Charta | LESSON NOTES

# Multi-source reasoning: find, combine, check

Data Insights

## 1 What the question gives you

- Two or three tabs: memo, table, email
- A rule in one tab, figures in another
- The question needs more than one tab
- Everything you need is on the page

IN THE LESSON

- Here is the shape of a multi-source question.
- Along the top are two or three tabs.
- You click a tab to read it, and you can switch back and forth.
- The tabs are different kinds of source.
- A memo or policy gives rules, such as a limit, a threshold or a formula.
- A table gives figures for several items.
- An email or a note gives a request, a claim or a proposal.
- Below the tabs sits a question, or a set of statements, that cannot be answered from one tab alone.
- You must take a rule from one tab, apply it to the figures in another, and sometimes use a fact from a third.
- Notice that every fact you need is on the page.
- You never need outside knowledge.

## 2 The method: skim, pick, combine, check

*Rules from one tab, figures from another*

| | | |
|---|---|---|
| **1. Skim the tabs** | rule, data or claim? | **kinds** |
| **2. Read the question** | which tabs does it need? | **pick** |
| **3. Note rules and figures** | exceptions and small print | **notes** |
| **4. Combine** | apply each rule, item by item | **table** |
| **5. Check** | exception missed? tab unused? | **check** |

IN THE LESSON

- Here is the method.
- First, skim the tabs, saying in a few words what kind of source each one is: rule, data or claim.
- Second, read the question carefully, and decide which tabs it needs.
- Third, pick out the exact rules and figures, and write them on your scratch board in short notes.
- Notice the small print: exceptions, such as unless the returns are high, and special words such as at least or no more than.
- Fourth, combine: apply each rule to the figures, one item at a time, and keep a small table of results.
- Fifth, check your answer against the question, and against any exception you may have missed.
- And if a tab is not needed, say so, and ignore it.
- Unused tabs are a feature of these questions.

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## 3 Three kinds of source

- Rule tab: limits, thresholds, exceptions
- Data tab: figures, with units and headings
- Claim tab: a view or a plan, not a fact
- If a claim and the data disagree, trust the data

**IN THE LESSON**

- It helps to treat each tab as one of three kinds.
- A rule tab, such as a policy, a grant condition or an owner's note, tells you what is allowed or required.
- Read every word, because limits like no more than and exceptions like unless are written there.
- A data tab, usually a table, gives you the figures.
- Check the units and the headings, as you would in a table question.
- And a claim tab, such as an email or a proposal, contains someone's view, request or plan, and may contain figures too.
- A claim is not a fact.
- A manager may say that one site handles the largest volume, but the table decides whether that is true.
- When a claim and a table disagree, the data wins.

## 4 The traps to watch for

- Exceptions and small print
- The wrong tab, or the wrong base
- Stopping after the first rule
- Trusting a claim before checking the data

**IN THE LESSON**

- Here are the traps.
- The first is missing an exception.
- A rule says commission is three percent, five percent or eight percent, but a note says that high returns cancel the higher rates.
- If you skip the note, every figure goes wrong.
- The second is using the wrong tab, such as taking a number from the memo that the table has already updated.
- The third is applying a rule to the wrong item or the wrong base, like a percentage of the total instead of a percentage of the part.
- The fourth is stopping at the first rule, when the question needs all of them.
- The fifth is trusting a claim without checking it against the data.
- And the sixth is giving up time on an unneeded tab.
- Read every tab quickly, and then work only with what you need.

## 5 Set 1: the rules and the email

- Current commission scheme:
- Each sales representative is paid commission every quarter on that quarter's sales, at 3% of the first USD 100,000 of sales, 5% of sales above USD 100,000 up to USD 200,000, and 8% of sales above USD 200,000.
- A representative whose customer returns in the quarter exceed 6% of that quarter's sales receives no commission on sales above USD 100,000.
- Email from the sales director: a proposal for next year (not needed for this question).

