Name _____ **Review 11 Modern Phy**

1. Which phenomenon can best be explained by the wave model of light rather than the particle model of light?
   (1) interference
   (2) reflection
   (3) energy transfer
   (4) photoelectric effect

2. Experiments performed with light indicate that light exhibits
   (1) particle properties, only
   (2) wave properties, only
   (3) both particle and wave properties
   (4) neither particle nor wave properties

3. If the mass of one proton is totally converted into energy, it will yield a total energy of
   (1) 5.1×10^{-19} J
   (2) 1.5×10^{-10} J
   (3) 9.3×10^{8} J
   (4) 9.0×10^{16} J

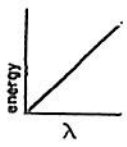
4. Approximately how much energy would be generated if the mass in a nucleus of a ${}_{1}^{2}H$ atom were completely converted to energy? [The mass of ${}_{1}^{2}H$ is 2.0 atomic mass units.]
   (1) 3.2×10^{-19} J
   (2) 1.5×10^{-10} J
   (3) 9.3×10^{2} MeV
   (4) 1.9×10^{3} MeV

5. A baryon may have a charge of
   (1) - 1/3 e
   (2) 0 e
   (3) + 2/3 e
   (4) + 4/3 e

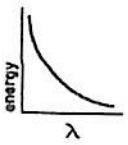
6. Which of the following reactions does not affect a baryon's charge?
   (1) An up quark changing into a strange quark.
   (2) A strange quark changing into a bottom quark.
   (3) A top quark changing into a charm quark.
   (4) A down quark changing into a strange quark.

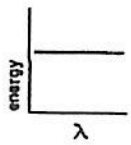
7. The energy of a photon varies
   (1) directly as the wavelength
   (2) directly as the frequency
   (3) inversely as the frequency
   (4) inversely as the square of the frequency

8. What is the charge on an anti-down quark?
   (1) $+\frac{1}{3}$ e
   (2) $+\frac{2}{3}$ e
   (3) $-\frac{1}{3}$ e
   (4) $-\frac{2}{3}$ e

9. Which graph best represents the relationship between the energy of a photon and its wavelength?
   (1) 

   (3) 

   (2) 

   (4) 

10. Which combination of quarks would produce a neutral baryon?
    (1) uud
    (2) udd
    (3) $\bar{u}\,\bar{u}d$
    (4) $\bar{u}dd$

11. Which color light has photons of the greatest energy?
    (1) red
    (2) yellow
    (3) green
    (4) blue

12. Which of the following gives evidence for the quark structure of baryons?
    (1) Baryons only have charges that are integral multiples of the electron charge.
    (2) The neutron has a magnetic moment.
    (3) Baryon number is conserved in all reactions.
    (4) The force that holds nuclei together is very strong.

13. As a photon loses energy during a collision, its wavelength
    (1) decreases
    (2) increases
    (3) remains the same

14. In which part of the electromagnetic spectrum does a photon have the greatest energy?
    (1) red
    (2) infrared
    (3) violet
    (4) ultraviolet

15. What is the minimum amount of energy required to excite a hydrogen atom in the ground state to the n = 3 energy level ?

16. As an electron in an atom moves in a circular path of constant radius around the nucleus, the total energy of the atom
(1) decreases
(2) increases
(3) remains the same

17. In his model of the atom, Bohr assumed that the electrons
(1) are distributed evenly throughout the atom
(2) are located only in the nucleus of the atom
(3) are located only in a limited number of specified orbits
(4) emit energy while in orbit

18. A baryon has a charge of –1 e. It CANNOT contain
(1) an up quark.
(2) a down quark.
(3) a charm quark.
(4) a bottom quark.

