

# Tutorial Sheet 7

## Optical sensors

### Photoelectric effect

- Q1:** What kind of sensor uses the photoelectric effect in order to produce an electrical signal?
- Q2:** In the *photoelectric effect*, light directed at the surface of certain metals causes electrons to be emitted. In the case of potassium, 2 eV of work must be done to remove an electron from the surface. (a) If light of wavelength  $5 \times 10^{-7}$  m falls on a potassium surface, what is the maximum energy of the photoelectrons that emerge? (b) If light of wavelength  $4 \times 10^{-7}$  m falls on the same surface, will the photoelectrons have more or less energy?
- Q3:** The work needed to remove an electron from the surface of sodium is 2.3 eV. Find the maximum wavelength of light that will cause photoelectrons to be emitted from sodium.
- Q4:** Photoelectrons are emitted by a copper surface only when light whose frequency is  $1.1 \times 10^{15}$  Hz or more is directed at it. What is the maximum energy of the photoelectrons when light of frequency  $1.5 \times 10^{15}$  Hz is directed at the surface?
- Q5:** The threshold wavelength for potassium is 558 nm. (a) What is the work function for potassium? (b) What is the stopping potential when light of wavelength 400 nm is used? Note: the *stopping potential* is the voltage necessary for the photoelectric current to only just stop. In other the words it is the voltage (potential) at which the current stops (hence, stopping potential).

### X-rays

- Q6:** In a certain television picture tube, electrons are accelerated through a potential difference of 10,000 V. Find the frequency of the X-rays emitted when these electrons strike the screen.
- Q7:** An X-ray tube emits X-rays whose wavelength is  $2 \times 10^{-11}$  m. What is the operating voltage of the tube?