Mathematics S (950)

OVERALL PERFORMANCE

The number of candidates for this subject was 1659. The percentage of candidates who obtained a full pass was 57.32%, an increase of 0.23% compared with the previous year.

The achievement of candidates according to grades is as follows:

Grade	A	A–	B+	B	B–	C+	C	C–	D+	D	F
Percentage	3.44	3.19	6.45	8.98	8.86	13.69	12.71	3.86	6.87	3.98	27.97

RESPONSES OF CANDIDATES

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General comments

Generally, there were mixed performances from the candidates. The good candidates did not face much difficulty in answering and presenting their answers. The answers given were properly planned and well-organized. These candidates showed full understanding of the questions and concepts and also possessed the manipulative skills required of them.

The moderate candidates seem to understand the questions. However, they tend to make careless mistakes. They were not able to answer well the more difficult questions.

In contrast, the weaker candidates were weak in many aspects, such as in understanding the question, not knowing the concept, not knowing or remembering the formulae, and their answers were not well presented. The candidates were very weak in answering questions which involved reasoning, deduction and sketching of two curves.

Generally, many candidates were poor in presenting mathematical arguments logically. An example is seen in question 9, where they were asked to show that the function is decreasing. As for integration, they knew integration by parts but could not proceed integrating tan x. Candidates were also very weak in functions. They didn't understand the meaning of composite functions. Generally, candidates depended too much on the calculator, and thus, sometimes they were not able to think correctly of the answers. For example, given a polynomial, the candidates used the calculator first to obtain the roots or factors before actually factorizing the polynomial. Similarly, candidates also used the calculator to evaluate certain value of log such as $\log_3 y = \frac{1}{2} \Rightarrow y = 1.732$ instead of $\sqrt{3}$ which is the exact value of y.

Comments on individual questions

Question 1

This question requires candidates to use $T_n = S_n - S_{n-1}$ to determine the nth term. Then, using this result, deduce the type of progression by showing that $T_n - T_{n-1} = 6$ which is a constant. It is a straight forward question, but quite a number of candidates answered differently. In some cases, candidates first find the values of S_1, S_2 and S_3 followed by T_1, T_2 and T_3. Candidates then deduced that the common difference is 6, and thus, an arithmetic progression without first determining the nth term T_n. Quite a number of the candidates used $T_n = a + (n - 1)d$ to prove that it is an arithmetic progression without finding the nth term.

Answer: $T_n = 6 - 3n$

Question 2

In answering this question, candidates were expected to take log (ln) on both sides and to perform implicit differentiation. However, candidates were not familiar with variable x as the index (raised to power). Quite a number of candidates were confused between $(2x)^{2x}$ with a^x. Some candidates differentiated as $\frac{dy}{dx} = (2x)(2x)^{2x-1}$. Some candidates differentiated ln $(2x)$ as $\frac{1}{2x}$ and forgot to multiply it by 2.

Answer: $\frac{dy}{dx} = 2(2x)^{2x}[1 + \ln(2x)]$

Question 3

In this question, candidates were required to show $\frac{d}{dx}(\tan x) = \sec^2 x$. However, quite a number of candidates failed to express $\tan x = \frac{\sin x}{\cos x}$ and then differentiated it using the quotient rule. But the candidates did manage to use the result $\frac{d}{dx}(\tan x) = \sec^2 x$ in the next part of the question. Many candidates were able to apply the result in the integration by part of $\int_0^{\frac{\pi}{3}} x \sec^2 x \, dx$. There were also a significant number of candidates who did not know how to integrate tan x. Some evaluated it as $\int \tan x \, dx = \ln \cos x$ and forgot the negative sign. There were also candidates who did not know that $\tan \frac{\pi}{3} = \sqrt{3}$.

Answer: $\frac{d}{dx}(\tan x) = \sec^2 x$

Question 4

Majority of the candidates were able to use the factor theorem to solve for a and b. But quite a number of them factorized p(x) wrongly. They wrote $2 - x - x^2 = (x + 2)(x - 1)$. Although, they could obtain the values for a and b, the factorization for $p(x) = (x + 2)(x - 1)(2x + 1)$ led them to the wrong answer. Some candidates did not give their answers in the set form.

Answers: $a = -2$, $b = 5$; $\{x: -2 < x < \frac{1}{2}, x > 1\}$

Question 5

This is a straight forward question which most candidates were able to answer. They knew how to find the inverse of a matrix. Those who could not get the correct answer are mostly due to their carelessness in multiplication of matrices.

A number of candidates were confused with the cofactor, adjoint and transpose of a matrix. Some candidates did not express the matrices $\mathbf{A}^2$ and $\mathbf{A}^3$ in full and complete forms. Instead, they just evaluated only a few of the elements. This caused them to lose marks as marks are allotted for complete matrices.

Answer: $x = 2$

Question 6

This question was not answered well by the candidates. Many of them could not understand the question, and did not know what a composite function was. Some candidates expressed the composite function of f and g as the product of the functions.

