General Mathematics marking guide

External assessment 2021

Short response (95 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 marking guide:

- 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.

Allowing for 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 be awarded so long as it still demonstrates the correct conceptual understanding or skill in the rest of the response.

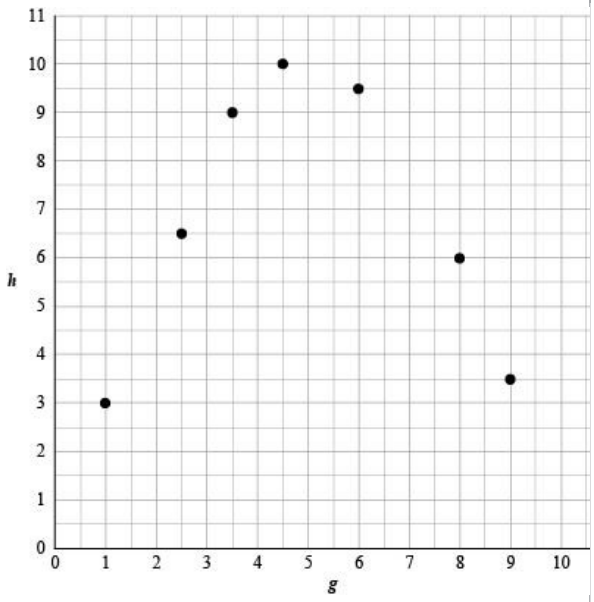
This mark may be implied by subsequent working — the full mathematical reasoning and/or working, as outlined in the sample response and associated mark, is not explicitly stated in the student response, but by virtue of subsequent working there is sufficient evidence to award the mark/s.

Marking guide

Paper 1: Multiple choice

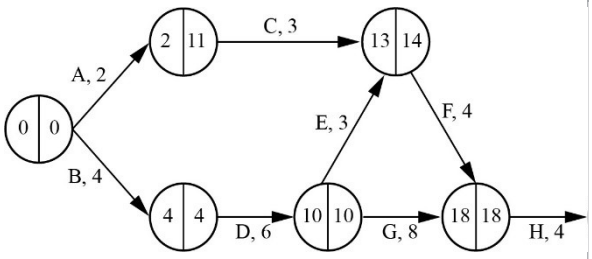
Question	Response
1	C
2	B
3	D
4	D
5	C
6	A
7	A
8	B
9	C
10	D
11	B
12	D
13	C
14	A
15	B

Paper 1: Short response

Q	Sample response	The response:
16a)		• correctly formats the Cartesian plane with *g* along the x-axis and *h* along the y-axis **[1 mark]** • correctly plots all the data points **[1 mark]**
16b)	non-linear and strong	• identifies form **[1 mark]** • identifies strength **[1 mark]**

Q	Sample response	The response:
17	$A = 720\,000$ $M = ?$ $i = \frac{0.048}{12} = 0.004$ $n = 25 \times 12 = 300$	• correctly determines the i and n values **[1 mark]**
	$A = M\left(\frac{1-(1+i)^{-n}}{i}\right)$ $A = M\left(\frac{1-(1+0.004)^{-300}}{0.004}\right)$ $720\,000 = M \times 174.520\ldots$	• substitutes into appropriate annuity rule **[1 mark]**
	$M = \frac{720\,000}{174.520\ldots}$ $M = 4125.578\ldots$	• determines monthly repayment **[1 mark]**
	The monthly repayment will be $4126 each month for 25 years.	• states solution to the nearest dollar **[1 mark]**

Q	Sample response	The response:
18a)	Let $x =$ the number of years since 2014 Let $y =$ the business's annual profit (in \$'000s) $y = 4.286x + 34.267$	• correctly defines the variables **[1 mark]** • correctly determines the equation of the least-squares line **[1 mark]**
18b)	For 2021, $x = 7$ $\therefore y = 4.286 \times 7 + 34.267$ $= 64.269$ The business will make \$64 300.	• correctly determines the x value **[1 mark]** • determines profit **[1 mark]**

