AQA A-Level Physics

9.2 Stars

Flashcards

What is apparent magnitude and absolute magnitude?

What is apparent magnitude and absolute magnitude? What equation links them?

Apparent magnitude (m): how bright the star appears from Earth

Absolute magnitude (M): how bright the star would appear if it were placed 10 parsecs from Earth.

$m-M=5\log(d/10)$ (where d = distance from Earth)

What is the Hipparcos scale?

What is the Hipparcos scale?

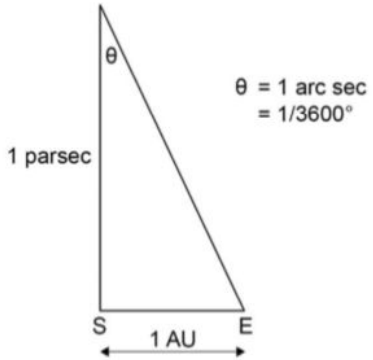
The Greek astronomer Hipparchus catalogued stars, defining their brightness in terms of apparent magnitudes (m), with brightest stars a magnitude of 1 and the faintest a magnitude of 6.

The scale has since been extended to include brighter objects (like the Sun, with an m of -26.47) and fainter objects that were discovered with the invention of the telescope.

Define parsec

Define parsec

The distance to an object that subtends an angle of one arcsecond (1/3600th of a degree) to the line that runs from the centre of the Earth to the centre of the Sun



https://filestore.aqa.org.uk/resources/physics/AQA-7407-7408-TG-A.PDF

Define light year

Define light year

A light year is the distance travelled by light in a vacuum in one year. In metres this is 9.46×10^{15} m (speed of light multiplied by the number of seconds in a year).

State Stefan's law

State Stefan's law

The power output of a star is directly proportional to its surface area and it's (absolute temperature)^4.

$P = \sigma A T^4$, where A = surface area (m^2), T = temperature (K) and σ = the Stefan constant = 5.67×10^{-8} W m^{-2} K^{-4}

State Wien's displacement law

State Wien's displacement law

The wavelength of a star's emission at peak intensity is inversely proportional to its absolute temperature.

$\lambda_{max} T = 2.898 \times 10^{-3}$ m k

(note: unit is metres Kelvin, not milliKelvin)

What is a black body?

What is a black body?

A black body absorbs electromagnetic radiation of all wavelengths and can emit electromagnetic radiation of all wavelengths. A black body does not reflect any radiation – it absorbs all radiation incident on it.

Draw 3 black body radiation curves for 3 black bodies of decreasing temperature

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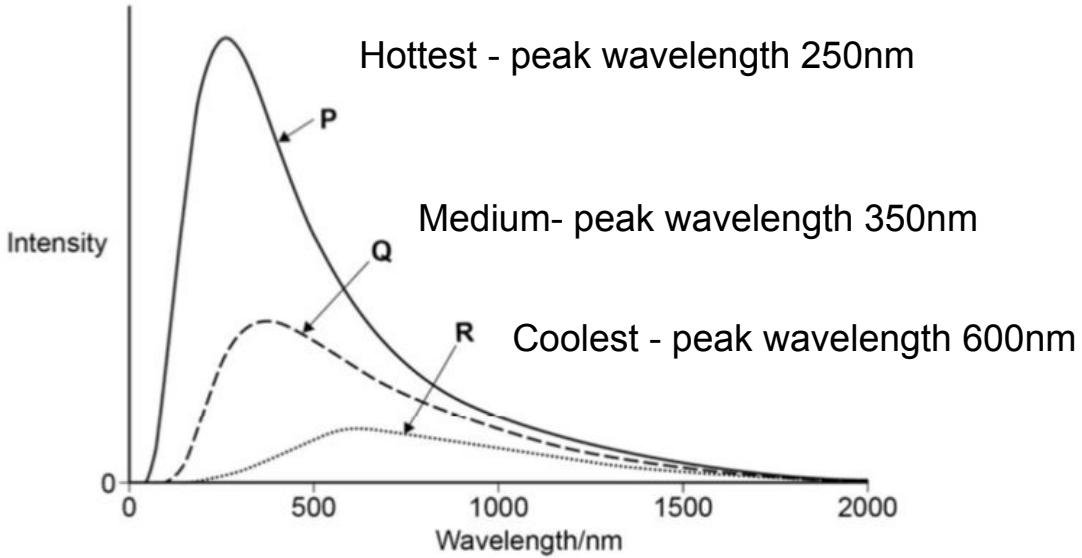


