Charta | LESSON NOTES

Inference questions: what must be true

Verbal Reasoning

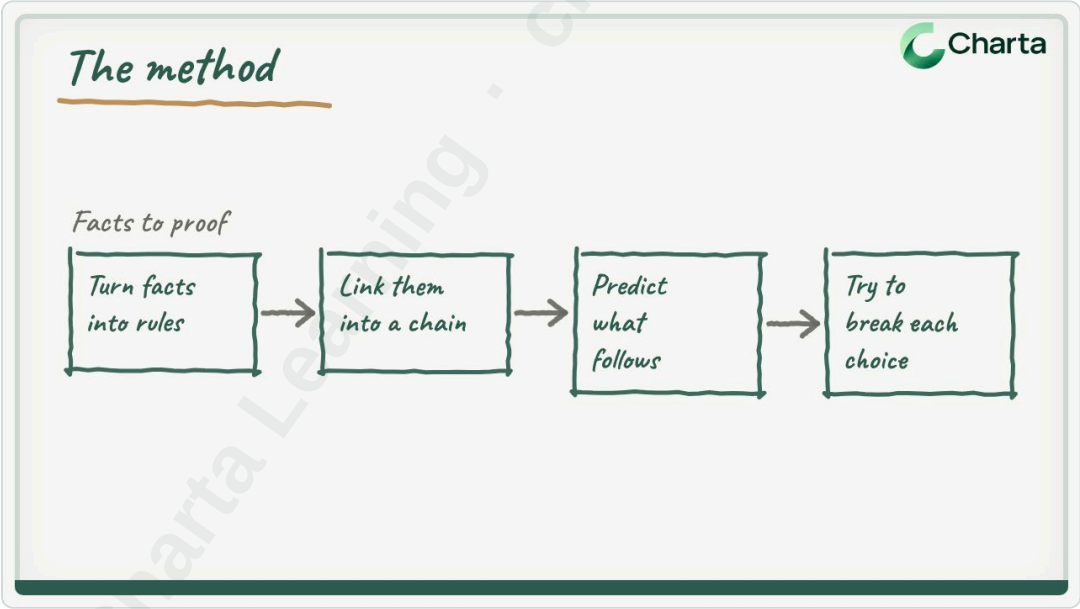
1 What the question asks

- Question line: if true, which must also be true?
- Must is a high bar: provable from the facts alone
- No outside knowledge, no guessing
- The right answer is often small and dull

IN THE LESSON

- The question line says something like, if the statements above are true, which of the following must also be true?
- Read that carefully.
- Must be true is a very high bar.
- Not likely, not reasonable, not probably: must.
- The right answer is a statement you could prove from the facts alone, with no outside knowledge and no guessing.
- That changes how you read the choices.
- In other question types, a bold, interesting choice can be right.
- Here, the bolder a choice, the more likely it is wrong.
- The right answer is often dull.
- It says something small that follows directly from combining two of the facts.
- Learn to love the dull answer.

2 The method



IN THE LESSON

- Here is the method.
- Step one, read the facts slowly, one at a time, and turn each into a short rule, such as chemistry means passed algebra.
- Step two, link the rules into a chain wherever the end of one matches the start of another.
- Step three, see what the chain lets you say about the person or thing in the last fact.
- Often you can predict the answer before you read the choices.
- Step four, test each choice by asking: could the facts all be true and this choice be false?
- If you can imagine such a case, the choice does not have to be true, so it is wrong.
- The right choice is the one you cannot break.

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3 Rules have a direction

Rule: every chemistry student has passed algebra

The rule	chemistry, so algebra	**true**
Reversed with nots	no algebra, so no chemistry	**also true**
Plain reverse	algebra, so chemistry	**not proved**
Remember	a rule runs one way	**the trap**

IN THE LESSON

- The most important idea in inference questions is that an if rule runs one way only.
- Take the rule: every chemistry student has passed algebra.
- It means, if chemistry, then algebra.
- It does not mean, if algebra, then chemistry.
- Plenty of students may pass algebra and never take chemistry.
- But the rule does let you run it backwards with a not on both sides: if a student has not passed algebra, that student is not in chemistry.
- That is called the contrapositive, and it is always true when the rule is true.
- So you have one rule, one safe reverse with two nots, and one trap: the plain reverse.

