MATHS FIELD GUIDE · GRADE 10

Grouped mean: step deviation

OPENING PROBLEM

If h = 10, what is the weighted code total?

Midpoint	10	20	30
Frequency	2	1	3
u with A=20	−1	0	1

02 Code the midpoints, then undo the code
03 Rules and worked cases
04 From the givens to the answer
05 Read the frequencies before estimating
06 Check your reasoning
07 Check your reasoning

ILLUSTRATED PROBLEM SHEET

Code the midpoints, then undo the code

With u = (x − A)/h, the estimated mean is A + h × ∑fu/∑f.

1

Midpoint	10	20	30
Frequency	2	1	3
u with A=20	−1	0	1

If h = 10, what is the weighted code total?

−2 + 0 + 3 = 1. Six observations give mean 20 + 10/6.

2

Midpoint	10	20	30
Frequency	2	1	3
u with A=10	0	1	2

Does changing the assumed mean change the final estimate?

Code sum is 7. The mean is 10 + 70/6 = 65/3, as before.

3

∑fu = 0
↓
∑f > 0
↓
Estimated mean = A

When is the chosen centre already the estimate?

When the weighted positive and negative code totals balance exactly.

4

A = 30, h = 5
↓
Mean code = −0.4
↓
Mean = 28

Why multiply by five before subtracting?

The average is 0.4 coded steps below the centre. Each step equals five original units.

A = 25, h = 5 and u = 2
midpoint 35.

Midpoint 15 with the same coding
u = −2.

CHAPTER PROBLEM

A=20,h=5,N=20,∑fu=12. Find the mean estimate.

23. Reconstruct A+h∑fu/N.

MATHS REFERENCE · GRADE 10

Grouped mean: step deviation

Rules, conditions and worked cases

Recognise the case	Mathematical reasoning
Code the midpoints	For x = 15,25,35, choose A = 25 and h = 10. Then u = (x − A)/h equals −1,0,1.
Restore units	With frequencies 2,3,5, ∑fu = 3 and N = 10. Mean estimate = 25 + 10 × 3/10 = 28.
Verify directly	(2 × 15 + 3 × 25 + 5 × 35)/10 = 280/10 = 28.

Read the representations

Code equal-width intervals in units of one class width

Let $u=(x-A)/h$ where h is a common class width. Then $x=A+hu$.

Substitute into the weighted mean to obtain $\text{mean}\approx A+h\sum fu/N$. This shortens arithmetic when midpoints differ by equal steps.

Grouped observations

Class	Frequency f	Midpoint x	Cumulative f
0–10	2	5	2
10–20	6	15	8
20–30	2	25	10

Keep coded units separate from measurement units

u is a coded number of class widths. Multiply by h when returning to the original units.

For unequal widths, direct or assumed-mean calculations remain valid; one common class width is unavailable.

Group	Count	Mean
A	4	80
B	16	60

What is the combined mean?

(320 + 960)/20 = 64. The larger group pulls the mean towards 60.

WORKED EXAMPLES

From the givens to the answer

Use a short coded calculation

1. For midpoints 5,15,25 and frequencies 1,6,3, choose A=15,h=10.
2. Codes are −1,0,1, so ∑fu=−1+0+3=2 and N=10.
3. Mean≈15+10(2/10)=17. Direct check: (5+90+75)/10=17.

Change the step size in the calculation

For midpoints 10, 20, 30 with frequencies 2, 1, 3, choose A = 20 and step h = 10. Estimate the mean.

1. Step deviations are −1, 0, 1. Their weighted sum is −2 + 0 + 3 = 1. Mean = 20 + 10 × (1/6) = 65/3. Direct check: 130/6 gives the same value.

Check another case

Example 1

A=60,h=10,x=80. Find u.

2

u=(x−A)/h.

Example 2

A=70,h=10,u=−2. Find x.

50

x=A+hu.

Reconstruct a missing frequency

Midpoints 5, 15, 25 have frequencies 2, k, 4. If the estimated mean is 17, use weighted total 110 + 15k = 17(k + 6).

Solving gives k = 4. Direct check: the total is 170 for ten observations, so the mean is 17.

