

Electromagnetic and Ionizing radiation

**Exam 7 — Supplementary Material & Chapter 30- pgs 592 -596
Lasers; Bio- and Chemiluminescence**

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) Lasing materials may be
 - A) solids
 - B) liquids
 - C) gases
 - D) all of the preceding.
 - E) none of the preceding.

- 2) A beam of photons having the same frequency, phase and direction is said to be
 - A) coherent
 - B) collimated
 - C) lasing
 - D) stimulated
 - E) none of the preceding

- 3) In order to be visible, a laser beam must
 - A) have a wavelength greater than 475 nm
 - B) have a power greater than 1 milliwatt (mW)
 - C) have a power greater than 5 milliwatts
 - D) be scattered off of the surface of something in the medium through which it passes
 - E) none of the preceding

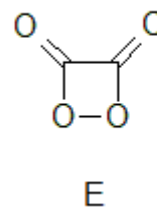
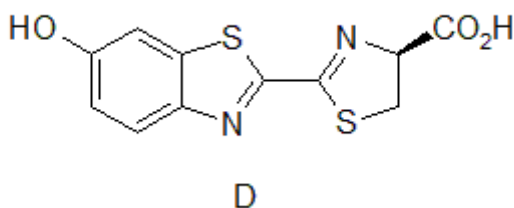
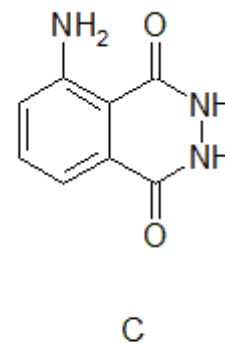
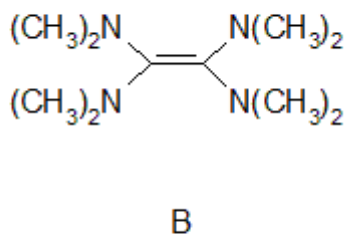
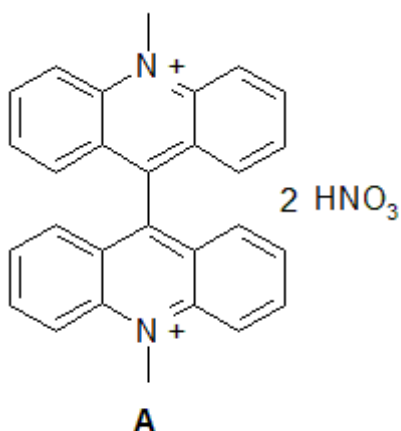
- 4) The space between the two reflecting mirrors of a laser is called the
 - A) optical cavity
 - B) focal chamber
 - C) pumping volume
 - D) lasing well
 - E) none of the preceding

- 5) Which of the following cannot be used as a pump source for a laser?
 - A) a flashlamp
 - B) high voltage
 - C) chemical excitation
 - D) all of the preceding are suitable as a pump source
 - E) none of the preceding are suitable as a pump source

- 6) What is the name of the four-membered ring consisting of two carbons and two adjacent oxygen atoms, which is an intermediate in many chemiluminescent reactions?
- A) 1,4-dioxane
 - B) 1,3-thiazole
 - C) 1,2-dioxetane
 - D) 1,2-oxazete
 - E) 1,3-oxazine
- 7) When an excited electron has fallen from a short-lived higher energy state to a longer lived lower energy state (but still above the ground state), that state is said to be
- A) stable
 - B) metastable
 - C) pseudostable
 - D) unstable
 - E) orthostable
- 8) In order for a material to be an effective lasing medium, electrons must remain in the excited state specified in the previous question for at least which of the following time ranges?
- A) picoseconds to nanoseconds
 - B) centiseconds to deciseconds
 - C) microseconds to milliseconds
 - D) one to ten seconds
 - E) none of the preceding
- 9) What is the energy source required for firefly bioluminescence?
- A) reduced nicotinamide adenine dinucleotide (NADH)
 - B) an as yet unidentified protein
 - C) adenosine triphosphate (ATP)
 - D) flavin mononucleotide (FMN)
 - E) none of the preceding
- 10) What inorganic cation is required for firefly bioluminescence to occur?
- A) K^+
 - B) Mg^{++}
 - C) Ca^{++}
 - D) Na^+
 - E) none of the preceding
- 11) In Lightsticks the "glow-in-the-dark" party favors demonstrated during the lecture, an excited molecule transfers its energy to a second molecule which is the actual emitter of a visible photon. What is the name given to these secondary molecules, which are frequently polynuclear hydrocarbons?
- A) emitters
 - B) sensitizers
 - C) PNAHs
 - D) luminizers
 - E) none of the preceding

