# General Mathematics marking guide

External assessment

## Short response (100 marks)

### Assessment objectives

This assessment instrument is used to determine student achievement in the following objectives:

1. select, recall and use facts, rules, definitions and procedures drawn from Units 3 and 4
2. comprehend mathematical concepts and techniques drawn from Units 3 and 4
3. communicate using mathematical, statistical and everyday language and conventions
4. evaluate the reasonableness of solutions
5. justify procedures and decisions by explaining mathematical reasoning
6. solve problems by applying mathematical concepts and techniques drawn from Units 3 and 4.

Queensland Government | Queensland Curriculum & Assessment Authority

*For all Queensland schools*

# Purpose

This document is an External assessment marking guide (EAMG).

The EAMG:

- Provides a tool for calibrating external assessment markers to ensure reliability of results
- Indicates the correlation, for each question, between mark allocation and qualities at each level of the mark range
- Informs schools and students about how marks are matched to qualities in student responses.

# Mark allocation

Where a response does not meet any of the descriptors for a question or a criterion, a mark of '0' will be recorded. Where no response to a question has been made, a mark of 'N' will be recorded.

*Allow FT mark(s)* – refers to 'follow through', where an error in the prior section of working is used later in the response, a mark (or marks) for the rest of the response can still be awarded so long as it still demonstrates the correct conceptual understanding or skill in the rest of the response.

*This mark may be implied by subsequent working* – the full mathematical reasoning and/or working, as outlined in the sample response and associated mark, is not evident in the student response, but by virtue of subsequent working there is sufficient evidence to award mark(s).

# External assessment marking guide

## Paper 1: Multiple choice

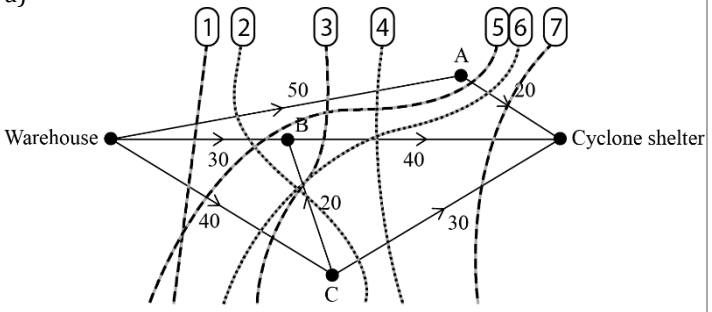
| Question | Response |
|---|---|
| 1 | C |
| 2 | A |
| 3 | C |
| 4 | D |
| 5 | B |
| 6 | B |
| 7 | C |
| 8 | B |
| 9 | D |
| 10 | D |
| 11 | B |
| 12 | A |
| 13 | A |
| 14 | C |
| 15 | A |

## Short response

| Q | Sample response | The response: |
|---|---|---|
| 16 | a) AFCFB<br>starts and ends at a different vertex<br>edge repeats: FC = CF<br>∴ Open walk<br><br>b) AFCEFBA<br>starts and ends at the same vertex<br>no edges are repeated<br>vertex F is repeated<br>∴ Closed trail<br><br>c) ABCDEFA<br>starts and ends at the same vertex<br>no edges are repeated<br>no vertices are repeated<br>∴ Cycle | • correctly identifies an open walk **[1 mark]**<br><br>• correctly identifies a closed trail **[1 mark]**<br><br>• correctly identifies a cycle **[1 mark]** |
| 17 | Distance is east / west<br>∴ distance $= 111.2 \times \cos\theta \times$ angular dist.<br><br>angular dist. $= 147° 37' - 140° 47'$<br>$= 6° 50'$<br><br>distance $= 111.2 \times \cos\theta \times$ angular dist.<br>$= 111.2 \times \cos(37° 50') \times (6° 50')$<br>$= 600.14$<br><br>It is approximately 600 km between Mount Gambier and Bairnsdale. | • correctly calculates the angular distance **[1 mark]**<br><br>• provides evidence of substituting into the appropriate distance rule **[1 mark]**<br><br>• calculates distance to the nearest km **[1 mark]** |

