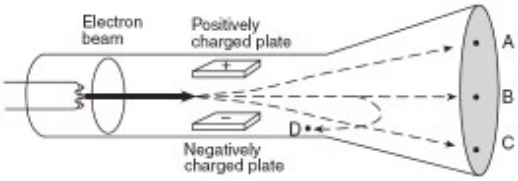
Name: _____

1. The diagram below shows a beam of electrons fired through the region between two oppositely charged parallel plates in a cathode ray tube.



After passing between the charged plates, the electrons will most likely travel path

A. *A*
B. *B*
C. *C*
D. *D*

2. Base your answer to the question on the information below.

A photon with a frequency of 5.02×10^{14} hertz is absorbed by an excited hydrogen atom. This causes the electron to be ejected from the atom, forming an ion.

a) Calculate the energy of this photon in joules.

Answer: E_{photon} = [ ] $\times 10^{-19}$ J

b) Determine the energy of this photon in electronvolts.

Answer: [ ] eV

c) What is the number of the *lowest* energy level (closest to the ground state) of a hydrogen atom that contains an electron that would be ejected by the absorption of this photon?

Answer: n = [ ]

Figure 1

Base your answer to the question on the information below and on your knowledge of physics.

The Great Nebula in the constellation Orion consists primarily of excited hydrogen gas. The electrons in the atoms of excited hydrogen have been raised to higher energy levels. When these atoms release energy, a frequent electron transition is from the excited $n = 3$ energy level to the $n = 2$ energy level, which gives the nebula one of its characteristic colors.

3. **[Refer to figure 1]**

Calculate the frequency of the emitted photon. [Show all work, including the equation and substitution with units.]

4. A hydrogen atom with an electron initially in the $n = 2$ level is excited further until the electron is in the $n = 4$ level. This energy level change occurs because the atom has

A. absorbed a 0.85-eV photon
B. emitted a 0.85-eV photon
C. absorbed a 2.55-eV photon
D. emitted a 2.55-eV photon

Figure 2

Base your answer to this question on the information below.

A photon with a frequency of 5.48×10^{14} hertz is emitted when an electron in a mercury atom falls to a lower energy level.

5. **[Refer to figure 2]**
Identify the color of light associated with this photon.

A. green
B. yellow
C. blue
D. orange

Figure 3

Base your answer to the question on the data table below. The data table lists the energy and corresponding frequency of five photons.

Photon	Energy (J)	Frequency (Hz)
A	6.63×10^{-15}	1.00×10^{19}
B	1.99×10^{-17}	3.00×10^{16}
C	3.49×10^{-19}	5.26×10^{14}
D	1.33×10^{-20}	2.00×10^{13}
E	6.63×10^{-26}	1.00×10^{8}

6. **[Refer to figure 3]**
In which part of the electromagnetic spectrum would photon *D* be found?

A. infrared
B. visible
C. ultraviolet
D. x ray

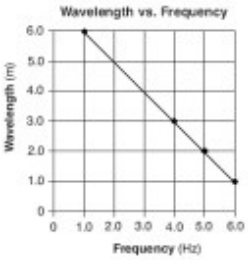
Figure 4

Base your answer to the question on the information below.

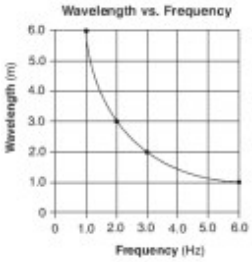
A student generates a series of transverse waves of varying frequency by shaking one end of a loose spring. All the waves move along the spring at a speed of 6.0 meters per second.

7. **[Refer to figure 4]**
Which graph below properly plots the points for wavelength versus frequency?

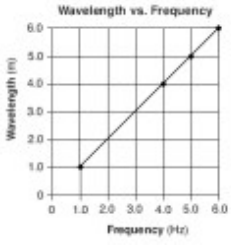
A.



C.



B.



D.

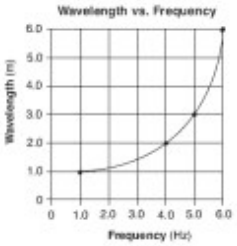


Figure 5

Base your answer to the question on the information below.

A photon with a wavelength of 2.29×10^{-7} meter strikes a mercury atom in the ground state.

8. **[Refer to figure 5]**
Determine the energy, in electronvolts, of this photon.

Answer: _____ eV

9. Base your answers to the questions on the Energy Level Diagram for Hydrogen in the ***Reference Tables for Physical Settings/Physics***.

(a) Determine the energy, in electronvolts, of a photon emitted by an electron as it moves from the $n = 6$ to the $n = 2$ energy level in a hydrogen atom.

Answer: _____ eV

(b) Convert the energy of the photon in part (a) to joules.

Answer: _____ $\times 10^{-19}$ J

(c) Calculate the frequency of the emitted photon.

Answer: _____ $\times 10^{14}$ Hz

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

The alpha line in the Balmer series of the hydrogen spectrum consists of light having a wavelength of 6.56×10^{-7} meter.

a Calculate the frequency of this light.

Answer: _____ $\times 10^{14}$ Hz

b Determine the energy in joules of a photon of this light.