19. Which of the following has the same charge as a neutron (udd)?
(1) proton (uud)
(2) sigma (Σ) (uus)
(3) xi (Ξ) (uss)
(4) omega (Ω) (sss)

20. One variety of delta (Δ) particle has a charge of +2 e. What is a possible quark configuration for it?
(1) uuu
(2) uud
(3) udd
(4) ddd

21. What is a possible charge for a baryon, but not for a meson?
(1) +2 e
(2) +1 e
(3) 0 e
(4) –1 e

22. A photon emitted from an excited hydrogen atom has an energy of 3.02 electronvolts. Which electron energy-level transition would produce this photon?
(1) n = 1 to n = 6
(2) n = 2 to n = 6
(3) n = 6 to n = 1
(4) n = 6 to n = 2

23. The electron in a hydrogen atom drops from energy level $n = 2$ to energy level $n = 1$ by emitting a photon having an energy of approximately
(1) 5.4×10^{-19} J
(2) 1.6×10^{-18} J
(3) 2.2×10^{-18} J
(4) 7.4×10^{-18} J

24. A baryon contains at least one charm quark. Which may NOT be its electric charge?
(1) +2 e
(2) +1 e
(3) 0 e
(4) –1 e

25. Which phenomenon provides evidence that the hydrogen atom has discrete energy levels?
(1) emission spectra
(2) photoelectric effect
(3) alpha particle scattering
(4) natural radioactive decay

26. An excited atom emits a photon of energy E when an electron changes from energy level n = 3 to n = 2. In order for the same electron to change directly from energy level n = 2 to n = 3, it may
(1) absorb a photon with energy E
(2) absorb a photon with energy 2E
(3) emit a photon with energy 3E
(4) emit a photon with energy E/2

27. Which electron transition in the hydrogen atom results in the emission of a photon of greatest energy?
(1) n = 2 to n = 1
(2) n = 3 to n = 2
(3) n = 4 to n = 2
(4) n = 5 to n = 3

28. The Millikan oil drop experiment determined the smallest unit of
(1) mass
(2) weight
(3) electric charge
(4) electric field strength

29. The omega (Ω) particle is made up of 3 strange quarks. It is
(1) a baryon with charge +1 e.
(2) a meson with charge +1 e.
(3) a baryon with charge –1 e.
(4) a meson with charge –1 e.

30. Which of the following particles is NOT made of quarks?
(1) proton
(2) electron
(3) pion
(4) neutron

31. A 14-electron-volt photon ionizes a hydrogen atom in its ground state. What is the kinetic energy of the ejected electron?

32. Which of the following CANNOT be the charge on a meson?

(1) 1 e
(2) $\frac{2}{3}$ e
(3) 0 e
(4) –1 e

3. A hydrogen atom emits blue light when it changes from the n = 4 energy level to the n = 2 energy level. Which color of light would the atom emit when it changes from the n = 5 level to the n = 2 level ?

34. A hydrogen atom undergoes a transition from the n = 3 state to the ground state. The total number of different possible photon energies that may be emitted is

35. What is the energy of the photon emitted by hydrogen atom when the hydrogen atom changes directly from the n = 5 state to the n = 2 state?

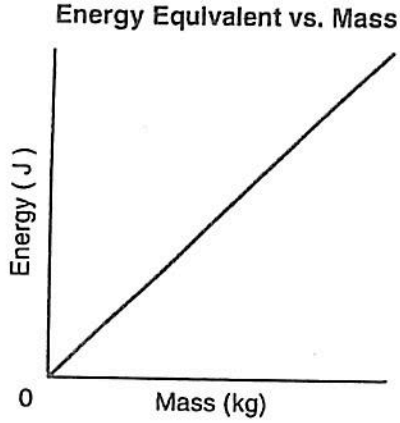
36. If a hydrogen atom is in the n = 5 energy level, what is the minimum energy needed to ionize the atom

37. During a collision between a photon and an electron, there is conservation of

38. What is the energy of a quantum of light having a frequency of 6.0×10^{14} hertz?

39. An atom changing from an energy state of –0.54 eV to an energy state of –0.85 eV will emit a photon whose energy is

40. The graph below represents the relationship between mass and its energy equivalent



The slope of the graph represents

Base your answers to questions 1 and 2 on the information below.

When an electron and its antiparticle (positron) combine, they annihilate each other and become energy in the form of gamma rays.

1. The positron has the same mass as the electron. Calculate how many joules of energy are released when they annihilate. [Show all work, including the equation and substitution with units.]