- 12) The bioluminescent jellyfish *Aequorea victoria*, from which was extracted the green fluorescent protein GFP, uses another protein molecule (aequorin) to produce the light that excites GFP. Which of the following colors describes the light produced by aequorin?
- A) blue B) yellow C) green D) orange E) red
- 13) The chemiluminescent compound that is used to detect traces of blood for forensic work is
- A) luciferin
B) luminol
C) lophine
D) lucigenin
E) singlet oxygen
- 14) The ideal mode for most laser operations is a transverse electromagnetic wave pattern (TEM) of
- A) TEM₁₀
B) TEM₁₁
C) TEM₀₁
D) TEM₀₀
E) none of the preceding
- 15) The lasing medium used in the first laser was
- A) helium
B) a diode semiconductor
C) a helium/neon mixture
D) a ruby crystal
E) carbon dioxide

16) Which of the five compounds shown below represents the chemical structure of luminol?



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

17) Which of the five structures above is the chemiluminescent emitter that transfers energy to a fluorescent molecule, producing the many different colors of Lightsticks?

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

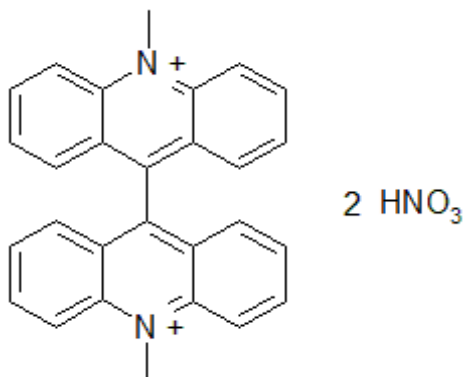
18) The marine creature *Euprymna scolopes* which returns to the surface at dawn to feed and has a bioluminescent bacteria-filled light organ on its underside is

- A) a squid B) an ostracod C) a jellyfish D) a shrimp E) a comb jelly

19) Which of the following must be true for lasing to occur?

- A) The stimulating photon and the emitted photon must both be moving in a different direction.
 B) The stimulating photon and the emitted photon must be 90° out of phase.
 C) The stimulating photon and the emitted photon must both be of the same amplitude.
 D) The stimulating photon must have the same energy as the allowed energy transition from the excited state to the ground state.
 E) None of the preceding are required for lasing.

20) The chemiluminescent compound shown below, bis-(N-methylacridinium) nitrate is also known as



- A) luminol.
 - B) lophine
 - C) luciferin
 - D) lucigenin
 - E) dioxetanedione
- 21) Light is emitted through only one of the two reflecting mirrors of a laser because
- A) the emitting mirror allows a small percentage of the light to be transmitted rather than reflected
 - B) the non-emitting mirror is made of a material that absorbs more light than it transmits
 - C) once lasing occurs, the non-emitting mirror becomes optically opaque
 - D) the emitting mirror has a small hole at its center
 - E) none of the preceding
- 22) The compounds responsible for bioluminescence are all referred to as
- A) luminols
 - B) lophines
 - C) luciferins
 - D) lucigenins
 - E) none of the preceding
- 23) The process whereby infrared photons are converted to visible light in a green laser is known as
- A) decavitation
 - B) color switching
 - C) color inversion
 - D) frequency doubling
 - E) none of the preceding
- 24) When there are more electrons in the excited state than the ground state, a material is said to have undergone a population
- A) excitation
 - B) transition
 - C) conversion
 - D) stimulated emission
 - E) none of the preceding.

- 25) Which of the following is believed to be the purpose of the bioluminescence of marine dinoflagellates?
- A) attracting a mate
 - B) attracting prey
 - C) attracting a predator that feeds on the fish that eat dinoflagellates
 - D) camouflage
 - E) none of the preceding