Charta | LESSON NOTES

Two-part analysis: test the pair, not the pieces

Data Insights

1 What the question gives you

- A scenario with conditions
- Two columns, each with a heading
- One list of options; one choice in each column
- Choose the pair that satisfies every condition

IN THE LESSON

- Here is what a two-part question looks like.
- First comes a short scenario, with conditions written in the text.
- Then a table with two columns, each with its own heading, such as price and number sold.
- Under the table is one list of options, and you pick one option for each column.
- The same option can be used in both columns if it fits.
- The key idea is that the two selections are linked by the conditions.
- A choice for the first column that looks fine on its own may be impossible once you pair it with a choice for the second.
- You are not looking for the best choice in each column separately.
- You are looking for the pair that works.

2 The method: conditions, candidates, test the pair

Test the pair against every condition

1. Read the headings	what does each column mean?	**meaning**
2. List the conditions	short notes, one each	**notes**
3. Build candidate pairs	the first condition narrows it	**pairs**
4. Test each pair	against every condition	**test**
5. Check the story	put the numbers back in	**check**

IN THE LESSON

- Here is the method.
- First, read the column headings, because they tell you what each choice means.
- Second, list the conditions in the scenario, one by one, in short notes, such as the product is three hundred sixty, or the number sold is nine more than the price.
- Third, build candidate pairs from the options.
- Often the first condition narrows the options to a few pairs.
- Fourth, test each candidate pair against every condition, including the ones you have not used yet.
- Fifth, choose the pair that passes every test, and put the two numbers back into the story to check that the story makes sense.
- Never choose a pair after testing only one condition.

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3 Three kinds of two-part question

- Numbers: equations, then test the option pairs
- Verbal: judge each option for each column
- Logic: place the fixed facts, rule out the rest
- The same test for all: every condition holds

IN THE LESSON

- Two-part questions come in three flavours, and each has a different first move.
- In a numbers question, translate each condition into an equation, then look for the pair among the options that fits them all.
- Often the options are chosen so that more than one pair fits the first equation, and only one fits the second.
- In a verbal question, such as strengthen and weaken, read each option once for each column and ask, which way does this point?
- An option can be true and important, and still point the wrong way for its column.
- In a logic puzzle, place the fixed facts first, then try the possibilities for the rest, and rule out whatever breaks a rule.
- In all three, the test is the same: does the pair obey every condition?

4 The traps to watch for

- The half right pair: test every condition
- The same option may serve both columns
- Judge each option for its own column
- Check units: minutes against hours

IN THE LESSON

- Here are the traps.
- The first is the half right pair.
- The options are built so that a wrong pair satisfies the first condition but not the second, so always test both.
- The second is assuming that an option may be used only once.
- If the same number fits both columns, it can be chosen twice.
- The third is solving for one column and forgetting the other.
- Both must be right.
- The fourth, in verbal questions, is judging an option in general instead of for the column you are in.
- The fifth is a unit slip, such as thirty minutes against half an hour.
- And the sixth is skipping the last check.
- Put your two choices back into the story.
- If the story stops making sense, something went wrong.

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5 A small example first

Add to 14, differ by 4: larger, then smaller

Pairs that add to 14	3 and 11; 5 and 9; 7 and 7	**three pairs**
3 and 11	differ by 8	**fails**
7 and 7	differ by 0	**fails**
5 and 9	differ by 4	**passes**
Larger, smaller	9 and 5	**9 and 5**

IN THE LESSON

- Before the real questions, a tiny example, to see the method with nothing in the way.
- Two numbers add up to fourteen, and they differ by four.
- For the first column pick the larger number, and for the second the smaller.
- The options are three, five, seven, nine and eleven.
- Step one, build the candidate pairs from the first condition.
- Which pairs add to fourteen?
- Three and eleven.
- Five and nine.
- Seven and seven.
- Step two, test each pair against the second condition.
- Three and eleven differ by eight.
- Seven and seven differ by zero.
- Five and nine differ by four.
- Only one pair survives.
- The larger number is nine, and the smaller number is five.
- Notice that each candidate passed the first condition, and so the first condition alone could never decide.