**IN THE LESSON**

- Our first set is about a company that pays commission to its sales representatives.
- There are three tabs.
- Tab one is the current commission scheme, a rule tab.
- It says each representative is paid commission every quarter on that quarter's sales: three percent on the first one hundred thousand dollars, five percent on sales above one hundred thousand dollars up to two hundred thousand, and eight percent on sales above two hundred thousand.
- Then comes the small print.
- A representative whose customer returns exceed six percent of the quarter's sales receives no commission on sales above one hundred thousand dollars.
- Tab three is an email from the sales director, a claim tab, proposing a flat rate for next year.

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## 6 Set 1: third quarter results

*Third quarter results*

| Representative | Region | Sales (USD) | Returns (USD) |
|---|---|---|---|
| Amara Lowe | North | 240000 | 9600 |
| Callum Price | North | 180000 | 12600 |
| Dina Shah | South | 95000 | 2850 |
| Felix Moreau | South | 210000 | 10500 |
| Greta Holm | East | 150000 | 6000 |
| Hugo Brandt | East | 260000 | 18200 |

**IN THE LESSON**

- Tab two is the data, a table of third quarter results for six sales representatives.
- The columns give each representative's region, their sales in dollars, and their returns in dollars.
- Amara Lowe sold two hundred forty thousand dollars, with returns of nine thousand six hundred.
- Callum Price sold one hundred eighty thousand, with returns of twelve thousand six hundred.
- Dina Shah sold ninety five thousand.
- Felix Moreau sold two hundred ten thousand.
- Greta Holm sold one hundred fifty thousand.
- And Hugo Brandt sold two hundred sixty thousand, with returns of eighteen thousand two hundred.
- Do not try to remember these.
- Notice that the returns column matters, because the small print in tab one is about returns.

## 7 Set 1: the question

- Under the current scheme, which representative earned the most commission in the third quarter?
- A. Hugo Brandt
- B. Felix Moreau
- C. Amara Lowe
- D. Callum Price
- E. Greta Holm

**IN THE LESSON**

- Now the question.
- Read it with me, and notice that the question names the scheme it is about.
- Say to yourself what kind of answer you are looking for: one name, picked from five.
- Under the current scheme, which representative earned the most commission in the third quarter?
- Choice A.
- Hugo Brandt.
- Choice B.
- Felix Moreau.
- Choice C.
- Amara Lowe.
- Choice D.
- Callum Price.
- Choice E.
- Greta Holm.
- Which tabs does it need?
- The rules and the table, but not the email.
- Keep that in mind as we work.

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## 8 Set 1: step one, the returns test

*Returns over 6% of sales: no commission above $100,000*

| Representative | Returns / sales | Over 6%? |
|---|---|---|
| Amara Lowe | 9,600 / 240,000 = 4% | No |
| Callum Price | 12,600 / 180,000 = 7% | Yes |
| Felix Moreau | 10,500 / 210,000 = 5% | No |
| Hugo Brandt | 18,200 / 260,000 = 7% | Yes |

IN THE LESSON

- Step one is the small print, because it can change everything.
- Does each representative's returns figure exceed six percent of their sales?
- Amara: nine thousand six hundred over two hundred forty thousand is four percent.
- That is fine.
- Callum: twelve thousand six hundred over one hundred eighty thousand is seven percent.
- Over six, so Callum gets no commission above one hundred thousand dollars.
- Dina is three percent, Felix is five percent, and Greta is four percent, all fine.
- Hugo: eighteen thousand two hundred over two hundred sixty thousand is seven percent.
- Over six, so Hugo is also capped.
- Now the cap is the reason the biggest seller is not automatically the winner.
- Callum and Hugo are both capped at three percent of the first one hundred thousand dollars.

## 9 Set 1: step two, the commissions

*Commission by tier, with the cap applied*

| Representative | Commission sum | Total |
|---|---|---|
| Amara Lowe | 3,000 + 5,000 + 3,200 | 11,200 |
| Felix Moreau | 3,000 + 5,000 + 800 | 8,800 |
| Greta Holm | 3,000 + 2,500 | 5,500 |
| Hugo, Callum (capped) | 3,000 each | 3,000 |
| Dina Shah | 3% of 95,000 | 2,850 |

IN THE LESSON

- Step two, apply the tiers to each representative.
- Amara has no cap, sales of two hundred forty thousand.
- Three percent of the first one hundred thousand is three thousand.
- Five percent of the next one hundred thousand is five thousand.
- Eight percent of the last forty thousand is three thousand two hundred.
- The total is eleven thousand two hundred dollars.
- Felix, with two hundred ten thousand, gets three thousand plus five thousand plus eight percent of ten thousand, which is eight hundred: eight thousand eight hundred.
- Greta gets three thousand plus two thousand five hundred, five thousand five hundred.
- Dina gets three percent of ninety five thousand, two thousand eight hundred fifty.
- Callum and Hugo, capped, get three thousand dollars each.
- The largest is Amara.

