

**Phys.G12-Atomic physics-H.W.****Multiple Choice**

Identify the choice that best completes the statement or answers the question.

- \_\_\_\_\_ 1. A monochromatic light beam with a quantum energy value of 3.0 eV is incident upon a photocell. The work function of the photocell is 1.6 eV. What is the maximum kinetic energy of the ejected electrons?
- |           |           |
|-----------|-----------|
| a. 1.4 eV | c. 2.4 eV |
| b. 4.6 eV | d. 4.8 eV |

**Choose the best answer from the options that follow each question.**

- \_\_\_\_\_ 2. A photon with an energy of 2.86 eV is absorbed by a hydrogen atom. Afterwards, three photons are spontaneously emitted. Which statement correctly describes the emitted photons?
- |   |
|---|
| a. The sum of the emitted photon energies equals 2.86 eV.                 |
| b. Three photons are always emitted when a 2.86 eV photon is absorbed.    |
| c. The photons are produced by a single electron energy-level transition. |
| d. The emitted photons each have the same wavelengths.                    |
- \_\_\_\_\_ 3. What type of spectrum is observed in the light from the sun and other stars?
- |                           |
|---------------------------|
| a. an absorption spectrum |
| b. a continuous spectrum  |
| c. an emission spectrum   |
| d. an atomic spectrum     |
- \_\_\_\_\_ 4. Which of the following statements correctly describes an atom's energy levels as they are depicted in an energy-level diagram?
- |   |
|---|
| a. The higher energy levels are separated by greater amounts. |
| b. The higher energy levels are separated by smaller amounts. |
| c. The energy levels are separated by equal amounts.          |
| d. The energy levels are the same for all elements.           |
- \_\_\_\_\_ 5. What is the energy of a photon whose frequency is  $6.0 \times 10^{20}$  Hz?  
( $h = 6.63 \times 10^{-34}$  J•s; 1 eV =  $1.60 \times 10^{-19}$  J)
- |            |            |
|------------|------------|
| a. 3.3 MeV | c. 2.5 MeV |
| b. 4.8 MeV | d. 1.6 MeV |
- \_\_\_\_\_ 6. Classical electromagnetic theory predicted that the energy radiated by a blackbody would become infinite as the wavelength became shorter. What was the contradiction between observation and this result called?
- |                              |                                |
|------------------------------|--------------------------------|
| a. the photoelectric effect  | c. the ultraviolet catastrophe |
| b. the wave-particle duality | d. the quantum theory          |
- \_\_\_\_\_ 7. Which of the following is *not* a weakness of the Rutherford model of the atom?
- |  |
|--|
| a. The atom is mostly empty space.         |
| b. The atom is unstable.                   |
| c. The atom radiates energy continuously.  |
| d. The atom cannot produce spectral lines. |

- \_\_\_\_\_ 8. What is the concentration of positive charge and mass in Rutherford's atomic model called?
- alpha particle
  - proton
  - nucleus
  - neutron
- \_\_\_\_\_ 9. What would you observe if light from argon gas were passed through a prism?
- a series of dark lines imposed on a continuous spectrum
  - a continuous spectrum
  - a single bright line
  - a series of discrete bright lines
- \_\_\_\_\_ 10. What is the frequency of a photon with an energy of  $1.99 \times 10^{-19}$  J?  
( $h = 6.63 \times 10^{-34}$  J•s)
- |                             |                             |
|-----------------------------|-----------------------------|
| a. $4.00 \times 10^{14}$ Hz | c. $1.00 \times 10^{14}$ Hz |
| b. $3.00 \times 10^{14}$ Hz | d. $2.00 \times 10^{14}$ Hz |
- \_\_\_\_\_ 11. Why is a probability wave required to describe an electron's location?
- The electron may be found at various distances from the nucleus.
  - The electron's location can be precisely determined.
  - The electron has less probability of being at the first Bohr orbit than at any other distance.
  - Electrons violate Heisenberg's uncertainty principle.