6 Verbal columns: what each heading asks

Read each option against one heading at a time

Heading	What to look for
Strengthens	rules out a rival; supports the link
Weakens	offers a rival cause; breaks the link
Assumption	an unstated step the argument needs
Must / cannot be true	follows from, or breaks, the rules

IN THE LESSON

- In verbal two-part questions the column headings do the work, so know what each one wants.
- A heading that says strengthens wants the option that makes the conclusion more likely, usually by ruling out a rival explanation.
- A heading that says weakens wants the option that makes it less likely, usually by offering a rival cause or breaking the link between evidence and conclusion.
- A heading that says assumption wants an unstated step that the argument cannot do without.
- And must be true, and cannot be true, headings in a logic puzzle, ask what follows from all the rules, and what breaks one of them.
- Read each option against one heading at a time, and write a short verdict, such as, strengthens, weakens or neither.

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7 Logic puzzles: place, group, rule out

- Draw the slots; place every fixed fact
- Treat an immediately after pair as a block
- Try each place the block can fit
- Earlier means anywhere before; immediately means next

IN THE LESSON

- Logic puzzles in two-part questions are small, so solve them on paper.
- First, draw the slots, such as one to five in a row, and place every fixed fact, like Ben in slot three.
- Second, notice groups: when one person must come immediately after another, treat the two as a block, which moves as one piece.
- Third, list where each block can fit, and try each place in turn.
- Fourth, use the other rules to rule out the places that break them.
- Often a single place survives, and the rest of the order follows.
- Be careful with words such as earlier, which means anywhere before and not right before, and immediately after, which means in the very next slot.
- Finish by checking every rule against your final order.

8 Question 1: the candle stall

- A market stall sold identical candles at a single price for a whole day.
- The stall's revenue from candles that day was USD 360, and the number of candles sold was 9 more than the price of one candle in USD.
- Columns: Price per candle (USD), and Number sold.
- Options: 10, 15, 20, 24, 30, 36

IN THE LESSON

- Question one is an easy numbers question.
- Read it with me.
- A market stall sold identical candles at a single price for a whole day.
- The stall's revenue from candles that day was three hundred sixty dollars, and the number of candles sold was nine more than the price of one candle in dollars.
- For the first column you select the price per candle, and for the second the number sold.
- The options are ten, fifteen, twenty, twenty four, thirty and thirty six.
- Try it yourself first, then watch the method.
- Notice there are two conditions in the text, one about revenue and one about the nine more, and the options are numbers that could go in either column.

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9 Question 1: conditions and pairs

Price times number is 360; number is price plus 9

Pairs with product 360	10 and 36; 15 and 24	**two pairs**
Price 10, number 36	10 + 9 = 19, not 36	**fails**
Price 36, number 10	36 + 9 = 45, not 10	**fails**
Price 15, number 24	15 + 9 = 24 and 15 x 24 = 360	**passes**
Key	price 15, number 24	**15 and 24**

IN THE LESSON

- Step one, the headings: the price of one candle, and the number sold.
- Step two, the conditions.
- One, price times number equals three hundred sixty.
- Two, the number sold is the price plus nine.
- Step three, build candidate pairs from the options using the first condition.
- Which two options multiply to three hundred sixty?
- Ten and thirty six give three hundred sixty.
- Fifteen and twenty four give three hundred sixty.
- Twenty and eighteen would too, but eighteen is not on the list.
- So we have two candidate pairs.
- Step four, test each against the second condition.
- Price ten and number thirty six: ten plus nine is nineteen, not thirty six.
- Price thirty six and number ten fails too.
- Price fifteen and number twenty four: fifteen plus nine is twenty four.
- It passes.

10 Question 2: the conclusion

- Elmbridge town council installed speed cameras on Mill Road.
- In the following year, the number of accidents on Mill Road fell by 30% compared with the year before.
- The council concludes that the cameras caused the fall in accidents on Mill Road.
- Columns: Strengthens, and Weakens.

IN THE LESSON

- Question two is a verbal question.
- Read it with me.
- Elmbridge town council installed speed cameras on Mill Road.
- In the following year, the number of accidents on Mill Road fell by thirty percent compared with the year before.
- The council concludes that the cameras caused the fall in accidents on Mill Road.
- For the first column, select the statement that would most strengthen the council's conclusion.
- For the second column, select the statement that would most weaken it.
- Notice what kind of argument this is.
- The council compares the year before with the year after, and concludes that the cameras caused the change.
- Whenever you see a before and after comparison, ask what else could have caused the change, because rival causes are what the two columns are about.