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## 10 Set 1: check the five choices

*Under the current scheme: who earned the most?*

| | | |
|---|---|---|
| **A: Hugo Brandt** | 7% returns: capped at 3,000 | **the cap** |
| **B: Felix Moreau** | 8,800 is below Amara's 11,200 | **second** |
| **C: Amara Lowe** | 11,200 is the most | **the answer** |
| **D: Callum Price** | 7% returns: capped at 3,000 | **the cap** |
| **E: Greta Holm** | 5,500: never reaches 8% | **too little** |

**IN THE LESSON**

- Now check the five choices.
- Choice A, Hugo Brandt, had the highest sales, but his returns are seven percent, so he earned only three thousand dollars.
- That is the trap of choosing the biggest seller.
- Choice B, Felix Moreau, earned eight thousand eight hundred, second best, because only ten thousand of his sales were in the top tier.
- Choice C, Amara Lowe, earned eleven thousand two hundred, the most.
- Choice D, Callum Price, is capped by his seven percent returns, at three thousand dollars.
- Choice E, Greta Holm, never reaches the top tier, so she earned five thousand five hundred.
- The answer is C.
- Had we skipped the small print, Hugo would have looked like the winner, which is exactly what the question wants you to do.

## 11 Set 2: the owner and the adviser

- Note from the owner of Thornbury Nurseries:
- I will only consider a system whose installation cost is no more than USD 60,000 and whose emissions are below 30 tonnes of carbon dioxide a year.
- Among the systems that meet both limits, we will choose the one with the lowest ten-year cost, counting the installation cost less any grant received, plus ten years of running costs at the quoted annual rate.
- Email from the regional energy adviser:
- The regional clean heat grant pays 25% of the installation cost of any system emitting less than 15 tonnes of carbon dioxide a year, up to a maximum of USD 12,000 per site.
- The grant is paid after installation, so the full installation cost is what counts against any spending limit you set.

**IN THE LESSON**

- Our second set is about a plant nursery that must replace the boiler heating its glasshouse.
- Tab one is a note from the owner, a rule tab.
- It says the owner will only consider a system whose installation cost is no more than sixty thousand dollars, and whose emissions are below thirty tonnes of carbon dioxide a year.
- Among the systems meeting both limits, choose the one with the lowest ten year cost, counting the installation cost less any grant, plus ten years of running costs.
- Tab three is an email from an energy adviser, another rule tab, about a grant: twenty five percent of the installation cost, for a system emitting below fifteen tonnes, up to twelve thousand dollars.
- The full installation cost still counts against the spending limit.

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## 12 Set 2: the quoted systems

*Quoted heating systems*

| System | Installation cost (USD) | Annual running cost (USD) | Emissions (tonnes CO2 per year) | Expected life (years) |
|---|---|---|---|---|
| Gas boiler | 28000 | 9500 | 42 | 15 |
| Biomass boiler | 52000 | 6000 | 8 | 20 |
| Air-source heat pump | 58000 | 4800 | 12 | 15 |
| Ground-source heat pump | 76000 | 3200 | 6 | 25 |
| Hybrid gas and heat pump | 45000 | 6800 | 24 | 15 |

**IN THE LESSON**

- Tab two is the table of five quoted systems.
- For each one it gives the installation cost, the annual running cost, the emissions in tonnes a year and the expected life in years.
- The gas boiler costs twenty eight thousand to install and emits forty two tonnes.
- The biomass boiler costs fifty two thousand and emits eight.
- The air source heat pump costs fifty eight thousand and emits twelve.
- The ground source heat pump costs seventy six thousand and emits six.
- And the hybrid gas and heat pump costs forty five thousand and emits twenty four.
- Read the headings carefully.
- The expected life column is a distractor, because the owner's rule counts ten years only, whatever the life.

