Tyngdpunkten 2026

Högstadiet

November 2026

Competition format and tips

- The competition consists of three parts:

  Part A - Quick questions. Short questions where only an answer is required.

  Part B - Everyday physics. Longer problems with several subproblems of varying difficulty.

  Part C - Problem solving. Harder problems that require more thinking.

- How many points each problem and subproblem gives is stated in parentheses, for example (2 p). The competition gives a total of 70 points.
- The problems do not have to be solved in order. It may be wise to split the problems among the team members.
- In problems with several subproblems you can get points on a subproblem even if you have not solved the previous ones. If you have not obtained an answer to, for example, a), you can make up a reasonable value and continue calculating with it in b).
- Justify your answers and show how you have reasoned. Even an incomplete solution can earn points. How much justification is required differs between the parts of the competition and is stated at the beginning of each part.

Good luck!

Part A: Quick questions

Only an answer is required.

Problem 1: Trivia (5 p)

Answer the following questions briefly. Each correct answer gives 1 point.

1. In what unit is force measured?
2. What does the law of conservation of energy say?
3. What is the nuclear reaction that makes the Sun shine called?
4. Which of the radiation types alpha, beta and gamma radiation is electromagnetic radiation?
5. What is the melting point of ice in kelvin?

Problem 2: True or false (5 p)

Decide whether the statements are true or false. Answer with ”true” or ”false”. Each correct answer gives 1 point.

1. Water has a higher density than ice.
2. Sound travels faster in air than in water.
3. Mercury is the planet in the solar system with the highest surface temperature.
4. Light can be bent by gravity.
5. In a vacuum, a heavy ball falls faster than a light one.

Part B: Everyday physics

Justify your answers and show your calculations.

Problem 3: A cold November morning (20 p)

Isaac wakes up on a cold November morning, unusually without any alarm having gone off.

a) He sits up in bed and notices that the bed sinks down a little. Why does this happen? (1 p)

The window had apparently been left ajar all night, and Isaac soon discovers that his hands are ice cold. He therefore rubs his hands against each other, and after a while they are warm again.

b) Why do his hands get warm when he rubs them against each other? (1 p)

Isaac reaches for the phone on his desk and gets a minor shock when he looks at the clock: 07:03. He must have forgotten to set the alarm last night! The first lesson is physics, so being late is of course out of the question. He gets straight out of bed and walks briskly to the kitchen to throw together a breakfast. As always, Isaac puts two slices of bread in the toaster and boils water for a cup of tea, but the water is too hot to drink right away. He can wait at most five minutes and wants the tea to be as cold as possible by then. He also wants to pour a little cold milk into the tea, but does not know whether to do it before or after he lets the tea cool.

c) What gives the coldest tea after five minutes: pouring in the cold milk right away and then waiting, or first waiting and then pouring in the cold milk? Justify your answer. You may assume that the same amount of milk is used in both cases and that Isaac stirs after pouring in the milk. (2 p)

To drink the tea, Isaac of course uses a straw.

d) Why is the tea drawn up when he sucks on the straw? Explain using pressure. (2 p)

After breakfast, Isaac washes his hands.

e) To squeeze out the soap, Isaac has to create an excess pressure $p = 30\,000\,\text{Pa}$ (above atmospheric pressure) inside the pump. The push button is connected to a circular piston with radius $r = 0.010\,\text{m}$. How large a force, in newtons, must Isaac at least exert on the button?

Use the relations

$$p = \frac{F}{A}, \qquad A = \pi r^2,$$

where p is the excess pressure in pascals, F is the force in newtons and A is the area of the button in square metres. (2 p)

It is now already 07:25 and time is running short. Before Isaac leaves home he takes a quick look in the hallway mirror. Unfortunately the mirror is too short, so to see his whole outfit he backs further away from the mirror.

f) Does Isaac see more of his outfit when he backs away from the mirror? Why or why not? (2 p)

Isaac lives on the sixth floor and therefore takes the lift down.

g) When the lift starts moving downwards he feels lighter than usual. After that he feels as heavy as usual for a while. When the lift slows down at the ground floor he suddenly feels heavier than usual. Explain the three sensations physically. (2 p)

Now the question is how Isaac gets to school the fastest. From his home, the school is 2 400 m to the east and 1 800 m to the south. There are two alternatives (see Figure 1):

- Isaac walks diagonally across the field with the average speed 1.5 m/s.
- The bus comes in 10 minutes and then travels the whole way by road with the average speed 7.0 m/s.

