IQM3003

LEVEL 3 · CONTROLLED STAFF DOCUMENT

INTO QUALIFICATIONS

Mathematics and Data Handling

Component 3: Paper 2 examination

STAFF ONLY · Mark scheme

Duration
2 hours 50 minutes

Total marks
150

Assessment window
_____

Assessment set
Set S of 2026

Audience
Staff only

Release timing
exam release

Exam date
_____

Assessment set ID
2026-S

Assessment window _____	**Exam date** _____
Paper P2	**Assessment set** Sample 2026 Stored ID 2026-S

General marking principles

- Use only the approved item-specific mark scheme for this assessment set.
- Award method, accuracy and independent marks exactly as specified; apply follow-through only where stated.
- Credit equivalent valid methods and answers where the item-specific scheme permits them.
- Record each awarded mark in the corresponding OCR-readable annotation on the candidate answer booklet.
- Escalate genuinely valid alternatives not anticipated by the scheme for standardisation; do not change the controlled scheme locally.

M1 is one method mark; A1 is one accuracy mark dependent on the associated method; B1 is one independent mark. Accept equivalent valid methods and exact forms. Correct answers can imply method. Accept non-exact numerical answers to 3 significant figures unless the question specifies another accuracy. No follow-through is awarded unless stated.

Item-specific mark scheme

Q	Question / requirement	Solution and mark allocation	Alternatives / notes	Max
1	A college has 600 students on science courses and 400 on business courses. It plans a stratified random sample of 50 students. (a) State how many students should be selected from each group. [2] (b) Explain how to select the students randomly within each group. [1]	B1: 30 science students. B1: 20 business students. B1: Number a complete list within each group and use a random-number generator without replacement.	No follow-through. Apply the general marking principles.	3
2	Simplify $\frac{12a^5b^{-2}}{3a^2b^{-5}}$, where a and b are non-zero. Give your answer with positive indices.	B1: Coefficient 4. B1: a exponent 5 − 2 = 3. B1: $4a^3b^3$.	No follow-through. Apply the general marking principles.	3

Q	Question / requirement	Solution and mark allocation	Alternatives / notes	Max
3	The distance s metres travelled after t seconds is $s = 2t^3 - 3t^2 + 4t$, for t ≥ 0. (a) Find $\frac{ds}{dt}$. [3] (b) Find the velocity at t = 2 seconds, including units. [2]	B1: Derivative of $2t^3$ is $6t^2$. B1: Derivative of $-3t^2$ is −6t. B1: Derivative of 4t is 4. M1: Substitute t = 2 into $6t^2 - 6t + 4$. A1: 16 m s^{-1}.	No follow-through. Apply the general marking principles.	5
4	Waiting times in minutes have minimum 2, lower quartile 5, median 8, upper quartile 11 and maximum 20. (a) Draw a box plot on a labelled scale. [3] (b) Find the interquartile range. [1]	B1: Labelled linear time axis covering 2 to 20. B1: Box from 5 to 11 with median at 8. B1: Whiskers ending at 2 and 20. B1: IQR = 11 − 5 = 6 minutes.	No follow-through. Apply the general marking principles.	4
5	A population is modelled by $N = 800\,e^{0.12t}$, with t in years. Find the time at which the model first reaches 1,600, giving your answer to 2 decimal places.	M1: $e^{0.12t} = 2$. M1: $t = \frac{\ln 2}{0.12}$. A1: t = 5.78 years.	No follow-through. Apply the general marking principles.	3

Q	Question / requirement	Solution and mark allocation	Alternatives / notes	Max
6	For five test sessions, study time x hours and score y are (1, 42), (2, 48), (3, 54), (4, 60), (5, 66). Use $S_{xx}=\sum(x-\bar{x})^2$, $S_{yy}=\sum(y-\bar{y})^2$ and $S_{xy}=\sum(x-\bar{x})(y-\bar{y})$. (a) Draw a labelled scatter diagram. [2] (b) Calculate $\bar{x}$, $\bar{y}$, S_{xx} and S_{xy}. [3] (c) Find the least-squares regression line $y=a+bx$. [2] (d) Calculate Pearson's correlation coefficient, using $r=\frac{S_{xy}}{\sqrt{S_{xx}S_{yy}}}$. [2] (e) Explain why the line should not be used to predict a score for x = 20, or to prove that study time causes higher scores. [2]	B1: Axes labelled study time in hours and score, with suitable scales. B1: All five points correctly plotted. B1: $\bar{x}$ = 3 and $\bar{y}$ = 54. B1: S_{xx} = 10. B1: S_{xy} = 60. M1: $b=\frac{60}{10}=6$. A1: $a=54-6\times3=36$, so $y=36+6x$. M1: S_{yy} = 360 and $r=\frac{60}{\sqrt{10\times360}}$. A1: r = 1. B1: x = 20 is far outside the observed 1–5 hour range; the relationship may not continue. B1: Association in five observations does not control other causes, such as prior attainment; it does not establish causation.	Follow through a candidate's correctly calculated earlier summaries into the regression line and correlation coefficient where the later method is valid. Do not follow through a correlation coefficient outside [−1, 1]. Apply the general marking principles.	11
7	Journey times t minutes are grouped as $0\le t<10$, $10\le t<20$ and $20\le t<40$, with frequencies 8, 12 and 10. (a) Calculate the frequency density for each class. [3] (b) Explain why frequency, rather than frequency density, is unsuitable as the height of each histogram bar. [1]	B1: $\frac{8}{10}=0.8$. B1: $\frac{12}{10}=1.2$. B1: $\frac{10}{20}=0.5$. B1: Class widths differ; bar area, not height alone, must represent frequency.	No follow-through. Apply the general marking principles.	4

