

## Unit X Conceptual Questions

**Please answer questions on Scantron form 882-ES. Otherwise you will receive a zero. Poorly erased responses will not be re-graded. Turn in two days before unit exam. You are encouraged to work together and discuss these questions!!!**

1. A passenger train travels east at high speed. One passenger is located at the east side of one car, another is located in the west side of that car. In the train's frame, these two passengers glance up at the same time. In the earth's frame,
  - a. they glance up simultaneously.
  - b. the passenger at the east side glances up first.
  - c. the passenger at the west side glances up first.
  - d. the passengers glance sideways.
2. An earthworm has eight hearts located at different parts of its body. The eight hearts must all beat at the same time in order to produce effective blood circulation. If an earthworm flies past us in a rocket ship traveling at  $3/5$ th the speed of light, its front hearts will be out of synch with its rear hearts. Nevertheless, the earthworm remains alive because
  - a. the worm is so short (due to length contraction) that it no longer requires effective blood circulation.
  - b. the worm is not perfectly rigid.
  - c. the hearts remain synchronized in the worm's own frame.
  - d. both the heartbeats and the respiration rate slow down.
3. Joe travels at high speed from the Earth to a star, five light years away. In Joe's Frame
  - a. the trip takes more time than it does in the Earth's frame.
  - b. Joe travels to the star over a length that is shorter than five light years.
  - c. clocks on Earth and on the star are synchronized.
  - d. The star travels to Joe over a length that is shorter than five light years.
4. The postulate that the speed of light in a vacuum is the same in all reference frames is
  - a. consistent with the results of the Michelson-Morley experiment.
  - b. inconsistent with the results of the Michelson-Morley experiment.
  - c. not related consistent to the results of the Michelson-Morley experiment.
5. A train is 1000 feet long in its own frame, and a railroad platform is 800 feet long in its own frame. The train rushes past the platform so fast that, in the platform's frame, the train and platform are the same length. How fast was the train moving?
  - a.  $0.4c$
  - b.  $0.6c$
  - c.  $0.8c$
  - d.  $1.2c$
  - e.  $1.67c$
6. When a battery is drained in ordinary use
  - a. its mass decreases because its rest mass decreases.
  - b. Its mass decreases, but its rest energy remains unchanged
  - c. Its mass remains unchanged, but its internal energy decreases.
  - d. Its mass decreases because its internal energy increases.
7. An astronaut heading out toward a star at constant high speed can determine he is in motion by
  - a. the contraction of on-board meter-sticks.
  - b. the slowing down of time on his clocks.
  - c. the increase of his mass.
  - d. the speeding of his heart.
  - e. none of the above.

8. When a two-megaton nuclear bomb is exploded approximately  $9.0 \times 10^{15}$  J of energy is released. How much mass is converted into energy during the process?
- $3.0 \times 10^6$  kg
  - 0.10 kg
  - $7.3 \times 10^{10}$  kg
  - $1.7 \times 10^3$  kg
9. According to the Theory of Special Relativity, doubling the speed of an object
- doubles the momentum of the object.
  - more than doubles the momentum of the object.
  - less than doubles the momentum of the object.
  - has no effect on the object's momentum.
10. According to the Theory of Special Relativity, doubling the speed of an object
- doubles the energy of the object.
  - more than doubles the energy of the object.
  - less than doubles the energy of the object.
  - has no effect on the object's energy.
11. The atomic mass number of an element is equal to
- the number of protons in the nucleus.
  - the sum of protons and neutrons in the nucleus.
  - the number of electrons in the outer shell.
  - the neutron number in the nucleus.
12. The  $\alpha$ -decay of  ${}^{232}_{90}\text{Th}$  produces:
- ${}^{228}_{86}\text{Rn}$
  - ${}^{228}_{88}\text{Rn}$
  - ${}^{230}_{88}\text{Rn}$
  - ${}^{232}_{88}\text{Rn}$
  - ${}^{228}_{92}\text{U}$
13. In a fission reaction, a  ${}^{235}\text{U}$  nucleus captures a neutron. This results in the creation of the products  ${}^{141}\text{Ba}$  and  ${}^{92}\text{Kr}$  along with how many neutrons?
- 1
  - 2
  - 3
  - 4
  - 5
14. Gamma decay from an excited nucleus results in the emission of a(n) ..
- electron
  - neutrino
  - photon
  - anti-neutrino
  - neutron
15. In a beta-decay process whereby a proton is converted into a neutron, the other decay products are
- a positron and anti-neutrino
  - a positron and neutrino
  - an electron and an anti-neutrino
  - an electron and a neutrino
16. The original nucleus and the final nucleus will be different isotopes of the same element for which of the following decay processes?
- alpha decay followed by two beta(electron)-decays
  - two gamma decays
  - a beta(electron)-decay followed by an alpha decay
  - a beta(electron)-decay followed by a proton decay

