

**1** The Griffith Observatory in Los Angeles includes an astronomical refracting telescope (Griffith telescope) with an objective lens of diameter 305 mm and focal length 5.03 m

- (a) Calculate the wavelength of light for which the Griffith telescope has a minimum angular resolution of  $1.8 \times 10^{-6}$  rad

wavelength = \_\_\_\_\_ m

**(2)**

- (b) The Griffith telescope is used to observe two point objects which subtend an angle of  $1.8 \times 10^{-6}$  rad at the unaided eye.

The typical human eye has a minimum angular resolution of approximately  $3.2 \times 10^{-4}$  rad

Calculate the focal length of the eyepiece lens so that an observer can just resolve the two objects when observing them through the Griffith telescope.

focal length = \_\_\_\_\_ m

**(3)**

(c) The asteroid Apophis has a diameter of 325 m

It has been calculated that, in 2029, its distance of closest approach to the Earth's surface will be  $3.0 \times 10^4$  km

The Griffith telescope may be used to view Apophis using the eyepiece calculated in question (b)

Deduce whether this telescope is suitable to obtain a detailed view of Apophis. Support your answer with a calculation.

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**(3)**  
**(Total 8 marks)**

**5**

Draw the ray diagram for a Cassegrain telescope. Your diagram should show the paths of two rays, initially parallel to the principal axis, as far as the eyepiece.

**(Total 2 marks)**

**6**

The Kielder Observatory in Northumberland includes two optical telescopes attached to the same mount, so that they can be used to view the same object.

Some of the properties of these telescopes are summarised in the table.

<b>Telescope</b>	<b>Type</b>	<b>Objective diameter/mm</b>
A	refractor	70
B	refractor	400

(a) The telescopes are used to view the same object.

Suggest which telescope in the table produces the brighter image.  
Support your answer with a suitable calculation.

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**(3)**

(b) The minimum angular resolution of a telescope can be determined using the Rayleigh criterion.

Explain what is meant by the Rayleigh criterion.

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**(2)**

- (c) Discuss which of the two telescopes in the table would be better at resolving the images of two objects that are close together.

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**(2)**

**(Total 7 marks)**

**12**

The concave mirrors used in some reflecting telescopes can suffer from spherical aberration.

- (a) Draw a diagram to show what is meant by spherical aberration when produced by a concave mirror.

**(2)**

- (b) The International Ultraviolet Explorer (IUE) and the Gran Telescopio Canarias (GTC) are two examples of reflecting telescopes.

The table below summarises some of the properties of the two telescopes.

<b>Name</b>	<b>IUE</b>	<b>GTC</b>
Objective Diameter	0.45 m	10.4 m
Location	Geosynchronous Earth orbit	Earth's surface, 2300 m above sea level
Spectrum detected	Ultraviolet	Visible and Infrared
Typical wavelength detected	$2.0 \times 10^{-7}$ m	$1.0 \times 10^{-6}$ m

