Name: Solutions

Group Members: ____________________

CORPUS CHRISTI COLLEGE
SEQUERE DOMINUM

Mark: ____________ /40

RESULTS:

y = 75.0 cm [1 mark]

Table 1 Mercury vapour

Line colour	Line wavelength λ (nm)	x (cm)		
		Observer 1	Observer 2	Average
yellow	571	26.7	26.7	26.7
green	546	25.1	25.2	25.2
violet/blue	436	19.7	19.8	19.8

3sf ✓

✓ ✓ ✓ [4 marks]

Table 2 Helium

Line colour	Line wavelength (nm)	x (cm)		
		Observer 1	Observer 2	Average
red	673	31.3	31.3	31.3
yellow	578	27.0	26.8	26.9
green	490	22.8	22.8	22.8
violet/blue	434	20.3	20.1	20.2

3sf ✓

✓✓ ✓ ✓ ✓ [4 marks]

Q2

Part B **<u>Calibration of the emission spectrum of helium</u>**
(Completed as an individual.)

AIM: To use the emission spectrum of mercury to calibrate the emission spectrum of helium.

PROCESSING OF RESULTS:

1. For the mercury vapour data, plot a graph of ***λ (nm)*** on the y-axis against ***average x (cm)*** on the x-axis.
   Draw the line of best fit. **[5 marks]**

(1) Title
(1) Scale
(1) Accurate plotting
(1) LOBF through (0,0)
(1) Labels / units

2. (a) Determine the gradient of the graph. Show your working clearly. **[3 marks]**

Using points $(0,0)$, $(20, 430)$

$$m = \underbrace{\frac{y_2 - y_1}{x_2 - x_1} = \frac{430}{20}}_{1} = \underbrace{21.5}_{1} \underbrace{nm\ cm^{-1}}_{1}$$

shown on graph

3sf

(b) Write the equation of the line of best fit. **[2 marks]**

$\lambda = 21.5x$

Use the answers to Q 2 to calculate the wavelengths of the visible part of the helium spectrum and ***record these in Table 2***.

Show your working of ***ONE*** of the calculations in the space below. **[3 marks]**

Working: $\lambda = 21.5x$

red $\lambda = 21.5 \times 31.3 = 672.95 = 673$ nm

1 for calculation

2 for filling in table

QUESTIONS

1. Measurement of the position ***x*** of the mercury vapour emission lines was repeated for each of the yellow, green and violet lines by ***two*** different students.

   (a) Why was the measurement repeated? **[1 mark]**

• Repeat + averaging reduces random error

• Identify outliers

   (b) Why was the measurement repeated by two different students? **[2 marks]**

• Subjective measurement ⇒ need 2 different students

→ gives independent results

→ accounts for / allows for vision defects

   (c) Suggest another method that could be used to repeat the measurement. [Hint: Consider page 1.] **[2 marks]**

• Spectrum is symmetrical about lamp

• Take reading from each side of lamp

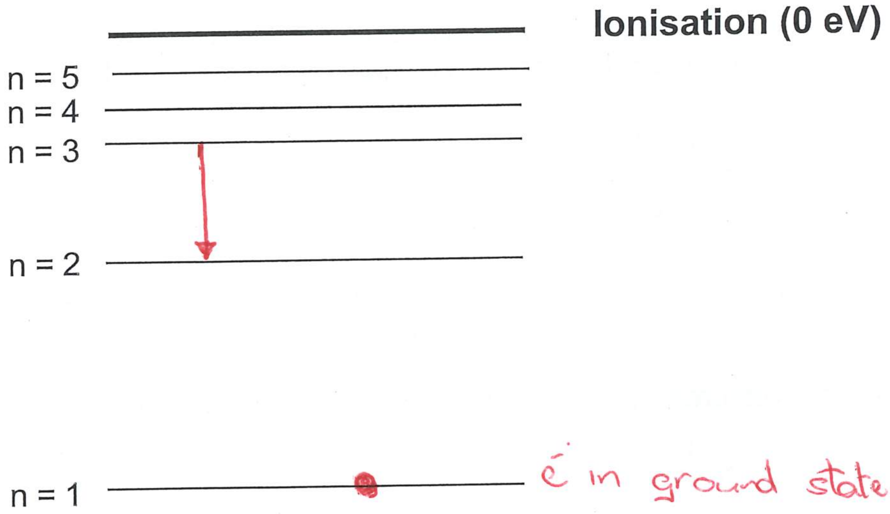
2. What would be the effect on the position ***x*** of the mercury vapour emission lines if the diffraction grating was placed 100 cm from the lamp instead of 75 cm from the lamp? Explain. **[2 marks]**

$\lambda = d\sin\theta$

For fixed λ, $\sin\theta$ is fixed ⇒ θ fixed / constant

$\theta = \tan^{-1}(x/y)$ ⇒ If $y\uparrow$, $x\uparrow$

3. The diagram below shows some of the possible electron energy levels in a hydrogen atom. The ionisation energy is 13.6 eV.



