# LUMINOUS FLUX PROBLEMS

More difficult problems are indicated with an asterisk.

1. A laser produces 10watts of monochromatic energy. How much luminous flux is produced if the wavelength of the laser light is (a)450 nm, (b) 500 nm, (c) 550 nm, (d) 600 nm, (e) 800 nm?

2. Which produces a greater visual sensation, 1000 lumens of light at wavelength 550 nm or 650 nm?

3.* What luminous flux is produced by a mercury vapor lamp with the power spectrum of figure 2?

4.* Over the visible range the power spectrum of figure 1 for a tungsten filament at 3500° K may be adequately represented by the equation $P_\lambda = 2.8 \times 10^{-4}\lambda - 0.092$ where $\lambda$ is in nanometers. What luminous flux is produced by that tungsten filament?

## ANSWERS to SELECTED PROBLEMS

1. (a) 260 lm, (b) 2206 lm, (c) 6795 lm, (d)4310 lm, (e) 0 lm. For energy confined to a narrow band $d\lambda$, $P_\lambda v_\lambda d\lambda = P v_\lambda$, so in each case the answer is $683 P v_\lambda$ where $P$=10watts.

2. This is akin to the question of which weighs more, a pound of lead or a pound of feathers. In fact a lumen produces the same magnitude of visual sensation regardless of the energy spectrum of the source. If we had said 1000 watts instead of 1000 lumens, the answer would have been 550 nm.

3. Use the sum $F = (683 \text{ lm/wt})(10 \text{ nm}) \Sigma_\lambda v_\lambda P_\lambda$. The answer is $1.1 \times 10^3$ lm.

4. The answer is $4.7 \times 10^3$ lm. To solve the problem, again use the equation $F = (683 \text{ lm/wt})(10 \text{ nm}) \sum_\lambda \nu_\lambda P_\lambda$. The most systematic way of doing the calculation is to lay it out on a table like that below:

| $\lambda$ | $\nu_\lambda$ | $P_\lambda$ | $F_\lambda$ |
|---|---|---|---|
| 400 | 0.000 | 0.0200 | 0.00 |
| 410 | 0.001 | 0.0228 | 0.16 |
| 420 | 0.004 | 0.0256 | 0.70 |
| . | . | . | . |
| . | . | . | . |
| . | . | . | . |
| 530 | 0.862 | 0.0564 | 332.05 |
| 540 | 0.954 | 0.0592 | 385.74 |
| 550 | 0.995 | 0.0620 | 421.34 |
| . | . | . | . |
| . | . | . | . |
| . | . | . | . |
| 710 | 0.002 | 0.1068 | 1.46 |
| 720 | 0.001 | 0.1096 | 0.75 |
| | | | 4732.16 |