Your name: _____

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Physics: Homework 01

1. The picture on the right is of a reflecting radio telescope at Stanford University. Does it look like you could see your face in it? If not, why might it work as a reflector?
Imperfections need only be smaller that $\lambda/4$.

2. If a telescope with focal length $30\,\text{cm}$ "sees" an object taking up 2° of its view, how big is the image in the telescope? The size is $s = \frac{\theta}{180^\circ}\pi f = \frac{2^\circ}{180^\circ}\pi \cdot 30 \approx 1.05\,\text{cm}$.

3. If an object makes an image that's $0.5\,\text{mm}$ on your retina, how many degrees of your view does it occupy? We have $0.5\,\text{mm} = \frac{\theta}{180^\circ}\pi \cdot 17\,\text{mm} \approx (0.3)(\theta)$. So, $\theta = 0.5/0.3 \approx 1.7^\circ$.

4. When you zoom into an object optically with your camera (not electronic zoom), does the lens extend or contract? Why? Extend in order to increase the focal length of the lens system.

5. Why is a ground-based x-ray telescope not a great idea? Few x-rays get through the atmosphere.

6. What is the resolution in seconds of telescope with a $0.5\,\text{m}$ diameter lens at visible light? $\theta_{\text{res}} = 1.22\frac{180}{\pi}\frac{\lambda}{D} = 1.22\frac{180}{\pi}\frac{5\times10^{-7}}{0.5} = \left(700\cdot10^{-7}\right)^\circ = \left(7\cdot10^{-5}\right)^\circ = \left(3600\cdot7\cdot10^{-5}\right)'' \approx 0.25''$.

7. Some telescopes are dual-purpose: they detect visible light and infra-red. Were the telescope in the question above capable of this, would it have higher resolution in infra-red or lower (compared to visible light)? Infra-red has longer wavelength, therefore a bigger θ_{res}, therefore *lower* resolution.

8. What diameter lens do you need on a telescope that can resolve up to a thousandth of a second? First convert $\left(10^{-3}\right)''$ to degrees: $10^{-3}/3600 = \left(2.8\times10^{-7}\right)^\circ$. So $2.8\times10^{-7} = 1.22\frac{180}{\pi}\left(\frac{5\times10^{-7}\,\text{m}}{D}\right)$. Or, $2.8 \approx \frac{350}{D}$. $D \approx \frac{350}{2.8} = 125\,\text{m}$.

9. A magnifying glass is rated at 3.5 magnification for normal eyes (i.e., mine, not some crazily good ones – Lucie, Remonia: I'm looking at you, or would be if I could only focus my eyes) that are focused on an image at the near point. What is its focal length? What would the focal length be if the magnification referred to a relaxed eye? $M = N/f + 1$. Near point: $3.5 = 25/f + 1$. So $2.5 = /25/f$, or $f = 10\text{cm}$. Relaxed: $3.5 = 25/f$. Or $f = 7.1\text{cm}$.

10. What optical instrument was used recently to detect gravitational radiation? Interferometer

11. Only for Ashley: what is the color of gold? Yell-oh? Yaller? Yelaux?