Value	2	5	8
Count	1	2	1

Find the mean without writing the full list.

Weighted total 2 + 10 + 8 = 20. Four observations give mean 5.

ILLUSTRATED PROBLEM SHEET

Read the frequencies before estimating

For grouped values, a midpoint, an interpolation or a frequency peak answers a different question.

1

Class	0–10	10–20	20–30
Frequency	2	6	2
Midpoint	5	15	25

Estimate the mean using all ten observations.

Weighted total = 2 × 5 + 6 × 15 + 2 × 25 = 150. Divide by ten for 15.

2

Class	0–10	10–20	20–30
Frequency	4	10	6
Cumulative	4	14	20

Where does the median lie?

Half the total is 10. Interpolate six tenths of the way across the middle class: 10 + 6 = 16.

3

Class	0–10	10–20	20–30
Frequency	3	9	6

Estimate the mode of these equal-width classes.

The rise to the peak is 6 and the fall is 3. Estimate 10 + 10 × 6/9 = 16⅔.

4

Midpoint	10	20	30
Frequency	2	1	3
Step code	−1	0	1

Choose centre 20 and step 10. Estimate the mean.

Weighted code sum = 1. The mean is 20 + 10/6 = 65/3.

Halve every frequency proportionally grouped mean unchanged.

Add five to every class boundary grouped mean rises by five.

CHAPTER PROBLEM

A=30,h=10,x=50. Find u.

2. u=(x−A)/h.

QUESTION BANK · FOLD OR COVER THE RIGHT COLUMN

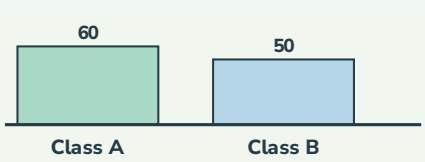
Check your reasoning

Try the problem	Solution and reasoning
01 Can you choose an assumed mean outside the classes?	Yes. Any centre works with consistent coding and decoding, though a central choice usually makes the arithmetic shorter.
02 Why can the grouped mean differ from the exact mean of the original data?	The calculation puts every observation at its class midpoint. Their actual positions are unknown.
03 A=50,h=10,u=−2. Find x.	30 x=A+hu.
04 A=60,h=4,N=10,∑fu=−5. Find the mean estimate.	58 The negative coded total shifts the mean down by 2.
05 Which factor restores the units after coding? A) N B) h C) f D) 1/h	h The deviation in original units is h times the code.
06 Codes −1,0,1 have frequencies 3,5,2. Find ∑fu.	-1 −3+0+2=−1.

How does coding change the unit?

Midpoints 10, 30, 50 are coded as −1, 0, 1 around 30 with step 20. A weighted average code of 0.25 is a quarter of one step above the centre.

The estimated mean is 30 + 20 × 0.25 = 35. Adding 0.25 directly would confuse steps with the original unit.



Bars show percent cycling. A has 20 pupils and B has 30. Which has more cyclists?

A has 12 cyclists and B has 15. A higher percentage need not mean a higher count.

QUESTION BANK · FOLD OR COVER THE RIGHT COLUMN

Check your reasoning

Try the problem	Solution and reasoning
07 Derive mean≈A+h∑fu/N.	Write x=A+hu for each midpoint. Multiply by f, sum and divide by N.
08 A learner reports A+∑fu/N after dividing deviations by h=10. What is missing?	The coded mean deviation must be multiplied by 10. Without h, the scale of the adjustment is incorrect.
09 A=30,h=5,N=20,∑fu=12. Find the mean estimate.	33 The mean coded displacement is 12/20 = 0.6 intervals. Each interval is five units, so the estimated mean is 30 + 5 × 0.6 = 33.
10 A=40,h=10,x=60. Find u.	2 u=(x−A)/h.
11 A=50,h=5,N=20,∑fu=12. Find the mean estimate.	53 The coded mean is 12/20 = 0.6. Restore the original scale and origin: 50 + 5 × 0.6 = 53.

Fresh sample: 20 pupils
↓
Only cycling-club members asked

Why might its travel survey overstate cycling?

The selection method favours cyclists. More responses from that same club do not remove the bias.

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