

Introduction

Jenny owns a nut and dried fruit shop. She often has leftover nuts and fruit when making mix nuts and fruit baskets. Jenny then decided to make a small and large nut bar to earn more extra money.

Jenny intends to sell \$25 small bar and \$22 for the large bar as a profit.

Now Jenny needs to find out if she will earn any profit by making the nut bars from the leftover ingredients.

Also need to investigate

- Jenny wants to find out the impact of the cost if she changes her prices, by swapping the cost around. Making the change to 35x and 25y
- Jenny wants to find out the impact on the profit made if she does not change her original prices for her bars
 - If she changes the available amount of her minimum requirement or maximum requirements
 - If she changes her amount of ingredients by decreasing one of her ingredient.

(A graphic calculator was used to assist in the investigations)

Table 1: Original data

Nut bars	Ingredients			
	Sultanas	Apricots	Nuts	
Small bar (x)	4	12	13	\$25
Large bar (y)	9	13	6	\$35
	No more than 36	No more than 78	No more than 78	

X is the ^{number of} price for the small bar and Y is the ^{number of} price for the large bar. The objective function is $(25x + 35y)$ dollars.

Objective function: $(25x + 35y)$ dollars

The objective function is the ^{maximum profit for selling the bars} amount of ingredients used to make the bars. By changing the prices to see out come with the new profit. The result will identify the

Mathematical Modelling and Problem-solving
Demonstrates attempted development of a mathematical model, as there is some confusion between selling the items and the profit made.

maximum new profit for the small bar and large bar. Also finding out what was wasted by changing the objective function.

Table 2: The constraints are the boundaries for the amount of ingredients in each two-size bar. The small bar and large bar must not have more than the amount given (sultana, apricots and nuts). Finding out what's available and the amount of ingredients used and wastage of the ingredients and profits made for the two sized bars.

Objective function: $25x+35y$

The constraints values	Re-order the constraints $y =$ to put into the graphic calculator
$x \geq 0$ $y \geq 0$ ✓	$x \geq 0$ $y \geq 0$
1. $4x+9y \leq 36$ ✓	1. $y \leq (36-4x) \div 9$ ✓
2. $12x+13y \leq 78$ ✓	2. $y \leq (78-12x) \div 13$ ✓
3. $13x+6y \leq 78$ ✓	3. $y \leq (78-13x) \div 6$ ✓

Mathematical Modelling and Problem-solving
Provides evidence of the use of linear programming techniques to develop a mathematical model which is appropriately implemented to find some solutions to the problem.

Table 3 To find out the viewed window for the minimum and maximum numbers to put it into the graphic calculator

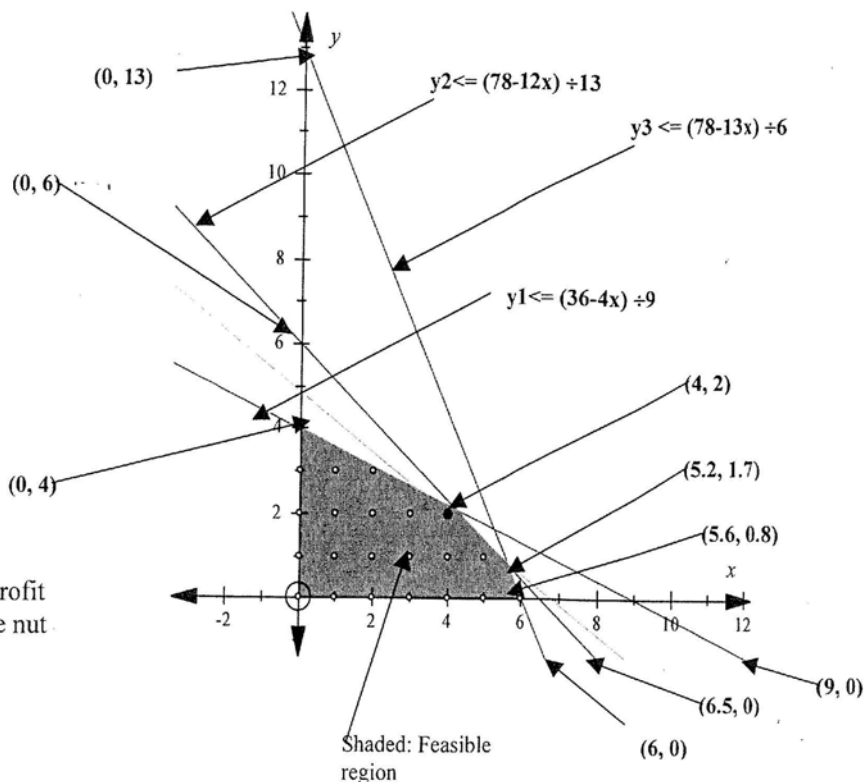
The findings them y intercept and x intercept		
	x	y
$y1 \leq (36-4x) \div 9$	0	4
	9	0
$y2 \leq (78-12x) \div 13$	0	6
	6.5	0
$y3 \leq (78-13x) \div 6$	0	13
	6	0
Min	0	0
Max	10	15

Original data
Graph: 1

$$\begin{aligned} x &\geq 0 \\ y &\geq 0 \\ 9y &\leq 36 - 4x \\ 13y &\leq 78 - 12x \\ 6y &\leq 78 - 13x \end{aligned}$$

Optimal solution
\$170
= 4x
= 2y

Meaning: jenny made \$170 profit
selling the 4 small and 2 large nut
bars.



