Victorian Essential Learning Standards

Sample Unit

Visiting Vines

Level 6 - Personal Learning, Mathematics,Thinking Processes

Contents

Victoria The Place To Be

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VICTORIAN CURRICULUM AND ASSESSMENT AUTHORITY
41 St Andrews Place East Melbourne Victoria 3002 Australia
TELEPHONE +61 3 9651 4300 FACSIMILE +61 3 9651 4324
EMAIL vcaa@edumail.vic.gov.au
WEB www.vcaa.vic.edu.au

Introduction

In *Visiting vines* students explore concepts and skills that have relevance to work in a vineyard. They apply their mathematical skills to estimate and calculate different aspects of the wine production process and participate in activities where they are encouraged to develop their problem solving strategies and reflect on the quality of their thinking shown throughout the unit. Students will also monitor and reflect on their progress as autonomous learners.

A visit to a vineyard is an essential component of this unit and illustrates how an excursion to an industrial setting can provide context and motivation for learning. This unit could be modified to suit other industries which may be more accessible or appropriate for your students. When organising an excursion teachers must consider the requirements of safe work practices and food handling, and the environmental issues that arise in a visit to a vineyard.

Present Activities 1, 2 and 3 as a sequence. Activities 4, 5, 6 and 7 stand alone. This unit is to be implemented over two to three weeks, or about six to nine hours. Some of the sections can be covered in a single session, such as Activity 1, while others, such as Activity 3, will require several sessions.
Suggested duration: six to nine hours over a three week period.

For further information see the Teaching, learning and assessment section.

Assessment

This unit provides opportunities for students to demonstrate achievement of elements of Level 6 standards in Mathematics, Personal Learning and Thinking Processes.
It will also help teachers identify ways in which the Level 6 standards support students to develop facets of employability skills.

For further information see the VELS and Employability Skills section.

Students are assessed on their ability to:

- apply mathematical knowledge and skills to calculate area, volume, quantities and costs
- estimate the capacity of containers
- interpret and create mathematical models
- employ appropriate methodologies for creating and verifying knowledge
- reason logically and critically
- select and use thinking processes and tools appropriate to particular tasks
- apply a range of problem solving strategies
- monitor and identify areas for improvement in their learning.

For further information see the Assessment section.

Acknowledgments

The VCAA acknowledges teachers from Billanook College who contributed ideas or materials that helped shape this unit.

Victorian Essential Learning Standards

Visiting vines provides opportunities to assess students against elements of Level 6 standards and facets of employability skills as detailed below.

For further information see the Employability Skills section.

Strand	Domain	Dimension	Element of standard	Related employability skill
Physical, Personal and Social Learning	Personal Learning	The individual learner	… monitor and reflect on and discuss their progress as autonomous learners, identifying areas for improvement in their learning and implementing actions to address them. … evaluate the effectiveness of their learning strategies … and learning habits, and make appropriate modifications.	Learning …reflects on own learning and identifies learning choices and uses a range of strategies
Discipline-based Learning	Mathematics	Number	… carry out arithmetic computations … … use appropriate estimates to evaluate the reasonableness of the results of calculations involving rational and irrational numbers, and the decimal approximations for them. … carry out computations to a required accuracy in terms of decimal places and/or significant figures.	
		Space	… recognise and describe boundaries, surfaces and interiors of common plane and three-dimensional shapes, including cylinders, spheres, cones, prisms and polyhedra. … use the conditions for shapes to be … similar.	

		Measurement, chance and data	… estimate and measure length, area, surface area, mass, volume, capacity and angle. … select and use appropriate units, converting between units as required. … calculate constant rates ... … use … trigonometric ratios … … calculate summary statistics for centrality … spread … and association	
		Structure	… form and test mathematical conjectures; for example, ‘What relationship holds between the lengths of the three sides of a triangle?’ … identify and represent linear, quadratic and exponential functions by table, rule and graph (all four quadrants of the Cartesian coordinate system) ... … use and interpret the functions in modelling a range of contexts.	

		Working mathematically	… choose, use and develop mathematical models and procedures to investigate and solve problems set in a wide range of practical, theoretical and historical contexts ... … select and use technology in various combinations to assist in mathematical inquiry, to manipulate and represent data, to analyse functions and carry out symbolic manipulation.	
Interdisciplinary Learning	Thinking Processes	Creativity	… apply selectively a range of creative thinking strategies to broaden their knowledge …	… identifies problems and applies a range of problem solving strategies.

For further information see the Assessment section.

Teaching, Learning and Assessment Activities

This unit focuses on students applying their mathematical knowledge and skills in the context of running a winery. Students use a range of thinking strategies and monitor and reflect on their progress as autonomous learners.

The activities include:

- Activity 1: Preparing for *Visiting vines*
- Activity 2: Visiting the vineyard
- Activity 3: Planning a vineyard
- Activity 4: Lines of vines – an investigation
- Activity 5: Bottles and barrels
- Activity 6: Creating and interpreting graphs
- Activity 7: Applying chemicals

Activity 1: Preparing for Visiting vines

Activities	Supporting the activities	Assessment
Introduce the unit, individual and team activities and assessment. As a class, conduct a brainstorming session. Use the results of the brainstorming to develop a concept map on 'planning a vineyard'. Complete Worksheet 1.	It would be useful to emphasise that students will not only be assessed on their mathematical knowledge and skills but also on their ability to use a range of thinking strategies and monitor and reflect on their progress as autonomous learners. Prepare students for their visit to a vineyard, their study of wine making and grape growing. Teachers may wish to conduct a brainstorming session on the steps involved and factors to consider in planning a vineyard. Provide each student Worksheet 1 - Visiting vines (See *Unit Resources* page 40). This worksheet contains prompts and instructions for students for this activity. See Activity 1 Teacher Reference (See Unit Resources page 21) for details. Other approaches to a concept map may be used to introduce this unit. For more information see Brainstorming and Concept maps in the Teaching and Learning Resource.	

Provide each student with a copy of the Capacity matrix. Explain that they will be referring and adding to the matrix throughout the unit to monitor their learning.	Distribute a copy of the Capacity matrix to each student and discuss as a class: • how the listed items reflect their insight into the topic • that the depth of mastery shown across each row is as important as the number of items ticked. • how it provides a framework within which they can monitor and reflect on their own learning.	Use the development of the Capacity matrix to assess Personal Learning – *The individual learner* and *Managing personal learning.*
Distribute a copy of A Learning Journal to each student. Students will use the learning journal to focus on: • analysing what and how they are learning • how their approach to learning might be improved.	The learning journal will provide a framework for students to present evidence of their reflection on their personal learning. The concept map and capacity matrix will form part of their journal. For more information see *Learning journals* in the Teaching and Learning Resource and A personal learning journal (See Unit Resources page 37) teacher resource sheet.	Regular review of the learning journals provides an opportunity for assessment *for* and assessment *as* learning. Collect students learning journals at the end of the unit to assess Personal Learning – *The individual learner* and *Managing personal learning* and Thinking Processes – *Reflection, evaluation and metacognition.* See Assessment rubric (See *Assessment* page 12).

Activity 2: Visiting the vineyard

Activities	Supporting the activities	Assessment
Students to complete the site appropriate questions on Worksheet 2 with the remaining questions to be completed in school.	Organise a field trip to a local winery This activity will need to be planned well in advance and in consultation with the winery. Students will require sturdy shoes and follow safety guideline for being on work sites. The main purpose of this activity is to provide students with an overview of the different aspects involved in setting up a vineyard and wine production. Worksheet 2 Visiting vines should be modified to suit the	

	location so that students focus on key aspects during the site visit. Provide each student with a copy of Worksheet 2 - Visiting vines (See Unit Resources page 43) to be completed both during the site visit and at school. See Activity 2 Teacher Reference (See Unit Resources page 23) for details on this activity.	
Students should be assigned into groups of three or four students Ask students to work in their groups to: • estimate and calculate the size in hectares of a large rectangular part of the vineyard. • use pace length to make their measurements and then devise a way to convert their pace length into metres.	Preliminary activities on estimating and calibrating pace length could be completed at school prior to the visit. A discussion on the variation between estimates could be held on site or back at school. Define the boundaries of a rectangular part of the vineyard which is less than four hectares. When students estimate the area in hectares, record class estimates on a dot plot. Discuss the reasons for multiple measurements.	
Students will also need to consider which factors determine the: • orientation and spacing between vines. • spacing of rows. • orientation of rows in relation to north. • distance between vines. • numbers of vines per hectare. • topography of the site.	See Activity 2 Teacher Reference (See Unit Resources page 43) for details on this activity.	Collect Worksheet 2 Visiting vines to assess Mathematics – *Number; Measurement, chance and data; Structure;* and *Space*. See Assessment rubric (See *Assessment* page 12).

Activity 3: Planning a vineyard

Activities	Supporting the activities	Assessment
Explain to students that their task in this activity is to calculate the costs involved in establishing a vineyard. In their groups ask students to: • list the materials necessary to establish a vineyard • determine the quantities • calculate the cost per hectare • estimate the total cost of materials for establishing a vineyard.	Students need to be encouraged to recognise that most quantities they will be dealing with are rates e.g. dollars per metre, poles per 100m. They should make estimates to confirm that the results of their calculations are reasonable and need to make a decision about the number of significant figures appropriate for their answer. Conversion between non-metric and metric units may be necessary.	Collect each group's calculations to assess Mathematics – *Number and Measurement, chance and data.* See Assessment rubric (See *Assessment* page 12).

Activity 4: Lines of vines – an investigation

Activities	Supporting the activities	Assessment
Students are asked to investigate how the rows of vines appear as a car travels along a road from one point to another. They need to consider: • where do the rows appear? • do they appear at a constant rate? • do they all seem to be equally well defined?.	Students are introduced to the tangent function as part of the analysis of the creation of virtual lines of poles observed from a car window as it is driven past the vineyard. This activity is intended as an open ended investigation, however, a set of questions suitable for a more structured approach is also provided in Worksheet 4. This structured approach could be used by teachers as a lesson plan for guiding students through the investigation. It is important that students observe the phenomenon or analyse a video. The vines should be free of leaves so the activity needs to be scheduled for winter or early spring. Provide each student with a copy of Worksheet 4 Visiting vines (See Unit Resources page 52).	Collect Worksheet 4 Visiting vines to assess Mathematics – *Number and Measurement, chance and data* and Thinking Processes– *Creativity.* See Assessment rubric (See *Assessment* page 12).

Activity 5: Bottles and barrels

Activities	Supporting the activities	Assessment
Tell students this activity encourages them to develop and justify methods for estimating capacity when direct measurement is difficult or when no formula for calculating capacity is known. The activity also focuses on students using creative thinking to assist in the development of mathematical approaches. Ask students to: • calculate the capacity of several of the large shapes and types of containers used for the storage and manufacture of wine • compare their calculation with the capacity stated on the container • develop and justify methods for estimating capacity when direct measurement is difficult or when no formula for calculating capacity is known.	This activity contains opportunities for teachers to focus on thinking processes and how these can be developed as students simultaneously pursue learning outcomes in the Mathematics discipline. There is also a specific CAS activity. See Teacher resource A CAS approach (See Unit Resources page 17). Students are using geometrical models for containers whose theoretical capacity is known. They can compare the computed and theoretical capacities and reflect on any differences in order to explain how the differences occurred and how the modelling process might be modified in order to minimize these differences. It is worthwhile to consider a checklist of problem solving strategies as an aid to critical thinking. See www.nzmaths.co.nz/PS/Info/PSStrategies.aspx. Provide each student with a copy of Worksheet 5 Visiting vines (See Unit Resources page 57). See Activity 5 Teacher Reference (See Unit Resources page 26) and Worksheet 5 Visiting vines (See Unit Resources page 57).	Collect Worksheet 5 Visiting vines to assess Mathematics – *Number; Measurement, chance and data; Structure; Working mathematically; and Space* and Thinking Processes – *Reflection, evaluation and metacognition.* See Assessment rubric (See *Assessment* page 12).

Activity 6: Creating and interpreting graphs

Activities	Supporting the activities	Assessment
Explain to students that the tasks in this activity are to interpret graphs using the example of time series graphs which are important in the wine industry. Ask students to use Worksheet 6 Visiting vines, questions 1 to 13 to analyse graphs of the relationships and use sets of values to obtain solutions. Questions 14 and 15 provide opportunities for independent investigation.	In this activity through questions 1 to 13, students are guided through the type of questions which graphs of data can answer and the level of analysis which is possible if aided by data collection. These questions will help prepare students for independent investigations in questions 14 and 15. A key aspect of the assessment is the use of the graphs for indications of maxima and rates of change. Provide each student with a copy of Worksheet 6 Visiting vines (See Unit Resources page 60) See Activity 6 Teacher Reference (See Unit Resources page 30)	Collect Worksheet 6 Visiting vines to assess Mathematics – *Number, Structure, Space and Working mathematically* and Thinking Processes – *Reasoning, processing and inquiry*. See Assessment rubric (See *Assessment* page 12).

Activity 7: Applying chemicals

Activities	Supporting the activities	Assessment
Explain to students in this activity they will learn that chemicals are used to modify soil structure, fertilise grapes and control weeds and insects. Using Worksheet 7 Visiting vines. Ask students to: • calculate the rate of application of chemicals • calculate the costs of applying chemicals at a vineyard • identify the single most important variable • establish an argument supporting their selection	This is a problem solving task involving identification of the factors affecting the rate of application of chemicals delivered from the spray tank of a tractor. Students can use a modified 32-16-4-1 structure as an aid to sorting out an approach to this problem. See Teacher resource 32-16-4-1 (See Unit Resources page 20) Provide each student with a copy of Worksheet 7 Visiting Vines (See Unit Resources page 64) See Activity 7 Teacher Reference (See Unit Resources page 31)	Collect Worksheet 7 Visiting vines to assess Mathematics – *Number and Measurement, chance and data* and Thinking Processes – *Reasoning, processing and inquiry Reflection, evaluation and metacognition.* Collect students Personal Learning journals and Capacity Matrix to assess Personal Learning – *The individual learner.* See Assessment rubric (See *Assessment* page 12).

Assessment

The Victorian Essential Learning Standards support a combination of assessment practices:

- Assessment of learning (summative)
- Assessment for learning (formative)
- Assessment as learning (formative).

The assessment tasks in this unit focus on collection of evidence of student learning for summative purposes. Some components could also be used to support assessment for learning and assessment as learning.

Assessment guide

When assessing student achievement, assessment criteria can be developed from relevant standards and associated tasks or activity. The table below shows the assessment criteria related to the assessment task/s and relevant Standards and the expected evidence to be used as the basis for assessment.

The table can also be used to assist teachers to make judgments about whether students are working *at* the standard (achieved the Standard), progressing *towards* the standard (have not met expectations of the Standard) or progressing *beyond* the Standard (have exceeded expectations of the Standard) for specific assessment criteria. It is provided as a guide only and may be adapted or modified to suit particular classrooms and/or student reporting.

See the Assessment Resource for advice on developing rubrics.

Assessment Task: Visiting vines

Evidence	Element of standard	Assessment criteria	Progressing towards the standard	At the standard	Progressing beyond the standard
Personal Learning – *The individual learner*					
Personal Learning (Activity 1-3) Student reflective diary. (Activities 1-4)	… monitor and reflect on and discuss their progress as autonomous learners, identifying areas for improvement in their learning…relationships …	Ability to reflect on own learning identifying areas for improvement.	Beginning to record learning experiences.	Maintain a comprehensive learning journal describing learning progress and areas for improvement.	Critically reflect on and modify plans.

