Formula Sheet

Mean • median • SD • Q1 • Q3 • IQR • fences • outliers • graphs

Start: 2. Stats: 1, 3. Dots: 4. Table: 5, 6. Words: 7. Frequency: 8, 9. Sampling: 10 to 12. Help: 13.
Paper Q3 example. Each answer feeds the next: quartiles → IQR → fences → outliers → boxplot.

Mean = average

Σ means add; n is the count. Here n = 29 and the values add to 784.

$$\bar{x} = \frac{\Sigma x}{n} = 784 \div 29 \approx 27.03$$

Sample standard deviation: s

Use the unrounded mean. Subtract it from each value, square, add, divide by n − 1, then take the square root.

$$s = \sqrt{\left(\frac{\Sigma(x - \bar{x})^2}{n - 1}\right)}$$

For x = 10: $(10 - 27.03448276\ldots)^2 \approx 290.17$. All 29 squared differences add to 1658.965517...
$s \approx \sqrt{(1658.965517\ldots \div 28)} \approx$ **7.70**.

Median and quartiles Q1, Q3

Sort low to high. Odd n: position (n + 1) ÷ 2. Here (29 + 1) ÷ 2 = 15; median = **26**. Even n: average the two middle values. When n is odd, leave the middle value out of the halves.

Q1 is the 25% mark; Q3 is the 75% mark.

Lower half: 10, 18, 18, 19, 21, 21, **21, 22**, 22, 22, 23, 23, 26, 26.
Q1 = (21 + 22) ÷ 2 = **21.5**.

Upper half: 27, 27, 28, 29, 29, 30, **31, 32**, 36, 36, 39, 40, 41, 41.
Q3 = (31 + 32) ÷ 2 = **31.5**.

IQR = Q3 − Q1

Q3 − Q1 = 31.5 − 21.5 = **10**

IQR means interquartile range: the width of the middle 50%. Subtract the lower quartile Q1 from the upper quartile Q3. Use 10 below.

Ordinary fences: outlier boundaries

Lower = Q1 − 1.5 × IQR
= 21.5 − 1.5 × 10 = **6.5**.
Upper = Q3 + 1.5 × IQR
= 31.5 + 1.5 × 10 = **46.5**.

Extreme fences

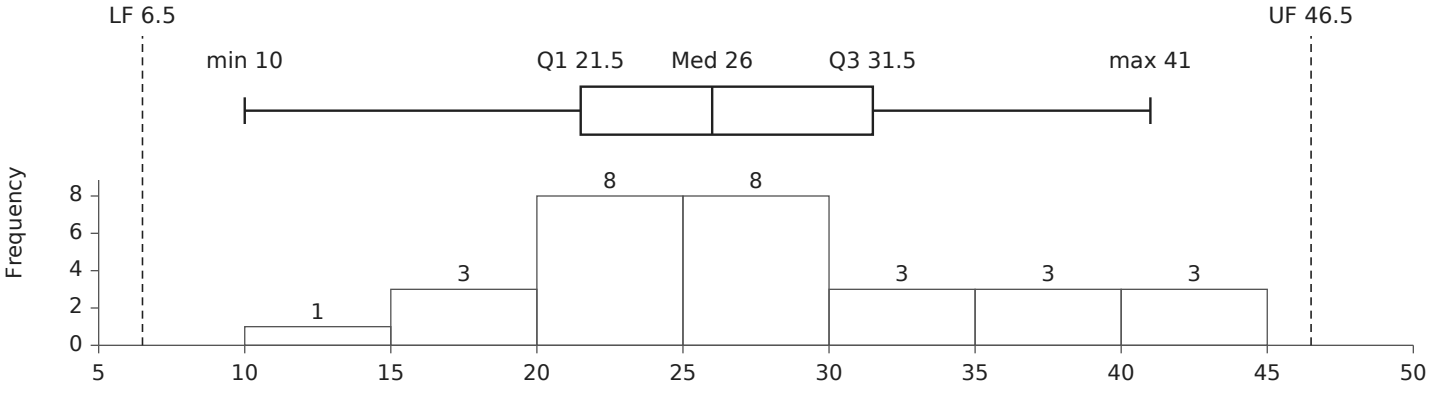
Lower = Q1 − 3 × IQR
= 21.5 − 3 × 10 = **−8.5**.
Upper = Q3 + 3 × IQR
= 31.5 + 3 × 10 = **61.5**.

Outliers and whiskers

Outside an ordinary fence: outlier. Outside an extreme fence: extreme outlier. Values exactly on a fence are not beyond it. Here 10 to 41 is within 6.5 to 46.5: **no outliers or extreme outliers**.

