

# “Calculation-Free” Science Problems: Test problems for GPT4 + Wolfram Alpha and GPT4 + Code Interpreter with answers and outputs

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For each problem, we give here:

1. The problem.
2. The correct solution.
3. The answer produced by GPT4 run with the Wolfram Alpha plug-in (GPT4+WA).
4. An edited form of the output of GPT4+WA. Editorial comments in this output are in italics.
5. A comment, including whether the answer was right, wrong, or got partial credit.
6. The answer produced by GPT4 run with the Code Interpreter plug-in (GPT4+CI).
7. In some cases, where it has features of interest, an edited form of the output of GPT4+CI. Editorial comments in this output are in italics.
8. A comment, as in (5).

In many cases, GPT did not call the plug-in; we note that as “used default GPT-4”.

## Eclipse problems

In all of the eclipse problems, both systems used default GPT-4; neither plug-in was called.

1. An astronaut is standing in the Sea of Tranquility during what on earth is called a total lunar eclipse. They are looking in the direction of the earth. What they see is:
  - A. The surface of the moon, illuminated by earth light.
  - B. The night side of the earth, occluding the sun.
  - C. The surface of the moon, illuminated only by starlight.
  - D. The surface of the moon, illuminated by the sun.
  - E. The sun.
  - F. The day side of the earth, with a small circular shadow moving quickly over it.
  - G. The night side of the earth. The sun is somewhere else entirely.
  - H. A starry sky. Neither the sun, the earth, or the surface of the moon is in the field of view.

**Answer:** B. The night side of the earth, occluding the sun.

**Both GPT4+WA and +CI Answer:** F. The day side of the earth, with a small circular shadow moving quickly over it.

**GPT4+WA Explanation:**

Explanation: During a total lunar eclipse as observed from Earth, the Earth is positioned between the Sun and the Moon, causing the Earth's shadow to fall on the Moon. This is why we see the Moon darken from our perspective on Earth.

However, from the perspective of an astronaut standing on the Moon and looking at the Earth during this event, they would see the Earth fully illuminated by the Sun (the "day side" of the Earth), because the Sun is behind the Earth from their perspective. They would also see a small circular shadow (the shadow of the Moon) moving quickly over the Earth's surface. This is because the Moon (where the astronaut is standing) is moving through the Earth's shadow.

**Comment:** Wrong.

2. An astronaut is standing in the Sea of Tranquility during what on earth is called a total lunar eclipse. They are looking in the direction of the sun. What they see is:

- A. The surface of the moon, illuminated by earth light.
- B. The night side of the earth, occluding the sun.
- C. The surface of the moon, illuminated only by starlight.
- D. The surface of the moon, illuminated by the sun.
- E. The sun.
- F. The day side of the earth, with a small circular shadow moving quickly over it.
- G. The night side of the earth. The sun is somewhere else entirely.
- H. A starry sky. Neither the sun, the earth, or the surface of the moon is in the field of view.

**Answer:** B. The night side of the earth, occluding the sun.

**Both GPT4+WA and +CI answer:** The correct answer is B. The night side of the earth, occluding the sun.

**GPT4+WA Explanation:**

During a total lunar eclipse as observed from Earth, the Earth is positioned directly between the Sun and the Moon, causing the Earth to cast its shadow on the Moon. This is why we see the Moon darken from our perspective on Earth.

If an astronaut were standing on the Moon (in this case, the Sea of Tranquility) during this event, looking towards the Sun, they would see the Earth blocking the Sun. This is because the Earth is directly between the Moon (where the astronaut is) and the Sun. The side of the Earth facing the Moon would be its night side, as the Sun is behind it from that perspective. Therefore, the astronaut would see the night side of the Earth occluding the Sun.

**Comment:** Right.

3. An astronaut is standing in the Sea of Tranquility during what on earth is called a total solar eclipse. They are looking in the direction of the earth. What they see is:

- A. The surface of the moon, illuminated by earth light.
- B. The night side of the earth, occluding the sun.
- C. The surface of the moon, illuminated only by starlight.
- D. The surface of the moon, illuminated by the sun.
- E. The sun.

- F. The day side of the earth, with a small circular shadow moving quickly over it.
- G. The night side of the earth. The sun is somewhere else entirely.
- H. A starry sky. Neither the sun, the earth, or the surface of the moon is in the field of view.

**Answer:** F. The day side of the earth, with a small circular shadow moving quickly over it.

**GPT4+WA Answer:** The correct answer is H. A starry sky. Neither the sun, the earth, nor the surface of the moon is in the field of view.

During a total solar eclipse on Earth, the Moon moves between the Earth and the Sun, casting a shadow on the Earth's surface. However, when an astronaut is standing in the Sea of Tranquility (a region on the Moon) during a total solar eclipse, they would not be able to see the Earth, as it would be located behind them. The Moon would be blocking their view of the Sun, leaving them with a starry sky in their field of view.

**Comment:** Wrong.

**GPT4+CI Answer:** F. The day side of the earth, with a small circular shadow moving quickly over it.

Comment: Right

4. An astronaut is standing in the Sea of Tranquility during what on earth is called a total solar eclipse. They are looking in the direction of the sun. What they see is:

- A. The surface of the moon, illuminated by earth light.
- B. The night side of the earth, occluding the sun.
- C. The surface of the moon, illuminated only by starlight.
- D. The surface of the moon, illuminated by the sun.
- E. The sun.
- F. The day side of the earth, with a small circular shadow moving quickly over it.
- G. The night side of the earth. The sun is somewhere else entirely.
- H. A starry sky. Neither the sun, the earth, or the surface of the moon is in the field of view.

**Answer:** A. The surface of the moon, illuminated by earth light.

**GPT4+WA Answer:** The astronaut sees:

B. The night side of the earth, occluding the sun.

**GPT4+WA Explanation:** During a total solar eclipse on Earth, the Moon is positioned directly between the Earth and the Sun. If an astronaut is standing on the Moon, looking towards the Sun at the exact time of the eclipse, they would see the Earth blocking (or occluding) the Sun. This means that the astronaut would see the night side of the Earth, with the Sun hidden behind it.

The astronaut might also see a faint illumination of the Earth's atmosphere known as the solar corona, a phenomenon visible from Earth during a total solar eclipse. However, this was not included as an option in your question.

Comment: Wrong.

**GPT4+CI Answer:** E. The Sun

Comment: Wrong.

5. An astronaut is standing on the so-called “dark side of the moon”, during what on earth is called a total lunar eclipse. They are looking in the direction of the earth. What they see is:

- A. The surface of the moon, illuminated by earth light.
- B. The night side of the earth, occluding the sun.
- C. The surface of the moon, illuminated only by starlight.
- D. The surface of the moon, illuminated by the sun.
- E. The sun.
- F. The day side of the earth, with a small circular shadow moving quickly over it.
- G. The night side of the earth. The sun is somewhere else entirely.
- H. A starry sky. Neither the sun, the earth, or the surface of the moon is in the field of view.

**Answer:** C. The surface of the moon, illuminated only by starlight.

Both GPT4+WA and +CI answer: B. The night side of the Earth, occluding the Sun.