| Q | Sample response | The response: |
|---|---|---|
| 18 | a) Arithmetic sequence<br>$t_1 = 353$<br>$t_3 = 439$<br><br>Find $d$<br>$t_3 = t_1 + 2d$<br>$439 = 353 + 2d$<br>$86 = 2d$<br>$43 = d$<br><br>b) Find $t_6$<br>$t_6 = t_1 + 5d$<br>$= 353 + 5 \times 43$<br>$= 568$<br><br>They would expect 568 people to attend the sixth day. | • correctly provides mathematical reasoning to support the answer **[1 mark]**<br><br>• correctly determines the common difference **[1 mark]**<br><br>• substitutes into an appropriate rule **[1 mark]**<br><br>• determines value **[1 mark]** |
| 19 | a) $x = 12$<br>$\therefore y = 2.3(12) + 31.4$<br>$= 59$<br><br>b) A correlation coefficient of 0.688 suggests a moderate association, which means that as the hours spent fishing increase so do the number of fish caught.<br><br>A coefficient of determination of 0.473 means that 47% of the variation in results can be explained by the variation of hours spent fishing.<br><br>Therefore the prediction of catching 59 fish after fishing for 12 hours may be valid, however other factors will also come into play. | • correctly calculates 59 **[1 mark]**<br><br>• correctly describes the strength as either moderate or strong **[1 mark]**<br><br>• correctly describes the meaning of the coefficient of determination **[1 mark]**<br><br>• evaluates the reasonableness of the solution **[1 mark]** |

| Q | Sample response | The response: |
|---|---|---|
| 20 | $A = 350\,000$<br><br>$M = ?$<br><br>$i = \frac{0.065}{12}$<br>$= 0.005416\ldots$<br><br>$n = 25 \times 12$<br>$= 300$<br><br>$A = M\left(\frac{1-(1+i)^{-n}}{i}\right)$<br><br>$A = M\left(\frac{1-(1+0.005416\ldots)^{-300}}{0.005416\ldots}\right)$<br><br>$350\,000 = M \times 148.102\ldots$<br><br>$M = \frac{350\,000}{148.102\ldots}$<br><br>$M = 2363.225\ldots$<br>The monthly repayment will be $2363.23 each month for 25 years. | • correctly determines the $i$ and $n$ values **[1 mark]**<br><br>• substitutes into appropriate annuity rule **[1 mark]**<br><br>• determines monthly repayment **[1 mark]**<br>• states solution with correct units and appropriate rounding **[1 mark]** |

| Q | Sample response | The response: |
|---|---|---|
| 21 | a)<br>  <br><br>Cut 1 → 50+30+40 = 120<br>Cut 2 → 50+30+20+30 = 130<br>Cut 3 → 50+40+40 = 130<br>Cut 4 → 50+40+30 = 120<br>Cut 5 → 20+30+40 = 90<br>Cut 6 → 20+40+40 = 100<br>Cut 7 → 20+40+30 = 90<br>The capacity of the minimum cut is 90, so the maximum flow of this network is 90.<br><br>b) Cut 1, 2, 3, 4, 5, 6 and 7 change to 70, 80, 80, 70, 70, 80 and 70.<br><br>The maximum flow is now 70. | • correctly identifies all the possible cuts **[1 mark]**<br>• correctly calculates the flow across all the cuts **[1 mark]**<br><br>• states maximum flow across minimum cut **[1 mark]**<br><br>• recalculates flow across minimum cut **[1 mark]**<br><br>• states new maximum flow **[1 mark]** |

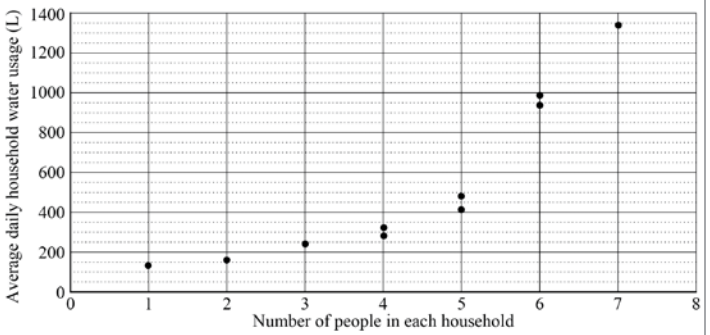
<table>
<tr><th>Q</th><th>Sample response</th><th>The response:</th></tr>
<tr><td>22</td><td>a) Total # change uniform = 115<br>Total # do not change = 95<br><br><table><tr><th></th><th>Change uniform</th><th>Do not change uniform</th></tr><tr><td>Junior staff</td><td>80%</td><td>29.5%</td></tr><tr><td>Senior staff</td><td>20%</td><td>70.5%</td></tr><tr><td></td><td>100%</td><td>100%</td></tr></table><br>b) There does appear to be an association between the staff groups and wanting to change the uniform.<br>The data suggests that junior staff want to change the uniform (80% as opposed to 20% of senior staff) and senior staff do not want to change (70.5% compared with 29.5% of junior staff).</td><td>• correctly determines column totals [1 mark]<br><br>• correctly represents the data in a percentaged two-way table [1 mark]<br><br>• suggests the presence of an association [1 mark]<br>• provides reasons to support conclusion [1 mark]</td></tr>
<tr><td>23</td><td>Depart Brisbane 22:45 Monday Brisbane time<br>Travel +14:35<br>Arrive Dubai 37:20 Monday<br>next day – 24:00<br>13:20 Tuesday<br><br>UTC correction – 6:00<br><br>7:20 am on Tuesday in Dubai</td><td>• correctly adds travel time [1 mark]<br><br>• calculates arrival time from Brisbane’s perspective [1 mark]<br>• correctly subtracts time difference [1 mark]<br><br>• calculates arrival time and day from Dubai’s perspective [1 mark]</td></tr>
</table>

