^{-19} J/ev}{(3X10^{8} m/s)^2}$$

$$m = 3.0X10^{-22} kg$$

4 A photon of energy $4.7X10^{-25}$ J has what frequency?

a) 710 kHz

b) 4.7 Mhz

c) 710 Mhz

d) 1.4 Ghz

e) 5.7 Ghz

$$E = hf$$

$$f = \frac{E}{h} = \frac{4.7X10^{-25} J}{6.63X10^{-34} J.s}$$

$$f = 710 Mhz$$

5) What is the wavelength of the matter wave associated with an electron moving with a speed of $2.5X10^{3}$ m/s?

a) 290 nm

b) 350 mb

c) 470 nm

d) 530 nm

e) 660 nm

$$\lambda = \frac{h}{p} = \frac{h}{mv} = \frac{6.63X10^{-34} J.s}{(9.1X10^{-31} kg)(2.5X10^{3} m/s)}$$

$$\lambda = 290 nm$$

6) The uncertainty in the position of a proton is 0.053 nm. What is the uncertainty in its speed?

a)1200 m/s

b) 960 m/s

c) 600 m/s

d)2.2 m/s

e)0.015 m/s

$$\Delta x \Delta p > \frac{h}{4\pi}$$

$$\Delta p > \frac{h}{4\pi\Delta x} = \frac{6.63X10^{-34} J.s}{4\pi(5.3X10^{-11} m)}$$

$$\Delta p > 9.96X10^{-25} kg.m/s$$

$$\Delta v > \frac{\Delta p}{m} = \frac{9.96X10^{-25} kg.m/s}{1.67X10^{-27} kg}$$

$$\Delta v > 596 m/s$$

7) What happens to the half-life of a radioactive substance as it decays?

a) it remains constant

b) it increases

c) it decreases

d) depending on circumstances, any of the above could happen

8) When an alpha particle is emitted from an unstable nucleus, the atomic mass of the nucleus

a) increases by 2

b) decreases by 2

c) increases by 4

d) decreases by 4

e) does not change

9) If $4.0X10^{18}$ atoms decay with a half-life of 2.3 years, how many atoms will be left after 3.7 years?

a)$2.5X10^{18}$

b)$1.7X10^{18}$

c)$1.3X10^{18}$

d)$1.1X10^{18}$

e)$8.0X10^{17}$

$$N = N_o e^{-0.693t/T_{1/2}}$$

$$\frac{N}{N_o} = e^{-0.693(3.7/2.3)}$$

$$\frac{N}{N_o} = e^{-1.11} = 0.33$$

$$N = 1.32X10^{18}$$

10) An electron is an example of

a) a hadron

b) a meson

c) a lepton

d) a baryon

e) a nucleon

11) The ratio of a photon's energy to its frequency is

a) its speed

b) its wavelength

c) its amplitude

d) Planck's constant

e) none of the above

12) The main reason electrons occupy discrete orbits in an atom is because

a) electrons orbiting the nucleus are like planets orbiting the Sun

b) electric forces act over quantized distances

c) electrons are basically discrete particles

d) the circumference of each orbit is an integral multiple of electron wavelengths

e) none of the above

13) Different isotopes of an element have different numbers of

a) protons

b) hadrons

c) photons

d) neutrons

e) electrons

14) The half-life of an isotope is one day. At the end of 3 days, how much of the isotope remains?

a) none

b) one-half

c) one-quarter

d) one-eighth

e) one-sixteenth

15) Most of the radioactivity we personally encounter comes from

a) the natural environment

b) medical X-rays

c) nuclear power plants

d) fallout from past testing of nuclear weapons

e) microwave ovens

16) The most abundant element in the universe is

a) hydrogen

b) helium

c) lead

d) carbon

e) uranium

17) Which of the following elements was not produced in the Big Bang (in any quantity)?

a) hydrogen

b) helium

c) nitrogen

d) all of the above elements

e) none of the above elements

18) What is the escape velocity for a 85 kg mass at the Earth's equator?

a) $3X10^8$ m/s

b) 579 m/s

c) $6.51X10^5$ m/s

d) $1.12X10^4$ m/s

e) $4.44X10^3$ m/s

$$v = \sqrt{\frac{2GM}{R}} = \sqrt{\frac{2(6.67X10^{-11} Nm^2/kg^2)(5.98X10^{24} kg)}{6.37X10^6 m}} = 1.12X10^4 m/s$$

19) What would be the Schwarzchild radius of a 150 kg mass?