Mathematics – *Number, Space, Measurement, chance and data, Structure, Working mathematically*					
Numbers	… carry out arithmetic computations … … use appropriate estimates to evaluate the reasonableness of the results of calculations involving rational and irrational numbers, and the decimal approximations for them. … carry out computations to a required accuracy in terms of decimal places and/or significant figures.	Ability to add, merge or delete cells as required carry out calculations be required accuracy and provide a suitable estimate.	Check calculation to see if there are reasonable.	Carry out calculations for area of a vineyard and compare with group estimates. Aware of the level of accuracy in calculations and the assumptions made in order to make a problem manageable.	Able to discuss the conflict that exists between creating a manageable model and the error associated with the model.
Space	… recognise and describe boundaries, surfaces and interiors of common plane and three-dimensional shapes, including cylinders, spheres, cones, prisms and polyhedra. Use the conditions for shapes to be..similar	Describe interior, boundary and surface of two- and three-dimensions shape as applicable.	Recognizes boundaries of two and three dimensional shapes.	Recognizes quadrilateral shapes. Calculate area of quadrilaterals where appropriate with the aid of technology.	Calculates exact values for dilation and translation and verifies by using graphing technology.

Measurement, chance and data	… estimate and measure length, area, surface area, mass, volume, capacity and angle. … select and use appropriate units, converting between units as required. … calculate constant rates … use … trigonometric ratios … … calculate summary statistics for centrality … spread … and association …	Estimate and measure a range of quantities and comment between units.	Estimate measure associate with 3 dimension objects.	Apply rates such as paces per 100m to estimation of distance. Use consistent units in calculation and converts to appropriate units for reporting results. Display data as ordered stemplot, determine quartiles and median and use boxplot ot illustrate relationship between median, quartiles and interquartile range. Use of technology to compute standard deviation.	Relate mean and standard deviation to 95% probability interval.
Structure	… form and test mathematical conjectures; for example, 'What relationship holds between the lengths of the three sides of a triangle?' … identify and represent linear, quadratic and exponential functions by table, rule and graph (all four quadrants of the cartesian coordinate system) ...	Describe possible notations and models them using functions.	Vertically describe relations.	Create a graph for converting between pace, length and distance.	Describes relation using function rule with consideration of domain.

	… use and interpret the functions in modelling a range of contexts …				
Working mathematically	choose, use and develop mathematical models and procedures to investigate and solve problems set in a wide range of practical, theoretical and historical contexts ... … select and use technology in various combinations to assist in mathematical inquiry, to manipulate and represent data, to analyse functions and carry out symbolic manipulation.	Selects and uses a suitable model.	Restricted to solving relatively routine examples. Thinks creatively but restricted in ability to translate ideas into actions.	Works creatively in transferring ideas into action and produces innovative solutions.	Consider alternative models & discussion strength & limitations.

Unit Resources

Websites

At the time of publication these websites cited were checked for accuracy and appropriateness of content. However, teachers are advised to prepare their own lists of sites applicable to this unit, and to check these sites prior to students accessing them.

NZ Maths Problem Solving strategies (www.nzmaths.co.nz/PS/Info/PSStrategies.aspx)

Teacher resources

Teaching and Learning Resource
This material provides information about teaching and learning strategies referred to in the task.

Assessment Resource

This document provides information about assessment strategies referred to in the task.

Student resources

Teacher Resource

A CAS approach

The following screens illustrate a sequence of steps using TI-*n*spire as a CAS tool. Similar steps will apply to many other CAS tools.

Step 1. Calculate radius values corresponding to the given circumferences.

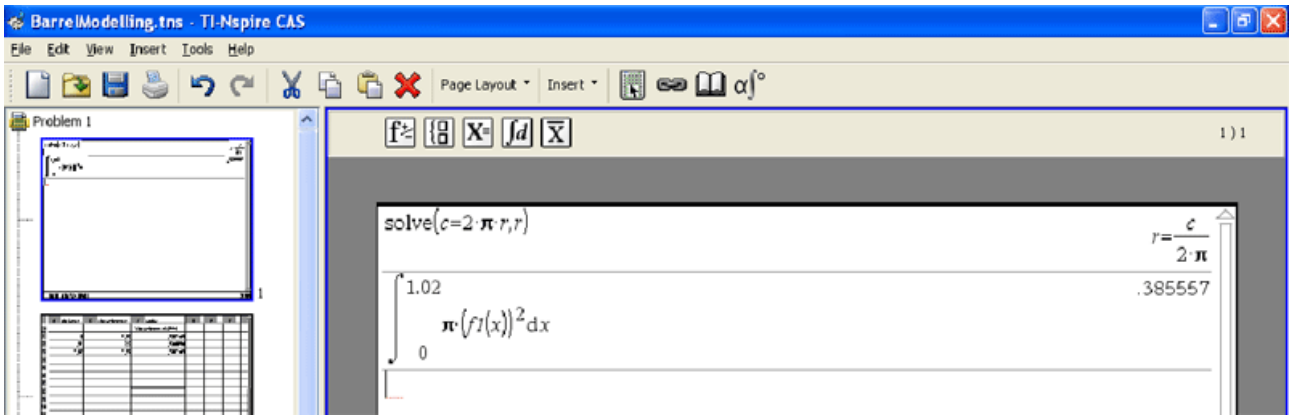
Step 2. Establish a table of values relating distance along the barrel and the barrel's radius.

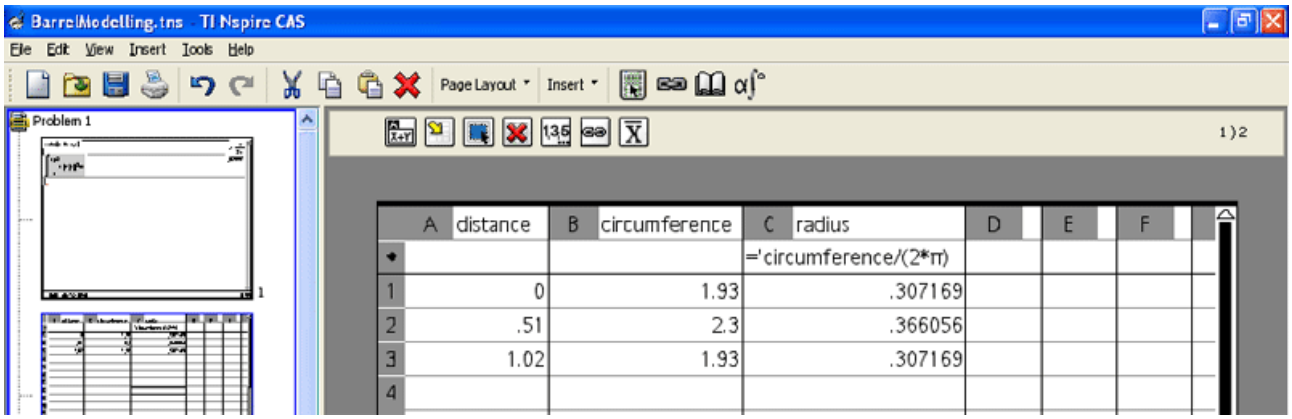
Step 3. Determine the regression equation relating distance and radius.

Step 4. Use the regression equation to model the barrel radius at various points. Approximate the barrel volume by creating a set of cylindrical discs (a disc width of 0.02 cm is convenient). Create a spreadsheet to represent these discs and their volume. One-variable statistics can be used to sum the related list of volumes. Alternatively '=sum( )' can be used.

Step 5. **Extension.** The CAS integral function can be used to calculate the volume of revolution by evaluating $\int_0^{1.0.2} \pi[f(x)]^2 dx$.

A 'black box' approach is necessary but the representation can be justified by relating it to $\lim_{\partial r \to 0} \sum_{r=0}^{1.02} \pi r^2 \partial r$ using step 4 as an illustration. The validity of the calculator's results can be established by considering the volume of rotation for a horizontal line and the resulting cylinder.




BarrelModelling.tns - TI-Nspire CAS
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Page Layout
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Problem 1
1)2
A distance
B circumference
C radius
D
E
F
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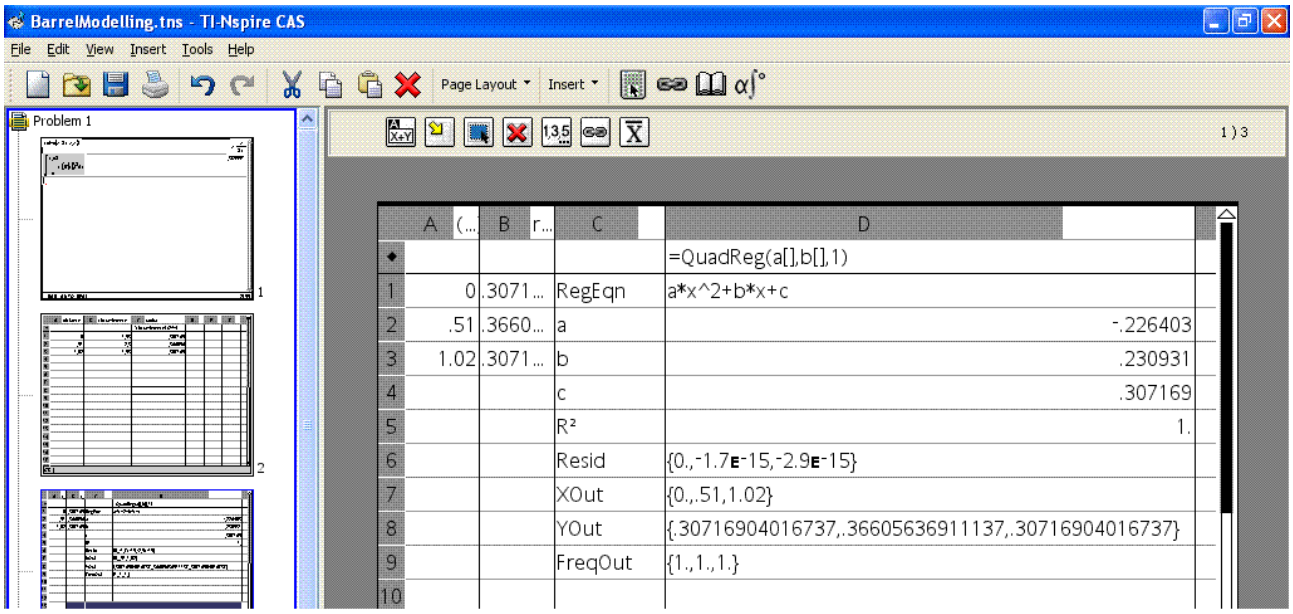
1 0 1.93 .307169
2 .51 2.3 .366056
3 1.02 1.93 .307169
4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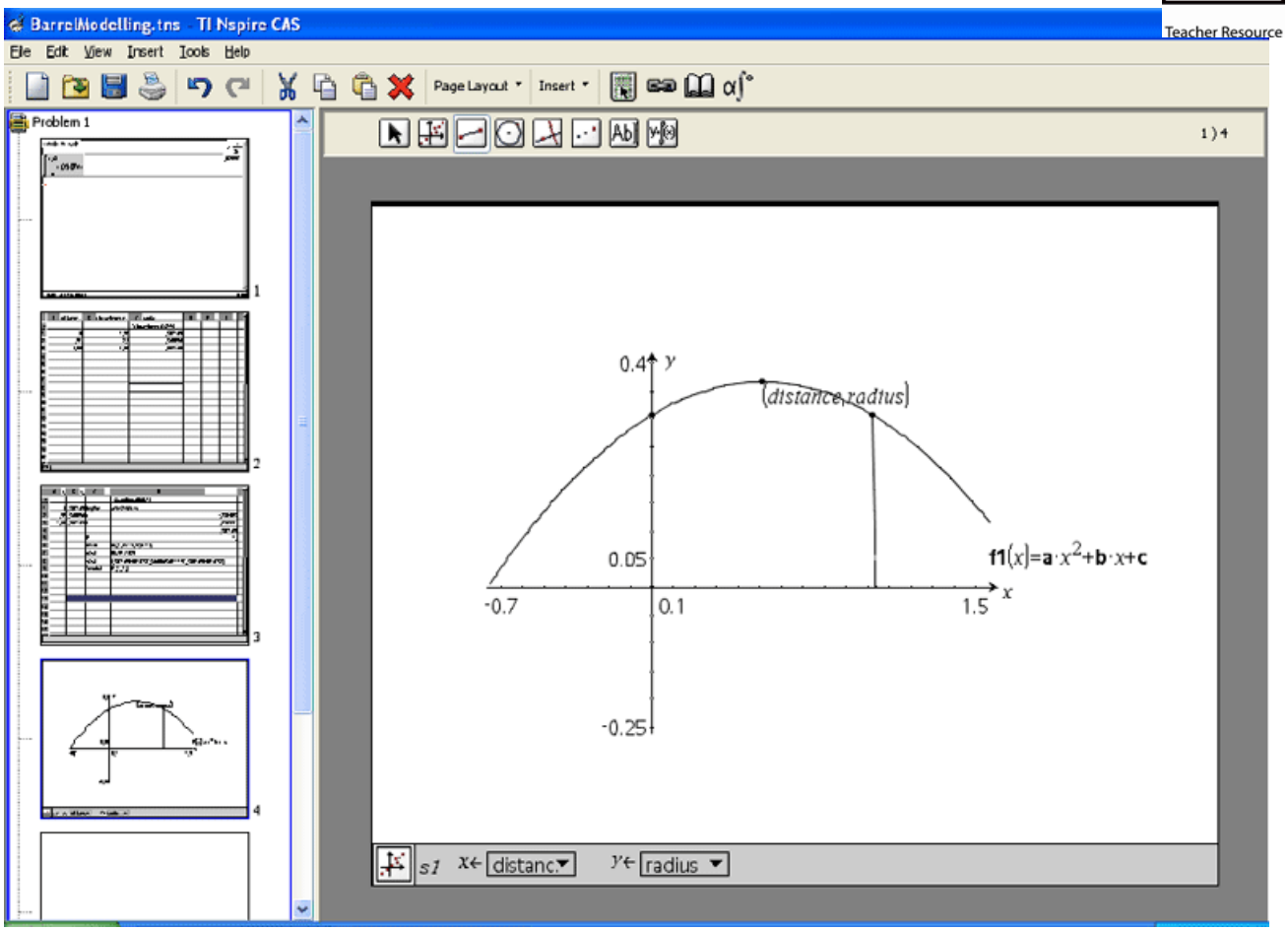
B r...
C
D
=QuadReg(a[],b[],1)
1 0 .3071... RegEqn a*x^2+b*x+c
2 .51 .3660... a -.226403
3 1.02 .3071... b .230931
4 c .307169
5 R² 1.
6 Resid {0.,-1.7E-15,-2.9E-15}
7 XOut {0.,.51,1.02}
8 YOut {.30716904016737,.36605636911137,.30716904016737}
9 FreqOut {1.,1.,1.}
10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Problem 1
1.4
0.4
y
(distance,radius)
0.05
f1(x)=a·x²+b·x+c
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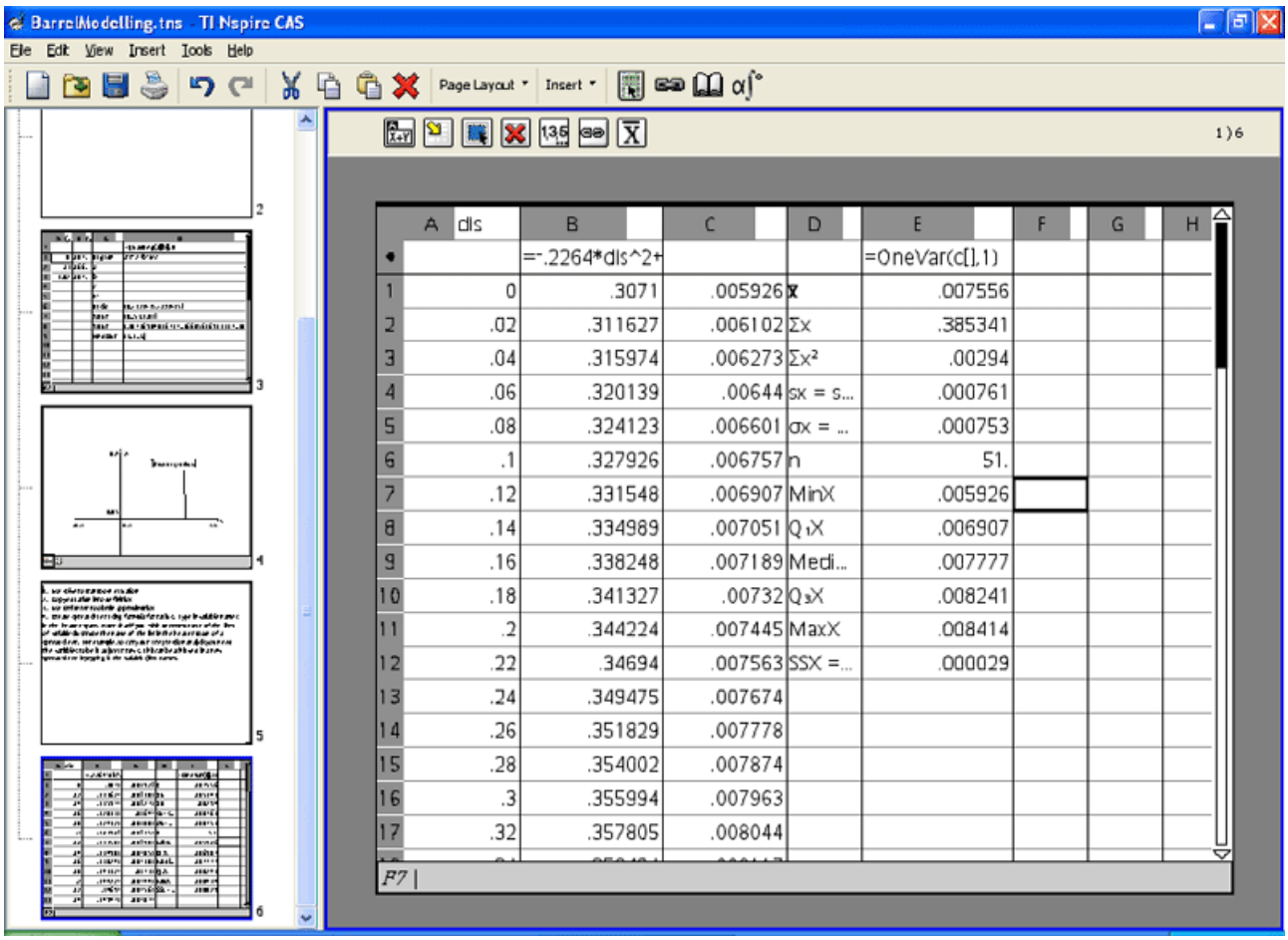
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1.6
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B
C
D
E
F
G
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=OneVar(c[],1)
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0 .3071 .005926 .007556
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.04 .315974 .006273 .00294
.06 .320139 .00644 .000761
.08 .324123 .006601 .000753
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.18 .341327 .00732 .008241
.2 .344224 .007445 .008414
.22 .34694 .007563 .000029
.24 .349475 .007674
.26 .351829 .007778
.28 .354002 .007874
.3 .355994 .007963
.32 .357805 .008044
F7