## 13 Set 2: the question

- Following the owner's rules, which system should Thornbury Nurseries choose?
- A. Biomass boiler
- B. Hybrid gas and heat pump
- C. Gas boiler
- D. Ground-source heat pump
- E. Air-source heat pump

**IN THE LESSON**

- Now the question.
- Read it with me, and notice that it asks you to follow the owner's rules, which means all of them, and in the order the note gives.
- Say to yourself which system you expect to win.
- Following the owner's rules, which system should Thornbury Nurseries choose?
- Choice A.
- Biomass boiler.
- Choice B.
- Hybrid gas and heat pump.
- Choice C.
- Gas boiler.
- Choice D.
- Ground-source heat pump.
- Choice E.
- Air-source heat pump.
- This question needs all three tabs: the owner, the table and the adviser.

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## 14 Set 2: step one, apply the limits

*Cost at most 60,000 and emissions below 30*

| | | |
|---|---|---|
| **Gas boiler** | 28,000 but 42 tonnes | **fails** |
| **Biomass boiler** | 52,000 and 8 tonnes | **passes** |
| **Air-source heat pump** | 58,000 and 12 tonnes | **passes** |
| **Ground-source heat pump** | 76,000: over 60,000 | **fails** |
| **Hybrid gas and heat pump** | 45,000 and 24 tonnes | **passes** |

IN THE LESSON

- Step one is the owner's two limits: installation cost no more than sixty thousand dollars, and emissions below thirty tonnes.
- Test each system.
- The gas boiler costs twenty eight thousand, but it emits forty two tonnes, which is over thirty.
- It fails.
- The biomass boiler costs fifty two thousand and emits eight: it passes both.
- The air source heat pump costs fifty eight thousand, under sixty, and emits twelve: it passes.
- The ground source heat pump emits only six tonnes, but it costs seventy six thousand, over sixty.
- It fails.
- And the grant cannot rescue it, because the adviser says the full installation cost counts against the limit.
- The hybrid costs forty five thousand and emits twenty four, which is below thirty: it passes.
- Three systems survive.

## 15 Set 2: step two, the ten year cost

*Ten year cost = installation - grant + 10 x annual running*

| System | Grant | Ten year cost |
|---|---|---|
| Biomass boiler | 12,000 (cap) | 52,000 - 12,000 + 60,000 = 100,000 |
| Air-source heat pump | 12,000 (cap) | 58,000 - 12,000 + 48,000 = 94,000 |
| Hybrid gas and heat pump | none (24 tonnes) | 45,000 + 68,000 = 113,000 |

IN THE LESSON

- Step two, the grant and the ten year cost for the three survivors.
- The grant pays twenty five percent of the installation cost for systems emitting below fifteen tonnes, up to twelve thousand dollars.
- The biomass boiler, at eight tonnes, qualifies.
- Twenty five percent of fifty two thousand is thirteen thousand, which is over the cap, so the grant is twelve thousand.
- The air source heat pump, at twelve tonnes, also qualifies, and twenty five percent of fifty eight thousand is fourteen thousand five hundred, so again the cap of twelve thousand applies.
- The hybrid, at twenty four tonnes, gets no grant.
- Now add.
- Biomass: fifty two thousand, less twelve thousand, plus sixty thousand of running costs, is one hundred thousand.
- The heat pump: ninety four thousand.
- The hybrid: one hundred thirteen thousand.