**Choose the best answer from the options that follow each question.**

- \_\_\_\_\_ 12. Classical electromagnetic theory predicted that the energy radiated by a blackbody would become infinite as the wavelength of the radiation became shorter. What was the contradiction between observation and this result called?
- the photoelectric effect
  - the quantum theory
  - the ultraviolet catastrophe
  - the Compton shift
- \_\_\_\_\_ 13. What is the energy of a photon with a frequency of  $5.45 \times 10^{14}$  Hz?  
( $h = 6.63 \times 10^{-34}$  J•s)
- $3.61 \times 10^{-19}$  J
  - $1.22 \times 10^{-48}$  J
  - $3.65 \times 10^{-40}$  J
  - $3.61 \times 10^{-34}$  J
- \_\_\_\_\_ 14. For a photoelectron to be emitted by a metal that is exposed to photons, the energy of the photons must be greater than what property of the metal?
- its work function
  - its electronegativity
  - its ionization energy
  - its threshold frequency

**Choose the best answer from the options that follow each question.**

- \_\_\_\_\_ 15. What is the momentum of a proton with a de Broglie wavelength of  $6.63 \times 10^{-9} \text{ m}$ ?  
( $h = 6.63 \times 10^{-34} \text{ J}\cdot\text{s}$ )
- $1.00 \times 10^{-25} \text{ kg}\cdot\text{m/s}$
  - $3.33 \times 10^{-34} \text{ kg}\cdot\text{m/s}$
  - $4.40 \times 10^{-44} \text{ kg}\cdot\text{m/s}$
  - $3.00 \times 10^{-17} \text{ kg}\cdot\text{m/s}$
- \_\_\_\_\_ 16. Which of the following experiments indicated that matter waves exist?
- the diffraction of electrons by a single crystal
  - the emission of electrons by a metal exposed to photons
  - the change in photon wavelength during scattering by electrons
  - the spontaneous emission of photons by electron transitions in an atom
- \_\_\_\_\_ 17. According to the matter-wave modification to the Bohr model of the atom, what do the orbits of electrons in an atom resemble?
- probability waves
  - standing waves
  - traveling waves
  - longitudinal waves
- \_\_\_\_\_ 18. What is the process in which an electron returns to a lower energy level and emits a photon?
- line absorption
  - line emission
  - spontaneous emission
  - energy transition
- \_\_\_\_\_ 19. What were the units of light energy emitted by blackbody radiation originally called?
- |               |                   |
|---------------|-------------------|
| a. quanta     | c. electron volts |
| b. resonators | d. joules         |

**Choose the best answer from the options that follow each question.**

- \_\_\_\_\_ 20. A monochromatic light beam with a quantum energy value of  $3.0 \text{ eV}$  is incident upon a photocell. The work function of the photocell is  $1.6 \text{ eV}$ . What is the maximum kinetic energy of the ejected electrons?
- $2.4 \text{ eV}$
  - $4.6 \text{ eV}$
  - $1.4 \text{ eV}$
  - $4.8 \text{ eV}$
- \_\_\_\_\_ 21. What causes the dark lines in the absorption spectrum of an element to occur?
- Photons are emitted when electrons jump from a higher-energy to a lower-energy state.
  - Photons are absorbed when electrons jump from a lower-energy to a higher-energy state.
  - Photons are absorbed when electrons jump from a higher-energy to a lower-energy state.
  - Photons are emitted when electrons jump from a lower-energy to a higher-energy state.
- \_\_\_\_\_ 22. Light with an energy equal to three times the work function of a given metal causes the metal to eject photoelectrons. What is the ratio of the maximum photoelectron kinetic energy to the work function?
- 4 : 1
  - 1 : 1
  - 3 : 1
  - 2 : 1