Teacher Resource

32:16:4:1

This tabular structure is useful in helping students to refine lists created when brain storming. The example below illustrates some responses to Question 2 in Worksheet

Write out as many variables as you can which may be related to the application rate of chemicals from a spray unit connected to a tractor.

Original strength of concentrated solution	Amount of concentrate	Amount of water	Strength of applied solution
Speed of tractor	Spray pattern	Droplet size	Temperature
Wind velocity	Wind direction	Number of jets	Jet size
Boom length	Density of weeds	Type of weeds	Pressure in tank
Path followed by tractor	Rate of flow of solution from tank	Diameter of hoses	Area to be sprayed
Slope of ground	Design of vineyard	Grape varieties planted	Volume of tank
Size of tractor	Source of water		

Refine the list above by removing variables that are least related to the application rate.

Original strength of concentrated solution	Amount of concentrate	Amount of water	Strength of applied solution
Speed of tractor	Spray pattern	Droplet size	Rate of flow of solution from tank
Number of jets	Jet size	Boom length	

Retain the most significant variables. For example, the original strength of concentrated solution, the amount used and the amount of water all determine the strength of the applied solution so can be replaced by this one variable.

Strength of applied solution	Speed of tractor	Rate of flow of solution from tank	Overall spray pattern

Is there one single variable that is more significant than the others? Arguably there isn't but it will be interesting for students to select and defend one.

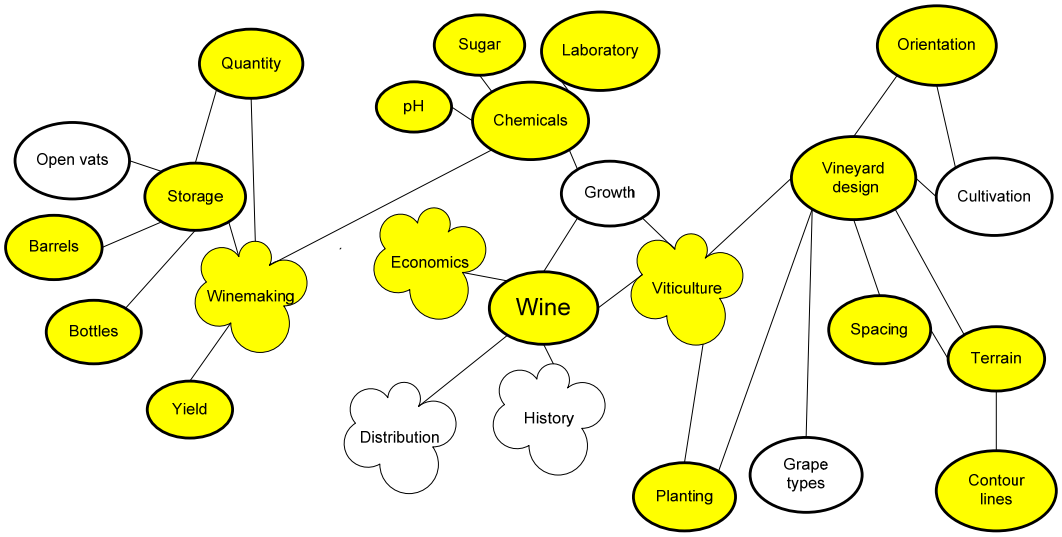
Teacher Resource

Teaching and learning activities, teacher support and assessment advice

The tables below include details of the components of the major activities, advice supporting the teacher in carrying out the activity and assessment information.

Activity 1: Preparing for *visiting vines*

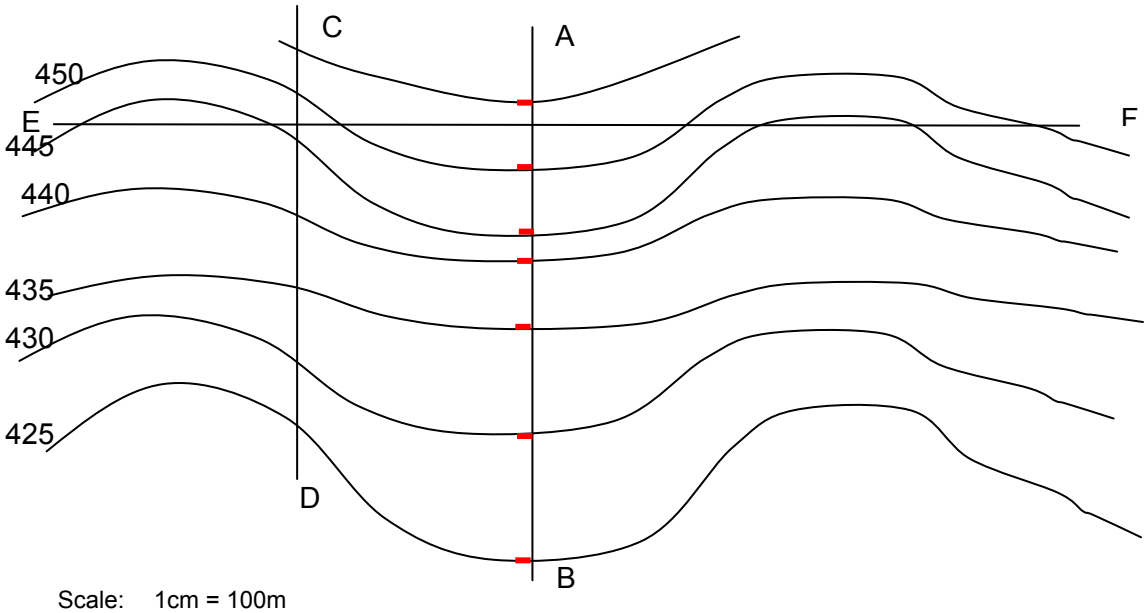
The purpose of the activity is to prepare students for their visit to a vineyard, their study of wine making and grape growing, the mathematics they may learn and how they can focus on improving their personal learning and thinking.



Activity component	Supporting the activity	Assessment
Conduct a brainstorming session focussing on planning a vineyard and use the results to develop a concept map.	Participate in a brainstorming activity where students work towards developing a concept map. The sample above represents some of the content areas which are associated with the theme of *visiting vines*. The areas highlighted in yellow represent the scope of this unit. This concept map forms a basis for a capacity matrix in which, with considerable guidance from their teacher, the students begin to list the specific items to be learned. This capacity matrix will grow as student's progress through the unit. The capacity matrix is a major self monitoring tool. The detail in the listing of items reflects the student's insight into a topic; the number of items they can tick off as learned is obviously important but equally important is the depth of mastery reflected across each row of the matrix. It provides students with a framework within which they can 'monitor and reflect on and discuss their progress as autonomous learners'	Personal Learning – *The individual learner* Managing personal learning
Students produce a learning journal with a view to analyse what and how they are learning and how their approach to learning might be improved.	The learning journal will enable students to present evidence of reflection on their personal learning. The concept map and capacity matrix will form part of the learning journal. Additional advice for teachers can be found on http://vels.vcaa.vic.edu.au/support/domainsupport/personal/approaches.html. and on http://vels.vcaa.vic.edu.au/support/teaching.html A useful overview of Garner's multiple intelligences can be found on http://www.tecweb.org/styles/gardner.html and fairly detailed self assessment material is provided in http://cookps.act.edu.au/mi.htm. Familiarize students with the content of Personal Learning Skills and Mathematics Rubric. Help them to understand how their learning journal can provide evidence which relates to the rows and columns in the rubric and explain how the rubric will be used throughout their work on the unit as an assessment tool.	

Teacher Resource

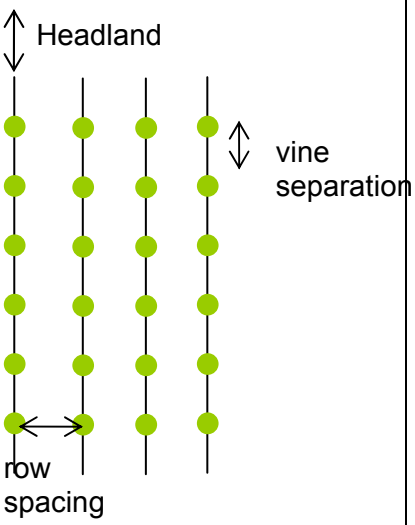
Activity 2: Visiting the vineyard.



Scale: 1cm = 100m
Contour interval: 5m

Activity component	Supporting the activity	Assessment
Tell students to Estimate and calculate the size in hectares of a large rectangular part of a vineyard during a vineyard visit. Pace length is used as an informal unit. Determine the relationship between personal pace length and a metre.	Define the boundaries of a rectangular part of the vineyard which is less than four hectares. Ask students to estimate the area in hectares, without explaining what a hectare is. Record class estimates on a dot plot. Expect to see a wide variety of values and little knowledge of the size of a hectare. (Note, a hectare is defined as the area of a 100 m $\times$ 100 m square = 10 000 m^2). For the pacing of distance in Worksheet 1, mark out a track with 100-metre and 10-metre markers. Teachers give students the opportunity to calibrate their paces. In anticipation of the activity, provide some introductory estimation of distances. Teachers discuss the reasons for multiple measurements and the error expected in the spread around the average. To create the conversion table in Question 3, students require a reasonable level of experience with spreadsheets including filling cells, creating cell formulas and formatting cells for decimal places.	***Mathematic – Number*** ***Measurement, chance and data*** ***Structure***

	Tabular and graphical approaches leading to ideas associated with modelling with linear functions are supported. Internet research on area measure is conducted.	
Research the definition of a hectare, the international system of weights and measures and alternative units for measuring area.		
Use scale diagrams to calculate areas of polygons. Research the polygon definitions and the computational formulae.	Students can use the graphing and measuring tools of CAS calculators in place of computation (see worked solutions). They can also use the 'solver' calculator routines to evaluate areas or create and substitute into user defined functions.	***Space***
Creation of vertical cross-sections from given contour maps and prepared grids.	Contour maps and prepared grids are provided in Worksheet 2. For Activity 2 students will find it useful to compare a contour map with the land it represents. However, topographical maps generally do not have a suitable scale for this activity. The school may have a contour map of its grounds or the local council may have contour maps of parklands. Many building subdivisions have contour maps. A golf course would be an ideal location.	Student responses to worksheet questions are assessed. An additional project task can be for students to produce elevation drawings from local maps, or maps of areas of interest.

Question 7 students consider which factors determine the orientation of rows of vines, the spacing of rows, and the distance between vines within a row. They prepare a chart that relates row spacing, distance between vines, and the number of vines per hectare. Students also analyse the materials needed to establish a vineyard and conduct a cost estimate. This is carried out as a group activity.  	This statistical exercise allows teachers to take this as far as they like. All the level 6 statistics can be taught using the data sets provided and generated here. Some computer graphing would be of assistance. Mean and standard deviation were chosen because they are the most sophisticated measures, are appropriate to level 6 and are supported on most calculators. All students really need to know is that the mean is a measure of the centre of the data and that the standard deviation can be used to compare spreads. Use data sets to confirm that 95% of data normally lies within two standard deviations of the mean.	***Measurement, chance and data***
Solution of a right angle triangle problem in order to find the distance between an anchor post and a trellis post.	There are a number of approaches to Question 3. Teachers can simulate the arrangement, create a scale drawing or demonstrate the trigonometry. CAS calculators can be used to set up a diagram of the situation and then provide a solution when 'asked' for the length of the missing side. The trigonometry is a useful introduction to subsequent work. Students can confirm experimentally that $x = \frac{1.8}{\tan 35^0}$ At this stage it is sufficient for the students to know that there is a relationship between gradient, tan θ, the ratio $\frac{\text{rise}}{\text{run}}$ and a right triangle. Teachers provide students with relevant formulas and treat the exercise as substitution and calculation. It could be supplemented with several similar right angle triangle examples or extended to include examples usually involving sine and cosine.	***Measurement, chance and data***

Teacher Resource

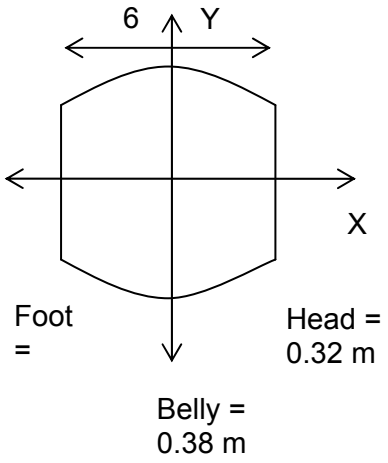
Activity 5: Bottles and barrels

Activity component	**Supporting the activity**	Assessment
Students user Worksheet 5 to: • calculate the capacity of several of these large shapes and types of containers used for the storage and manufacture of wine • compare their calculation with the capacity stated on the container • develop and justify methods for estimating capacity when direct measurement is difficult or when no formula for calculating capacity is known. This activity focuses on using creative thinking to assist in the development of mathematical approaches. There is also a specific CAS activity.  	Worksheet 5 contains opportunities for teachers to focus on thinking processes and how these can be developed as students simultaneously pursue learning outcomes in the Mathematics discipline. Students are using geometrical model for containers whose theoretical capacity is known. They can compare the computed and theoretical capacities and reflect on any differences in order to explain how the differences occurred and how the modelling process might be modified in order to minimize these differences. Additional related teaching and learning resources supporting thinking processes can be found on http://vels.vcaa.vic.edu.au/support/teaching.html The information on graphic organizers is particularly relevant to this section of work.	Mathematics- *Space* Personal Learning- *Managing personal learning*
	Question 3 suggests it is worthwhile to consider a checklist of problem solving strategies as an aid to critical thinking. Appendix 3 provides a list based on information in http://www.nzmaths.co.nz/PS/Info/PSStrategies.aspx which provides advice on problem solving strategies and numerous sample problems. In Question 3 students need to draw a picture and label it with known information. They need to make an organized list of dimensions given and needed and would benefit by recall of known skills which they applied in calculating the capacity of a simpler cylinder where the information provided was optimal.	Mathematics- *Working mathematically* *Structure* Thinking Processes- *Reasoning, processing and inquiry* *Reflection, evaluation and metacognition*