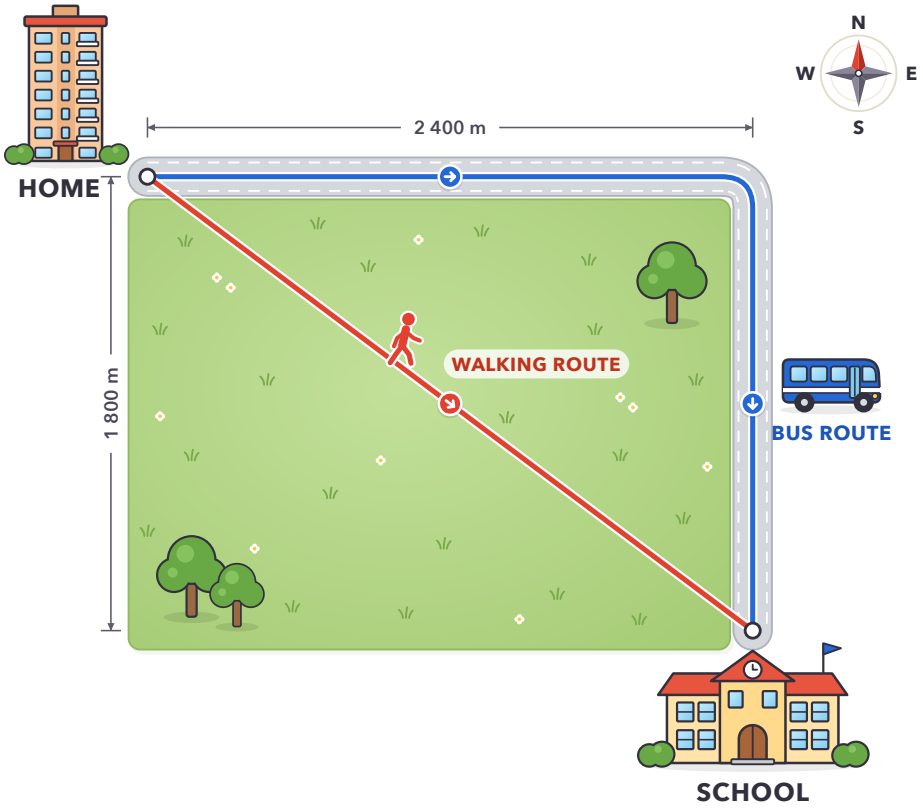


Figure 1: The way from Isaac's home to the school.

h) Which alternative gets Isaac to school the fastest, and how much faster is it? Show your calculations clearly. (2 p)

To come across more interesting physics problems on the way, Isaac decides to take the bus, regardless of what is fastest. While he waits for the bus he sees the Sun slowly starting to creep above the horizon. "It really is taking its time", he thinks.

i) Why does the sunrise last longer in the middle of November than earlier in the autumn? When during the year does the sunrise last the longest, and when does it last the shortest, at a place in Sweden where the Sun rises every day? Here, *the duration of the sunrise* means the time from when the first edge of the solar disc is visible until the whole solar disc is visible above the horizon. (3 p)

Luckily, the bus arrives exactly on time and Isaac gets on.

j) The bus runs on biogas. Describe which energy conversions take place in the bus during the trip to school. (1 p)

When the bus stops at a stop roughly halfway to the school, Isaac hears an ambulance. Since the ambulance is quite far away, he finds it hard to hear whether it is on its way towards the bus or away from it. With an app on his phone he therefore measures the frequency of the siren to be 740 Hz. He knows that the city's ambulances emit a sound with the frequency 700 Hz.

k) Based on the two frequencies, is the ambulance on its way towards the bus or away from it? Justify your answer briefly. (2 p)

Isaac finally arrives at school, just in time for the physics lesson. Today's task is to create physics problems based on one's own everyday life. He thinks for a while, smiles slightly to himself and then puts pen to paper: *Isaac wakes up on a cold November morning, unusually without any alarm having gone off...*

Problem 4: You are electric (10 p)

a) Describe what physically happens in a short circuit. (2 p)

To prevent precisely short circuits and overloads, fuses are installed in our houses. The downside is that they limit how many appliances one can use at the same time. If the current exceeds what the fuse is rated for, the circuit is broken. One can calculate how large the current in a circuit is using the formula $P = U \cdot I$, where

- P is the power in watts (W),
- U is the voltage in volts (V),
- I is the current in amperes (A).

In Isaac's house the wall sockets have the voltage 230 V, and we assume that all of them are connected to the same 10 A fuse. The table below shows how much power each kitchen appliance draws when it is in use.

Kitchen appliance	**Power (W)**
Kettle	1800
Coffee maker	1200
Microwave oven	1500
Toaster	800

Table 1: Power of some common kitchen appliances.

b) What is the current in the circuit when Isaac uses the toaster? (2 p)

c) What is the current in the circuit when he turns on the coffee maker at the same time as the toaster? (2 p)

d) Can Isaac use the kettle and the microwave oven at the same time? (2 p)

e) Kalle has a wall socket with the voltage 230 V and a 16 A fuse connected. What is the maximum power that Kalle can connect in his kitchen? (2 p)

Part C: Problem solving

These problems are harder. Even a partial solution or a well-justified idea can earn points.