Image: AQA

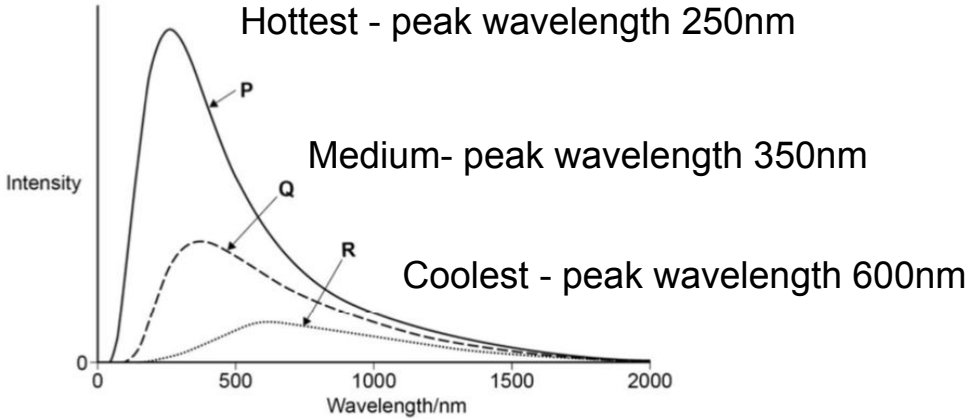
Use Wien's displacement law to find the temperature at P on the black body radiation curve

Use Wien's displacement law to find the temperature at P on the black body radiation curve

$\lambda_{max} T = 0.0029$ m K

$T = 0.0029/2.5 \times 10^{-7}$

$= 11600$K



Draw a table to show the characteristics of each stellar spectral class, include colour, temperature and absorption lines

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Spectral class	Intrinsic colour	Temperature / K	Prominent absorption lines
O	blue	25 000–50 000	He+, He, H
B	blue	11 000–25 000	He, H
A	blue-white	7500–11 000	H (strongest) ionised metals
F	white	6000–7500	ionised metals
G	yellow-white	5000–6000	ionised and neutral metals
K	orange	3500–5000	neutral metals
M	red	< 3500	neutral atoms, TiO

Image: AQA

How are each of the Spectral Classes related to Balmer lines?

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Spectral class	Prominence of Balmer lines	Explanation
O	weak	star's atmosphere too hot hydrogen likely to be ionised
B	slightly stronger	
A	strongest	high abundance of hydrogen in $n=2$ state
F	weak	too cool, hydrogen unlikely to be excited
G	very weak/none	too little atomic hydrogen, far too cool to be excited
K		
M		

Image: AQA

Draw the Hertzsprung-Russell diagram

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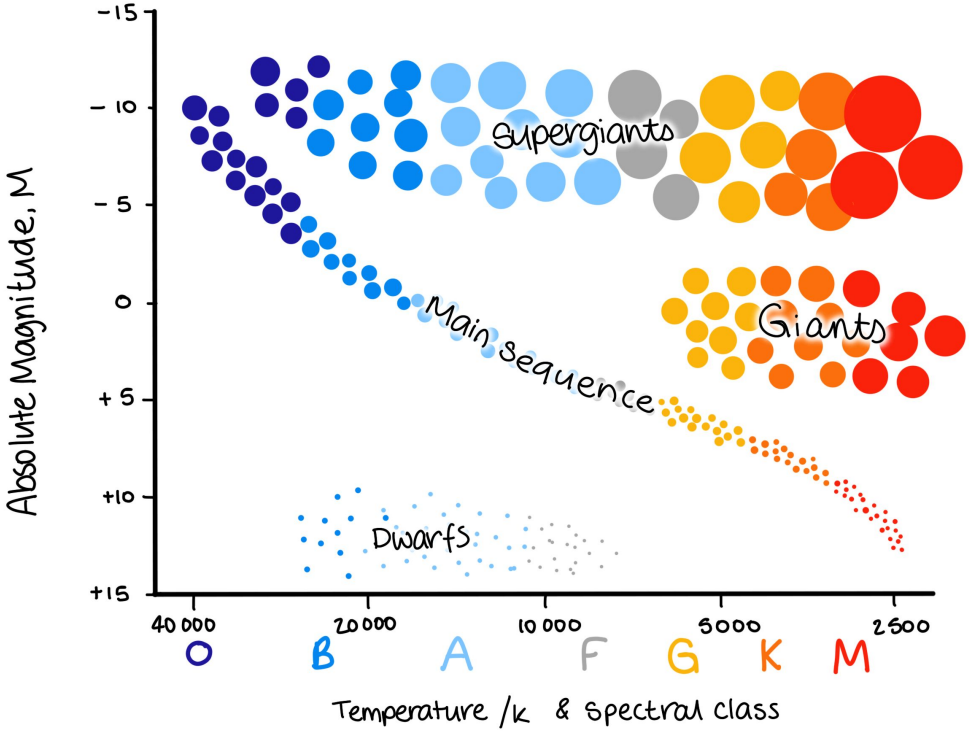