| Q | Sample response | The response: |
|---|---|---|
| 24 | a) 11 cm<br><br>b) Interpolation<br><br>c) The least-squares line provided does suggest that at 29 days, the seedling will be 32 cm high.<br><br>However, the data values are levelling off at about 25 cm, so extrapolation is unwise. | • provides the correct value including units **[1 mark]**<br><br>• correctly classifies the prediction as interpolation **[1 mark]**<br><br>• identifies that the least-squares line supports the statement **[1 mark]**<br>• identifies potential dangers of extrapolation **[1 mark]** |
| 25 | Option 1<br>$i_{e1} = (1 + \frac{i}{n})^n - 1$<br>$= (1 + \frac{0.07}{4})^4 - 1$<br><br>$\approx 0.07186$<br><br>Option 2<br>$i_{e2} = (1 + \frac{i}{n})^n - 1$<br>$= (1 + \frac{0.068}{12})^{12} - 1$<br><br>$\approx 0.07016$<br><br>Option 1 is better because it has a slightly higher effective interest rate. | • correctly substitutes into appropriate rule **[1 mark]**<br><br>• calculates effective interest rate for Option 1 **[1 mark]**<br><br>• correctly substitutes into appropriate rule **[1 mark]**<br>• calculates the effective interest rate for Option 2 **[1 mark]**<br><br>• states better option **[1 mark]** |

| Q | Sample response | The response: |
|---|---|---|
| 26 | a) Determine the common ratio<br>$r = 1 - 0.17$<br>$= 0.83$<br><br>Determine the model<br>let $n$ = the number of years since 2015<br>and $t_n$ = the number of birds<br><br>$t_n = t_1 r^{(n-1)}$<br>$= 483 \times 0.83^{n-1}$<br><br>b) $n = 6$<br>$t_6 = 483 \times 0.83^5$<br>$= 190.255 \ldots$<br><br>Expect 190 birds remaining. | • correctly determines the common ratio **[1 mark]**<br><br>• determines geometric model **[1 mark]**<br><br>• correctly determines the $n$ value **[1 mark]**<br><br>• determines $t_6$ **[1 mark]**<br><br>• states a reasonable answer **[1 mark]** |

## Paper 2

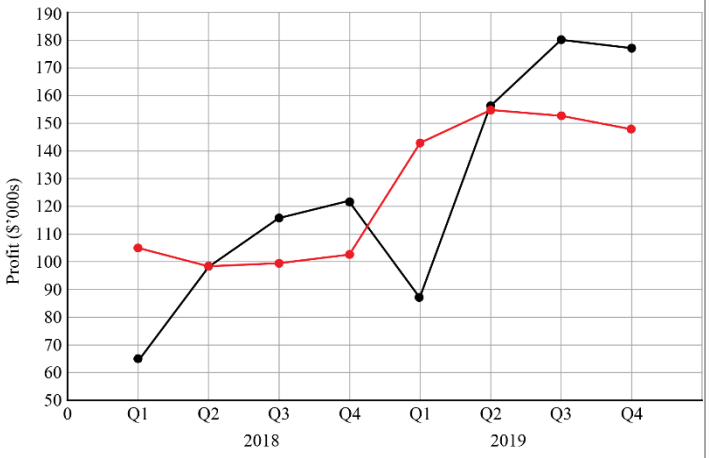
| Q | Sample response | The response: |
|---|---|---|
| 1 | **Option 1: Arithmetic sequence**<br>$n =$ the number of minutes starting at 1<br>$t_n =$ the amount of water in the tank<br><br>$t_1 = 12\,500$<br>$d = -135$<br>$t_n = 5000$<br>$n = ?$<br><br>Find $n$<br>$t_n = t_1 + (n-1)d$<br>$\therefore \quad 5000 = 12\,500 - 135(n-1)$<br>$\therefore 135(n-1) = 7500$<br>$\therefore \quad n - 1 = 55.5556$<br>$\therefore \quad n \quad = 56.5556$<br><br>The tap was left on until the 57th term.<br>The tap was left on for about 56 minutes. | • correctly defines the variables **[1 mark]**<br><br>• correctly identifies the parameters $t_1$, $d$ and $t_n$ **[1 mark]**<br><br>• substitutes values into appropriate model **[1 mark]**<br><br>• determines $n$ value **[1 mark]**<br><br>• states a reasonable answer rounded to the nearest minute **[1 mark]** |
| | **Option 2: Linear function**<br>$x =$ the time that the tap has been on<br>$y =$ the amount of water in the tank<br><br>$c = 12\,500$<br>$m = -135$ | • correctly defines the variables **[1 mark]** |
| | $y = mx + c$<br>$\therefore y = -135x + 12\,500$<br><br>Find $x$ when $y = 5000$ | • correctly identifies the parameters $y$, $m$ and $c$ **[1 mark]** |