Q	Question / requirement	Solution and mark allocation	Alternatives / notes	Max
8	Parcel masses m kg are grouped as $0 \le m < 2$, $2 \le m < 4$, $4 \le m < 6$ and $6 \le m < 8$. Frequencies are 4, 10, 12 and 4 respectively. (a) Estimate the mean using class midpoints. [3] (b) Estimate the population standard deviation using $\sqrt{\frac{\sum f m^2}{\sum f} - \left(\frac{\sum f m}{\sum f}\right)^2}$, where m now denotes a midpoint. [3] (c) Give the cumulative frequencies at the four upper class boundaries. [1] (d) Estimate the median by linear interpolation. [2]	M1: Midpoints 1, 3, 5, 7 and $\sum f = 30$. A1: $\sum f m = 122$. A1: Estimated mean = $\frac{122}{30} = 4.07$ kg (3 s.f.). M1: $\sum f m^2 = 4 + 90 + 300 + 196 = 590$. M1: Variance = $\frac{590}{30} - \left(\frac{122}{30}\right)^2$. A1: Standard deviation = 1.77 kg (3 s.f.). B1: Cumulative frequencies 4, 14, 26, 30. M1: Median estimate = $4 + \frac{15 - 14}{12} \times 2$. A1: 4.17 kg (3 s.f.).	Follow through consistent candidate midpoints, totals or cumulative frequencies in later calculations where the stated method remains valid. Apply the general marking principles.	9
9	A factory uses machine A for 60% of its items and machine B for 40%. The probability an item is defective is 0.02 for A and 0.05 for B. (a) Draw a fully labelled probability tree. [4] (b) Find the probability a randomly chosen item is defective. [3] (c) Given that an item is defective, find the probability it came from B. [3] (d) Two items are selected independently from production. Find the probability both are non-defective. [2]	B1: First branches A 0.6 and B 0.4. B1: A defective branch 0.02. B1: A non-defective 0.98; B defective 0.05. B1: B non-defective 0.95 and correct tree connectivity. M1: Multiply along routes: 0.6 × 0.02 and 0.4 × 0.05. M1: Add route probabilities. A1: P(D) = 0.032. M1: Use $\frac{P(B \cap D)}{P(D)}$. A1: Numerator 0.02 and denominator 0.032. A1: $P(B \mid D) = 0.625$. M1: $(1 - 0.032)^2$. A1: 0.937024.	Follow through a candidate's earlier valid value for P(D) in parts (c) and (d) where the conditional-probability or complement method is correct. Apply the general marking principles.	12

Q	Question / requirement	Solution and mark allocation	Alternatives / notes	Max
10	In a group of 80 students, 45 study French, 32 study Spanish and 18 study both. (a) Draw a Venn diagram showing all four regions, including neither language. [3] (b) Find the probability a randomly chosen student studies exactly one language. [1] (c) Find P(French | Spanish). [2]	B1: Intersection 18. B1: French only 27 and Spanish only 14. B1: Neither 21, inside the universal set outside both circles. B1: $\frac{41}{80}$. M1: Use intersection divided by Spanish total. A1: $\frac{18}{32}=\frac{9}{16}$.	No follow-through. Apply the general marking principles.	6
11	P(A) = 0.4, P(B) = 0.3 and $P(A\cap B)$ = 0.12. (a) Determine, with a calculation, whether A and B are independent. [2] (b) Determine whether they are mutually exclusive. Explain. [1] (c) Find $P(A\cup B)$. [1]	M1: $P(A)P(B)=0.4\times0.3=0.12$. A1: Independent because this equals $P(A\cap B)$. B1: Not mutually exclusive because the intersection has positive probability. B1: 0.4 + 0.3 − 0.12 = 0.58.	No follow-through. Apply the general marking principles.	4
12	A discrete random variable X takes values 0, 1, 2 and 3 with probabilities 0.2, 0.3, k and 0.1 respectively. (a) Find k. [1] (b) Find E(X). [2] (c) Find P(X ≥ 2). [1]	B1: k = 0.4. M1: $E(X)=0\times0.2+1\times0.3+2\times0.4+3\times0.1$. A1: E(X) = 1.4. B1: 0.4 + 0.1 = 0.5.	No follow-through. Apply the general marking principles.	4
13	A seed germinates with probability 0.7 independently of other seeds. Ten seeds are planted. Let X be the number germinating. (a) State the distribution of X and its parameters. [1] (b) Find P(X = 8), to 3 significant figures. [3] (c) Find the probability that at least one seed germinates, to 6 decimal places. [2]	B1: X ~ Bin(10, 0.7). M1: $\binom{10}{8}\times0.7^8\times0.3^2$. A1: $45\times0.7^8\times0.3^2=0.2334744405$. A1: 0.233. M1: Use complement $1-0.3^{10}$. A1: 0.9999940951; A1: 0.999994 to 6 decimal places. The exact expression $1-0.3^{10}$ is method evidence only; it does not earn the final accuracy mark without the requested rounding.	No follow-through. Apply the general marking principles.	6

