Physics Name

Modern + Nuclear Review

1 An x-ray photon collides with an electron in an atom, ejecting the electron and emitting another photon. During the collision, there is conservation of

1 momentum, only
2 energy, only
3 both momentum and energy
4 neither momentum nor energy

2 After Rutherford bombarded gold foil with alpha particles, he concluded that the volume of an atom is mostly empty space. Which observation led Rutherford to this conclusion?

1 Some of the alpha particles were deflected 180°.
2 The paths of deflected alpha particles were hyperbolic.
3 Many alpha particles were absorbed by gold nuclei.
4 Most of the alpha particles were not deflected.

3 The threshold frequency for a photoemissive surface is 1.0×10^{14} hertz. What is the work function of the surface?

(1) 1.0×10^{-14} J
(2) 6.6×10^{-20} J
(3) 6.6×10^{-48} J
(4) 2.2×10^{-28} J

4 A metal surface emits photoelectrons when illuminated by green light. This surface must also emit photoelectrons when illuminated by

1 blue light
2 yellow light
3 orange light
4 red light

5 Which electron transition in the hydrogen 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 $n = 3$
(4) $n = 5$ to $n = 4$

6 The term "electron cloud" refers to the

1 electron plasma surrounding a hot wire
2 cathode rays in a gas discharge tube
3 high-probability region for an electron near an atom
4 negatively charged cloud that can produce a lightning strike

7 What is the minimum energy required to ionize a hydrogen atom in the $n = 3$ state?

(1) 13.60 eV
(2) 12.09 eV
(3) 5.52 eV
(4) 1.51 eV

8 When a source of dim orange light shines on a photosensitive metal, no photoelectrons are ejected from its surface. What could be done to increase the likelihood of producing photoelectrons?

1 Replace the orange light source with a red light source.
2 Replace the orange light source with a higher frequency light source.
3 Increase the brightness of the orange light source.
4 Increase the angle at which the photons of orange light strike the metal.

9 In Rutherford's model of the atom, the positive charge

1 is distributed throughout the atom's volume
2 revolves about the nucleus in specific orbits
3 is concentrated at the center of the atom
4 occupies most of the space in the atom

10 When 8.0-electronvolt photons strike a photoemissive surface, the maximum kinetic energy of ejected photoelectrons is 6.0 electronvolts. The work function of the photoemissive surface is

(1) 0.0 eV
(2) 2.0 eV
(3) 7.0 eV
(4) 14.0 eV

11 If the momentum of a particle is 1.8×10^{-22} kilogram-meter per second, its matter wavelength is approximately

(1) 1.2×10^{-55} m
(2) 2.7×10^{11} m
(3) 3.7×10^{-12} m
(4) 5.0×10^{-7} m

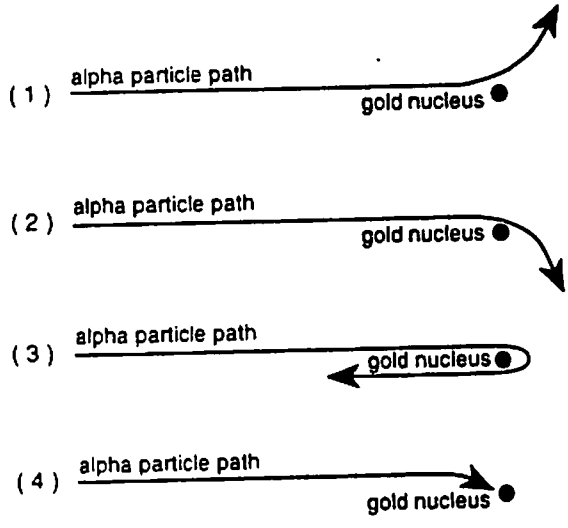
12 The work function for a copper surface is 7.3×10^{-19} joule. If photons with an energy of 9.9×10^{-19} joule are incident on the copper surface, the maximum kinetic energy of the ejected photoelectrons is

(1) 2.6×10^{-19} J
(2) 7.3×10^{-19} J
(3) 9.9×10^{-19} J
(4) 1.7×10^{30} J

13 The threshold frequency of a photoemissive surface is 7.1×10^{14} hertz. Which electromagnetic radiation, incident upon the surface, will produce the greatest amount of current?