a) 2.2X10^{-25} m

b) 0.0000039 m

c) 4.94X10^{-25} m

d) 3.29X10^{-25} m

e) 1.62X10^{-18} m

$$r = \frac{2GM}{c^2} = \frac{2(6.67X10^{-11}N.m^2/kg^2)(150kg)}{(3X10^8 m/s)^2}$$

$$r = 2.2X10^{-25}m$$

20) Of the four fundamental forces, which is the weakest?

a) strong

b) weak

c) electromagnetic

d) gravitational

e) they are all of the same strength

21) Of the four fundamental forces, which have a finite range of action?

a) strong and weak

b) strong and gravitational

c) weak and electromagnetic

d) weak and gravitational

e) strong and electromagnetic

22) A clock in a stationary reference frame has exactly one second between `ticks'. When this clock is observed while moving at a speed of 0.91c, what is the time interval between ticks?

a) 1 second

b) 1.46 seconds

c) 0.53 seconds

d) 2.41 seconds

e) 5.54 seconds

$$\gamma = \frac{1}{\sqrt{1-\beta^2}} = \frac{1}{\sqrt{1-0.91^2}} = 2.41$$

23) When a nucleus emits a beta particle (an electron), its atomic number

a) increases by 1

b) decreases by 1

c) increases by 2

d) decreases by 2

e) doesn't change

24) In nuclear fission and fusion processes, the amount of mass converted to energy or otherforms is

a) less than 1%

b) about 10%

c) about 20%

d) about 30%

e) 100%

25) What would happen it the Earth if the Sun were replaced by a black hole of the same mass?

a) the Earth would spiral into the Sun

b) the Earth would fly away from the Sun

c) nothing

d) the radius of the Earth's orbit would double

e) the radius of the Earth's orbit would decrease by a factor of 2

26) The major component of the universe is

a) stars and planets

b) dust and gas

c) dark energy

d) dark matter

e) none of the above

27) Hadrons

a) are particles with no size

b) experience only the weak force

c) can interact through the strong force

d) have no electric charge

e) none of the above

28) General relativity predicts

a) that light will be bent by gravitational fields

b) that time moves more slowly in strong gravitational fields

c) that large masses bend space

d) none of the above

e) all of the above

29) The Carbon-14 present in the Earth's atmosphere is produced by

a) plants and animals

b) radioactive decays in the Earth's crust

c) cosmic ray bombardment of the atmosphere

d) none of the above

e) all of the above

30) Consider alpha, beta and gamma radiation. Which is not a high speed massive particle?

a) alpha

b) beta

c) gamma

d) all are

e) none are

31) The property of an atom that determines the element is

a) the number of electrons

b) the number of protons

c) the number of neutrons

d) the number of neutrons + protons

e) all of the above

32) The Higgs mechanism

a) explains how particles acquire mass

b) explains why gravity is so weak

c) explains why there are three generations of quarks and leptons

d) all of the above

e) none of the above

33) In both fusion and fission reactions, mass

a) before and after the event is the same

b) is created from energy

c) is converted to energy

d) none of the above

34) If a muon, which normally lives 2.2 μs, is observed to live for 15.6 μs, how fast must it be travelling?

a) c

b) 1.1 c

c) 0.99 c

d) 0.93 c

e) 0.517 c

$$\gamma = \frac{1}{\sqrt{1-\beta^2}} = 7.1$$

$$1-\beta^2 = \frac{1}{7.1^2}$$

$$v = 0.99c$$

Match each of the bosons with the force that it is responsible for

a) photon
b) gluon
c) W/Z

35) Weak nuclear force **c**

36) Strong nuclear force **b**

37) Electromagnetic force **a**

38) How many generations of quarks and leptons are there?

a) 1

b) 2

c) 3

d) 4

e) 5

39) A spaceship moves away from the Earth with a speed of 0.8c. The spaceship then fires a missile with a speed of 0.5c relative to the spaceship. What is the velocity of the missile measured by observers on Earth if the missile is fired directly away from the Earth?

a) 0.30c

b) 0.50c

c) 0.93c

d) 0.89c

e) 1.3c

$$v_{obs} = \frac{u+v}{1+\frac{uv}{c^2}} = \frac{0.8c+0.5c}{1+\frac{(0.8c)(0.5c)}{c^2}}$$

$$v_{obs} = 0.93c$$

40) The idea of extra dimensions for the universe may explain why

a) gravity is so much weaker than any of other forces

b) the weak force is so much weaker than any of the other forces

c) the electromagnetic force is so much weaker than any of the other forces

d) why there are 3 families of quarks and leptons

e) why there are 3 types of neutrinos