

תידון המדע הירושלמי תשס"ח - Jerusalem Science Contest 2008-2009
Electromagnetic and Ionizing radiation
Exam 8 — Chapter 31- Light Quanta

Name: _____

Date: _____

Raw Score: _____

Percentage Score: _____ %

Proctor for this Examinaton: _____ Form: _____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

- 1) A particle traveling at a relativistic velocity will
 - A) have a smaller mass than a slower moving particle
 - B) have a greater wavelength than a slower moving particle
 - C) have a smaller momentum than a particle travelling at a slower speed
 - D) have a greater frequency than a slower moving particle.
 - E) none of the preceding

- 2) Niels Bohr, one of the founders of quantum physics, referred to the combined wave/particle nature of photons and electrons by what term?
 - A) Supplementation
 - B) Strangeness
 - C) Complementary
 - D) Duality
 - E) none of the preceding

- 3) Which of the following is the correct mathematical representation of the uncertainty principle?
 - A) $\Delta p/\Delta x \geq h$
 - B) $\Delta p\Delta x \geq h$
 - C) $\Delta p/\Delta x \geq \hbar$
 - D) $\Delta p\Delta x \geq \hbar$
 - E) none of the preceding

- 4) A photon behaves as a particle
 - A) when it is in transit (between emission and detection times)
 - B) when it is being emitted
 - C) when it is being detected
 - D) when it is being emitted and when it is being detected
 - E) none of the time

- 5) What are the SI units of minimum uncertainty (\hbar)?
- A) kg m/s^2
 - B) $\text{kg m}^2/\text{s}^2$
 - C) $\text{kg m}^2/\text{s}$
 - D) kg m/s
 - E) none of the preceding
- 6) Angular frequency, ω , is equal to $2\pi f$, where f is the frequency (in Hertz). The angular frequency of a particle is directly proportional to what physical property (with \hbar as the proportionality constant)?
- A) mass
 - B) energy
 - C) velocity
 - D) momentum
 - E) none of the preceding
- 7) Momentum is directly proportional to which of the following, given \hbar as the proportionality constant?
- A) wave number
 - B) amplitude
 - C) frequency
 - D) wave length
 - E) none of the preceding
- 8) A photon of light has both wave and particle properties. An electron
- A) only behaves as a wave if it is a photoelectron
 - B) always behaves as a particle
 - C) like a photon, has both wave and particle properties
 - D) only behaves as a particle if it is a photoelectron
 - E) always behaves as a wave
- 9) Einstein was awarded the Nobel Prize in physics in 1921 for his work on?
- A) the theory of general relativity
 - B) the photoelectric effect
 - C) the confirmation of Maxwell's equations
 - D) the theory of special relativity
 - E) none of the preceding are suitable as a pump source
- 10) According to the uncertainty principle, if a particle's energy is known precisely, what associated physical parameter can not be exactly known?
- A) velocity
 - B) time
 - C) displacement
 - D) mass
 - E) none of the preceding

- 11) According to the de Broglie equation, every object in motion has a wavelength. A very massive object traveling at a slow speed would have
- A) a wavelength that increased with increasing velocity
 - B) a very small wavelength
 - C) a very large wavelength
 - D) an indeterminate wavelength
 - E) a wavelength that increased with increasing mass
- 12) Why can't the wavelength of a 20 g bullet travelling at 330 m/s be experimentally determined?
- A) The waves are too large to measure, about 10^{34} m
 - B) Objects that large do not have a wavelength
 - C) The waves are too small to measure, about 10^{-34} m
 - D) Because of the uncertainty principle
 - E) none of the preceding
- 13) In order for a photoelectron to be ejected an incoming photon must have a certain minimum
- A) amplitude
 - B) energy
 - C) momentum
 - D) velocity
 - E) none of the preceding.
- 14) The angular wave number, k , is equal to
- A) $\lambda/2\pi r$
 - B) none of the preceding
 - C) $\pi/2\lambda$
 - D) $\lambda/2\pi$
 - E) $\lambda/2\pi r^2$
- 15) The first person to observe the photoelectric effect was
- A) Albert Einstein
 - B) James Clerk Maxwell
 - C) Christian Huygens
 - D) Heinrich Hertz
 - E) Max Planck
- 16) Laser light is passed through a double slit refractor. Which of the following can be used to show the dual particle/wave nature of this light?
- A) lack of an interference pattern on film after a very short exposure (i.e. a pattern of apparently random dots)
 - B) the presence of an interference pattern of long exposure.
 - C) both A and B
 - D) none of the preceding

- 17) Which of the following equations show the relationship between the reduced Planck's constant, ' \hbar ' and Planck's constant, (' h ')?
- A) $\hbar = h/2\pi r$
 - B) $h = \hbar/2\pi r$
 - C) $h = \hbar/2\pi$
 - D) $\hbar = h/2\pi$
 - E) none of the preceding
- 18) Who was the physicist who first formulated the uncertainty principle?
- A) Werner Heisenberg
 - B) Niels Bohr
 - C) Albert Einstein
 - D) Max Planck
 - E) none of the preceding
- 19) The term "quantum" was first applied to discrete bundles of energy by
- A) Albert Einstein
 - B) Max Planck
 - C) James Clerk Maxwell
 - D) Heinrich Hertz
 - E) none of the preceding
- 20) A single photon of green light causes the ejection of a photoelectron when it hits the surface of a particular metal. If the intensity of light is increased
- A) the photoelectron will not be ejected
 - B) the photoelectron will be ejected at a greater velocity
 - C) more photoelectrons will be ejected
 - D) there will be no effect
 - E) none of the preceding.
- 21) Which of the following equations can be used to demonstrate that a gamma ray photon is much more damaging to living tissue than an infrared photon?
- A) $E = hc/f$
 - B) $E = hf$
 - C) $E = mc^2$
 - D) $c = \lambda v$
 - E) $E = h\lambda$

22) The expression $\frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$ is known as the

- A) Lorentz factor
- B) relativistic correction factor
- C) de Broglie factor
- D) Dirac factor
- E) none of the preceding

- 23) The minimal amount of energy, W_0 , required for an electron to leave a surface is called the
- A) binding coefficient
 - B) surface binding energy
 - C) work function
 - D) Maxwell's constant
 - E) none of the preceding
- 24) According to the uncertainty principal, which of the following two properties cannot be simultaneously known with exactitude?
- A) energy and momentum
 - B) mass and velocity
 - C) position and angular frequency
 - D) velocity and momentum
 - E) none of the preceding
- 25) Whose thesis, "Recherches sur la théorie des quanta" (Researches on the quantum theory), published in 1924, made him the first person to ever be awarded a Nobel prize for a doctoral dissertation?
- A) Henri Poincaré
 - B) Paul Dirac
 - C) Henri Becquerel
 - D) Louis de Broglie
 - E) none of the preceding