**GPT4+WA Explanation:** The term "dark side of the moon" is a bit of a misnomer. It's more accurately described as the "far side of the moon" - the side that is always facing away from Earth due to the moon's synchronous rotation. This side of the moon is not always dark; it receives sunlight when the moon is between the Earth and the sun.

If the astronaut is on the far side of the moon during a total lunar eclipse (as viewed from Earth), it means that the Earth is positioned directly between the Sun and the Moon. In this situation, the Earth is blocking sunlight from reaching the moon. Therefore, if the astronaut is looking towards the Earth, they would see:

- B. The night side of the Earth, occluding the Sun.

Please note that during a total lunar eclipse, the Earth's atmosphere refracts sunlight around the Earth, causing the Earth to appear ringed with a reddish light. This light (called "earth-shine") might not be bright enough to illuminate the moon's surface significantly from the astronaut's perspective, but it would be a spectacular sight to observe from the far side of the moon.

**Comment:** Wrong. The paragraph about "the dark side of the moon" being a misnomer was included in every response to every question that included that phrase, though we have edited it out.

- 6. An astronaut is standing on the so-called "dark side of the moon", during what on earth is called a total lunar eclipse. They are looking in the direction of the sun. What they see is:

- A. The surface of the moon, illuminated by earth light.
- B. The night side of the earth, occluding the sun.
- C. The surface of the moon, illuminated only by starlight.
- D. The surface of the moon, illuminated by the sun.
- E. The sun.
- F. The day side of the earth, with a small circular shadow moving quickly over it.
- G. The night side of the earth. The sun is somewhere else entirely.
- H. A starry sky. Neither the sun, the earth, or the surface of the moon is in the field of view.

**Answer:** C. The surface of the moon, illuminated only by starlight.

Both GPT4+WA and +CI answer: E. The sun.

**GPT4+WA Explanation:**

A total lunar eclipse occurs when the Earth is between the sun and the moon, and the Earth's shadow falls on the moon. This event is observed from Earth, not from the moon.

So, if an astronaut is standing on the far side of the moon (the side facing away from Earth) during a total lunar eclipse (as observed from Earth), they would be facing the sun. The Earth would be behind them, and they would not see the Earth or its shadow.

Therefore, the astronaut would see the sun.

**Comment:** Wrong.

7. An astronaut is standing on the so-called “dark side of the moon”, during what on earth is called a total solar eclipse. They are looking in the direction of the earth. What they see is:

- A. The surface of the moon, illuminated by earth light.
- B. The night side of the earth, occluding the sun.
- C. The surface of the moon, illuminated only by starlight.
- D. The surface of the moon, illuminated by the sun.
- E. The sun.
- F. The day side of the earth, with a small circular shadow moving quickly over it.
- G. The night side of the earth. The sun is somewhere else entirely.
- H. A starry sky. Neither the sun, the earth, or the surface of the moon is in the field of view.

**Answer:** D. The surface of the moon, illuminated by the sun.

**Both GPT4+WA and GPT4+CI answer:** B. The night side of the earth, occluding the sun.

**GPT4+WA Explanation:** In the scenario you've described, the astronaut is on the far side of the moon during a total solar eclipse. A total solar eclipse occurs when the moon comes between the Earth and the sun, blocking the sun's light from reaching some areas on Earth.

If the astronaut is looking towards the Earth during this event, they would see the night side of the Earth blocking the sun. The Earth would appear as a dark disk surrounded by the glowing light of the sun's corona. So, the correct answer is B. The night side of the earth, occluding the sun.

**Comment:** Wrong.

8. An astronaut is standing on the so-called “dark side of the moon” during what on earth is called a total solar eclipse. They are looking in the direction of the sun. What they see is:

- A. The surface of the moon, illuminated by earth light.
- B. The night side of the earth, occluding the sun.
- C. The surface of the moon, illuminated only by starlight.
- D. The surface of the moon, illuminated by the sun.
- E. The sun.
- F. The day side of the earth, with a small circular shadow moving quickly over it.
- G. The night side of the earth. The sun is somewhere else entirely.
- H. A starry sky. Neither the sun, the earth, or the surface of the moon is in the field of view.

**Answer:** E. The sun.

**Both GPT4+WA and +CI answer:** The correct answer is E. The sun.

**GPT4+WA explanation** During a total solar eclipse as seen from Earth, the Moon is positioned directly between the Earth and the Sun. Therefore, an astronaut standing on the far side of the Moon (often incorrectly referred to as the “dark side of the Moon”) and looking towards the Sun would see the Sun fully, as there are no bodies between the Moon and the Sun at that time.

**Comment:** Right.

## Distance combination problems

9. Joe says that he lives 10 miles from the Atlantic, that Beth lives 10 miles from the Atlantic, and that he and Beth live 3000 miles apart. Is it possible that Joe is telling the truth? Answer "Yes" or "No". **Answer:** Yes

**GPT4+WA Answer:** (used default GPT-4). Yes, it is possible that Joe is telling the truth.

**GPT4+WA Explanation:** Even though both Joe and Beth live 10 miles from the Atlantic, they don't necessarily live near the same point on the Atlantic. The Atlantic Ocean spans a large area, and it's possible for two points along its coastline to be 3000 miles apart. For example, one could be in the northern part of the United States and the other could be in South America. Both would be 10 miles from the Atlantic, but 3000 miles apart from each other.

**Comment:** Right, correct explanation.

**GPT4+CI Answer:** No. (used default GPT-4)

**GPT4+CI Explanation.**

To explain, let's use a simple model where the Earth is a perfect sphere and the Atlantic Ocean is a straight line (this is a simplification, but it will help us understand the problem).

In this model, Joe and Beth's locations can be visualized as two points that are each 10 miles away from the Atlantic Ocean. If we draw a line from Joe's location, through the center of the Earth, to Beth's location, we would create a triangle. The three points of this triangle are Joe's location, the center of the Earth, and Beth's location.

The minimum distance between Joe and Beth would occur if they were both on the same line from the Atlantic Ocean, effectively on opposite sides of the Earth. The Earth's diameter is roughly 7917.5 miles, so even in this most extreme situation, they would be less than 8000 miles apart.

Joe's claim that he and Beth are 3000 miles apart, despite both being 10 miles from the Atlantic Ocean, is therefore not possible.

**Comment:** Wrong. Explanation is gibberish.

10. Joe says that he lives 10 miles from New York City, that Beth lives 10 miles from New York City, and that he and Beth live 3000 miles apart. Is it possible that Joe is telling the truth? Answer "Yes" or "No". **Answer:** No.

**GPT4+WA and GPT4+CI Answer:** No. Both used default GPT-4.

**GPT4+WA Explanation:** No, it is not possible for Joe to be telling the truth. If both Joe and Beth live 10 miles from New York City, they should be at most 20 miles apart (if they are on opposite sides of the city), not 3000 miles.

**Comment:** Right (though the comment is not precisely correct.)

11. Joe says that he lives 10 miles from Lake Michigan, that Beth lives 10 miles from Lake Michigan, and that he and Beth live 100 miles apart. Is it possible that Joe is telling the truth? Answer "Yes" or "No". **Answer:** Yes

**GPT4+WA and GPT4+CI Answer:** No.

**GPT4+WA Explanation:** The scenario Joe describes is not possible. Here's why:

If we imagine Lake Michigan as a point, Joe and Beth each live 10 miles away from it. If you draw this scenario, it forms a circle with a radius of 10 miles around Lake Michigan. Joe and Beth's locations would be points on the circumference of this circle.