Five numbers: **10, 21.5, 26, 31.5, 41**.
Box: Q1 to Q3, line at the median. Whiskers stop at actual values that are not outliers: 10 and 41. Fences are cutoffs, not whiskers.

Boxplot and histogram: one shared horizontal scale



The boxplot is placed above the bars; its height does not represent frequency.

Formula Sheet

Start here • find the question • find the keys • know what to write

Match the format and question words in the table: raw list, category table, classes with counts, or a probability about a sample average.
A comma between keys means press them one at a time. 2ND, 1 means press 2ND, then 1.



Official TI84 Evo keypad. Look for the printed key names and the small labels above them.

Blue function: press **2ND**, then its key.
Green function: press **ALPHA**, then its key.
The negative **(−)** key is on the bottom row.
Subtraction **−** is in the right column.

1 Start in Calculator

Press the bottom left **ON / house** key for the Home apps. Use the arrow keys to highlight **Calculator**, then ENTER.
If the MIDTERM guide is running, 9 exits its guide menu; then 2ND, MODE, YES returns out of Python. Choose Calculator.

2 Match the words in the question

Question asks for…	Use these pages
Raw list: mean, median, SD, quartiles, boxplot	Formula 1; keys 3
Construct a dot plot	Drawing and count 4
Category table: AND, OR, GIVEN probability	Formula 5; keys 6
Meaning of >, ≥, <, ≤, between	Words and examples 7
Classes + counts: grouped mean, percent, histogram	Formula 8; keys 9
Sampling method, bias, improve survey	Reasoning 10
Given μ, σ, n: probability for a sample average	Formula 11; keys 12
Wrong screen, plot icon, graph window	Screen help 13

3 Read the key instructions

2ND, MODE = QUIT back to Calculator.
2ND, 1 inserts L1; **2ND, 2** inserts L2.
2ND, Y= opens the plot settings.
ALPHA, STAT opens DISTR.
2ND, x² gives √. **2ND, comma** gives EE.
A **field** is the place on screen where you enter a value. Arrows move the cursor/highlight.

For every answer:
words → formula → your numbers → keys → check → answer.
Σ means add. n means how many. Round at the end. Follow a question's rounding instructions.

Keypad image: Texas Instruments.

TI84 Evo Calculator Method

Mean • median • SD • Q1 • Q3 • IQR • fences • boxplot • histogram

Fresh start: open Calculator. If MIDTERM is open: 9, then 2ND, MODE, choose YES; select Calculator, ENTER. This page uses individual observations: FREQLIST is blank in Stats; FREQ is 1 in Plot1.

1 Enter all 29 values in L1

STAT, 1: Edit. UP until L1 itself is highlighted. CLEAR, ENTER. DOWN to the first cell. Type one value, ENTER; repeat. Keep every repeat. Save any list data you still need first.

26, 26, 36, 26, 18, 27, 23, 27, 28, 18,
29, 39, 29, 19, 36, 40, 30, 10, 21, 41,
31, 21, 22, 22, 32, 22, 23, 41, 21

2 Run 1-Var Stats

STAT → RIGHT to CALC → 1: 1-Var Stats.
LIST = L1: press 2ND, 1.
FREQLIST must be blank. If it contains L2, move to that field; CLEAR, ENTER.
Press ZOOM to CALCULATE.

Check n = **29**. Scroll DOWN.
$\bar{x}$ = mean ≈ **27.03**
Sx = sample SD ≈ **7.70**
minX **10** • Q1 **21.5** • Med **26**
Q3 **31.5** • maxX **41**

New question: enter its own values and check n = its count. Use Sx for sample SD. Keep full digits; round the final answer.

3 IQR and all four fences

2ND, MODE (QUIT), CLEAR. Type each expression, then ENTER:

IQR: 31.5 − 21.5 → **10**
Lower: 21.5 − 1.5 × 10 → **6.5**
Upper: 31.5 + 1.5 × 10 → **46.5**
Extreme lower: 21.5 − 3 × 10 → **−8.5**
Extreme upper: 31.5 + 3 × 10 → **61.5**

4 Prepare a clean graph

2ND, Y= opens the plot menu. Choose Plot2, select OFF, ENTER. Repeat for Plot3. Press Y=; highlight any selected = sign and press ENTER to turn that function off. This hides its line without erasing it.

5 Boxplot

2ND, Y= → 1: Plot1.
Choose ON, ENTER.
At TYPE choose the box icon with separate outlier dots, ENTER.
XLIST = L1 (2ND, 1). FREQ = 1.
Icon picture: page 13. ZOOM → 9: ZoomStat.

