Results of Secondary 3 Mathematics in Territory-wide System Assessment 2018

The percentage of Secondary 3 students achieving Mathematics Basic Competency in 2018 is 80.0%.

Secondary 3 Assessment Design

The design of assessment tasks for S.3 was based on the documents *Mathematics Curriculum: Basic Competency for Key Stage 3 (Tryout Version)* and *Syllabuses for Secondary Schools – Mathematics (Secondary 1 – 5), 1999*. The tasks covered the three dimensions of the mathematics curriculum, namely **Number and Algebra**, **Measures**, **Shape and Space**, and **Data Handling**. They focused on the Foundation Part of the S1 – 3 syllabuses in testing the relevant concepts, knowledge, skills and applications.

The Assessment consisted of various item types including multiple-choice questions, fill in the blanks, answers-only questions and questions involving working steps. The item types varied according to the contexts of the questions. Some test items consisted of sub-items. Besides finding the correct answers, students were also tested in their ability to present solutions to problems. This included writing out the necessary statements, mathematical expressions and explanations.

The Assessment consisted of 146 test items (198 score points), covering all of the 129 Basic Competency Descriptors. These items were organized into four sub-papers, each 65 minutes in duration and covering all three dimensions. Some items appeared in more than one sub-paper to act as inter-paper links and to enable the equating of test scores. Each student was required to attempt one sub-paper only. The number of items on the various sub-papers is summarized in Table 8.4. These numbers include several overlapping items.

Table 8.4 Number of Items and Score Points for S.3

Subject	No. of Items (Score Points)				
	Paper 1	Paper 2	Paper 3	Paper 4	Total*
Mathematics					
Written Paper					
Number and Algebra	22 (31)	22 (31)	20 (26)	21 (26)	64 (84)
Measures, Shape and Space	19 (24)	19 (24)	20 (27)	20 (28)	64 (84)
Data Handling	6 (10)	6 (10)	7 (12)	6 (11)	18 (30)
Total	47 (65)	47 (65)	47 (65)	47 (65)	146 (198)

* Items that appear in different sub-papers are counted once only.

The item types of the sub-papers were as follows:

Table 8.5 Item Types of the Sub-papers

Section	Percentage of Score Points	Item Types
A	~ 30%	• Multiple-choice questions: choose the best answer from among four options
B	~ 30%	• Calculate numerical values • Give brief answers
C	~ 40%	• Solve application problems showing working steps • Draw diagrams or graphs • Open-ended questions requiring reasons or explanations

Performance of Secondary 3 Students Achieving Basic Competence in Territory-wide System Assessment 2018

Secondary 3 Number and Algebra Dimension

S.3 students performed quite well in this dimension. The majority of students demonstrated recognition of the basic concepts of rational and irrational numbers, directed numbers, formulating problems with algebraic language and linear inequalities in one unknown. Performance was only fair in items related to numerical estimation, using percentages and manipulations of polynomials. Comments on students' performances are provided with examples cited where appropriate (question number *x* / sub-paper *y* quoted as Q*x*/M*y*). More examples may also be found in the section ***General Comments***.

Number and Number Systems

- Directed Numbers and the Number Line: Students were able to use directed numbers to represent the rise and drop in the water level. They could also demonstrate recognition of the ordering of integers on the number line and the basic operations of directed numbers.
- Numerical Estimation: The majority of students were able to determine whether the value mentioned in a simple context was obtained by estimation or by computation of the exact value. They could judge the reasonability of answers obtained. Nevertheless, half of the students were not able to estimate the values with reasonable justifications according to the question.

Q45/M4
Exemplar Item (Estimate the total amount needed for buying the souvenirs and judge whether the Student Union has enough money to buy them) Student Union of a school wants to buy <u>598</u> souvenirs for Sports Day. The price of each souvenir is $<u>29.9</u> . Student Union can only use $20 000 to buy the souvenirs. Based on the description above, give approximations for the **TWO UNDERLINED VALUES** respectively. Use these 2 approximations to estimate the total amount needed for buying the souvenirs and judge whether the Student Union has enough money to buy them. Briefly explain your estimation method.

Example of Student Work (Without giving approximations for the underlined values)

The total amount needed for buying the sovenirs
598 x $29.9
= $17880.2
∵ $20000 > $17880.2
∴ The Student Union has enough money to buy them.

∴ The Student Union *has / does not have enough money to buy the souvenirs.
(*Circle the correct answer)

Example of Student Work (Good performance)

598 souvenirs ≈ 600 souvenirs
Price $29.9 ≈ Price $30
The price
= $600 x 30
= $18000
∵ $20000 > $18000

∴ The Student Union *has / does not have enough money to buy the souvenirs.
(*Circle the correct answer)

- Approximation and Errors: Many students were able to convert a number in scientific notation to decimal. They also could round a number to 3 decimal places or 3 significant figures. However, only half of the students were capable of representing a small number in scientific notation.

- Rational and Irrational Numbers: Many students were able to represent a decimal on a number line. They were able to demonstrate recognition of the integral part of $\sqrt{a}$.

Comparing Quantities

- Using Percentages: The performance of students was fair in solving problems regarding simple selling, simple interest, compound interest and growths.

Q40/M2

Exemplar Item (Find the profit per cent)

The cost of a piece of jewellery is $5 000 . Kelly sells it for $6 500 . Find the profit per cent.

Example of Student Work (Mistakenly used $\frac{\text{selling price}-\text{cost}}{\text{selling price}}\times 100\%$ to calculate the profit per cent)

盈利百分率:

$\frac{6500-5000}{6500}\times 100\%$

$=\frac{1500}{6500}\times 100\%$

$=23\frac{1}{13}\%$

Example of Student Work (Correct solution)

盈利百分率: $\frac{6500-5000}{5000}\times 100\%$

$=30\%$

Q40/M1

Exemplar Item (Find the simple interest)

Mabel deposits $3 750 in a bank at a **simple interest rate** of 2% p.a. Find the interest she will receive after 3 years..

Example of Student Work (Confused simple interest with compound interest)

The interest she will receive

$3750(1+2\%)^3-3780$

$=3979.53-3750$

$=229.53$

$\therefore$ She will receive $229.53

Q41/M1

Exemplar Item (Find the present value)

The value of a pair of diamond earrings is increased by 5% per year. Mandy bought the earrings for $8 000 three years ago. Find the present value of the earrings.

Example of Student Work (Has mistakenly calculated the increase in value)
The value : $8000 \times (1+5\%)^3 - 8000$ $= 261$ ∴ the value is \$261.

Example of Student Work (Confused growth with depreciation)
$\$8000 \times (1-5\%)^3$ $= \$6859$ The present value of the earrings are \$6859

- Rate and Ratio: The performance of students was satisfactory. They were able to use rate and ratio to solve simple real-life problems and demonstrate recognition of the difference between rate and ratio.

Observing Patterns and Expressing Generality

- Formulating Problems with Algebraic Language: Many students were capable of substituting values into some common and simple formulas and finding the value of a specified variable. They could also write down the next few terms in geometric sequences from several consecutive terms that were given, translate word phrases/contexts into algebraic languages and formulate simple equations. However, only some students were able to distinguish the difference between $(-2)^n$ and $-2n$.
- Manipulations of Simple Polynomials: The majority of students were able to deal with the additions, subtractions and expansions of simple polynomials. They were also able to distinguish polynomials from algebraic expressions, but many of them could not demonstrate recognition of terminologies such as number of terms.

Q22/M4
Exemplar Item (Terminologies of polynomials) Write down the number of terms of the polynomial $8y^3 + 12y^2 + 5y - 27$.
Example of Student Work (Confused the number of term with the degree) 多項式的項數是 3 。
Example of Student Work (Confused the number of term with the constant) 多項式的項數是 -27 。

- Laws of Integral Indices: Students had steady performance in using the laws of integral indices to simplify simple algebraic expressions.

