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6 May 2013

Education and Innovation Committee
Queensland Parliament

Re: Submission to the Parliamentary Inquiry into Senior Mathematics, Physics and Chemistry Assessment

Dear Committee Members

Please note that the views in this submission have been endorsed by nine of the other eleven senior mathematics teachers at this school.

I graduated from UQ in 1971 with a B.Sc. in Chemistry and Physics and worked at Mobil Oil Australia's Research and Development laboratory in Melbourne before becoming a sales chemist with that company. In 1974 I immigrated to Canada and worked in the marine surface coating industry before spending a year at the University of British Columbia to obtain a teaching qualification. Since then, I have taught Chemistry, Physics and Mathematics in British Columbia, Canada, and back in Australia in Victoria, Tasmania and now Queensland. I am passionate about the subjects I teach and have always taken a keen interest in improving subject delivery and the status of the teaching profession; by way of this, on a recent trip to Europe, I spent a day at a high school in Helsinki observing lessons and speaking with mathematics and science teachers.

Until a few years ago I taught both senior physics and mathematics at this school. I withdrew from physics when the new curriculum was implemented because of grave concerns about what I deemed a de-emphasis of the subject's core nature, and an increased workload on a workload that was already eating up too much of my out-of-school time. It's a shame because I was a very good physics teacher.

My experience outside Queensland enables me to judge the Queensland assessment system in the light of other systems. I do not consider it to be world's best practice as promoted by the QSA and others. If it is world best, after all these years, there would be many followers, and there are not.

I would be happy to appear as a witness in your investigations should you think it appropriate.

Positive and neutral aspects of the Queensland system

Moderated internal assessment allows teachers, within the constraints of their department, to teach and assess in a way that best suits their or their department's goals. This flexibility is more valued in the areas of language and social science than in mathematics and the physical sciences. In general, across the whole curriculum, this flexibility has led to much assessment being by way of assignment.

The emphasis on problem solving and communication in mathematics is a feature of this system. These universally important aspects of mathematics have always been embedded in assessment items in other systems with which I am familiar. In Queensland they are separate.

Negatives of the Queensland assessment system

Demands on teacher time and energy

It seems that when this assessment system was introduced in Queensland there was no extra preparation time made available to teachers to work with it, even though it is significantly more time consuming than the system in, for example, NSW. Given that there is a limit to a teacher's available time and energy, something must be suffering to make the Queensland system work: teaching and home life perhaps?

Each school has to make its own individual work program when mathematics is the same the world over. Teachers in Helsinki are teaching the same mathematics as we are. I would be happy to have the same work program for the whole state, as in other places. That would have the added benefit of making life easier for students who change schools during Years 11 and 12; they would not be tripped up because of different topic orders at different schools.

The assessment items I write must be of a very high standard because of the use to which they are put. This takes a great deal of time. I'm sure that what I produce is not too inferior to that produced in places where classroom teachers do not write the final exams, e.g. in places where appropriately resourced people outside the schools write them. A small anecdote here: When I taught physics at Launceston College, we physics teachers would discuss physics at lunchtime. Where I teach now, we mathematics teachers discuss little but assessment. Most conversations between colleagues in all curriculum areas seem to be about assessment. This is sad.

It's easy to write the mathematics solutions in the test or assignment. Producing the criteria grids that go with the Modelling and Problem Solving (MAPS) solutions is very time consuming. (See Appendix 1 for a Term 1, 2013, Year 11 Mathematics B test, one student's solutions, and the teacher's solutions with grids. These are provided with the principal's permission but school and student identifiers have been removed.)

I find judging MAPS solutions according to the grids very difficult and confess here that I do my best to absorb the grids and then mark my 45 or so papers by intuition. I address any problems with my judgements when I go through the solutions with the students. My experience is that students would be happier with straight marks. They find these grids unnecessarily confusing.

The ranking of students at the end of the year takes many hours as subject teachers deliberate over, in our case, 140 profiles for the Year 11 Mathematics B cohort. In 2010 I did a parallel ranking in my class. I added the KAPS and MAPS numbers and worked out a percentage. The ranking is almost the same as the profile system and has the advantage that other teachers would get an identical result. I doubt that two teachers independently ranking using profiles would end up with the same order. (See Appendix 2 for a sample profile and my What if we used marks? experiment)

The unfairness of the separate Communication and Justification criterion

The third criterion, Communication and Justification (CAJ), is the most problematic as different teachers have different views of how it should be implemented. If several teachers marked the same set of tests, I believe that the range in KAPS and MAPS grades would be quite small, but the CAJ would be larger because of the range of interpretations.

The larger problem is that if a student does poorly in MAPS they cannot do well in CAJ because, normally, there isn't much evidence in their solutions to give them a good CAJ grade. A student rushing at the end of a paper, jumbling the mathematics, will do poorly in both the MAPS and CAJ judgement. They are being hit twice. This is not fair.

Clarity of progress

The most difficult question a student can ask me is not about calculus or trigonometry, it's, 'How am I going?' There is no simple answer. We don't assign letter grades until the end of a semester when we spend hours analysing student profiles and assigning criteria and overall letter grades according to a set of guidelines (See Appendix 3 for How to finalise grades). So, although I may be able to give the student a rough idea of how they are going, they have to wait until June or December for definitive letter grades. In Canada, after every test we would post student results listed by student number on a board. Students would rush to the board to see their test result and cumulative percentage. It was a powerful motivating force .... 'If I do slightly better in the next test I'll jump from a C^+ to a B^-' etc.. This motivating opportunity is lacking in Queensland. Students don't have a clear idea of how the profiles are judged and parents have even less of an idea. Everyone understands percentage. It's a time-tested and beautiful way of measuring and comparing.

The playing field is not level

This is particularly true for take-home assignments. Over the years I have seen many poor students produce wonderful assignments which help mask poor test grades. How have they been able to do that? One reason is that time is not limited as it is in tests. Another is that students can get help outside school. I know of tutors who have helped students to such an extent that the teacher is actually marking the tutor's work, not the student's. This is an area I am reluctant to investigate further since it would be very difficult to prove excessive help and parental backlash can be vicious.

I am sometimes called to help my two nephews with assignments. I don't do the assignments for them but I do point them in the right direction and point out errors in drafts. Clearly they have an advantage in mathematics, physics or chemistry assignments over students without such help.

The expectations of panels across the state vary. I gather from conversations I have had with panel members from various parts of the state that the breadth and level of difficulty of assessment items varies significantly between panel areas and even within a panel area.

Possible corruptibility in assessment

There are a number of ways in which a department or individual teacher could give their students an advantage.

A teacher could give a test very similar to the real test a few days before the real test and then go through the solutions. This will boost the grade of any student willing to make the effort to learn what they didn't know. The school or class will have higher grades than had there been no first test.

A teacher could give hints in class of what will be on the test or spend a disproportionate amount of time on particular problem types that are on the test. Once again, this would boost performance on the test.

Does this actually happen? I have heard of cases where it has. It's probably rare, but it does happen and would be difficult to detect.

Student workload from other subjects and the effect on mathematics

Students in this internal assessment system don't get a break from assessment. They go from one assignment to the next across their chosen subjects. I find that a significant number of students don't keep up with the mathematics on a day to day basis because various assignments have priority. They postpone mathematics study until near the test date and cram.

The MAPS effect on earlier year levels

In order to prepare students for Years 11 and 12, we start dividing test papers into the three criteria in Year 8. Many of these young and keen students score marks such as 23/25 in Knowledge and 4/10 in Problem Solving (we use marks at the junior level but still report with three criteria). The Problem Solving mark sometimes causes much grief. Many times I have had to explain that 4/10 is not so bad and that the student will improve. In fact, because of time constraints, we never spend enough time on problem solving questions in class. In addition, part of the MAPS preparation for Years 11 and 12 is to give these Year 8 students problems a little different to anything they have seen in their preparation. The overall effect is that student confidence takes a bashing. If the Problem Solving mark above was included with the Knowledge mark to produce one total, 27/35, there would be less grief.

Thoughts and suggestions

A crucial question is: What is the purpose of the assessment system in Queensland? Is it to determine who gets into the high demand faculties at university, the OP 1s and 2s? If the universities screened those applicants, we could have an internal assessment system that was not so high-stakes and cumbersome. Assessment could take a back seat to good teaching.

Suggestion 1: The three criteria could be harmonised with the KAPS/MAPS balance checked by inspection rather than a multitude of grids. The questions would be identified as KAPS or MAPS on the test paper. The test would have a total mark only which could be added to previous marks to produce a percentage and provide ongoing feedback to students. CAJ would be dropped but there would be a small mark penalty for poor communication, e.g. leaving units off an answer, leaving out a formula. Since the question types would be identified students would still be able to see how they have done in KAPS and MAPS.

Suggestion 2: Assignments could be replaced with short (90 minute maximum) in-class activities with no take-home component.

Suggestion 3: The QSA could take on a new and 21st century role that would help teachers and solve many of the current problems: test production. Here's how it could work: A teacher would go to the QSA website when ready to do a test on a particular topic, e.g. rates of change, and a test with a random, but balanced in terms of KAPS and MAPS questions, would be generated from a QSA bank. This would be done just before the actual test date. This would take a great deal of work off teachers and panels and help level the playing field, the level of difficulty across the state would be constant. All a panel would have to do is ensure that marking across schools was consistent. This has the added benefit of putting the teacher on the same side as the students. When NSW went from 100% external to 50%

internal testing, a NSW teacher told me that the students' attitude to him changed from being their guide against a common enemy, the external test, to tester.

Suggestion 4: The submissions to panels should not be identified by school and they should not be from the panel area. Panel members have told me that they have observed bias towards or against certain schools, e.g. 'The next submission is from Harry at School X, it's always good'. I have been told by panel members that there is a reluctance to criticise a panel chair's school's submission. Both these issues could be solved by schools being identified by number not name and panels not looking at their own submissions, e.g. Brisbane Central looks at Rockhampton, Rockhampton looks at Cairns and Brisbane looks at Cairns.

Suggestion 5: A state wide exam counting for 50% of a student's grade could be implemented, as in NSW.

Conclusion

In my view, the Queensland assessment system in mathematics, physics and chemistry needs to be restructured to make it less onerous and cumbersome for teachers to administer and easier for students and parents to understand. This can be done without a drop in standards.

Thank you for the opportunity to make this submission.

Michael May

YEAR 11

SUBJECT: Mathematics B

UNIT: Introduction to Functions 1, Periodic Functions 1, Applied Statistics 1

STUDENT NAME: _____

TEACHER/S NAME:

Task Summary:

1. **Completion Date:**
   21st March 2013

2. **Time Allowed:**
   120 minutes + 10 minutes perusal

3. **Conditions and Nature of Assessment Task**
   Supervised exam conditions – individual work
   No teacher input

4. **Points to Observe**
   Write on only one side of the blue-lined paper provided in blue or black pen
   Draw diagrams and graphs in pencil
   The use of whiteout or correction tape is not permitted
   Calculators are necessary
   SHOW ALL WORKING

Semester 1 Item 1

KAPS

Marks		
	28	

MAPS

Q	Grade	Rating
9	*	
10	**	
11	**	
12	***	
13	***	
	O/All	

CAJ

QNS	Rating
1-3, 7-8	
4 - 6	
9, 12, 13	
10, 11	
O/All	

Key Common Curriculum Elements embedded in this task

Comprehend & collect	Structure & sequence	Analyse, assess & conclude	Create & present	Apply techniques & procedures
1. Recognising letters, words and symbols 3. Recalling/remembering 4. Interpreting the meaning of words and other symbols 5. Interpreting the meaning of pictures/illustrations 6. Interpreting the meaning of tables or diagrams or maps or graphs 7. Translating from one form to another 14. Compiling results in a tabular form 32. Reaching a conclusion which is necessarily true provided a given set of assumptions is true	36. Applying strategies to trial and test ideas and procedures 38. Generalising from information 45. Judging, evaluating 48. Justifying 51. Identifying shapes in two and three dimensions	22. Structuring / organising a mathematical argument 33. Reaching a conclusion which is consistent with a given set of assumptions 44. Synthesising 60. Sketching/drawing	9. Using correct spelling, punctuation and grammar 10. Using vocabulary appropriate to a context 12. Compiling lists/statistics 15. Graphing 16. Calculating with or without calculators	19. Substituting in formulae 20. Setting out, presenting, arranging, displaying 43. Analysing

