Name: _____ Period: ____

Questions for Regents Practice

Part A

1. In which part of the electromagnetic spectrum does a photon have the greatest energy?

(1) red

(2) infrared

(3) violet

(4) ultraviolet

2. The energy of a photon varies directly with its

(1) frequency

(2) wavelength

(3) speed

(4) rest mass

3. The wavelength of photon A is greater than the wavelength of photon B. Compared to the energy of photon A, the energy of photon B is

(1) less

(2) greater

(3) the same

4. Which is conserved when a photon and a free electron collide?

(1) velocity only

(2) both velocity and energy

(3) momentum only

(4) both momentum and energy

5. The concept that electrons exhibit wave properties can best be demonstrated by the

(1) collisions between photons and electrons

(2) existence of an electron antiparticle

(3) production of electron interference patterns

(4) classification of the electron as a lepton

6. Compared to the amount of energy required to excite an atom, the amount of energy released by the atom when it returns to the ground state is

(1) less

(2) greater

(3) the same

10

11

12

13

7. A hydrogen atom is excited to the $n = 3$ state. In returning to the ground state, the atom could *not* emit a photon with an energy of

(1) 1.89 eV

(2) 10.20 eV

(3) 12.09 eV

(4) 12.75 eV

8. During which energy level change of the hydrogen atom does the emitted photon have the shortest wavelength?

(1) $n = 5$ directly to $n = 2$

(2) $n = 4$ directly to $n = 2$

(3) $n = 2$ directly to $n = 4$

(4) $n = 2$ directly to $n = 5$

9. Which type of force overcomes the repulsive electrostatic force between protons in the nucleus of an atom?

(1) magnetic

(2) nuclear

(3) gravitational

(4) centripetal

10. How much energy would be generated if a 1.00×10^{-3}-kilogram mass was completely converted to energy?

(1) 9.31×10^{-1} MeV

(2) 9.31×10^{2} MeV

(3) 9.00×10^{13} J

(4) 9.00×10^{16} J

11. The subatomic particles that make up both protons and neutrons are called

(1) electrons (3) positrons

(2) leptons (4) quarks

12. The electron is classified as a

(1) baryon

(2) lepton

(3) meson

(4) quark

13. If c is the speed of light in a vacuum, which is an acceptable unit for the mass of a subatomic particle?

(1) GeV

(2) GeV · c

(3) GeV/c

(4) GeV/c^2

Base your answers to questions 14 and 15 on the following information, which represents a nuclear reaction.

$$^{3}_{1}\text{H} + {}^{1}_{1}\text{H} \rightarrow {}^{4}_{2}\text{He} + \text{energy}$$

The masses of the nuclei are:

$^{1}_{1}$H = 1.00813 u

$^{3}_{1}$H = 3.01695 u

$^{4}_{2}$He = 4.00388 u

14. Which occurs as a result of this reaction?

(1) Mass is converted into energy.

(2) Energy is converted into matter.

(3) Mass and energy are destroyed.

(4) Mass and energy are created.

15. How much energy is released during the reaction?

(1) 3.39×10^{-21} MeV

(2) 2.12×10^{-2} MeV

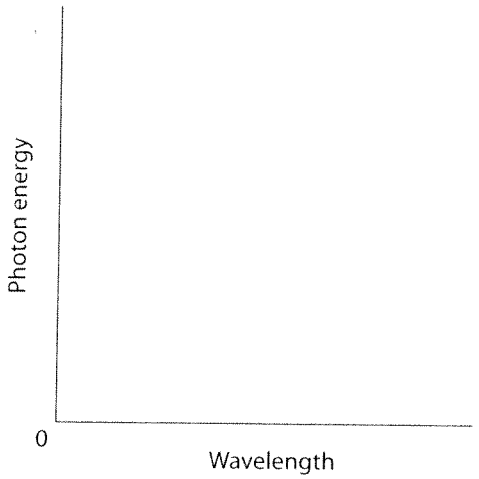
(3) 1.97×10^{1} MeV

(4) 1.91×10^{15} MeV

Part B

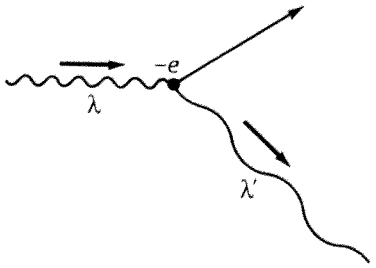
16. Determine the energy of a photon with a frequency of 5.00×10^{15} hertz. [2]

17. On the axes below sketch a line to represent the relationship between photon energy and wavelength for a series of photons. [1]



Base your answers to questions 18 through 20 on the following information and diagram.

The diagram represents the collision of an X-ray photon having wavelength λ with an electron $-e$ in an atom. The electron is ejected from the atom, and a photon having a longer wavelength λ' than the incident photon is also emitted.



18. Determine the wavelength λ of an incident photon which has a frequency of 1.00×10^{18} hertz. [2]

19. Energy is conserved in the collision. Write an expression in terms of photon wavelength to represent the electron's increase in energy as a result of the collision. [1]

20. Compared to the total momentum of the photon-electron system before the collision, the total momentum of the photon-electron system after the collision is

(1) less

(2) greater

(3) the same

Base your answers to questions 21 through 24 on the information that follows.