1 low-intensity infrared radiation
2 high-intensity infrared radiation
3 low-intensity ultraviolet radiation
4 high-intensity ultraviolet radiation

14 Which diagram shows a possible path of an alpha particle as it passes very near the nucleus of a gold atom?



15 A hydrogen atom could have an electron energy-level transition from $n = 2$ to $n = 3$ by absorbing a photon having an energy of

(1) 1.51 eV
(2) 1.89 eV
(3) 4.91 eV
(4) 10.20 eV

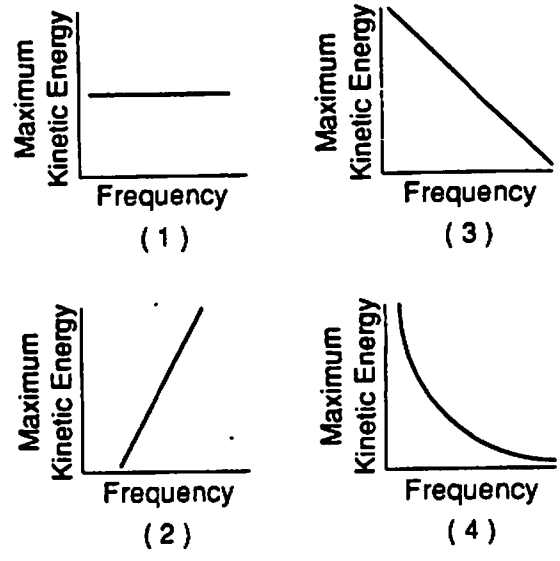
16 What is the *minimum* amount of energy needed to ionize a mercury electron in the *c* energy level?

(1) 0.57 eV
(2) 4.66 eV
(3) 5.52 eV
(4) 10.38 eV

17 All of the following particles are traveling at the same speed. Which has the greatest wavelength?

(1) proton (2) alpha particle (3) neutron (4) electron

18 Which graph below best represents the relationship between the frequency of a light source causing photoemission and the maximum kinetic energy of the photoelectrons produced?



19 Which observation was made by Rutherford when he bombarded gold foil with alpha particles?

1 Alpha particles were deflected toward a positive electrode.
2 Some alpha particles were deflected by the gold foil.
3 Most alpha particles were scattered 180° by the gold foil.
4 Gold foil had no effect on the path of alpha particles.

20 In the photoelectric effect, the speed of emitted electrons may be increased by

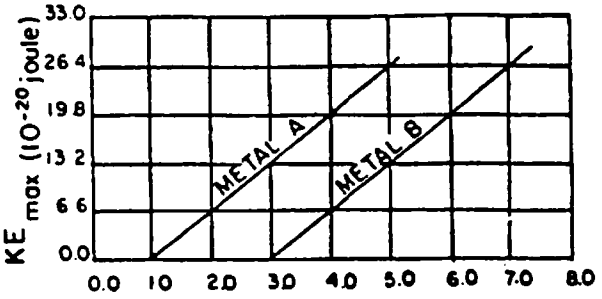
1 increasing the frequency of the light
2 decreasing the frequency of the light
3 increasing the intensity of illumination
4 decreasing the intensity of illumination

21 The Rutherford scattering experiments suggested that the mass of the atom is composed mostly of

1 electrons
2 positrons
3 nucleons
4 alpha particles

M + N #3

Base your answers to questions 22 through 26 on the graph below which represents the maximum kinetic energy of photoelectrons as a function of incident electromagnetic frequencies for two different photoemissive metals, *A* and *B*.



Note: 1 hertz = 1 cycle / second

22 The slope of each line is known as
1 Bohr's constant
2 the photoelectric constant
3 Compton's constant
4 Planck's constant

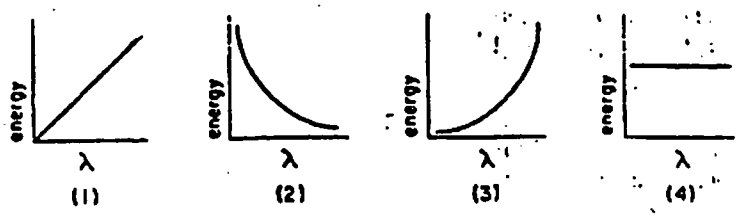
23 The threshold frequency for metal *A* is
(1) 1.0×10^{14} Hz
(2) 2.0×10^{14} Hz
(3) 3.0×10^{14} Hz
(4) 0.0 Hz