Appendix 1 - Test - 7 pages of questions

11 MATHEMATICS B SUPERVISED EXAM TEST 1

SHADING REPRESENTS OPPORTUNITY PRESENTED IN A PARTICULAR TASK

Knowledge and Procedures

Criterion # Routine Simple ## Non-Routine Simple ### Routine Complex #### Non-Routine Complex	KAPS QUESTIONS							
	1 #	2 ##	3 ###	4 #	5 ##	6 ####	7 #	8 ##
Grade	2	3	5	5	3	3	5	2
K1 Recall, access, selection of definitions, rules and procedures in routine & non routine simple through to routine complex, both life related and abstract.								
K2 Application of definitions rules & procedures in routine & non routine simple through to routine complex, both life related and abstract.								
K3 Numerical calculations, spatial sense and algebraic facility demonstrated in a variety of situations.								
K4 Appropriate selection and use of technology								
Abstract Mathematical (AM) or Life Related (LR)	AM	AM	LR	AM	AM	LR	LR	LR

Modelling and Problem Solving

Criterion @ Routine Simple @@ Non-Routine Simple @@@ Routine Complex @@@@ Non-Routine Complex	MAPS QUESTIONS				
	9 @	10 @@	11 @@@	12 @@@@	13 @@@@
Grade	3	4	4	5	5
M1 Use of problem-solving strategies to interpret, clarify and analyse problems to develop responses from routine simple tasks through to non-routine complex tasks in life-related and abstract situations					
M2 Identification of assumptions parameters and/or variables. Identifies effects of assumptions (A-standard response only).					
M3 Use of mathematical models to generate data. Use of data to synthesise mathematical models - (B-standard response in simple situations, A-standard response in a variety of situations).					
M4 Evaluates validity of mathematical arguments, Investigates strength and limitations of a model and/or analyses results in context. (A-response only) Interpretation of results in context. (For B standard responses simple to complex or C standard – simple routine situations)					
Abstract Mathematical (AM) or Life Related (LR)	AM	LR	LR	AM	AM

Communication and Justification

Criterion	KAPS QUESTIONS		MAPS QUESTIONS	
	1, 2, 3, 7, 8	4, 5, 6	9, 12, 13	10, 11
C1 Appropriate interpretation & use of mathematical terms, symbols & conventions, simple to complex, life related to abstract.				
C2 Organisation and presentation of information into a variety of forms (For H & H/S standard responses this must be evident in a variety of representations).				
C3 Translation of information from one representation into another in simple situations (In a variety of situations for H or H/S standard response).				
C4 Use of mathematical reasoning to develop sequences within a response in simple situations (In a variety of situations for H or H/S standard response).				
C5 Justification of procedures, decisions and/or results.				
C6 Justifies the reasonableness of a response where appropriate (H standard response only).				

Test

Knowledge and Procedures (27 marks)

Question 1 (2 marks)

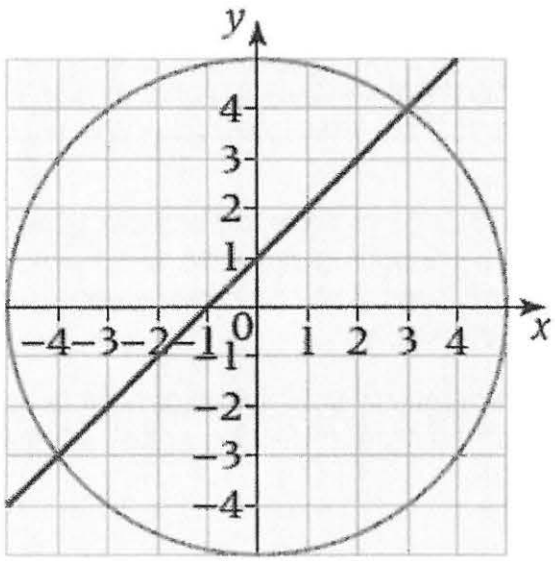
Solve for x in the following equation:

$$\frac{x+1}{4}=\frac{1}{6}+\frac{2-x}{3}.$$

Question 2 (1, 2 - marks)

(a) The line $y = x + 1$ intersects the circle $x^2 + y^2 = 25$ at two distinct points as shown in the diagram below.

Write down your estimate for the coordinates of these points of intersection by directly reading the scales on the graph.



(b) Justify the reasonableness of your answer by solving the following simultaneous equations algebraically.

$$y = x + 1 \quad and \quad x^2 + y^2 = 25$$

Test

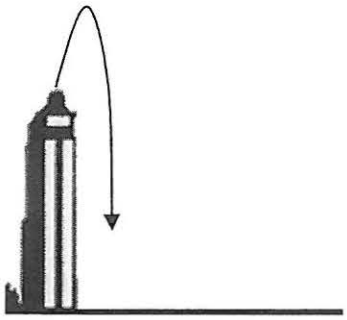
9

Question 3 (1, 1, 1½, 1½ – 5 marks)

An archer standing on the top of a building in the city shoots an arrow upwards. The height, *h*, in metres above street level, of the arrow is represented by the function:

$$h = -16t^2 + 80t + 96$$

where *t* is the time, in seconds, after the arrow was shot.



a) Find algebraically:

(i) the height of the building above the street, and,
(ii) the time from when the arrow was shot until it hits the street below.

b) With the assistance of your graphics calculator, sketch the graph of the height function for the length of time the arrow was in the air. Indicate on your sketch the intercepts and turning point of your graph. Hence determine the maximum height reached by the arrow.

c) With the assistance of your graphics calculator, find (correct to 2 decimal places) the length of time the arrow was above a height of 50 m above street level.

Question 4 (1, 2, 2 – 5 marks)

a) Convert $\frac{7\pi}{12}$ radians to degrees.

b) Find the exact value of **tan 225°** without use of your graphics calculator.

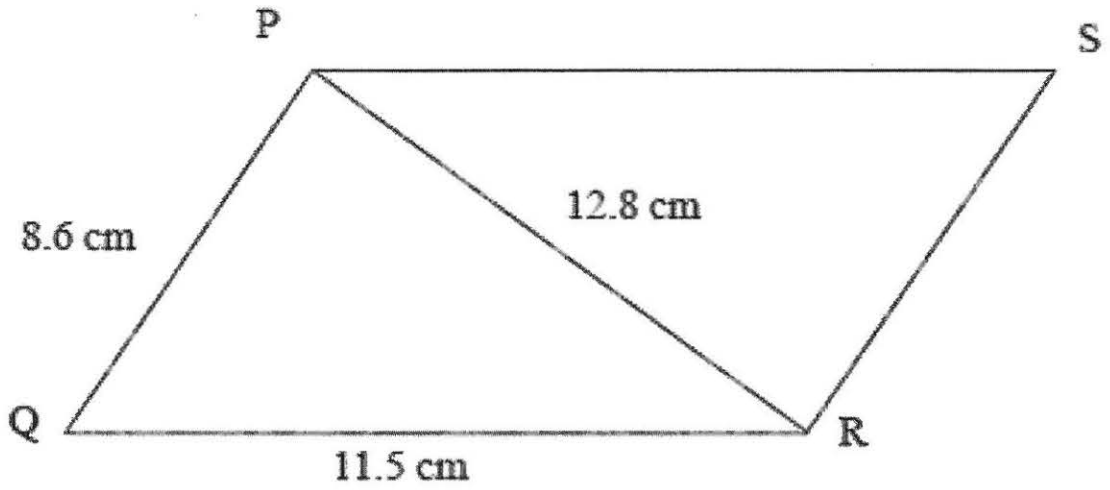
Justify with an appropriate diagram.

c) Find the exact value of **cos** $(\frac{5\pi}{6})$ without use of your graphics calculator.
Justify with an appropriate diagram.

Test

Question 5 (3 marks)

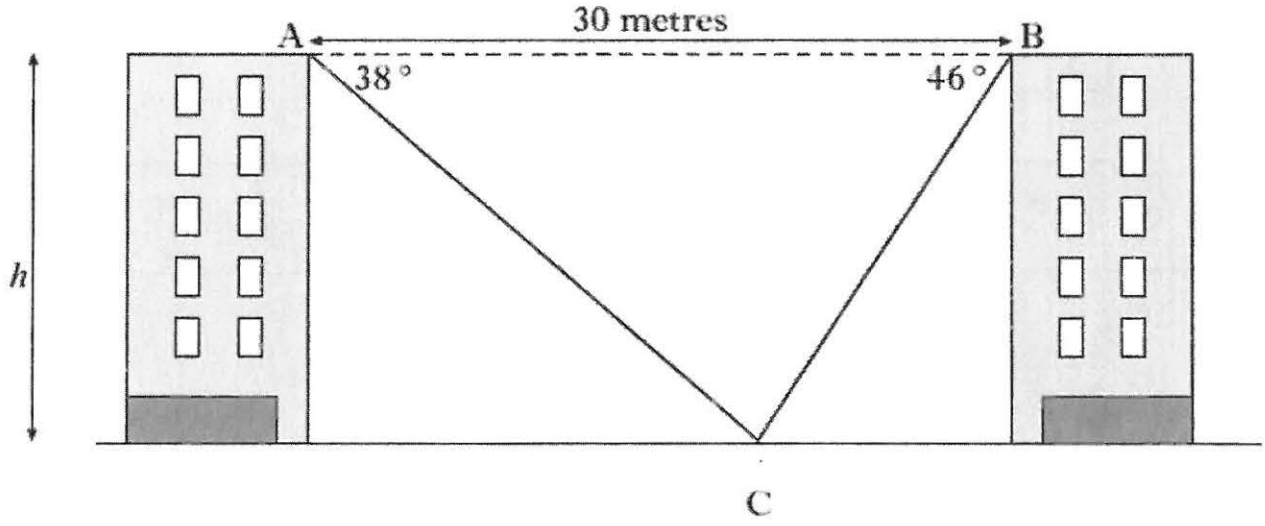
The sketch shows a parallelogram PQRS.



Calculate the size of ∠PSR (rounded to the nearest minute)

Question 6 (3 marks)

The diagram shows two blocks of flats of equal height



A and B represent points on the top of the flats and C represents a point on the ground between them.

To calculate the height, ***h***, of each block of flats, a surveyor measures the angles of depression from A and B to C.

From A, the angle of depression is 38°. From B, the angle of depression is 46°. The distance AB is 30 metres.

Calculate the height, *h*, in metres.

Test

Question 7 (1, 2, 1, 1 – 5 marks)

The scores of two hockey goal shooters, A and B, are listed below:

Shooter A:	4	10	10	17	3	20	16	15	41
Shooter B:	35	39	30	41	35	40	37	29	0

(a) Is the data discrete or continuous? Briefly explain.

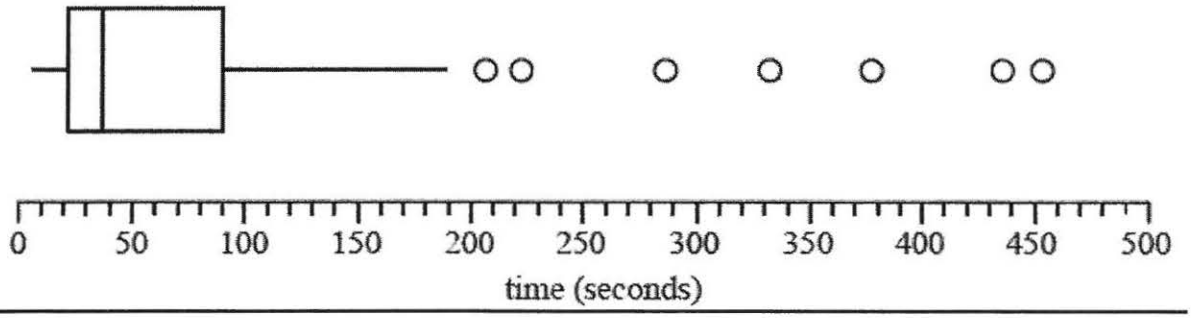
(b) Construct a back-to-back stem plot for this data.

(c) Use your graphics calculator to find Q_1 and Q_3 for Shooter B.
Hence, find the interquartile range (IQR) for Shooter B.

(d) Determine whether or not any of Shooter B's scores qualify as outliers.

