UNIVERSITY OF CAPE TOWN
EXAMINATION ANSWER BOOK

FOLD (Fold over on dotted line and seal with stickers supplied.) FOLD

Surname (In block letters) Nguenya

First Name(s) Thobile

Student No. NGWTH0016

All answer books must be numbered

Number of books handed in	
Number of this book	

1 8 0 4 8 0 9

EVERY CANDIDATE MUST [illegible]**elow the book number and the number of each question answered (in the order in which it has been answered); leave columns (3) and (4) blank.**

1 Book Number	2 Question Number	3 Internal	4 External
	2	11	
	3	12	
	4	7	
		30	
Examiner's Initials		SBP	

Date 09 June 2025

Degree/Diploma/Certificate for which you are registered (e.g. BA BSc) MSc

Course code and description ACB
(to be copied from the heading on the Examination Paper)

Paper No
(to be copied from the heading on the Examination Paper)

Venue: Astro Seminar Room

STUDENTS ARE TO READ THE IMPORTANT NOTES AND WARNINGS ON THE BACK COVER.

Any dishonesty will render the candidate liable to disqualification and to disciplinary action.

with the disc becoming more and more cooler. The cooling wave then propagates from within the region to the outer part of disc. This then regulates the temperature and puts the nova back into a quiescent state. ✓

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b) suppose you have two blobs of bubbles (ionised gas) and one is in the inner part of the disc and the other is in the outer part. Suppose they connected by a field line. The blob in the inner region rotates faster than the one in the outer region. This causes the inner bubble to slow down while losing momentum and the one in the outer region to move faster and gain angular momentum.

The radius of the accretion disc becomes enlarged during an outburst because the material has been accreted, and the surface density increases. A larger surface density would mean that the radius of the disc has enlarged which supports the DIM.

c) Z Cam stars and nova-like CVs have a white dwarf as a primary star and a red dwarf as the secondary star. The red dwarf is a star that is at its late stage in the main sequence cycle, with the white dwarf originating from the evolution of a low-mass star.

Z Cam stars and nova-like CVs mostly undergo outbursts that last for a longer period. ✓ The observed luminosity of these stars is very large during the outburst stages.

1

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- during low accretion rates, the boundary layer is optically thin, which makes the particles to not be able to radiate E. The dominant mechanism is the Bremstrauhlung which then show the hard X-ray emission in the spectrum.

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c) • as explained, the boundary layer becomes optically thin at low accretion rates.
The gas in that region becomes hot, then forms a layer of corona above the boundary layer. At this stage, the density in the corona is low. As the gas heats up, the corona get heated and ~~coo~~ heats up the cool disk which causes it to evaporate more.
This can give rise to a siphon effect because the corona can get heated while there is low mass transfer and as the temperature rises, with angular momentum and opacity increasing, the ~~corona~~ boundary layer then slowly gets filled up with mass and the siphon effect takes place.

4

12

a)
4) • initially, the disc experiences a constant mass transfer, leaving it in a quiescent state.
• then the mass in the disc starts piling up, increasing the surface density.
• the gas in the disc starts becoming dense enough to heat the disc. At this stage, the temperature is rising and becoming high.
• the increase in temperature causes hydrogen to beionised.
• ionization increases the opacity and also increases the viscosity, which then puts the disc into a viscous state.
• the increase in viscosity causes angular momentum transfer, where the inner region of the disc loses momentum and the outer layer gains momentum which causes the material to funnel in from the inner region. An outburst occurs.
• when the temperature starts dropping, the viscosity drops as well

* the period ~~minimum~~ gap is when magnetic baking has stopped and mass transfer also temporarily stops. The CVs become too faint to detect at this point and this is why there is a low reading in the period gap.

* the period minimum is when the secondary star has lost so much mass that it starts behaving like a white dwarf (degenerate). As it loses mass, it starts to expand which causes it to become bigger. This ~~then~~ region is mostly influenced by gravitation radiation.

(8) * the ultimate faint of the secondary star is that it evolves ~~to~~ be Jupiter-like stars.

a)

3) • a boundary layer is the region where the fast rotating gas from the accretion disk meets the slow rotating gas from the white dwarf's surface.

• the fast rotating gas now has to tunnel into the white dwarf's surface.

• the angular momentum of the gas decreases, which causes it to release gravitational energy. ?

3 • this is where 'winds' can also form as the atom from the accretion disk travels to the white dwarf, it encounters photons. The atom will absorb the photon which causes it to be expelled as wind. But, it will again emit a photon of certain energy, and the cycle continues. There will be excitations and de-excitations, and this we refer to as the resonance state with resonance lines produced.

b) - during high accretion rates, the boundary layer becomes optically thick, the particles get trapped. The SED becomes that of a black body radiation with it peaking in the UV and soft-Xrays side of the spectrum. This is usually observed during an outburst.

2)

a) • they first start off as binaries ✓

• with one star being a high mass star and the other being a low-mass star.

• binaries are two stars that are gravitationally bound, at a certain distance from each other.

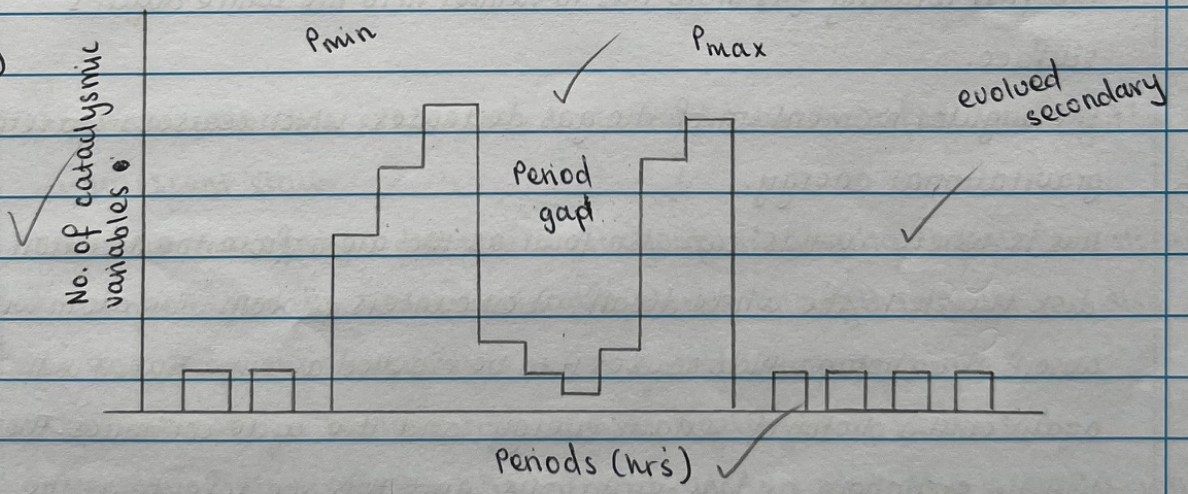
• the high mass star evolves quickly than the low-mass star. As it evolves, it fills it Roche lobe which is the point at which the secondary star starts accreting onto the primary star. ✗

• as it fills its Roche lobe, the angular momentum decreases which causes the Roche lobe to decrease in size and the high mass star starts accreting material onto the low mass star. ✗

(3) • as the accretion continues, the high mass star loses mass, and the low mass star gains angular momentum. ✗

• over time, the high mass star loses mass then the system evolves into a planetary nebula. ✗

b)



* for the long period, this is when the dominant mass transfer is the magnetic baking mechanism. Secondary stars that have high mass, have their stellar wind which interacts with the stellar magnetic fields which then slows down the secondary star and triggers mass transfer. This is why they have longer periods.