Use TRACE and LEFT or RIGHT to read **10, 21.5, 26, 31.5, 41**.
Add the fences at 6.5 and 46.5 on your paper. They are not the whisker endpoints.

6 Histogram

2ND, Y= → 1: Plot1.
Choose ON. At TYPE select bars, ENTER.
XLIST = L1. FREQ = 1.
Press WINDOW and enter:

Xmin **10** • Xmax **45** • Xscl **5**
Ymin **0** • Ymax **9** • Yscl **1**

These bins are for the 29 values above. For new data use page 13. GRAPH, then TRACE: **1, 3, 8, 8, 3, 3, 3**. The counts add to 29.

7 What to draw and write

Use a shared horizontal scale from 5 to 50 for the histogram and boxplot. Mark fences at 6.5 and 46.5.
“No values are outside the fences, so there are no outliers or extreme outliers.”

Histogram: slight right skew. 16 values are from 20 to under 30. The low value 10 lengthens the left whisker. Compare both graphs.

Formula Sheet

Dot plot • one dot per value • count repeats • check the total

Question words: “Construct a dot plot of the data.” Paper Q5 supplies the list below. No probability formula is needed.
An observation is one recorded value. A frequency is how often that value appears.

Hand method: draw the data

0, 1, 1, 2, 2, 2, 3, 3, 4, 4,
5, 5, 5, 5, 6, 6, 7, 9, 12, 15

1. Draw a number line from the smallest value, 0, to the largest, 15. Mark every whole number with equal spacing.
2. Read the list one value at a time. Place a dot above its number.
3. When a value repeats, stack a new dot directly above the previous one.
4. Count all dots. There must be **20**.

For 5, there are four observations: 5, 5, 5, 5. Draw **four dots above 5**. Empty values still get number line marks.

Calculator method: check the count

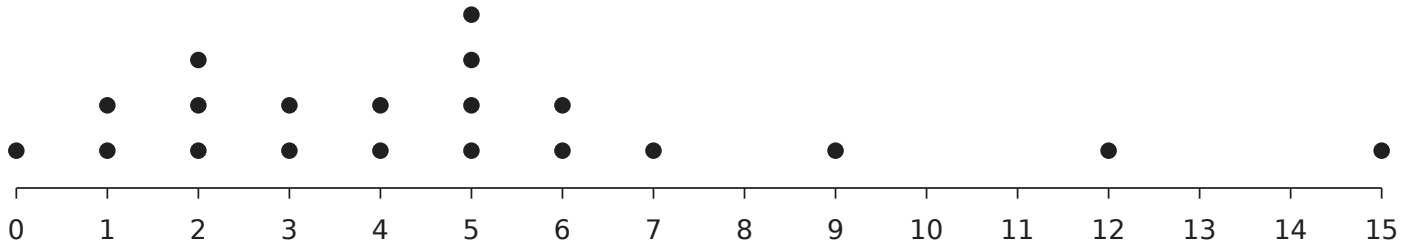
1. Start in Calculator (page 2). STAT, 1: Edit. UP to the L1 heading; CLEAR, ENTER. DOWN to the first cell.
2. Enter the 20 values at left, each followed by ENTER.
3. STAT → RIGHT to CALC → 1: 1-Var Stats. LIST = L1 (2ND, 1). FREQLIST blank; clear an old L2 from that field.
4. ZOOM to CALCULATE. Read **n = 20**.

The calculator checks how many values you entered. You draw the dot plot on paper. It is not the boxplot icon or the histogram icon.

Check the frequencies

0:1, 1:2, 2:3, 3:2, 4:2, 5:4,
6:2, 7:1, 9:1, 12:1, 15:1.
The counts add to **20**.

New question: replace the list. Use its smallest and largest values and check that dots = number of observations.



Leave 8, 10, 11, 13 and 14 empty. The values stretch farther to the right, toward 15, so this plot is skewed right. For a new graph, describe the direction of its longer tail.

Formula Sheet

Two way table • AND • OR • GIVEN • independent or dependent

Paper Q1. P means probability (chance); | means GIVEN. Top of a fraction = wanted count; bottom = group total. GIVEN female: circle the entire Female row horizontally (across). Its total 450 becomes the denominator.