Mathematical Knowledge and Skills and Their Application

Provides evidence of use of mathematical algorithms and techniques (graphed electronically) to support finding some correct solutions to a complex question.

Wastage: Original data

Saultana: $4x + 9y = 16 + 18$

= 34

2 grams of salut tanntanas was wasted

Apricots: $12x + 13y = 48 + 26$

= 74

4 grams of apricots was wasted

Nuts: $13x + 6y = 52 + 12$

= 64

36 grams of nuts was wasted.

As the results this shows that nuts has the larges wastage and saultana with the least wastage.

Change in objective function: graph 2

Objective function: $35x + 25y$

$$\begin{aligned} x &\geq 0 \\ y &\geq 0 \\ 9y &\leq 36 - 4x \\ 13y &\leq 78 - 12x \\ 6y &\leq 78 - 13x \end{aligned}$$

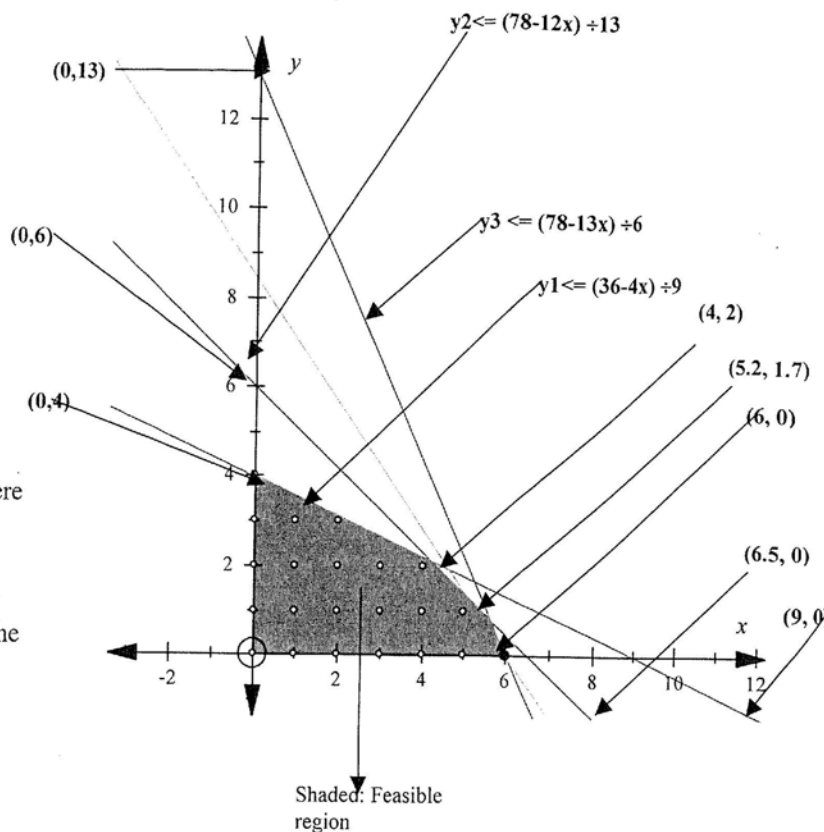
Optimum solution

\$210

$= 6x$

$= 0y$

Meaning: 6 small nut bars were sold and no large bar was brought. However, Jenny still made more profit by selling the small bar



Wastage: Change in objective function

$$\text{Saultana: } 4x6 + 9x0 = 24+0$$

$$= 24$$

12 grams of salut tanntanas was wasted

$$\text{Apricots: } 12x6 + 13x0 = 72+0$$

$$= 72$$

6 grams of apricots was wasted

$$\text{Nuts: } 13 \times 6 + 6 \times 0 = 78+0$$

$$= 78$$

No nuts was wasted.

As the result of chaging the price, this has affect the wastage significantly. This had been an increase of wastage in saultana and a slight increase in apricots. But the good thing is that there are no wastage in the nuts, which has been usedup compared to the oringal data..