Question 8 (1, 1 - 2 marks)

The box plot below shows the distribution of the time, in seconds, that 79 customers spent moving along a particular aisle in a large supermarket.



(a)

The shape of the distribution is best described as:

A. symmetric.
B. negatively skewed.
C. negatively skewed with outliers.
D. positively skewed.
E. positively skewed with outliers.

(b)

From the box plot, it can be concluded that the median time spent moving along the supermarket aisle is:

A. less than the mean time.
B. equal to the mean time.
C. greater than the mean time.
D. double the interquartile range.
E. one quarter of the range.

Test

12

Modelling and Problem Solving **Name:**_____

Teacher:_____

Question 9 *

(i) Use your knowledge of exact ratios to determine the **exact value** of the expression:

$$sin(^{\pi}/_{6}) \times cos(^{2\pi}/_{3}) + sin(^{2\pi}/_{3}) \times cos(^{\pi}/_{6}).$$

(ii) Your mathematics teacher says that the expression $sin(^{\pi}/_{6} + ^{2\pi}/_{3})$

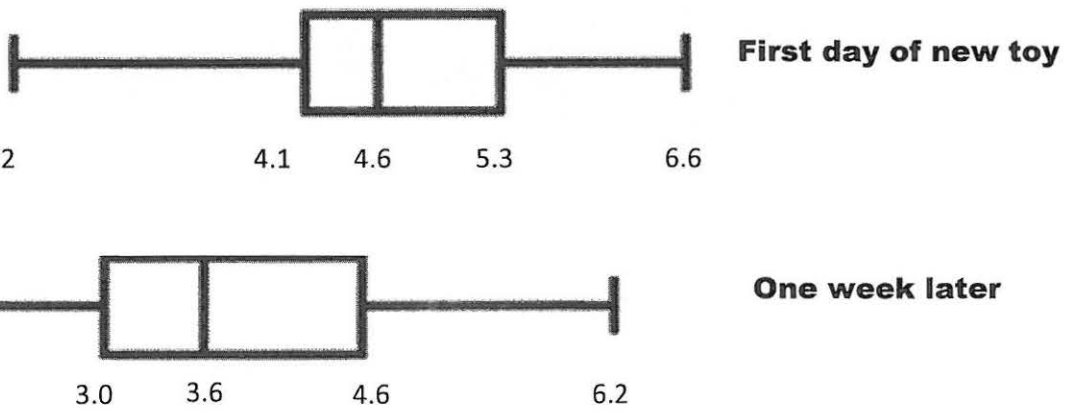
is equal to the expression in part **(i).**

Investigate the validity of the teacher's statement.

Question 10 **

A plastic toy manufacturer has 120 employees working on an assembly line, all making the same new toy. The day the toy was introduced, the company selected a random sample of 20 workers and timed how long it took each of them to assemble one toy.

A week later, **another** sample of 20 workers was selected and timed. The results are shown in the box-plots, with times given to the nearest tenth of a minute.



(a) Has there been an improvement in assembly time? Justify your conclusion with at least **two** relevant but **distinct** statistical measures of centre and/or spread.

(b) State one assumption you have made in reaching this conclusion. Would your conclusion be different if this assumption was invalid?

Test

Question 11 **

The cross-section of the bottom of a canal can be represented by:

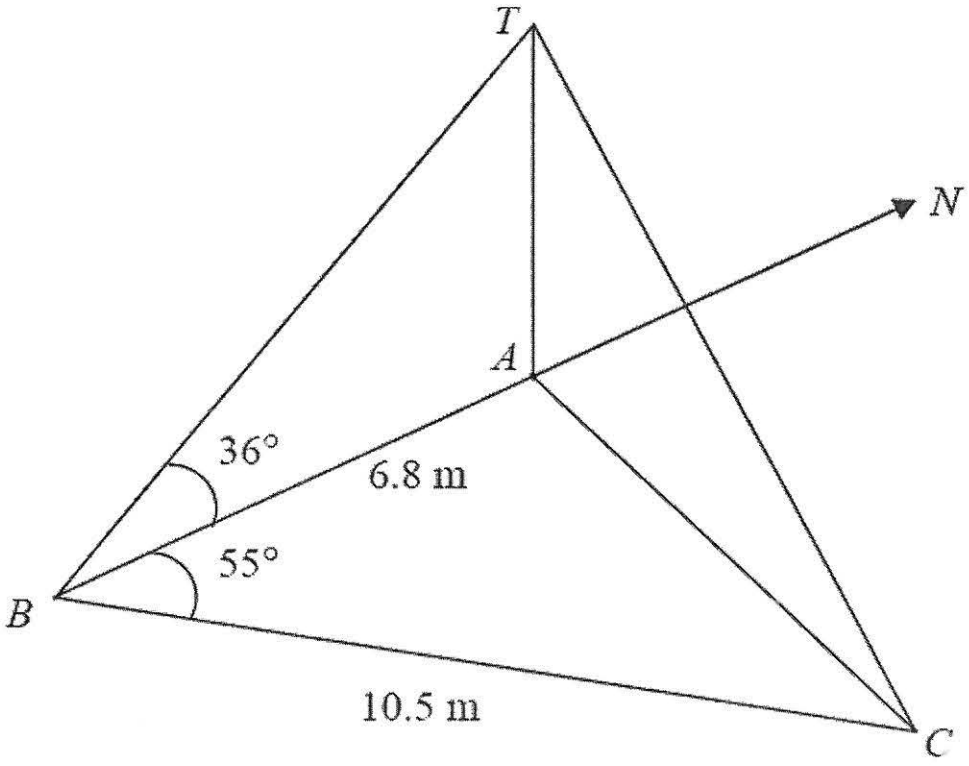
$$d = \frac{1}{30}x^2 - \frac{3}{2}x$$

where d is the depth of the canal in metres and x is the horizontal distance in metres from the left bank towards the right bank.

The skipper of a rectangular bottom barge, 20 metres wide and 10 metres deep, is about to sail the barge along the canal. Will the barge run aground (i.e. hit the bottom or sides of the canal)?

Justify your answer with full working. Your solution should include a labelled sketch of the canal cross-section and barge. All graphing should be done on your graphics calculator with the sketch to be an approximation of what you see on the screen.

Question 12 ***



Three points *A, B* and *C* lying on horizontal ground are spaced such that *AB* = 6.8 m and *BC* = 10.5 m.

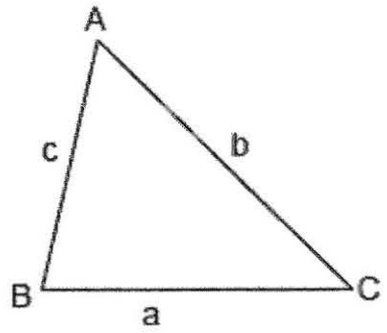
A vertical mast *AT* stands at point *A.* The angle of elevation of *T* from *B* is 36°. Point *B* is due south of *A.* The bearing of *C* from *B* is 055°.

Test

Find the angle of elevation of T from C **and** the bearing of C from A.

Question 13 ***

The ***sine rule*** and ***cosine rule*** can be used for finding unknown sides or angles in a triangle.



Show that the following rule holds true for ***any*** triangle ABC:

$$\boldsymbol{b\,(c \times cosA - a \times cosC) = c^2 - a^2}$$

Show full algebraic working for justification.

YEAR 11

SUBJECT: Mathematics B

UNIT: Introduction to Functions 1, Periodic Functions 1, Applied Statistics 1

STUDENT NAME: _____

TEACHER/S NAME:

Task Summary:

1. **Completion Date:**
   21st March 2013

2. **Time Allowed:**
   120 minutes + 10 minutes perusal

3. **Conditions and Nature of Assessment Task**
   Supervised exam conditions – individual work
   No teacher input

4. **Points to Observe**
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   Draw diagrams and graphs in pencil
   The use of whiteout or correction tape is not permitted
   Calculators are necessary
   SHOW ALL WORKING

Semester 1 Item 1

KAPS

Marks	
26	28

MAPS

Q	Grade	Rating
9	*	2
10	**	2½
11	**	1½
12	***	1½
13	***	½
	O/All	—

CAJ

QNS	Rating
1-3, 7-8	H
4 - 6	H
9, 12, 13	L
10, 11	H|S
O/All	—

Key Common Curriculum Elements embedded in this task				
Comprehend & collect	**Structure & sequence**	**Analyse, assess & conclude**	**Create & present**	**Apply techniques & procedures**
1. Recognising letters, words and symbols 3. Recalling/remembering 4. Interpreting the meaning of words and other symbols 5. Interpreting the meaning of pictures/illustrations 6. Interpreting the meaning of tables or diagrams or maps or graphs 7. Translating from one form to another 14. Compiling results in a tabular form 32. Reaching a conclusion which is necessarily true provided a given set of assumptions is true	36. Applying strategies to trial and test ideas and procedures 38. Generalising from information 45. Judging, evaluating 48. Justifying 51. Identifying shapes in two and three dimensions	22. Structuring / organising a mathematical argument 33. Reaching a conclusion which is consistent with a given set of assumptions 44. Synthesising 60. Sketching/drawing	9. Using correct spelling, punctuation and grammar 10. Using vocabulary appropriate to a context 12. Compiling lists/statistics 15. Graphing 16. Calculating with or without calculators	19. Substituting in formulae 20. Setting out, presenting, arranging, displaying 43. Analysing

Appendix 1 Student solutions - 13 pages of work

KAPS

Q1 $\frac{x+1}{4} = \frac{1}{6} + \frac{2-x}{3}$

$\therefore \frac{x+1}{4} = \frac{1}{6} + \frac{2(2-x)}{6}$

$\therefore \frac{x+1}{4} = \frac{1+4-2x}{6}$

$\therefore \frac{x+1}{4} = \frac{5-2x}{6}$

$\therefore 6(x+1) = 4(5-2x)$ 2/2

$\therefore 6x+6 = 20-8x$

$\therefore 6x+8x = 20-6$

$\therefore 14x = 14$

$\therefore x = 1$

Q2 $y = x+1$ $\quad x^2+y^2 = 25$

a) intersection: $(3,4)$ and $(-4,-3)$

b) $y = x+1$ ①

$x^2+y^2 = 25$ ②

$\therefore$ sub ① into ②

$\therefore x^2+(x+1)^2 = 25$

$\therefore x^2+x^2+2x+1 = 25$

$\therefore 2x^2+2x+1 = 25$

$\therefore 2x^2+2x+1-25 = 0$

$\therefore 2x^2+2x-24 = 0$

$\therefore 2(x^2+x-12) = 0$

$\therefore 2(x-3)(x+4) = 0$ 3/3

$\therefore x-3 = 0$ or $x+4 = 0$

$\therefore x = 3$ or $x = -4$

when $x = 3$ sub into ①

$\therefore y = 3+1$

$\therefore y = 4$

$\therefore$ intersects at $(3,4)$

(2)

when $x = -4$ sub into (1)

$\therefore y = -4 + 1$

$\therefore y = -3$

$\therefore$ intersects at $(-4, -3)$

$\therefore$ both estimations were correct. ✓

Q3 $h = -16t^2 + 80t + 96$

a) i) sub 0 - where 0 is the time the arrow had not been launched ✓

$\therefore h = -16 \times 0^2 + 80 \times 0 + 96$

$\therefore h = 96m$ $\therefore$ the height of the building is 96 m

ii) $h = -16t^2 + 80t + 96$

$\therefore 96 = -16t^2 + 80t + 96$

$\therefore 0 = -16t^2 + 80t + 96 - 96$

$\therefore 0 = -16t^2 + 80t$

$\therefore x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$ Ult q.c.

