InkPhysics

QUESTION WORKBOOK

Telescopes and image formation

Astrophysics · Year 13

AQA 3.9.1.1, 3.9.1.2

20 questions · 60 marks

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SECTION A · Warm-up

A1 State what is meant by a refracting telescope in normal adjustment, and where the final image is formed. [2]

A2 Define the angular magnification of an astronomical telescope. [2]

A3 Name the two mirrors of a Cassegrain reflecting telescope, giving the shape of each, and state where the light comes to its final focus. [2]

A4 Explain why the angular magnification of a telescope has no unit. [2]

A5 A refracting telescope is pointed at a distant star. State where the objective lens forms an image of the star, and the nature of that image. [2]

A6 A telescope in normal adjustment has its eye lens replaced by one of half the focal length. State the effect on the angular magnification. [1]

SECTION B · Standard

B1 A refractor has an objective of focal length 1.5 m and an eye lens of focal length 30 mm. For normal adjustment, calculate the angular magnification and the length of the telescope. [3]

B2 The Moon subtends an angle of 9.0×10^{-3} rad to the naked eye. Calculate the angle it subtends through a telescope with a 1.0 m objective and a 25 mm eye lens in normal adjustment. [3]

B3 A refractor in normal adjustment has an angular magnification of 60 and a tube 1.22 m long. Calculate both focal lengths. [4]

B4 Explain what causes chromatic aberration in a refracting telescope, and why a reflecting telescope does not suffer from it. [3]

B5 Explain what is meant by spherical aberration, and how the design of the Cassegrain primary mirror avoids it. [3]

B6 Two stars are separated by an angle of 1.5×10^{-4} rad when viewed with the unaided eye. Through a refractor in normal adjustment fitted with a 20 mm eye lens, they appear separated by 6.0×10^{-3} rad. Calculate the focal length of the objective. [3]

B7 An astronomer removes the eyepiece of a refractor and places a CCD in the focal plane of the objective, which has a focal length of 1.4 m. Mars subtends an angle of 1.2×10^{-4} rad to the naked eye. The pixels of the CCD are 5.0 µm wide. Determine the number of pixels spanned by the diameter of the image of Mars. [4]

B8 Explain how the Cassegrain design gives a long effective focal length in a short tube, and give one practical benefit of the short tube. [2]

B9 A refractor in normal adjustment has an objective of focal length 1.25 m in a tube 1.30 m long. Show that its angular magnification is about 25. Go on to calculate the angle subtended through the telescope by a lunar crater that subtends 6.0×10^{-5} rad to the naked eye. [4]

SECTION C · Stretch

C1 A Cassegrain telescope has an effective focal length of 3.2 m and is used with an 8.0 mm eyepiece. A lunar crater subtends 4.0×10^{-5} rad to the naked eye. Calculate the magnification and the angle the crater subtends through the telescope. [4]

C2 A school is choosing between a large refractor and a Cassegrain reflector of the same aperture. Give two advantages of the reflector and one practical advantage of the refractor. [4]

C3 A magazine advert praises a small telescope for its “500× magnification”. Explain why this figure alone says little about the telescope's quality. [2]

C4 A catalogue states that a refractor gives an angular magnification of 60 in normal adjustment with the 25 mm eyepiece supplied, in a tube 1.05 m long. Deduce whether the claim is consistent with the stated dimensions. [4]

C5 A refractor in normal adjustment is pointed at a distant star cluster. Explain fully how the two lenses produce the final image, and show how the angular magnification is related to the two focal lengths. [6]