| Q | Sample response | The response: |
|---|---|---|
| | $\therefore\ 5000 = -135x + 12500$<br>$\therefore\ 135x = 7500$<br>$\therefore\ \ x = 55.5556$<br><br>The tap was left on for about 56 minutes. | • substitutes values into appropriate model **[1 mark]**<br>• determines $x$ value **[1 mark]**<br><br>• states a reasonable answer rounded to the nearest minute **[1 mark]** |
| 2 |  <br>From the calculator $r = 0.886$<br>A correlation coefficient of 0.886 indicates that the relationship is a very strong positive relationship.<br><br>However, this relationship as shown in the scatterplot does not appear to be linear, therefore the correlation coefficient should not be used. | • correctly constructs a scatterplot **[1 mark]**<br><br>• correctly determines the correlation coefficient **[1 mark]**<br>• interprets the value of the correlation coefficient **[1 mark]**<br><br>• correctly identifies that the scatterplot is not linear **[1 mark]**<br>• correctly identifies that the correlation coefficient should not be used **[1 mark]** |
| 3 | $y = 2.1875x + 0.0625$<br>$\therefore b = 2.1875$<br>$\ \ a = 0.0625$<br><br>From the table of values<br>$\bar{x} = 5$ | • correctly identifies the $a$ and $b$ values **[1 mark]**<br><br>• correctly determines $\bar{x}$ **[1 mark]** |

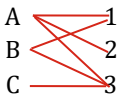
| Q | Sample response | The response: |
|---|---|---|
| | Using $a$<br>$a = \bar{y} - b\bar{x}$<br>$0.0625 = \bar{y} - 2.1875 \times 5$<br>$\therefore \bar{y} = 11$<br><br>From the table<br>$\bar{y} = \frac{\Sigma y}{n}$<br>$\therefore \quad 11 = \frac{4+8+p+q+16}{5}$<br>$\therefore \quad 55 = 28 + p + q$<br>$\therefore p + q = 27$<br><br>If $q = p + 3$ then<br>$p + p + 3 = 27$<br>$\therefore \quad 2p = 24$<br>$\therefore \quad p = 12$<br>$\therefore \quad q = 15$ | • determines $\bar{y}$ **[1 mark]**<br><br>• determines sum of missing values **[1 mark]**<br><br>• determines values for $p$ and $q$ **[1 mark]**<br>• shows logical organisation, communicating key steps **[1 mark]** |

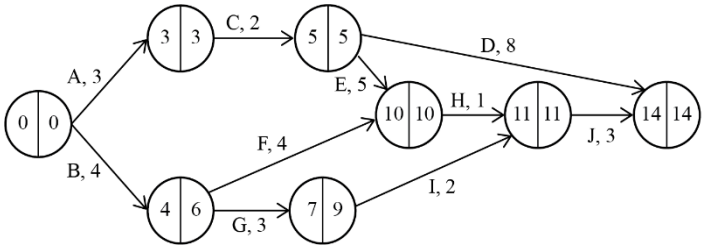
| Q | Sample response | The response: |
|---|---|---|
| 4 | | • correctly determines the yearly averages **[1 mark]**<br>• determines profit/yearly average values **[1 mark]**<br>• determines seasonal indices **[1 mark]**<br>• determines deseasonalised values **[1 mark]** |