$\therefore x = \dfrac{-80 \pm \sqrt{80^2 - 4 \times -16 \times 0}}{2 \times -16}$

$\therefore x = \dfrac{-80 \pm \sqrt{6400}}{-32}$

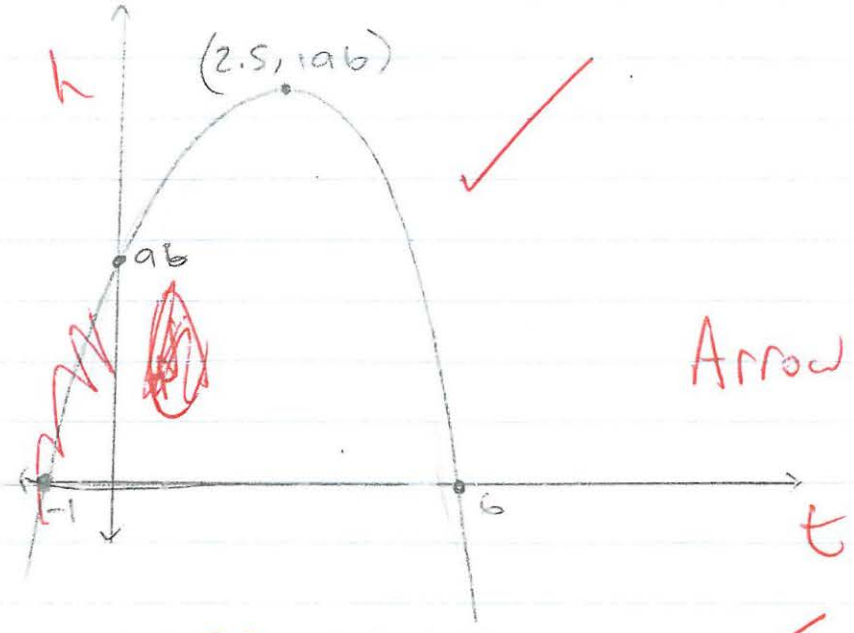
~~$x = 0$ or $x =$~~

$\therefore x = \dfrac{-80 \pm 80}{-32}$

$\therefore x = -1$ or $x = 5$ 2. ✓

$\therefore -1$ is the time the arrow had not been launched and 5 is the time that the arrow hits the ground. 2

b)



Arrow reaches 196.

c) when $y = 50$ $x = 5.52$

$\therefore$ the arrow was 50 m above street level for 5.52 seconds.

Q4a) $\frac{7\pi}{12}$ radians

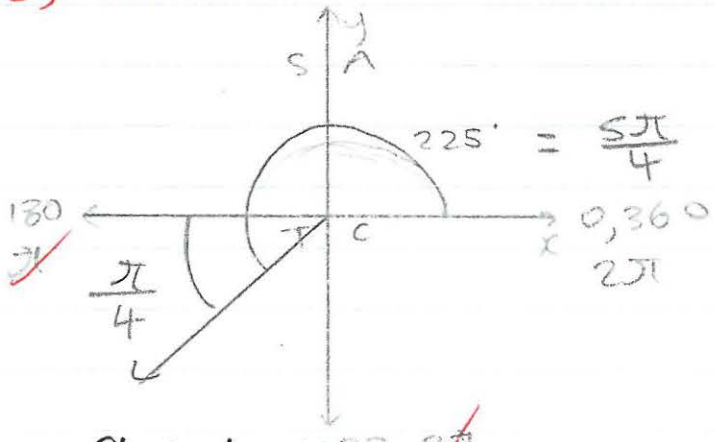
degrees = radians $\times \frac{180}{\pi}$

$\therefore$ $d = \frac{7\pi}{12}$ radians $\times \frac{180}{\pi}$

$\therefore$ $d = 105°$

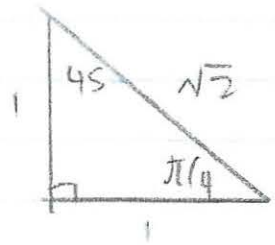
$\therefore$ $\frac{7\pi}{12} = 105°$

b) tan 255°



Student solutions

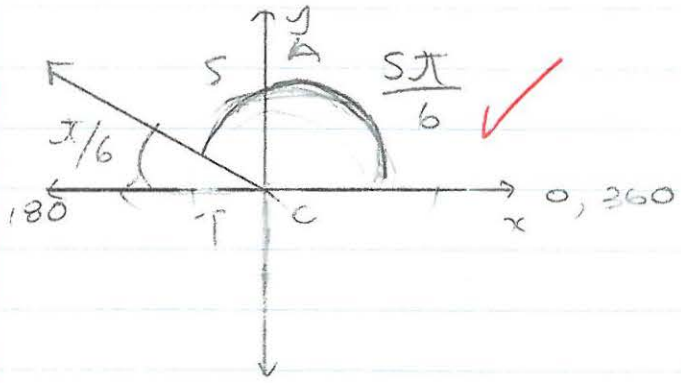
(4)



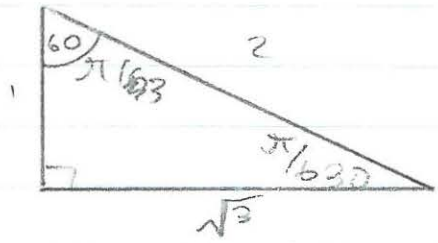
reference angle = $\frac{\pi}{4}$ 45° Q in degrees ✓ 2

∴ tan 255° = ✓1

c) cos ($5\pi/6$)



5/5

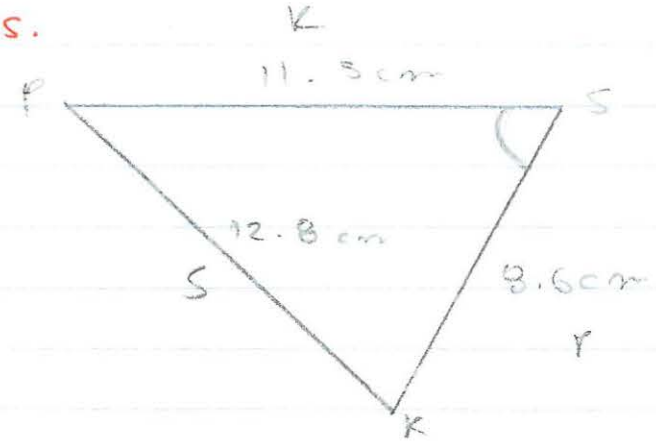


reference angle = $\pi/6$ ✓ 2

∴ cos ($5\pi/6$) = $\frac{-\sqrt{3}}{2}$ ✓

Student solutions

Q5.



$s^2 = p^2 + r^2 - 2pr\cos S$

$\therefore 12.8^2 = 8.6^2 + 11.5^2 - 2 \times 8.6 \times 11.5 \cos S$

$\therefore 163.84 = 73.96 + 132.25 - 197.8 \cos S$

$\therefore 197.8\cos S = 73.96 + 132.25 - 163.84$

$\therefore 197.8\cos S = 42.37$

$\therefore \cos S = \frac{42.37}{197.8}$

$\therefore S = \cos^{-1}(42.37/197.8)$

$\therefore S = 77.63°$

$\therefore \angle PSR = 77.63°$ ✓

2½/3

$(77.63 - 77) \times 60$

$= 0.63103497 \times 60$

$= 37.86$

$37.86 - 37$

$= 0.86 \times 60$

$= 51.72$

$\therefore 77.63° = 77°37'52''$

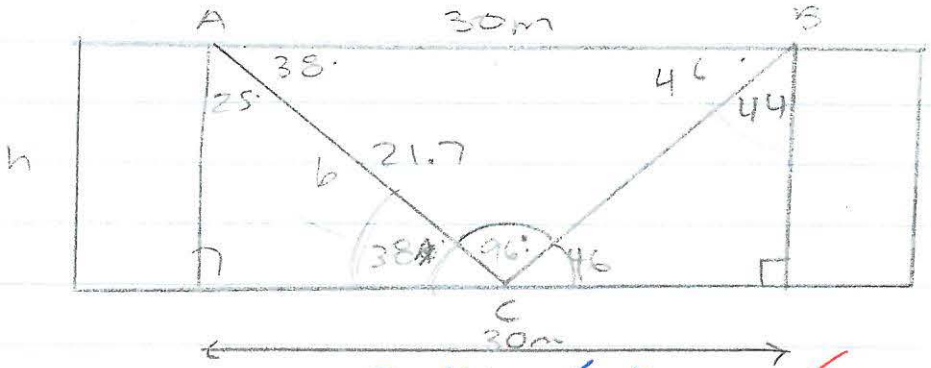
$\therefore 77.63° = 78°$

$\therefore \angle PSR = 78$ minutes ✗

Student solutions

(6)

Q6



$\angle ACB = 180 - 38 - 46$ (∠s)

$\therefore \angle ACB = 96°$

$\angle ABC = 90 - 46$ (∠)

$\therefore \angle ABC = 44°$

$\angle ACB = 180 - 90 - 44$ (∠s)

$= 46°$

$\angle ACB = 180 - 96 - 46$ (∠)

$\therefore \angle ACB = 38°$

$\angle BAC = 180 - 90 - 38$ (∠)

$\therefore \angle BAC = 52°$

$$\frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\therefore \frac{b}{\sin 46} = \frac{30}{\sin 96}$$

$$\therefore b = \frac{30 \sin 46}{\sin 96}$$

$$\therefore b = 21.70\text{m}$$

Student solutions

$\sin\theta = \text{opp/hyp.}$

$\therefore \sin 38° = h/21.7$

$\therefore \quad h = 21.7 \sin 38°$

$\therefore \quad h \doteq 13.36\text{m}$

$\therefore \quad h \doteq 13\text{m}$

∴ the height of the block of flats is approximately 13 m.

7.) a) discrete. As the numbers are all rational and cannot be irrational, data is discrete.

ratio expressed as fraction

non terminating non repeating decimal

b)

Shooter A		Shooter B
4 3	0	0
7 6 5 1 1	1	
0	2	9
	3	0 5 5 7 9
1	4	0 1

c) $Q1 = 29.5$

$Q3 = 39.5$

$\therefore IQR = Q3 - Q1$

$\therefore IQR = 10$

d) upper boundary $= Q3 + 1.5 \times IQR$

$\therefore \quad ub = 39.5 + 1.5 \times 10$

$\therefore \quad ub = 54.5$

lower boundary $= Q1 - 1.5 \times IQR$

$\therefore \quad lb = 29.5 - 1.5 \times 10$

$\therefore \quad lb = 14.5$

∴ Shooter B has 1 outlier; 0

(8)

8. a) e) ✓ E not e
b) a) ✓ A not a

2/2

MAPS (1)

Q9. $\frac{\pi}{6} = 30°$ $\frac{2\pi}{3} = 120°$

i) $\sin(\pi/6) \times \cos(2\pi/3) + \sin(2\pi/3) \times \cos(\pi/6$

$\therefore = 1/2 \times -1/2 + \sqrt{3}/2 * \sqrt{3}/2$

$\therefore = -1/4 + 3/4$

$\therefore = 1/2$

Show all working.

Did you just use a calculator?

ii) $\sin(\pi/6 + 2\pi/3)$

$= 1/2$

Maps 2 Q4 (a) (b)

$\therefore$ the teachers statement is valid as $1/2 = 1/2$

10) a) median 1st day = 4.6

median 1st week later = 3.6

$\therefore$ the median is better one week later

$IQR_{day1} = Q3 - Q1$

$\therefore = 5.3 - 4.1$

$\therefore IQR_{day1} = 1.2$

No need to rewrite numbers

$IQR_{1\text{week later}} = Q3 - Q1$

$\therefore = 4.6 - 3$

$\therefore IQR = 1.6$

Range day 1 = 6.6 − 2.2

Range = 4.4

Range 1 week later = 6.2 − 1.6

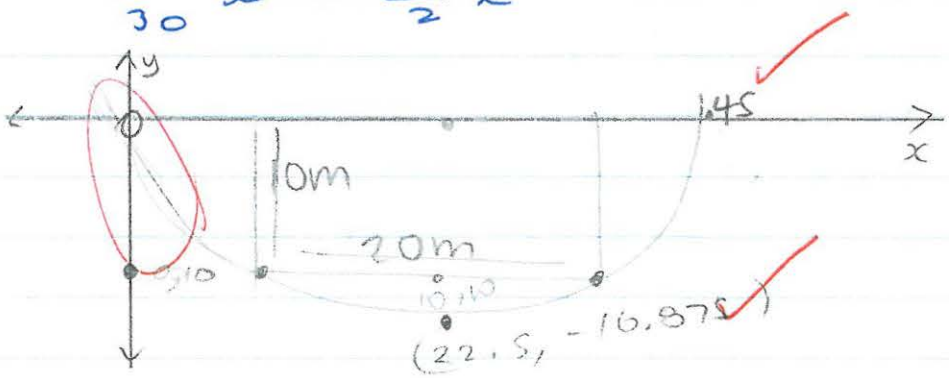
= 4.6

b) IQR Q1 & Q3 IQR is a range - it can't be lower and range is lower, therefore has better times than 1 week later than the first day