Some of candidates did not have the skill to express x in terms of y or vice versa when finding $g(x)$. For candidates that were able to determine $g(x)$, some were not able to obtain the domain.

Answers: (*a*) $gx = \sqrt{\ln x - 2}$; $\{x : x \geqslant e^2\}$ (*b*) e^3

Question 7

Most candidates were able to answer this question well. Common mistakes made by the candidates were using the wrong formula/properties of logarithm and writing $(\log_3 x)(\log_3 y) = \log_3(x + y)$, $(\log_3 x)(\log_3 y) = \log_3 (x) + \log_3 (y)$, and $(\log_3 x)(\log_3 y) = \log_3 (xy)$. Some candidates gave their answers in decimal form instead of the exact value.

Answers: $x = 9$, $y = \sqrt{3}$; $x = \frac{1}{\sqrt{3}}$, $y = \frac{1}{9}$

Question 8

Most candidates were able to express the expression in partial fraction form. However, when showing sum to the nth terms, a majority of them did not show the second last term. As for the last part, when finding the sum to infinity, many candidates tended to write $\frac{1}{\infty}$ for $\lim_{n\to\infty} \frac{1}{n}$. Some candidates did not write appropriately or did not know that $S_\infty = \lim_{n\to\infty} S_n$. They also did not multiply with $\frac{1}{3}$ to get the final answer.

Answers: $\frac{3}{(3r-1)(3r+2)} = \frac{1}{3r-1} - \frac{1}{3r+2}$, $\frac{1}{6}$

Question 9

In part (*a*), some candidates expressed $f(x) = \frac{u}{v} = uv^{-1}$. So, instead of the using quotient rule to differentiate, they used the product rule. Generally, most candidates were able to differentiate using either the quotient or product rule.

In part (*b*), there were quite a number of the candidates that did not know how to show that $f'(x) < 0$. There were also candidates that did not know the concept of a decreasing function. Some were not aware of the relationship between negative gradient and decreasing function. Some candidates did not show that $x^2 + x + 1 > 0$, instead they just substituted the value. Basically, many candidates did not argue that since $1 + x + x^2 = \left(x + \frac{1}{2}\right)^2 + \frac{3}{4} > 0$, $(1 + x^2)^{\frac{3}{2}} > 0$ and $e^{-x} > 0$, thus, $f'(x) < 0$, which implies that f is a decreasing function. The candidates failed in completing the square and to conclude that f is a decreasing function. However, many were able to give a sketch of the graph.

Question 10

In part (*a*), quite a number of candidates were not able to find the inverse of f since they did not realize that they had to complete the square in order for them to express x in terms of y for $y = x^2 - x$. However, some of these candidates do realize that the domain of f^{-1} is the same as the range of f. So, they were able to state the domain of $x^2 - x$.

In part (*b*), quite a number of candidates did not realize that the intersection point of f and its inverse can also be found by finding the intersection of $x^2 - x$ and x since f and f^{-1} intersects on the line $y = x$.

In part (*c*), the candidates were able to sketch both graphs of f and its inverse since they knew the reflection property of f about the line $y = x$ gives the graph of f^{-1}.

Answers: (*a*) $f'(x) = \frac{1}{2} + \sqrt{x + \frac{1}{4}}$; Domain $f^{-1} = \left\{x : x \geqslant -\frac{1}{4}\right\}$; (*b*) (2, 2);

Question 11

This is a relatively easy question. Most candidates were able to answer part (*a*). As for part (*b*), a majority of the candidates were able to determine the equation of tangents by finding the derivative using implicit differentiation. For the weaker candidates, they failed to understand the question and went to find a line passing through *A* and *B* instead. Many candidates were also able to find the shortest distance using the distance formula since the equation of the line *AB* is given.

Answers: (*a*) $A(-\frac{1}{2}, 2)$, $B(1, -1)$; (*b*) $C\left(\frac{5}{2}, 5\right)$; (*c*) $d = \frac{9}{\sqrt{5}} = \frac{9\sqrt{5}}{5} = 4.02$

Question 12

In part (*a*), majority of the candidates understood the concept of rationalizing and writing z^2 in terms of its real and imaginary parts. However, many failed to understand that the imaginary part is a real number, and instead most of them wrote $-\frac{4}{25}i$ for the imaginary part. However, the candidates were still able to solve the equation to determine z_1 and z_2.

The aim of part (*b*) of this question is to establish the relationship between the roots of a real polynomial. Generally, in any polynomial, the roots need not be conjugates of each other. This property only holds for real polynomial. Candidates that answered the question in the sequence given and solved for *a* and *b* could easily find the second root and deduced the answer. However, there were some candidates that assumed the conjugate relationship before actually verifying it and used it to solve for *a* and *b*.