A mercury atom makes a direct transition from energy level *e* to energy level *b*.

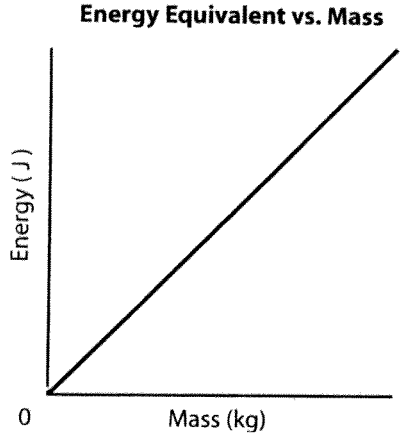
21. Determine the energy in electronvolts that is given off in this transition. [1]

22. What is the energy in joules of the photon emitted in the transition? [1]

23. Determine the frequency of the radiation corresponding to the emitted photon. [2]

24. Explain what would happen if a 4.50-electronvolt photon was incident on a mercury atom in the ground state. [1]

25. The following graph represents the relationship between mass and its energy equivalent.



What is the physical signficance of the slope of the line? [1]

26. A proton has a quark content of *uud* and a neutron has a quark content of *udd*. What is the quark content of an antiproton? [1]

Base your answers to questions 27 and 28 on your knowledge of physics.

27. Explain how scientists are able to identify the elements in a star without sending a space probe to it. [1]

28. Show how Planck's constant could be written with the unit kilogram · meter^2/second. [1]

Base your answers to questions 29 through 31 on the information in the following chart.

Particle	Rest Mass
proton	1.0073 u
neutron	1.0087 u

29. Determine the energy equivalent of the rest mass of a neutron in megaelectronvolts. [2]

30. A tritium nucleus consists of one proton and two neutrons and has a total mass of 3.0170 universal mass units. Determine the difference in mass between the total mass of the nucleons and the mass of the tritium nucleus. [2]

31. Which force between the proton and the neutrons in a tritium atom has the greatest magnitude?

(1) electrostatic force

(2) gravitational force

(3) magnetic force

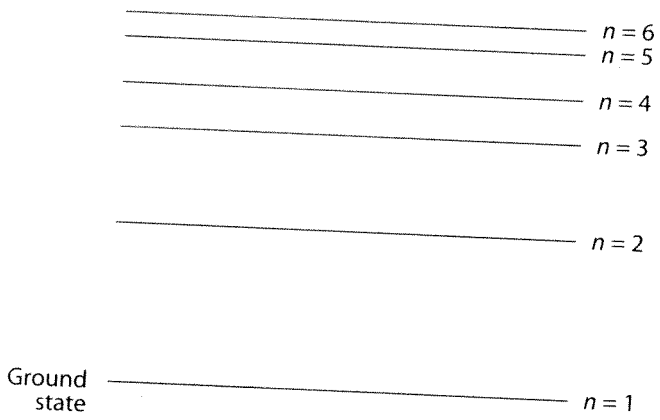
(4) nuclear force

Part C

32. According to the *Reference Tables for Physical Setting/Physics,* one universal mass unit is equal to 9.31×10^2 megaelectronvolts. Determine the value for the universal mass unit in kilograms. [2]

33. An alpha particle consists of 2 protons and 2 neutrons. A gold atom has 79 electrons and a nucleus containing 79 protons and 118 neutrons. Determine the force of repulsion between the alpha particle and the gold nucleus when they are separated by a distance of 1.00×10^{-10} meter. [2]

34. The diagram that follows is the energy-level diagram for a fictitious element. Draw arrows on the diagram to represent all possible electron transitions that would cause photons to be emitted from atoms of this element in the $n = 5$ excited state. [2]



35. Determine the approximate number of photons emitted each second by a 150-watt incandescent bulb that produces white light. [3]

Base your answers to questions 36 through 38 on the following information.

According to Bohr's model of the hydrogen atom, the electron can exist only in certain allowed orbits each having radius r_n, which is determined by the energy level n. The equation for calculating this radius is $r_n = \frac{n^2h^2}{4\pi^2 m_e k e^2}$, where the quantities are represented by the same symbols as in the *Reference Tables for Physical Setting/Physics.*

36. Determine the radius in meters of the hydrogen atom in the ground state. [3]

37. Express the radius of the hydrogen atom in the ground state in nanometers to the proper number of significant digits. [1]

38. Express, in lowest terms, the ratio of the radius of a hydrogen atom in excited state $n = 4$ to the radius of a hydrogen atom in excited state $n = 2$. [1]

Base your answers to questions 39 through 42 on the following statement.

Under certain conditions an electron and a positron can annihilate each other and produce two photons. Annihilation is a process in which a particle and its antiparticle are converted into energy.

39. Determine the combined energy in joules of the photons created when an electron and a positron annihilate each other. [2]

40. Assuming the photons are identical, express the energy of one photon in electronvolts. [1]

41. Assuming the photons are identical, determine the frequency of one photon. [2]

42. According to information in the electromagnetic spectrum chart in the *Reference Tables for Physical Setting/Physics,* how would one of these photons be classified? [1]