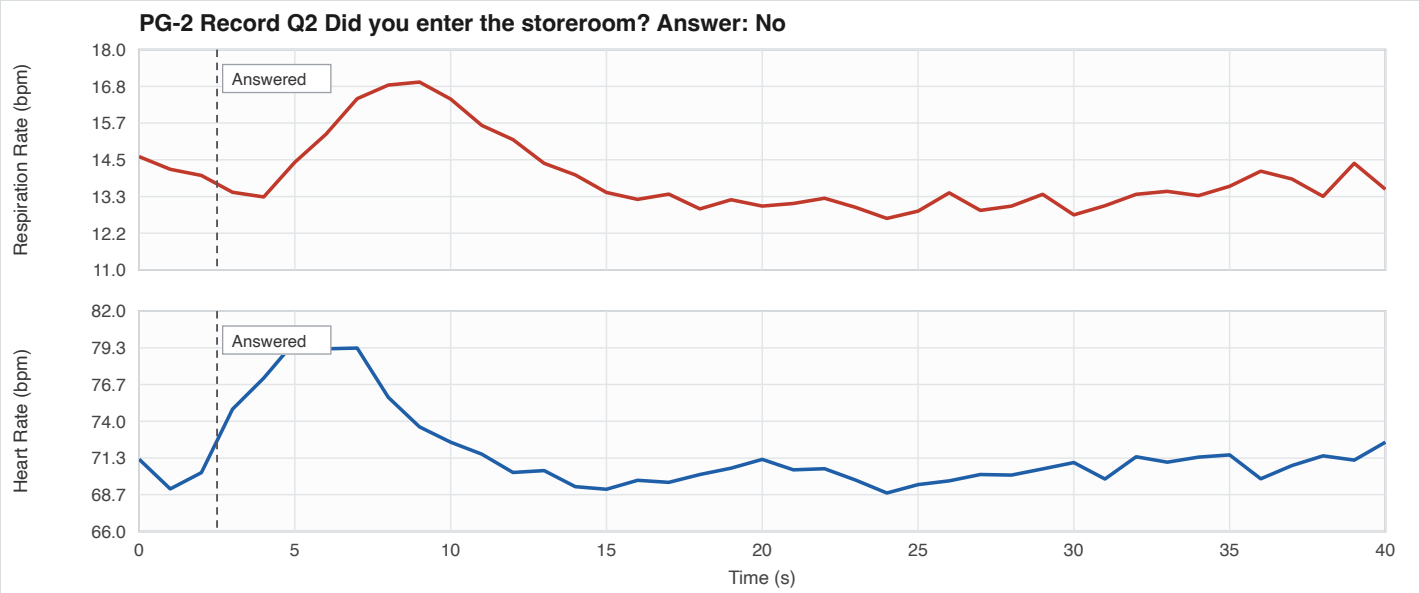
How to read a physiological chart

Keep this card next to you while you work.

CLAIM CEILING. READ THIS FIRST.

- **Polygraph.** It records breathing and heart rate. A change in either one is a physiological response. It is not a measurement of lying, and nothing in this unit produces a deception call.
- **Hair.** Microscopic similarity can support consistency or support exclusion. It cannot identify one person.
- **Fingerprint.** Pattern class can narrow a field or exclude a person. By itself it cannot name a source, and it never says when or why a finger touched something.
- **Timeline.** A scheduled event is not proof the person was there. Time of death is not established in the early case evidence.



The two-channel chart format used in the case evidence. Respiration rate on top, heart rate below.

Method card for PG-1, PG-2, PG-3, and PG-4. This card teaches you to measure a physiological signal. A physiological change is not a measurement of deception, and no scoring rule anywhere in this unit produces a deception call.

What this test can and cannot tell you

- **Claim ceiling.** These charts record physiology. They do not record lying. Nothing in this unit turns a number from these charts into a statement about whether someone told the truth.
- It can give you a change in respiration rate and a change in heart rate, both in beats or breaths per minute, measured between a baseline window and a response window that you defined before you looked.

- It cannot tell you why a change happened. Alarm, anger, embarrassment, a shift in the chair, a cold room, and a startling question all move heart rate the same direction.
- It cannot see anything faster than one second, because the record holds one reading per second, and it cannot be compared to another chart until both are read in the same units on the same scale.