Gender	Increasing	Same	Decreasing	Not sure	Total
Male	175	185	51	39	450
Female	209	154	37	50	450
Total	384	339	88	89	900

Rows and columns add to their totals. Missing cell = total − the other entries.
Male Same: 339 − 154 = 185. Female Decreasing: 88 − 51 = 37. Grand total: 900.

b One group: “not sure”

$$P(A) = \frac{\text{wanted count}}{\text{grand total}}$$

$$P(\text{not sure}) = \frac{89}{900} \approx 0.0989$$

c AND: male and same

Use the shared cell where the male row meets the Same column. One person must satisfy both descriptions.

$$P(\text{male AND same}) = \frac{185}{900} \approx 0.2056$$

d OR: increasing or decreasing

Add both totals; subtract the overlap.
P(A OR B) = P(A) + P(B) − P(A AND B). The overlap is 0: nobody chose both answers.

$$P = \frac{384 + 88 - 0}{900} \approx 0.5244$$

e OR: female or increasing

Female total 450; Increasing total 384. The shared cell 209 was counted twice, so subtract it once.

$$P = \frac{450 + 384 - 209}{900} \approx 0.6944$$

GIVEN: first find the group

Underline the group after GIVEN. In P(A | B), A is wanted and B is given. B’s total goes on the bottom.

Formula: P(A | B) =
shared count ÷ given group total.

P(increasing | female)
= 209 ÷ 450 ≈ **0.4644**.
Circle the whole Female row across.
Total **450** is on the bottom; within that row, Increasing = **209**.

Reverse the wording:
P(female | increasing) = 209 ÷ 384
≈ **0.5443**. Circle the whole Increasing column up and down. Total **384** is on the bottom. See page 6.

Independent or dependent?

Keep the same A. Compare P(A | B) with P(A) using exact values.
Equal: independent. Different: dependent.

P(increasing | female) = 209/450
P(increasing) = 384/900
209/450 ≠ 384/900: **dependent**.

Other GIVEN wording: “among females,” “of the females,” or “if the person is female.” All restrict you to the Female row: denominator 450.

TI84 Evo Calculator Method

Two way table probability • AND • OR • GIVEN • independence

Start fresh in Calculator. If MIDTERM is open: 9, then 2ND, MODE, YES; select Calculator, ENTER.
Press 2ND, MODE (QUIT), CLEAR. Type each expression below, then ENTER. No STAT menu is needed.

Gender	Increasing	Same	Decreasing	Not sure	Total
Male	175	185	51	39	450
Female	209	154	37	50	450
Total	384	339	88	89	900

GIVEN Increasing: circle its whole column vertically (up and down). Total **384** is the denominator; Female within that column is **209**. Compare the horizontal Female row on page 5.

b Probability of “not sure”

Wanted column total = 89.
Whole table total = 900.

89 ÷ 900, ENTER
0.0988888889… → **0.0989**

c Male AND same

Find the shared cell: male row, Same column = 185. Divide by everyone.

185 ÷ 900, ENTER
0.2055555556… → **0.2056**

d Increasing OR decreasing

Increasing 384 + Decreasing 88.
Overlap 0. Keep the parentheses.

(384 + 88 − 0) ÷ 900, ENTER
472 ÷ 900 ≈ **0.5244**

e Female OR increasing

Female 450 + Increasing 384.
Subtract their overlap: 209.

(450 + 384 − 209) ÷ 900, ENTER
625 ÷ 900 ≈ **0.6944**

Always put the whole numerator in parentheses when it contains more than one operation. Round only the final answer.

GIVEN: increasing given female

Underline GIVEN female. Circle the whole Female row horizontally. Total 450 goes on the bottom; Increasing within it is 209.

209 ÷ 450, ENTER
0.4644444444… → **0.4644**

GIVEN increasing: circle the whole Increasing column vertically, as above. Total 384 goes on the bottom. The Female cell is still 209.

209 ÷ 384, ENTER
0.5442708333… → **0.5443**

Independent or dependent?

A = Increasing. Keep that same event for both calculations:

GIVEN female: 209 ÷ 450, ENTER
≈ **0.4644444444…**
Overall: 384 ÷ 900, ENTER
≈ **0.4266666667…**

The exact probabilities differ, so write:
“Increasing and Female are **dependent**.”
Do not compare P(increasing | female) with P(female).

Check the denominator first

Use your question’s grand total for AND/OR.
For GIVEN, use its group total.
New table: replace these counts.

Formula Sheet

Read the question • translate the words • choose the right group

These four new practice wordings use the 29 actual pet food values in paper Q3, within the original graph topic. X stands for one data value. Count observations, keeping repeats. These are not extra midterm topics.

Words → symbols

> means greater than
More than, higher than, bigger than, taller than, faster than, above.
X > 30: do not include 30.

≥ means greater than or equal to
At least, no less than.
X ≥ 30: include 30.

< means less than
Smaller than, slower than, below, under.
X < 30: do not include 30.

≤ means less than or equal to
No more than, at most.
X ≤ 21: include 21.

