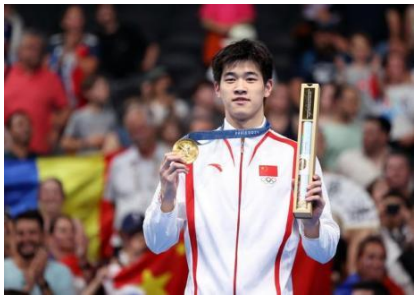
2025 "Huashu Cup" International Mathematical Contest in Modeling

MCM

Problem A: Can He Swim Faster



Background

At the 2024 Paris Olympic Games, Chinese swimmer Pan Zhanle has become the focus of global attention with his outstanding performance. Only 19 years old, he won the men's 100m freestyle with a time of 46.40 seconds and set his own world record. Pan Zhanle and his teammates Xu Jiayu, Qin Haiyang and Sun Jiajun won another gold medal for the Chinese swimming team in the final of the men's 4× 100m medley relay with a time of 3:27.46, breaking the 40-year monopoly of the US team in the event.

Pan showed a tremendous amount of speed in the final freestyle, finishing his part in 45.92 seconds. It was even faster than his world record of 46.40 seconds set in the 100m freestyle final. His performance not only helped the Chinese team reverse and win the gold medal, but also once again proved his absolute strength in the short distance freestyle event.

Pan Zhanle's individual swimming prowess should not be underestimated. However, some people still have questions about his tactical use in the swimming competition.

They think there is still room for improvement.

Requirements

In order to further study Pan Zhanle's swimming performance, please build mathematical models and answer the following questions.

- The outstanding achievements of athletes in the competition are often rooted in their hard and persistent professional training. This process not only honed their swimming skills, but also greatly enhanced their physiological reserves. In the competition, the commentators often mention Maintaining Personal Rhythm, Seeking the Best Physical Condition Rhythm and Reasonable Distribution of Physical Strength, which is the concise summary of how athletes scientifically controlling swimming speed in the competition to pursue the best performance strategy. For freestyle events, please build a model for analysis. How to arrange the speed to get the best results? Is there any difference between different races (50 m, 100 m, 200 m)? Can the model be further verified and evaluated?

- Pan Zhanle's success is no accident. His technical, tactical and psychological qualities are among the best in the world. In the freestyle competition, it is often mentioned that the athletes Mutual Testing, which involves the leading strategy, following strategy and other tactics. However, some people argue that There are no tactics, just focus on swimming. How to balance tactical interaction between athletes and individual optimal swimming strategies? Is there one strategy that is better than the others in different situations? Give your opinion and build a model to verify it.

- China trailed the United States by 0.75 seconds at the end of the third leg of the men's 4x100m mixed swimming relay at the 2024 Paris Olympics. The last freestyle will be completed by Pan Zhanle. In this case, please draw up a race strategy for him based on your research. Can this strategy achieve a better time than 45.92 seconds in the final?

Your PDF solution of no more than 25 total pages should include:

• One-page Summary Sheet.

• Table of Contents.

• Your complete solution.

• References list.

• AI Use Report (If used does not count toward the 25-page limit.)

References

[1]https://tv.cctv.cn/2024/04/26/VIDENqP6GEkE2KF0r9gt1u0K240426.shtml

[2]https://content-static.cctvnews.cctv.com/snow-book/index.html?item_id=2589529706246186591&track_id=5654fd05-65fc-428d-8f37-ffbf985b75ec

[3]https://sports.cctv.com/2024/02/17/ARTIk2GIxRcatb0yE48Owdim240217.shtml

[4]https://sports.cctv.com/2024/08/05/VIDERCCzY6VvBwJOHW1vxMZf240805.shtml?spm=C67245673465.PvP1nMXT7mxa.0.0