

Norwegian Olympiad on Astronomy and Astrophysics – Round 2

Statistics

General Statistics

From Round 1, we invited 111 students to participate in Round 2. From these 111, we only got 99 submissions, despite extending the deadline by a week due to several teachers reporting a lot of illness among their students. The question sets were sent out Friday week 3, and the deadline without the extension was Friday week 4, although we did wait for Friday week 5 for the rest.

The total score distribution is shown in Figure 1, with mean score $\mu = 9.99$ and standard deviation $\sigma = 3.74$ for the $n = 99$ students. The maximum possible score was 20, and was attained by one student! The distribution resembles a sort of a normal distribution, and suggests that the difficulty level for this round was adequate.

Total Score Distribution

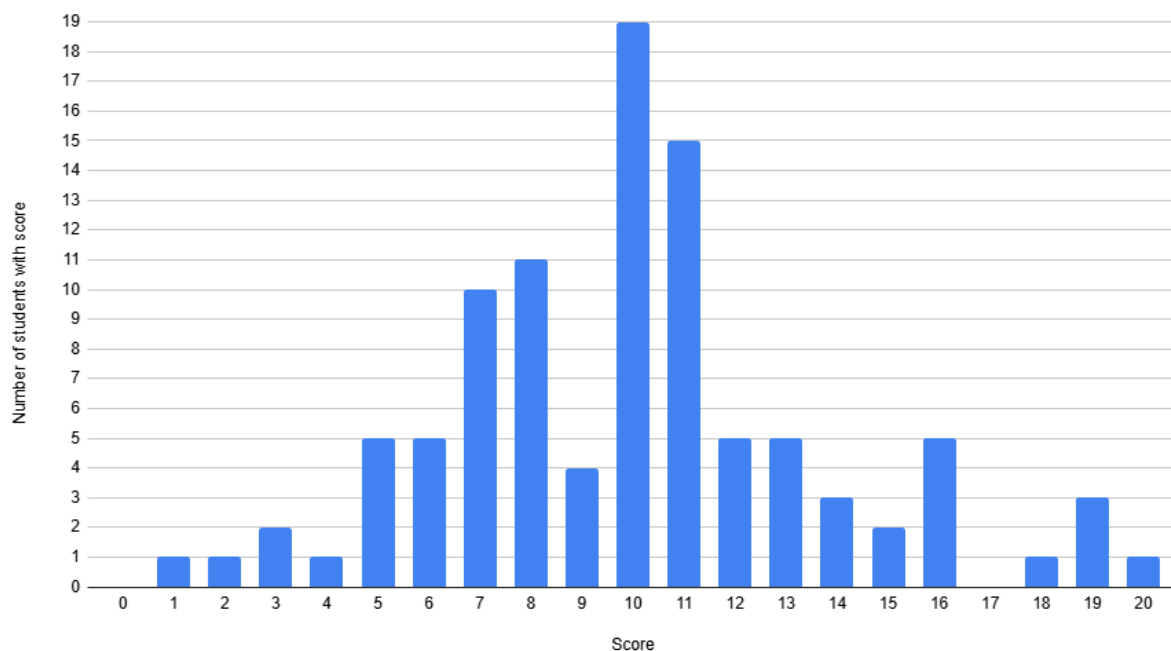


Figure 1: Total Score Distribution for Round 2

Just like with Round 1, no single question was answered correctly by all students, but there are several that show up as being easier than the rest. We will do a deep dive into answer distributions for each question, but the full summary can be found in Figure 2. Some questions weren't answered by all students for some reason, so the deep-dive numbers may not all add up to 99.