- \_\_\_\_\_ 23. What is the frequency of a photon with an energy of  $1.99 \times 10^{-19}$  J?  
( $h = 6.63 \times 10^{-34}$  J•s)
- $4.00 \times 10^{14}$  Hz
  - $3.00 \times 10^{14}$  Hz
  - $1.00 \times 10^{14}$  Hz
  - $2.00 \times 10^{14}$  Hz
- \_\_\_\_\_ 24. What does the peak of a probability curve for an electron in an atom indicate?
- that the electron's location can be precisely determined
  - the distance from the nucleus at which the electron is most likely to be found
  - the location where there is zero probability of finding the electron
  - that Heisenberg's uncertainty principle is violated
- \_\_\_\_\_ 25. What were the units of light energy emitted by blackbody radiation originally called?
- joules
  - quanta
  - electron volts
  - resonators
- \_\_\_\_\_ 26. What is the speed of a 50 g rock if its de Broglie wavelength is  $3.32 \times 10^{-34}$  m? ( $h = 6.63 \times 10^{-34}$  J•s)
- 20 m/s
  - 30 m/s
  - 60 m/s
  - 40 m/s
- \_\_\_\_\_ 27. What is the concentration of positive charge and mass in Rutherford's atomic model called?
- proton
  - alpha particle
  - nucleus
  - neutron
- \_\_\_\_\_ 28. When a high potential difference is applied to a low-pressure gas, what kind of spectrum will the gas emit?
- emission
  - monochromatic
  - continuous
  - absorption
- \_\_\_\_\_ 29. What is the process in which an electron returns to a lower energy level and emits a photon?
- line absorption
  - spontaneous emission
  - line emission
  - energy transition
- \_\_\_\_\_ 30. Which of the following processes is more easily observable for light with a short wavelength?
- interference
  - the photoelectric effect
  - radio transmission
  - diffraction
- \_\_\_\_\_ 31. What observation confirmed de Broglie's theory of matter waves?
- the scattering of alpha particles
  - the photoelectric effect
  - the spontaneous emission of photons
  - the diffraction of electrons
- \_\_\_\_\_ 32. Which statement about Rutherford's model of the atom is not correct?
- The model explains spectral lines.
  - The model states that atoms are unstable.
  - The model depicts electrons orbiting the nucleus as planets orbit the sun.
  - The model states that positive charge is unevenly distributed.
- \_\_\_\_\_ 33. What would you observe if light from argon gas were passed through a prism?
- a single bright line
  - a continuous spectrum
  - a series of discrete bright lines
  - a series of dark lines imposed on a continuous spectrum

- \_\_\_\_\_ 34. Which of the following is *not* a feature of Bohr's model of the atom?
- Electrons emit radiation continuously while orbiting the nucleus.
  - Only certain electron orbits are allowed.
  - Electrons move in circular orbits about the nucleus.
  - Electron jumps between energy levels account for discrete spectral lines.
- \_\_\_\_\_ 35. When a high potential difference is applied to a low-pressure gas, what kind of spectrum will the gas emit?
- emission
  - continuous
  - monochromatic
  - absorption

**Problem** Choose answers from A to D

36. How much energy does a photon of red light that has a wavelength of 645 nm contain? ( $h = 6.63 \times 10^{-34}$  J•s;  $c = 3.00 \times 10^8$  m/s; 1 eV =  $1.6 \times 10^{-19}$  J)
37. What is the energy, in eV, of a photon whose frequency is  $5.6 \times 10^{14}$  Hz? ( $h = 6.63 \times 10^{-34}$  J•s; 1 eV =  $1.60 \times 10^{-19}$  J)
38. A metal surface is illuminated first with light that has a wavelength of  $4.86 \times 10^{-7}$  m, then with light that has a wavelength of  $4.38 \times 10^{-7}$  m. The photoelectrons emitted by the metal under the  $4.25 \times 10^{-7}$  m light have twice the maximum kinetic energy of the photoelectrons emitted under the  $4.50 \times 10^{-7}$  m light. What is the work function of metal? ( $h = 6.63 \times 10^{-34}$  J•s;  $c = 3.00 \times 10^8$  m/s; 1 eV =  $1.60 \times 10^{-19}$  J)
39. What is the energy of a photon whose frequency is 312nm?  
( $h = 6.63 \times 10^{-34}$  J•s;  $c = 3.00 \times 10^8$  m/s; 1 eV =  $1.60 \times 10^{-19}$  J)

- A 2.3 eV  
B 3.98 eV  
C 1.93 eV  
D 2.29 eV

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