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11 Question 2: the six statements

- 1. Mill Road carries more traffic than any other road in Elmbridge.
- 2. The cameras cost the council less to install than it had budgeted.
- 3. In the same year, the sharp bend on Mill Road where most earlier accidents had occurred was straightened.
- 4. Several residents of Mill Road told a local newspaper that they supported the cameras.
- 5. Fines collected from the cameras are used to fund road maintenance across the town.
- 6. On similar roads in Elmbridge without cameras, the number of accidents did not change over the same period.

IN THE LESSON

- Here are the six statements.
- Read each one, and decide in your own mind what it says about the cause.
- Statement one.
- Mill Road carries more traffic than any other road in Elmbridge.
- Statement two.
- The cameras cost the council less to install than it had budgeted.
- Statement three.
- In the same year, the sharp bend on Mill Road where most earlier accidents had occurred was straightened.
- Statement four.
- Several residents of Mill Road told a local newspaper that they supported the cameras.
- Statement five.
- Fines collected from the cameras are used to fund road maintenance across the town.
- Statement six.
- On similar roads in Elmbridge without cameras, the number of accidents did not change over the same period.
- Look for the statements that say something about the cause of the fall, and ignore the rest.

12 Question 2: judge each option for each column

Strengthen: rule out other causes. Weaken: offer one.

1, 2, 4 and 5	traffic, cost, opinions, fines	**irrelevant**
3 the bend was straightened	a rival cause, same year	**weakens**
6 similar roads, no change	a comparison group	**strengthens**
Key	strengthens 6, weakens 3	**6 and 3**

IN THE LESSON

- Step one, the conclusion: the cameras caused the fall.
- A before and after comparison can be explained by something else, so strengthening means ruling out other explanations, and weakening means offering one.
- Step two, test each option for each column.
- Option one, heavy traffic, says nothing about what caused the fall.
- Option two, cost, says nothing about causes.
- Option three, the bend was straightened that same year: a rival cause for the fall, so it weakens.
- Option four, residents' opinions, says nothing about causes.
- Option five, how the fines are used, is irrelevant.
- Option six, similar roads without cameras saw no change: a comparison group, so the fall is not a town wide trend, and it strengthens.
- The pair is six for strengthens, and three for weakens.

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13 Question 3: the jacket sale

- A retailer buys a jacket for a cost of c dollars and sets a list price of L dollars.
- During a sale it sells the jacket at 20% off the list price, and at that sale price it still makes a profit of 25% of its cost.
- The profit on each jacket sold during the sale is USD 16.
- Columns: Cost c (USD), and List price L (USD).
- Options: 40, 48, 64, 75, 90, 100

IN THE LESSON

- Question three is a medium numbers question.
- A retailer buys a jacket for a cost of c dollars, and sets a list price of capital L dollars.
- During a sale it sells the jacket at twenty percent off the list price, and at that sale price it still makes a profit of twenty five percent of its cost.
- The profit on each jacket sold during the sale is sixteen dollars.
- For the first column select the cost, and for the second the list price.
- The options are forty, forty eight, sixty four, seventy five, ninety and one hundred.
- This time there are more conditions, and they are linked: the sale price, the profit, and the cost all depend on each other.
- Do not rush.

14 Question 3: from the profit to the pair

Profit 16 is a quarter of the cost; sale price is 80% of list

Profit is 25% of cost	cost = 4 x 16	**64**
Sale price	64 + 16	**80**
Sale price is 80% of list	list = 80 / 0.8	**100**
Check: 20% off 100	100 - 20	**80**

IN THE LESSON

- Step one, the headings: the cost, and the list price.
- Step two, the conditions.
- One, the sale price is eighty percent of the list price.
- Two, the sale price is the cost plus twenty five percent of the cost, which is one and a quarter times the cost.
- Three, the profit is sixteen dollars.
- Step three, use the exact fact first.
- A profit of sixteen dollars is a quarter of the cost, so the cost is four times sixteen, which is sixty four.
- That cost is on the list.
- Then the sale price is sixty four plus sixteen, which is eighty.
- Eighty is eighty percent of the list price, so the list price is eighty divided by point eight, which is one hundred.
- Step four, test the pair.
- Twenty percent off one hundred is eighty.
- It checks out.