4 The traps in the wrong choices

- Reverses a rule
- Too strong: most, all, every
- Adds a detail the facts never give
- Sounds sensible, or widens a rule, but is not forced

IN THE LESSON

- Now the traps.
- The first is the reversed rule: it turns, if chemistry then algebra, into, if algebra then chemistry.
- It is the most common trap of all.
- The second is too strong: it says most, all or every when the facts support only some, or none at all.
- The third adds a detail, such as when something happened or how well someone did, that the facts never mention.
- The fourth is plausible but unsupported: it sounds like common sense, but the facts do not force it.
- And the fifth widens a rule: the facts are about a night allowance, and the choice talks about any allowance.
- For each choice, try to imagine a world where the facts hold and the choice is false.

5 Question 1: chemistry and algebra

- Every student enrolled in Advanced Chemistry at Brookfield High School has passed Algebra II. At Brookfield, a student may take Algebra II only after passing Geometry. Priya is enrolled in Advanced Chemistry at Brookfield.
- If the statements above are true, which of the following must also be true?

IN THE LESSON

- Question one is an easy one.
- Read it with me, and turn each fact into a rule as you go.
- Every student enrolled in Advanced Chemistry at Brookfield High School has passed Algebra II.
- At Brookfield, a student may take Algebra II only after passing Geometry.
- Priya is enrolled in Advanced Chemistry at Brookfield.
- The question: If the statements above are true, which of the following must also be true?

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6 Question 1: build the chain

Brookfield: chemistry students, Algebra II, Geometry, Priya

Rule one	chemistry, so Algebra II	**rule**
Rule two	Algebra II, so Geometry	**rule**
Chain	chemistry, Algebra II, Geometry	**linked**
Priya	in chemistry, so Geometry	**proved**

IN THE LESSON

- Let us turn the facts into rules.
- Fact one: every Advanced Chemistry student has passed Algebra Two.
- So, chemistry means passed Algebra Two.
- Fact two: a student may take Algebra Two only after passing Geometry.
- So, Algebra Two means passed Geometry.
- Notice how the end of the first rule matches the start of the second.
- We can link them: chemistry, then Algebra Two, then Geometry.
- Fact three: Priya is in Advanced Chemistry.
- Now run her along the chain.
- She is in chemistry, so she passed Algebra Two, so she passed Geometry.
- Predict: Priya has passed Geometry.
- That is a small, dull statement, and it is proved.

7 Question 1: the five choices

- A. Every Brookfield student who has passed Algebra II enrolls in Advanced Chemistry.
- B. Priya earned a higher grade in Algebra II than in any other mathematics course she took.
- C. Most Brookfield students who pass Geometry go on to enroll in Advanced Chemistry at the school.
- D. Priya has passed Geometry.
- E. Priya passed Geometry during her first year at Brookfield High School.

IN THE LESSON

- Here are the five choices.
- Choice A.
- Every Brookfield student who has passed Algebra II enrolls in Advanced Chemistry.
- Choice B.
- Priya earned a higher grade in Algebra II than in any other mathematics course she took.
- Choice C.
- Most Brookfield students who pass Geometry go on to enroll in Advanced Chemistry at the school.
- Choice D.
- Priya has passed Geometry.
- Choice E.
- Priya passed Geometry during her first year at Brookfield High School.
- One of them is our prediction, word for word.

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8 Question 1: test each choice

Prediction: Priya has passed Geometry

A: Algebra II leads to chemistry	reverses the first rule	**reversed**
B: Priya's best grade	grades are never mentioned	**adds detail**
C: most who pass Geometry	no proportions given	**too strong**
D: Priya has passed Geometry	the chain proves it	**must be true**
E: Geometry in her first year	the year is never given	**adds detail**

IN THE LESSON

- Choice A says every student who passed Algebra Two enrols in chemistry.
- That is rule one reversed.
- Many students could pass Algebra Two and skip chemistry.
- Choice B is about Priya's grades, which the facts never mention.
- Choice C says most Geometry students go on to chemistry, but the facts give no proportions at all, so it is too strong.
- Choice D is our prediction: Priya is in chemistry, so she passed Algebra Two, so she passed Geometry.
- You cannot imagine the facts true and this false.
- Choice E adds a detail, her first year, that the facts never give.
- She passed Geometry, but we do not know when.
- The answer is D.

9 Question 2: the night allowance

- Orwell Foods pays a night allowance to every employee who works nights. Every employee who receives a night allowance must attend the safety briefing. Hanna works for Orwell Foods and is not required to attend the safety briefing.
- If the statements above are true, which of the following must also be true?

