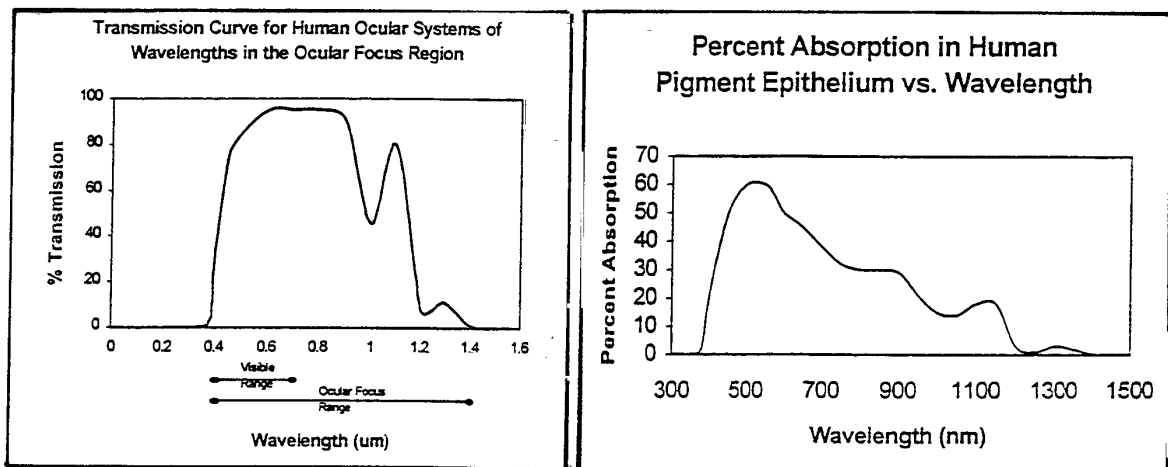


**QUESTION 9**

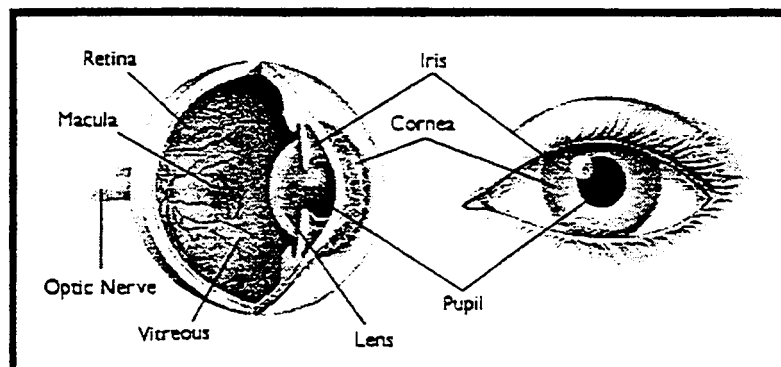
As Laser Safety Officer you are asked the following questions concerning laser hazards and safety.

**GIVEN**

- Limiting aperture = 7 mm.
- Following transmission and absorption graphs:



- Anatomy of the eye:



**POINTS**

- 20** A. Preventing eye injury is a primary concern of laser safety programs. For the following four types of lasers, **IDENTIFY** the anatomical structure(s) of the eye that are the most sensitive to damage. **JUSTIFY** the selection of the anatomical structure(s).
- 1) Far infrared, carbon dioxide laser (10.6  $\mu\text{m}$ ).
  - 2) Visible, gold vapor laser (0.628  $\mu\text{m}$ ).
  - 3) UV-A, nitrogen laser (0.337  $\mu\text{m}$ ).
  - 4) UV-C, krypton fluoride excimer laser (0.248  $\mu\text{m}$ ).
- 15** B. Maximum Permissible Exposure Limits vary considerably within a narrow range of the visible spectrum. For example, MPEs of  $2.5 \times 10^{-3} \text{ W cm}^{-2}$  and  $1.7 \times 10^{-5} \text{ W cm}^{-2}$  apply respectively to quarter-second exposures for wavelengths of 0.647  $\mu\text{m}$  (red) and 0.530  $\mu\text{m}$  (green). Briefly **EXPLAIN** the source(s) of these differences.
- 15** C. Deleterious effects to the skin are associated with exposure to lasers with wavelengths in the ultraviolet region of the electromagnetic spectrum. **LIST** the skin effect(s) associated with the following UV bands:
- 1) UV-A (0.315  $\mu\text{m}$  - 0.400  $\mu\text{m}$ ).
  - 2) UV-B (0.280  $\mu\text{m}$  - 0.315  $\mu\text{m}$ ).
  - 3) UV-C (0.200  $\mu\text{m}$  - 0.280  $\mu\text{m}$ ).
- 20** D. Lasers have gained wide acceptance for refractive eye surgery. Surgical units, such as LASIK (**L**aser **I**n **S**itu **K**eratomileusis) systems, are typically equipped with laser alignment devices which operate in the visible region. Assuming that beam divergence is negligible, calculate the maximum allowable power output (in units of mW) for the following alignment system:
- |                         |                          |
|-------------------------|--------------------------|
| Laser:                  | Continuous Wave Diode    |
| Wavelength:             | 635 nm                   |
| MPE:                    | $0.01 \text{ J cm}^{-2}$ |
| Laser to eye distance   | 0.2 m                    |
| Beam diameter           | 3.5 mm                   |
| Blinking Reflex Time:   | Inhibited for surgery    |
| Maximum Alignment Time: | 1.2 seconds per eye      |

- 30 E. A local sports team plans to add a laser show to their pre-game entertainment routine. The show will include figure tracing and direct audience scanning. The proposed laser array includes the following:

Laser:	Q-Switched 40W Nd:YAG
Wavelength:	532 nm
Pulse Width:	20 microseconds
Pulse Frequency:	25 kHz
Beam diameter	2 mm
Laser to audience distance:	25 m
Beam Divergence:	0.2 milliradians
Scanning Rate:	20,000 cm sec <sup>-1</sup>
MPE:	1.8 t <sup>3/4</sup> x 10 <sup>-3</sup> J cm <sup>-2</sup>

Using the MPE as your guide, is this equipment appropriate for use in such a show? Assume no optically aided viewing. **Justify your answer.**