Problem 5: Lunar eclipse (10 p)

a) A ray of sunlight takes 8 minutes and 19 seconds to travel from the Sun to the Earth. Use the speed of light, $c = 3.00 \cdot 10^8$ m/s, to calculate the distance between the Sun and the Earth. (1 p)

b) The radius of the Earth is 6 371 km. The solar disc has an area that is roughly 12 000 times larger than the cross-sectional area of the Earth. Calculate the radius of the Sun from this. (2 p)

c) When the Sun shines on the Earth, a shadow is formed behind the Earth in two parts. In the *umbra* the Sun is completely hidden, and in the *penumbra* the Sun is only partially hidden, see Figure 2. Since the Sun is larger than the Earth, the umbra takes the shape of a cone that narrows to a tip behind the Earth. Use the sizes of the Sun and the Earth as well as the distance to the Sun to calculate how far behind the Earth the tip of the umbra is located. (3 p)

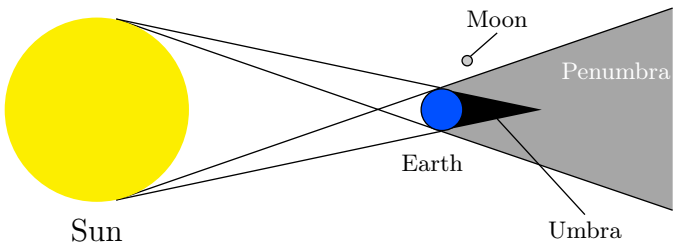


Figure 2: The shadow of the Earth consists of the umbra, where the Sun is completely hidden, and the penumbra, where the Sun is partially hidden. The figure is not to scale.

d) The Moon is on average 384 400 km from the Earth. Calculate how wide the umbra is at this distance (its diameter). (2 p)

e) The Moon has the radius 1 737 km and moves in its orbit with the average speed 1.02 km/s. Assume that the Moon moves along a straight line such that its centre passes through the centre of the umbra. Also assume that the Earth stands still during the process. Determine for how long the Moon is completely inside the umbra, that is, how long the total lunar eclipse lasts. (2 p)

Problem 6: Weightless but not massless (5 p)

If you want to find your mass here on Earth (what we usually call our "weight"), you can stand on an ordinary scale. Many of these work by measuring the normal force from the scale and then dividing by the acceleration due to gravity $g = 9.82\,\mathrm{m/s^2}$. Imagine that you are an astronaut out in space and that you want to measure your mass. Assume perfect weightlessness. How can you then measure your mass?

Hint: There are several ways to solve the problem, creative solutions are encouraged! You may assume that you have access to any equipment whatsoever, for example objects of known mass, as long as you explain how you would proceed and why the method works.

Problem 7: Cleaners on the loose (5 p)

Boris and Natasha have got jobs as cleaners in Luleå. Boris can be considered lazy and Natasha diligent. When they are heading home from work it is snowing, and they each ride an identical rail trolley[1] on parallel tracks down a hill. Boris rests and lets it snow on his trolley. Natasha does not; she chooses to brush each snowflake off to the side right after it has landed on the trolley, so that it does not land on the trolley again. Who gets down the hill first, if we neglect friction and air resistance?

Problem 8: Vroooooom!!! (10 p)

Alvin drives onto the motorway and sees a car 50 metres ahead of him in which Palmgren is driving at the speed 20 m/s (72 km/h). Alvin decides to catch up and puts his foot down. His velocity during the drive can be seen in Figure 3. After how long does he catch up, and how far has he then driven on the motorway?

Hint: Full marks require an exact answer, but reasonable estimates can earn partial credit!

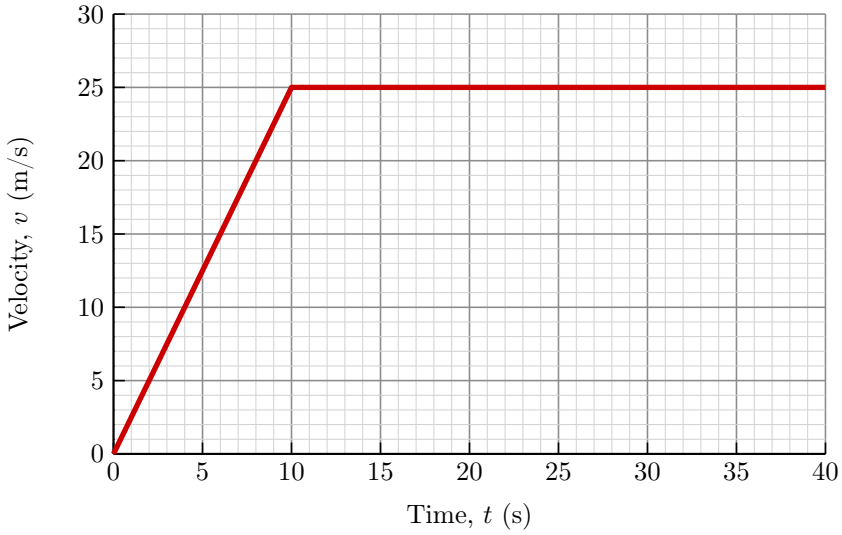


Figure 3: Alvin's velocity (in m/s) over time (in seconds).

[1] A rail trolley (draisine) is a small railway vehicle.