IN THE LESSON

- Question two is a medium one.
- Read it with me.
- This time the last fact contains a not, so you will need the safe reverse.
- Orwell Foods pays a night allowance to every employee who works nights.
- Every employee who receives a night allowance must attend the safety briefing.
- Hanna works for Orwell Foods and is not required to attend the safety briefing.
- The question: If the statements above are true, which of the following must also be true?

10 Question 2: run the chain backwards

Orwell Foods: nights, allowance, briefing; Hanna not required

Chain	nights, allowance, briefing	**linked**
Hanna	not required to attend	**a not**
Reverse with nots	no briefing, no allowance	**safe**
So	Hanna does not work nights	**proved**

IN THE LESSON

- Turn the facts into rules.
- Fact one: works nights means gets the night allowance.
- Fact two: gets the night allowance means must attend the safety briefing.
- Link them: nights, then allowance, then briefing.
- Fact three: Hanna is not required to attend the briefing.
- She is at the end of the chain with a not.
- So we use the safe reverse, with nots on both sides: no briefing means no night allowance, and no night allowance means no night work.
- Predict: Hanna does not work nights, and she does not get the night allowance now.
- Be careful with the word now.
- The facts describe the present, so they say nothing about what she received in the past.

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11 Question 2: the five choices

- A. Hanna does not work nights.
- B. Hanna would be required to attend the safety briefing if she received any allowance from Orwell Foods.
- C. Hanna has never received a night allowance.
- D. Only employees who work nights are required to attend the safety briefing.
- E. Hanna receives no allowance of any kind from Orwell Foods.

IN THE LESSON

- Here are the five choices.
- Choice A.
- Hanna does not work nights.
- Choice B.
- Hanna would be required to attend the safety briefing if she received any allowance from Orwell Foods.
- Choice C.
- Hanna has never received a night allowance.
- Choice D.
- Only employees who work nights are required to attend the safety briefing.
- Choice E.
- Hanna receives no allowance of any kind from Orwell Foods.
- Watch for choices that widen the night allowance into any allowance.

12 Question 2: test each choice

Prediction: Hanna does not work nights

A: Hanna does not work nights	the reversed chain proves it	**must be true**
B: any allowance means briefing	only the night allowance does	**widens**
C: never had a night allowance	the past is not covered	**adds detail**
D: only night workers attend	others might attend too	**reversed**
E: no allowance of any kind	other allowances are possible	**widens**

IN THE LESSON

- Choice A is our prediction.
- If Hanna worked nights she would get the allowance, and then she would have to attend.
- She does not have to, so she does not work nights.
- You cannot break it.
- Choice B says any allowance would bring the briefing.
- The facts tie only the night allowance to the briefing, so B widens the rule.
- Choice C says she has never had a night allowance.
- The facts describe what is true now.
- She may have had one in the past, so C adds a detail.
- Choice D says only night workers must attend.
- The facts never say that nobody else attends, so it reverses the chain.
- Choice E, no allowance of any kind, widens the rule again.
- The answer is A.

13 Question 3: tomatoes, beans and pesticides

- Every Dunmore allotment holder who grows tomatoes also grows beans. No allotment holder who grows beans uses chemical pesticides. Some Dunmore allotment holders use chemical pesticides.
- If the statements above are true, which of the following must also be true?

IN THE LESSON

- Question three is another medium one, and it mixes every with some.
- It is short, so read it with me slowly.
- Every Dunmore allotment holder who grows tomatoes also grows beans.
- No allotment holder who grows beans uses chemical pesticides.
- Some Dunmore allotment holders use chemical pesticides.
- The question: If the statements above are true, which of the following must also be true?
- Find a group that the word some tells you exists, then run it through the rules.

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14 Question 3: follow the people who exist

Dunmore: tomatoes, beans, pesticides; some use pesticides

Chain	tomatoes, beans, no pesticides	**linked**
Some exist	holders who use pesticides	**real**
Reverse with nots	users: no beans, no tomatoes	**safe**
So	some grow no tomatoes	**proved**

IN THE LESSON

- Rules first.
- Grows tomatoes means grows beans.
- Grows beans means no chemical pesticides.
- Link them: tomatoes, then beans, then no pesticides.
- Now the some fact: some holders do use chemical pesticides.
- Those people really exist, so follow them.
- Use the safe reverse: uses pesticides means no beans, and no beans means no tomatoes.
- So the pesticide users grow no tomatoes.
- And since some pesticide users exist, some holders do not grow tomatoes.
- Predict that.
- Notice what we cannot say.
- We do not know that anyone grows beans or tomatoes at all.
- The rules only tell us what would follow if they did.
- Only the pesticide users are guaranteed to exist.

