Question 1:

a)

Figure(a) This is the younger cluster. Correct.

- There is a dense central cluster of stars which indicate recent star formation. I wouldn't say so - A is a loose, open cluster
- There is a surrounding void possibly cleared by strong stellar winds or supernovae from massive young stars.
- The presence of bright filament like structures facing the inner cluster are likely super heated interstellar gas, now emitting in the visible and IR spectrum.

Figure(b) The older cluster Well done.

- A large bright cluster without any obvious void suggesting the cluster has evolved over a longer period of time. (no void because no ISM outside galactic disk).
- The absence of any interselar material also indicates that the orginal giant molecular cloud (GMC) has been fully consumed by star formation or dispersed by stellar feedback.
- The interstellar filaments are now absent possibly due to secondary star formation. ?

1 1 1 1 4/4

b)

$$T \approx \frac{GMm}{kR}$$

Starting by stating equation - well done, but also define variables too: where T = gas temperature etc

Make M the subject

$$T \approx \frac{GMm}{kR}$$

$$kRT \approx GMm$$

$$M \approx \frac{kRT}{Gm}$$

Good.

1

Substituting $T = 1.7 \times 10^7\,\mathrm{K}$ and $R = 2.3\,\mathrm{R}_\odot$

$$\approx \frac{1.38 \times 10^{-23} \times 2.3\,\mathrm{R}_\odot \times 1.7 \times 10^7}{6.67 \times 10^{-11} \times \frac{1}{2}\,(1.67 \times 10^{-27})}$$

$$\approx 6.742\,994\,012 \times 10^{30}$$

1

divide by $\mathrm{M}_\odot$

yes, but show the calculation for this too

$$= 3.4\,\mathrm{M}_\odot$$

to 2 s.f

Well done.

1

Great, but answer the last bit for an extra mark - which hydrogen burning reaction pathway is likely to be operating in the star's core? (CNO cycle)

3/4

Total for question 1: 7/8

Question 2:

a)

Young Star's Mysterious Disappearance Stuns Astronomers

A young star in the Mon R2 star-forming region mysteriously dimmed to just one-tenth of its usual brightness before slowly recovering. The event, lasting 80 to 320 days*, has left scientists investigating its cause.

name the astronomers involved - essental info

Figure 1: The molecular cloud and embedded star cluster Monoceros R2.

Astroa physics. `http://astroa.physics.metu.edu.tr/Astronom/SC/MONR2A.HTM`. Accessed: 2025-14-02

The star, known as [CMD97]-1031, is located 3,400 light-years away in Monoceros. It is an X-ray-emitting young stellar object (YSO) with an accretion disk, a swirling structure of gas and dust feeding material onto the star. Despite this, it exhibits little mid-infrared emission, indicating a relative lack of dust in its outer regions.

explain further for non-astronomers or leave out

A Star That Nearly Vanished

Using data from the **Zwicky Transient Facility (ZTF), ATLAS, and Gaia, astronomers tracked the star's brightness from 2014 to 2022. Normally, [CMD97]-1031 shines at magnitude 18 (r-band), but at the height of this event, its brightness dropped by a factor of 10, rendering it nearly invisible.

ok but when was the paper published?

Adding to the mystery, the star "blinked" during its dimming phase, with fluctuations of **up to 2 magnitudes before settling at a lower brightness. Once it began to recover, it remained slightly fainter and redder than before—suggesting lasting changes in its surrounding material.

What Could Be Happening?

Brightness variations are common in YSOs, but such a deep, prolonged dimming is rare. A similar event was observed in ASASSN-21qj, but its exact cause remains uncertain.

One possibility is that a dense dust cloud temporarily obscured the star, a phenomenon seen in UX Orionis-type variables, where orbiting dust periodically blocks starlight. If confirmed, this event could provide valuable insight into how dust and gas distribute a round young stars—a crucial factor in planet formation.

Good.

Why Does This Matter?

The fading and recovery of [CMD97]-1031 is among the most extreme cases of YSO variability observed. These events highlight the importance of long-term sky surveys** in uncovering hidden astrophysical processes that shape stars and planetary systems.

What other secrets might this young star still be hiding?

Word count 247

Well done, though a little short - you had another 100 words you could have used to pick up marks here.

Suitable headline:	1 /1
Factual content:	7½/9
Appropriate structure and language	7/8
Word count:	1/2

b)

i.

In the article they talk about the median and standard deviations of the cyan and orange bands using formulae

$$\sigma_{c-o} = \sqrt{\sigma_c^2 + (C) + \sigma^2\,(o)}$$

so to make it more accessible I simply said the star was fainter and redder.

ii.

I had to use my knowledge of how young stars are created in the presence of a molecular cloud. To try and understand how the accretion disc would be formed around new young stars.

Well done.

Total for question 2: 20½/24

Grand Total: 28/32