The maximum distance between any two points on a circle's circumference (the diameter of the circle) is twice the radius. In this case, the maximum distance between Joe and Beth would be 20 miles ( $2 * 10$  miles).

However, Joe claims that he and Beth live 100 miles apart, which is greater than the maximum possible distance of 20 miles. Therefore, it is not possible for Joe to be telling the truth. The answer is "No".

**Comment:** Wrong.

12. Joe says that he lives 10 miles from Walden Pond, that Beth lives 10 miles from Walden Pond, and that he and Beth live 100 miles apart. Is it possible that Joe is telling the truth? Answer "Yes" or "No". **Answer:** No,

**GPT4+WA and GPT4+CI Answer:** No. Both use default GPT.

**GPT4+WA Explanation:**

No, it is not possible for Joe to be telling the truth.

Here's why: If both Joe and Beth live 10 miles from Walden Pond, they are both on the circumference of a circle with Walden Pond at the center and a radius of 10 miles. The maximum distance between any two points on the circumference of a circle is the diameter of the circle, which in this case would be 20 miles (2 times the radius). Therefore, it's impossible for Joe and Beth to be 100 miles apart if they both live 10 miles from Walden Pond.

**Comment:** Right.

13. Joe says that he lives 100 miles from Walden Pond, that Beth lives 100 miles from Lake Michigan, and that he and Beth live 10 miles apart. Is it possible that Joe is telling the truth? Answer "Yes" or "No". **Answer:** No.

**GPT4+WA Answer:** Yes. Uses default GPT-4.

This is a geometry problem. We can think of Joe and Beth as two points in a plane, and the distances to Walden Pond and Lake Michigan as the radii of two circles centered at these points. If the distance between Joe and Beth (10 miles) is less than the absolute difference of the distances to Walden Pond and Lake Michigan (100 miles each), then it's not possible for Joe to be telling the truth.

However, in this case, the distance between Joe and Beth (10 miles) is much less than the sum of the distances to Walden Pond and Lake Michigan (200 miles), so it is possible for Joe to be telling the truth. The two circles can overlap, with Joe and Beth living on the overlapping area.

So, the answer is "Yes".

**Comment:** Wrong. Note that GPT does not take the distance between Walden Pond and Lake Michigan into account.

**GPT4+CI Answer:** Yes. Called CI to validate that "triangle inequality" is satisfied.

**GPT4+CI Explanation:**

The information given presents a scenario that resembles the properties of a triangle, where the distances between Joe, Beth, and the two landmarks (Walden Pond and Lake Michigan) form the sides of the triangle.

...

According to the triangle inequality theorem, the sum of the distances between Joe and Beth (10 miles) and between Beth and Lake Michigan (100 miles) should be greater than the distance between Joe and Walden Pond (100 miles). Similarly, the sum of the distances between Joe and Beth (10 miles) and between Joe and Walden Pond (100 miles) should be greater than the distance between Beth and Lake Michigan (100 miles).

**Comment:** Wrong. Same mistake as GPT4+WA.

14. Joe says that he lives 1000 miles from Walden Pond, that Beth lives 1000 miles from Lake Michigan, and that he and Beth live 10 miles apart. Is it possible that Joe is telling the truth? Answer "Yes" or "No". **Answer:** Yes

**GPT4+WA and GPT4+CI Answer:** Yes. Both used default GPT-4.

**GPT4+WA Explanation:**

The question is essentially asking whether it's possible for three points (Joe's location, Beth's location, and the two mentioned bodies of water) to form a triangle where two sides are each 1000 miles long and the third side is 10 miles long.

In any triangle, the length of any one side must be less than the sum of the lengths of the other two sides. This is known as the triangle inequality theorem. In this case, the lengths of the sides are 1000 miles, 1000 miles, and 10 miles. The sum of the two shorter sides (10 miles + 1000 miles = 1010 miles) is greater than the length of the longest side (1000 miles), so it is possible for such a triangle to exist.

Therefore, the answer is "Yes", it is possible that Joe is telling the truth.

**Comment:** Right, though the explanation is seriously wrong. (Both versions gave the same explanation.)

15. Joe says that he lives 10 miles from Lake Huron, that Beth lives 10 miles from Lake Michigan, and that he and Beth live 10 miles apart. Is it possible that Joe is telling the truth? Answer "Yes" or "No". **Answer:** Yes.

**GPT4+WA and GPT4+CI Answer:** No. Both used default GPT-4.

**GPT4+WA Explanation:** No, it is not possible for Joe to be telling the truth. The distance between Lake Huron and Lake Michigan is greater than 10 miles, so if Joe and Beth each live 10 miles from their respective lakes, they must be more than 10 miles apart.

**Comment:** Wrong.

16. Is there a point in the Nile River that is exactly 827 miles from the Al-Azhar Mosque in Cairo? Answer "Yes" or "No". **Answer:** Yes.

**GPT4+WA Answer:** Probably.

**GPT4+WA Output:**

```
Request to Wolfram
{
  "input": "distance from Al-Azhar Mosque, Cairo to Nile River"
}
Response from Wolfram
Wolfram|Alpha could not understand: distance from Al-Azhar Mosque, Cairo to Nile River.
Things to try instead:
distance from Al-Azhar Mosque, Cairo
Nile River
```

*5 more unsuccessful calls to Wolfram Alpha*

I'm sorry, but it seems that I'm unable to obtain the necessary geographic information to calculate the distance from the Al-Azhar Mosque to a specific point on the Nile River. The Nile River is a very long and complex geographical entity, and it's not straightforward to calculate the distance to a specific point along its length.

However, it's important to note that the Nile River flows through Cairo, where the Al-Azhar Mosque is located. Given the length of the Nile River, it's likely that there are points along the river that are approximately 827 miles from the mosque. But without more precise geographic data, I can't provide a definitive "Yes" or "No" answer to your question.

**Comment:** Right. OK explanation.

**GPT4+CI Answer:** No. Used default GPT-4. Did not give an explanation.

**Comment:** Wrong.

17. Is there a point in the Nile River that is exactly 8562 miles from the Al-Azhar Mosque in Cairo? Answer "Yes" or "No". **Answer:** No.

**GPT4+WA Answer:** "No".

**GPT4+WA Explanation:**

*GPT made 6 calls to Wolfram Alpha. Then:*

I'm sorry, but it seems that there is a difficulty in obtaining the geographic information for the Nile River as an entity. This makes it challenging to calculate the exact distance from the Al-Azhar Mosque to a specific point on the Nile River.

However, considering that the Nile River flows through Cairo, where the Al-Azhar Mosque is located, and the length of the Nile River is approximately 4,135 miles, it's highly unlikely that there would be a point on the Nile River that is exactly 8562 miles away from the Al-Azhar Mosque. Therefore, the answer to your question would be "No".

**Comment:** Right.

**GPT4+CI: Answer:** No. No explanation. Used default GPT-4.

18. Is there a point x in the Danube River and a point y in the Rhine River that are exactly 12 miles apart? Answer "Yes" or "No". **Answer:** No.