Q	Question / requirement	Solution and mark allocation	Alternatives / notes	Max
14	A supplier claims that 10% of its components fail a test. An engineer suspects the failure rate has increased. In a random sample of 20 components, 5 fail. Let X be the number of failures. Use a 5% significance level. Under X ~ Bin(20, 0.10), P(X ≥ 4) = 0.13295, P(X ≥ 5) = 0.04317 and P(X ≥ 6) = 0.01125. (a) State the null and alternative hypotheses. [2] (b) State two assumptions needed for the binomial model, in context. [2] (c) Give the p-value and the test decision, with justification. [3] (d) State the critical region and explain why its lower boundary is 5 rather than 4. [2] (e) Explain what a Type I error means here and give the actual significance level of this test. [2]	B1: $H_0: p = 0.10$, where p is the population failure probability. B1: $H_1: p > 0.10$. B1: Independent outcomes for the sampled components. B1: Constant failure probability across the sample, with each component classified fail/not fail. B1: One-sided p-value 0.04317. M1: Compare 0.04317 < 0.05. A1: Reject H_0; evidence at 5% that the failure rate has increased, not proof. B1: X ≥ 5. B1: P(X ≥ 4) exceeds 0.05 whereas P(X ≥ 5) does not. B1: Concluding the rate has increased when it is actually 0.10. B1: Actual significance 0.04317 = 4.317%.	No follow-through. Apply the general marking principles.	11
15	Package mass X is modelled as normal with mean 500 g and standard deviation 8 g. For a standard normal Z, Φ(−1.5) = 0.0668, Φ(1) = 0.8413 and Φ(1.5) = 0.9332, where Φ(z) = P(Z ≤ z). (a) Find P(X < 488). [2] (b) Find P(492 < X < 512). [3] (c) Estimate how many packages in a batch of 2,000 exceed 512 g. [2]	M1: $z = \frac{488 - 500}{8} = -1.5$. A1: 0.0668. M1: Standardised limits −1 and 1.5. M1: $\Phi(-1) = 1 - 0.8413 = 0.1587$. A1: 0.9332 − 0.1587 = 0.7745. M1: 2000(1 − 0.9332). A1: 133.6, about 134 packages.	No follow-through. Apply the general marking principles.	7

Q	Question / requirement	Solution and mark allocation	Alternatives / notes	Max
16	Battery life X hours follows a normal model with mean 40 and standard deviation 6. The manufacturer wants a warranty life w such that only 5% of batteries fail before w. Use Φ(−1.645) = 0.05. (a) Calculate w. [3] (b) Explain one reason the normal model may be unsuitable for a population containing two substantially different battery types. [2]	M1: P(X < w) = 0.05 and $\frac{w-40}{6}=-1.645$. M1: $w=40-1.645\times 6$. A1: w = 30.1 hours to 3 significant figures; 30.13 hours may be retained as an intermediate value. B1: The types may have different mean lifetimes/distributions. B1: Their mixture may be bimodal or non-normal, so one normal model can misstate the lower-tail warranty risk.	No follow-through. Apply the general marking principles.	5
17	The curve is $y=x^2+2x-3$. Find the equations of the tangent and the normal at x = 1.	B1: At x = 1, y = 0. B1: $\frac{dy}{dx}=2x+2$. A1: Tangent gradient 4. A1: Tangent $y=4(x-1)$, or $y=4x-4$. M1: Normal gradient $-\frac{1}{4}$. A1: Normal $y=-\frac{x-1}{4}$.	No follow-through. Apply the general marking principles.	6
18	For $f(x)=x^3-6x^2+9x+2$, find the coordinates of both stationary points and determine their nature.	B1: $f'(x)=3x^2-12x+9$. M1: Set $3(x-1)(x-3)=0$. A1: x = 1 and 3. A1: Points (1, 6) and (3, 2). M1: $f''(x)=6x-12$ gives −6 at x = 1 and 6 at x = 3. A1: Maximum at (1, 6); minimum at (3, 2).	No follow-through. Apply the general marking principles.	6
19	(a) Find $\int(6x^2-4x+3)\,dx$. [4] (b) Evaluate $\int_1^3(2x+1)\,dx$. [3] (c) The curve $y=x(4-x)$ meets the x-axis at x = 0 and x = 4. Find the area enclosed by the curve and the x-axis. [3]	B1: Integral term $2x^3$. B1: Integral term $-2x^2$. B1: Integral term 3x. B1: Include + C in the indefinite integral. M1: Antiderivative x^2+x. M1: (9 + 3) − (1 + 1). A1: 10. M1: Integrate $4x-x^2$ to $2x^2-\frac{x^3}{3}$. M1: Evaluate from 0 to 4. A1: $\frac{32}{3}$ square units.	No follow-through. Apply the general marking principles.	10