How to read “between”

20 < X < 30: greater than 20 AND less than 30. Leave both endpoints out.
20 ≤ X ≤ 30: include both endpoints.
20 ≤ X < 30: include 20, leave 30 out.

“Between” alone can be unclear about the endpoints. Follow the question’s signs or stated inclusion. Histogram bins here include the left edge and exclude the right edge.

X is the value, not a sign for “between.” Read the whole expression. The symbol × means multiply: 1.5 × IQR.

1 More than

English: “How many pet food values are more than 30?”
Symbols: count X > 30.
Work: 31, 32, 36, 36, 39, 40, 41, 41.
Answer: 8 values. Leave out 30.

2 At least

English: “How many pet food values are at least 30?”
Symbols: count X ≥ 30.
Work: 30, 31, 32, 36, 36, 39, 40, 41, 41.
Answer: 9 values. Include 30.

3 At most / no more than

English: “How many pet food values are no more than 21?”
Symbols: count X ≤ 21.
Work: 10, 18, 18, 19, 21, 21, 21.
Answer: 7 values. Include every 21.

4 Between, with clear endpoints

English: “How many pet food values are between 20 and 30, including 20 but excluding 30?”
Symbols: count 20 ≤ X < 30.
Work: add the histogram bars from 20 to under 25 and 25 to under 30.
8 + 8 = **16 values**.

Graph or original list?

A bar counts its whole interval. If a question cuts through a bar, use the original values. For X ≤ 21, the 20 to under 25 bar also contains 22s and 23s; do not count that whole bar.

For X ≥ 30, add the last three bars: 3 + 3 + 3 = 9. For X > 30, subtract the one value equal to 30: 9 − 1 = 8.

Formula Sheet

Frequency • midpoint • boundaries • percent • grouped mean

f = count in a class; x = class midpoint; Σf = total count; Σ(x × f) = sum of midpoint times frequency.
For classes recorded in whole numbers, subtract 0.5 from the lower limit and add 0.5 to the upper limit.

$$\text{Midpoint } x = \frac{\text{lower limit} + \text{upper limit}}{2}$$

$$\text{Relative frequency} = \frac{f}{\Sigma f}$$

Class 43 to 51: (43 + 51) ÷ 2 = **47**.
Boundaries: **42.5 to 51.5**.

Percent = (f ÷ Σf) × 100.
(4 ÷ 60) × 100 ≈ **6.67%**.

Notebook class	Boundaries	x	f	x × f	Percent
34 to 42	33.5 to 42.5	38	2	76	3.33%
43 to 51	42.5 to 51.5	47	4	188	6.67%
52 to 60	51.5 to 60.5	56	7	392	11.67%
61 to 69	60.5 to 69.5	65	8	520	13.33%
70 to 78	69.5 to 78.5	74	14	1036	23.33%
79 to 87	78.5 to 87.5	83	10	830	16.67%
88 to 96	87.5 to 96.5	92	15	1380	25.00%
Total			60	4422	100%

Estimated mean $\bar{x} \approx \Sigma(x \times f) \div \Sigma f = 4422 \div 60 =$ **73.7**.
Histogram: horizontal axis is class boundaries, vertical axis is frequency. Touching bars have heights **2, 4, 7, 8, 14, 10, 15**.

Paper Q6: confirm the repeated class

15 to 17 is printed twice, and 2 to 5 is wider than later classes. The table below keeps both printed rows; its totals are conditional on both rows counting.

Class	f	x	x × f	Percent
2 to 5	1	3.5	3.5	3.57%
6 to 8	6	7	42	21.43%
9 to 11	10	10	100	35.71%
12 to 14	7	13	91	25.00%
15 to 17	2	16	32	7.14%
15 to 17	2	16	32	7.14%

If both rows count: Σf = 28; Σ(x × f) = 300.5; mean ≈ **10.73**.
First row boundaries: 1.5 to 5.5. Next: 5.5 to 8.5.
Confirm the source before using a corrected table.

What each number means

x in this table means the class midpoint. It is not $\bar{x}$, the average.
f is the count in that class.
x × f means midpoint times count.
Σf adds the counts; **Σ(x × f)** adds the products.

Your class: ____ to ____
Midpoint = (____ + ____) ÷ 2
Lower boundary = ____ − 0.5
Upper boundary = ____ + 0.5
Percent = (f ____ ÷ total ____) × 100

Use the same formula on new numbers

Tested practice class 10 to 19, f = 2, total = 10:
Midpoint = (10 + 19) ÷ 2 = **14.5**.
Boundaries = **9.5 to 19.5**.
x × f = 14.5 × 2 = **29**.
Percent = (2 ÷ 10) × 100 = **20%**.