15 Question 3: the five choices

- A. Some Dunmore allotment holders who grow beans do not grow tomatoes.
- B. Every Dunmore allotment holder who grows beans also grows tomatoes.
- C. Some Dunmore allotment holders do not grow tomatoes.
- D. Every Dunmore allotment holder who does not grow tomatoes uses chemical pesticides.
- E. Some Dunmore allotment holders who do not use chemical pesticides do not grow beans.

IN THE LESSON

- Here are the five choices.
- Choice A.
- Some Dunmore allotment holders who grow beans do not grow tomatoes.
- Choice B.
- Every Dunmore allotment holder who grows beans also grows tomatoes.
- Choice C.
- Some Dunmore allotment holders do not grow tomatoes.
- Choice D.
- Every Dunmore allotment holder who does not grow tomatoes uses chemical pesticides.
- Choice E.
- Some Dunmore allotment holders who do not use chemical pesticides do not grow beans.
- Which one follows from the pesticide users?

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16 Question 3: test each choice

Prediction: some holders do not grow tomatoes

A: bean growers without tomatoes	no bean grower must exist	**not forced**
B: all bean growers grow tomatoes	reverses the first rule	**reversed**
C: some grow no tomatoes	the pesticide users	**must be true**
D: no tomatoes means pesticides	runs the chain backwards	**reversed**
E: no pesticides, no beans	all of them might grow beans	**not forced**

IN THE LESSON

- Choice A needs someone who grows beans but not tomatoes.
- But the facts never say any bean grower exists, so A could be false.
- Choice B is rule one reversed: tomato growers must grow beans, not the other way round.
- Choice C is our prediction.
- The pesticide users exist, they cannot grow beans, so they cannot grow tomatoes.
- You cannot break it.
- Choice D runs the chain backwards: someone who grows no tomatoes might also use no pesticides.
- Choice E says some people who avoid pesticides also grow no beans.
- That could be false too: every holder who avoids pesticides might grow beans.
- The answer is C.

17 Question 4: two hospitals, two drugs

- At each of two hospitals, a larger proportion of the patients who were given Drug A survived than of the patients who were given Drug B. Yet across the two hospitals taken together, a larger proportion of the patients given Drug B than of the patients given Drug A survived.
- If the statements above are true, which of the following must also be true?

IN THE LESSON

- Question four is a hard one.
- It looks impossible at first, so read it with me and do not panic.
- At each of two hospitals, a larger proportion of the patients who were given Drug A survived than of the patients who were given Drug B.
- Yet across the two hospitals taken together, a larger proportion of the patients given Drug B than of the patients given Drug A survived.
- The question: If the statements above are true, which of the following must also be true?

18 Question 4: how can both be true?

Drug A better at each hospital; Drug B better in total

Each hospital	Drug A does better	**fact**
Both together	Drug B does better	**fact**
Same split?	A's lead would carry over	**impossible**
So	the splits differ	**proved**

IN THE LESSON

- At each hospital, Drug A did better.
- Yet with the two hospitals added together, Drug B did better.
- How can that happen?
- Picture it.
- Suppose hospital one is a hospital where most patients survive, and hospital two is one where many do not.
- Suppose most Drug A patients were treated at the tough hospital two, while most Drug B patients were treated at the easier hospital one.
- Then Drug B's combined result is lifted by where its patients were, not by the drug.
- That is the only way the reversal can happen.
- If both drugs had been split between the hospitals in the same proportions, Drug A's lead at each hospital would carry over to the total.
- Predict: the two drugs' patients were split differently.

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19 Question 4: the five choices

- A. More patients across the two hospitals were given Drug A than were given Drug B.
- B. Patients at one of the two hospitals were on the whole more seriously ill than patients at the other hospital.
- C. Drug A patients and Drug B patients were not split between the two hospitals in the same proportions.
- D. Most of the patients given Drug A were at the hospital with the lower overall survival rate.
- E. Drug B is the more effective drug for the patients at the two hospitals taken as a whole.