Q41/M2
Example of Student Work (Has mistakenly taken $(x^m)^n = x^{m^n}$) a) $(x^2)^6$ $= x^{64}$ b) $\frac{(x^2)^6}{x^{-5}}$ $= \frac{x^5 x^{64}}{1} = \frac{x^{69}}{1} = x^{69}$
Example of Student Work (Has mistakenly taken $(x^m)^n = x^{m+n}$) (a) $(x^2)^6$ $= x^8$ (b) $\frac{(x^2)^6}{x^{-5}}$ $= \frac{x^8}{x^{-5}}$ $= x^{8-5}$ $= x^3$
Example of Student Work (Has mistakenly taken $\frac{1}{x^{-m}} = x^{-m}$ in part (b)) (a) $(x^2)^6 = x^{2\cdot 6} = x^{12}$ (b) $\frac{(x^2)^6}{x^{-5}} = \frac{x^{12}}{x^{-5}} = x^{12-5} = x^7$
Example of Student Work (Correct solution) a) $(x^2)^6$ $= x^{12}$ b) $\frac{(x^2)^6}{x^{-5}}$ $= \frac{x^{12}}{x^{-5}}$ $= x^{12-(-5)}$ $= x^{17}$

- Factorization of Simple Polynomials: Students were able to demonstrate recognition of factorization as a reverse process of expansion. They did quite well in factorizing simple polynomials by using the difference of two squares, perfect square expressions, cross method and by taking out common factors. However, a small proportion of students still could not factorize simple polynomials by the relevant methods.

Q27/M1
Exemplar Item (Factorize the expression by using the difference of two squares) Factorize $x^2 - 49$.
Example of Student Work (Not able to factorize the expression by using the difference of two squares) (1) $(x-49)(x)$ (2) $(x^2-7)(x^2+7)$ (3) $x(x-49)$ (4) $(x-49)(x+49)$

Q27/M3
Exemplar Item (Factorize the expression by using the cross method) Factorize $x^2 + 10x + 9$.
Example of Student Work (Not able to factorize the expression by using the cross method) (1) $x(x+10)9$ (2) $(x+3)(x+3)$ (3) $(x-1)(x-9)$ (4) $(1+x)(10+9)$

Algebraic Relations and Functions

- Linear Equations in One Unknown: The majority of students were able to formulate equations from simple contexts and solve simple equations. However, more than half of the students were not able to demonstrate understanding of the meaning of roots of equations.
- Linear Equations in Two Unknowns: The performance of students in plotting graphs of linear equations in 2 unknowns was fair. They were quite good in solving a system

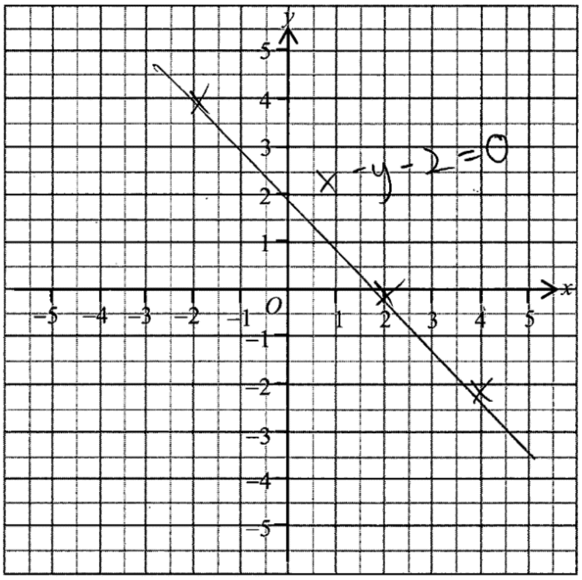
of simple linear simultaneous equations by algebraic methods and formulating simultaneous equations from simple contexts, but a small proportion of students could not do correct computation, provide complete solution or solve a system of simple linear simultaneous equations by algebraic methods. Moreover, they were able to demonstrate recognition that graphs of equations of the form $ax + by + c = 0$ are straight lines.

Q44/M2

Example of Student Work (Could not find the correct values of y)

$x - y - 2 = 0$

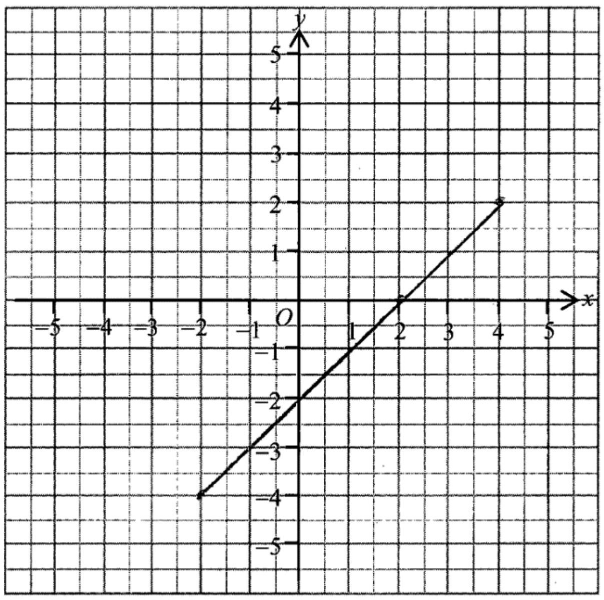
x	–2	2	4
y	4	0	-2



Example of Student Work (Did not extend at two ends)

$x - y - 2 = 0$

x	–2	2	4
y	–4	0	2



Q42/M1

Example of Student Work (Solving simultaneous equations – although the student knew how to use the method of substitution, mistakes occurred in the computation)

$$\begin{cases} 3x + 5y = 31 \quad ① \\ 3x - 5y = 11 \quad ② \end{cases}$$

$$x = \frac{11+5y}{3} \quad ③$$

Sub ③ into ①

$$3\left(\frac{11+5y}{3}\right) + 5y = 31$$

$$\frac{33+15y}{9} + 5y = 31$$

$$33 + 15y + 45y = 279$$

$$y = 4.1$$

$$3x - 5(4.1) = 11$$

$$x = 10.5$$

Example of Student Work (Solving simultaneous equations – only *x* was solved)

$$3x + 5y = 31$$

$$5y = 31 - 3x$$

$$3x - (31 - 3x) = 11$$

$$3x - 31 + 3x = 11$$

$$6x = 42$$

$$x = 7$$

Example of Student Work (Correct solution)

$$\begin{cases} 3x + 5y = 31 - ① \\ 3x - 5y = 11 - ② \end{cases}$$

① + ②

$$6x = 42$$

$$x = 7$$

代 $x = 7$ 入 ①

$$3(7) + 5y = 31$$

$$5y = 10$$

$$y = 2$$

$$\therefore x = 7, \ y = 2$$

- Identities: Many students were able to distinguish identities from equations. About half of them could not expand simple algebraic expressions by using the difference of two squares.

Q26/M3	
Exemplar Item (Expand algebraic expressions by using the difference of two squares) Expand $(2x+y)(2x-y)$.	
Example of Student Work	
(1) $4x^2 - 4xy + y^2$	(Mistakenly took $(a-b)(a+b) = (a-b)^2$)
(2) $(2x+y)^2$	(Mistakenly took $(a-b)(a+b) = (a+b)^2$)
(3) $4x^2 - 2xy + 2yx - y^2$	(Did not give the answer in the simplest form)

- Formulas: The majority of students were able to find the value of a specified variable in the formula. However, their performance in manipulating of algebraic fractions and performing change of subject in simple formulas was not satisfactory.

Q27/M4	
Exemplar Item (Change of subject) Make B the subject of the formula $A = 12 - 5B$.	
Example of Student Work	
(1) $\frac{12+A}{-5} = B$	(Wrong computation)
(2) $B = 12 - 5A$	(Mistakenly thought that change of subject was just a direct exchange of A and B)

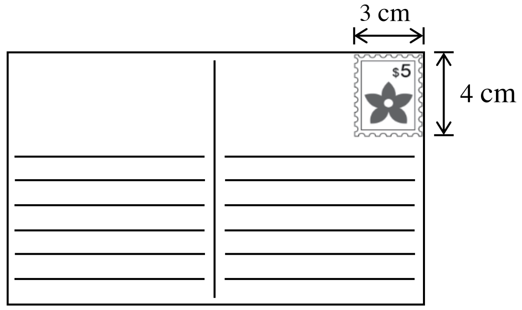
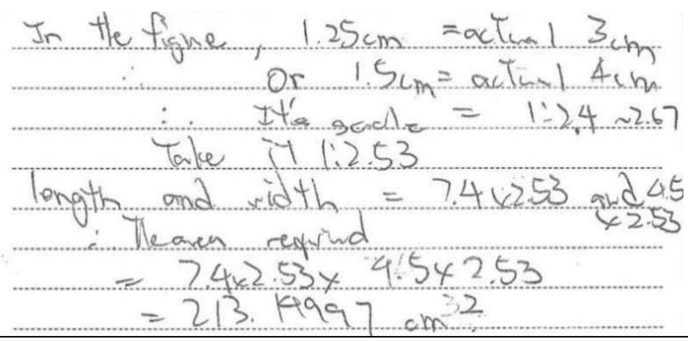
- Linear Inequalities in One Unknown: The performance of students was good. They did well in using inequality signs to compare numbers and formulating linear inequalities in one unknown from simple contexts. Their performance was fair in solving simple linear inequalities.