Activity component	Supporting the activity	Assessment
	Making a model would not be out of the question. If a more structured approach is preferred teachers may wish to substitute the alternative more structured versions provided here: 3. a) The cylindrical stainless steel tanks used to store wine are huge. It is difficult to measure their height directly. As you can see from the preceding photograph the tanks are made up of a series of sections, each section being 1.8m high. A particular tank is composed of four such sections. How high is it? b) It is also not possible to measure the radius. But we can measure its circumference (C). Circumference and radius are related by the formula: $C = 2\pi r$ (i) The circumference of the tank is 15m. What is its radius? (ii) Calculate the volume of the tank. (iii) If wine sells for around $20 per litre, calculate the value of the wine stored in the tank. c) It would be useful to have a formula for calculating the capacity of a cylinder from its circumference and height directly. Show that the formula: $V = \frac{C^2 h}{4\pi}$ does this. where b = 0.19. Substitute in (0.305, 0.16) will enable calculation of a. 4. Think of a simpler but related problem Think in terms of $y = a x^2$. What transformation does *a* perform? In $y = a x^2 +$ b what transformation does b perform? 5. Solve part of the problem. Can we evaluate b by inspection	

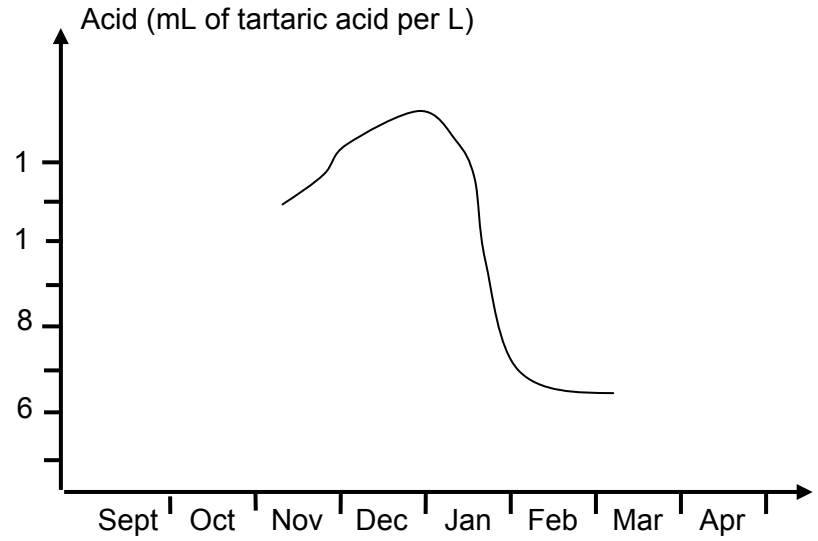
Activity component	Supporting the activity	Assessment
	Question 4 (a), although brief, invites students into a major modelling activity and teachers should seek to capitalize on the opportunities here for learning about problem solving and research. There are a number of possible approaches. Students could establish upper and lower boundaries for the barrel volume by using a circumscribed and inscribed cylinder. An estimate of the volume could be obtained by averaging these results. Students should discuss whether averaging provides an unbiased estimate or either a consistent underestimate or overestimate. In the latter cases how could the average be improved as an estimate. Students could use a pair of truncated cones as estimates. Students could divide the barrel into a number (say 20 or so) slices and treat each as a cylinder. Adding these creates a measure of the capacity. Students could search for formulas for computation of the capacity of barrels. A sophisticated approach involves creating an algebraic model for the cross-section of a barrel and using this to assist in calculating the barrels capacity. A detailed sample is included later see A CAS approach which includes screen displays illustrating a sequence of steps using TI-Nspire as a CAS tool. Similar steps will apply to any CAS tool. A variety of other approaches could parallel the CAS development. Here we highlight the problem solving strategies associated with development of the rule for the cross-section of the barrel without using CAS.	

Teacher Resource

Activity component	Supporting the activity	Assessment
	1. Draw a diagram. Label the diagram. Use a Cartesian plane. Choose the simplest location for the shape. (Draw the barrel in a more difficult position on the Cartesian plane. Draw the barrel in a simpler position)  2.Tabulate the data x | y -0.305 | 0.16 0 | 0.19 0.305 | 0.16 3. Determine an algebraic relationship. Use finite differences, standard quadratic form or least squares regression. For the barrel location above $y = a x^2 + b$	

Teacher Resource

Activity 6: Creating and interpreting graphs



Activity component	Supporting the activity	Assessment
In this activity students learn that time series graphs are important in the wine industry. As grapes develop, their sugar concentration increases and their acidity decreases. Grapes are picked at optimum times when there are desirable relationships between these and other grape properties. Students use Worksheet 6 to analyse graphs of the relationships and use sets of values to obtain solutions. Questions 14 and 15 suggest investigations which could be pursued by the students to deal with: • heat and fermentation • export growth • a Grange Hermitage inflation index • wine and the standard drink • alcohol concentrations and alternative units such as 'percentage proof' • statistics on teenagers and alcohol • capacity of wine glasses • the barrel as a unit quantity (standardisation of barrel sizes, imperial and US gallons).	For Activity 6 teachers provide students with information on herbicides as they provide an interesting exercise in identification and interpretation of data. Questions 1 to 13 guide students through the type of questions which graphs of data can answer and the level of analysis which is possible if aided by data collection. These questions will help to prepare students for independent investigations in Questions 14 and 15. In carrying out these investigations students need to be encouraged to avoid superficial responses. For example, if a student was investigating 'How does the capacity of a wine glass vary?' responding that some are large and some are small is hardly adequate. They need to create a scaffold of sib-questions, some of which will require significant research. An approach may address these questions: Are white wine glasses different in size to red wine or desert wine glasses? What types of glasses occur in sets produced by glass manufacturers? Is there a standard size for a red wine glass? Is there more than one type of red wine glass? Why are desert wine glasses smaller than red wine glasses? Does a champagne flute hold more champagne than a flat champagne glass? How do restaurants decide what makes up a 'full glass'? How many glasses are there in a bottle? What spread in capacity occurs in red wine glasses from different manufacturers?	A key aspect of the assessment is the use of the graphs for indications of maxima and rates of change. *Mathematics -* *Number* *Structure* *Working mathematically* Thinking processes- *Reasoning, processing and inquiry* *Reflection, evaluation and metacognition*

Teacher Resource

Activity 7: Applying chemicals

Activity component	Supporting the activity	Assessment
Students use Worksheet 7 to calculate the application rates and costs of applying chemicals at a vineyard.	Chemicals are used to modify soil structure, fertilise the grapes and control weeds and insects.	Mathematics- *Number* *Measurement, chance and data* Assessment criteria can focus on students' ability to apply rates and calculate cost changes.
Question 2 presents a problem solving task involving identification of the factors affecting the rate of application of chemicals delivered from the spray tank of a tractor.  	Question 2 can be used as a catalyst for this idea. In approaching question 2 students need to display that they understand the question. Do they know what a tractor driven spray unit looks like? Have students draw a diagram. Students can use a modified 32-16-4-1 structure as an aid to sorting out an approach to this problem (See **32-16-4-1**) Encourage students to creatively list all the factors that might effect delivery rate of chemicals e.g. original concentration of supplied chemical, amount of water added, rate of delivery from tank, number of jets, size of jets, spray pattern, length of spray arm, depth of weed cover, speed of tractor, overlap of spray track, wind, rain, temperature etc. These go in the 60 table. Next they need to consider whether the factor will affect the amount of chemical applied. This list goes in the 16 cell table. They should be encouraged to refine and prioritize their list. For example, if we know the rate at which the chemical solution is pumped from the tank we do not need to know the number of jets or the jet size. This refined list goes in the 6 cell table. Students can be encouraged to identify the single most important variable and establish an argument supporting their selection. They may choose speed of tractor, rate of flow of liquid from pump, concentration of chemical or the overall mass of chemical applied per unit area.	Thinking Processes- Reasoning, processing and inquiry

Teacher Resource

Solutions to worksheets

Worksheet 1

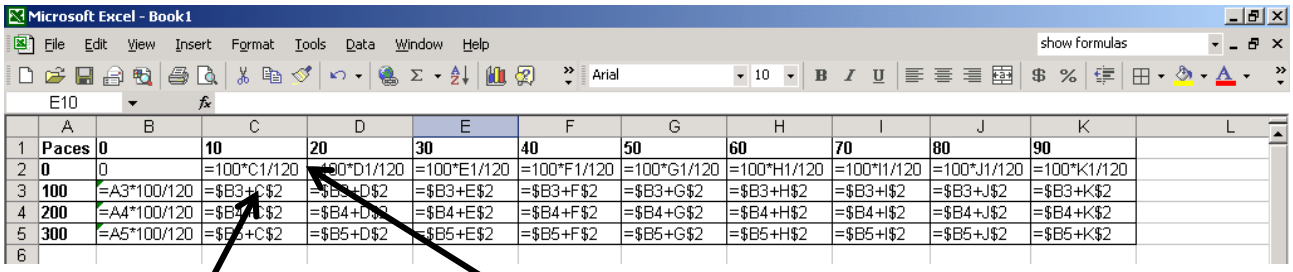
1. and 2. Answers will vary.

Worksheet 2

1. to 3. Answers will vary.

3. c.

Paces	0	10	20	30	40	50	60	70	80	90
0	0m	8m	17m	25m	33m	42m	50m	58m	67m	75m
100	83m	92m	100m	25m	117m	125m	133m	142m	150m	158m
200	167m	175m	183m	192m	200m	208m	217m	225m	233m	242m
300	250m	258m	267m	275m	283m	292m	300m	308m	317m	325m



Note the use of $B3 to lock the sum reference to column B and the use of C$2 to lock the reference

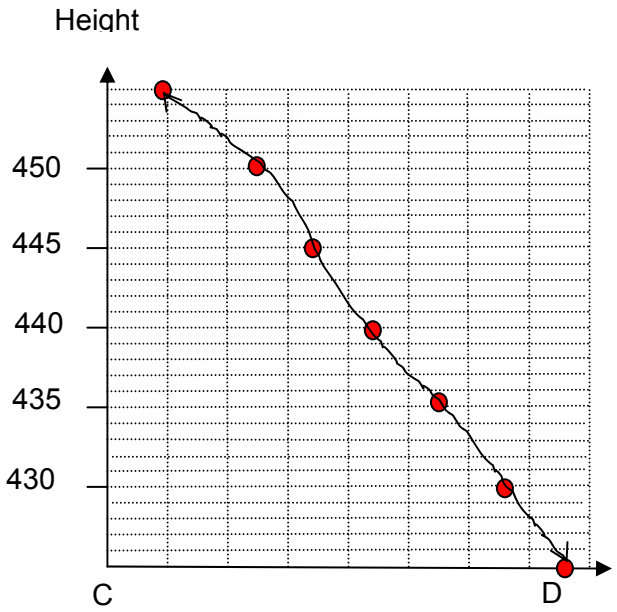
The 120 here needs to be replaced by whatever is the number of paces per 100m.

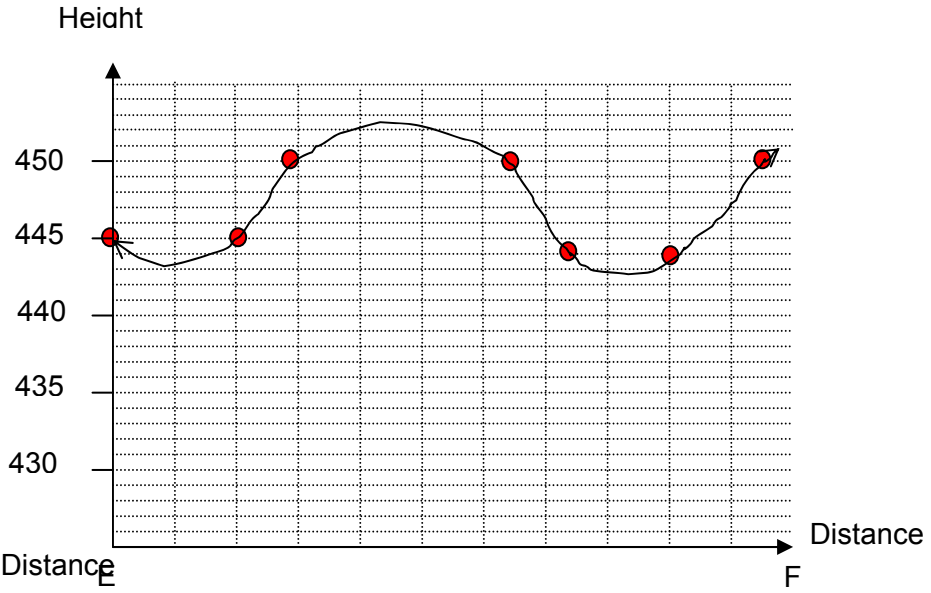
4. One hectare = 10 000 m^2

5. d.(a) 37 950m^2 (b) 20 625m^2 (c) 35 000m^2 (d) 21 373m^2 (e) 63 125m^2

Teacher Resource

6.





Worksheet 2

Solutions will need to be individually checked.

7. (a) climate, types of vines, machinery clearance.

(b) growth rate, soil fertility, available space and mature size of vines.

(c)

Vine separation (m)	Row spacing (m)		
	2	3	4
1	4 500	3 000	2 250
2	2 250	1 500	1 125
3	1 500	1 000	750

(d) Approx. 1 200

(e) Row spacing mean = 5.585, standard deviation = 0.29

Vine separation mean = 1.80, standard deviation = 0.013

(f) Answers will vary.

Worksheet 3

Answers will vary.

Worksheet 4

1. (a)

Position	Angle, θ	Rise	Run	Gradient $= \frac{\text{rise}}{\text{run}}$
1	21°	3	8	0.375
2	27°	3	6	0.5
3	37°	3	4	0.75
4	56°	3	2	1.5
5	72°	6	2	3
6	77°	9	2	4.5

Worksheet 5

1. 4.75L

2. Answers will vary.

3. (e) height =7.2m, radius = 2.387m, volume = 128880L

   (f) $2 577 600 at $20 per litre

4. (a) (i) V = 360L (approx.) (ii) 113L , 286L (approx.)

   (b) (i) $V = ((C1 + C2)/4)^2 \times \pi \times h$ (ii) 392L (iii) The rule uses an average diameter.

   (iv) It varies depending on the longitudinal curve of the barrel.

   (v) Overestimate.

   (vi) 5.9L, 187L, 386L

   (c) $2.08

Worksheet 6

1. Rapid increase of concentration in January, slows a little in February and March with a late increase in the rate in March.

2. January.

3. (a) January.

   (b) December

4. November.

5. $2cm^3$

6. Steady increase from November to February then a decline in size.

7. (a) They shrivel in size.

   (b) They dry out.

8. Towards end of February to achieve a balance between both factors.

9. Acidity needs to be retained for taste and longevity.

10. Early January

11. No solutions provided.

12. Mid January.

13. (a) 27 February

    (b) 21 February

Worksheet 7

1. $329 per ha.

2. Tractor speed, concentration of spray, area of overlap.

3. (a) 10–15L

   (b) (i) $129.80, $72.60, $31.90 (ii) $6.49, $14.52, $31.90

   (iii) $64.90 – $478.50 (iv) $132.16, $73.92, $32.48.