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15 Question 3: why the other pair fails

The half right pair: cost 48, list price 75

Sale price at 20% off 75	75 x 0.8	**60**
1.25 times cost 48	48 x 1.25	**60**
Profit of 25% of 48	0.25 x 48	**12**
The condition says profit	16 is not 12	**fails**

IN THE LESSON

- Now the trap.
- The options were built so that a second pair fits the ratio between sale price and cost.
- Suppose the cost is forty eight and the list price is seventy five.
- Twenty percent off seventy five is sixty.
- And sixty is one and a quarter times forty eight, so that pair satisfies the percentages.
- A solver who stops there picks it.
- But the third condition says the profit is sixteen dollars.
- With a cost of forty eight, a profit of twenty five percent is only twelve dollars.
- So that pair fails the profit condition.
- This is exactly the half right pair.
- It passes two conditions and fails the third.
- That is why we test every condition before we choose, and why we use the exact fact, the sixteen dollars, as early as we can.

16 Question 4: the seminar order

- Five speakers, Ana, Ben, Cara, Dev and Eli, each give one talk at a seminar, in slots 1 to 5, one speaker per slot.
- Ben speaks in slot 3.
- Dev speaks in the slot immediately after Cara.
- Eli speaks in an earlier slot than Ana.
- Ana does not speak in slot 5.
- Columns: Speaks in slot 1, and Speaks in slot 2.
- Options: Ana, Ben, Cara, Dev, Eli

IN THE LESSON

- Question four is a logic puzzle.
- Five speakers, Ana, Ben, Cara, Dev and Eli, each give one talk at a seminar, in slots one to five.
- Ben speaks in slot three.
- Dev speaks in the slot immediately after Cara.
- Eli speaks in an earlier slot than Ana.
- And Ana does not speak in slot five.
- For the first column select the speaker who must speak in slot one, and for the second the speaker who must speak in slot two.
- The five options are the five names.
- Notice that the question asks who must speak there, so the answer is certain from the rules.
- For a puzzle like this, fix what you can, and then ask which arrangements are left.

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17 Question 4: place, then rule out

Ben 3; Cara then Dev; Eli before Ana; Ana not 5

Cara and Dev in slots 1, 2	then Eli 4, Ana 5: Ana last	**impossible**
Cara and Dev in slots 4, 5	Eli and Ana take 1 and 2	**possible**
Eli earlier than Ana	Eli 1, Ana 2	**forced**
Order	Eli, Ana, Ben, Cara, Dev	**Eli and Ana**

IN THE LESSON

- Step one, place the fixed facts.
- Ben is in slot three.
- Step two, treat Cara and Dev as one block, Cara then Dev, in two neighbouring slots.
- With Ben in the middle, the block fits either in slots one and two, or in slots four and five.
- Step three, try each.
- Suppose the block is in slots one and two.
- Then Eli and Ana fill slots four and five, with Eli first, because Eli is earlier than Ana.
- That puts Ana in slot five, which the rules forbid.
- So that is impossible.
- So the block is in slots four and five, with Cara in four and Dev in five.
- Eli and Ana fill slots one and two, and Eli must be earlier.
- So Eli speaks first and Ana second.
- The pair is Eli, and Ana.

18 Question 5: the cycling round trip

- A cyclist rides 30 km from her home to a nearby town at a constant speed and returns home along the same route at a different constant speed.
- Her average speed for the whole round trip is exactly 24 km per hour, and the outward ride takes exactly 30 minutes longer than the return ride.
- Columns: Outward speed (km per hour), and Return speed (km per hour).
- Options: 12, 15, 18, 20, 30, 36

IN THE LESSON

- Question five is the hard one.
- A cyclist rides thirty kilometres from her home to a nearby town at a constant speed, and returns home along the same route at a different constant speed.
- Her average speed for the whole round trip is exactly twenty four kilometres per hour, and the outward ride takes exactly thirty minutes longer than the return ride.
- For the first column select the outward speed, and for the second the return speed.
- The options are twelve, fifteen, eighteen, twenty, thirty and thirty six.
- Think about what an average speed means.
- It is total distance divided by total time, and it is not the simple average of the two speeds.