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## 16 Set 2: check the five choices

*Following the owner's rules, which system is chosen?*

| | | |
|---|---|---|
| **A: Biomass boiler** | 100,000, above the heat pump | **dearer** |
| **B: Hybrid gas and heat pump** | no grant: 113,000 | **dearest** |
| **C: Gas boiler** | 42 tonnes: over the limit | **fails** |
| **D: Ground-source heat pump** | 76,000: over the limit | **fails** |
| **E: Air-source heat pump** | 94,000, the lowest | **the answer** |

IN THE LESSON

- Now check the five choices.
- Choice A, the biomass boiler, costs one hundred thousand dollars over ten years, which is more than the heat pump.
- Choice B, the hybrid, receives no grant, so it costs one hundred thirteen thousand, the highest of the three.
- Choice C, the gas boiler, fails the emissions limit.
- Choice D, the ground source heat pump, fails the installation cost limit, and the grant cannot help, because of the adviser's last sentence.
- Choice E, the air source heat pump, costs ninety four thousand dollars, the lowest.
- The answer is E.
- Look at how three tabs were needed.
- The owner's note gave the limits and the cost rule, the table gave the figures, and the adviser's email gave the grant and the warning about the spending limit.

## 17 Set 3: the grant conditions

- Grant conditions from Ellery Town Council:
- 1. The council will fund up to 60% of a festival's total budgeted cost, to a maximum of USD 18,000.
- 2. At least 15% of the total budgeted cost must be spent on safety, meaning stewards and first aid.
- 3. No single supplier may receive more than 40% of the total budgeted cost.
- 4. The budget must include a contingency of at least 5% of the total of all other costs.
- Email from the festival treasurer: about supplier changes and sponsorship (not needed for this question).

IN THE LESSON

- Our third set is about a summer festival that wants a grant from a town council.
- Tab one lists the council's four grant conditions, which are rules.
- One: the council will fund up to sixty percent of the total budgeted cost, to a maximum of eighteen thousand dollars.
- Two: at least fifteen percent of the total budgeted cost must be spent on safety, meaning stewards and first aid.
- Three: no single supplier may receive more than forty percent of the total budgeted cost.
- And four: the budget must include a contingency of at least five percent of the total of all other costs.
- Tab three is an email from the treasurer about changing suppliers and sponsorship.
- This question asks only about the draft budget in tab two, so we can leave tab three alone.

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## 18 Set 3: the draft budget

*Draft budget for the Ellery Summer Festival*

| Item | Supplier | Cost (USD) |
|---|---|---|
| Stage and sound | Brightline Events | 10200 |
| Marquees | Brightline Events | 4800 |
| Stewards | Guardwell Security | 3000 |
| First aid cover | Medway Ambulance Volunteers | 1200 |
| Toilets | Clearflow Hire | 2400 |
| Publicity | Inkpot Printers | 1800 |
| Contingency | None | 1300 |

IN THE LESSON

- Tab two is the draft budget, with seven items, each with a supplier and a cost in dollars.
- Stage and sound, ten thousand two hundred, and marquees, four thousand eight hundred, are both from Brightline Events.
- Stewards cost three thousand, from Guardwell Security.
- First aid cover costs one thousand two hundred, from the Medway Ambulance Volunteers.
- Toilets cost two thousand four hundred.
- Publicity costs one thousand eight hundred.
- And the contingency is one thousand three hundred, with no supplier.
- The first job is to find the total of everything: twenty four thousand seven hundred dollars, contingency included.
- Total budgeted cost means all of it.
- Write that total down, because three of the four conditions are percentages of it.

## 19 Set 3: the question

- For each of the council's conditions below, select Meets if the draft budget meets the condition. Otherwise select Does not meet.
- 1. Condition 2, on spending for safety
- 2. Condition 3, on the share paid to any one supplier
- 3. Condition 4, on the contingency

IN THE LESSON

- Now the question.
- For each of the council's conditions below, select Meets if the draft budget meets the condition, and otherwise select Does not meet.
- The three conditions are, condition two, on spending for safety.
- Condition three, on the share paid to any one supplier.
- And condition four, on the contingency.
- Notice what this question asks: not for one answer, but for a verdict on each condition, and each verdict is independent.
- Condition one, on the size of the grant, is not asked about.
- Each of the three needs a figure from the table, and a percentage line from the rules tab.
- The method is the same for all three: find the figure, find the line, compare.