TI84 Evo Calculator Method

Frequency table • grouped mean • histogram

Fresh start: open Calculator. If MIDTERM is open: 9, then 2ND, MODE, YES; select Calculator, ENTER.
Table with counts: LIST = L1, FREQLIST = L2. For its graph, XLIST = L1 and FREQ = L2.

1 One class: calculator arithmetic

For notebook class 43 to 51, f = 4 and total f = 60: 2ND, MODE (QUIT), CLEAR. Type each expression, then ENTER.

(43 + 51) ÷ 2 → midpoint **47**
43 − 0.5 → lower boundary **42.5**
51 + 0.5 → upper boundary **51.5**
4 ÷ 60 → relative frequency **0.0667…**
(4 ÷ 60) × 100 → **6.67%**

2 Enter the notebook table

STAT, 1: Edit. At L1 heading: CLEAR, ENTER. DOWN; enter all midpoints in L1. UP to its heading, RIGHT to L2 heading: CLEAR, ENTER. DOWN; enter the matching counts in L2, in the same order.

L1 midpoint	L2 frequency
38	2
47	4
56	7
65	8
74	14
83	10
92	15

3 Weighted 1-Var Stats

STAT → RIGHT to CALC → 1: 1-Var Stats.
LIST = L1 (2ND, 1).
FREQLIST = L2 (2ND, 2).
Press ZOOM to CALCULATE.

$\bar{x}$ = estimated mean **73.7**
n = total frequency **60**

Blank FREQLIST would count only the seven midpoints. L2 tells the calculator how many observations each midpoint represents.

4 Prepare the histogram

2ND, Y=: Plot2 OFF, Plot3 OFF. In Y=, highlight selected = signs and ENTER to hide functions.
2ND, Y= → Plot1. Choose ON. At TYPE select bars, ENTER.
XLIST = L1. FREQ = L2.
Icon picture and recovery: page 13.

5 Choose a window for your classes

Field	What goes there
Xmin	First lower class boundary
Xmax	Last upper class boundary
Xscl	Class width, for equal width classes
Ymin	0
Ymax	A little above the largest count
Yscl	Step between vertical scale marks

Notebook classes 34 to 96:
Xmin **33.5** • Xmax **96.5** • Xscl **9**
Ymin **0** • Ymax **16** • Yscl **2**

WINDOW, enter these values, then GRAPH.
TRACE counts: **2, 4, 7, 8, 14, 10, 15**.
These add to 60. ZoomStat can change the bin settings, so keep your chosen window.

6 New classes need new settings

Tested practice: 10 to 19, 20 to 29, 30 to 39, 40 to 49; counts 2, 4, 3, 1.

Xmin **9.5** • Xmax **49.5** • Xscl **10**
Ymin **0** • Ymax **5** • Yscl **1**
GRAPH; TRACE counts **2, 4, 3, 1**.

Do not copy the notebook's 33.5 to 96.5 window into this new question: it misses classes. For unequal class widths, draw the stated intervals separately; a fixed bin width cannot match them all.

Formula Sheet

Sampling methods • clue words • possible bias • a fairer selection

Paper Q4 and the survey paragraph in Q5. No calculator is needed.
For each scenario, write three parts: the method, a possible bias, and an improvement.

Question clue	Method	What it means
Random names from everyone	Simple random	Individuals chosen by chance
Some from each group	Stratified	Sample within every group
Every 20th person	Systematic	Use a fixed interval
Selected whole rooms	Cluster	Survey everyone in chosen rooms
Easy to reach people	Convenience	Use whoever is nearby
People choose to return it	Voluntary response	People select themselves

Q4a “20 students are selected from each grade”

Method: Stratified.
Possible bias: The paper does not say how the 20 are chosen. Equal numbers can overrepresent a smaller grade.
Improve: Choose randomly within each grade, in proportion to the grade’s size.

Q4b “Every 20th person” at the front doors

Method: Systematic.
Possible bias: Could miss other entrances or times, depending on when and where the survey is taken.
Improve: Use the full student list, choose a random starting point, then take every 20th name.

Q4c “Eight homerooms are selected”

Method: Cluster, if everyone in the selected rooms is asked.
Possible bias: The room selection method is not stated. Unrepresentative rooms could distort the results.
Improve: Choose rooms randomly and survey everyone in them; otherwise more selection details are needed.

Q4d Surveys handed out in the cafeteria

Method: Convenience.
Possible bias: Students who are not in the cafeteria are missed.
Improve: Select randomly from the full student list instead.