| Year | Quarter | Profit (in $1000s) | Yearly average | Profit/ yearly average | Seasonal indices | Deseasonalised |
|---|---|---|---|---|---|---|
| 2018 | 1 | 64 | 100 | 0.64 | 0.61 | 104.92 |
| | 2 | 98 | | 0.98 | 1.01 | 97.03 |
| | 3 | 116 | | 1.16 | 1.18 | 98.31 |
| | 4 | 122 | | 1.22 | 1.2 | 101.67 |
| 2019 | 1 | 87 | 150 | 0.58 | 0.61 | 142.62 |
| | 2 | 156 | | 1.04 | 1.01 | 154.46 |
| | 3 | 180 | | 1.2 | 1.18 | 152.54 |
| | 4 | 177 | | 1.18 | 1.2 | 147.5 |




• accurately plots deseasonalised data on provided graph **[1 mark]**

| Q | Sample response | The response: |
|---|---|---|
| 5 | Matrix form<br>3 3 1<br>4 7 2<br>4 4 1<br>row reduction: $R_1 - 1, R_2 - 2, R_3 - 1$<br>2 2 0<br>2 5 0<br>3 3 0 | • correctly reduces each row **[1 mark]** |
| | only need 1 line to cover all the 0s,<br>∴ column reduction: $C_1 - 2, C_2 - 2$<br>0 0 0<br>0 3 0<br>1 1 0 | • correctly reduces each column **[1 mark]** |
| | need 3 lines to cover all the 0s, ∴ bipartite graph:<br>  <br> | |
| | contractor task cost<br>A 2 3<br>B 1 4<br>C 3 1<br>Total 8 | • allocates each task to one contractor **[1 mark]** |
| | ∴ Minimum cost is $8000. | • determines minimum cost **[1 mark]**<br>• shows logical organisation, communicating key steps **[1 mark]** |

| Q | Sample response | The response: |
|---|---|---|
| 6 | Network<br>  <br><br>Determine minimum completion time.<br>Shortest path is 14, so with a large enough workforce the job could be completed on the 14th day. | • correctly translates the information into a network **[1 mark]**<br>• determines LST for each activity **[1 mark]**<br>• determines EST for each activity **[1 mark]**<br>• determines minimum completion time **[1 mark]** |
| | Find how many employees required.<br>At the start of the project only tasks A and B can be done, so employing more than 2 people at the start would be wasteful.<br>If the company employed 3 people as suggested, the following job allocation could be used.<br>Worker 1 follows the critical path to complete the job on day 14.<br>Worker 2 works on non-critical jobs that are available.<br>Day 5 is the first day where having 3 employees would be useful. | • determines whether three workers are sufficient **[1 mark]** |
| | Day<br>1 2 3 4 5 6 7 8 9 10 11 12 13 14<br>worker<br>1 A A A C C E E E E E H J J J<br>2 B B B B F F F F<br>3 G G G I I<br>4 D D D D D D D D | |
| | But with 3 workers, activity D could not be completed by day 14.<br>The owner's belief is incorrect: at least 4 workers must be employed. | • evaluates reasonableness of the claim **[1 mark]**<br>• shows logical organisation, communicating key steps **[1 mark]** |

| Q | Sample response | The response: |
|---|---|---|
| 7 | Perpetuity — find the size of the savings<br>M = 3600<br>$i = \frac{0.0576}{12}$<br>$= 0.0048$<br>A = ?<br><br>$A = \frac{M}{i}$<br>$= \frac{3600}{0.0048}$<br>$= 750\,000$<br>Use the total savings to find the size of the monthly payment<br>$A = 750\,000$<br>M = ?<br>$i = \frac{0.042}{12}$<br>$= 0.0035$<br>$n = 20 \times 12$<br>$= 240$<br><br>$A = M\left(\frac{(1+i)^n - 1}{i}\right)$<br><br>$750\,000 = M \times 375.13 \ldots$<br><br>$M = 1999.281$<br><br>The monthly savings were $1999.29. | • correctly determines the $i$ value **[1 mark]**<br><br>• correctly recalls the perpetuity rule **[1 mark]**<br>• determines purchase price of perpetuity **[1 mark]**<br><br>• correctly determines the $i$ and $n$ values **[1 mark]**<br>• correctly selects the appropriate annuity rule **[1 mark]**<br><br>• determines payment **[1 mark]**<br><br>• shows logical organisation, communicating key steps **[1 mark]** |