

|           |                                                                                                                                                    |
|-----------|----------------------------------------------------------------------------------------------------------------------------------------------------|
| 8(a)      | <ul style="list-style-type: none"> <li>quantum of energy</li> </ul>                                                                                |
|           | <ul style="list-style-type: none"> <li>of electromagnetic radiation</li> </ul>                                                                     |
| 8(b)(i)   | $(\Delta)E = hc / \lambda$                                                                                                                         |
|           | $\lambda = (6.63 \times 10^{-34} \times 3.00 \times 10^8) / (1.96 \times 1.60 \times 10^{-19})$                                                    |
|           | $= 6.3 \times 10^{-7} \text{m}$                                                                                                                    |
| 8(b)(ii)  | number per unit time = power / energy per photon                                                                                                   |
|           | $= (1.0 \times 10^{-2}) / (1.96 \times 1.60 \times 10^{-19})$                                                                                      |
|           | $= 3.2 \times 10^{16} \text{s}^{-1}$                                                                                                               |
| 8(b)(iii) | <i>either:</i> force = rate of change of momentum<br><i>or:</i> $F = \Delta p / t$                                                                 |
|           | $p = E / c$                                                                                                                                        |
|           | half the photons have change in momentum $p$ , the other half have change in momentum $2p$                                                         |
|           | $F = [(1.96 \times 1.60 \times 10^{-19}) / (3.00 \times 10^8)] \times 3.2 \times 10^{16} \times [(2 + 1) / 2]$<br>$= 5.0 \times 10^{-11} \text{N}$ |