   (c) 100mL – 133mL

Capacity Matrix – Visiting vines

Student Materials

Capacity Matrix

Domains	Activity	Skills and knowledge needed in order to achieve learning outcomes related to the activity	Level of learning achieved: Information e.g. I have heard of this	Knowledge e.g. I can explain this in my own words	Know-how e.g. I can apply this on my own	Application e.g. I relate this to new situations and teach others.
Personal learning and Mathematics	**Determine the area of a vineyard**	Measurement				
		Paces and metres				
		Areas of triangles				
		Areas of composite figures				
	Plan a vineyard	Topography				
		Slope				
		Cross-section				
		Vine separation				
		Number of vines				
		Variability in separation and direction				
		Designing trellis				
		Calculating quantities				
	Describing and demonstrating personal learning	Concept map				
		Summarizing information				
		Monitor and discuss progress				
		Identify short and long term goals				

A Personal Learning journal

Teacher Resource

Learning journals are a commentary on the learning and development of the student over time. Entries are dated to show the student's progress and achievement of goals. The journals often contain:

- samples of the student works
- photographs and evidence of the students' development as a learner
- teacher feedback

Personal Learning journals can contain student comments, reflections and teacher annotations. Peer and self assessments can also be included.

For students to be successful in completing meaningful reflections about their learning they need to be provided with guidance and direction. For reflection to be meaningful and support student learning it must be conducted on a regular basis, be integrated into the curriculum and contribute to assessment. Students can be encouraged to identify their preference for different styles of learning and hence be encouraged to attempt to diversify the way they learn.

One researcher has described different learning styles in the following way:

Visual / spatial – like to draw, read maps and daydream.

Body / kinaesthetic – hands on learning with physical activity

Musical / rhythmic – can be taught by turning lessons into songs

Interpersonal – like to work with others either in student groups or with their teacher

Intrapersonal – like to work alone with time to think things out for themselves

Verbal / linguistic – Think in terms of words and can learn by being told something without being shown

Logical / mathematical – Like to experiment, solve problems and calculate.

Discuss with students with the range of learning styles, how they might identify their own learning style and encourage them to diversify the way they learn.

Effective journals will be fairly open in their format but may include some structured components like the examples below:

Teacher Resource

General journal page

Name: Date:

Date	Description of what I have learned today. Who taught me? How well do I know it?	Identify the learning style used and how well it suited my learning.	What can I do to expand the scope of learning styles in order to improve my learning?
	E.g. I have learned to estimate the area of a rectangle by using calibrated paces. My teacher introduced the idea but I also learned a lot from discussion with my fellow student. Jess helped me by suggesting I keep count of my paces by transferring a stone between my hands each time I paced 100m.	E.g. I prefer activty (kinaesthetic) approaches. We used an actual block of land and that helped me because I could work directly on the object rather than a diagram. It was also useful to be physically involved with pacing the distance and to realize the variation between people's pace lengths.	E.g. I could record the data on a diagram and note the steps involved in the calculation. I could set up similar diagrams and calculate their areas in order to be less dependent on being physically present in the situation

Self analysis questionnaire

Name: Date:

	Agree				Disagree
	5	4	3	2	1
I take a creative and practical approach to problems					
I am flexible and adaptable					
I identify options and possibilities					
I can translate plans into actions					
I can set realistic goals					
I have a positive approach to learning					
I have a range of ITC skills which I apply when appropriate					
I learn effectively in groups					
I can focus and concentrate for a long period of time (over 30 minutes)					
I don't need teacher feedback to know how well or poorly I am performing					
I plan my time carefully and complete tasks on time					
I can work independently and maximize my learning					

Teacher Resource

My journal

Name:	Date:
What do I need to do today?	1. 2. 3.
An example of how I worked with others	
Something I have learned	
How I learned this.	
How I would help somebody else to learn this	
Things to do next	
Circle how you feel today	

Skills record

Name: Date:

Skill, attribute or knowledge	Where and how have I displayed this skill, attribute or knowledge?	What evidence do I have?
Eg. Recognized how paces can be used to estimate length and how the measurement can be improved by calibrating paces	Eg. Estimation and measurement of the boundary of a vineyard	Eg. Responses on worksheet 1. Photographs of the vineyard activity.

Worksheet 1 – Planning for Visiting vines (7.1)

Student Materials

1. (a) Conduct a brainstorming session focussing on planning a vineyard. Consider (among others) these questions

   (i) What do you know about vineyards?

   (ii) What would you like to know?

   (iii) When would be the best time to visit a vineyard?

   (iv) Where could we go to visit a vineyard?

   (v) What mathematical skills are needed to plan a vineyard?

   (vi) How could you obtain information about vineyards?

   (b) Record the results of your brainstorming session on a concept map

   (c) A capacity matrix is an aid to structuring learning (See table below). It is called a capacity matrix because the idea is based on an aid developed in human resource management for recording employees capacity (ability) to perform aspects of a job.

   (i) Insert the items below in the appropriate gap.

Contour lines	Monitoring progress	Estimating large area
Capacity matrix	Paces and metres	Number of vines

Accessing and recording information from web sites

   (ii) Indicate with a cross the level of learning achieved. This will, of course, need to be reviewed as you progress through the unit.

You will be asked to continue to add items to the matrix as you work through the unit and will be able to use it to monitor development of your knowledge and skills.

Worksheet 1 – Planning for Visiting vines (7.1)

Student Materials

Capacity Matrix

Domains	Activity	Skills and knowledge needed in order to achieve learning outcomes related to the activity	Level of learning achieved: Information e.g. I have heard of this	Knowledge e.g. I can explain this in my own words	Know-how e.g. I can apply this on my own	Application e.g. I relate this to new situations and teach others.
Personal learning and Mathematics	**Determine the area of a vineyard**	Measurement				
		Paces and metres				
		Areas of triangles				
		Areas of composite figures				
	Plan a vineyard	Topography				
		Slope				
		Cross-section				
		Vine separation				
		Number of vines				
		Variability in separation and direction				
		Designing trellis				
		Calculating quantities				
	Describing and demonstrating personal learning	Concept map				
		Summarizing information				
		Monitor and discuss progress				
		Identify short and long term goals				

(d) Commence work on a journal or diary in which you can record learning activities, self assessment and progress.

2 (a) Different people prefer to learn in different ways and some people learn better with one approach to learning than with another. One researcher has described different learning styles in the following way:

Visual / spatial – like to draw, read maps and daydream.

Body / kinaesthetic – hands on learning with physical activity

Musical / rhythmic – can be taught by turning lessons into songs

Interpersonal – like to work with others either in student groups or with their teacher

Intrapersonal – like to work alone with time to think things out for themselves

Verbal / linguistic – Think in terms of words and can learn by being told something without being shown

Logical / mathematical – Like to experiment, solve problems and calculate.

(i) Select three items from the capacity breakdown list and describe how you learned about each one.

(ii) Classify the way you learned in terms of one or several of the learning styles listed.

Example:

Calibrating pace length to measure distance. Body / kinaesthetic (used our body, physical, linked to real object, actually did it) learning and Interpersonal (needed to cooperate to get group data)

(b) Do you think that you have a strong preference for one learning style over all others? What evidence do you have for this?

(c) Use your Learning Journal throughout this unit to record what you learned, how you learned it, how effective the learning process was for you and, most significantly, how you can improve.

(d) (i) Add 'Knowledge of learning styles' to the 'Skills and knowledge …' column associated with the 'Describing and demonstrating personal learning' outcome of your capacity matrix.

(ii) Indicate with a cross the 'Level of learning achieved' for all 'Skills and knowledge …' categories.

Worksheet 2 –Visiting the vineyard

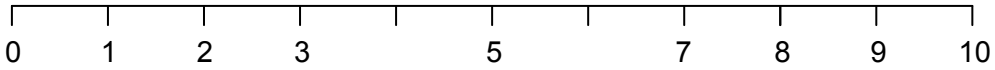
Student Materials

1. (a) Estimate the size (in hectare) of the block of land specified by your teacher. Indicate with an X where your estimate fits on the number line below.

   (b) Add other Xs to indicate the estimates of other students in your class.

   (c) What single value best represents the class estimate for the size of the block?

   (d) Clearly the class members did not all get the same value for their estimate. What value could be used to describe the variation in estimates within the class?



Number of hectares

2. One way to measure the dimensions of the rectangular area is by pacing.

   (a) Count the number of paces you take to measure one side of a rectangle

   (b) Write down your number of paces and the minimum and maximum number of paces for your class.

   (c) Comment on the strengths and weaknesses of using paces as a measuring unit.

   (d) How could these problems be overcome?

3. One way to improve pace use as a method of measuring is to find out how many paces you take in 100 metres and 10 metres.

   (a) Complete the following table by carrying out several trials.

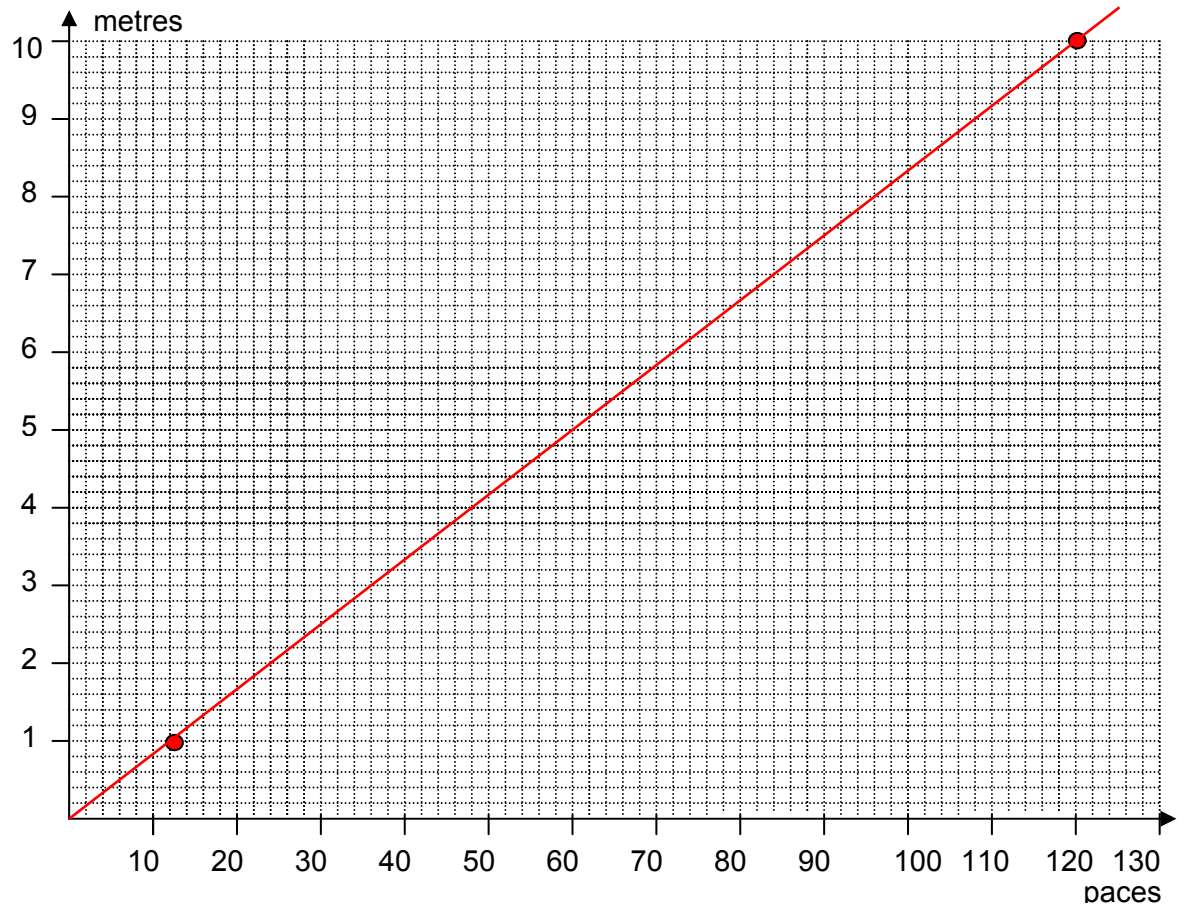
Distance	Trial 1	Trial 2	Trial 3	Average
10m				
100m				

   (i). What spread of values did you get for 100m?

   (ii). What is the percentage error associated with your average for 100m?

   (iii). Why carry out three trials?

(b) Produce a personal conversion graph by plotting the averages from the table. The following example is for 120 paces = 100 metres.



(c) Produce a conversion table like this to convert paces to metres for your pace length. For example in this table, 240 paces = 200 metres. (This table could be produced relatively easily with the assistance of a spreadsheet)

Paces	**0**	**10**	**20**	**30**	**40**	**50**	**60**	**70**	**80**	**90**
0	0m	8m	17m	25m			50m			75m
100			100m			125m			150m	
200		175m			200m			225m		
300	250m			275m			300m			325m

Sometimes, one metre can be approximated by one pace.

(d) Create a conversion calculator on a CAS calculator for converting paces to metres for your own pace length.

Measure the length and width of the rectangular piece of land in paces, convert the paces to meters and calculate the area.

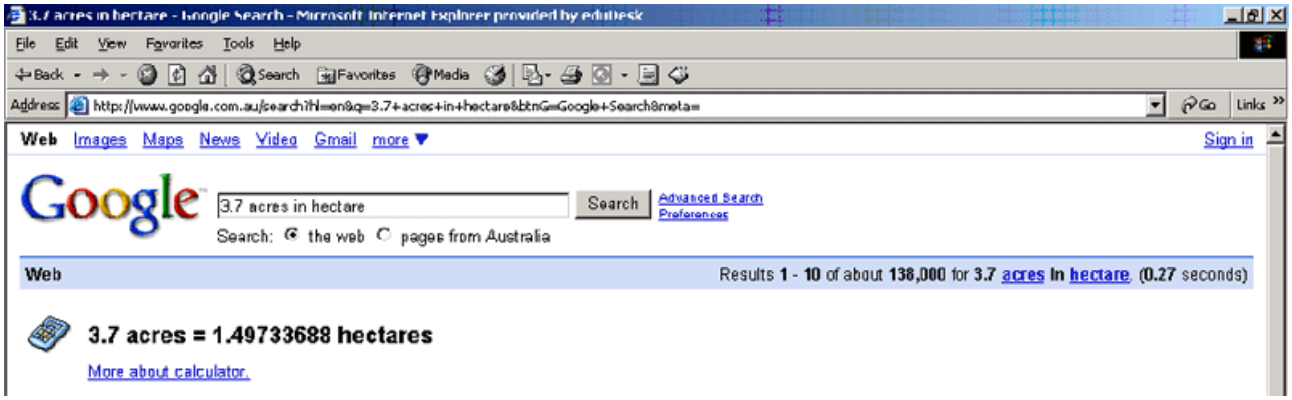
4. Carry out research on the internet in order to determine the number of m^2 in a hectare. Determine some other questions of interest associated with land and other measurements eg What is the relationship between the acre and the hectare? Are there other units used in other countries?

   You can start your research by entering 'hectare' into a search engine such as Google. http://en.wikipedia.org could be used as an alternative starting point. http://www.bipm.org/en/si/ provides access to information about the System International of the Bureau International des Poids et Mesures. (What language is being used? Why this choice of language?)

   Draft a list of six questions which interested you and create a PowerPoint or similar presentation to share the answers with the class.

   Research http://en.wikipedia.org/wiki/Hectare

The following screen dumps illustrate a fascinating property of the Google search engine.



5. Not all vineyards are rectangles. Many are made up of triangles or irregular quadrilaterals. Each shape has a particular definition and a formula for calculating area.