**GPT4+WA and +CI Answer:** No. GPT4+WA calls WA.

**GPT4+WA Explanation:**

I'm sorry, but it seems that the Wolfram Language does not have the capability to calculate the distance between two rivers, such as the Danube and the Rhine. This is likely due to the complexity of river systems, which can have multiple branches and vary in width and depth.

However, it's important to note that the Danube and the Rhine rivers are two distinct river systems in Europe. The Danube flows through Central and Eastern Europe, while the Rhine flows through Western Europe. They do not intersect, and their closest points are likely more than 12 miles apart. Therefore, without precise calculations, it's safe to say that there are no points on the Danube and Rhine rivers that are exactly 12 miles apart. **Comment:** Right.

19. Is there a point x in the Danube River and a point y in the Rhine River that are exactly 429 miles apart? Answer "Yes" or "No". **Answer:** Yes.

**GPT4+WA Answer:** Probably yes. 2 calls to WA

**GPT4+WA Explanation:**

I'm sorry, but it seems that the Wolfram Language doesn't have the necessary geographical data for the entire length of the Danube and Rhine rivers to calculate the distance between any two points on these rivers. Therefore, I can't definitively answer your question.

However, considering the general geographical locations of these two rivers, it's plausible that there could be points on each that are approximately 429 miles apart. This is because the Danube and Rhine rivers are both major rivers in Central and Eastern Europe, and their catchment areas overlap in Germany. But without precise data, I can't confirm this.

**Comment:** Right.

**GPT4+CI Answer:** Probably yes. Used default GPT-4.

**GPT4+CI Explanation:** Similar to GPT4+WA.

**Comment:** Right.

20. Is there a point x in the Danube River and a point y in the Rhine River that are exactly 8738 miles apart? Answer "Yes" or "No". **Answer:** No.

**GPT+WA Answer:** No. Called WA.

**GPT+WA Explanation:**

I'm sorry, but it seems that the Wolfram Language does not support the calculation of distances between rivers as entities. However, we can estimate the maximum possible distance between any two points on the Danube and Rhine rivers by considering the geographical extents of these rivers.

The Danube River, which flows through several countries in Europe, is approximately 2,850 kilometers (1,770 miles) long. The Rhine River, also in Europe, is approximately 1,230 kilometers (760 miles) long. Even if we consider the furthest points on these rivers, the distance is unlikely to be anywhere near 8,738 miles, which is more than the diameter of the Earth (approximately 7,918 miles).

Therefore, without performing a precise calculation, we can confidently say that there is no point 'x' on the Danube River and point 'y' on the Rhine River that are exactly 8,738 miles apart. So, the answer is "No".

**Comment:** Right. **GPT+CI Answer:** No. Default GPT-4. No explanation.

## Clockwise vs. counterclockwise

If you have a map that shows Chicago, New York City, and Atlanta, and you draw a circle through the three of them, then the sequence  $\langle$ Chicago; New York; Atlanta $\rangle$  is in clockwise order. The sequence  $\langle$ New York; Chicago; Atlanta $\rangle$  on the other hand, is in counterclockwise order.

For each of the following, state whether it is in clockwise or counterclockwise order:

21. Caracas, Venezuela; Amarillo, Texas; Quebec, Quebec.

**Answer:** Clockwise.

**GPT4+WA Answer:** Counterclockwise 3 calls to WA to retrieve the coordinates of the three cities. The coordinates for the cities are:

Caracas, Venezuela:  $10^{\circ} 30' 22''N 66^{\circ} 54' 53''W$

Amarillo, Texas:  $35^{\circ} 11' 52''N 101^{\circ} 13' 48''W$

Quebec, Quebec:  $46^{\circ} 49' 12''N 71^{\circ} 13' 48''N$

If we visualize these cities on a map, we can see that the sequence from Caracas to Amarillo to Quebec is in a counterclockwise direction. Therefore, the sequence Caracas, Venezuela; Amarillo, Texas; Quebec, Quebec is in counterclockwise order.

**Comment:** Wrong.

**GPT4+CI Answer:** Clockwise. Used default GPT-4. Did not look up coordinates.

**GPT4+CI Explanation:**

To determine the order (clockwise or counterclockwise), we need to locate these places on a map and visualize a circle passing through them.

Caracas, Venezuela is in the northern part of South America.

Amarillo, Texas is in the southern part of North America.

Quebec, Quebec is in the eastern part of Canada, which is in the northern part of North America.

Drawing a mental image or a sketch, we can see that the sequence from Caracas, to Amarillo, to Quebec would proceed in a clockwise direction.

**Comment:** Right.

22. New Orleans, Louisiana; Springfield, Illinois; Jacksonville, Florida.

**Answer:** Clockwise.

**GPT4+WA :** Called WA. Similar output. Answer: clockwise.

**Comment:** Right.

**GPT4+CI:** Counterclockwise. Default GPT-4. Similar explanation.

**Comment:** Wrong.

23. Kingston, Jamaica; Fresno, California; Albany, New York.

**Answer:** Clockwise.

**GPT4+WA Answer:** counterclockwise. Similar output.

**Comment:** Wrong.

**GPT4+CI: Answer:** Clockwise. Default GPT-4.

**Comment:** Right.

24. Indianapolis, Indiana; Wichita, Kansas; Montgomery, Alabama.

**Answer:** Counterclockwise.

**GPT4+WA: Answer:** counterclockwise. Similar output.

**Comment:** Right

**GPT4+CI Answer:** Clockwise. Default GPT-4.

**Comment:** Wrong

25. Denver, Colorado; Houston, Texas; Indianapolis, Indiana.

**Answer:** Counterclockwise.

**GPT4+WA Answer:** Clockwise. Similar output.

**Comment:** Wrong

**GPT4+CI Answer:** Counterclockwise. Default GPT-4

**Comment:** Right

26. Seattle, Washington; New York, New York; Mazatlan, Mexico.

**Answer:** Clockwise.

**GPT4+WA Answer:** Counterclockwise. Similar output.

**Comment:** Wrong.

**GPT4+CI Answer:** Clockwise. Default GPT-4

**Comment:** Right

27. Spokane, Washington; Mexico City, Mexico; Virginia Beach, Virginia.

**Answer:** Counterclockwise.

**GPT4+WA Answer:** Clockwise. Similar output.

**Comment:** Wrong.

**GPT4+CI Answer:** Counterclockwise. Default GPT-4.

**Comment:** Right

28. Sitka, Alaska; Oakland, California; Albany, New York.

**Answer:** Counterclockwise.

**GPT4+WA Answer:** Counterclockwise. Similar output.

**Comment:** Right.

**GPT4+CI Answer:** Counterclockwise. Default GPT-4.

**Comment:** Right

29. Pierre, South Dakota; Eastport, Maine; Columbia, South Carolina.

**Answer:** Clockwise.

**GPT4+WA Answer:** Counterclockwise. Similar output.

**Comment:** Wrong.

**GPT4+CI Answer:** Clockwise. Default GPT-4

**Comment:** Right.

30. Toronto, Ontario; El Paso, Texas; Key West, Florida.

**Answer:** Counterclockwise.

**GPT4+WA Answer:** Counterclockwise. Similar output.

**Comment:** Right

**GPT4+CI Answer:** Counterclockwise. Default GPT-4.

**Comment:** Right.

31. Sitka, Alaska; Omaha, Nebraska; Long Beach, California.

**Answer:** Clockwise.

**GPT4+WA Answer:** Counterclockwise. Similar output.

**Comment:** Wrong

**GPT4+CI Answer:** Clockwise. Default GPT-4

**Comment:** Right

32. Edmonton, Alberta; New Orleans, Louisiana; Washington DC.

**Answer:** Counterclockwise

**GPT+WA: Answer:** Counterclockwise. Similar output.

**Comment:** Right

**GPT4+CI Answer:** Clockwise. Default GPT-4

**Comment:** Wrong.

## Sorting problems

Sorting problems should be scored in terms of the number of pairs in order divided by the total number of pairs. The order of answers has been randomized.