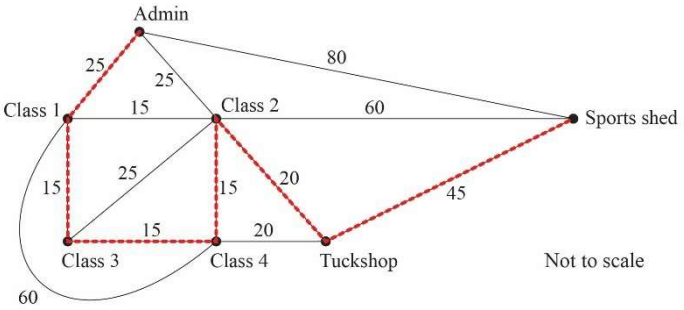
Q	Sample response	The response:
19a)		• correctly translates the information into a network diagram **[1 mark]** • correctly labels each activity letter and duration **[1 mark]** • provides evidence of forward and backward scanning **[1 mark]**
19b)	BDGH	• determines critical path **[1 mark]**
19c)	22 days	• determines shortest time **[1 mark]**
20	**Option 1: Arithmetic sequence** $t_1 = 45\,100$ $d = -2700$ $n = 10$ $t_n = ?$ $t_n = t_1 + (n-1)d$ $\therefore t_n = 45\,100 - 2700(10-1)$ $\therefore = 20\,800$ The tractor will be worth $20 800.	• correctly identifies the model **[1 mark]** • correctly identifies the parameters t_1, d and n **[1 mark]** • substitutes values into appropriate model **[1 mark]** • determines value of tractor, including units **[1 mark]**
	Option 2: Linear function $c = 45\,100$ $m = -2700$ $x = 9$ $y = mx + c$ $\therefore y = -2700 \times 9 + 45\,100$ $= 20\,800$ The tractor will be worth $20 800.	• correctly identifies the model **[1 mark]** • correctly identifies the parameters c, m and x **[1 mark]** • substitutes values into appropriate model **[1 mark]** • determines value of tractor, including units **[1 mark]**

Q	Sample response	The response:
21a)	Indi	• correctly identifies the federal electorate **[1 mark]**
21b)	Point A: $37.25° \text{ S } 141.75° \text{ E}$ Point B: $37.25° \text{ S } 148.5° \text{ E}$ $\text{angular distance} = 6.75°$ Distance is E–W $D = 111.2 \times cos\theta \times \text{angular distance}$ $= 111.2 \times \cos(37.25°) \times 6.75°$ $= 597.48$ The points are approximately 600 km apart.	• correctly identifies the latitude for A and B ($37.1° \text{ S}$ to $37.3° \text{ S}$) **[1 mark]** • correctly identifies the longitudes for A ($141.6° \text{ E}$ to $141.9° \text{ E}$) and B ($148.3° \text{ E}$ to $148.7° \text{ E}$) **[1 mark]** • determines angular distance **[1 mark]** • substitutes values into appropriate rule **[1 mark]** • states answer rounded to the nearest 100 km **[1 mark]**
22	**Option 1: Recursion** $i = \frac{4.8}{1200}$ $= 0.004$ $\therefore r = 1.004$ $R = 278$ $A_0 = 32\,000$ $A_{n+1} = rA_n - R$ $\therefore A_1 = 1.004 \times 32\,000 - 278$ $= 31\,850$ $\therefore A_2 = 1.004 \times 31\,850 - 278$ $= 31\,699.4$ After 2 months, Rosa owes $31 699.40	• correctly determines the i value **[1 mark]** • correctly substitutes into an appropriate rule **[1 mark]** • substitutes for A_2 using result from A_1 **[1 mark]** • provides answer rounded to the nearest cent **[1 mark]**

Q	Sample response	The response:
	Option 2: Annuity $i = \frac{4.8}{1200}$ $= 0.004$ $\therefore r = 1.004$ $R = 278$ $P = 32\,000$	• correctly determines the i value **[1 mark]**
	$A_n = P(1+i)^n - M\left(\frac{(1+i)^n - 1}{i}\right)$ $\therefore A_2 = 32\,000(1.004)^2 - 278\left(\frac{1.004^2 - 1}{0.004}\right)$ $= 31\,699.4$	• correctly substitutes into an appropriate compound interest rule **[1 mark]** • correctly substitutes into an appropriate annuity rule **[1 mark]**
	After 2 months, Rosa owes $31 699.40	• provides answer rounded to the nearest cent **[1 mark]**