   (a) Draw diagrams of each of the following shapes and write down a definition for each

   i. Scalene triangle

   ii Right angle triangle

   iii. Quadrilateral

   iv. Rhombus

   v. Parallelogram

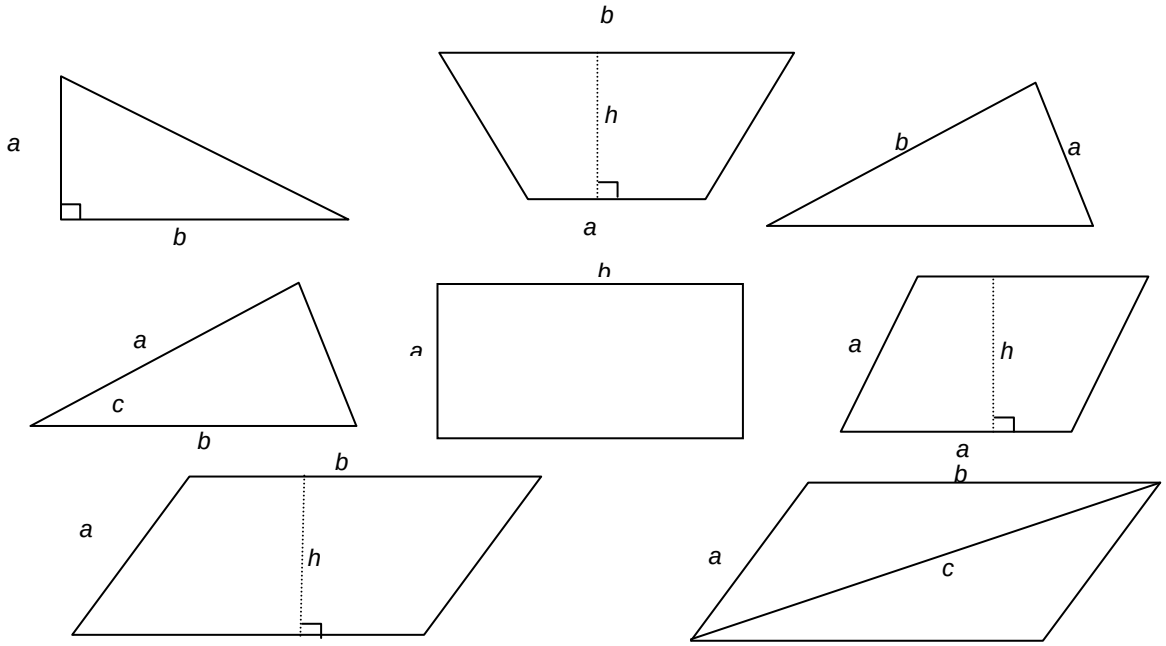
   vi. Trapezium

Worksheet 2 –Visiting the vineyard

Student Materials

You will find definitions in a dictionary and will be able to find diagrams in a Mathematics text book. Your classmates may know some of the answers and if stuck you could always ask your teacher for help. The internet is also a useful source of information

(d) Carry out similar research in order to find out the formulas which could be used to calculate the areas of these figures.

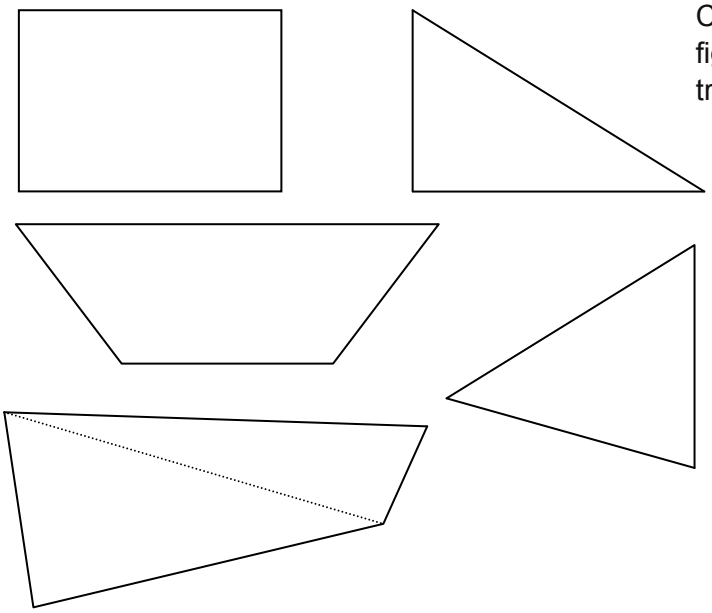


(c) (i). List the sources of information you used to answer questions (a) and (b) above.

(ii).List the additional sources you could have used, but didn't.

(iii).Do you think that any of the unused resources might have been more useful than the resources you actually used?

(d) The formulas can be used to calculate areas in practical situations or with scale diagrams such as the following. The scale in each case is 1: 5 000. What distance is represented by each centimetre? Calculate the area represented by these figures.

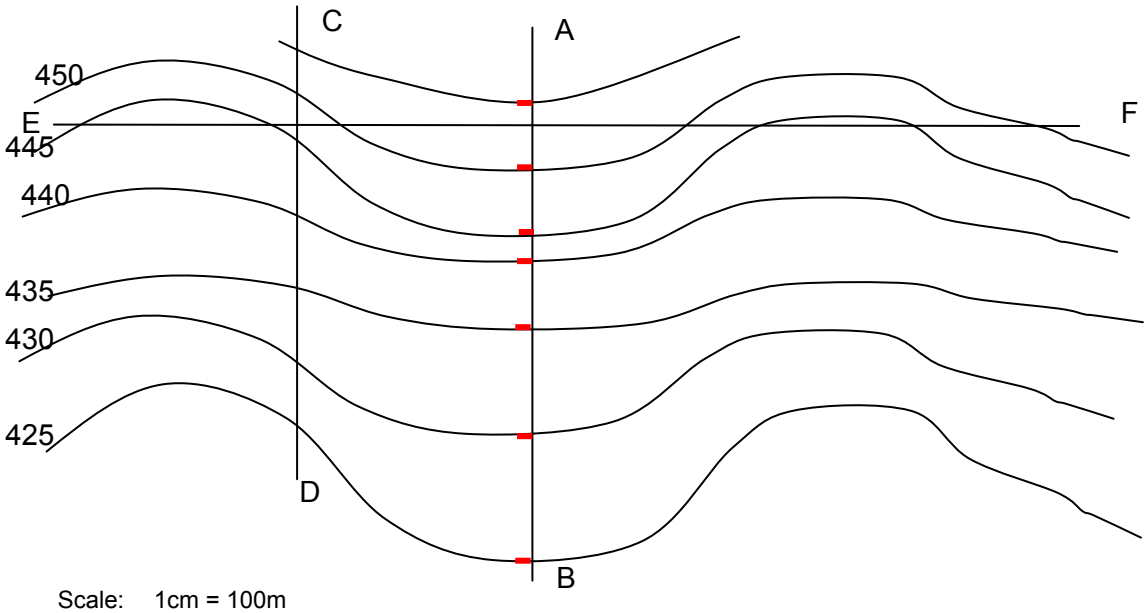


Calculate the area of this figure by breaking it into two triangles.

6. It is important to consider the topography of the land when planning the layout of a vineyard.

(a) What is topography?

(b) Work through the following tasks to determine the topography of the land for a vertical cross-section along the line segment *AB*.

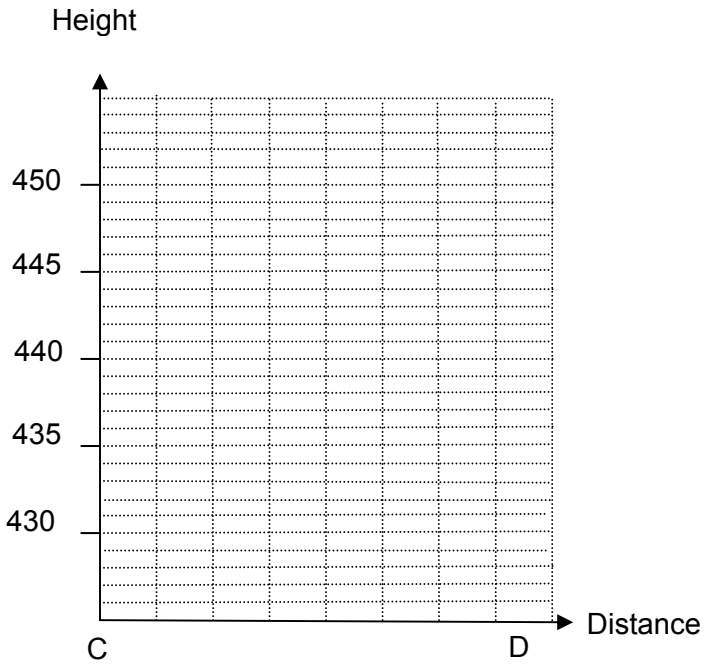


Scale: 1cm = 100m
Contour interval: 5m

To draw a cross-section of the land, place a piece of paper on the line segment *AB* and mark the location of each contour line. Using this paper, transfer the contour lines to the vertical axis of a graph of height versus distance. Then plot the height of each contour.

Note: the land is steepest where the contour lines are closest together. This is similar to the property for isobars (lines with the same barometric pressure) on weather maps. The closer they are together the stronger the winds are likely to be.

(d) (c) Graph the cross-sections *CD* and *EF* using the following grids.



Choose another line segment GH on the contour map. It need not be a vertical line segment. Determine a vertical cross section for GH.

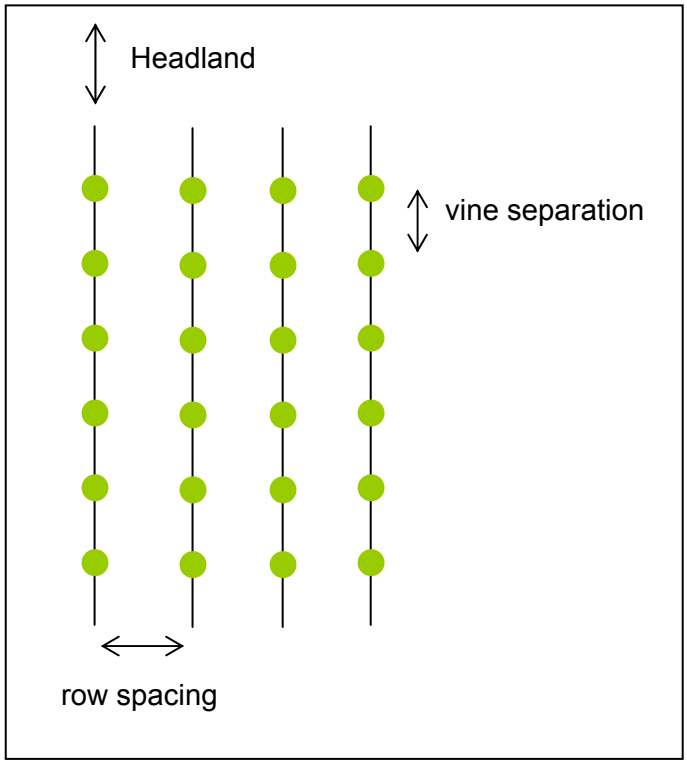
(e) Obtain a topographical map for an area near your home or school or of the vineyard you plan to visit. Use it to create a cross section for a geographical feature with which you are familiar. Comment on how well the cross section relates to the actual land.

(f) Design a method for using a contour map to assist you in creating a physical model of the geographical feature.

(g) How does topography influence the design of a vineyard?

(h) Investigate other uses which could be made of contour lines.

7. A typical vineyard consists of parallel rows with a headland at the end of each row to enable a tractor to turn around. The headland area means that, on average, only about 90% of an area of land can be planted to vines. The orientation of the rows depends on the shape of the land to some extent but usually they run north–south.



(a) What factors determine the row spacing of vines?

(b) What factors determine the vine separation?

(c) In Australia you will usually find row spacing of between 2 and 4 metres and vine separations between 0.8 and 3 metres. Row spacing and vine separation will

determine the number of vines planted and the cost of establishing a vineyard. Complete the following table by calculating the corresponding number of vines per hectare.

Number of vines per hectare			
Vine separation (m)	**Row spacing (m)**		
	2	**3**	**4**
1			
2			
3			

(d) Typically you will find a row spacing of 3m and vine separation of 2.5m. Calculate the number of vines per hectare.

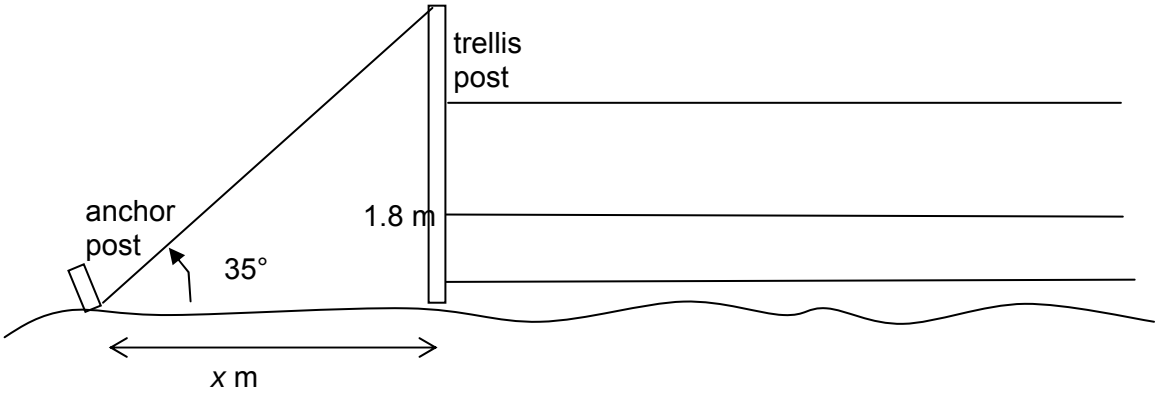
(e) How variable are these factors in a vineyard? The following data was collected from a Yarra Valley vineyard. Calculate the mean and standard deviation for this data.

Row spacing (m)				
3.7	3.9	3.4	3.3	4.3
3.4	3.7	3.0	3.6	3.7
3.0	3.6	3.7	3.6	3.7
3.7	3.6	3.5	3.8	3.5

Vine separation (m)				
1.85	1.85	1.68	1.70	1.66
2.04	1.82	1.58	1.88	1.85
1.80	1.64	2.00	1.76	1.88
1.63	1.94	1.85	1.63	1.90

(f) Carry out a survey of a vineyard. Make 20 measurements of row spacings and determine the mean and standard deviation. Make 20 measurements of vine separation at randomly chosen places within a vineyard paddock. Calculate the mean and standard deviation for this data.

8. To create a stable trellis for the vines it has been decided to have a supporting wire fixed at an angle of 35° to the horizontal. How far from the first trellis post must the short anchor post be? (Evaluate x.)

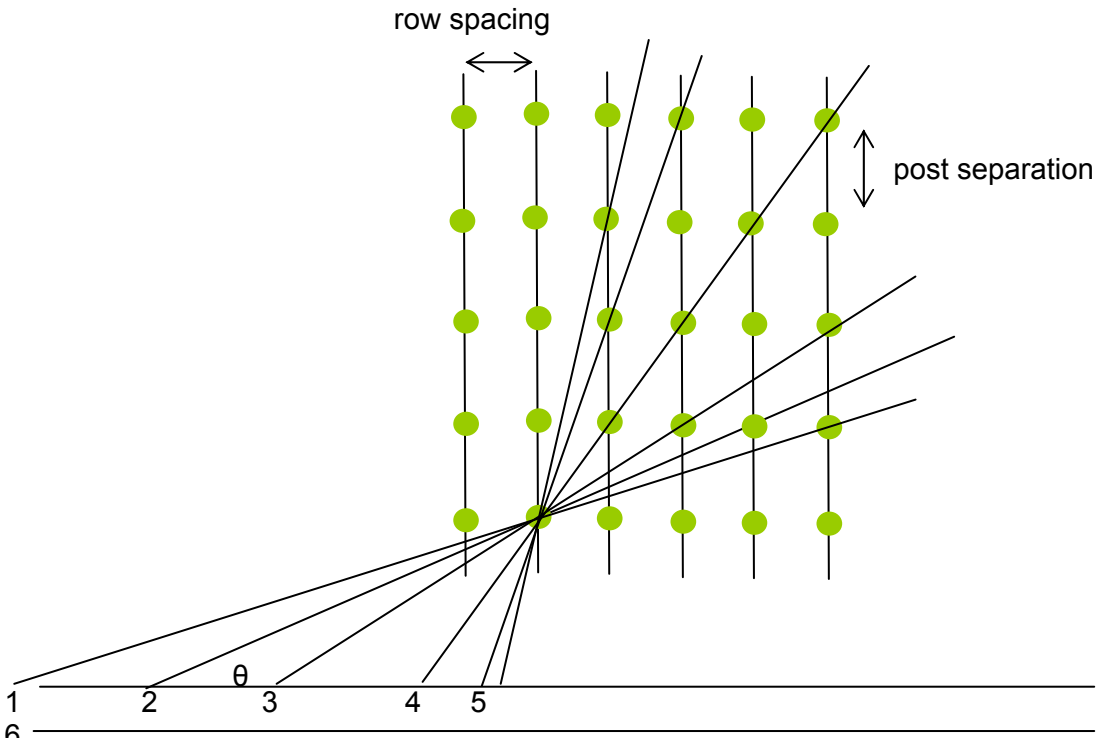


9. Update any progress made in the 'level of learning achieved' for any rows in your capacity matrix.

Worksheet 4 - Lines of vines: an investigation

Student Materials

As a car travels along a road as shown in the following figure, a well-set-out vineyard will present a series of situations where the posts in the vine trellis line up.