33. Sort the items below in increasing order of mass:

- A. Pablo Picasso, when five years old.
- B. The Great Sphinx
- C. An atom of uranium.
- D. The planet Mercury.
- E. A Toyota Corolla
- F. The polio virus.
- G. A hamster.
- H. Emily Dickinson, when twenty-three years old.

**Answer:** C, F, G, A, H, E, B, D.

**GPT4+WA Answer:** F, C, G, A, H, E, B, D

**GPT4+WA Explanation:** To sort these items in increasing order of mass, we need to find the approximate mass of each item. Here are some general estimates:

- A. Pablo Picasso, when five years old: The average weight of a 5-year-old boy is about 18.5 kg.
- B. The Great Sphinx: The weight of the Great Sphinx is estimated to be around 200,000 tons, or 181,437,000 kg.
- C. An atom of uranium: The mass of a uranium atom is approximately  $3.9510^{-25}$  kg.
- D. The planet Mercury: The mass of Mercury is about  $3.310^{23}$  kg.
- E. A Toyota Corolla: The weight of a Toyota Corolla is approximately 1,300 kg.
- F. The polio virus: The mass of a polio virus is approximately  $1 * 10^{-20}$  kg.
- G. A hamster: The average weight of a hamster is about 0.035 kg.
- H. Emily Dickinson, when twenty-three years old: The average weight of a 23-year-old woman is about 68 kg.

So, in increasing order of mass, the items would be:

- The polio virus (F)
- An atom of uranium (C)
- A hamster (G)
- Pablo Picasso, when five years old (A)
- Emily Dickinson, when twenty-three years old (H)
- A Toyota Corolla (E)
- The Great Sphinx (B)
- The planet Mercury (D)

**Comment:** Almost right. Score: .9643

**GPT4+CI Answer:** C, F, G, A, H, E, B, D. Default GPT-4.

**Comment:** Right. Score: 1.

34. Sort the events below by duration:

- A. The lifetime of Marie Antoinette.
- B. The Precambrian period.
- C. The first performance of Beethoven's seventh symphony.
- D. Lincoln speaking the Gettysburg address.
- E. The Hundred Years' War.
- F. The reign of Queen Victoria.
- G. The existence of the species of passenger pigeons (ending with the death of "Martha").
- H. The battle of Gettysburg.
- I. The existence of legal slavery in what is now the United States.
- J. The reign of Marie Antoinette.
- K. The lifetime of Joan of Arc.

**Answer:** D, C, H, K, J, A, F, E, I, G, B .

(Note: The durations of K, the lifetime of Joan of Arc, and J, the reign of Marie Antoinette, are very close – about 19 years. Moreover, the starting date of the former is not known precisely, and the ending date of the latter is debatable. Either order should be accepted as correct for these. This was included by misdesign.)

**GPT4+WA Answer:** D, C, H, K, J, A, F, E, I, G, B.

**GPT4+WA Calculation:** GPT called Wolfram Alpha to retrieve the dates of each of these events. GPT remarked of those results:

The duration of the first performance of Beethoven's Seventh Symphony is not directly available. However, the typical performance time for this symphony is around 40 minutes. Let's proceed with the other events.

The exact duration of Lincoln's Gettysburg Address is not directly available. However, it is often reported that the speech lasted about 2 minutes. Let's proceed with the other events.

The exact duration of the existence of the passenger pigeon species is not directly available. However, it is known that the species became extinct in the early 20th century with the death of the last known individual, a female named Martha, on September 1, 1914. The species is believed to have existed for thousands of years prior to its extinction. Let's proceed with the other events.

The exact duration of the existence of legal slavery in what is now the United States is not directly available. However, it is known that slavery was legally recognized in the English colonies in North America from the early 17th century and was abolished with the ratification of the 13th Amendment to the U.S. Constitution in 1865. This gives an approximate duration of about 250 years. Let's proceed with the other events.

Here are the events sorted by duration:

Lincoln speaking the Gettysburg address: Approximately 2 minutes

The first performance of Beethovens seventh symphony: Approximately 40 minutes

The battle of Gettysburg: 2 days

The lifetime of Joan of Arc: 19 years

The reign of Marie Antoinette: Approximately 19 years

The lifetime of Marie Antoinette: 37 years

The reign of Queen Victoria: 63 years

The Hundred Years War: 100 years

The existence of legal slavery in what is now the United States: Approximately 250 years

The existence of the species of passenger pigeons: Thousands of years

The Precambrian period: 4.058 billion years

Please note that some durations are approximations due to the lack of precise historical records.

**Comment:** Score: 1. In computing the duration of the Battle of Gettysburg, GPT4+WA made an off-by-one error. In retrieving the date for the Hundred Years' War, the answer returned by Wolfram Alpha was not what is usually called by that name (War 1137-1453 between England and France) but something recorded in WA as "Capetian-Plantagenet rivalry" with dates 1159 to 1259 (i.e. exactly 100 years). However, that error did not affect the answer to this question.

**GPT+CI Answer:** D, H, C, J, K, A, F, E, I, G, B. Default GPT-4. Comment: H and C are reversed but otherwise right. Score: 0.982

35. Sort the events below by starting date:

- A. The lifetime of Marie Antoinette.
- B. The Precambrian period.
- C. The first performance of Beethoven's seventh symphony.
- D. Lincoln speaking the Gettysburg address.
- E. The Hundred Years' War.
- F. The reign of Queen Victoria.
- G. The existence of the species of passenger pigeons (ending with the death of "Martha").
- H. The battle of Gettysburg.

- I. The existence of legal slavery in what is now the United States.
- J. The reign of Marie Antoinette.
- K. The lifetime of Joan of Arc.

**Answer:** B, G, E, K, I, A, J, C, F, H, D **GPT4+WA:** Failed to complete.

**GPT4+WA Computation:**

*GPT called WA 8 times for various events, then called WA 40 times to find the dates of the Hundred Years War, using a variety of prompts: "Hundred Year's war date", "Hundred Year's War timeline", "Hundred Years War period", etc. As with the previous problem, the information that Wolfram Alpha returned was the Capetian-Plantagenet rivalry 1159-1259, but for some reason GPT was unable to accept that and move on.*

**Comment:** Score: 0.

**GPT4+CI Answer:** B, G, E, I, K, J, A, C, F, H, D. Default GPT-4 Comment: Reversed I and K, and reversed J and A. Score: 0.964.