IN THE LESSON

- Here are the five choices.
- Choice A.
- More patients across the two hospitals were given Drug A than were given Drug B.
- Choice B.
- Patients at one of the two hospitals were on the whole more seriously ill than patients at the other hospital.
- Choice C.
- Drug A patients and Drug B patients were not split between the two hospitals in the same proportions.
- Choice D.
- Most of the patients given Drug A were at the hospital with the lower overall survival rate.
- Choice E.
- Drug B is the more effective drug for the patients at the two hospitals taken as a whole.
- Look for the one that says only what the reversal forces.

20 Question 4: test each choice

Prediction: the drugs' patients were split differently

A: more patients got Drug A	totals alone cannot do it	**not forced**
B: one hospital's patients sicker	care could differ instead	**not forced**
C: the splits are different	needed for the reversal	**must be true**
D: most A patients at tough one	more than B's share, not most	**too strong**
E: Drug B is more effective	A did better at each	**not forced**

IN THE LESSON

- Choice A says more patients got Drug A.
- Totals alone cannot cause the reversal.
- It is the split between hospitals that matters.
- Choice B says one hospital's patients were sicker.
- That is one possible reason the hospitals differ, but better care could be the reason instead, so B is not forced.
- Choice C is our prediction.
- If the splits were the same, Drug A would win overall.
- They cannot be the same, so C must be true.
- Choice D says most Drug A patients were at the tougher hospital.
- Drug A's patients must lean towards it more than Drug B's do, but that can fall short of most.
- So D is too strong.
- Choice E says Drug B is better, yet Drug A won at each hospital.
- The answer is C.

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21 Accurate and quick

- Question line first: you need proof
- Rules with arrows; write them if it helps
- Start from the named person or the some fact
- Try to break each choice
- Two left? Prefer the more modest one

IN THE LESSON

- Some habits that keep you accurate and quick.
- First, read the question line first, so you know you are looking for proof, not support.
- Second, turn each fact into a short rule with an arrow in your head, and write it down if it helps.
- Third, look for the fact with some, or the fact about one named person, because that is where the chain is used.
- Fourth, predict before you read the choices: usually one short sentence.
- Fifth, when a choice tempts you, try to break it: imagine the facts true and the choice false.
- If you can, cross it out.
- Finally, if two choices remain, prefer the more modest one.
- A smaller claim is harder to break.

22 What the four questions taught

- Forwards along a chain
- Backwards, with nots on both sides
- Follow the people that some guarantees
- Two clashing facts: what makes both true?

IN THE LESSON

- Look back at the four answers.
- In question one, a named person ran forwards along a chain: chemistry, Algebra Two, Geometry.
- In question two, a not at the end meant we ran the chain backwards with nots on both sides.
- In question three, the word some gave us people who really exist, and we followed them through the rules.
- And in question four, two facts that seemed to clash could only both be true in one way, and that way was the answer.
- In every question, the most tempting trap was a rule run the wrong way, or a claim stronger than the facts allow.
- The right answers were all small and dull, and all impossible to break.

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23 Quick check

1. Every pilot has a licence. Sam has a licence. Must Sam be a pilot?
   Answer: No: that reverses the rule.
2. Every pilot has a licence. Jo has no licence. What must be true?
   Answer: Jo is not a pilot: the safe reverse.
3. A choice says most, but the facts give no proportions. Answer?
   Answer: No: too strong.

IN THE LESSON

- A quick check.
- Pause after each question.
- Question one.
- The rule is, every pilot has a licence.
- Sam has a licence.
- Must Sam be a pilot?
- The answer is no.
- That reverses the rule.
- A licence holder need not fly.
- Question two.
- Same rule.
- Jo has no licence.
- What must be true?
- The answer: Jo is not a pilot.
- That is the safe reverse, with nots on both sides.
- Question three.
- A choice says most of the members joined before two thousand and ten, but the facts give no numbers or proportions.
- Could it be the answer to a must be true question?
- The answer is no.
- It is too strong, because the facts do not support most.

24 Recap: the inference method

- Facts become rules; link them into a chain
- Run the person or the some group along it
- Try to break every choice
- The answer is the one you cannot break

IN THE LESSON

- Let us recap.
- In an inference question you need what must be true, so you need proof.
- Turn each fact into a rule, link the rules into a chain, and run the named person or the some group along it, forwards or backwards with nots on both sides.
- Predict the small conclusion that follows.
- Then try to break every choice by imagining the facts true and the choice false.
- Name the trap each time: reversed rule, too strong, adds a detail, sounds sensible but is not forced, or widens a rule.
- The right answer is the one you cannot break.
- Practise this on every inference question.

Summary notes for the Charta whiteboard lesson. Figures are from the lesson's made-up examples.

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