Each location where the posts line up can be defined by the angle, θ, which the line makes with the road. The gradient of the line is determined by the post separation and the row spacing. For the vineyard illustrated, the post separation is 3m and the row spacing is 2m.

Investigate how the rows of vines appear from the car as it travels along the road from 1 to 4. Consider, among others, such questions as:

- Where do the rows appear?
- Do they appear at a constant rate?

Do they all seem to be equally well defined?

Worksheet 4 - Lines of vines: an investigation

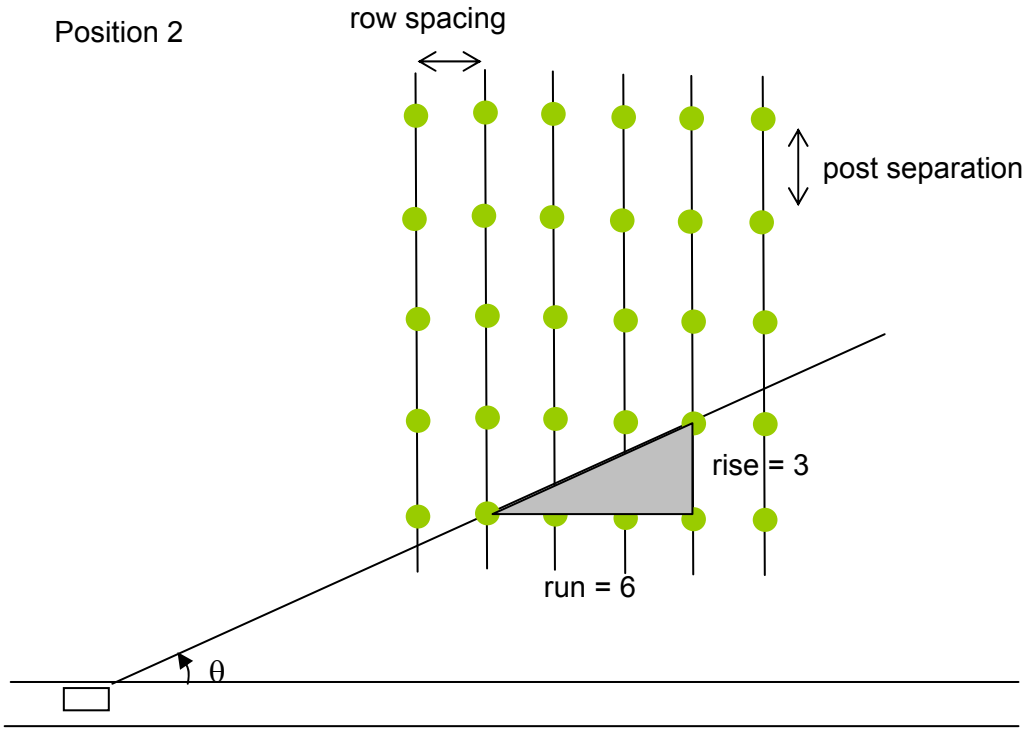
Student Materials

If students need a more structured approach the following questions could be used.

1. The following figure illustrates the situation when the car is at position 2.

The angle, θ, is measured to be 27°. We can calculate the gradient from the rise and the run.

Gradient $= \frac{\text{rise}}{\text{run}} = \frac{3}{6} = 0.5.$

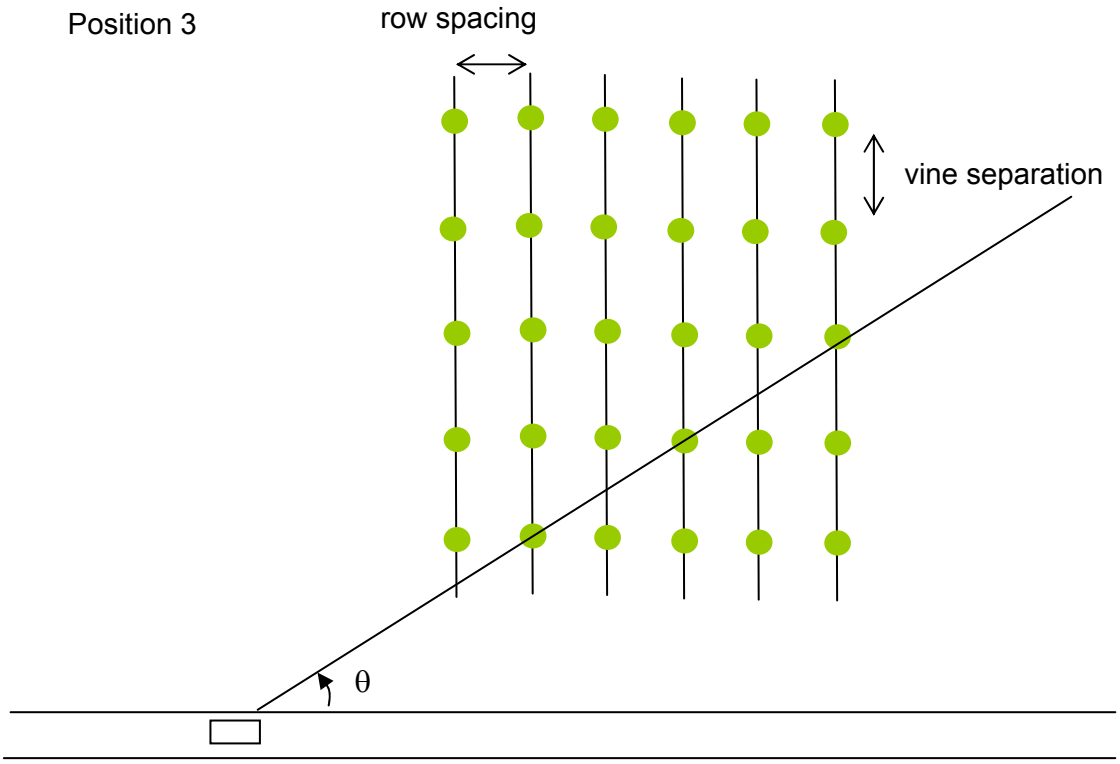


(a) Parts of the question below lead to completion of the following table of values.

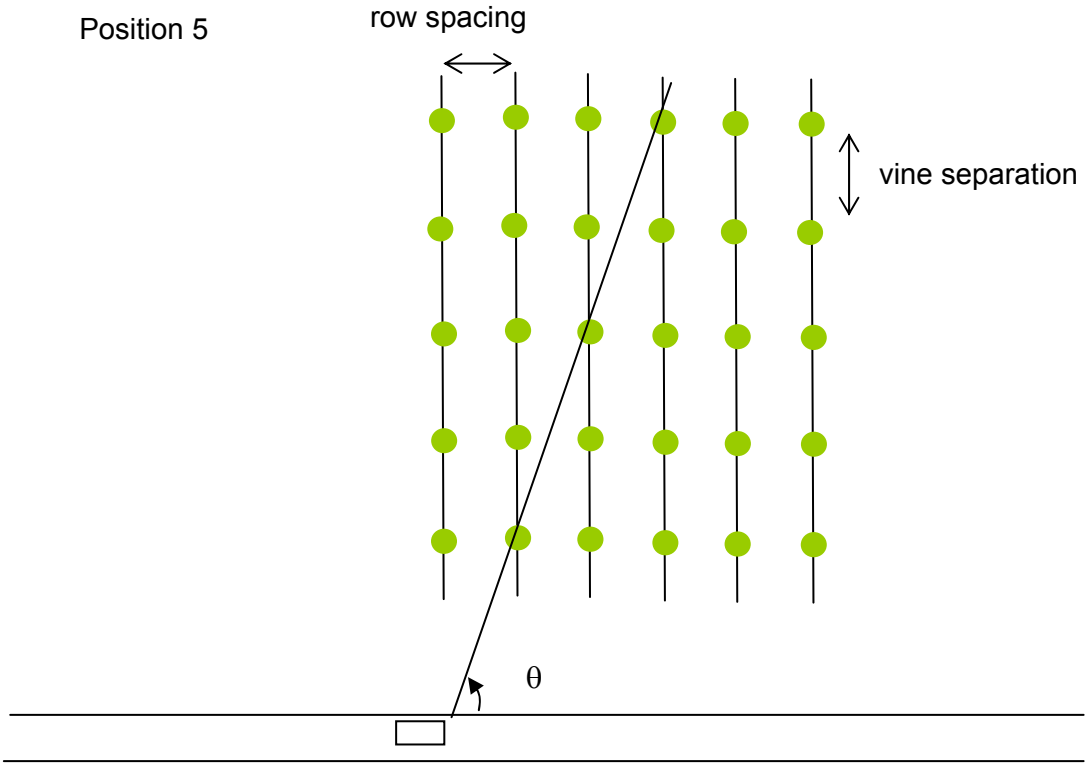
Position	**Angle, θ**	**Rise**	**Run**	**Gradient** $= \frac{\text{rise}}{\text{run}}$
1				
2	27°	3	6	0.5
3				
4				
5				
6				

Add the values corresponding to positions 3 and 5 to the table above using the following figures.

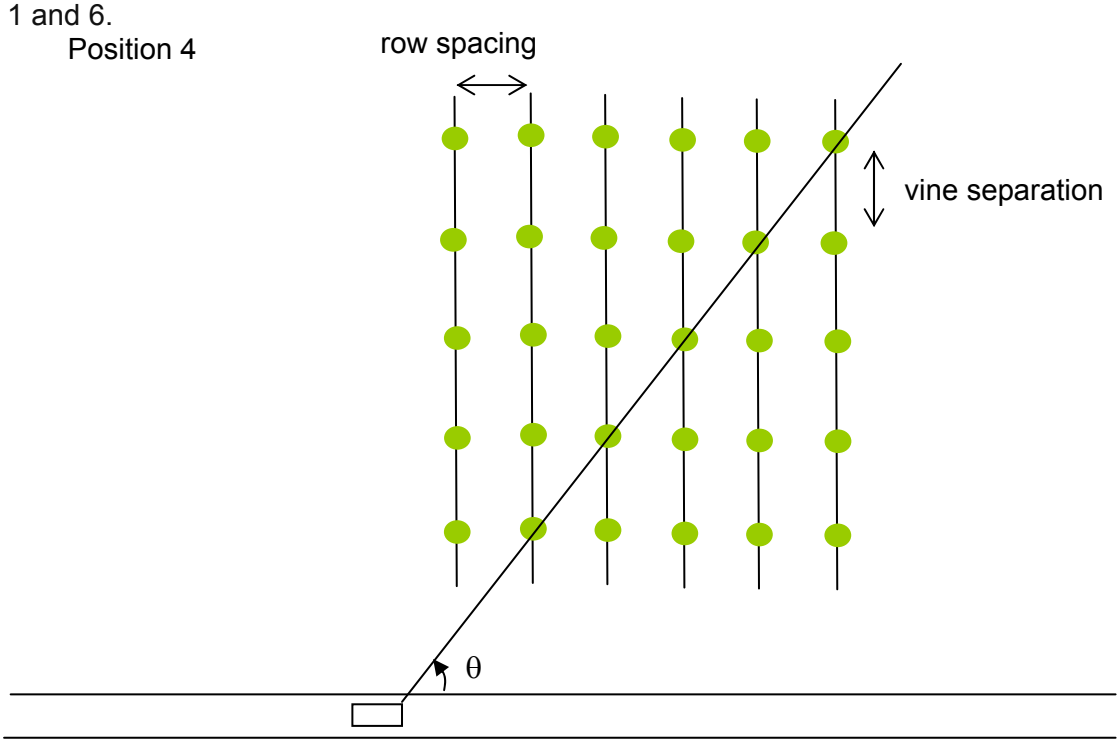
Position 3



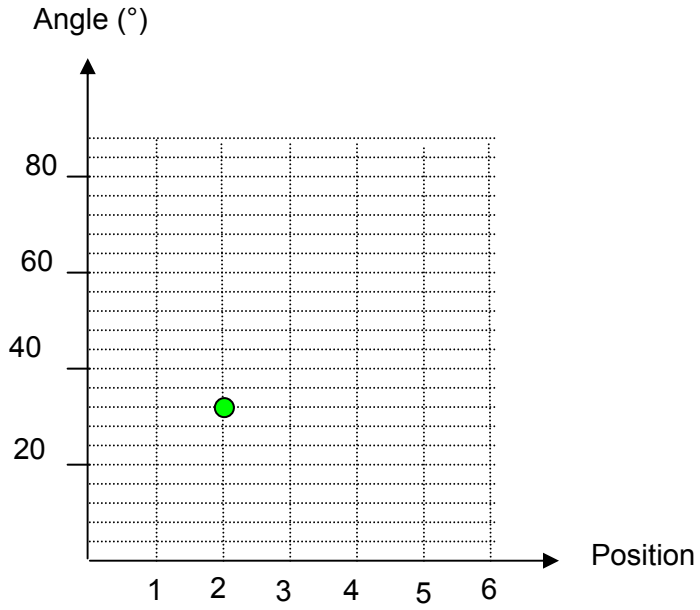
Position 5



(b) Looking at the pattern of rise and run, predict the values of rise and run for positions 1, 4 and 6. Confirm your predictions using the following diagram for position 4 and the first diagram for positions 1 and 6.



(c) Complete the following graph of the relationship between position and angle.



(d) Use the graph to predict the angles for positions 1, 4 and 6.

(e) Make measurements to verify your predictions.

(f) Calculate the percentage error associated with your predictions.

2. Predicting for position 4 is called interpolation. Predictions for positions 1 and 6 are called extrapolations.

(a) What do these words – *interpolation* and *extrapolation* mean?

(b) Why is interpolation more likely to be accurate than extrapolation?

(c) Are your error calculations consistent with this?

3. The angle can be calculated directly from the gradient using a built-in calculator function called tan (short for tangent).

   $\tan\theta$ = gradient = $\frac{\text{rise}}{\text{run}}$

   The tangent function can be used in reverse to calculate angles.

   Using a calculator, and the data for position 1, undertake the following the key steps.

   (a) Check that the calculator is in degree mode.

   (b) Press [2nd F] This stands for second function.

   (c) Press [tan] $\tan^{-1}$ is displayed. The $^{-1}$ shows that you are using the tangent function in reverse.

   (d) Enter the gradient, 0.5.

   (e) Press [=] The result is 26.57°. Compare this to our measured value of 27°.

   (f) Repeat the process to calculate θ for the remaining positions.

4. (a) Add a new activity row 'Investigating lines' to your capacity matrix. Add details to the 'Skills and knowledge … ' column relating to skills and knowledge needed or gained from this activity.

   (b) Indicate with a cross the level of learning achieved.

   (c) Update any progress made in the level of learning achieved.

Worksheet 5 - Bottles and barrels

Student Materials

In the process of winemaking, wine is stored in barrels and in stainless steel tanks. A lot of wine is destined for sale in wine casks and most of our better wine is sold in bottles.

2. A wine bottle has this shape, and it is filled to within 6.5cm of the top.

(a) Determine an appropriate cylinder to represent the capacity of the bottle.

(b) Justify your choice.

(c) Calculate the capacity of the cylinder by using the formula:

$V = \pi r^2 h$

where $\pi \approx 3.1416$, r = the radius of the cylinder and h = its height.

(d) Compare your answer with the stated volume of 750mL and explain any differences between the values.