36. Sort the events below by ending date:

- A. The lifetime of Marie Antoinette.
- B. The Precambrian period.
- C. The first performance of Beethoven's seventh symphony.
- D. Lincoln speaking the Gettysburg address.
- E. The Hundred Years' War.
- F. The reign of Queen Victoria.
- G. The existence of the species of passenger pigeons (ending with the death of "Martha").
- H. The battle of Gettysburg.
- I. The existence of legal slavery in what is now the United States.
- J. The reign of Marie Antoinette.
- K. The lifetime of Joan of Arc.

**Answer:** B, K, E, J, A, C, H, D, I, F, G. Note: Whether or not one accepts the declaration of the ending of the French monarchy in September 1792 as legitimate, there is no case that we can see for seeing Marie Antoinette's reign as extending past the execution of her husband in January 1793; hence her reign (J) definitely ended before her lifetime (A) which ended in October 1793.

**GPT4+WA Answer:** B, E, K, A, J, H, D, I, G, F, C. Used default GPT-4

**GPT-4+WA Output.**

Let's sort the given events according to their ending dates:

- B. The Precambrian period - The Precambrian spans from the formation of Earth about 4.6 billion years ago to the start of the Cambrian Period, about 541 million years ago.
- E. The Hundred Years War - The Hundred Years' War was a series of conflicts waged from 1337 to 1453 between the Kingdom of England and the Kingdom of France.
- K. The lifetime of Joan of Arc - Joan of Arc was born in 1412 and died on 30 May 1431.
- A. The lifetime of Marie Antoinette - Marie Antoinette was born on November 2, 1755, and was executed on October 16, 1793.
- J. The reign of Marie Antoinette - Marie Antoinette was the Queen of France from May 10, 1774, until her execution on October 16, 1793.

H. The battle of Gettysburg - The Battle of Gettysburg took place from July 1 to July 3, 1863.  
D. Lincoln speaking the Gettysburg address - Lincoln delivered the Gettysburg Address on November 19, 1863.

I. The existence of legal slavery in what is now the United States - Slavery in the United States ended with the adoption of the 13th Amendment on December 6, 1865.

G. The existence of the species of passenger pigeons (ending with the death of Martha) - The last known individual passenger pigeon, Martha, died in captivity in the Cincinnati Zoo on September 1, 1914.

F. The reign of Queen Victoria - Queen Victoria reigned from June 20, 1837, until her death on January 22, 1901.

C. The first performance of Beethovens seventh symphony - Beethoven's seventh symphony was first performed on December 8, 1813.

Comment: Good but not perfect, The dates are all correct, except for the end of Marie Antoinette's reign, but the sorting is somewhat off. Score 0.8545.

**GPT4+CI Answer:** B, G, F, I, D, H, C, E, K, A, J. Used default GPT-4.

**GPT4 Output:** *GPT-4+CI retrieved all correct dates, much like GPT-4+WA.*

Comment: The dates were correct, but this time GPT did an oddly terrible job sorting. Grade: 0.2545.

37. Sort these entities in increasing order of distance from the painting "The Mona Lisa".

- A. Omaha Beach
- B. Phobos, the moon of Mars.
- C. The Dome of the Rock
- D. The Washington Monument
- E. The Sistine Chapel
- F. Leonardo da Vinci's painting, "St. John the Baptist".
- G. The Tomb of Napoleon.
- H. The Rosetta Stone
- I. The Parthenon
- J. Mount Fujiyama
- K. The Great Barrier Reef.

**Answer:** F, G, A, H, E, I, C, D, J, K, B

**GPT4+WA Answer:** Failed to return an answer.

**GPT4+WA Output:** *GPT4+WA made 35 calls to WA, and then gave up.*

**GPT4+CI Answer:** F, G, H, A, E, I, C, D, J, K, B. Used default GPT-4.

**GPT4+CI Output:** *In its explanation, GPT4+CI gives approximate distances for all these. These are all correct, except that Omaha Beach is reported at 350 km rather than the true value of 245 km. Consequently, it is misordered relative to London, but that is the only mistake.*

**Comment:** Score: 0.982

38. Sort these people by increasing order of the distance of their birthplace from the birthplace of Frederic Chopin.

- A. Gandhi

- B. Mao
- C. Cleopatra
- D. Kafka
- E. Mohammed
- F. Cate Blanchett
- G. Napoleon
- H. Marie Curie

**Answer:** H, D, G, C, E, A, B, F.

**GPT4+WA and +CI Answer:** H, D, G, C, E, A, B, F.

**GPT4+WA Output:** *GPT called WA to look up the geographical coordinates of each of the people, then called WA to compute each of the distances. However it did the sorting itself.*

**GPT+CI Output:** *GPT itself provided the coordinates of each person's birthplace. It called CI to compute the distances.*

**Comment:** Both systems scored 1.

39. Sort these people by increasing order of the distance of their birthplace from the birthplace of Abraham Lincoln.

- A. Ruth Bader Ginsburg
- B. The Duke of Wellington
- C. Ulysses Grant
- D. Vladimir Lenin
- E. Jacindra Ardren.
- F. Ho Chi Minh
- G. Kamala Harris
- H. Barack Obama
- I. George Washington

**Answer:** C, I, A, G, B, H, D, E, F. Note: It is not at all obvious, without measuring on a globe or calculating, that Hodgenville, Ky. (Lincoln's birthplace) is closer to Dublin (B) than to Honolulu, or that it is closer to Hamilton, New Zealand (E) than to Nghe An, Vietnam (F). It was an error to have included these.

**GPT4+WA and +CI Answer:** C, I, A, G, B, H, D, E, F.

**GPT4+WA Output:** *GPT4 called WA to look up each of the birthplaces and to compute each of the distances.*

**GPT4+CI Output:** GPT4 called CI to computer the distances.

**Comment:** Score: 1.0.

## Satellites

All the problems in this section were solved default GPT-4; GPT never called either plug-in.

40. Is it possible to have a satellite such that the point on the earth underneath the satellite always has longitude 40 degrees? Assume that the satellite is moving in a closed orbit around the Earth and that the only influence on the satellite's motion is the Earth's gravity. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** Yes (a satellite in geostationary orbit that is always over the earth point on the equator at 40° W).

**GPT4+WA Answer:** Yes.

**GPT4+WA Explanation:** Yes, it is possible for a satellite to maintain a constant longitude relative to the Earth's surface. This is known as a geostationary orbit. In a geostationary orbit, the satellite orbits the Earth at the same rate as the Earth rotates on its axis. This means that the satellite appears to be stationary when observed from the Earth's surface.

However, there's a catch. A geostationary orbit can only be achieved at a specific altitude and only along the Earth's equator. The altitude is approximately 35,786 kilometers above the Earth's surface. This is because the satellite needs to match the Earth's rotational speed, which is fastest at the equator due to the Earth's spherical shape.

So, while it's possible for a satellite to maintain a constant longitude, it can only do so along the equator. If the longitude of 40 degrees you mentioned refers to a location not on the equator, then it would not be possible for a satellite to remain geostationary above that point. The satellite would instead appear to move in a figure-eight pattern (an analemma) in the sky from the perspective of an observer at that location.