Answers: (*a*) $z^2 = \frac{3}{25} - \frac{4}{25}i$, Real part $= \frac{3}{25}$, Imaginary part $= -\frac{4}{25}$, $z_1 = \frac{1}{5}(2 - i)$, $z_2 = \frac{1}{5}(-2 + i)$;

(*b*) $a = 4$, $b = 1$ or $a = -4$, $b = 1$;

(*c*) $z_3 = \frac{2}{5} + \frac{1}{5}i$ or $z_3 = -\frac{2}{5} - \frac{1}{5}i$; z_1 and z_3 conjugate of each other

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General comments

In general, performance of candidates demonstrated a wide range of mathematical concepts and knowledge. Good performers showed systematic and critical thinking in their working; whereas weaker candidates showed little or no conceptual understanding at all in their presentation of answering the questions. Some of the mistakes made by the candidates were substituting wrong value, transferring wrong points, forgetting to label the vertical/horizontal axes. Basically, students were weak at answering questions on permutation and combination, conceptual and explanation.

Comments on individual questions

Question 1

This question was not well answered by the candidates, especially for part (*a*). They could not differentiate clearly the question on combination and permutation.

Answers: (*a*) 72; (*b*) $\frac{3}{5}$

Question 2

Candidates performed moderately. Among the mistakes made by candidates included the use of a scale which was too small and not consistent. They forgot to join the points plotted as required in the time series. Most of the candidates were unable to comment on the pattern of the time series.

Answers: (*b*) no specific pattern

Question 3

This question was quite well answered. Candidates tended to wrongly choose the sampling distribution. Parts from that, candidates forgot to square root and divide with n the sample size for the variance. Some candidates were not careful in choosing the correct sides with respect to the mean, where they are not sure on the negative and positive values when reading from the standard normal table.

Answers: (*a*) $\bar{X} \sim \mathrm{N}\left(20, \frac{6.25}{n}\right)$; (*b*) $n = 10$

Question 4

Most candidates were able to answer part (*a*), but failed to solve part (*b*) correctly.

Answers: (*a*) 0.59; (*b*) 0.05085

Question 5

In part (*a*), most candidates were able to answer correctly but they wrongly identify the midpoint of each class which produced "21730/200".

In part (*b*), the candidates answered poorly as they could not calculate "number of subscribers whose monthly....." correctly.

Answers: (*a*) RM 108.15; (*b*) 42%

Question 6

Many candidates were able to answer the question well, except for the probability distribution function. They did not write the final answer in the form of function. Some candidates were not able to use correct variance formulae.

Answers: (*b*) $E(X) = 4$, $\text{Var}(X) = 1\frac{1}{3}$

Question 7

Candidates were unable to answer the question satisfactorily.

In part (*a*), some candidates were unable to show the standard deviation as required.

In part (*b*), some candidates did not convert their answer in the form of percentage as required.

In part (*c*), most candidates did not attempt this part because they did not fully understand the question and were not aware of the necessary formulae.

Answers: (*b*) 11.5%; (*c*) 0.00152

Question 8

As for this question, candidates failed to use the correct notation for mean. They used the wrong sample of distribution. Some of the candidates even got confused with the population distribution.

In short, candidates failed to understand the meaning to the questions for part (*b*) and part (*c*) correctly.

Answers: (*a*) 0.6666; (*b*) 0.8664; (*c*) 0.0668

Question 9

Most candidates could not draw the network correctly. They missed to include the directed path and dummy activity. Candidates were also not able to differentiate between path and activity. They listed out the critical paths instead of critical activities.

In part (*c*), most candidates did not show the method used.

Answers: (*b*) *B, F*, 24 weeks; (*c*) *A, D, G*, 21 weeks

Question 10

This question was well answered by the candidates. But some were unable to interpret boxplots correctly. Among other mistakes made were forgetting the unit and not fully understand the meaning of words "skewed", "symmetrical" and "normal distribution". Most candidates were not aware of the sensitivity of mean and median to the outlier.

Answers: (*a*) RM 77 000, RM 65 000, RM 65 000, Program *A*
(*b*) Program *C*, symmetrical; (*c*) Program *B*; (*d*) skewed to the left, skewed to the right, symmetrical; (*e*) Mean is larger, median almost unaffected

Question 11

In parts (*a*) and (*b*), generally, these parts were well-answered.

In part (*c*), many candidates failed to understand the meaning of "percentage of variation", where r^2 should be calculated instead of r. Some candidates failed to change the final value into percentage.

Answers: (*b*) (i) $r = 0.781$ (ii) Quality of product has greater influence; (*c*) 61%

Question 12

This question was poorly answered. Many candidates did not find enough constraints from the given information. These leads to wrong initial tableau that produces wrong final answer.

Answers: (*b*) x_1 = RM 1 million, x_2 = RM 2.5 million, x_3 = RM 1.5 million;
(*c*) Fully utilized, $x_1 + x_2 + x_3$ = RM 5 million