Q	Sample response	The response:
23a)	L_4 is not valid because the tank and the tap are on the same side of the line.	• correctly explains why L_4 is not a valid cut **[1 mark]**
23b)	L_1 capacity = 20 + 22 + 15 = 57 L_2 capacity = 18 + 19 + 22 + 15 = 74 L_3 capacity = 18 + 8 + 10 = 36	• correctly determines the L_1 capacity **[1 mark]** • correctly determines the L_2 capacity **[1 mark]** • correctly determines the L_3 capacity **[1 mark]**
24	1. Non-linear form 2. Seasonal cycle every 12 months 3. Positive long-term trend	• correctly identifies the non-linear form **[1 mark]** • correctly identifies a seasonal pattern **[1 mark]** • correctly identifies a positive long-term trend **[1 mark]**
25a)	Depart Brisbane 10:30 Mon 7/12 Flight: + 7:40 Arrive Singapore 18:10 UTC correction –2:00 = 16:10 4:10 pm in Singapore on Mon 7/12	• correctly adds the flight time **[1 mark]** • correctly determines the local time, day and date in Singapore **[1 mark]**
25b)	Arrive Singapore 17:00 Mon 7/12 Flight: – 8:25 Depart Dubai 8:35 UTC correction –4:00 = 4:35 4:35 am in Dubai on Mon 7/12	• correctly subtracts the flight time **[1 mark]** • correctly determines the local time, day and date in Dubai **[1 mark]**

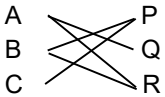
Paper 2: Short response

Q	Sample response	The response:
1	Home latitude = $14°52′$ S Change time difference to angular difference Angle $= 1\frac{13}{60} \times 15°$ $= 18.25°$ Home longitude $= 145°29′ - 18°15′$ $= 127°14′$ Home coordinates are $14°52′$ S, $127°14′$ E	• correctly identifies the latitude **[1 mark]** • correctly determines the angle **[1 mark]** • subtracts angle from longitude in same format **[1 mark]** • determines longitude **[1 mark]**
2	 Minimum spanning tree $= A - C1 - C3 - C4 - C2 - T - SS$ Total length $= (15 \times 3) + 20 + 25 + 45 = 135$ m Total cost $= 135 \times 1200 = \$162\,000$ Since \$155 000 is less than \$162 000, the school cannot afford the project.	• correctly identifies a minimum spanning tree **[1 mark]** • determines – total length of minimum spanning tree **[1 mark]** **OR** – cost of each arc of minimum spanning tree **[1 mark]** • determines total cost **[1 mark]** • determines if the school can afford the project **[1 mark]**

Q	Sample response	The response:
3	Value of regular contributions $M = 2500$ $i = \frac{3.6}{400}$ $= 0.009$ $n = 6 \times 4$ $= 24$ $A = M\left(\frac{(1+i)^n - 1}{i}\right)$ $= 2500\left(\frac{(1.009)^{24} - 1}{0.009}\right)$ $= 66\,639.94$ Value of extra payment $P = 10\,000$ $i = \frac{3.6}{400}$ $= 0.009$ $n = 2 \times 4$ $= 8$ $A = P(1+i)^n$ $= 10\,000(1.009)^8$ $= 10\,743.09$ Total value $= 66\,639.94 + 10\,743.09$ $= 77\,383.03$ $= \$77\,383$	• correctly determines the i and n values **[1 mark]** • substitutes into appropriate annuity rule **[1 mark]** • substitutes into appropriate rule **[1 mark]** • determines sum of two values **[1 mark]** • determines total value, rounded to the nearest dollar **[1 mark]**