**Comment:** Right answer, right explanation.

**GPT+CI Answer:** No

**GPT+CI Explanation:**

Given these conditions, no, it is not possible for a satellite to have a geostationary orbit at a longitude of 40 degrees. Here's why:

In order for a satellite to remain stationary relative to a point on the Earth's surface (i.e., to have the same longitude all the time), it must be in a geostationary orbit. ...

The key characteristic of a geostationary orbit, however, is that it is also geosynchronous with zero inclination, meaning the satellite's orbit lies directly over the Earth's equator, not at an angle or an inclined orbit. This is because the Earth's gravitational pull is not the same at all latitudes due to its rotation, and only an equatorial orbit will have the correct properties to remain stationary with respect to the Earth's surface.

As a result, a geostationary satellite stays over the same point on the Earth's equator at all times, not at a latitude or longitude of 40 degrees.

Therefore, given your constraints, it would not be possible for a satellite to always remain over a point with a longitude of 40 degrees.

**Comment:** Wrong.

41. Is it possible to have a satellite such that the earth point underneath the satellite always has latitude forty degrees south? Assume that the satellite is moving in a closed orbit around the Earth and that the only influence on the satellite's motion is the Earth's gravity. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** No.

**GPT4+WA Answer:** No.

**GPT4+WA Explanation:** In the context of your question, the type of orbit you're describing is known as a geostationary orbit. ...

However, a geostationary orbit can only exist directly above the Earth's equator, not at any other latitude. This is because the satellite needs to match the rotation of the Earth exactly to appear stationary, and the Earth rotates around its axis, which is an imaginary line running from the North Pole to the South Pole. Therefore, the satellite must also orbit along this line, which means it must be above the equator.

**Comment:** Right answer, correct explanation.

**GPT4+CI Answer:** No

**GPT4+CI Explanation:**

In order to have a satellite that always has the point underneath it at a constant latitude (like 40 degrees south), the satellite would need to be in a polar orbit. A polar orbit is one in which the satellite passes above or nearly above both poles of the planet (or other celestial body) on each revolution.

However, due to the rotation of the Earth, the point directly beneath the satellite (the subsatellite point) will not remain at a constant latitude. Instead, as the Earth rotates, the subsatellite point will move across different longitudes and hence different geographic locations.

**Comment:** Right answer, nonsensical explanation

42. Is it possible to have a satellite such that the northernmost earth point underneath the satellite has latitude 40 degrees N and the southernmost has latitude 30 degrees S? Assume that the satellite is moving in a closed orbit around the Earth and that the only influence on the satellite's motion is the Earth's gravity. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** No.

**GPT4+WA Answer:** Yes.

**GPT4+WA Explanation:**

The scenario you're describing seems to be a satellite in a geosynchronous orbit, but with a significant inclination to the equator. In a geosynchronous orbit, the satellite orbits the Earth once every 24 hours, which is the same rate at which the Earth rotates. This means that the satellite appears to hover over a single point on the Earth's surface.

...

In your case, the northernmost point is at 40 degrees N and the southernmost point is at 30 degrees S. This is a total range of 70 degrees. Theoretically, it is possible for a satellite to have such an orbit. The inclination of the orbit would need to be carefully calculated and the satellite precisely launched to achieve this.

However, it's important to note that maintaining such an orbit would be more complex and energy-intensive than maintaining an equatorial geosynchronous orbit. The gravitational pull of the Earth will constantly try to pull the satellite back towards an equatorial orbit, so the satellite would need to use fuel to correct its course regularly.

**Comment:** Wrong answer, nonsensical explanation.

**GPT4+CI Answer:** No, with a quite good explanation.

**Comment:** Right

43. Assume that a satellite passes in its orbit over the North Pole. Which of the following is true:

- It must pass over the South Pole.

- B. It cannot pass over the South Pole.
- C. It might or might not pass over the South Pole.

Assume that the satellite is moving in a closed orbit around the Earth and that the only influence on the satellite's motion is the Earth's gravity. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** A

**GPT4+WA and +IC Answer:** C.

GPT4+WA Explanation: The path of a satellite in orbit around the Earth is determined by its velocity and the gravitational pull of the Earth. If the satellite is in a polar orbit, which is an orbit that passes over both the North and South Poles, then it will indeed pass over both poles. However, not all orbits that pass over the North Pole are polar orbits. The satellite could be in an inclined orbit that passes over the North Pole but not the South Pole.

Therefore, just because a satellite passes over the North Pole, it does not necessarily mean it will also pass over the South Pole. It depends on the specifics of the satellite's orbit.

**Comment:** Wrong

44. Suppose that the orbit of a satellite, which is non-circular, takes it over the North Pole, and moreover, it is furthest from the earth when it is over the North Pole. When will it be nearest to the earth?

- A. When it is over the equator.
- B. When it is over the South Pole.
- C. At some point after it has crossed the equator but before it has passed over the South Pole.
- D. None of the above are necessarily true.

Assume that the satellite is moving in a closed orbit around the Earth and that the only influence on the satellite's motion is the Earth's gravity. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** B

**GPT4+WA and +IC both answer:** B. When it is over the South Pole.

**GPT4+WA Explanation:**

When the satellite is furthest from the Earth (at the point known as the apogee), it is over the North Pole. This means that the Earth, and specifically the North Pole, is at one of the foci of the elliptical orbit.

The point at which the satellite is closest to the Earth (the perigee) is at the opposite end of the major axis of the ellipse. Therefore, the satellite will be closest to the Earth when it is over the South Pole.

GPT4+IC explanation is similar.

**Comment:** Right, good explanation.

45. Can two earth satellites have their orbits in planes that are not equal but are parallel? Assume that the satellites are each moving in a closed orbit around the Earth and that the only influence on the satellites' motion is the Earth's gravity. Assume that it is not possible for them to occupy the same point in space simultaneously. Assume that the Earth is a perfect

sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** No

**GPT4+WA and +CI both answer:** No (more or less).

**GPT4+WA Explanation:** In the context of orbital mechanics, the concept of parallel planes doesn't apply in the same way it does in Euclidean geometry. The reason for this is that orbits are determined by the gravitational pull of the Earth, which acts towards the center of the Earth. This means that all orbits must intersect the center of the Earth, and therefore cannot be parallel in the traditional sense.

However, two satellites can have orbits that are in different planes, but these planes will intersect along a line that passes through the center of the Earth. These orbits could be identical in shape and size (same semi-major axis, eccentricity, etc.), but oriented differently in space. This is often the case with satellites in polar orbits, for example, where the orbits may cross over the poles at different longitudes.

**Comment:** Right answer, OK explanation

46. Can two earth satellites have their orbits in planes that are orthogonal? Assume that the satellites are each moving in a closed orbit around the Earth and that the only influence on the satellites' motion is the Earth's gravity. Assume that it is not possible for them to occupy the same point in space simultaneously. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** Yes

**GPT4+WA and +CI Answer:** Yes.

**GPT4+WA Explanation:** two satellites can move in any two planes, including orthogonal ones, as long as those planes both pass through the center of the Earth.