Q5 Students choose whether to return a survey

Method: Voluntary response.
Possible bias: Strong opinions may be more likely to be returned.
Improve: Choose students randomly, ask them directly, and follow up with nonresponders.

Sampling methods and bias describe selection. For the sampling distribution of a sample mean, use the added formulas and calculator method on pages 11 and 12.

Formula Sheet

Sampling distribution of a mean • standard error • z • normal probability

Added study coverage requested after comparing the whiteboard and paper. This new practice story is not an original paper question.
Think: take a sample, find its average, repeat with new samples of the same size. The averages form a distribution.

1 Spot "average of a sample"

Underline mean or average of n people. This asks about $\bar{x}$ (x bar), a group average, rather than X, one person's value.

> One person: **X**, use population SD **σ**.
> Average of n people: $\bar{x}$, use **σ ÷ √n**.

2 Read the symbols

μ (mu): population mean.
σ (sigma): population SD, given in the question.
n: people in each sample.
$\bar{x}$: the sample's average.
SE: standard error, the SD of the sample averages. It is not a mistake.

3 Write the formulas

> Mean of sample averages = **μ**.
> The center stays the same.

$$SE = \frac{\sigma}{\sqrt{n}} = 12 \div \sqrt{16} = 3$$

$$z = \frac{\bar{x} - \mu}{SE} = (56 - 50) \div 3 = 2$$

For 47: $z = (47 - 50) \div 3 = \mathbf{-1}$.
z tells how many standard errors the cutoff is above or below the mean.

4 When can I use a normal curve?

Use random, independent observations. If the population is normal, its sample mean is normal for any n. Otherwise the central limit theorem gives an approximate normal shape for sufficiently large n.

n ≥ 30 is a common class guideline; strong skew or outliers can need more. For sampling without replacement, n ≤ 10% of the population is a common independence check.

Practice story: measurement averages

Suppose measurements are normal, with population mean **μ = 50** and population SD **σ = 12**. Randomly sample **n = 16** independent observations.

> Mean of the averages = **50**.
> SE = 12 ÷ √16 = 12 ÷ 4
> = **3**.

Translate, sketch, then calculate

"Average is more than 56"
$P(\bar{x} > 56) = P(Z > 2)$
Shade to the right of 56.
Answer ≈ **0.0228 = 2.28%**.

"Average is below 47"
$P(\bar{x} < 47) = P(Z < -1)$
Shade to the left of 47.
Answer ≈ **0.1587 = 15.87%**.

"Average is between 47 and 56"
$P(47 < \bar{x} < 56) = P(-1 < Z < 2)$
Shade between 47 and 56.
Answer ≈ **0.8186 = 81.86%**.

Boundary words still matter

At least 56: $P(\bar{x} \geq 56)$.
At most 47: $P(\bar{x} \leq 47)$.
A continuous normal model assigns probability 0 to exactly one value, so > and ≥ give the same tail area here. Likewise for < and ≤.

> For normal averages, do not subtract 1 from a cutoff. That count adjustment belongs to discrete whole number problems.

If only sample SD s is supplied, the known σ normal recipe here is not automatically justified. Check the question's stated method first.

TI84 Evo Calculator Method

Sampling mean • choose the numbers • choose the bounds • enter • check • answer

Question words: “average of a sample of n.” Use the standard error, not the population SD, in normalcdf.
Worked practice from the physical test: μ = 50, σ = 12, n = 16. Your new question supplies its own values.

1 Write the given numbers first

Population mean μ = **50**
Population SD σ = **12**
Sample size n = **16**

2 Find the standard error

Start in Calculator (page 2). 2ND, MODE (QUIT), CLEAR.
Type **12 ÷ √(16)**, ENTER.
√ is 2ND, x². Close the parenthesis.

SE = 12 ÷ √16 = 12 ÷ 4 = **3**.
Write **3** in the wizard’s σ field.

3 Choose bounds from the words

Words	Lower	Upper
More than / at least a	a	1E99
Below / at most a	−1E99	a
Between a and b	a	b

More than 56: lower **56**, upper **1E99**.
Between 47 and 56: lower **47**, upper **56**.

Your numbers for a new question

μ = ____ • σ = ____ • n = ____
SE = ____ ÷ √____ = ____
Lower = ____ • Upper = ____

Probability formula on the calculator:
normalcdf(lower, upper, μ, SE).
Do not round SE early. For a normal average, do not subtract 1 from a cutoff.

4 Open the normalcdf wizard

ALPHA, STAT opens DISTR.
Highlight **1: Normal**, ENTER.
Highlight **normalcdf(**, ENTER.
Use ENTER or DOWN to move between fields.
Replace all four values for a new question.