Annotate the Hertzsprung-Russell diagram to show the Sun's evolution

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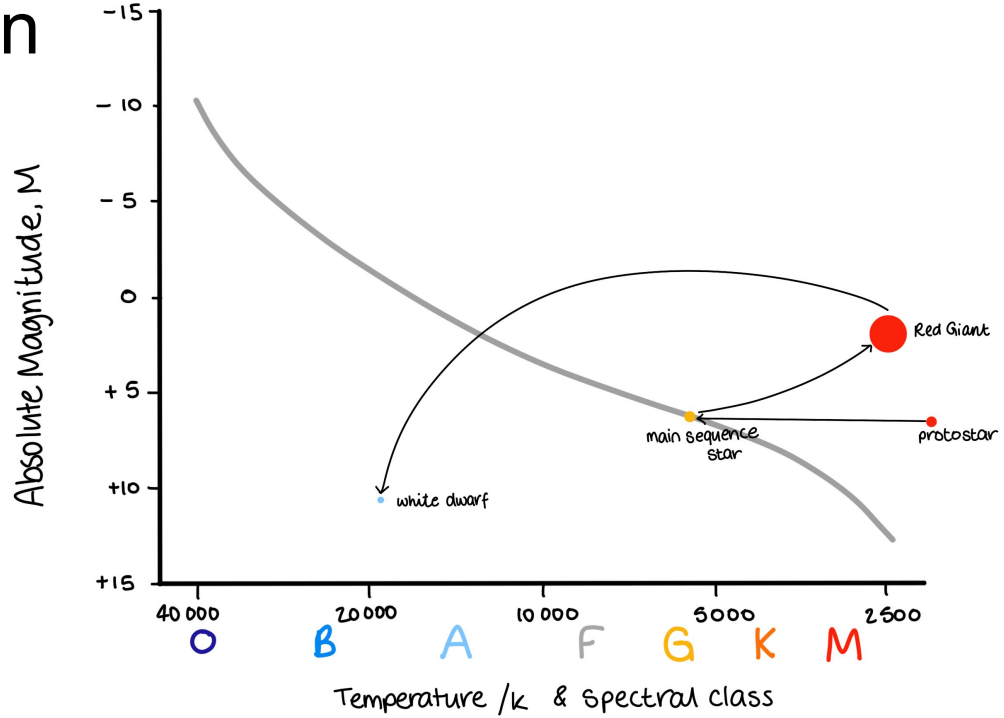

What are supernovae? Describe how type Ia and type II form

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A supernova is the explosion of a star, which causes it to very suddenly and rapidly increase in absolute magnitude.

Type Ia Supernova: The result of a white dwarf core accumulating too much matter from its binary partner and exploding above a critical mass

Type II Supernova: A single star (for example a red giant) that collapses rapidly under its own gravity, causing its outer layers to be ejected

Explain why Type II supernovae cannot be used as standard candles whereas Type Ia supernovae can.

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A standard candle is an astronomical object that has a known absolute magnitude so astronomers can calculate the distance using $m - M = 5\log(d/10)$. All Type Ia supernovae explosions have the same peak absolute magnitude (approximately -19.3) as they all have the same critical mass (thus have consistent light curves) so they can be used as standard candles. Type II supernovae are not as predictable, so they cannot be used as standard candles.

Draw the light curve of a typical type Ia supernova

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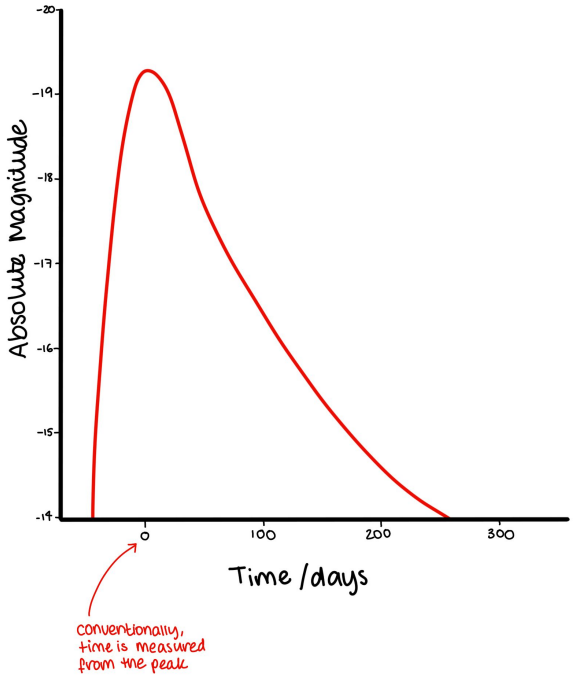

Light curves are graphs of absolute magnitude against **time since peak magnitude**. The peak magnitude of a type Ia supernova is -19.3.

What is a black hole?

What is a black hole?

When the core of a star larger than 3 solar masses collapses, it forms a black hole. The escape velocity of a black hole is greater than the speed of light – light cannot escape it, which is where black holes earned their name.

The boundary at which the escape velocity equals the speed of light is called the **event horizon**, and the distance from the centre of the black hole to the event horizon is called the **Schwarzchild Radius**.

What is dark energy?

What is dark energy?

- When astronomers calculated the distance to some Type Ia supernovae, they discovered them to be dimmer than expected. This suggested the expansion of the universe is accelerating, which has been attributed to dark energy.
- Dark energy is thought to be energy that has an overall repulsive effect throughout the universe.

How do you calculate the radius of a black hole?

How do you calculate the radius of a black hole?

Schwarzschild radius $R_s = 2GM/c^2$

Where G is the gravitational constant, M is the object mass and c is the speed of light