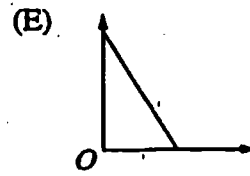
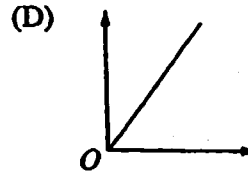
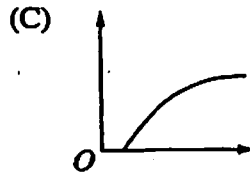
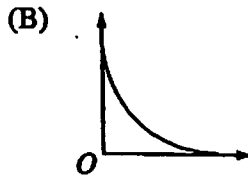
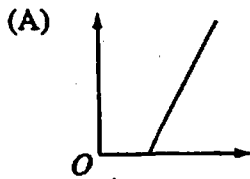


Questions 1 & 2 relate to the photoelectric effect. For each question, choose an answer from the following graphs.



1. Which graph shows the maximum kinetic energy of the emitted electrons *versus* the frequency of the light?

- (A) A
- (B) B
- (C) C
- (D) D
- (E) E

2. Which graph shows the total photoelectric current *versus* the intensity of the light for a fixed frequency above the cutoff frequency?

- (A) A
- (B) B
- (C) C
- (D) D
- (E) E

3. If the momentum of an electron doubles, its de Broglie wavelength is multiplied by a factor of

- (A) $\frac{1}{4}$
- (B) $\frac{1}{2}$
- (C) 1
- (D) 2
- (E) 4

4. Quantum concepts are critical in explaining all of the following EXCEPT

- (A) Rutherford's scattering experiments
- (B) Bohr's theory of the hydrogen atom
- (C) Compton scattering
- (D) the blackbody spectrum
- (E) the photoelectric effect

5. If photons of light of frequency f have momentum p , photons of light of frequency $2f$ will have a momentum of

- (A) $2p$
- (B) $\sqrt{2}p$
- (C) p
- (D) $\frac{p}{\sqrt{2}}$
- (E) $\frac{1}{2}p$

6. In an experiment, light of a particular wavelength is incident on a metal surface, and electrons are emitted from the surface as a result. To produce more electrons per unit time but with less kinetic energy per electron, the experimenter should do which of the following?

- (A) Increase the intensity and decrease the wavelength of the light.
- (B) Increase the intensity and the wavelength of the light.
- (C) Decrease the intensity and the wavelength of the light.
- (D) Decrease the intensity and increase the wavelength of the light.
- (E) None of the above would produce the desired result.

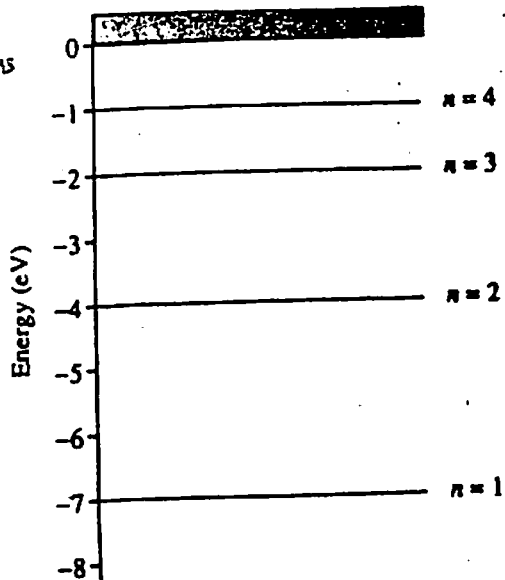
7. Quantum transitions that result in the characteristic sharp lines of the X-ray spectrum always involve

- (A) the inner electron shells
- (B) electron energy levels that have the same principal quantum number
- (C) emission of beta particles from the nucleus
- (D) neutrons within the nucleus
- (E) protons within the nucleus

Atomic Physics (pg. 1)

Questions

8 & 9



A hypothetical atom has four energy states as shown above.

8. Which of the following photon energies could NOT be found in the emission spectra of this atom after it has been excited to the $n = 4$ state?

- (A) 1 eV
- (B) 2 eV
- (C) 3 eV
- (D) 4 eV
- (E) 5 eV

9. Which of the following transitions will produce the photon with the longest wavelength?

- (A) $n = 2$ to $n = 1$
- (B) $n = 3$ to $n = 1$
- (C) $n = 3$ to $n = 2$
- (D) $n = 4$ to $n = 1$
- (E) $n = 4$ to $n = 3$

Radio waves
Infrared radiation
Visible light
Ultraviolet radiation
Gamma radiation

10. For the five types of electromagnetic radiation listed above, which of the following correctly describes the way in which wavelength, frequency, and photon energy change as one goes from the top of the list to the bottom?

| | Wavelength | Frequency | Photon Energy |
|-----|------------|-----------|---------------|
| (A) | Decreases | Decreases | Increases |
| (B) | Decreases | Increases | Increases |
| (C) | Increases | Decreases | Decreases |
| (D) | Increases | Decreases | Increases |
| (E) | Increases | Increases | Increases |

11. Of the following phenomena, which provides the best evidence that light can have particle properties?

- (A) Interference of light in thin films
- (B) Electromagnetic radiation
- (C) Photoelectric effect
- (D) Electron diffraction
- (E) X-ray diffraction

12. Of the following phenomena, which provides the best evidence that particles can have wave properties?

- (A) The absorption of photons by electrons in an atom
- (B) The α -decay of radioactive nuclei
- (C) The interference pattern produced by neutrons incident on a crystal
- (D) The production of x-rays by electrons striking a metal target
- (E) The scattering of photons by electrons at rest

13. In the photoelectric effect, the maximum speed of the electrons emitted by a metal surface when it is illuminated by light depends on which of the following?

- I. Intensity of the light
- II. Frequency of the light
- III. Nature of the photoelectric surface

- (A) I only
- (B) III only
- (C) I and II only
- (D) II and III only
- (E) I, II, and III

14. Atoms of isotopes of the same element contain the same number of

- (A) protons but a different number of neutrons
- (B) electrons but a different number of protons
- (C) neutrons but a different number of protons
- (D) neutrons as electrons
- (E) protons as neutrons

15. Which of the following experiments provided evidence that electrons exhibit wave properties?

- I. Millikan oil-drop experiment
- II. Davisson-Germer electron-diffraction experiment
- III. J. J. Thomson's measurement of the charge-to-mass ratio of electrons

- (A) I only
- (B) II only
- (C) I and III only
- (D) II and III only
- (E) I, II, and III