24 The work function for metal *B* is closest to
(1) 0.0 joules
(2) 2.0×10^{-19} joule
(3) 3.0×10^{-19} joule
(4) 1.5×10^{-14} joule

25 Compared to the work function for metal *B*, the work function for metal *A* is
1 less
2 greater
3 the same

26 Monochromatic light with a period of 2.0×10^{-15} second is incident on both of the metals. Compared to the energy of the photoelectrons emitted by metal *A*, the energy of the photoelectrons emitted by metal *B* is
1 less
2 greater
3 the same

27 Which graph best represents the relationship between the energy of a photon and its wavelength?



28 If an orbiting electron falls to a lower orbit, the total energy of that atom will
1 decrease
2 increase
3 remain the same

29 Compared to the photon momentum of blue light, the photon momentum of red light is
1 less
2 greater
3 the same

30 A hydrogen atom changes from the $n = 1$ energy state to the $n = 3$ energy state. This change could be caused by a single photon which has an energy of
(1) 1.5 eV
(2) 10.2 eV
(3) 12.1 eV
(4) 13.6 eV

31 Which photon could be absorbed by a hydrogen atom in the ground state?
(1) 11.0-eV photon
(2) 10.2-eV photon
(3) 3.4-eV photon
(4) 0.54-eV photon

32 Which energy level jump would show as a bright line in the *visible* spectrum of hydrogen?
(1) 1 to 2
(2) 2 to 3
(3) 3 to 2
(4) 4 to 7

M + N #4

33 How many neutrons are in an atom of $^{222}_{86}Rn$?

(1) 84
(2) 86
(3) 136
(4) 222

34 The chart below shows the masses of selected particles.

Particle	Mass
$^{235}_{92}U$	235.0 u
$^{138}_{56}Ba$	137.9 u
$^{95}_{36}Kr$	94.9 u
$^{1}_{0}n$	1.0 u

In the equation

$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{138}_{56}Ba + ^{95}_{36}Kr + 3^{1}_{0}n + E$,

the energy E is equivalent to a mass of

(1) 0.2 u
(2) 2.0 u
(3) 2.2 u
(4) 0.0 u

35 Isotopes of the same element have nuclei with identical

1 mass numbers
2 binding energies
3 numbers of neutrons
4 numbers of protons

36 Which subatomic particle can *not* be accelerated by an electromagnetic field?

1 alpha
2 neutron
3 electron
4 positron

37 According to the Uranium Disintegration Series, the immediate decay product of $^{234}_{90}Th$ is

(1) $^{230}_{92}U$
(2) $^{230}_{89}Ac$
(3) $^{238}_{92}U$
(4) $^{234}_{91}Pa$

38 In the reaction $^{27}_{13}Al + ^{4}_{2}He \rightarrow ^{30}_{15}P + ^{1}_{0}n + X$, what could X represent?

1 proton
2 gamma radiation
3 alpha particle
4 beta particle

39 A radioactive isotope has a half-life of 3 minutes. If 10 kilograms of this isotope remains after 15 minutes, the original mass of the isotope must have been

(1) 50 kg
(2) 160 kg
(3) 250 kg
(4) 320 kg

40 When an atomic nucleus captures an electron, the atomic number of that nucleus

1 decreases by 1
2 decreases by 2
3 increases by 1
4 increases by 2

41 The equation $^{3}_{1}H + ^{1}_{1}H \rightarrow ^{4}_{2}He +$ energy is an example of

1 alpha decay
2 positron capture
3 fusion
4 fission

42 Which equation represents nuclear fission?

(1) $^{214}_{82}Pb \rightarrow ^{214}_{83}Bi + ^{0}_{-1}e$

(2) $4^{1}_{1}H \rightarrow ^{4}_{2}He + 2^{0}_{+1}e$

(3) $^{235}_{92}U + ^{1}_{0}n \rightarrow ^{138}_{56}Ba + ^{95}_{36}Kr + 3^{1}_{0}n$

(4) $^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He$

Base your answers to questions 43 through 46 the information in the chart below.