Q	Sample response	The response:
4	Let $n =$ the number of years since 2019 Let $t_n =$ the amount of money In 2020, $n = 1$ and $t_1 = 250$ In 2038, $n = 19$ and $t_{19} = 2750$ Find r $t_n = t_1 r^{(n-1)}$ $\therefore 2750 = 250 \times r^{18}$ $\therefore 11 = r^{18}$ $\therefore r = 1.1425$ The geometric model for Model 1 $\therefore t_n = 250 \times 1.1425^{(n-1)}$ The arithmetic model for Model 2 $t_n = t_1 + (n-1)d$ $\therefore t_n = 126(n-1)$ Comparison of investments in 2030, $n = 11$ Model 1's amount in 2030, $t_{11} = 250 \times 1.1425^{10}$ $= 947.33$ Model 2's amount in 2030, $t_{11} = 126 \times 10$ $= 1260$ Difference $= 1260 - 947.33$ $= 312.67$ In 2030 Model 2 is \$313 more than Model 1.	• correctly substitutes the values into a geometric rule **[1 mark]** • determines geometric model for Model 1 **[1 mark]** • correctly determines an arithmetic model for Model 2 **[1 mark]** • determines the amounts for both models in 2030 **[1 mark]** • determines difference to nearest dollar **[1 mark]** • shows logical organisation communicating key steps **[1 mark]**

Q	Sample response	The response:
5	Predicted data @ $x = 31$ $y_A - y_P = -0.75$ $119 - y_P = -0.75$ $\therefore y_P = 119.75$ Find b $b = r\frac{s_y}{s_x}$ $= 0.875 \times \frac{6}{4}$ $= 1.3125$ Find a $y = bx + a$ $119.75 = 1.3125 \times 31 + a$ $\therefore 79.0625 = a$ Model: $y = 1.3125x + 79.0625$ Oldest patient @ $x = 40$ $y = 1.3125 \times 40 + 79.0625$ $= 131.5625$ Residual = 1.4 $y = 131.5625 + 1.4$ $y = 132.9625$ The oldest person in the sample has a systolic blood pressure of 133.	• correctly determines the y_P value **[1 mark]** • correctly determines the b value **[1 mark]** • determines a value **[1 mark]** • determines predicted y value for oldest person **[1 mark]** • determines actual systolic blood pressure as a whole number **[1 mark]** • shows logical organisation communicating key steps **[1 mark]**

Q	Sample response	The response:
6	**Hungarian algorithm** Matrix form P Q R A $x+6$ $2x+3$ $x+7$ B $x+3$ $2x+4$ $x+5$ C x $2x+1$ $x+3$ Row reduction: $R_1-(x+6), R_2-(x+3), R_3-x$ 0 $x-3$ 1 0 $x+1$ 2 0 $x+1$ 3 Column reduction: $C_2-(x-3), C_3-1$ 0 0 0 0 4 1 0 4 2 Only 2 lines are needed to cover all the 0s; therefore, need to use Hungarian algorithm with minimum of 1. Add 1 to overlap, subtract 1 from uncovered. 1 0 0 0 3 0 0 3 1 Bipartite graph  AQ BR CP $\text{Total distance} = 2x+3+x+5+x$ $32 = 4x+8$ $24 = 4x$ $x = 6$ It is 6 km from C to P.	• correctly converts the network information into a matrix form **[1 mark]** • determines each matrix element by reducing each row **[1 mark]** • determines each matrix element by reducing each column **[1 mark]** • correctly applies Hungarian algorithm **[1 mark]** • determines minimum allocation **[1 mark]** • determines x **[1 mark]** • shows logical organisation communicating key steps **[1 mark]**

Q	Sample response	The response:
7	Let $n = \frac{\#\text{ of days}}{5}$ Let $t_n = \text{the total number of plays}$ $\therefore\ t_1 = 8$ $r = \frac{12}{8}$ $= 1.5$ $\therefore t_n = 8 \times 1.5^{(n-1)}$ At 60 days $n = \frac{60}{5}$ $= 12$ Total number of plays (in 1000s) $\therefore t_{12} = 8 \times 1.5^{11}$ $= 691.98$ Total predicted income Income $= 0.175 \times 691\,980$ $= 121\,096.5$ cents $= \$1210.97$ At least \$1000 is a reasonable prediction if plays continue as a geometric progression.	• correctly defines the variables **[1 mark]** • correctly determines the parameter r **[1 mark]** • correctly determines a geometric (exponential) model **[1 mark]** • determines total number of plays **[1 mark]** • determines income **[1 mark]** • evaluates reasonableness of solution **[1 mark]**