Let us take a light source that emits a single line - that is the spectrum of the emitted light has a negligible intrinsic width at the wavelength λ'. This spectrum can be approximated by a delta function δ(λ–λ'). The light emitted by our He-Ne laser is a good approximation of this: much more than 99% of the emitted light is given by photons with wavelengnths that differ by less than 0.01 ångstrom, much less than the resolution of our monochromator. If we send this light into the monochromator, at the output we measure a spectrum that has a shape and a full width at half maximum (FWHM) that depends on the width of the slits and on the optical aberrations of the optical elements of the monochromator. Let us call this spectrum when the integrated power of the input radiation is 1 watt R(λ,λ'). R(λ,λ') is the intensity measured at the output at wavelength λ when the input is a single narrow line of power 1 watt at the wavelenght λ'. For instance this spectrum could in some cases be approximated by a Gaussian

$$R(\lambda,\lambda') \approx A(\lambda')/(\sqrt{2\pi}\,\sigma)\exp(-(\lambda-\lambda')^2/2\sigma^2)$$

σ is proportional to the FWHM of the output spectrum and depends on the width of the slits, on the aberrations of the optical elements, and on the construction errors of the monochromator, A depends on the reflectivity of the mirrors, the shape of the lines of the grating and the reflectivity of the material used for the grating, on the width of the slits. The reflectivities and the efficiency of the monochromator depend on λ'.

Let us call S(λ) the spectrum emitted by sample, we can write

$$S(\lambda)= \int S(\lambda')\delta(\lambda-\lambda')d\lambda'$$

Since δ(λ–λ') is transformed by the monochromator into R(λ,λ') the measured spectrum at the output of the monocromator $S_m(\lambda)$ is

$$S_m(\lambda)= \int S(\lambda')R(\lambda,\lambda')d\lambda'$$

The measured spectrum is different from the real spectrum, therefore if we want to know the real spectrum we have to correct the measured spectrum. Let us make some approximations. Let us assume that S(λ) is nearly constant in λ intervals of the order of the FWHM of R(λ,λ'), and that R(λ,λ') can be approximated as described above. Then

$$S_m(\lambda)\approx S(\lambda)A(\lambda)$$

A(λ) can be measured using a source with a known spectrum. A practical source to be use is a black body source, it is easy to build and its spectrum is very well known. If $S_{bb}(\lambda)$ is its spectrum

$$A(\lambda)=S_m(\lambda)/S_{bb}(\lambda)$$

We can therefore put a black body source at a known temperature in front of the monochromator entrance slit (with the filter you used to measure the quantum well spectra), a chopper in between, measure the output spectrum with a photomultiplier and a lock-in amplifier. The ratio between the measured spectrum and the black body spectrum is the response function of the monochromator times that of the filter times that of the photomultiplier A'(λ).

Therefore, if the real spectrum S(λ) changes slowly in wavelength intervals of the order of σ, i.e. if the real spectrum has features not narrower than a few times σ, it is given approximately by

$$S(\lambda)=S_m(\lambda)/A'(\lambda)$$

Where $S_m(\lambda)$ is the spectrum measured by the lock-in.

The photomultiplier gives an output proportional to the number of photons arriving per unit time at the photocathode. Therefore we need to now the number of photons emitted per unit time per unit wavelength interval by the black body source. The proportionality constants are not important, we are interested at the wavelength dependence of the spectrum, not at the absolute number of photons. The spectrum of the number of photons emitted by a black body at the absolute temperature T per unit wavelength interval is approximately (for $h\nu >> kT$)

$$S_{bb}(\lambda) = \text{const } \frac{e^{-hc/(\lambda kT)}}{\lambda^4}$$

If the spectrum has features with a width comparable to σ or smaller, and if $R(\lambda, \lambda')$ depends on $\lambda - \lambda'$ only, i.e. if it is $R(\lambda - \lambda')$, then

$$S_m(\lambda) = \int S(\lambda') R(\lambda - \lambda') d\lambda'$$

The measured spectrum is the convolution of the real spectrum and $R(\lambda - \lambda')$. We can apply the theorems on the Fourier transform of a convolution, and we obtain that the Fourier transform of $S(\lambda)$ is the Fourier transform of $S_m(\lambda)$ divided by the Fourier transform of $R(\lambda - \lambda')$. Calculating the back-Fourier transform we get $S(\lambda)$. The main problem with this method is that you need to measure both $S_m(\lambda)$ and $R(\lambda - \lambda')$ with very small noise to get $S(\lambda)$ with acceptable noise. When you divide the two Fourier transform the noise/signal ratio increases, especially at the high frequencies where the Fourier transforms vanish.

The response function $A'(\lambda)$ is a smooth function of λ. It is not necessary to measure it with a λ step very marrow. You have to measure it in the wavelength range that you have used to collect the data. When you have $A'(\lambda)$ measured in N points, you can fit it with a polynomial – for instance- in the region of interest, and use this polynomial function to correct the measured spectrum and obtain the real spectrum. You have to evaluate the error of $A'(\lambda)$ and the error of the real spectrum.

For the final report:
State the aim of the experimental activity you have done
Describe the main features of the experimental system you have used and how you have characterized some of them (e.g. resolutions, systematic errors, response functions, reproducibility of the results…..) .
Evaluate the errors of the spectra and of the experimental data.
Photoluminescence: If you have taken more than one spectrum of a sample, compare them. Extract information on the energy jumps from the spectra
Compare the experimental data with the results of the calculations in the envelope function (or effective mass) approximation.
Extract information on the electron temperature and compare it with the measured temperature