Secondary 3 Measures, Shape and Space Dimension

S.3 students performed quite well in this dimension. They were able to perform simple calculations regarding transformation and symmetry, areas and volumes, trigonometric ratios and quadrilaterals. However, more improvement could be shown in items related to coordinate geometry and deductive geometry. Comments on students' performances are provided with examples cited where appropriate (question number *x* /sub-paper *y* quoted as Q*x*/M*y*). More items may also be found in the section ***General Comments***.

Measures in 2-D and 3-D Figures

- Estimation in Measurement: The majority of students were able to choose an appropriate unit and the degree of accuracy for real-life measurements, find the range of measures from a measurement of a given degree of accuracy and select the appropriate ways to reduce errors in measurements. However, their performance in estimating measures with justification was only fair.

Q45/M3
Exemplar Item (Estimate the area of the postcard) The figure shows a stamped postcard. The length and width of the stamp are 3 cm and 4 cm respectively. Estimate the area of the postcard and explain your estimation method. 
Example of Student Work (Calculated the area of the postcard by measurement and conversion) 

Example of Student Work (Estimated with reasonable justification)

Estimated area
(3×6)×(4×3)
= 216 cm² //

The width of postcard is like the 3 times of the length of the stamp so it's (4×3) cm, and the length of the postcard is like the 6 times of the width of stamp, so it is (3×6) cm //

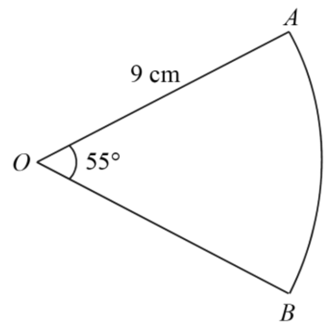
- Simple Idea of Areas and Volumes: Many students were able to use the formulas for areas of circles and surface areas of cubes. Their performance in using the formula for volumes of cylinders was quite good.

- More about Areas and Volumes: Many students were capable of calculating arc lengths, areas of sectors, volumes of circular cones and surface areas of spheres. They showed improvement in distinguishing among formulas for lengths, areas, volumes by considering dimensions, but only almost half of them were able to use the relationships between sides and surface areas of similar figures to solve related problems.

Q46/M4

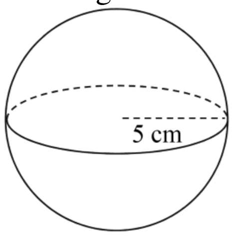
Exemplar Item (Find the area of the sector)

In the figure, the radius of sector OAB is 9 cm and $\angle AOB = 55°$. Find the area of the sector. Give the answer correct to 3 significant figures.



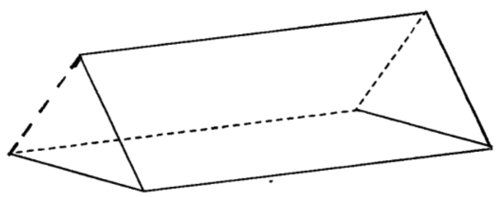
Example of Student Work (Has mistakenly calculated the arc length of the sector and missing the unit)

扇形面積 $= 2\pi(9)\times\frac{55°}{360°}$
$= 8.64$

Q45/M2
Exemplar Item (Find the surface area of the sphere) The figure shows a sphere of radius 5 cm . Find the surface area of the sphere. Give the answer correct to 3 significant figures. 
Example of Student Work (Missing the unit) 球体的表面面積. $4\pi r^2$ $4\pi \times 5^2$ = 314 (準確至3位有效數字).

Learning Geometry through an Intuitive Approach

- Introduction to Geometry: Most students could use notations to represent angles and identify 3-D solids from given nets. Many students were able to sketch simple solids, identify types of angles with respect to their sizes and identify cross-sections of given solids. However, they were weak in identifying convex polygons.

Q28/M3
Example of Student Work (Form a diagram of a triangular prism - Inappropriate use of solid lines and dotted lines) 

- Transformation and Symmetry: Students were able to determine the number of axes of symmetry and the order of rotational symmetry from a figure. They could also identify the image of a figure and the effect on the size and shape under a single transformation.

- Congruence and Similarity: Students demonstrated recognition of the conditions for similar triangles. They could apply the properties of congruent and similar triangles to find the sizes of angles and the lengths of sides in general. However, a small proportion of students confused the reasons for similar triangles with that for congruent triangles when identifying two similar triangles.

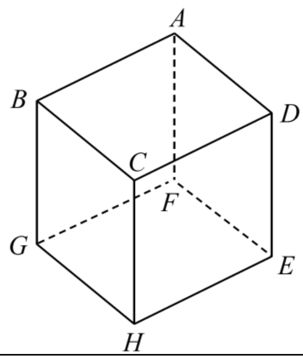
- Angles related with Lines and Rectilinear Figures: Students did well in solving simple geometric problems like using the properties of angles of triangles, using the relations between sides and angles associated with isosceles/equilateral triangles and using the formula for the sums of the exterior angles of convex polygons.

- More about 3-D Figures: Students were able to identify planes of reflectional symmetries, axes of rotational symmetries and the nets of cubes. They could also match 3-D objects built up of cubes from 2-D representations from various views. In addition, more than half of the students were able to name the angle between a line and a horizontal plane or the angle between 2 planes.

Q34/M4

Exemplar Item (Name the angle between two planes)

The figure shows a cube *ABCDEFGH* . By using the vertices in the figure, name the angle between the plane *ABHE* and the vertical plane *CHED* .



Example of Student Work (Not able to name the correct angle)

(1) $\angle CHG$

(2) $\angle BGH$

(3) $\angle GHB$ 、 $\angle AEC$

(4) $\angle BHE$.

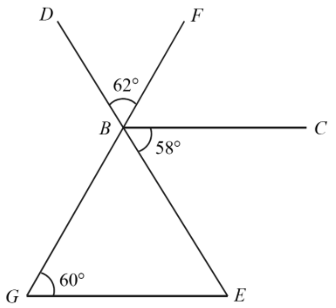
Learning Geometry through a Deductive Approach

- Simple Introduction to Deductive Geometry: More than half of the students were able to identify medians of a triangle. They could write the correct steps of a geometric proof and use the conditions for similar triangles to perform simple proofs, but many of them could not provide sufficient reasons or complete the proof correctly.

Q46/M3

Exemplar Item (Geometric proof)

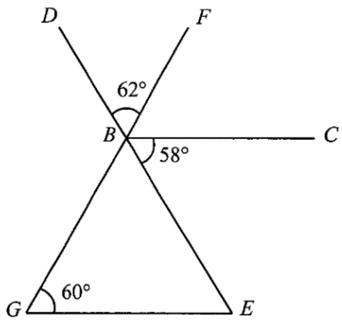
In the figure, DBE and FBG are straight lines. $\angle DBF = 62°$, $\angle CBE = 58°$ and $\angle BGE = 60°$. Prove that $BC \parallel GE$.