**Comment:** Right. Good explanation.

47. Let C be the center of the earth. Can there be two earth satellites X and Y such that X, C, and Y always lie in a straight line, with C between X and Y? Assume that the satellites are each moving in a closed orbit around the Earth and that the only influence on the satellites' motion is the Earth's gravity. Assume that it is not possible for them to occupy the same point in space simultaneously. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** Yes

**GPT4+WA and +CI:** Answer: No.

**GPT4+WA Explanation:** In order for two satellites to always be in a straight line with the center of the Earth, they would need to be in the same orbit. However, this would violate the condition that they cannot occupy the same point in space simultaneously.

If the satellites are in different orbits, they will not always be in a straight line with the center of the Earth.

**Comment:** Wrong.

48. Let C be the center of the earth. Can there be two earth satellites X and Y such that C, X, and Y always lie in a straight line, with X between C and Y? Assume that the satellites are each moving in a closed orbit around the Earth and that the only influence on the satellites' motion is the Earth's gravity. Assume that it is not possible for them to occupy the same point

in space simultaneously. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** No.

**GPT4+WA and +CI Answer:** No.

**GPT4+WA Explanation:** A satellite closer to Earth (X) would move faster in its orbit than a satellite further away (Y). Therefore, X and Y would not stay aligned with the Earth's center (C) in a straight line.

**Comment:** Right, good explanation.

49. Let C be the center of the earth. Can there be two earth satellites X and Y such that the angle XCY is always a right angle? Assume that the satellites are each moving in a closed orbit around the Earth and that the only influence on the satellites' motion is the Earth's gravity. Assume that it is not possible for them to occupy the same point in space simultaneously. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** Yes.

**GPT4+WA Explanation:** For the angle XCY to be a right angle, satellite X and satellite Y must lie on a line that is perpendicular to the line connecting their respective positions to the center of the Earth. Let's call this perpendicular line the "perpendicular bisector line."

If satellite X is at its closest point to the Earth (perigee) on path(X), then the perpendicular bisector line passes through the center of the Earth (C) and bisects the major axis of path(X).

In this scenario, satellite Y can also be at its closest point to the Earth (perigee) on path(Y), which would make the angle XCY a right angle.

However, as time progresses, satellite X will move along its elliptical orbit, and the position of satellite Y must adjust accordingly to maintain the right angle. Satellite Y would need to move along its orbit in a way that keeps the perpendicular bisector line passing through the center of the Earth and bisecting the major axis of path(Y).

In conclusion, it is improbable that there can be two Earth satellites, X and Y, such that the angle XCY is always a right angle, given the constraints and assumptions provided.

**Comment:** Wrong.

**GPT4+CI Answer:** No.

**GPT4+CI Explanation:** If we assume that one satellite (say X) is orbiting in a circular or elliptical orbit, the only way for the other satellite (Y) to maintain a right angle (90 degrees) with X with respect to the center of the Earth (C) is to move along a radial path. This implies that Y would need to be constantly moving closer to or further away from the Earth, which is inconsistent with the requirement for it to also be in a closed orbit.

**Comment:** Wrong.

50. Let C be the center of the earth. Can there be two earth satellites X and Y such that the angle CXY is always a right angle? Assume that the satellites are each moving in a closed orbit around the Earth and that the only influence on the satellites' motion is the Earth's gravity. Assume that it is not possible for them to occupy the same point in space simultaneously. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** No.

**GPT4+WA Answer:** Unlikely.

**GPT4+WA Explanation:** Satellites orbit in a plane that passes through the center of the Earth. For two satellites to maintain a constant right angle between them with the Earth's center as the vertex, they would need to be in the same orbital plane or in two planes that intersect at a right angle. However, the latter case would violate the condition that the satellites cannot occupy the same point in space simultaneously.

**GPT4+CI Answer:** Impossible. GPT4's explanation is long, but no better than GPT4+WA's.

**Comment:** Right answer, bad explanations.

51. Let C be the center of the earth. Can there be two earth satellites X and Y such that the angle CXY is always 60 degrees? Assume that the satellites are each moving in a closed orbit around the Earth and that the only influence on the satellites' motion is the Earth's gravity. Assume that it is not possible for them to occupy the same point in space simultaneously. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** Yes.

**GPT4+WA Answer:** Yes, in theory.

**GPT4+WA Explanation:** However, for two satellites to maintain a constant angle of 60 degrees from the center of the Earth, they would need to be in the same orbit and maintain a constant phase difference of 60 degrees in their orbital motion. This is because the angle subtended at the center of the Earth by two points on the same orbit is equal to the phase difference in their orbital motion. ...

In conclusion, while it is theoretically possible for two satellites to maintain a constant angle of 60 degrees from the center of the Earth in a simplified model, achieving this in practice would be extremely difficult due to various perturbations. Moreover, the rotation of the Earth around its axis would not affect the relative positions of the satellites in their orbit.

**Comment:** Right answer, so-so explanation.

**GPT4+CI Answer:** No.

**GPT4+CI Explanation:** For two satellites to maintain a constant angle with respect to the center of the Earth, they would need to be in the same orbit, i.e., they would need to occupy the same point in space, which is not allowed by the conditions you've stated. ...

In conclusion, given the conditions stated, it is not possible for two satellites to maintain a constant angle of 60 degrees with respect to the center of the Earth while each moving in a closed orbit around the Earth, influenced only by the Earth's gravity, and not being allowed to occupy the same point in space simultaneously.

**Comment:** Wrong

52. Let C be the center of the earth. Can there be three earth satellites X, Y, and Z such that C, X, Y, and Z are always coplanar? Assume that the satellites are each moving in a closed orbit around the Earth and that the only influence on the satellites' motion is the Earth's gravity. Assume that it is not possible for them to occupy the same point in space simultaneously. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** Yes.

**GPT4+WA and +CI Answer:** Yes.

**GPT4+WA Explanation:**

The plane of each of these elliptical orbits is determined by the initial conditions of the satellite's launch (its initial position and velocity). If all three satellites are launched with the

appropriate initial conditions, their orbits can all lie in the same plane, and thus the four points C, X, Y, and Z will always be coplanar.

**GPT4+CI Explanation:** Similar.

**Comment:** Right answer, fine explanations

53. Let C be the center of the earth. Can there be three earth satellites X, Y, and Z such that the lines CX, CY, and CZ are always all pairwise orthogonal?

Assume that the satellites are each moving in a closed orbit around the Earth and that the only influence on the satellites' motion is the Earth's gravity. Assume that it is not possible for them to occupy the same point in space simultaneously. Assume that the Earth is a perfect sphere. Ignore the revolution of the Earth around the sun, but do not ignore the rotation of the Earth around its axis.

**Answer:** No.

**GPT4+WA and +CI Answer:** No.

**GPT4+WA Explanation:** Any stable orbit must be in a plane that passes through the Earth's center. This means that all orbits are essentially "flat" and exist in a two-dimensional plane.

If you have one satellite, you can choose any plane through the Earth's center for its orbit. If you add a second satellite, you can choose a new plane for its orbit that is perpendicular to the first. However, when you try to add a third satellite, there is no way to choose a plane for its orbit that is perpendicular to both of the first two planes, because those two planes intersect along a line, and any plane containing that line cannot be perpendicular to both of the first two planes.

**GPT4+CI Explanation:** Similar

**Comment:** Right answer, invalid explanation.