2. What conservation law prevents this from happening with two electrons?

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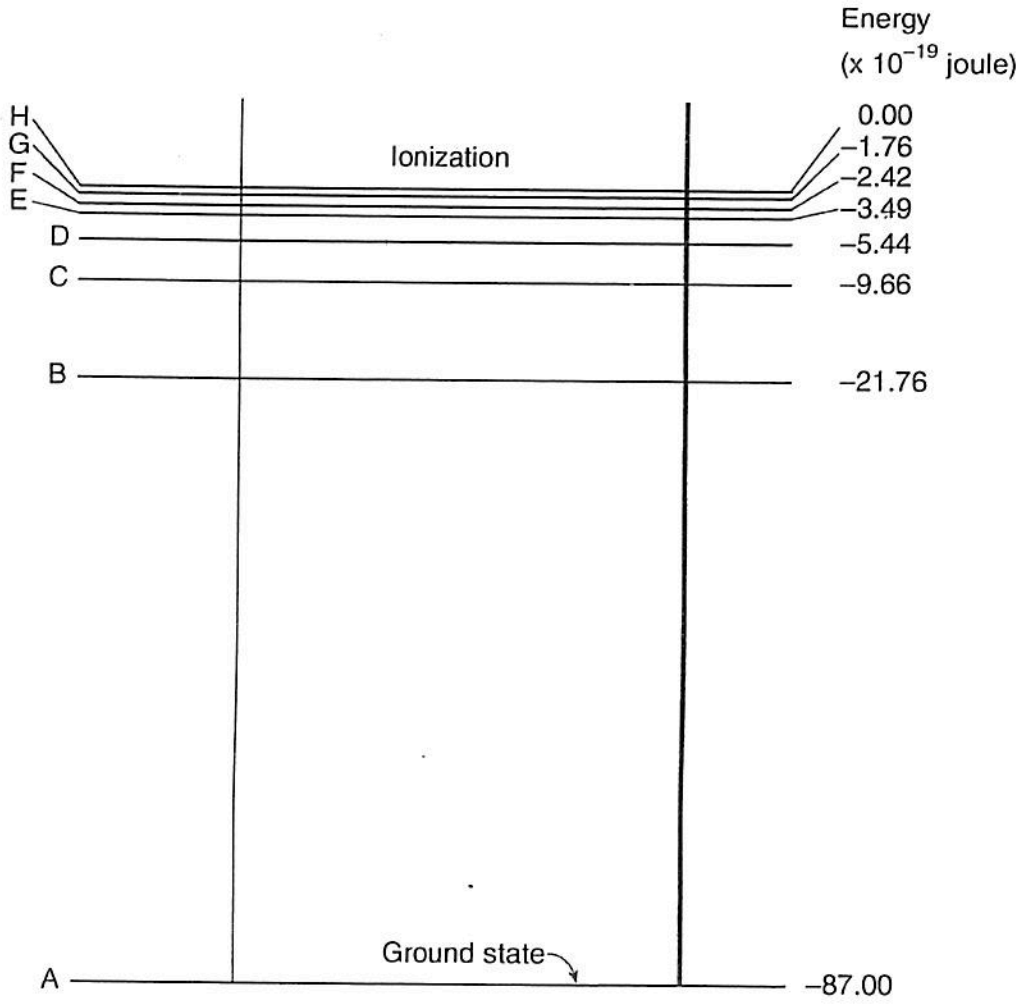
Base your answers to questions 3 and 4 on the diagram below, which shows some energy levels for an atom of an unknown substance.



3. Determine the minimum energy necessary for an electron to change from the *B* energy level to the *F* energy level.

4. Calculate the frequency of the photon emitted when an electron in this atom changes from the *F* energy level to the *B* energy level. [Show all work, including the equation and substitution with units.]

Base your answers to questions 5 and 6 on the information and diagram below. The diagram shows the collision of an incident photon having a frequency of 2.00×10^{19} hertz with an electron initially at rest.

5. Calculate the initial energy of the photon. [Show all calculations, including the equation and substitution with units.]

6. What is the total energy of the two-particle system after the collision?

Base your answers to questions 7 through 10 on the information below.

When an electron in an excited hydrogen atom falls from a higher to a lower energy level, a photon having a wavelength of 6.58×10^{-7} meter is emitted.

7. Calculate the energy of a photon of this light wave in joules. [Show all calculations, including the equation and substitution with units.]

8. Convert the energy of the photon to electronvolts.

9. Determine which *two* energy levels the electron has fallen between to emit this photon.

10. Is this photon an x-ray photon? Justify your answer.