Example of Student Work (Incorrect logical reasoning in the proof – used the conclusion $BC \parallel GE$ as a reasoning)

$\because \angle BGE = \angle FBC$ (同位角)

$\therefore GE \parallel BC$



Example of Student Work (Not able to provide sufficient reasons)

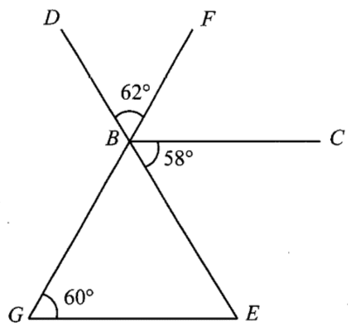
$\angle GBE = 62°$

$\angle GEB = 180° - 62° - 60°$

$= 58°$

$\because \angle CBE = \angle GEB$

$\therefore BC \parallel GE$



Example of Student Work (Good performance)

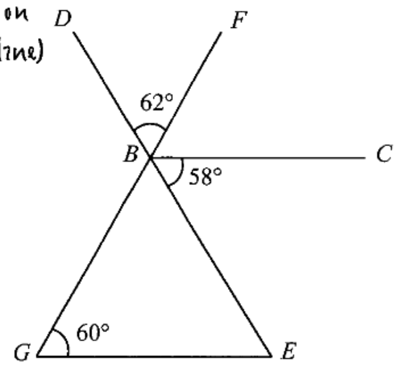
$\angle FBC + 62^\circ + 58^\circ = 180^\circ$ (adj. $\angle$s on straight line)

$\angle FBC = 60^\circ$

$\because \angle BGE = 60^\circ$ (given)

$\angle BGE = \angle FBC = 60^\circ$

$\therefore BC \parallel GE$ (corr. $\angle$s equal)

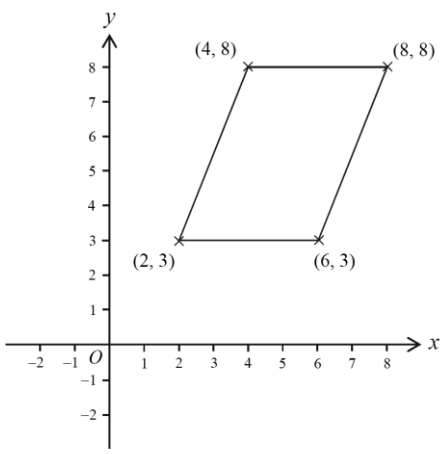


- Pythagoras' Theorem: Many students were able to use Pythagoras' Theorem and the converse of Pythagoras' Theorem to solve simple problems.
- Quadrilaterals: The performance of students in using the properties of squares in numerical calculations was very good.

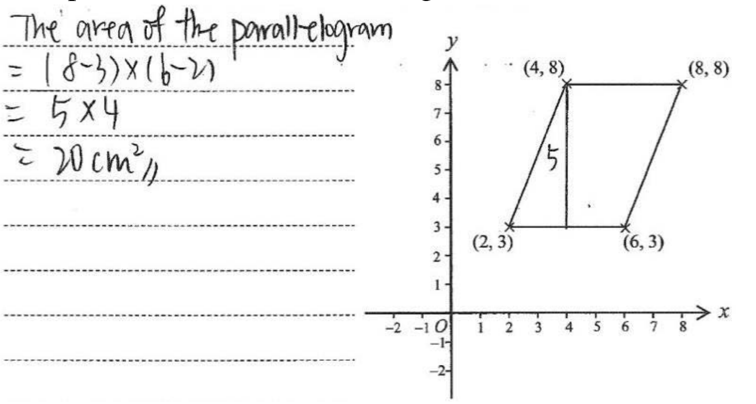
Learning Geometry through an Analytic Approach

- Introduction to Coordinates: Students could grasp the basic concepts of the rectangular coordinate system, but they were quite weak in problems regarding polar coordinates. They were able to match a point under a single transformation with its image in the rectangular coordinate plane, but there was room for improvement in calculating areas of simple figures.

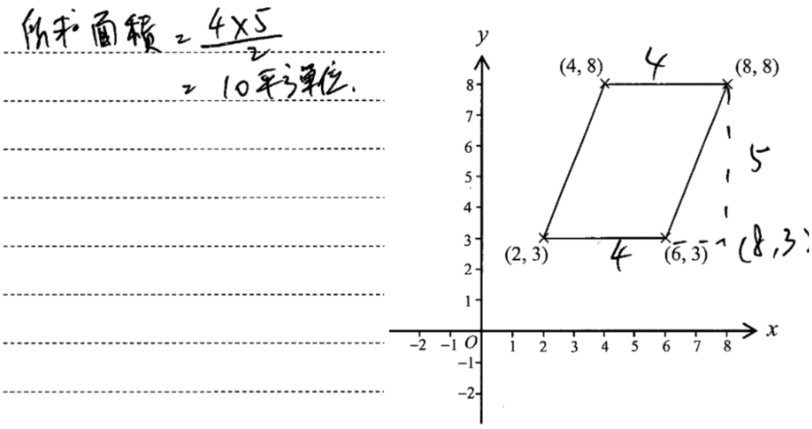
Q42/M3
Exemplar Item (Calculating areas of simple figures) Find the area of the parallelogram in the figure.



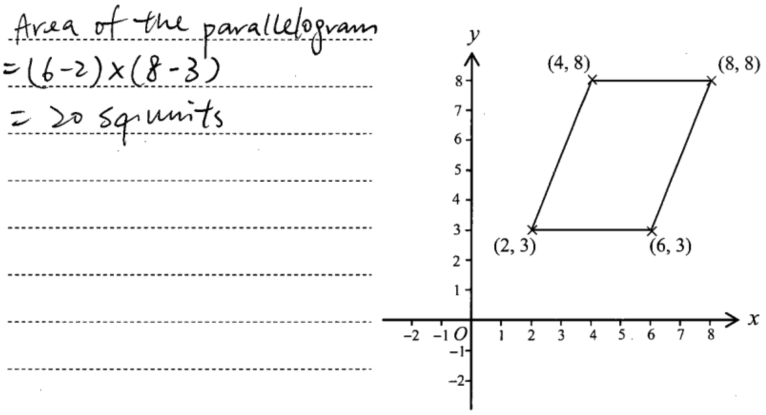
Example of Student Work (Wrong unit)



Example of Student Work (Wrong formula was used to find the area of the parallelogram)



Example of Student Work (Good performance)



- Coordinate Geometry of Straight Lines: Many students were able to use distance formula, the formula of finding slopes and the mid-point formula. Their performance was only fair in demonstrating recognition of the conditions for parallel lines.

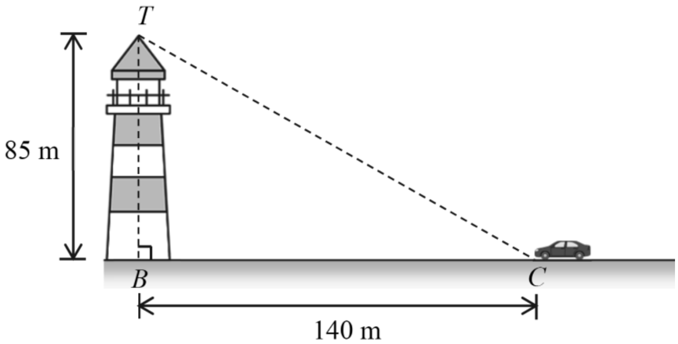
Trigonometry

- Trigonometric Ratios and Using Trigonometry: Students had the basic concepts of trigonometric ratios. They could find the tangent ratios for angles and vice versa. Their recognition of the concepts of bearing was good. They were able to solve 2-D problems involving one right-angled triangle.

Q42/M4

Exemplar Item (Finding the angle of elevation)

The figure shows a lighthouse TB. A car is located at point C which lies on the same horizontal plane with point B. It is given that $TB \perp BC$, $TB = 85$ m and $BC = 140$ m. Find the angle of elevation of T from C. (Correct to 3 significant figures)



Example of Student Work (Misunderstood the angle of elevation)

$\tan \angle TCB = \frac{85}{140}$

$\angle TCB = 31.3°$

$31.3° + 90° + \angle CTB = 180°$ (△內角和)

$\angle CTB = 58.7°$

∴ 由C測得T的仰角是58.7°

Example of Student Work (Confused opposite sides with adjacent sides)

$\tan \theta = \frac{140}{85}$

$\theta = 58.7°$

Example of Student Work (Good performance)

$\tan \angle TCB = \frac{85}{140}$

$\angle TCB = 31.3°$

∴ 由C測得T的仰角為31.3°

Secondary 3 Data Handling Dimension

The performances of S.3 students were quite good in this dimension. They were able to construct and interpret statistical charts, organize the same set of data by different grouping methods, find mean and median from a set of ungrouped data and calculate probabilities. However, performance was weak when students were asked to choose appropriate diagrams/graphs to present a set of data. They were not able to identify sources of deception in cases of misuse of averages. Comments on students' performance are provided below with examples cited where appropriate (question number *x* / sub-paper *y* quoted as Q*x*/M*y*). More examples may also be found in the section ***General Comments***.