Number of Students With Correct Answers for Each Question

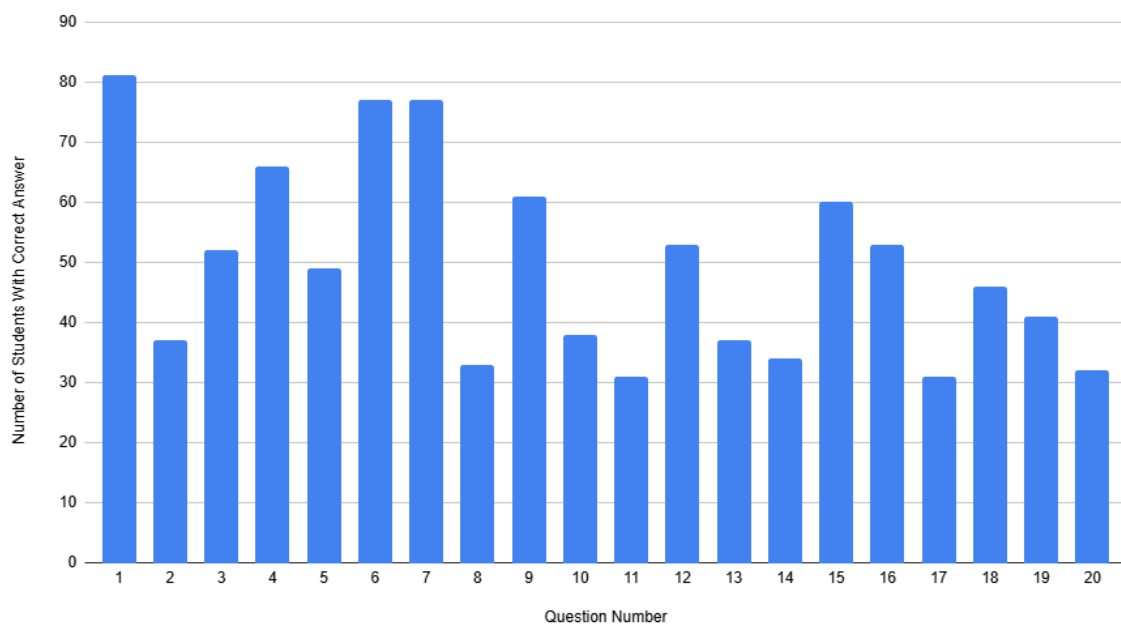


Figure 1: Number of students to correctly answer each question.

Per-Question Statistics

Question 1

	Alternatives	Number of Students
Question 1	A	81
	B	7
	C	3
	D	8

This question was on recognising the main property of pulsars, namely extremely regular and periodic bursts. A lot of the question is the story behind pulsar discovery and its aftermath, keeping in theme with us wanting to tell about the history of astronomy, especially through a female-oriented lens. A vast majority of the students got this question right, so they are able to extract important information from a long text, and are aware of this fundamental property of pulsars, which is great!

Question 2

	Alternatives	Number of Students
Question 2	A	12
	B	37
	C	37
	D	13

The first of many questions to come directly from reading the handouts. We recommend the students read through the handouts - it's okay if they don't yet understand some concepts fully. At this point, familiarisation is the most important, and the handouts cover most of the syllabus needed for the international version as well, so being comfortable with their contents will prove to be very beneficial in the Norwegian qualifying rounds.

Knowing the parts of coordinate systems is a crucial part when needing to work with them at a later stage. There was a perfectly even split between equatorial and ecliptic coordinates.

Question 3

	Alternatives	Number of Students
Question 3	A	21
	B	10
	C	16
	D	52

We asked essentially the same question last year, only without the story behind how cepheids were discovered. We recommend students use previous Olympiads to practice, as many questions and concepts will get repeated in some way or the other. More than 50% of the students got the correct answer, which is a very good sign!

Question 4

	Alternatives	Number of Students
Question 4	A	11
	B	66
	C	16
	D	6

Another question straight out of the handout, asking about chromatic aberration. This is an important observational difference between refracting and reflecting telescopes, and knowing the differences will be incredibly useful once the students start to observe. We purposefully hinted at the correct answer by writing out a fuller explanation for alternatives B and C, where the students could conclude that light of different wavelengths does not reflect differently, but it does refract differently. Two thirds of the students got this question correct, which is great!

Question 5

	Alternatives	Number of Students
Question 5	A	49
	B	8
	C	3
	D	39

This question was on the reason why we always see the same side of the Moon from the Earth. The key is to understand the principle of tidal locking. In addition to knowing the physics behind everything, and knowing about space in general, a lot of the Olympiad is knowledge of our planet and its interactions with other celestial bodies.

There was a relatively even split between the correct alternative and the Moon's orbit and Earth's rotation being synchronised, showing a split in understanding what an object being tidally locked actually means.

Question 6

	Alternatives	Number of Students
Question 6	A	7
	B	10
	C	77
	D	5

The equation of time is a complex concept, but again an important property of our planet arising from the properties of Earth's orbit. We expected more students to get this question wrong, but to our surprise, a vast majority of them actually got it correct, which is great!

Question 7

	Alternatives	Number of Students
Question 7	A	77
	B	13
	C	4
	D	5

A cosmology question on the level of general knowledge where we ask about why and how we know about dark matter. Again, a vast majority of students got this right, pointing to at least good pop-sci knowledge, which is incredibly relevant for the Olympiad!

Question 8

	Alternatives	Number of Students
Question 8	A	29
	B	33
	C	8
	D	29

This question is also taken straight out of one of the handouts and concerns the Shell Theorems, which are required to know for the international Olympiad. Here we have a pretty even split between three alternatives. The difficult part of this question wasn't the algebra, but the fact that only the inner part of a planet exerts a gravitational force, and not the outer. It is understandable that students got it wrong if they haven't seen the Shell Theorems before, but it is a good sign that a third actually got it right!

Question 9

	Alternatives	Number of Students
Question 9	A	7
	B	61
	C	7
	D	24

We doubled down on the question about the sidereal year from round 1, expecting students who got it wrong last time (and there were very many) to have learned from their mistake and the solution provided in round 1. Far more students got the question this time, which is great! Compare last round's sidereal time question where 21% got it correct to this time where 62% got it correct! We love to see an improvement in students' understanding between rounds and often make questions that build upon concepts asked about in a previous round.

