1. Modify the following text so that the statement is true.

When an electron meets a hole, it falls into a lower energy level, and releases energy in the form of a photon. When the electron can undergo the down-ward transition by itself, the photon emission process is called (**spontaneous** / ~~stimulated~~) emission.

---

2. Modify the following text so that the statement is true.

A photon is absorbed by a semiconductor if the photon energy is (**greater** / ~~lower~~) than the band gap of the material, Eg.

---

3. Calculate the NA (numerical aperture) of an optical fibre formed by a core with a refractive index n_1 = 1.45 and a cladding with a refractive index n_2 = 1.42. Indicate the acceptance angle of the fibre, φ_{max}, to air. The refractive index of air: n = 1.000293.

$$NA = n \cdot \sin(\varphi_{\max}) = \sqrt{n_1^2 - n_2^2} = 0.29$$

$$\varphi_{\max} = \arcsin\left(\frac{\mathrm{NA}}{n}\right) = \arcsin\left(\frac{0.29}{1.000293}\right) = 18.86\,^{\circ}$$

---

4. Fill the table indicating the color of light emitted by LEDs made from the following semiconductor materials.

Semiconductor material	LED color
GaN	Blue
InGaN	Green
GaAsP	Yellow

---

5. List three different types of optical amplifiers (OAs).

1. EDFAs (erbium-doped fibre amplifiers)
2. SOAs (semiconductor optical amplifiers)
3. Raman and Brillouin amplifiers

Erasmus+
This project has been funded with support from the European Commission.
This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

6. A fibre optic has a core of Si_3N_4 with a refractive index: n = 2.72 for wavelengths of 0.4 µm. Calculate the time required to send data at that wavelength along 1 km of that fibre optic.

$$v = \frac{c}{n} = \frac{3 \cdot 10^8 \text{ ms}^{-1}}{2.72} = 1.1 \cdot 10^8 \text{ ms}^{-1}$$

$$t = \frac{x}{v} = \frac{1000}{1.1 \cdot 10^8} \text{ s} = 9.07 \text{ µs}$$

---

7. List three different applications of Laser diodes.

1. CD readers
2. Radar
3. Optical data storage

---

8. Write the Planck–Einstein relation.

$$E = h\upsilon = h\frac{c}{\lambda}$$

---

9. Modify the following text so that the statement is true.

Human eyes can detect lights of wavelength in the range of (~~250 nm to 820 nm~~ / **450 nm to 650 nm**).

---

10. Could you describe the meaning of φ_{1c} in the following equation: $\varphi_{1c} = \arcsin\left(\frac{n_2}{n_1}\right)$?

φ_{1c}: Critical Angle for total internal reflection (TIR)

Erasmus+
This project has been funded with support from the European Commission.
This publication [communication] reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.