Organization and Representation of Data

- Introduction to Various Stages of Statistics: Students were able to demonstrate recognition of various stages of statistics, use simple methods to collect data and organize the same set of data by using different grouping methods. More than half of the students could distinguish between discrete and continuous data.

- Construction and Interpretation of Simple Diagrams and Graphs: The majority of students could interpret stem-and-leaf diagrams and construct simple statistical charts. Their performance was good. However, more than half of the students could not choose appropriate diagrams/graphs to present a set of data.

Q47/M2

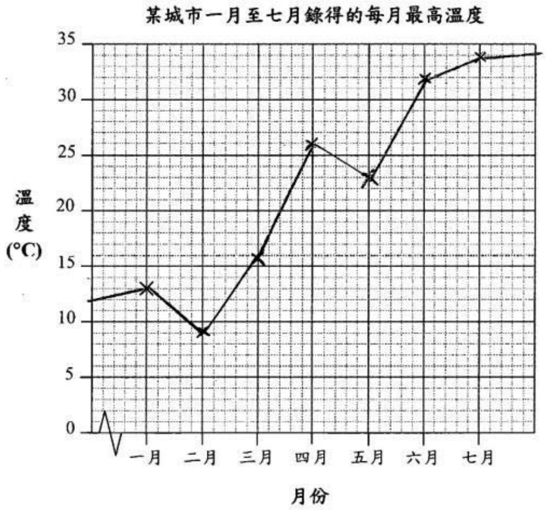
Exemplar Item (Drawing a broken line graph)

The table below shows the highest temperature (correct to the nearest °C) of each month recorded from January to July in a city.

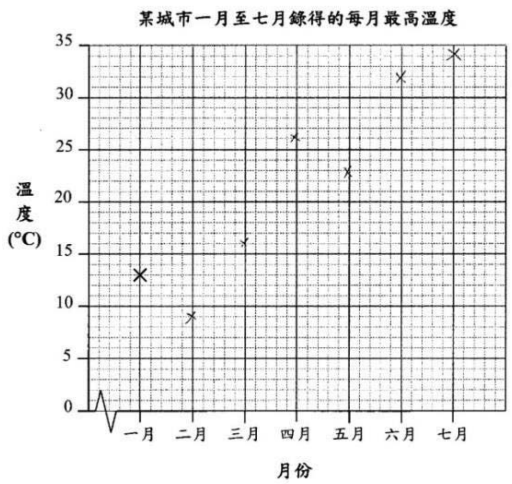
Month	January	February	March	April	May	June	July
Highest temperature (°C)	13	9	16	26	23	32	34

Draw a broken line graph in the **ANSWER BOOKLET** to represent the above data.

<table>
<tr><td>
Example of Student Work (Construct broken line graphs – Mistakenly extended at two ends)



</td></tr>
<tr><td>
Example of Student Work (Construct broken line graphs – Did not join all the points with straight lines)



</td></tr>
</table>

Analysis and Interpretation of data

- Measures of Central Tendency: The majority of students were able to find the mean and median from a set of ungrouped data. They could also find modal class from a set of grouped data. A considerable number of students could calculate the weighted mean of a set of data. However, they were quite weak in identifying sources of deception in cases of misuse of averages.

Q47/M3

Exemplar Item (Find mean from a set of grouped data)

The table below shows the amount raised by 40 students taking part in a charity walk.

Amount ($)	100 – 124	125 – 149	150 – 174	175 – 199
Frequency	8	14	16	2

Find the mean of the amount raised by the 40 students.

Example of Student Work (Did not consider the frequencies in the calculation of the amount raised)

平均數：

(112+137+162+187) ÷ (8+14+16+2)

= 598 ÷ 40

= $14.95

Example of Student Work (Did not consider the frequencies)

算術平均數：$\frac{112+137+162+187}{4}$

= $149.5

Q47/M1

Exemplar Item (Identify sources of deception)

The football team, Blue Fighter, participated in 20 matches last year. The results are shown below:

Result	Win	Draw	Lose
Number of matches	8	7	5

It is given that the mode of the results in these 20 matches is “Win”.
Hence the captain claims, “More than half of the results are ‘Win’ in these 20 matches.”
Do you agree with the captain’s claim? Explain your answer.

Example of Student Work (Stating the half number of matches only, without further explanation as to why the student didn't agree with the captain's saying)

理由：

不同意，因為20的一半是10，但勝卻只得8場。

∴我 * 同意 / 不同意 該隊長的宣稱。 (*圈出正確答案)

Example of Student Work (Good performance)

Reason:

No, I don't agree with captain. Although the mode of the results in 20 matches is "Win", however it only happened eight time, while the team may at least win 11 times if they claim more than half of the results are "Win". And obviously $11 > 8$. Therefore I disagree with captain's claim.

∴ I * agree / disagree with the captain's claim. (*Circle the correct answer)

Probability

- Simple Idea of Probability: Students' performance in calculating the theoretical probability by listing was good. It was better than that of calculating the empirical probability.

General Comments on Secondary 3 Student Performances

The overall performance of S.3 students was satisfactory. They did quite well in the Measures, Shape and Space Dimension and in the Data Handling Dimension. Performance was steady in the Number and Algebra Dimension.

The areas in which students demonstrated adequate skills are listed below:

Directed Numbers and the Number Line

- Use positive numbers, negative numbers and zero to describe situations like profit and loss, floor levels relative to the ground level (e.g. Q21/M2).
- Demonstrate recognition of the ordering of integers on the number line (e.g. Q21/M1).

Numerical Estimation

- Determine whether to estimate or to compute the exact value in a simple context (e.g. Q1/M1).

Rational and Irrational Numbers

- Represent real numbers on the number line (e.g. Q23/M2).

Formulating Problems with Algebraic Language

- Translate word phrases/contexts into algebraic languages (e.g. Q3/M2).

Manipulations of Simple Polynomials

- Multiply a binomial by a monomial (e.g. Q25/M3).

Laws of Integral Indices

- Use the laws of integral indices to simplify simple algebraic expressions (e.g. Q4/M3).

Factorization of Simple Polynomials

- Demonstrate recognition of factorization as a reverse process of expansion (e.g. Q5/M1).

Formulas

- Substitute values of formulas (in which all exponents are positive integers) and find the value of a specified variable (e.g. Q29/M3).

Linear Inequalities in One Unknown

- Use inequality signs $\geq$, $>$, $\leq$ and $<$ to compare numbers (e.g. Q30/M2).
- Formulate linear inequalities in one unknown from simple contexts (e.g. Q8/M1).

Estimation in Measurement

- Find the range of measures from a measurement of a given degree of accuracy (e.g. Q9/M2).
- Choose an appropriate unit and the degree of accuracy for real-life measurements (e.g. Q10/M2).

Simple Idea of Areas and Volumes

- Use the formulas for volumes of prisms and cylinders (e.g. Q41/M3).

Introduction to Geometry

- Use common notations to represent points, line segments, angles and polygons (e.g. Q12/M1).
- Make 3-D solids from given nets (e.g. Q13/M1).

Transformation and Symmetry

- Name the single transformation involved in comparing the object and its image (e.g. Q14/M1).
- Demonstrate recognition of the effect on the size and shape of a figure under a single transformation (e.g. Q13/M2).

Congruence and Similarity

- Demonstrate recognition of the properties of congruent and similar triangles (e.g. Q33/M1 and Q33/M2).

Angles related with Lines and Rectilinear Figures

- Use the relations between sides and angles associated with isosceles/equilateral triangles to solve simple geometric problems (e.g. Q34/M2).

More about 3-D Figures

- Identify the nets of cubes, regular tetrahedra and right prisms with equilateral triangles as bases (e.g. Q15/M3).

Quadrilaterals

- Use the properties of parallelograms, squares, rectangles, rhombuses, kites and trapeziums in numerical calculations (e.g. Q33/M3).

Introduction to Coordinates

- Use an ordered pair to describe the position of a point in the rectangular coordinate plane and locate a point of given rectangular coordinates (e.g. Q34/M3).

Trigonometric Ratios and Using Trigonometry

- Find the sine, cosine and tangent ratios for angles between 0° to 90° and vice versa (e.g. Q18/M3).

Introduction to Various Stages of Statistics

- Organize the same set of data by different grouping methods (e.g. Q37/M2).