Question 10

	Alternatives	Number of Students
Question 10	A	17
	B	38
	C	30
	D	13

A simple parallax calculation answer, requiring students to think about half-angles and conversion from degrees to radians. Although the biggest percentage went for the correct alternative, most of the students actually got it wrong. We thought this was a matter of simple calculation, and even with getting the half-angle wrong, the other alternatives were thought to be far beyond a reasonable order of magnitude for the students to calculate their way to them. This is one of the formulae not given in the very start - we give more complex formulae and those requiring constants, but expect students to know angle conversions and simpler formulae such as the parallax.

Question 11

	Alternatives	Number of Students
Question 11	A	28
	B	31
	C	14
	D	26

Another question plucked straight from the handout. As the rounds progress, we expect the students to become more and more familiar with reading sky charts and orienting themselves in the night sky. Only a third getting this question right suggests the students aren't completely familiar with orienting themselves using stars, which is something we want to push on them a little more. A key point to understand is that with north up and south down, east will actually be to the left, and west to the right, which is the opposite to what they're used to from geographical maps. The observational handout explains why this is the case.

Question 12

	Alternatives	Number of Students
Question 12	A	12
	B	23
	C	53
	D	11

A build-up from the previous question. In the handout, we even state explicitly that this exact sky chart is from Trondheim at 60 degrees north latitude. Surprisingly more students managed to answer this question without having answered the previous one. This could be both to them knowing how to use Polaris to determine latitude, but also them just (correctly) assuming that the sky chart generated was in Norway, with 60 degrees being the only matching one.

Question 13

	Alternatives	Number of Students
Question 13	A	18
	B	37
	C	21
	D	22

This we considered to be one of our more difficult questions for this round, as it required understanding that one of the alternatives only contains zodiacal constellations which both the Sun, the Moon and the planets appear to move through. Although difficult if one hasn't been made aware of the properties of the zodiacal constellations, more students than expected managed to get it right! Again, observational astronomy is extremely important, and knowledge of constellations is a requirement the further into the Olympiad they go.

Question 14

	Alternatives	Number of Students
Question 14	A	47
	B	34
	C	11
	D	7

Another cosmology question, this time on how planets with prominent atmospheres are made. We have another split here between the correct alternative and one of the wrong ones. Although the first condition can be applied to exoplanets we refer to as "hot Jupiters", the best conditions are as specified in the correct alternative. This is not a question they will find explicitly written in their textbooks, but one that requires reasoning and knowing what the consequences of, say, weak and strong gravitational fields are.

Question 15

	Alternatives	Number of Students
Question 15	A	12
	B	4
	C	23
	D	60

A question about stellar evolution, comparing the mass of stars to their lifetimes, especially in relation to our Sun. A majority of the students actually got this correct, which is great and serves as a good starting point to understand stellar evolution!

Question 16

	Alternatives	Number of Students
Question 16	A	53
	B	2
	C	33
	D	11

This classic HR diagram question can be answered quite straightforwardly by knowing where in the HR diagram white dwarfs are located. Although the majority got it correct, there's a substantial amount that went for the alternative corresponding to where giants in the HR diagram are. We ask about HR diagrams and placing stellar types in them every round every year, and hope that a majority of students will answer correctly next time around!

Question 17

	Alternatives	Number of Students
Question 17	A	31
	B	25
	C	19
	D	24

This question we didn't expect students to know right out of the box. We expected alternatives B and C to be discarded, as these are the classic consequences of Doppler shift that they know from both their textbooks and the previous round. It is surprising that so many went for one of the two, but it is positive that almost a third manage to reason themselves to the correct answer. Although alternative d is an implausible answer to the question, it is understandable that students went for it if they struggled between A and D, not knowing which one to pick.

Question 18

	Alternatives	Number of Students
Question 18	A	41
	B	3
	C	46
	D	9

This question is on the nature of apparent retrograde motion and why exactly that occurs. Many went for the alternative on relative velocities, maybe being led astray by the fact that the correct alternative had the word "circular" in it, and then knowing that the orbits aren't perfectly circular. The near 50-50 split on those alternatives is understandable, and it's great that most went for the correct answer!

Question 19

	Alternatives	Number of Students
Question 19	A	23
	B	41
	C	27
	D	8

A counter-intuitive question that we expected many to get wrong, so we provided the temperature graph to hopefully make it a bit easier, since heating mechanisms for the atmosphere of the Sun are a big unknown in research today. The highest percentage went for the correct alternative, and a significant portion went for the intuitive alternative that we expected a lot to fall for, but there is also a significant part that for some reason answered that the core is the coldest, but getting the hotness of the outer atmosphere correct. All in all, this was deemed to be one of the more complicated questions, as it isn't very straightforward to conclude that the corona is hotter than the photosphere.

Question 20

	Alternatives	Number of Students
Question 20	A	32
	B	7
	C	43
	D	17

An intuition- and knowledge-based question regarding the Lagrange points, which, again, can be read about in the handouts. Most failed here, not knowing about the stability properties of the different Lagrange points, although we did purposefully formulate the alternatives to require a bit more intuitive thought.