5 More than 56: right tail

lower **56** • upper **1E99**
μ **50** • σ **3**
WINDOW or ZOOM for PASTE, then ENTER.

normalcdf(56,1E99,50,3)
Evo display: 0.022750062.
Write **$P(\bar{x} > 56) \approx 0.0228$**.
Percent: unrounded result × 100 ≈ **2.28%**.

6 Between 47 and 56

Open ALPHA, STAT → Normal → normalcdf again.
Replace all four fields:

lower **47** • upper **56**
μ **50** • σ **3**
WINDOW or ZOOM (PASTE), ENTER.

normalcdf(47,56,50,3)
Evo display: 0.8185946784.
Write **$P(47 < \bar{x} < 56) \approx 0.8186$**
= 81.86%.

How to enter the far end bounds

1E99: 1, 2ND, comma (EE), 9, 9.
−1E99: negative (−) first, then the same sequence. Use EE, not the letter E. The negative key is on the bottom row.

These upper and between examples were executed on the physical Evo. The wizard fields are shown on page 13. This is operator verification, not a beginner trial.

Formula Sheet

Screen help • choose the right icon • choose the right fields • recover without a reset

These are actual screens from the five question physical Evo test. The practice values differ from the original paper.
Use the screen to recognize the field you need, then enter your own question's numbers.

Plot TYPE: picture of the box icon



Choose the box with separate dots, not the diagonal line plot. At TYPE, arrows move the blue highlight; ENTER selects the picture. If the fields say YLIST, you are still on a scatter/line type.

The two different frequency settings

Data format	Stats FREQLIST	Plot FREQ
Raw individual values	Blank	1
Midpoints + counts	L2	L2

For raw data: XLIST = L1, FREQ = 1.
For grouped data: XLIST = L1, FREQ = L2. Do not type the letter L then a number; use 2ND, 1 or 2ND, 2.

When SYNTAX points to YLIST

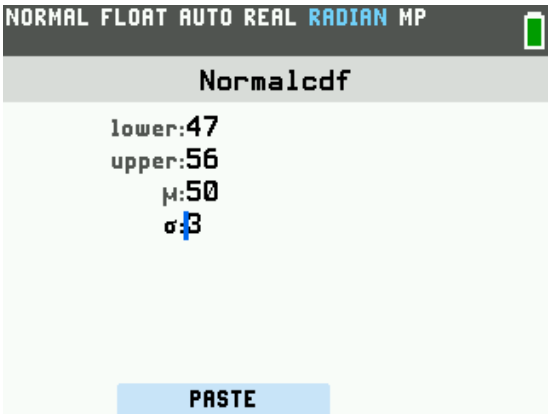
This happened during the test after I chose the wrong plot type and entered 1.
1. Choose **2: Go to** on the error screen.
2. At YLIST, CLEAR, 2ND, 2 inserts valid L2 so you can leave the field.
3. UP to TYPE. Choose the correct box or histogram icon, ENTER.
4. Set XLIST = L1; FREQ = 1 for raw values, or L2 for grouped counts.

A short entry check from your notes

Raw L1 values: **1, 3, 5, 7, 9, 11**.
Use the raw Stats route on page 3.
FREQLIST blank; check **n = 6**.
Sum = 36; mean = 36 ÷ 6 = **6**.

This small list is an entry exercise. For the actual question, replace it with that question's own observations.

normalcdf: what goes in each field



lower = bottom end of the asked interval.
upper = top end.
μ = population mean, 50 here.
σ = standard error, 3 here.
Check all four, then PASTE and ENTER.

New graph or new numbers?

Histogram: first boundary → Xmin; last boundary → Xmax; class width → Xscl. Ymin = 0; choose Ymax above the tallest bar. The old example's numbers are not defaults.

Raw list with no given bins: choose equal intervals covering all values. For 2 to 18, one study choice is width 4 with boundaries 2, 6, 10, 14, 18, 22; counts 3, 3, 2, 0, 1. **Put a boundary value in the bin that starts there:** 6 goes in 6 to under 10. Follow specified class intervals when given.

Boxplot: with the correct raw list and FREQ = 1, ZOOM → 9: ZoomStat fits the values. TRACE reads the five number summary.

Boxplot and histogram on one scale

1. Draw one horizontal value scale, 5 to 50 for paper Q3.
2. Histogram: vertical axis is count. Draw touching width 5 bars, with heights 1, 3, 8, 8, 3, 3, 3.
3. Above the bars draw the box from Q1 21.5 to Q3 31.5. Mark median 26, whiskers 10 and 41.
4. Mark fences 6.5 and 46.5 as separate dashed cutoffs. The finished aligned drawing is on page 1.