Construction and Interpretation of Simple Diagrams and Graphs

- Construct simple statistical charts (e.g. Q47/M2).
- Interpret simple statistical charts (e.g. Q38/M1 and Q38/M3).

Measures of Central Tendency

- Find the mean, median and mode from a set of ungrouped data (e.g. Q39/M1).

Simple Idea of Probability

- Calculate the theoretical probability by listing (e.g. Q47/M4).

Other than items in which students performed well, the assessment data also provided some entry points to strengthen learning and teaching. Items worthy of attention are discussed below:

Formulating Problems with Algebraic Language

- Distinguish the difference between $2x$ and $2 + x$; $(-2)^n$ and -2^n; x^2 and $2x$, etc (e.g. Q3/M1): Only some students chose the correct answer, option D. Nearly 40% of students chose options A. They might not know $(-a)^2 = a^2$ and $-(-a^2) = a^2$.

Q3/M1
$(-a)^2 - (-a^2) =$ A. 0. B. a^4. C. $-2a^2$. D. $2a^2$.

Manipulations of Simple Polynomials

- Distinguish polynomials from algebraic expressions (e.g. Q4/M2): Quite a number of students chose the correct answer, option B. However, nearly 30% of students chose option C or option D. They were not able to recognize that $6\sqrt{x}$ or $6x^{-10}$ cannot be a term of a polynomial.

Q4/M2
Which of the following is a polynomial? A. $4x^3 - 5x^2 + \frac{6}{x} + 1$ B. $4x^3 - 5x^2 + 6x + 1$ C. $4x^3 - 5x^2 + 6\sqrt{x} + 1$ D. $4x^3 - 5x^2 + 6x^{-10} + 1$

Linear Equations in One Unknown

- Demonstrate understanding of the meaning of roots of equations (e.g. Q3/M4): More than half of the students could not choose the correct answer, option C. Students are expected to find out which equation with the root 20 by the method of substitution instead of solving each equation one by one.

Q3/M4
Which of the following is an equation with the root 20? A. $x + 20 = 0$ B. $20x - 1 = 0$ C. $\frac{x}{20} - 1 = 0$ D. $\frac{x}{20} + 1 = 0$

Estimation in Measurement

- Choose an appropriate measuring tool and technique for real-life measurements (e.g. Q8/M4): Quite a number of students chose the correct answer, option A. However, more than 20% of students still chose option C. Although they could choose an appropriate measuring tool, they were not able to recognise that measuring a larger number of identical objects together can reduce errors in measurement.

Q8/M4

Ruler *A* Ruler *B*

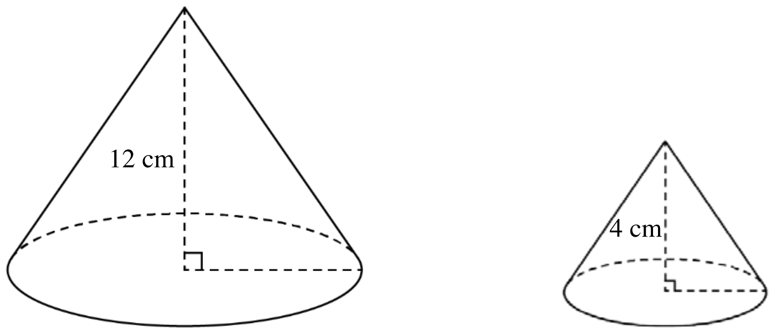
The above figure shows Ruler *A* and Ruler *B* with different graduations. Betty wants to find the thickness of a twenty-dollar note. Which of the following methods is the best?

A. Betty uses Ruler *A* to measure the thickness of 40 twenty-dollar notes and then divides the thickness by 40 .
B. Betty uses Ruler *B* to measure the thickness of 40 twenty-dollar notes and then divides the thickness by 40 .
C. Betty uses Ruler *A* to measure the thickness of a twenty-dollar note.
D. Betty uses Ruler *B* to measure the thickness of a twenty-dollar note.

More about Areas and Volumes

- Use the relationships between sides and surface areas/volumes of similar figures to solve related problems (e.g. Q11/M2): Almost half of the students chose the correct answer, option C, but more than 40% of students still chose option A. Those students mistakenly took the ratio of the total surface areas of two similar solids as the ratio of their corresponding heights. Moreover, almost 10% of students chose B. They mistakenly thought that the total surface area of Cone *B* is $\frac{1}{6}$ times that of Cone *A*.

Q11/M2
In the figure, Cone A and Cone B are similar solids. Their heights are 12 cm and 4 cm respectively. The total surface area of Cone A is $108\pi\,\text{cm}^2$. Find the total surface area of Cone B.



Cone A Cone B

A. $36\pi\,\text{cm}^2$

B. $18\pi\,\text{cm}^2$

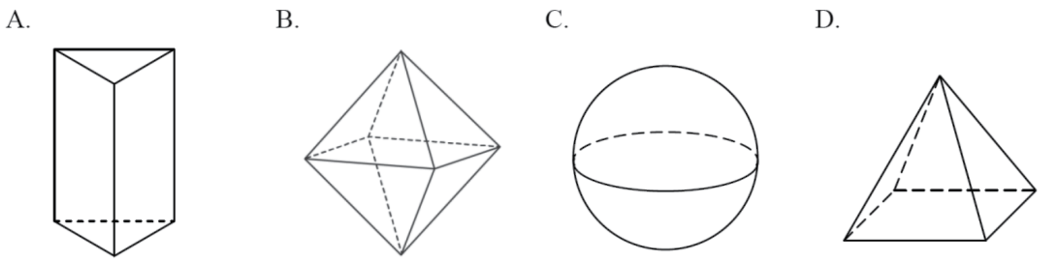
C. $12\pi\,\text{cm}^2$

D. $4\pi\,\text{cm}^2$

Introduction to Geometry

- Demonstrate recognition of common terms in geometry (e.g. Q11/M1): Quite a number of students chose the correct answer, option B, though there were about 30% of students who still chose option A or option D. They were not able to demonstrate recognition of regular polyhedra.

Q11/M1
Which of the following figures can represent a regular polyhedron?



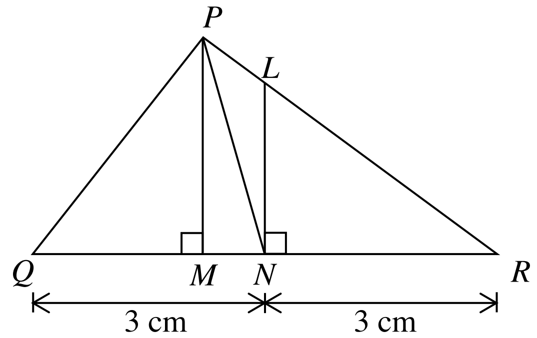
Simple Introduction to Deductive Geometry

- Identify medians, perpendicular bisectors, altitudes and angle bisectors of a triangle (e.g. Q16/M3): More than half of the students chose the correct answer B, though there were more than 20% of students who still chose option A. They mistakenly took the perpendicular bisector *LN* as a median of $\triangle PQR$.

Q16/M3

In the figure, *PLR* and *QMNR* are straight lines. Consider $\triangle PQR$, $QN = NR = 3$ cm. $PM \perp QR$ and $LN \perp QR$. Which of the following is a median of $\triangle PQR$?

A. *LN*
B. *PN*
C. *PM*
D. *QM*



Coordinate Geometry of Straight Lines

- Demonstrate recognition of the conditions for parallel lines and perpendicular lines (e.g. Q18/M2): Quite a number of students chose the correct answer, option D. However, option B was chosen by more than 10% of students. They confused the conditions for parallel lines with those for perpendicular lines.

Q18/M2

It is given that the slope of a straight line ℓ is 5 . Which of the following straight lines is parallel to ℓ ?

Line	L_1	L_2	L_3	L_4
Slope	-5	$\frac{-1}{5}$	$\frac{1}{5}$	5

A. L_1
B. L_2
C. L_3
D. L_4

Construction and Interpretation of Simple Diagrams and Graphs

- Choose appropriate diagrams/graphs to present a set of data (e.g. Q19/M4): Almost half of the students chose the correct answer, option D. However, more than 30% of students still chose option C. They mistakenly took a cumulative frequency polygon as the most suitable statistical graph to present the given set of data.