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## 20 Set 3: each condition, figure against line

*Figure against the line, for each condition*

| | | |
|---|---|---|
| **Safety: 3,000 + 1,200** | 4,200 against 15% = 3,705 | **Meets** |
| **Brightline: 10,200 + 4,800** | 15,000 against 40% = 9,880 | **Does not meet** |
| **Contingency 1,300** | against 5% of 23,400 = 1,170 | **Meets** |
| **Key** | Meets, Does not meet, Meets | **M, D, M** |

IN THE LESSON

- Condition two, safety.
- Stewards and first aid cost three thousand plus one thousand two hundred, which is four thousand two hundred.
- Fifteen percent of twenty four thousand seven hundred is three thousand seven hundred five.
- Four thousand two hundred is above that line, about seventeen percent.
- Meets.
- Condition three, any one supplier.
- Brightline gets ten thousand two hundred plus four thousand eight hundred, which is fifteen thousand dollars.
- Forty percent of the total is nine thousand eight hundred eighty.
- Fifteen thousand is far above, about sixty one percent.
- Does not meet.
- Condition four, the contingency.
- The other costs total twenty three thousand four hundred, so five percent is one thousand one hundred seventy.
- The budget has one thousand three hundred.
- Meets.
- The key: meets, does not meet, meets.

## 21 Set 3: what to take from it

- Define the base before every percentage
- Each condition: a figure against a line
- Skim every tab; ignore what the question does not need
- Different conditions can use different bases

IN THE LESSON

- Three things to take from this set.
- First, define the base before any percentage.
- Safety and supplier share use the total including the contingency, but the contingency condition uses the total of all other costs.
- Two different bases, in two conditions, in the same rules tab.
- Second, each condition is a figure against a line, so write them as a pair and compare.
- Third, we ignored the treasurer's email entirely, and we were right to.
- Many multi-source questions include a tab for a different question in the same set.
- Skim every tab to know what it holds, and then read closely only what the question needs.
- Skimming is quick, and ignoring is a skill.

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## 22 Accurate and quick

- Skim every tab; label rule, data or claim
- Read the question before digging in
- Notes and a small table, not the whole tab
- Re-read the small print before you answer
- About three minutes a question

IN THE LESSON

- Now habits that save time without losing accuracy.
- First, skim all the tabs in the first thirty seconds, and label each one as rule, data or claim.
- Second, read the question before you dig into the tabs, so that you know what to look for.
- Third, write the rules and figures you need as short notes, in a small table, and do not keep going back to the tabs.
- Fourth, apply each rule to every item, and use a quick estimate to rule out any item that is far from a limit.
- Fifth, read the small print again before you answer, looking for exceptions, special words and unused tabs.
- And sixth, keep to about three minutes a question.
- Multi-source questions are long, so do not let one eat the clock.

## 23 Quick check

1. Rule: plan if late rate is above 6%. What do you compute?
   **Answer:** Late orders / orders shipped, for each site.
2. An email claims a site had the most late shipments?
   **Answer:** Check the table: the data wins over a claim.
3. The question needs two of the three tabs?
   **Answer:** Skim the third to know it, then ignore it.

IN THE LESSON

- Now a quick check.
- Pause after each question and answer it yourself.
- Question one.
- A rule tab says a warehouse must submit a plan if its late rate is above six percent.
- A table gives late orders and orders shipped.
- What do you compute?
- The answer: late orders divided by orders shipped, for each warehouse, and compare it with six percent.
- Question two.
- A manager's email claims that one site had the most late shipments.
- What do you do?
- The answer: check it against the table, because the data wins over a claim.
- Question three.
- A question needs only two of the three tabs.
- What do you do with the third?
- The answer: skim it, so you know what it holds, and then ignore it.

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## 24 Recap: the multi-source method

- Label each tab: rule, data or claim
- Pick the rules and figures; note exceptions
- Apply the rule to each item; small table
- Test claims against the data
- Re-read the small print

**IN THE LESSON**

- Let us recap the technique.
- Skim the tabs and label each as rule, data or claim.
- Read the question and decide which tabs it needs.
- Pick out the exact rules and figures, noting exceptions and special words.
- Then combine: apply the rule to each item in the data, and keep a small table of results.
- Define the base for every percentage, and check the units.
- Treat a claim as a statement to test against the data, and never as a fact.
- Before you answer, read the small print again, because an exception or a limit may change the answer.
- And do not spend time on a tab that the question does not need.
- With a plan, a long set of tabs becomes a few small steps.

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

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