Answer: _____ $\times 10^{-19}$ J

c Determine the energy in electronvolts of a photon of this light.

Answer: _____ eV

11. Which phenomenon is most easily explained by the particle theory of light?

A. photoelectric effect
B. constructive interference
C. polarization
D. diffraction

12. An atom of $^{131}_{53}\mathrm{I}$ and an atom of $^{127}_{53}\mathrm{I}$ contain the same number of

A. quarks
B. neutrons
C. nucleons
D. protons

13. **[Refer to figure 2]**
Determine the energy of this photon in electronvolts.

Answer: [ ] eV

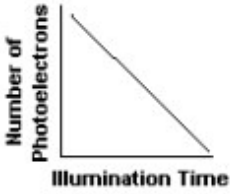
14. A photon has a wavelength of 9.00×10^{-10} meter. Calculate the energy of this photon in joules.

Answer: [ ] $\times 10^{-16}$ J

15. A beam of monochromatic light incident on a metal surface causes the emission of photoelectrons. The length of time that the surface is illuminated by this beam is varied, but the intensity of the beam is kept constant. Which graph below best represents the relationship between the total number of photoelectrons emitted and the length of time of illumination?

A.

C.



B.

D.

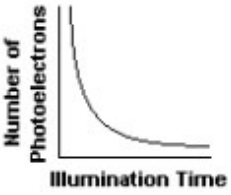


Figure 6

Base your answer to the question on the information below.

In a mercury atom, as an electron moves from energy level *i* to energy level *a,* a single photon is emitted.

16. **[Refer to figure 6]**
Determine the energy, in electronvolts, of this emitted photon.

Answer: _____ eV

17. The energy required to separate the 3 protons and 4 neutrons in the nucleus of a lithium atom is 39.3 megaelectronvolts. Determine the mass equivalent of this energy, in universal mass units.

Answer: _____ $\times 10^{-2}$ u

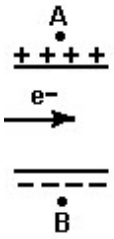
18. An electron in a hydrogen atom drops from the $n = 3$ energy level to the $n = 2$ energy level. The energy of the emitted photon is

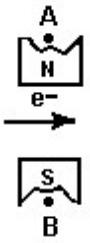
A. 1.51 eV
B. 1.89 eV
C. 3.40 eV
D. 4.91 eV

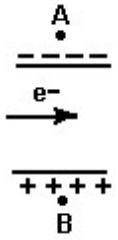
19. An excited hydrogen atom returns to its ground state. A possible energy change for the atom is a

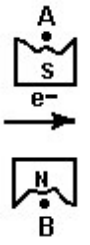
A. loss of 10.20 eV
B. gain of 10.20 eV
C. loss of 3.40 eV
D. gain of 3.40 eV

20. In each diagram below, an electron travels to the right between points *A* and *B*. In which diagram would the electron be deflected toward the bottom of the screen?

A.


C.


B.


D.


21. Which particles will not increase in kinetic energy in a particle accelerator?

A. alpha particles
B. beta particles
C. protons
D. neutrons

22. Excited hydrogen atoms are all in the $n = 3$ state. How many different photon energies could possibly be emitted as these atoms return to the ground state?

A. 1
B. 2
C. 3
D. 4

23. How much energy, in megaelectron volts, is produced when 0.250 universal mass unit of matter is completely converted into energy?

Answer: _____ MeV

Figure 7

Base your answer to the question on the information in the chart below and on your knowledge of physics.

Particle	Rest Mass
proton	1.0073 u
neutron	1.0087 u

24. **[Refer to figure 7]**
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?

A. 0.0014 u
B. 0.0077 u
C. 1.0010 u
D. 2.0160 u

Figure 8

Base your answer to this question on the information below.

As a mercury atom absorbs a photon of energy, an electron in the atom changes from energy level *d* to energy level *e*.

25. **[Refer to figure 8]**
Calculate the frequency of the absorbed photon.

A. 1.99×10^{14} Hz
B. 3.0×10^{15} Hz
C. 29.9×10^{14} Hz
D. 2.99×10^{14} Hz

Answer Key for Modern Physics Practice

1. A
2. 3.33, 2.08, 3
3.

Allow credit for the equation and substitution with units *or* for an answer, with units, that is consistent with the student's response to the previous question.

Example of a correct response:

$E_{photon} = hf$

$f = \frac{E_{photon}}{h}$

$f = \frac{3.02 \times 10^{-19}\ J}{6.63 \times 10^{-34}\ J \bullet s}$

Allow credit for the correct answer with units *or* for an answer, with units, that is consistent with the student's response to the first part of the question.

Example of a correct response:

$f = 4.56 \times 10^{14}$ Hz

Note: Do *not* penalize the student more than 1 credit for errors in units in the question.

4. C
5. A
6. A
7. C
8. 5.43
9. 3.02, 4.83, 7.29
10. 4.6 or 4.57, 3.0 or 3.03, 1.9 or 1.89
11. A
12. D
13. 2.27
14. 2.21
15. B
16. 8.82
17. 4.22
18. B
19. A
20. B
21. D
22. C
23. 233
24. B
25. D