3. The cylindrical stainless steel tanks used to store wine are huge. It is difficult to measure their height directly. As you can see from the preceding photograph the tanks are made up of a series of sections, each section being 1.8m high. A particular tank is composed of four such sections. The circumference of each tank is 15 m. You need to calculate the capacity of the tank

It may be useful to think about this collection of problem solving strategies:

Guess
- Guess and check
- Guess and improve

Act It Out
- Make a model
- Use equipment

Draw
- Draw a picture
- Draw a diagram

Make a list
- Make an organised list
- Make a table

Think
- Be systematic
- Keep track
- Look for patterns (Have you seen a simpler but related problem?)
- Use symmetry
- Work backwards
- Use known skills (Have you seen a similar problem?)

(a) What information are you given in the question?

(b) What dimensions of the tank are needed in order to calculate its volume?

(c) Which of these are you given in the question?

(d) Explore how you could obtain the un-stated dimensions needed.

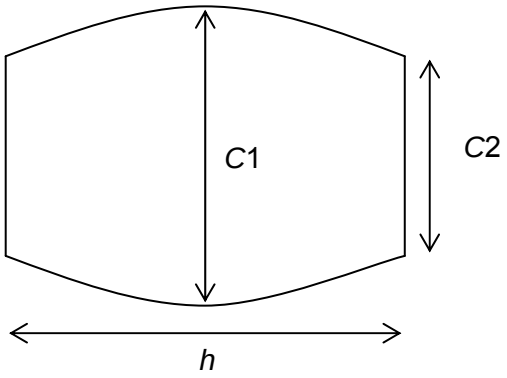
(e) Determine the capacity of the tank

(f) Estimate the commercial value of the wine in the tank, explaining how you determined this estimate and how you could validate the estimate.

(g) Explain how the procedure you followed relates to the problem solving strategies listed above.

(h) Present your results in question 3 in the form of a poster.

4. (a) Barrels are frequently used for the maturation of red wine.



It is difficult to directly measure the radius of the centre of a full barrel so the circumference ($C1$) is measured.

(i) For a particular barrel $C1$ = 2.30m, $C2$ = 1.93m and h = 1.02m. Develop a method for estimating the capacity of the barrel in litres. Justify any assumptions you have made.

(ii) Use this method to calculate the capacity of barrels with the following dimensions.

(ii) Explain how you could validate your method.

C1	***C2***	***h***
0.54m	2.00m	0.88m
0.75m	2.90m	1.08m

(b) A cooper (a barrel maker) was contacted and asked what formula he used to calculate the volume of a barrel. He said that he used Pythagoras' theorem. He said that he 'measured the head and the belly of the barrel, added these together, divided by 4, multiplied this by itself then multiplied by the height, then multiplied by 'three point one four zero'. He measures the belly of an empty barrel by placing a stick through the bung hole.

(i) Create a mathematical formula for the cooper's method.

(ii) A 350L barrel measures 0.61m across the head (diameter of the top), 0.72m across the belly (diameter at the centre) and is 1.13m high. Check that the rule works for this barrel.

(iii) Explain why the rule works.

(iv) Would you expect it to be exact?

(v) Would you expect it to give an overestimate or an underestimate of the size?

(vi) Calculate the volume of the following barrels.

Head (m)	**Belly (m)**	**Height (m)**
0.32	0.38	0.61
1.09	1.23	1.75
1.65	1.42	2.06

(c) A new 300L oak barrel costs $2 500. For premium wine it would be used for 3 vintages. A bottle of wine contains 750mL. How much does the barrel cost contribute to the cost of the wine?

(d) Prepare a written report on your work on Question 4.

Worksheet 6 - Creating and interpreting graphs

Student Materials

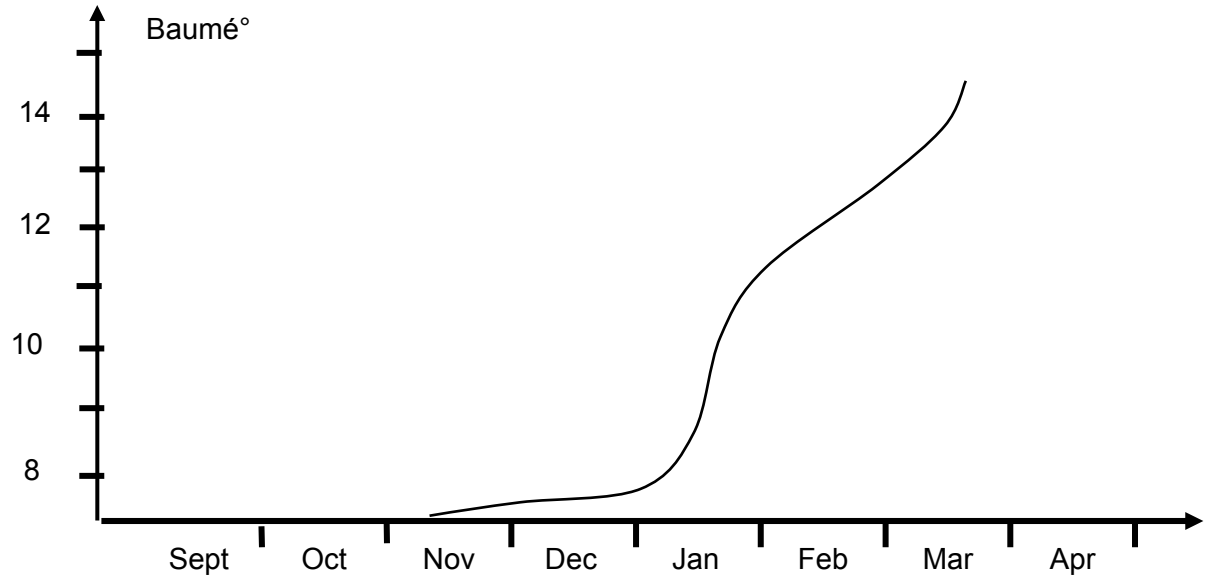
During the ripening period between mid-January and March, maturity analysis of ripeness, pH and acid content are performed to plot the progress of the fruit. The level of ripeness is determined by hydrometer or refractometer, which measures the total soluble solids. In grape juice this is essentially all sugar. This is then expressed in a measurement of Brix or Baumé.

Each degree Brix is equivalent to 1% of sugar in the juice. For example, grape juice which measures 15.5 degrees on the Brix scale contains about 15.5% sugar.

One Baumé = 1.8 Brix. Each degree Baumé equates to approximately 1% of alcohol after fermentation. Hence fruit harvested at 12 Baumé or 21.6 Brix produces a wine of approximately 12% alcohol. The fermentation process involves the yeast converting grape sugar to ethanol.

The following graphs illustrate measurable changes in the characteristics of grapes. You will be asked interpretive questions on these relationships, and will be given sets of data gathered at specific times and asked to forecast future measurements.

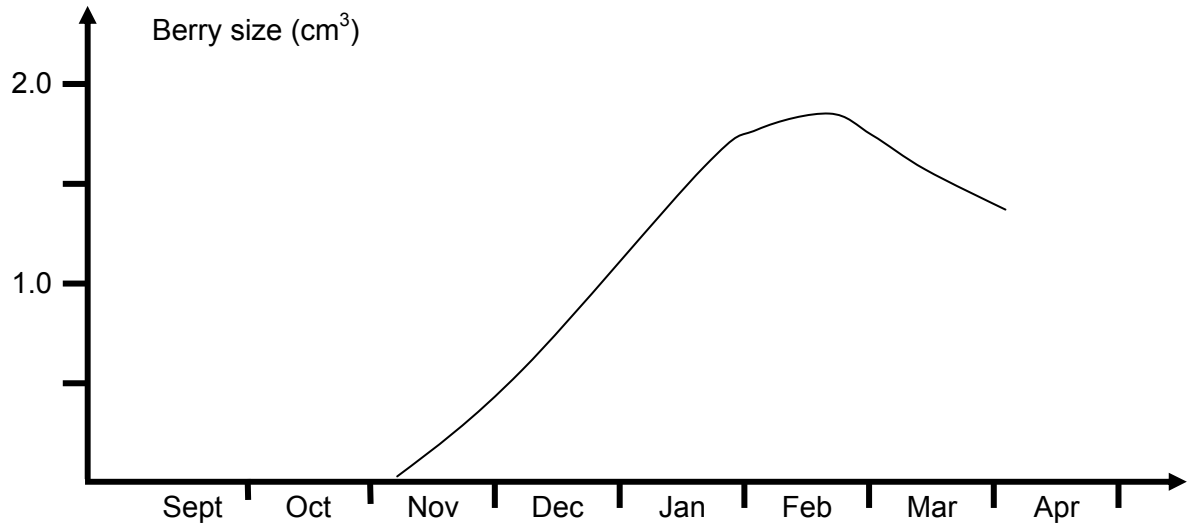
Ripeness



1. Describe how the sugar content of grapes changes between January and March.
2. In what month does the greatest change in sugar concentration occur?
3. (a) When is the sugar concentration changing most rapidly?

   (b) When is the sugar concentration changing most slowly?

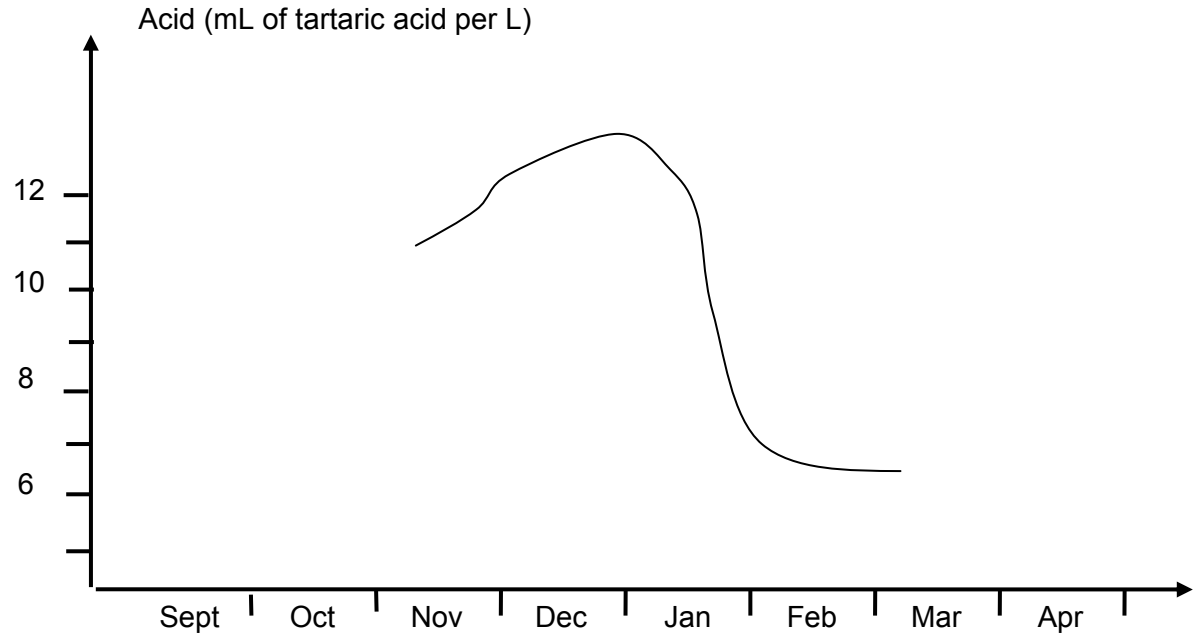
Fruit size



4. When do the grapes first appear?
5. What is the maximum berry size?
6. Describe what happens to the berry size between November and April.
7. (a) What happens to the berry size in March?

   (b) Why does this happen?
8. Considering the graphs of berry size and sugar content, when is the best time to pick the grapes? Explain your reasons.

Acidity



9. Why is it important to measure the acid concentration of grape juice?

10. The most common measure of acidity is pH. Theoretically pH values range from 0 to 14. The lower the pH, the more acidic the grape juice. When would the pH of the grape juice be at its lowest?

11. Research the definition of pH.

12. The objective for wine production is that the sugar concentration should be high (in order to produce sufficient alcohol) and the acid concentration should not be too low (in order to produce a refreshing, clean wine). When would you expect to see these conditions in the vineyard?

13. Over four successive days the following measurements were made of sugar concentration and pH.

Date	**Sugar (Baumé)**	**Acid (mL per L)**
12 February	12.25	7.245
13 February	12.30	7.205
14 February	12.35	7.167
15 February	12.40	7.131

(a) Ideally, the winemaker wants a sugar concentration of 13 Baumé. When should she recommend that the grapes should be harvested?

(b) The ideal acid concentration is 6.8 mL per L. When should the grapes be harvested to achieve this?

(c) Given your answers to (a) and (b), what questions would you ask the winemaker if you had to advise her of the best date for planning to harvest the grapes?

14. Select a set of variables from those listed below. Gather data and pose questions which you would like to investigate. Determine answers to these questions and submit a written report.

(a) heat and rate of fermentation

(b) alcohol content and fermentation

(c) time and export volume

(d) Time and the price of a bottle of Grange Hermitage (use this to develop an inflation index)

15. Investigate one of these topics

(a) What quantity of wine would represent a ‘standard drink’?

(b) How is alcohol concentration measured? What alternative measures have been used in the past? What is ‘percentage proof’?

(c) To what extent are teenagers consuming alcohol? Is there any reliability in official figure?

(d) How does the capacity of wine glasses vary?

(e) Is the barrel a standard unit? Why is there a difference between imperial and US gallons?

16. (a) Add a new activity row ‘Creating and interpreting graphs’ to your capacity matrix. Add details to the ‘Skills and knowledge … ‘ column relating to skills and knowledge needed or gained from this activity.

    (b) Indicate with a cross the level of learning achieved.

    (c) Update any progress made in the level of learning achieved and add new rows to the ‘Describing and demonstrating personal learning’ column.

Worksheet 7 - Applying chemicals

Student Materials

1. Applying gypsum is one of the most effective ways to improve soil structure. Gypsum is the common name for calcium sulphate. In clay soil it may be advisable to apply up to 7 tonnes per hectare before planting a vineyard. Gypsum is relatively cheap at approximately $47 per tonne. What is the cost per hectare of the initial application of gypsum?
2. Chemicals need to be applied in the correct quantities. If too little is used then the desired effect will not be achieved. If too much is used then there is a risk of damage to the vines or of injury to those applying the chemicals. Most vineyards apply chemicals from a spray tank on a tractor.
   a) Draw a diagram illustrating your understanding of the problem.

   (b) List as many variables as you can think of which may be related to the situation.

   (c) Refine that list by removing those that will not directly affect the amount of chemical applied

   (d) Attempt to identify the four principal variables associated with the rate of application of chemicals and describe the measurements needed in order to calculate the amount of chemical applied.

   (e) Argue the case for one variable being more significance than the others
3. Glyphosate is a systemic herbicide used to control weeds. It is absorbed by the green tissue of plants and transported in the sap throughout the plant and to the roots. The quantities recommended for a particular range of weeds are as follows.

   Boom spray 2–3 L per ha

   Knapsack 75–100 mL per 15 L

   (a) What volume range would be required to spray the weeds on 5 hectares of land in preparation for planting a vineyard?

   (b) The glyphosate price varies with the size of container purchased as follows.

Size of container	**Price** (excluding GST)
20L	$118
5L	$66
1L	$29

   (i) Calculate the price with a GST of 10% included.

   (ii) Compare the cost per litre of the various containers.

   (iii) Specify the range of costs for applying glyphosate to the 5-hectare vineyard.

   (iv) Notice has been given that prices are going to increase by 12%. Calculate the prices for the three sizes of containers after the price increase.

   (c) A 20L knapsack spray is to be used for spot spraying. Specify the range of amounts of glyphosate to be used.

4 (a) Add a new activity row ‘Applying chemicals’ to your capacity matrix. Add details to the ‘Skills and knowledge … ‘ column relating to skills and knowledge needed or gained from this activity.

(b) Indicate with a cross the level of learning achieved.

(c) Update any progress made in the level of learning achieved and add new rows to the ‘Describing and demonstrating personal learning’ column.