Evaluation guidelines for part 2 of project 3 in AST3220, 2024

In general: Many questions require some calculus/algebra/arithmetic. We deduct 1-2 points for mistakes, depending on [redacted] how serious they are

Problem 1

See general comment. Question e) can be answered in a very simple way, and you get 2 bonus points if you have found it.

Problem 2

a) gives 6 points, b) 4 points

All three assumptions in the problem text are necessary in a), and you must have used all of them in your argument to get the maximum points. In b), the important

insight is that even if the expansion is accelerating today, it was decelerating in the past, so the same argument as in a) can be used here. To get 4 points, you must show signs of having understood this.

Problem 3

See general comment

Problem 4

Horizon problem: No calculations required, just need to say that without inflation, the CMB temperature would not be expected to be the same across the whole sky

Flatness problem: Same here, just need to say that without inflation, the deviation from flatness would grow with time, so enormous fine-tuning is required to have an almost flat universe today.

Problem 5

To get max points: Must find N_{tot} and relate it to ϵ (or η).

Problem 6

To get max points: Use the EoS parameter

$$w_\phi = \frac{\frac{1}{2}\dot{\phi}^2 - V(\phi)}{\frac{1}{2}\dot{\phi}^2 + V(\phi)}$$

and that inflation requires $\ddot{a} > 0$.

Problem 7

a), b) and c) fall in under the general comment. In question d) you need to show that you understand that inflation never ends in this model, and that this is a bad thing

Problem 8

These are "show that" - questions, and therefore require detailed, step-by-step demonstations.

The exception is the very last question, which is quite difficult. You don't need the full argument from the solution I posted to get points here, just some argument that makes it reasonable to think that δH will disappear quickly.