Q19/M4

The table below shows the heights and weights of 10 students.

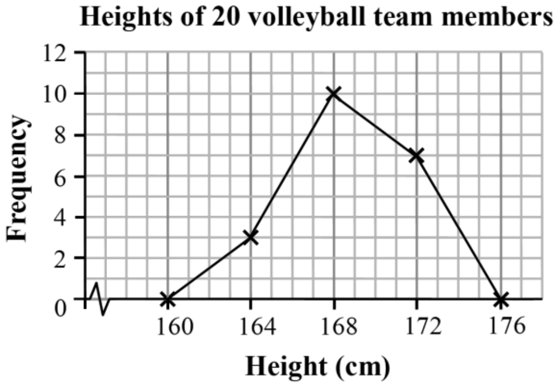
Student	A	B	C	D	E	F	G	H	I	J
Height (cm)	170	152	164	173	156	185	162	177	165	180
Weight (kg)	57	48	53	62	52	74	56	66	57	71

Mr. Chan wants to use a statistical graph to find out whether the heights and weights are related to each other. Which of the following is the most suitable for presenting the data above?

A. Pie chart
B. Stem-and-leaf diagram
C. Cumulative frequency polygon
D. Scatter diagram

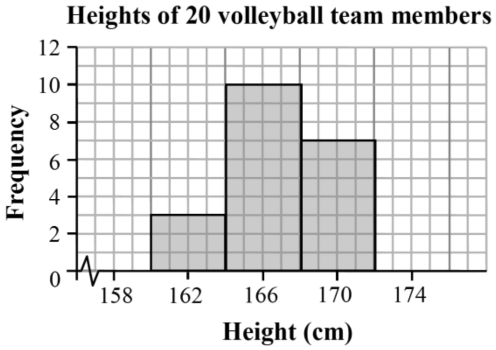
- Compare the presentations of the same set of data by using statistical charts (e.g. Q19/M2): Many students chose the correct answer C, though there were more than 10% of students who still chose option A. They ignored the fact that the values marked on the horizontal axes of frequency polygons are class marks instead of class boundaries.

Q19/M2
The frequency polygon below shows the heights (cm) of 20 volleyball team members:

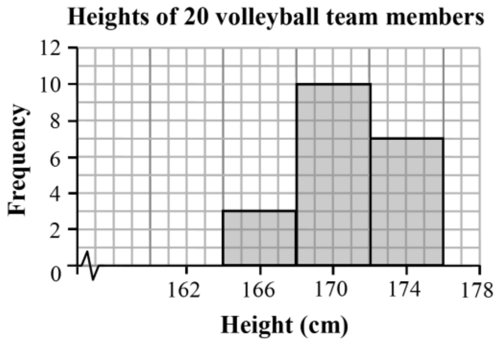


If the same set of data are presented by a histogram, which of the following diagrams could be obtained?

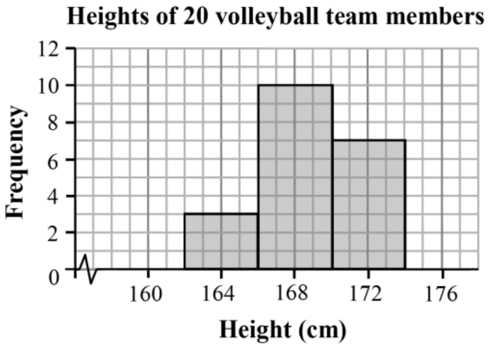
A.



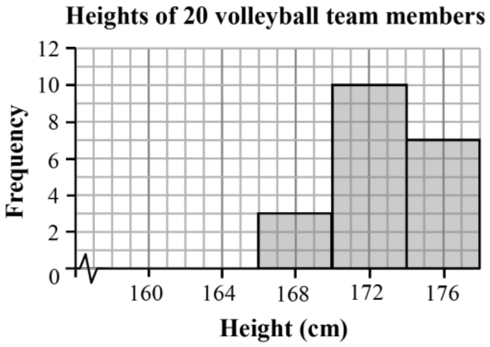
B.



C.



D.



Good Performance of Secondary 3 Students in Territory-wide System Assessment 2018

- Students with good performance demonstrated mastery of the concepts and skills assessed by the sub-papers. Their performance in numeracy skills and problem-solving skills was good, so they were able to solve various types of problems relating to directed numbers, percentages, numerical estimation, rate and ratio. Students had a thorough conceptual understanding of algebra and could observe patterns and express generality. They were able to deal with the basic operations, factorization and expansion of simple polynomials, and were familiar with laws of indices and linear inequalities in one unknown. They were capable of solving equations by using algebraic and graphical methods. They could also plot graphs of linear equations in two unknowns.

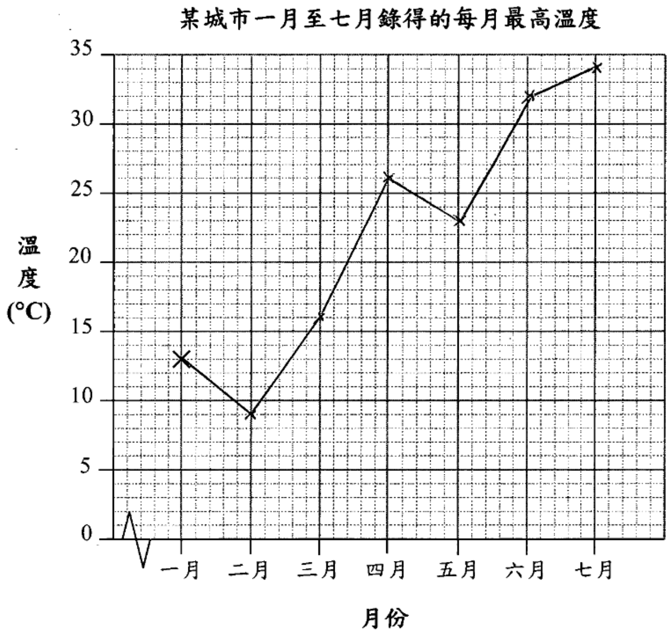
- Students with good performance were also capable of calculating the areas of simple plane figures and the surface areas and volumes of some solids. They were able to demonstrate good recognition of the concepts of transformation and symmetry, congruence and similarity, coordinate geometry, quadrilaterals, trigonometry, and Pythagoras' Theorem. In doing geometric proofs, they were able to write the steps correctly and provide sufficient reasons to complete the proofs.

- Students with good performance had a good knowledge of the various stages of statistics and grasp the basic concepts of probability. They were able to construct and interpret simple statistical charts, use statistical charts appropriately, read information from graphs, find the mean, median and mode/modal class, as well as identify sources of deception from a set of data.

The examples of work by these students are illustrated as follows:

Students were able to construct simple statistical charts by using the given data.

Q47/M2
Example of Student Work (Construct simple statistical charts)



Students were able to solve the problem correctly with complete and clear presentation.

Q46/M4
Example of Student Work (Find the area of a sector)

解：扇形面積：$\pi r^2 \times \frac{55^\circ}{360^\circ}$

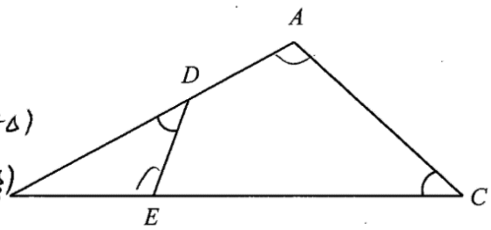
$= \pi \times 9^2 \times \frac{55^\circ}{360^\circ}$

$= 38.9\ cm^2$

∴扇形的面積是 $38.9\ cm^2$.

Students were able to make good use of the given conditions and solve the problem systematically.

Q45/M4
Example of Student Work (Estimate values) Approximations : souvenirs ≈ 600, price ≈ 30 600 × 30 ≈ 18000 ∴ 18000 < 20000, student union has enough $ to buy the souvenirs ∴ The Student Union * has / does not have enough money to buy the souvenirs. (*Circle the correct answer)

Q46/M1
Example of Student Work (Geometric proof) ∠ACB = ∠EDB (given) ∠ABC = ∠EBD (common ∠) ∠ABC + ∠BCA + ∠CAB = 180° (∠ sum of △) ∠EBD + ∠BDE + ∠DEB = 180° (∠ sum of △) ∴ ∠CAB = ∠DEB ∴ △ABC ~ △EBD (AAA) 

Some common weaknesses of high-achieving students were that:

- Some students were not familiar with the concepts of some terminologies such as degree, coefficients and number of terms.
- Some students were not able to distinguish the difference between $(-2)^n$ and -2^n.
- Some students were not able to determine whether a polygon is convex.