Therefore showing an improvement from the first day to a week later. This can be seen through the lower median, as well as smaller quartile values.

b). An assumption was made that all workers were under the same conditions, using the same machinery and production line, that both data were recorded under the same tests (fair testing) with the same abilities. The answer above would not be valid if different working conditions were in place. such as,

Q11. $d = \frac{1}{30}x^2 - \frac{3}{2}x$



y-int = 0

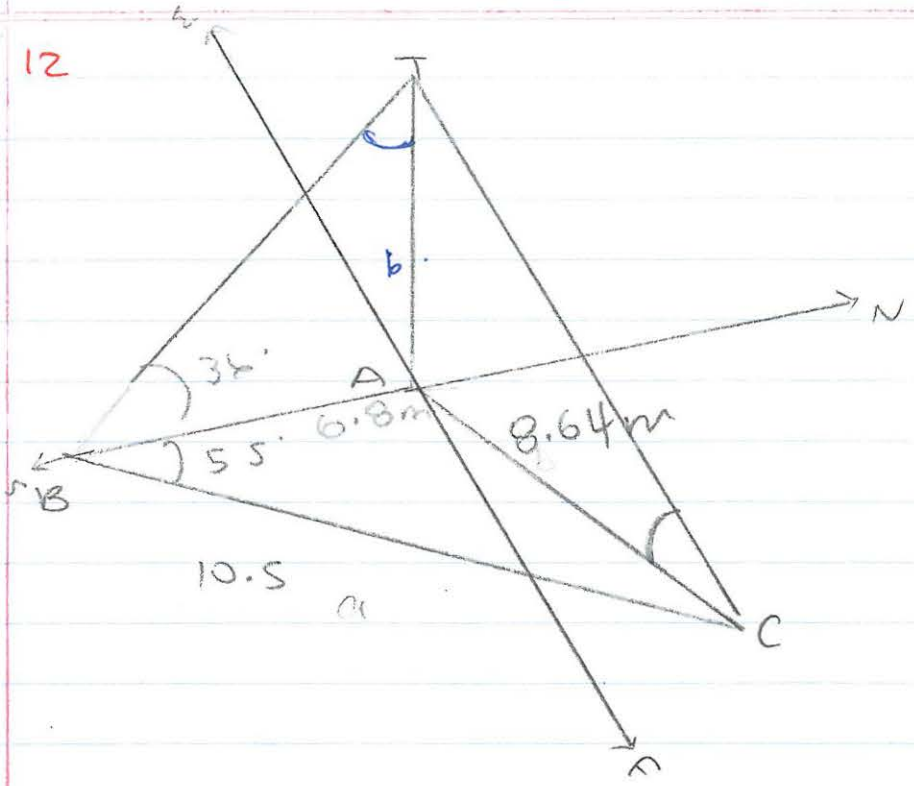
∴ point (0,0) lies on the parabola → sub into equation + 10m is on y-int sub in (seperately

$d = \frac{1}{30}x^2 - \frac{3}{2}x$

$\therefore 10 = \frac{1}{30}x^2 - \frac{3}{2}x$

$\therefore 0 = \frac{1}{30}x^2 - \frac{3}{2}x - 10$

12



$b^2 = a^2 + c^2 - 2ac\cos B$

$\therefore b^2 = 10.5^2 + 6.8^2 - 2 \times 10.5 \times 6.8 \cos 55°$

$\therefore b^2 = 110.25 + 46.24 - 142.8\cos 55°$

$\therefore b^2 = 156.5 - 142.8\cos 55°$

$\therefore b = \sqrt{156.5 - 81.91}$

$\therefore b \doteq 8.64\text{m}$

Bearing of point A from C = 360 - 6C (8)

$b^2 = a^2 + c^2 - 2ac\cos B$

$\therefore b^2 = a^2 + 6.8^2 - 2 \times a \times$

Maps $1\frac{1}{2}$*

Cal L+

Need a lot more evidence.

$$\therefore x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$$\therefore x = \frac{3/2 \pm \sqrt{3/2^2 - 4 \times 1/30 \times -10}}{2 \times 1/30}$$

g.c.

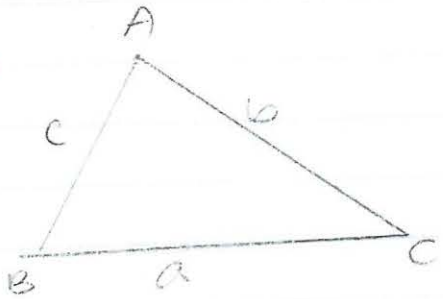
$$\therefore x = \frac{3/2 \pm \sqrt{129}/2}{1/15}$$

$$\therefore x = \frac{3/2 \pm \sqrt{129}/2}{1/15}$$

$$\therefore x = 50.89 \text{ or } -5.89$$

2 sf

Q13.



$b(c \times \cos A - a \times \cos C) = c^2 - a^2$

$\therefore bc\cos A - ab\cos C = c^2 - a^2$

$\therefore bc\cos A + \cos C = \frac{c^2 - a^2}{-ab}$

$\therefore bc\cos A + \cos C = \frac{c^2 + a}{b}$

$\therefore \cos A + \cos C = \frac{c^2 + a}{bc + b}$

$\therefore \cos A + \cos C = \frac{c + a}{2b}$

$\therefore 2b(\cos A + \cos C) = c + a$

$\therefore 2b\cos A + 2b\cos C = c + a$

$\therefore$

Maps ½* Cay (L)

KAPS SOLUTIONS 2013 Test 1 (28 marks)

Question 1

$$\frac{x+1}{4}=\frac{1}{6}+\frac{2-x}{3}.$$

$$12\left(\frac{x+1}{4}=\frac{1}{6}+\frac{2-x}{3}\right)$$

$$\left(\frac{12}{1}\right)\frac{x+1}{4}=\left(\frac{12}{1}\right)\frac{1}{6}+\left(\frac{12}{1}\right)\frac{2-x}{3}$$

$$\frac{3}{1}\cdot\frac{x+1}{1}=\frac{2}{1}\cdot\frac{1}{1}+\frac{4}{1}\cdot\frac{2-x}{3}$$

$3(x+1)=2+4(2-x)$ ✓

$3x+3=2+8-4x$ ✓

$3x+3=10-4x$

$+4x \qquad +4x$

$7x+3=10$

$-3 \quad -3$

$7x=7$ ✓

$x=1$ ✓

[2 KAPS]

Appendix 1 - Marking scheme - 20 pages long

Question 2

(a) By inspection. Points of intersection close to (-4, -3) ✓ and (3, 4) ✓

(b)

Substituting $y = x + 1$ into $x^2 + y^2 = 25$ gives:

$x^2 + (x+1)^2 = 25$

$2x^2 + 2x + 1 = 25$ ✓

$2x^2 + 2x - 24 = 0$

$x^2 + x - 12 = 0$

$(x+4)(x-3) = 0$ so either $x = -4$ or $x = 3$ ✓

When $x = -4$, $y = (-4) + 1 = -3$

When $x = 3$, $y = 3 + 1 = 4$ ✓

Hence, the circle and line intersect at $(-4, -3)$ and $(3, 4)$.

✓

This confirms and justifies the reasonableness of the estimate in part (a).

[3 KAPS]

Question 3

a)

(i) the height of the building above the street can be found by substituting t = 0, giving h = 96 m. Hence building height is 96 m. ✓✓

(ii) the time from when the arrow was shot until it hits the street below can be found by solving: $0 = -16t^2 + 80t + 96$

$\Rightarrow 0 = -16(t^2 - 5t + 6)$

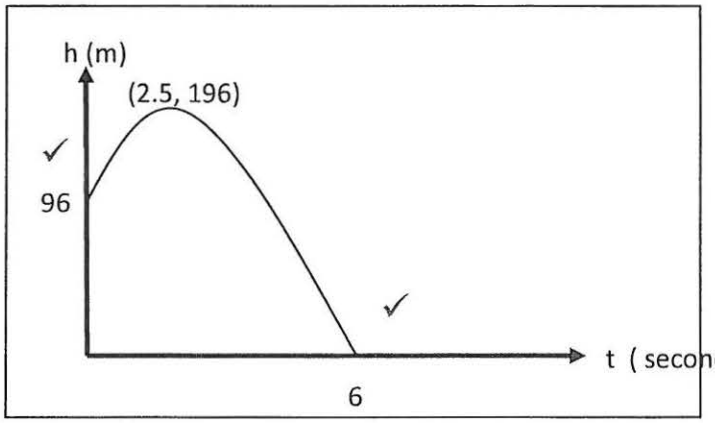
$\Rightarrow 0 = -16(t-6)(t+1)$

$\Rightarrow t = 6\,s \text{ or } -1\,s$

In this context we can only accept the positive solution.

Therefore arrow hits ground after 6 seconds. ✓✓

b) The graph of the height function for the length of time the arrow was in the air.



Marking scheme

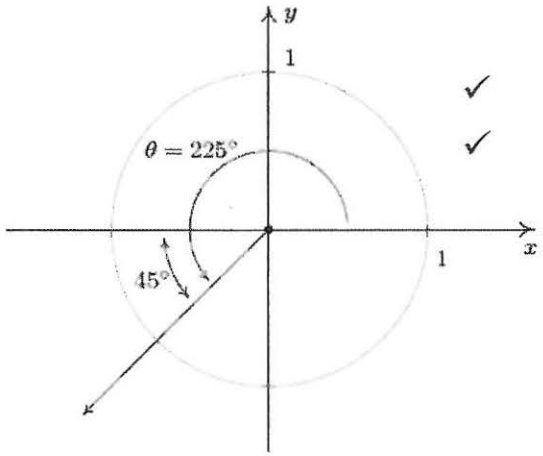
Turning point of your graph found using G-Solve Max. Hence the maximum height reached by the arrow was 196 m. ✓

c) The length of time the arrow was above a height of 50 m above street level can be found using G-Solve x-Cal when y = 50. ✓
This gives one ✓ possible answer in the domain $0 \leq t \leq 6$.
This is 5.52 seconds. ✓ [5 KAPS]

Question 4

(a) $\frac{7\pi}{12} = \frac{7\pi}{12} \times \frac{180}{\pi} = 105^{\circ}$ ✓ ✓

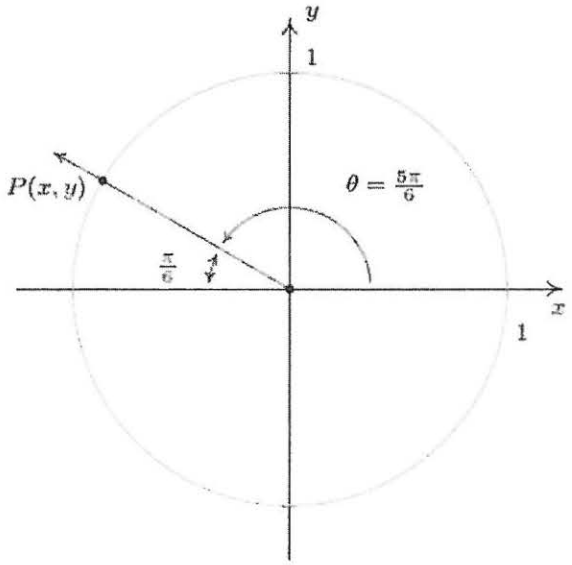
(b)



✓
✓

tan 225°
= tan 45° ✓
= $1/\sqrt{2}$ ✓

(c)



