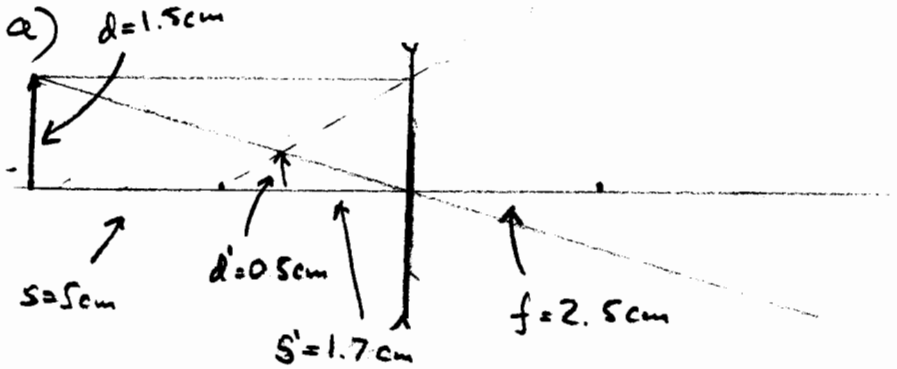
PHYS 471 Optics

Midterm solutions

1

a)



b) virtual, reduced, erect image

c) $\frac{1}{s} - \frac{1}{s'} = -\frac{1}{f}$

($\frac{1}{s}$: virtual image; $-\frac{1}{f}$: concave lens)

$$\frac{1}{5\,\text{cm}} - \frac{1}{1.7\,\text{cm}} = -\frac{1}{2.5\,\text{cm}}$$ ✓

2

$$\left|\frac{\Delta\omega}{\omega}\right| = \left|\frac{\Delta\lambda}{\lambda}\right| = \frac{v}{c} \quad \Rightarrow |\Delta\lambda| = \lambda\frac{v}{c}$$

$$v \propto \sqrt{\frac{kT}{m}} \propto \frac{1}{\sqrt{m}}$$

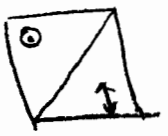
$$\frac{\Delta\lambda_{Na}}{\Delta\lambda_{Rb}} = \frac{\lambda_{Na}/\sqrt{m_{Na}}}{\lambda_{Rb}/\sqrt{m_{Rb}}} = 1.44$$

$$v \propto \sqrt{T}$$

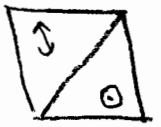
T increases by ×2 ⇒ linewidth increases by $\times\sqrt{2}$

3 a) Wollaston prism

b)



or



c)

H-polarization is extraordinary in the first prism, ordinary in the second. Index of refraction for H is lower in the second prism $\Rightarrow n_e > n_o$. Positive

By similar argument, $n_e < n_o$. Negative

4 a) $v_{ph} = \frac{c}{n} = \frac{\omega}{k} \Rightarrow k = \frac{1}{c}\omega\, n(\omega)$

b) $v_{gr}^{-1} = \frac{dk}{d\omega} = \frac{1}{c} n(\omega) + \frac{1}{c}\omega \frac{dn}{d\omega}$

$$v_{gr} = c \frac{1}{n(\omega) + \omega \frac{dn}{d\omega}}$$