The two kinds of question, because you are asked to sort them

An examination mixes two kinds of question on purpose, and you are asked to label each record as one or the other before you measure anything.

Kind	What it asks	Example from this unit
Control question	Something ordinary that has nothing to do with the case, asked so there is something to compare against. The answer is not in dispute.	"Is today Tuesday?" and "Are you a student here?"
Relevant question	Something directly about the matter under investigation.	"Did you enter the storeroom?" and "Did you take the key?"

Why the comparison is weaker than it sounds The reasoning behind the comparison is that a bigger change on a relevant question than on a control question means something. It does not mean deception. A relevant question is, by construction, the frightening one, and being asked a frightening question moves your heart rate whether or not you did anything. An innocent person who knows they are suspected has every reason to react to "Did you take the key?" and none at all to "Is today Tuesday?" Sort the questions, measure the change, and stop there.

Before you start: what you need

- The printed chart for the record you are scoring, both panels visible
- The printed chart for a control question from the same person
- The record list for that person, so you can check the labels against each other
- An index card or a folded sheet, used to cover the plotted line
- A clear plastic ruler with millimetre marks
- A sharp pencil and an eraser
- Your PG measurement sheet, with a notes column
- A calculator
- A partner who has not seen your numbers

The steps

1. Write down the record ID. Before you look at any line, copy four things onto your sheet: the person's code, the question number, whether the question is labelled relevant or control, and the file name of the chart. Then check that ID against the record list for that person. This packet labels two different items as "Relevant Question 4" for the

same person, so if you find a repeated label, name your two sheets 4a and 4b and write "packet label repeated" beside both. You are done with this step when: four ID fields are filled in, and any repeated label is flagged in writing.

2. Cover the trace and read both axes. Lay the index card over the plotted line so you can see the axis numbers and nothing else. For each of the two panels, write down the channel name, the units, the bottom number of the y axis, the top number, and how many gridline spaces run between them. Then write the x axis, which is time in seconds from 0 to 40, and the sample spacing, which is one reading per second. Each panel was scaled on its own, so the two y ranges will usually be different, and the range for the same channel will usually be different on the next chart too. You are done with this step when: both panels have a written y range in bpm on your sheet, and you have not yet looked at the shape of either line.

3. Check the record is possible. Slide the card off and look at the whole record once, checking physiology rather than meaning. Refuse the record if the respiration rate starts at 0 bpm and climbs in a straight line, if a channel is a perfectly flat line, if a trace is pinned along the top of the panel, if there is one spike far outside the human range, or if a block of samples is missing. A respiration rate of 0 bpm on the same page as a beating heart describes a person who was not breathing, which is a problem with the chart and tells you nothing about the person. You are done with this step when: the word "measurable" or "refused" is on your sheet, with the artefact named if you refused it.

4. Lock your two windows. Write both windows on your sheet before you measure a single value. The baseline window is the three readings at 0 s, 1 s, and 2 s, which are the readings before the Answered marker at 2.5 s. The response window is 3 s to 18 s. Use these same two windows on every record for the rest of the unit, including the records that come out the way you did not expect. You are done with this step when: "baseline 0 to 2 s" and "response 3 to 18 s" are written in pencil on your sheet, and no measurement has been taken yet.

5. Measure the baseline. Measure the panel height in millimetres from the bottom line to the top line. Divide the y range in bpm by that height in millimetres to get bpm per millimetre, and write that number down. Then measure how high the line sits above the bottom at 0 s, at 1 s, and at 2 s, convert each to bpm, and average the three. Write the answer to one decimal place with "bpm" after it. You are done with this step when: one baseline value with bpm units is written for each of the two channels.

6. Find the peak inside the window. Put your pencil tip on the trace at 3 s and slide it right along the line to 18 s without lifting it off the page. Stop at the highest point of the line inside that stretch and mark it. Read its height in millimetres, convert to bpm using the same bpm per millimetre from step 5, and write down the time in seconds where the peak sat. You are done with this step when: a peak value in bpm and a peak time in seconds are written for each channel, and each peak time falls between 3 s and 18 s.

7. Compute the change with units. Subtract the baseline from the peak for each channel. Write the answer as a signed number with units, such as "+14.7 bpm". Do not write "big", "a jump", or "a spike", because none of those can be compared to anything. If the line dipped below the baseline before it rose, write the size of the dip in your notes column as an observation and leave the score as the peak, because peak is the rule you locked in step 4. You are done with this step when: two signed change values with bpm units are written, one per channel.