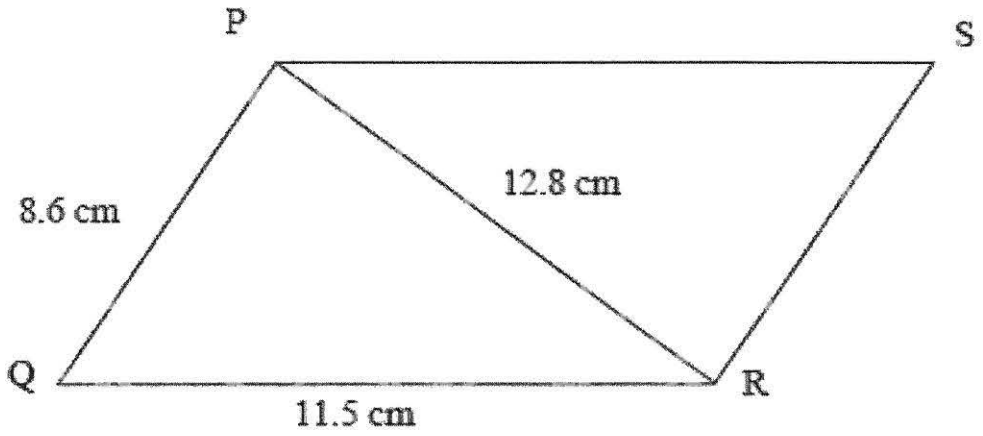
✓
✓

$\cos\frac{5\pi}{6}$
$= -\cos\frac{\pi}{6}$ ✓
$= -\sqrt{3}/2$ ✓

[5 KAPS]

Marking scheme

Question 5



Cosine Rule

$$q^2 = p^2 + r^2 - 2prcosQ$$

$\Rightarrow$ $12.8^2 = 8.6^2 + 11.5^2 - 2 \times 8.6 \times 11.5 \times cosQ$ ✓ ✓

$\Rightarrow$ $\text{cosQ} = \frac{12.8^2 - 8.6^2 - 11.5^2}{-2 \times 8.6 \times 11.5}$ ✓ ✓

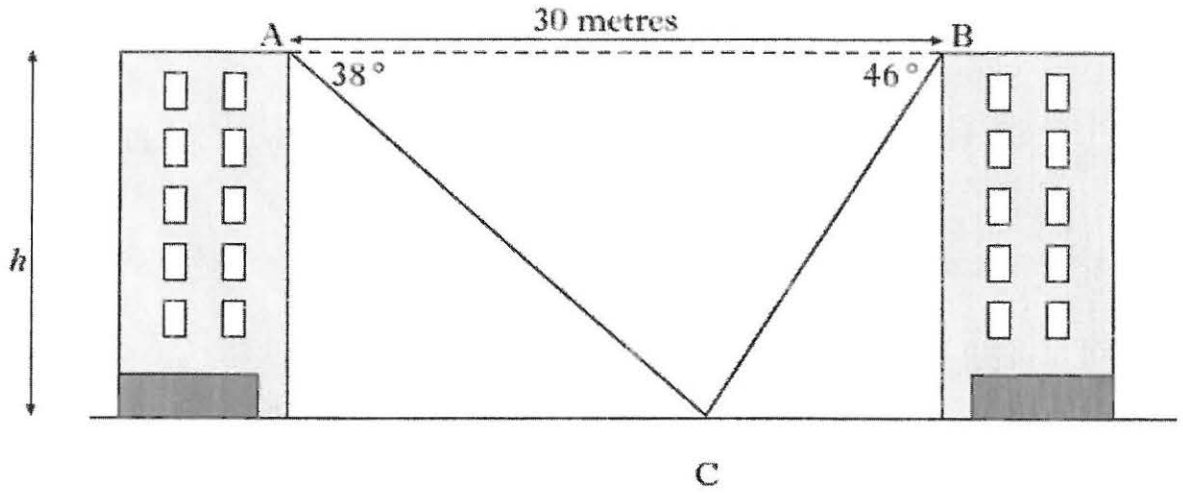
$\Rightarrow$ cosQ ÷ 0.2142

$\Rightarrow$ $\angle PQR = \angle PSR$ ÷ **77° 38′** ✓✓

---------- [3 KAPS]

Marking scheme

Question 6

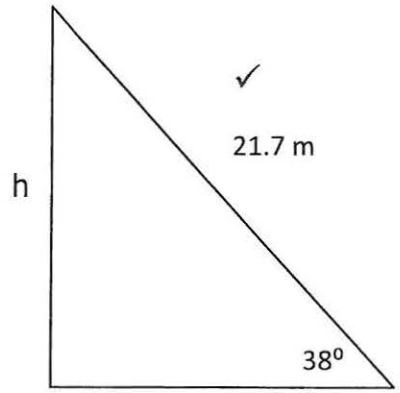


Sine Rule $\quad \frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

$\angle ACB = 180^0 - 38^0 - 46^0 = 96^0$ ✓

$\frac{sin46}{AC} = \frac{sin96}{30} \Rightarrow AC = 21.7\ m$ ✓ ✓

Now using right-angled triangle on the left:



✓

$\sin\theta = {}^{O}/_{H}$

$\Rightarrow \quad \sin 38 = {}^{h}/_{21.7}$ ✓

$\Rightarrow \quad h = 13.36\ m$ ✓

Height of building is about 13.36 m

---------- **[3 KAPS]**

Marking scheme

Question 7

The scores of two hockey goal shooters, A and B, are listed below:

Shooter A:	4	10	10	17	3	20	16	15	41
Shooter B:	35	39	30	41	35	40	37	29	0

(a) The data is discrete - only whole numbers possible. ✓ ✓

(b) Stem plot for the Hockey Scores. Key: 2 | 9 = 29 ✓

✓ Shooter A	✓	Shooter B ✓
4, 3	0	0
7, 6, 5, 0, 0	1	
0	2	9
	3	0, 5, 5, 7, 9
1	4	0, 1

(c) Use your graphics calculator to find Q_1, Q_3 and hence the interquartile range (IQR) for Shooter B.

Q_3 = 39.5 and Q_1 = 29.5 ; So IQR = 39.5 - 29.5 = 10 ✓ ✓

(d) Determine whether or not any of Shooter B's scores qualify as outliers.

Lower Limit: $Q_1 - 1.5 \times IQR = 14.5$
Upper Limit: $Q_3 + 1.5 \times IQR = 54.5$ } ✓

Only the score 0 is outside the limits. ✓ ∴ 0 is an outlier.

[5 KAPS]

Question 8

(a) E ✓ ✓ **(b) A** ✓ ✓

[2 KAPS]

Marking scheme

35

MATHS B CAJ MARKING CRITERIA FOR KAPS

CAJ for KAPS - (QNS 4, 5, 6) Trigonometry

CAJ SOLUTION FEATURES

(a) Correct use of mathematical terms, units and symbols:
Eg. degrees or radians

(b) Organises information into suitable into suitable forms; presentation appropriate:
Eg. labelling diagrams or logical setting out of procedures.

(c) Translation of information into other representations:
Eg. Diagram to trig-ratios, or words into diagrams

(d) Evidence of mathematical reasoning:
Eg. substitution and manipulation of symbols in formulae.

(e) Justifies procedures, decisions and results:
Eg. Working for exact values with aid of a diagram, or writing a generic rule .

NOTE: Justifies reasonableness of results not required in Qns 4, 5, 6

CAJ for MAPS	
H	All features consistently demonstrated
H/S	Four of the five features (a)-(e) consistently demonstrated
S	Four of the five features (a)-(e) sometimes demonstrated (simple level only)
L	Features (a) and (b) usually demonstrated
N	Attempts to demonstrate aspects of (a) and (b)

Marking scheme

MATHS B CAJ MARKING CRITERIA FOR KAPS

CAJ for KAPS (QNS 1, 2, 3, 7 and 8) Algebra & Statistics

CAJ SOLUTION FEATURES

(a) **Correct use of mathematical terms, units and symbols:**
Eg. correct statistics symbols

(b) **Organises information into suitable forms; presentation appropriate:**
Eg. logical steps, statements,...

(c) **Translation of information into other representations:**
Eg. from equation to graphical display or from diagram to statements

(d) **Evidence of mathematical reasoning:**
Eg. Logical calculations to produce results; discussing assumptions on which procedures are based.

(e) **Justifies procedures, decisions and results:**
Eg. Using evidence given in question or results of calculations to support decisions.

(f) **Justifies reasonableness of results:** Only relevant in Q2.

CAJ for MAPS	
H	All six of the features are consistently demonstrated.
H/S	At least four of the features are consistently demonstrated.
S	At least three of the features are consistently demonstrated.
L	Features (a) and (b) demonstrated in several questions.
N	Attempts to demonstrate aspects of (a) and (b)

Marking scheme

,QUESTION 9 ★

(i)

$$\cos\frac{\pi}{6} = \frac{\sqrt{3}}{2}$$

$$\sin\frac{\pi}{6} = \frac{1}{2}$$

$$\cos\frac{2\pi}{3} = -\cos\frac{\pi}{3} = -\frac{1}{2}$$

$$\sin\frac{2\pi}{3} = +\sin\frac{2\pi}{3} = \frac{\sqrt{3}}{2}$$

$$\sin\frac{\pi}{6}\cos\frac{2\pi}{3} + \sin\frac{2\pi}{3}\cos\frac{\pi}{6} = \frac{1}{2}\times -\frac{1}{2} + \frac{\sqrt{3}}{2}\times\frac{\sqrt{3}}{2} = -\frac{1}{4}+\frac{3}{4} = {}^1/_2$$

(ii)

$$\sin\left(\frac{\pi}{6}+\frac{2\pi}{3}\right) = \sin\left(\frac{5\pi}{6}\right) = {}^1/_2$$

Since $\sin\frac{\pi}{6}\cos\frac{2\pi}{3} + \sin\frac{2\pi}{3}\cos\frac{\pi}{6} = \sin(\frac{5\pi}{6})$, teacher's argument appears to be valid.

GENERAL MAPS CRITERIA

M1	Interpretation, clarification & analysis of problem. And/or Use of appropriate problem solving strategies.
M2	Identification of assumptions, parameters and/or variables. And/or Analysing effects of assumptions.
M3	Use of data to synthesize mathematical model and/or Use of mathematical model to generate data
M4	Interpretation of results in context and/or Evaluate validity of argument including strengths and limitations of model

Marking scheme

MAPS SOLUTIONS 2013 – Test 1

GENERAL FEATURES OF Q9✱

	SOLUTION FEATURE	ATTRIBUTE
(a)	Determines exact value: $cos\frac{\pi}{6}$ & $sin\frac{\pi}{6}$ with working.	M1 & M3
(b)	Determines exact value: $cos\frac{2\pi}{3}$ & $sin\frac{2\pi}{3}$ with working.	M1 & M3
(c)	Determines exact value: $sinAcosB + sinBcosA = ½$ with working.	M1 & M3
(d)	Shows that $\sin(A + B) = \sin(^{5\pi}/_{6}) = ½$ as well.	M1 & M4

TEACHERS GUIDE FOR GRADING Q9✱

	MAPS
3	Features (a) to (d) complete and correct.
2.5	As for 3 with one minor calculation error.
2	Three features complete and correct.
1.5	Two features complete and correct.
1	One features complete and correct.
0	Response makes very limited progress or no response at all.

Marking scheme

MAPS SOLUTIONS 2013 – Test 1

QUESTION 10 ★★

(a) A Possible Student Conclusion:

The evidence suggests "Yes" there has been improvement since the first day.

Justification:

1. All 5 number summary values are less than those from first day. Eg. Med on first day was 4.6 minutes. One week later, Med was 3.6 m.

2. Percentage of workers reaching particular assembly times has improved. Eg. On first day, about 50% of the sample could assemble the toy in 4.6 minutes or less. One week later, about 75% of workers could achieve the same goal.

(b) Assumptions: (need at least one valid assumption --- examples below)

1. Both samples of 20 workers were true (unbiased) random samples which are representative of the entire population.

2. The same timing device and methods are used on both occasions and that these devices are not faulty or behave differently on different days.

3. The external conditions on both days are the same --- eg. similar temperatures, similar time of day, etc.

Effects on conclusion:

Clearly if any of the above assumptions are invalid, the conclusions reached would be false. For example, if one day was much hotter or humid the other, working conditions would differ which could bias the results.