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20	An open-topped box is made by cutting squares of side x cm from each corner of a 30 cm by 20 cm rectangle and folding up the sides. Take 0 < x < 10. (a) Show that the volume is $V = 4x^3 - 100x^2 + 600x$. [3] (b) Find the value of x that maximises the volume, giving x to 3 significant figures. [5] (c) Calculate the maximum volume to the nearest cm³. [2] (d) State one physical assumption and explain its effect on the model. [2]	B1: Base dimensions 30 − 2x and 20 − 2x; height x. M1: $V = x(30-2x)(20-2x)$. A1: Correct expansion $4x^3 - 100x^2 + 600x$. B1: $V' = 12x^2 - 200x + 600$. M1: Set derivative to zero and use a valid quadratic-solving method. A1: $x = \frac{25 \pm 5\sqrt{7}}{3}$, approximately 3.92375 and 12.743. B1: Select x = 3.92 because the other root is outside 0 < x < 10. B1: $V'' = 24x - 200 < 0$ at this point (or derivative sign change from + to −); endpoints have zero volume. M1: Substitute unrounded feasible root into V. A1: 1056 cm³. B1: A relevant assumption, e.g. negligible material thickness/no folding loss. B1: Explain effect, e.g. real internal dimensions and capacity may be smaller because material has thickness.	Follow through a candidate's feasible stationary value from part (b) into part (c) when 0 < x < 10 and the maximum test is valid. Apply the general marking principles.	12
21	A triangular plot has two sides of 12 m and 15 m enclosing an angle of 40°. (a) Calculate the third side to 3 significant figures. [3] (b) Calculate the plot's area to 3 significant figures. [2] (c) A circular path has radius 12 m and central angle 40°. Find the arc length to 3 significant figures. [2]	M1: $c^2 = 12^2 + 15^2 - 2 \times 12 \times 15 \cos 40^\circ$. A1: $c^2 = 93.224000\ldots$. A1: c = 9.66 m. M1: Area = $\frac{1}{2} \times 12 \times 15 \sin 40^\circ$. A1: 57.9 m². M1: Arc = $12 \times \frac{40\pi}{180}$. A1: 8.38 m.	No follow-through. Apply the general marking principles.	7
22	Solve $\log_{10}(x-1) + \log_{10}(x+2) = 1$. Explain why one algebraic solution must be rejected.	M1: $\log_{10}[(x-1)(x+2)] = 1$. M1: $x^2 + x - 12 = 0$. A1: Algebraic roots x = 3 and x = −4. B1: Only x = 3 is valid because both logarithm arguments must be positive, requiring x > 1.	No follow-through. Apply the general marking principles.	4

Q	Question / requirement	Solution and mark allocation	Alternatives / notes	Max
23	(a) Simplify $\frac{x^2-9}{x^2+x-6}$, stating all exclusions from the original domain. [4] (b) Solve $x^2-5x+6>0$. [2] (c) A dataset has lower quartile 12 and upper quartile 20. Using the 1.5 × IQR rule, decide whether 34 is an outlier. Show your calculation. [2]	M1: Numerator $(x-3)(x+3)$. M1: Denominator $(x+3)(x-2)$. A1: $\frac{x-3}{x-2}$. B1: Exclude x = −3 and x = 2. M1: Factorise $(x-2)(x-3)$ and use sign analysis. A1: x < 2 or x > 3. M1: IQR = 8; upper fence = 20 + 1.5 × 8 = 32. A1: 34 is an upper outlier because 34 > 32.	No follow-through. Apply the general marking principles.	8