8. Compare relevant to control on one scale. Put the relevant record and a control record for the same person side by side. Ignore how tall the two lines look on the page. Each panel was autoscaled on its own, so a smaller change on a tighter axis can be drawn taller than a larger change on a wider axis. Compare only the change values you computed in bpm, and write the difference between the two changes as one signed number with units. You are done with this step when: both y ranges, both changes in bpm, and the difference between the changes are all written down with units.

9. State what the number does and does not support. Write one sentence reporting the change in bpm, the baseline it came from, and the window it was measured in. Then write a second sentence naming at least two things other than deception that could produce a change that size, for example the question itself was alarming, the person shifted in the chair, the room was cold, or the person was already anxious before the question was asked. A change in heart rate is a change in heart rate, and that is the whole finding. You are done with this step when: both sentences are written, and neither one contains the words lie, lying, deception, or guilty.

Worked example, done all the way through

I started with a different record and threw it out in about fifteen seconds. Its respiration panel began at 0 bpm at time 0 and climbed in a straight line for the first ten seconds, while the heart rate panel showed a steady 70 bpm the whole time. A person whose heart is beating is breathing. I wrote "refused, respiration ramps from zero, physiologically impossible" and moved on without measuring anything. There is nothing to score on a record that could not have been produced by a living person.

The record I did score was labelled "Relevant Question 4" for person B. Checking the record list, a second and different item carried the same label. I named them R-4a and R-4b, wrote "packet label repeated" on both sheets, and scored R-4a.

I covered the trace and read the axes first. Heart rate panel: bottom 68 bpm, top 89 bpm, six gridline spaces. Respiration panel: bottom 9 bpm, top 21 bpm, six gridline spaces. Time axis 0 to 40 s, one reading per second. Then I pulled up the control record C-4 for the same person and read its axes the same way. Its heart rate panel ran 67 bpm to 82 bpm. Two heart rate panels, two different ranges, on the same person.

Neither record showed an artefact, so both were measurable.

I wrote my windows down before measuring: baseline 0 to 2 s, response 3 to 18 s.

R-4a, heart rate. The panel measured 60 mm tall. The range was 89 minus 68, which is 21 bpm, so 21 divided by 60 gives 0.35 bpm per millimetre. Baseline readings sat 9 mm, 8 mm, and 10 mm above the bottom line, which converts to 71.2, 70.8, and 71.5 bpm. Average baseline 71.2 bpm. Sliding from 3 s to 18 s, the highest point sat at 6 s, 51 mm above the bottom, which is 85.9 bpm. Change +14.7 bpm.

C-4, heart rate. Same panel height, 60 mm. Range 82 minus 67, which is 15 bpm, so 0.25 bpm per millimetre. Baseline readings 10 mm, 9 mm, and 11 mm above the bottom, which is 69.5, 69.25, and 69.75 bpm. Average baseline 69.5 bpm. Peak at 8 s, 50 mm above the bottom, which is 79.5 bpm. Change +10.0 bpm.

That is the part worth stopping on. On the page, the R-4a peak sits 51 mm up and the C-4 peak sits 50 mm up. One millimetre apart. If I had compared the shapes I would have written "about the same". In bpm they are 14.7 and 10.0, a difference of 4.7 bpm, because the two panels were autoscaled and one millimetre is worth 0.35 bpm on one chart and 0.25 bpm on the other.

R-4a, respiration rate. This is where I actually got stuck. Range 21 minus 9, which is 12 bpm over 60 mm, so 0.2 bpm per millimetre. Baseline readings 26 mm, 27 mm, and 26 mm, which is 14.2, 14.4, and 14.2 bpm. Average baseline 14.3 bpm. Then the line did two things. It dropped to 10.5 bpm at 5 s, which is 3.8 bpm below baseline, and then it rose to 18.6 bpm at 10 s, which is 4.3 bpm above baseline. Both are inside the response window and both are real movement in the trace.