GENERAL MAPS CRITERIA

M1	Interpretation, clarification & analysis of problem. And/or Use of appropriate problem solving strategies.
M2	Identification of assumptions, parameters and/or variables. And/or Analysing effects of assumptions.
M3	Use of data to synthesize mathematical model and/or Use of mathematical model to generate data
M4	Interpretation of results in context and/or Evaluate validity of argument including strengths and limitations of model

Marking scheme

40

MAPS SOLUTIONS 2013 – Test 1

GENERAL FEATURES OF Q10✶✶

	SOLUTION FEATURE	ATTRIBUTE
(a)	Identifies a conclusion – Yes or No A first relevant statistical measure used to support.	M1 & M3
(b)	A second relevant statistical measure used to support. Second measure **distinct** from first in nature.	M1 & M3
(c)	Interprets results in context. States a relevant assumption on which conclusion was reached.	M4 & M2
(d)	Interprets and analyses effect of assumption.	M2

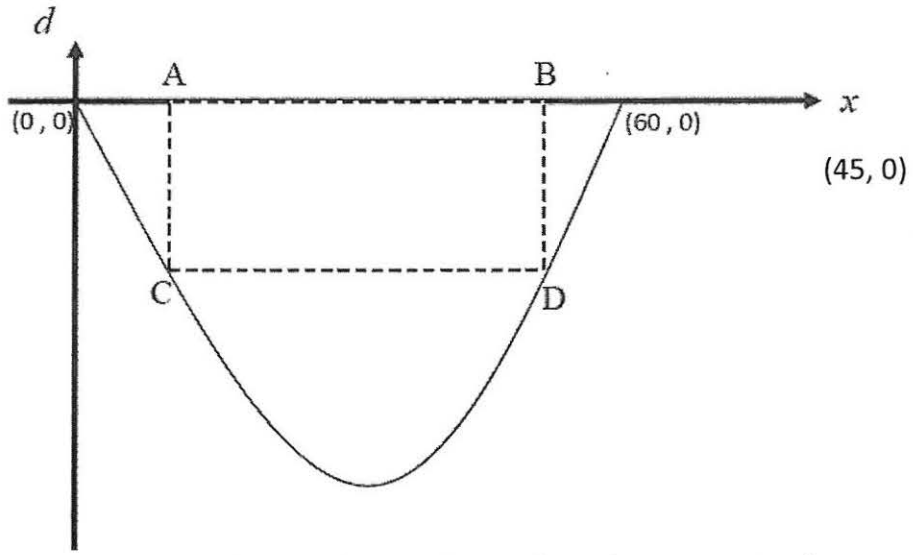
TEACHERS GUIDE FOR GRADING Q10✶

	MAPS
4	Features (a) to (d) complete and correct.
3.5	As for 4 with one minor calculation error.
3	Three features complete and correct.
2	Two features complete and correct.
1	One features complete and correct.
0	Response makes very limited progress or no response at all.

Marking scheme

MAPS SOLUTIONS 2013 – Test 1

QUESTION 11 ★★



Best case scenario for skipper is to place barge centrally.

Possible Method :

Let w = allowable width when d = -10

Substituting d = -10 into equation and solving for x gives: x = 8.14 and 36.86

This means, the maximum allowable width of a barge at a depth of 10 m would be given by:

$$w = 36.86 - 8.14 = 28.72 \text{ m}$$

Since barge is 20 m wide and w < 28.72, the barge will easily fit.

Other Possible Method :

If barge is to be 20 m wide, then distance AB = 20 m.

Hence: Point A needs to be 12.5 m away from origin.
Point B needs to be 32.5 m away from origin.

This means: A is at (12.5, 0) and B is at (32.5, 0).

Suppose point C is the point on the parabola vertically below A.
Suppose point D is the point on the parabola directly below B.

When x = 12.5, $d = \frac{1}{30} \times 12.5^2 - 1.5 \times 12.5 = -13.5$

When x = 32.5, $d = \frac{1}{30} \times 32.5^2 - 1.5 \times 32.5 = -13.5$

This means: C is at (12.5, -13.5) and D is at (32.5, -13.5).
This tells us that a barge 20 m wide and 10 m deep will easily fit with bottom corner's not touching the sides of the canal.

Marking scheme

GENERAL FEATURES OF Q11✶✶

	SOLUTION FEATURE	ATTRIBUTE
(a)	Relevant parabola features identified. Eg. Intercepts (0,0) & (45,0) by GC or algebraically.	M1 & M3
(b)	Sketch appropriate graph of canal cross-section with barge centrally positioned.	M1
(c)	Find x-values at d = -10, to determine canal width OR Find y-values at x = 12.5 and x = 32.5 to find depth.	M1 & M3
(d)	Evaluate / Interpret results in context to barge fitting.	M4

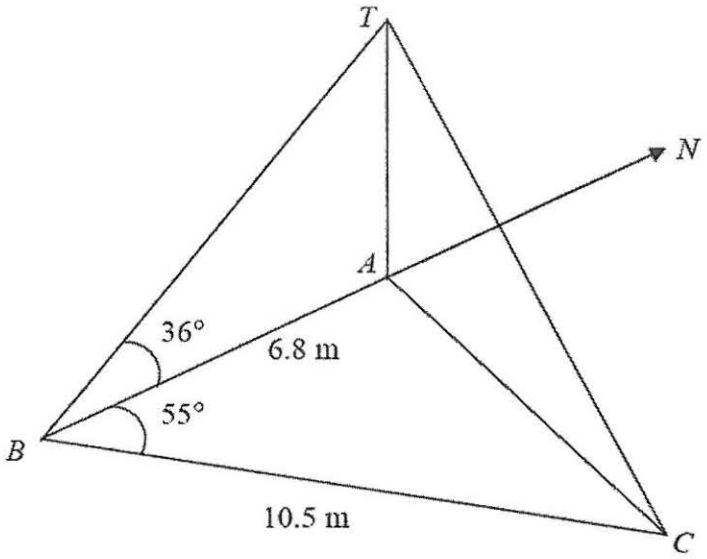
TEACHERS GUIDE FOR GRADING Q11✶✶

MAPS	
4	Features (a) to (d) complete and correct.
3.5	As for 3 with one minor calculation error.
3	Three features complete and correct.
2	Two features complete and correct.
1	One features complete and correct.
0	Response makes very limited progress or no response at all.

Marking scheme

MAPS SOLUTIONS 2013 – Test 1

QUESTION 12 ★★★



Cosine Rule: $a^2 = b^2 + c^2 - 2bc\cos A$

$\Rightarrow \quad AC^2 = 6.8^2 + 10.5^2 - 2\times6.8\times10.5\cos55^0$

$\Rightarrow \quad AC = 8.636$ m

Let ϑ represent $\angle$TBA

Triangle ABT: $tan\theta = {}^{O}/_{A}$

$$tan36^0 = {}^{TA}/_{6.8} \Rightarrow TA = 4.94 \text{ m}$$

Angle of elevation of T from C:

$$tan\theta = {}^{4.94}/_{8.636} \Rightarrow \theta = 29^0 46'$$

Let ϑ represent $\angle$BAC

Angle $\angle$BAC : $10.5^2 = 6.8^2 + 8.636^2 - 2\times8.636\times6.8\cos\Theta$

$\Rightarrow \quad cos\theta = 0.090$

$\Rightarrow \quad \theta = 84.84^0$

Now: $180^0 - 84.84^0 = 95.16^0$

Hence bearing of C from A is 095.16^0 T

Marking scheme

MAPS SOLUTIONS 2013 – Test 1

GENERAL MAPS CRITERIA

M1	Interpretation, clarification & analysis of problem
M2	Identification of assumptions, effects and/or variables
M3	Use of data to synthesize mathematical model and/or Use of mathematical model to generate data
M4	Interpretation of results in context and/or Evaluate validity of argument including strengths and limitations of model

GENERAL FEATURES OF Q12 ✱✱✱

	SOLUTION FEATURE	ATTRIBUTE
(a)	Correctly determines mast height AT from ΔBAT	M1 & M3
(b)	Correctly determines distance AC from ΔBAC	M1 & M3
(c)	Correctly determines angle $\angle ACT$ from ΔCAT	M1 & M3
(d)	Correctly determines angle $\angle CAB$ from ΔABC	M1 & M3
(e)	Interprets results $\Rightarrow$ Provides bearing of A from C	M4
(f)	Identifies or defines parameters, pro-numerals eg ϑ	M2

TEACHERS GUIDE FOR GRADING Q12✱✱✱

MAPS	
5	Features (a) to (f) complete and correct.
4.5	As for 5 with one minor calculation error.
4	Four features complete and correct.
3	Three features complete and correct.
2	Two or more features complete and correct.
1	At least one feature attempted using trigonometry.
0	Response makes very limited progress or no response at all.

Marking scheme

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QUESTION 13 ★★★

$$a^2 = b^2 + c^2 - 2bccosB \quad \Rightarrow \quad cosB = \frac{a^2 - b^2 - c^2}{-2bc} \ldots\ldots\ldots \textcircled{1}$$

$$c^2 = a^2 + b^2 - 2abcosC \quad \Rightarrow \quad cosC = \frac{c^2 - a^2 - b^2}{-2ab} \ldots\ldots\ldots \textcircled{2}$$

Then: LHS = $\boldsymbol{b\,(ccosA - acosC)}$

$$= \text{bc}\left(\frac{a^2-b^2-c^2}{-2bc}\right) - ba\left(\frac{c^2-a^2-b^2}{-2ab}\right)$$

$$= \frac{a^2-b^2-c^2}{-2} - \frac{c^2-a^2-b^2}{-2}$$

$$= \frac{a^2-b^2-c^2-c^2+a^2+b^2}{-2}$$

$$= \frac{-2c^2+2a^2}{-2}$$

$$= c^2 - a^2 \quad = \quad RHS \quad \therefore \text{ Proven} \quad \therefore \text{ Statement true}$$

GENERAL MAPS CRITERIA

M1	Interpretation, clarification & analysis of problem. And/or Use of appropriate problem solving strategies.
M2	Identification of assumptions, parameters and/or variables. And/or Analysing effects of assumptions.
M3	Use of data to synthesize mathematical model and/or Use of mathematical model to generate data
M4	Interpretation of results in context and/or Evaluate validity of argument including strengths and limitations of model

Marking scheme

MAPS SOLUTIONS 2013 – Test 1

GENERAL FEATURES OF Q13✱✱✱

	SOLUTION FEATURE	ATTRIBUTE
(a)	Develops expressions for bccosC and bacosA in terms of a,b,c	M1
(b)	Develops accurate expressions for: (bccosC − bacosA) with a common denominator.	M1
(c)	Simplifies expression for (bccosC − bacosA) to express as an expression with no denominator.	M1
(d)	Completes the proof and interprets the result to confirm validity of the rule with respect to **any** triangle.	M4

TEACHERS GUIDE FOR GRADING Q13✱✱✱

	MAPS
5	Features (a) to (d) complete and correct.
4	As for 5 with one minor error.
3	Three features complete and correct.
2	Two features complete and correct.
1	One features complete and correct.
0	Response makes very limited progress or no response at all.

Marking scheme

MATHS B CAJ MARKING CRITERIA FOR MAPS

CAJ for MAPS - (Q9*), (Q12***) (Q13***), Trigonometry

CAJ SOLUTION FEATURES

(a) **Correct use of mathematical terms, units and symbols:**
Eg. degrees or radians

(b) **Organises information into suitable into suitable forms; presentation appropriate:**
Eg. labelling diagrams or logical setting out of procedures.

(c) **Translation of information into other representations:**
Eg. Diagram to trig-ratios, or words into diagrams

(d) **Evidence of mathematical reasoning:**
Eg. substitution and manipulation of symbols in formulae.

(e) **Justifies procedures, decisions and results:**
Eg. Working for exact values with aid of a diagram, or writing a generic rule .

(f) **Justifies reasonableness of results:**
Eg. Q12 – attempt made to determine if rule applies to any triangle ABC?

CAJ for MAPS	
H	All features consistently demonstrated
H/S	Features (a)-(e) usually demonstrated , may have attempted feature - (f)
S	Features (a)-(e) sometimes demonstrated (simple level)
L	Features (a) and (b) demonstrated
N	Attempts to demonstrate aspects of (a) and (b)

Marking scheme

MATHS B CAJ MARKING CRITERIA FOR MAPS

CAJ for MAPS (Q10*), (Q11**) Algebra & Statistics

CAJ SOLUTION FEATURES

(a) **Correct use of mathematical terms, units and symbols:** Eg. correct statistics symbols
(b) **Organises information into suitable forms; presentation appropriate:** Eg. logical steps, statements,...
(c) **Translation of information into other representations:**
Eg. from equation to graphical display or from diagram to statements
(d) **Evidence of mathematical reasoning:**
Eg. Logical calculations to produce results; discussing assumptions on which procedures are based.
(e) **Justifies procedures, decisions and results:**
Eg. Using evidence given in question or results of calculations to support decisions.
(f) **Justifies reasonableness of results:** Only if relevant to any assumptions made.