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19 Question 5: time first, then speeds

Average speed = total distance / total time

Total time	60 km / 24 km per hour	**2.5 hours**
Return time t	t + (t + 0.5) = 2.5	**t = 1 hour**
Outward time	1 + 0.5	**1.5 hours**
Speeds	30 / 1.5 and 30 / 1	**20 and 30**

IN THE LESSON

- Step one, the headings: the outward speed and the return speed.
- Step two, the conditions.
- One, the round trip is sixty kilometres, at an average of twenty four, so the total time is sixty divided by twenty four, which is two and a half hours.
- Two, the outward ride takes half an hour longer than the return ride.
- Step three, solve for the times.
- If the return takes t hours, the outward takes t plus a half, and together they take two and a half.
- So two t plus a half is two and a half, which makes t equal to one hour.
- The return takes one hour and the outward takes one and a half hours.
- Step four, turn times into speeds.
- The outward speed is thirty over one and a half, which is twenty.
- The return speed is thirty over one, which is thirty.

20 Question 5: the half right pair

The half right pair: 18 and 36

Times at 18 and 36	1 2/3 hours and 5/6 hour	**2.5 hours**
Average speed	60 / 2.5	**24 passes**
Outward minus return	50 minutes	**not 30**
Pair 18 and 36	fails the second condition	**fails**
Pair 20 and 30	1.5 and 1 hours: 30 minutes	**passes**

IN THE LESSON

- Again there is a trap, and it is the same half right pair.
- Suppose the outward speed is eighteen and the return speed is thirty six.
- The two times are thirty over eighteen, which is one and two thirds hours, and thirty over thirty six, which is five sixths of an hour.
- The total is two and a half hours, so the average speed is twenty four.
- That pair satisfies the first condition exactly, and a solver who stops there would choose it.
- But the outward ride then takes fifty minutes longer than the return, not thirty.
- So it fails the second condition.
- This is why the method says to test every condition, and why you should put the pair back into the story.
- The pair twenty and thirty passes both.
- The key is twenty, and thirty.

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21 Accurate and quick

- Write each condition as a short note
- Use the most exact condition first
- Make a short list of candidate pairs
- Test the survivor against every condition
- About two to three minutes, then decide

IN THE LESSON

- Now habits that save time without losing accuracy.
- First, read the headings and conditions, and write each condition as a short note.
- Second, use the most exact condition first, such as a total or a named value, because it narrows the options fastest.
- Third, build a short list of candidate pairs from the options and test them, instead of solving every equation from scratch.
- Fourth, always test the survivor against every condition, including the ones you have not used.
- Fifth, in verbal questions, read the options once for each column.
- Sixth, remember that the same option can be chosen for both columns.
- And last, spend about two to three minutes.
- If you are stuck, test the options in pairs and see which ones fail first.

22 Quick check

1. First condition met; second untested. Choose it?
   Answer: No: test every condition first.
2. The same number fits both columns. Select it twice?
   Answer: Yes: one option may serve both columns.
3. A true option about cost, but the claim is about causes?
   Answer: Neither column: it does not touch the conclusion.

IN THE LESSON

- Now a quick check.
- Pause after each question and answer it yourself.
- Question one.
- A pair of options satisfies the first condition, but you have not tested the second.
- Can you choose it?
- The answer: no.
- Test every condition before you choose.
- Question two.
- In a two-part question, the same number fits both columns.
- Can you select it twice?
- The answer: yes, one option may serve both columns if it fits.
- Question three.
- In a strengthen and weaken question, an option is true and important, but it is about cost, not causes.
- Which column does it go in?
- The answer: neither.
- An option that says nothing about the conclusion does not strengthen or weaken it.

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23 Recap: the two-part method

- Headings, then every condition in notes
- Most exact condition first, candidate pairs
- Test each pair against every condition
- Verbal: judge each option for its column
- Put the pair back in the story

IN THE LESSON

- Let us recap the technique.
- Read the column headings so you know what each choice means.
- List every condition in short notes.
- Use the most exact condition first to build a short list of candidate pairs.
- Then test each candidate against every condition, because the wrong pairs are built to satisfy only some of them.
- In verbal questions, judge each option for the column you are in.
- In logic puzzles, place the fixed facts first and rule out the arrangements that break a rule.
- Remember that the same option can fill both columns.
- Finally, put your pair back into the story, and check that it makes sense.
- When the pair passes every test, you can be certain.

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

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