(a) Explain what is meant by ionisation energy?

The energy required to remove a ground state electron from an atom

[1 mark]

(b) Indicate on the diagram where the electron would be if it were in “the ground state”.

[1 mark]

(c) Light from a hydrogen discharge tube consists of a *line emission spectra.* Explain how line emission spectra are produced.

[4 marks]

1 Electrons can only exist within atom in discrete energy levels

1 Electrons in discharge tubes are excited to a higher energy level, and then transition back ground state

1 Energy in the form of a photon is released when downward transition occurs. The frequency of this energy is proportional to the change in energy level

1 Each line represents a possible energy transition for that atom

(d) The only emission spectra which occur in the visible region are those involved with transitions to level 2.

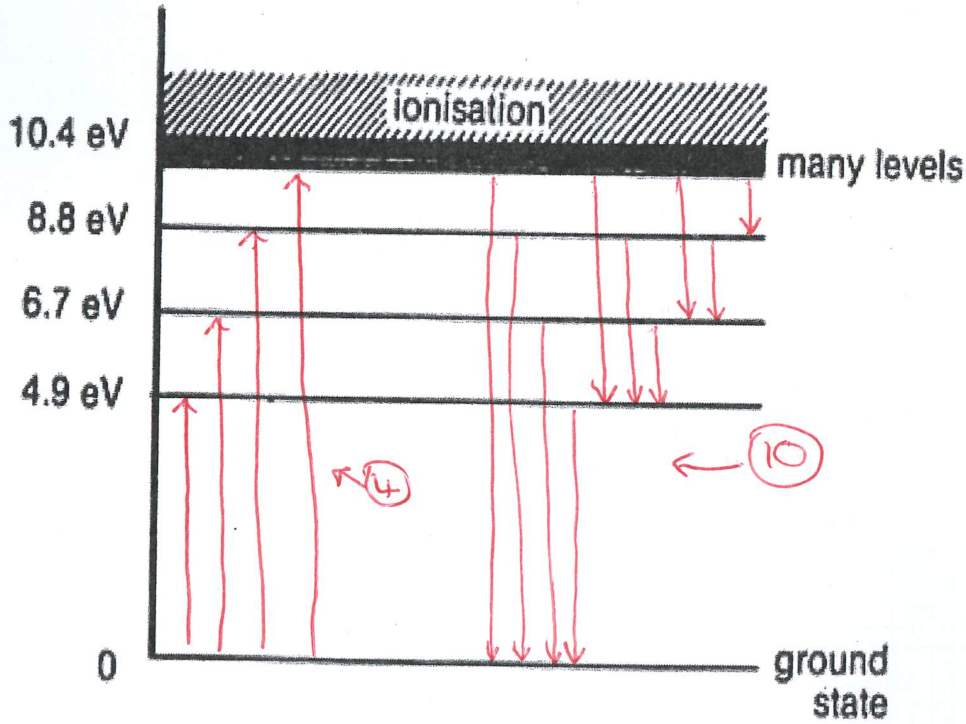
Draw an arrow on the diagram to represent the transition for the longest wavelength photon emitted in the visible region. Calculate the energy difference in joules, for this transition if the longest wavelength of these in the visible region has a wavelength of 655 nm.

[3 marks]

1 on diagram Longest wavelength corresponds to shortest transition
⇒ 3 → 2

$E = hf = \frac{hc}{\lambda} = \frac{(6.63\times10^{-34})(3\times10^{8})}{655\times10^{-9}} = 3.04\times10^{-19}\ J$

4. The diagram below shows some of the energy levels inside a mercury atom.



a) How many lines would you expect this atom to show in its

i) Absorption spectrum

[1 marks]

4

ii) Emission spectrum

[1 marks]

10