CAJ for MAPS	
H	At least five of the features are consistently demonstrated.
H/S	At least four of the features are consistently demonstrated.
S	At least three of the features are consistently demonstrated.
L	Features (a) and (b) demonstrated in several questions.
N	Attempts to demonstrate aspects of (a) and (b)

Marking scheme

[redacted] - MATHEMATICS B PROFILE

Name	[redacted]				Year	2012/ 2013

		KAPS			MAPS											CAJ								
Sem	Instrument	Score		Grade	*	*	*	**	**	**		***	***	***	Grade	H	H/S	S	L	N	Grade	LOA	TCH	Comment
1	1. Assign. 1	7	8	A-	3							5			A+	2	0	0	0	0	A		MMO	
	2. Test 1	23.5	28	B+	2	3		3.5				3	0		B-	1	3				B		MMO	
	3. Test 2	29	35	B+	2			4	3.5	4		4			B+	4					A		MMO	
2	1. Assign 2	**9**	**9**	**A+**				**2**				**5**	**2.5**		**B***	**2**					**A**		**MMO**	
	2.Test 3	**28**	**32**	**A-**	**2.5**	**1.5**		**4**				**5**	**3.5**		**A-**	**4**					**A**		**MMO**	
	3. Test 4	**28**	**30**	**A***	**3**			**4**	**3.5**			**5**			**A+**	**4**					**A**		**MMO**	
	Semester 1	**83.8**	**%**	**B+**											**B+**				**A***			**B10**	**MMO**	
	Semester 2	**91.5**	**%**	**A***											**A-**				**A+**			**A6**	**MMO**	
	Year 11	**87.8**	**%**	**A-**											**A-**				**A+**			**A5**	**MMO**	**A**

↑ Final grade

One student's profile at the end of Year 11

The three criteria letter grades and final grade are determined using the 7 pages of instructions which follow. Ranking of students follows. It is possible for different teachers to come up with slightly different rankings.

Use of a single percentage would be more transparent and less subjective

Appendix 2 Profile

What if we used marks?

This experiment was conducted in December 2010 using data from one Year 12 Mathematics B class. Student grades were converted to marks as shown below.

Letter grades from profiles 8, 9, 10 = + 1, 2 , 3 = – KAPS, MAPS, CAJ, Overall	**Student ranking by letter grades**	**KAPS marks for semester** /130	**MAPS for semester converted to marks** (***=5, **=4, *=3) /113	**Total marks** (no allowance for CAJ) /243	**Percent**	**Change to order**
A8,A10,A5 **A+**	**1**	**123.5**	**105**	**228.5**	**94**	
A7,A8,A3 **A**	**2**	**123.5**	**97**	**220.5**	**91**	
A4,A8,A4 **A**	**3**	**117**	**91**	**208**	**86**	
A4,A4, B7 **A-**	**4**	**117**	**88.5**	**205**	**85**	
A1,A3,A1 **A-**	**5**	**110.5**	**84.5**	**195**	**80**	
A1,A3,A2 **A-**	**6**	**110.5**	**84**	**194.5**	**80**	
B8,A3,B5 **B+**	**7**	**105.5**	**81.5**	**187**	**77**	
B8,B9,B5 **B**	**8**	**104**	**73**	**177**	**73**	
B1,B9,B3 **B**	**9**	**93**	**73**	**166**	**68**	
B3,B2,B2 **B-**	**10**	**95**	**68.5**	**163.5**	**67**	
B1,B2,B4 **B-**	**11**	**91**	**67.5**	**158.5**	**65**	
C9,B4,B3 **B-**	**12**	**87**	**69.5**	**156.5**	**64.5**	
B1,B1,B2 **B-**	**13**	**90**	**58**	**145**	**61**	**14**
B1,C7,B1 **B-**	**14**	**88.5**	**61.5**	**150**	**62**	**13**
C9,C6,B1 **C+**	**15**	**83**	**58**	**141**	**58**	
C9,C5,C5 **C**	**16**	**83**	**51**	**134**	**55**	
C5,C5,C4 **C**	**17**	**77**	**50**	**127**	**52**	

With over 100 students in the subject and five teachers, the ranking of students from profiles took many hours and involved a significant level of subjectivity. I am very uncomfortable with this method; I cannot justify it to my students. Because of its transparency and objective nature, I consider the percentage method superior. It is also easier to communicate and justify to students and parents. As can be seen, the order of students remains substantially the same.

11 MATHEMATICS A, B & C
MARKBOOKS & PROFILES – GUIDELINES

After entering all grades into markbook and printing profiles for your class, please **check** the following **before** finalising you grades:

SEMESTER

1. HOW TO FINALISE KAPS GRADE FOR A SEMESTER:

(i) Does the overall KAPS grade for **each assessment task** on profile reflect these cut-offs?

0	E-
10	E*
20	E+
29.5	D-
34.5	D*
45	D+
49.5	C-
54.5	C*
65	C+
69.5	B-
75	B*
80	B+
84.5	A-
90	A*
95	A+

(ii) Is the overall KAPS grade for a **semester** very close to a cut-off according to above table? Each is important but especially look at for A-, B-, C- or D-.

(iii) Does the overall KAPS grade for a ***semester*** reflect the KAPS grade in each of the three assessment pieces on the profiles.
Eg. Below Sem 1 is acceptable, but Sem 2 is questionable.

Assignment 1	C-
Test 1	B+
Test 2	A-
Assignment 2	B*
Test 3	C-
Test 4	B+
Sem. 1 Grade	B+
Sem. 2 Grade	C+

Please discuss anything close to cut-off or is not reflective with HOD.

Appendix 3 - How to finalise grades

2. HOW TO FINALISE MAPS GRADE FOR A SEMESTER:

(i) Does the overall MAPS grade for **each assessment task** reflect the results awarded in each of the questions? Please discuss with HOD if in any doubt, particularly in borderline cases for A-, B-, C- and D- .

Generally, an A standard should show an ability to do each of *, ** and ***

Generally, a B standard should show an ability to do most of *, ** and some ***

Generally, a C standard should show an ability to do *, and maybe some of ** and/or ***

(ii) Is the **overall semester** MAPS standard very close to a cut-off according to the table below?

0	E-
2	E*
10	E+
12	D-
15	D*
25	D+
35	C-
40	C*
51	C+
56	B-
64	B*
74	B+
79	A-
86	A*
96	A+

(iii) Does the overall MAPS grade for a ***semester*** reflect the MAPS grade in each of the three assessment pieces on the profiles.

Assignment 1	C*
Test 2	B+
Test 3	B+
Sem Grade	B*

} Sem

Please discuss anything close to cut-off or is not reflective with HOD.

How to finalise grades

3. HOW TO FINALISE CAJ GRADE FOR A SEMESTER:

(i) Does the overall CAJ grade for **each assessment task** reflect the grade awarded? If in any doubt, please see HOD.

(ii) Does the overall CAJ grade for the ***semester*** reflect the CAJ grade in each of the three assessment pieces on the profiles.

Assignment 1	C/B
Test 1	C
Test 2	C/B
Sem Grade	C+

} Sem

Please discuss anything not reflective with HOD.

5. HOW TO FINALISE OVERALL GRADE FOR A SEMESTER:

The markbook spreadsheet automatically considers syllabus exit standards. Please also manually check this when awarding semester exit levels of achievement.

A	Standard *A* in any two criteria and no less than a *B* in the remaining criterion
B	Standard *B* in any two criteria and no less than a *C* in the remaining criterion
C	Standard *C* in any two criteria, *one of which must be the* Knowledge and procedures *criterion*, and no less than a *D* in the remaining criterion
D	At least Standard *D* in any two criteria, *one of which must be the* Knowledge and procedures *criterion*
E	Standard *E* in the three criteria

How to finalise grades

1. HOW TO FINALISE KAPS GRADE FOR A YEAR:

(i) Is the **overall year** KAPS standard very close to a cut-off according to the table below?

0	E-
10	E*
20	E+
29.5	D-
34.5	D*
45	D+
49.5	C-
54.5	C*
65	C+
69.5	B-
75	B*
80	B+
84.5	A-
90	A*
95	A+

(ii) Does the **overall year** KAPS standard reflect the KAPS standard in each of the six assessment pieces on the profiles, considering latest and fullest?

Eg. Standard for Student 1 is reflective but Student 2 is questionable.

	Student 1	Student 2
Assignment 1	C-	A-
Test 1	B+	B+
Test 2	A-	A-
Assignment 2	B*	A+
Test 3	B+	B+
Test 4	B+	B+
Year Standard	B+	A-

Please discuss anything close to cut-off or is not reflective with HOD.

How to finalise grades

2. HOW TO FINALISE MAPS STANDARD FOR A YEAR:

(i) Does the MAPS standard for **each assessment task** reflect the results awarded in each of the questions?

Generally, an A standard should show an ability to do each of *, ** and ***

Generally, a B standard should show an ability to do most of *, ** and some ***

Generally, a C standard should show an ability to do *, and maybe some of ** and/or ***

(ii) Is the **overall year** MAPS standard very close to a cut-off according to the table below?

0	E-
2	E*
10	E+
12	D-
15	D*
25	D+
35	C-
40	C*
51	C+
56	B-
64	B*
74	B+
79	A-
86	A*
96	A+

(iii) Does the **overall year** MAPS standard reflect the MAPS standard in each of the six assessment pieces on the profiles, considering latest and fullest?

Eg. Standard for Student 1 is reflective but Student 2 is questionable.

	Student 1	Student 2
Assignment 1	A-	B+
Test 1	B-	C+
Test 2	C+	C+
Assignment 2	B+	A*
Test 3	B*	C+
Test 4	B*	C+
Year Standard	B*	B-

How to finalise grades

(iv) Does the **overall year** MAPS standard reflect the results awarded in each of the questions? Refer again to general guidelines in (i).

Please discuss anything close to cut-off or is not reflective with HOD.

3. HOW TO FINALISE CAJ STANDARD FOR A YEAR:

(i) Does the CAJ standard for **each assessment task** reflect the results awarded in each of the questions?

(ii) Does the **overall year** CAJ standard reflect the CAJ standard in each of the six assessment pieces on the profiles?

Assignment 1	C/B
Test 1	C
Test 2	C/B
Assignment 2	B/A
Test 3	C
Test 4	C/B
Year Standard	**C+**

(iii) Does the **overall year** CAJ standard reflect the results awarded in each of the questions, considering latest and fullest?

Please discuss anything that is not reflective with HOD.

5. HOW TO FINALISE OVERALL GRADE FOR YEAR:

The markbook spreadsheet automatically considers syllabus exit standards. Please also manually check this when awarding year levels of achievement.

A	Standard *A* in any two criteria and no less than a *B* in the remaining criterion
B	Standard *B* in any two criteria and no less than a *C* in the remaining criterion
C	Standard *C* in any two criteria, *one of which must be the* Knowledge and procedures *criterion*, and no less than a *D* in the remaining criterion
D	At least Standard *D* in any two criteria, *one of which must be the* Knowledge and procedures *criterion*
E	Standard *E* in the three criteria

How to finalise grades

6. TROUBLE SHOOTING

- If your profiles are consistently producing incorrect results, there is probably a formula error in markbook. Please notify [redacted] as soon as possible if this is the case.
- If your profiles are **mostly correct**, but one or two results occur that may not best reflect student performance, then this means that a **judgement call** needs to be made by you as to the best grade for the student. This might be the case in one or more of the criteria or even when deciding upon the best overall grade. You will need to consider what fullest and latest results indicate and please discuss with HOD.

  Borderline/threshold decisions should be made in consultation with the HOD. Do not write grades on report cards until you have checked your borderline/threshold students with HOD.

- Please note that the report is to be based on the result achieved in any Semester.

- Special provisions are considered at Verification & Exit only, however if not considering them at end of year would produce a very different result, we need to discuss.

VERY IMPORTANT

Once all decisions and changes are finalised (with agreement from the HOD), you will need to:

(i) **Give profiles to [redacted] or [redacted] to change the grades** in the appropriate section of **markbook**.

(ii) **Then reprint profiles** which have changed.

(iii) Write your report cards.

How to finalise grades