



ANSWER BOOK

Star brightness and magnitude

Astrophysics · Year 13

AQA 3.9.2.1, 3.9.2.2

11 questions · 32 marks

NAVY EDITION

SECTION A · Warm-up

- A1** Brighter objects have smaller (and then negative) magnitudes; the scale runs backwards. The dimmest naked-eye stars are about magnitude +6. [2]
- A2** One parsec is the distance at which one astronomical unit (the mean Earth–Sun distance) subtends an angle of one arcsecond. 1 pc = 3.26 light years. [2]
- A3** One magnitude step is a received-intensity ratio of 2.51; five steps are exactly 100. The eye judges brightness roughly logarithmically, so the equal-feeling steps of the ancient scale correspond to equal ratios of intensity. [3]

SECTION B · Standard

- B1** P is brighter (smaller number), by $2.51^{(7.0 - 2.0)} = 2.51^5 = 100$ times. [3]
- B2** $M = m - 5 \log(d/10) = -1.5 - 5 \log(0.264) = +1.4$. [3]
- B3** $m = M + 5 \log(d/10) = 0.6 + 5 \log(2.5) = +2.6$. [3]
- B4** $m - M = 7.5 = 5 \log(d/10)$, so $\log(d/10) = 1.5$ and $d = 10 \times 10^{1.5} = 316$ pc, about 3.2×10^2 pc. [4]
- B5** m differs by $5 \log(50/5.0) = 5.0$ magnitudes, so the nearer star appears $2.51^5 = 100$ times brighter. [3]

SECTION C · Stretch

- C1** $d = 42/3.26 = 12.9$ pc. $M = 5.0 - 5 \log(12.9/10) = +4.4$: a star quite like the Sun. [4]
- C2** The gap is 25.2 magnitudes, so the ratio is $2.51^{25.2} \approx 1.2 \times 10^{10}$: ten billion times, entirely because the Sun is close. [3]
- C3** Apparent magnitude mixes the star's true output with its distance: a feeble nearby star can look brighter than a distant giant. Absolute magnitude removes the distance by quoting the apparent magnitude every star would have at the same standard 10 pc. [2]