I did not know which one was "the change". The dip felt like the bigger event because it was so abrupt, and I wanted to score it. I went back to step 4 and read my own handwriting. My rule said peak, and peak means the highest value inside the window. So the score is +4.3 bpm and the dip is an observation. I wrote "dip to 10.5 bpm at

5 s, 3.8 bpm below baseline, not scored under the locked rule" in the notes column. I also wrote one line for myself: a rule that only takes the maximum throws away the dip, which is a limit of the rule I chose and not a discovery about person B. Had I switched to scoring the dip after seeing that it was larger, I would have picked the rule that gave me the answer I wanted.

What I reported. On R-4a, heart rate rose 14.7 bpm from a baseline of 71.2 bpm to a peak of 85.9 bpm at 6 s, and respiration rate rose 4.3 bpm from a baseline of 14.3 bpm to a peak of 18.6 bpm at 10 s. On C-4, heart rate rose 10.0 bpm from a baseline of 69.5 bpm to a peak of 79.5 bpm at 8 s. The heart rate change on R-4a was 4.7 bpm larger than on C-4.

That is the finding. Person B's heart rate rose more after one question than after another. Person B may have found the question alarming, may have shifted in the chair, may have already been anxious about being tested at all, or may simply have been asked a question about a dead friend. My measurement cannot separate those, and no rule in this unit is built to.

How to write your conclusion

Fill in one of these three. Use the same words every time.

1. "On record _____, _____ rate rose _____ bpm, from a baseline of _____ bpm measured across 0 to 2 s to a peak of _____ bpm at _____ s, inside the 3 to 18 s response window."
2. "Comparing on the same units, the change on relevant question _____ was _____ bpm and the change on control question _____ was _____ bpm, a difference of _____ bpm. The relevant panel ran _____ to _____ bpm and the control panel ran _____ to _____ bpm, so the two lines cannot be compared by shape."
3. "Record _____ is refused and not scored, because _____. No baseline, peak, or change is reported for this record."

Two sentences to never write:

"**His heart rate jumped on Relevant Question 2, so he was lying about the money.**" This is a deception claim, and the chart cannot carry it. The record holds beats per minute and breaths per minute over forty seconds. Nothing in it separates a person who is lying from a person who is frightened, angry, embarrassed, cold, or startled by the question. The National Research Council reviewed polygraph research and reported that at roughly a 10 percent false-positive rate, the share of deceptive people correctly flagged ran from 43 percent to 100 percent across the selected studies in that review (NRC-2003). Those values are specific to those studies. They are not a percent-correct figure for this classroom packet, and they do not give the chance that one person is lying.

"**The relevant chart has a much bigger spike than the control chart.**" This compares two shapes drawn on two different y axes. In the worked example the two peaks sat one millimetre apart on the page while the actual changes were 14.7 bpm and 10.0 bpm, because one panel was worth 0.35 bpm per millimetre and the other was worth 0.25. A sentence about a shape says nothing until both charts have been read in bpm. Also, "bigger spike" cannot be checked by anyone else, and a number can.

The three mistakes that cost people most

Comparing shapes across differently scaled axes. Every panel in this packet is autoscaled on its own, so the software picks a y range that makes each line fill its box. Two charts side by side almost never share a y range, which means the taller-looking line is regularly the smaller change. The fix takes ten seconds. Cover the trace, write

both y ranges in bpm, compute bpm per millimetre for each panel, and then compare only the change values in bpm. If you cannot state both y ranges from memory, you are not ready to say which change was larger.

Scoring an artefact record instead of refusing it. The first question about a record is whether it can be measured at all, and the second question is what it means. Taking them in that order matters, because the measuring steps work perfectly well on impossible data and will hand you a confident baseline and a confident peak from a trace that no living person produced. The packet contains a real example, a respiration rate that ramps up in a straight line from 0 bpm while the heart rate panel shows a beating heart. Refuse it, name the artefact, and report no numbers. A refusal is a result, and it is worth more than a number that came from a broken record.

Sliding from "his heart rate rose" to "he was lying". This slide happens in the space of one sentence and it is easy to miss in your own writing. You measure a real change, you report it accurately, and then the next sentence quietly swaps the physiological finding for a claim about honesty. Read your conclusion back and check every noun. If the words lie, lying, deception, guilty, or nervous-because appear anywhere, delete that sentence and write the measurement again. The chart records breathing and heartbeat. Getting from breathing and heartbeat to what somebody knew requires evidence this instrument does not collect.