Particle	Rest Mass
proton	1.0073 u
neutron	1.0087 u

43 The energy equivalent of the rest mass of a proton is approximately

(1) 9.4×10^2 MeV
(2) 1.9×10^3 MeV
(3) 9.1×10^{16} MeV
(4) 6.4×10^{18} MeV

44 A tritium nucleus consists of one proton and two neutrons and has a total mass of 3.0170 atomic mass units. What is the mass defect of the tritium nucleus?

(1) 0.0014 u
(2) 0.0077 u
(3) 1.0010 u
(4) 2.0160 u

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

1 electrostatic force
2 gravitational force
3 magnetic force
4 nuclear force

46 Tritium would most likely be used as a

1 fuel in a fusion reaction
2 fuel in a fission reaction
3 coolant in a nuclear reactor
4 moderator in a nuclear reactor

47 A nucleus having an odd number of protons and an odd number of neutrons is likely to be radioactive. Which nuclide matches this description?

(1) $^{29}_{14}Si$
(2) $^{32}_{15}P$
(3) $^{32}_{16}S$
(4) $^{35}_{17}Cl$

48 How do cloud chambers, spark chambers, and Geiger counters aid in the study of the nucleus?

1 They detect subatomic particles that exit the nucleus.
2 They detect the presence of a magnetic field around the nucleus.
3 They accelerate the nucleus before it collides with the particle beam.
4 They accelerate subatomic particles that exit the nucleus.

49 Which nuclear particle is emitted as an atom of $^{238}_{92}U$ decays to $^{234}_{90}Th$?

1 neutron
2 positron
3 alpha particle
4 beta particle

50 In the equation below, what is particle X?

$$^{9}_{4}Be + {}^{4}_{2}He \rightarrow {}^{12}_{6}C + X$$

1 an electron
2 a proton
3 a positron
4 a neutron

51 In a nuclear reactor, the function of a control rod is to

1 slow down neutrons
2 speed up neutrons
3 absorb neutrons
4 produce neutrons

52 The radioactive waste strontium-90 has a half-life of 28 years. How long must a sample of strontium-90 be stored to insure that only $\frac{1}{16}$ of the original sample remains as radioactive strontium-90?

(1) 28 years
(2) 56 years
(3) 84 years
(4) 112 years

53 Which atom has the same number of neutrons as $^{16}_{8}O$?

(1) $^{16}_{7}N$ (3) $^{15}_{7}N$
(2) $^{17}_{8}O$ (4) $^{15}_{8}O$

54 The force that holds the nucleons of an atom together is

1 weak and short-ranged
2 weak and long-ranged
3 strong and short-ranged
4 strong and long-ranged

55 Approximately how much energy is produced when 0.50 atomic mass unit of matter is completely converted into energy?

(1) 9.3 MeV (3) 4.7 MeV
(2) 9.3×10^2 MeV (4) 4.7×10^2 MeV

56 Atoms of different isotopes of the same element contain the same number of

1 neutrons, but a different number of protons
2 neutrons, but a different number of electrons
3 electrons, but a different number of protons
4 protons, but a different number of neutrons

57 The disintegration of the nucleus of an atom of a naturally occurring radioactive element may produce more

1 neutrons in the nucleus
2 electrons in the nucleus
3 protons in the nucleus
4 atomic mass

58 In the nuclear equation $^{14}_{6}C \rightarrow {}^{14}_{7}N + X$, the X represents a

1 beta particle 3 neutron
2 gamma ray 4 positron

59 The half-life of a radium isotope is 1,600 years. After 4,800 years, approximately how much of an original 10.0-kilogram sample of this isotope will remain?

(1) 0.125 kg (3) 1.67 kg
(2) 1.25 kg (4) 3.33 kg

60 In nuclear reactors, neutrons are slowed down by

1 moderators 3 fuel rods
2 control rods 4 accelerators

61 For nuclear fusion to occur, the reacting nuclei must

1 absorb thermal neutrons
2 have large kinetic energies
3 be fissionable
4 have a critical mass

Note that question 62 has only three choices.

62 If the mass defect for nucleus X is larger than the mass defect for nucleus Y, then nucleus X has

1 a smaller binding energy than nucleus Y
2 a larger binding energy than nucleus Y
3 the same binding energy as nucleus Y

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