17. The atomic mass of chlorine is 35.5, which is not an integer. Why is this so?
- The proton and neutron have different masses.
  - Because of the binding energy of the chlorine nucleus.
  - There are different isotopes of chlorine.
  - The chlorine nucleus has 35.5 nucleons.
18. Two radionuclides A and B have decay constants  $\lambda_A$  and  $\lambda_B$ , with  $\lambda_A > \lambda_B$ . Which of the following is true regarding the radionuclides?
- The activity of A is greater than that of B.
  - The activity of B is greater than that of A.
  - The half-life of A is greater than that of B.
  - The half-life of B is greater than that of A.
19. Two samples of radionuclides have half-lives  $t_A$  and  $t_B$  with  $t_A > t_B$ . Both samples consist of the same number of atoms. How do their decay rates compare?
- A has a greater rate than B
  - B has a greater rate than A
  - The rates are equal.
20. Suppose that a free neutron undergoes the following decay:  $n \rightarrow p + e^- + \bar{\nu}_e$   
This reaction is an **example** of:
- $\alpha$  decay
  - $\beta^-$  decay
  - $\beta^+$  decay
  - $\gamma$  decay
21. Two nuclei of different masses undergo alpha decay. The energy released during the decay process is the same. Which of the following has a higher kinetic energy?
- The lighter daughter nucleus.
  - The alpha particle from the lighter nucleus.
  - The heavier daughter nucleus.
  - The alpha particle from the heavier nucleus.
22. Suppose that the free neutron of the previous question starts at rest. Assuming zero mass for  $\bar{\nu}_e$ , and assuming that no photons are generated by the decay, what is the **total kinetic energy** carried away by the products of this reaction?
- 780keV
  - 82.7MeV
  - 8.72MeV
  - 82.7MeV
  - 278MeV
23. In a nuclear reaction, the value of Q
- is always positive
  - is positive in a spontaneous decay
  - is positive only for gamma emission
  - is always negative
  - none of the above
24. If an atom decays such that its atomic mass remains the same but its atomic number decreases by one, the decay process that occurred is
- alpha
  - beta (electron)-decay
  - beta (positron)-decay
  - gamma decay
25. In order to balance this nuclear reaction:  ${}_{14}^{28}\text{Si} + {}_{14}^{28}\text{Si} \rightarrow {}_{26}^{56}\text{Fe} + 2 \text{_____} + 2\nu_e + \text{energy}$  two of **what particle** are created?
- alpha
  - electron
  - neutron
  - positron
  - proton

26. Which of the following will not affect the rate in which nuclear reactions will occur in a nuclear power plant that uses a  $^{235}\text{U}$  and  $^{238}\text{U}$  mixture as fuel?
- the moderating material
  - control rods
  - the percentage of energy that is used to produce electricity
  - the relative amounts of  $^{235}\text{U}$  and  $^{238}\text{U}$
27. Fusion reactions require very high temperatures ( $\sim 10^8$ ) in order to
- melt the hydrogen fuel
  - overcome Coulomb repulsion between protons
  - to break protons and neutrons into constituent quarks
  - strip the hydrogen atoms of their electrons
28. The most stable elements have the \_\_\_\_\_ binding energies. This energy arises from the \_\_\_\_\_ of the nuclear particles. The two words that best complete the two statements are:
- highest, mass.
  - lowest, charge.
  - highest, size
  - lowest, size
29. To produce a self-sustained controlled thermonuclear reaction, which of the following conditions must be met for the fuel?
- It must be confined for a sufficient amount of time.
  - It must have a sufficiently high density.
  - It must be sufficiently high temperature.
  - All of the above.
30. What is the advantage of a fusion reactor as compared to a fission reactor?
- The fuel is cheaper
  - There is less radioactive waste material.
  - Both A and B
  - None of the above.