Overview of Student Performances in Mathematics at Secondary 3 Territory-wide System Assessment 2016-2018

The percentage of students achieving Basic Competency in the Territory-wide System Assessment this year was 80.0% which was about the same as last year.

The percentages of students achieving Basic Competency from 2016 to 2018 are listed below:

Table 8.6 Percentages of S.3 Students Achieving Mathematics Basic Competency from 2016 to 2018

Year	% of Students Achieving Mathematics Basic Competency
2016	80.0
2017	79.9
2018	80.0

The performances of S.3 students over the past three years in each dimension of Mathematics are summarized in the following table:

Table 8.7 Overview of Student Performances in Mathematics at S.3 Territory-wide System Assessment 2016-2018

Year / Number and Algebra	2016	2017	2018	Remarks
Strengths	• Students could use directed numbers to describe real life situations. They also recognized the ordering of integers on the number line. • Students could determine whether to estimate or to compute the exact value in a simple context. • Students were able to round off a number to a certain number of significant figures. • Students were able to solve simple selling problems by using percentages. • Students were able to solve problems by using rate and ratio. • Students were able to substitute values into formulas to find the unknown value. • Students could formulate equations from simple contexts. • Students demonstrated recognition of inequalities.	• Students did well in the operations of directed numbers. They demonstrated recognition of the number line. They could also use directed numbers to describe real-life situations. • Students were able to solve simple problems on depreciations. • Students were able to convert numbers in scientific notation to integers and round off a number to 3 significant figures. • Students were able to solve simple problems by using rate. • Students were able to solve a system of linear simultaneous equations by algebraic methods. • Students were able to substitute values into formulas to find the unknown values. • Students demonstrated recognition of inequalities.	• Students were good at using directed numbers to describe real life situations. They also recognized the ordering of integers on the number line. • Students could determine whether to estimate or to compute the exact value in a simple context. • Students did well in representing real numbers on the number line. • Students were able to solve simple problems by using ratio. • Students were able to substitute values into formulas to find the unknown values. • Students demonstrated good recognition of inequalities.	• Many students were not familiar with some concepts or some terminologies including number of terms of simple polynomials, growths and depreciations. • Students were willing to show their working steps and strategies used in solving problems, but sometimes the solutions were incomplete or contained errors. • Many students did not use a ruler to draw straight lines.

Year / Number and Algebra	2016	2017	2018	Remarks
Weaknesses	• Students mixed up simple interest and compound interest. Consequently, they used the incorrect methods in solving problems. • Students were weak in recognizing the terminologies of polynomials. • Students could not distinguish whether an equality is an equation or an identity. • Students were weak in manipulating algebraic fractions.	• Quite a number of students were not able to estimate values with reasonable justifications. • Students mixed up the formulas for finding simple interest and compound interest. • Quite a number of students were not able to distinguish polynomials from algebraic expressions. • Students were weak in recognizing the terminologies of polynomials. • Students' performance was only fair in change of subject in simple formulas.	• Quite a number of students were not able to estimate values according to the given context with reasonable justifications. • Quite a number of students were not able to distinguish the difference between $(-2)^n$ and -2^n. • Students were weak in recognizing the terminologies of polynomials such as number of terms. • Students were quite weak in recognizing the meaning of roots of equations. • Students' performance was not satisfactory in manipulating algebraic fractions.	

Year / Measures, Shape and Space	2016	2017	2018	Remarks
Strengths	• Students were able to choose an appropriate unit and the degree of accuracy for real-life measurements. • Students were able to select the appropriate ways to reduce errors in measurements. • Students were able to find the volumes of cones. • Students could identify the relationship between simple 3-D solids and their corresponding 2-D figures. They could also sketch simple solids. • When the object and its image were given, students could identify the single transformation involved. • Students could demonstrate recognition of terminologies on angles. • Students could use the angle properties associated with intersecting lines/parallel lines and the properties of triangles to solve simple geometric problems. • Students could recognize the axes of rotational symmetries of cubes. • Students had good knowledge of the rectangular coordinate system.	• Students were able to find the range of measures from a measurement of a given degree of accuracy and estimate measures with justification. • Students were able to select the appropriate ways to reduce errors in measurements. • Students were able to use the formulas of volumes of prisms, find the areas of sectors and the total surface areas of pyramids. • Students were able to identify the relationship between simple 3-D solids and their corresponding 2-D figures. • Students were able to demonstrate recognition of the concepts of transformation and symmetry. • Students were able to use the angle properties associated with intersecting lines/parallel lines and the properties of triangles to solve simple geometric problems. • Students were familiar with the properties of parallelograms. • Students had good knowledge of the rectangular coordinate system.	• Students were able to choose an appropriate unit and the degree of accuracy for real-life measurements. • Students were able to find the volumes of cylinders. • Students could use notations to represent angles. • Students demonstrated good recognition of the concepts of transformation. • Students were able to identify the nets of cubes. • Students were good at using the properties of squares in numerical calculations. • Students had good knowledge of the rectangular coordinate system. • Students understood the basic concepts of trigonometric ratios.	• Students could estimate measures. However, their explanations were very limited and incomplete when they had to elaborate their estimation methods. • In doing geometric proofs, some students used circular arguments and gave incorrect logical reasoning. They did not understand the differences between some theorems, for instance, the difference between ‘corr. ∠s equal’ and ‘corr. ∠s, $AB//CD$’. • Many students wrote the wrong units or omitted the units for the answers.

Year / Measures, Shape and Space	2016	2017	2018	Remarks
Weaknesses	• Students' performance was quite weak in finding the total surface areas of cylinders. • Students were weak in abstract concepts (such as distinguishing among formulas for volumes by considering dimensions). • Students could not demonstrate recognition of common terms in geometry. • Quite a number of students were not able to recognize straight angles and concave polygons. • Students could not demonstrate recognition of the conditions for congruent and similar triangles. • Students in general could not complete the proofs of simple geometric problems.	• Students in general were unable to use relationship of similar figures to find measures and distinguish among formulas for areas by considering dimensions. • Many students were not able to determine whether a polygon is equilateral. • Students were quite weak in recognizing the conditions for congruent and similar triangles. • Students were weak in identifying the planes of reflectional symmetries of cubes. • Students in general were not able to complete the proofs of simple geometric problems. • Many students were not able to name the angle between a line and a plane. • Students' performance was only fair in applying the conditions for two perpendicular lines.	• Students' performance in using the relationships between sides and surface areas of similar figures to solve related problems was fair. • Many students were not able to determine whether a polygon is convex. • Students were not able to use the conditions for similar triangles to perform simple proofs. • Students in general were not able to complete the proofs of simple geometric problems.	

Data Handling / Year	2016	2017	2018	Remarks
Strengths	• Students could use simple methods to collect data. • Students could organize the same set of data by different grouping methods. • Students could construct and interpret simple statistical charts. • Students were able to compare the presentations of the same set of data by using statistical charts. • Students could identify sources of deception in misleading graphs/accompanying statements.	• Students were able to use simple methods to collect data. • Students were able to interpret simple statistical charts. • Students were able to choose appropriate diagrams/graphs to present a set of data. • Students were able to find mean and median from a set of ungrouped data. • Students' performance was quite good in calculating probabilities.	• Students could organize the same set of data by different grouping methods. • Students could construct and interpret simple statistical charts. • Students were able to find mean and median from a set of ungrouped data. • Students could calculate the theoretical probability by listing.	• Students were not able to give sufficient explanations in describing the sources of deception in cases of misuse of averages.
Weaknesses	• Students could not read upper quartiles from diagrams/graphs. • Without providing the table or tree diagram for guidance, quite a number of students were not able to calculate the theoretical probability.	• Students' performance was only fair in distinguishing discrete and continuous data. • Students in general were not able to construct histograms correctly. • Quite a number of students were not able to identify sources of deception in cases of misuse of averages.	• Students could not choose appropriate diagrams/graphs to present a set of data in general. • The performance of students in identifying sources of deception in cases of misuse of averages was not satisfactory.	