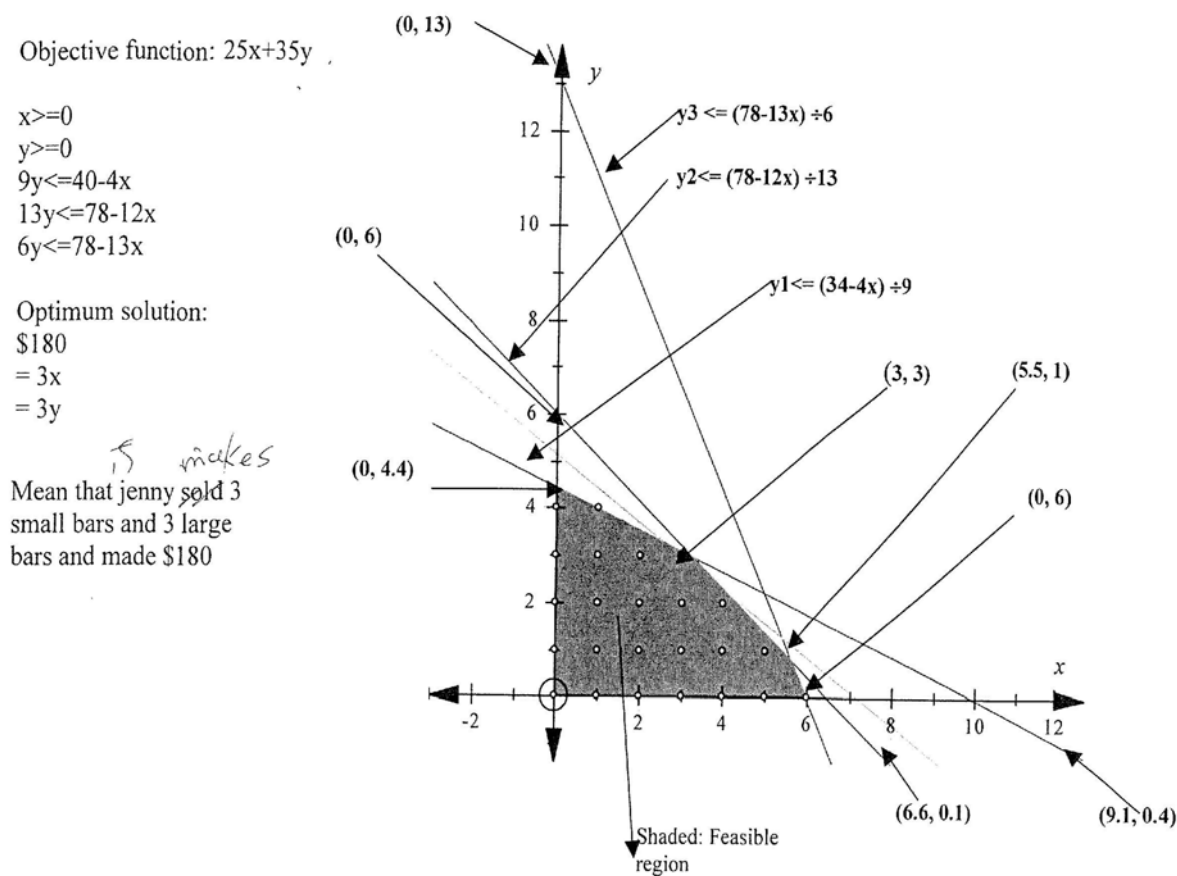
Mathematical Knowledge and Skills and Their Application

Demonstrates some application of knowledge and skills to find the wastage of each product, leading to mostly accurate and complete solutions to the problem.

Mathematical Modelling and Problem-solving

Provides evidence that points to attempted interpretation of the mathematical results in the context of the problem. The calculations for wastage are completed but little understanding of the purpose is evident.

Change in what available: graph 3



Objective function: $25x + 35y$

The constraints values	Re-order the constraints $y =$ to put into the graphic calculator
$x \geq 0$ $y \geq 0$	$x \geq 0$ $y \geq 0$
1. $4x + 9y \leq 40$ 2. $12x + 13y \leq 78$ 3. $13x + 6y \leq 78$	1. $y \leq (40 - 4x) \div 9$ 2. $y \leq (78 - 12x) \div 13$ 3. $y \leq (78 - 13x) \div 6$

Communication of Mathematical Information

The range of tables and graphs provides evidence of mostly accurate use of appropriate notation (e.g. mostly correct format of constraints), representations (e.g. graphs), and terminology (e.g. feasible region, objective function).

Wastage: Change in what available

$$\text{Saultana: } 4 \times 3 + 9 \times 3 = 12 + 27$$

$$= 39$$

An extra 2 gram of saultana was used. (over used)

$$\text{Apricots: } 12 \times 3 + 13 \times 3 = 36 + 39$$

$$= 75$$

3 grams of apricots was wasted

$$\text{Nuts: } 13 \times 3 + 6 \times 3 = 39 + 18$$

$$= 49$$

25 grams of nuts was wasted.

As the result of changing what available had a result of over use of saultana and a slight increase in apricots. However, there is still a significant wastage of nuts, even though the objective function pricing change sold the same amount, but had less profit in selling nut bars.

Change amount of ingredient: graph 4

Nut bars	Ingredients			
	Sultanas	Apricots	Nuts	
Small bar (x)	4	12	13	\$25
Large bar (y)	9	9	6	\$35
	No more than 36	No more than 78	No more than 78	

Objective function: $25x + 35y$

$$x \geq 0$$

$$y \geq 0$$

$$9y \leq 78 - 12x$$

$$13x \leq 78 - 12x$$

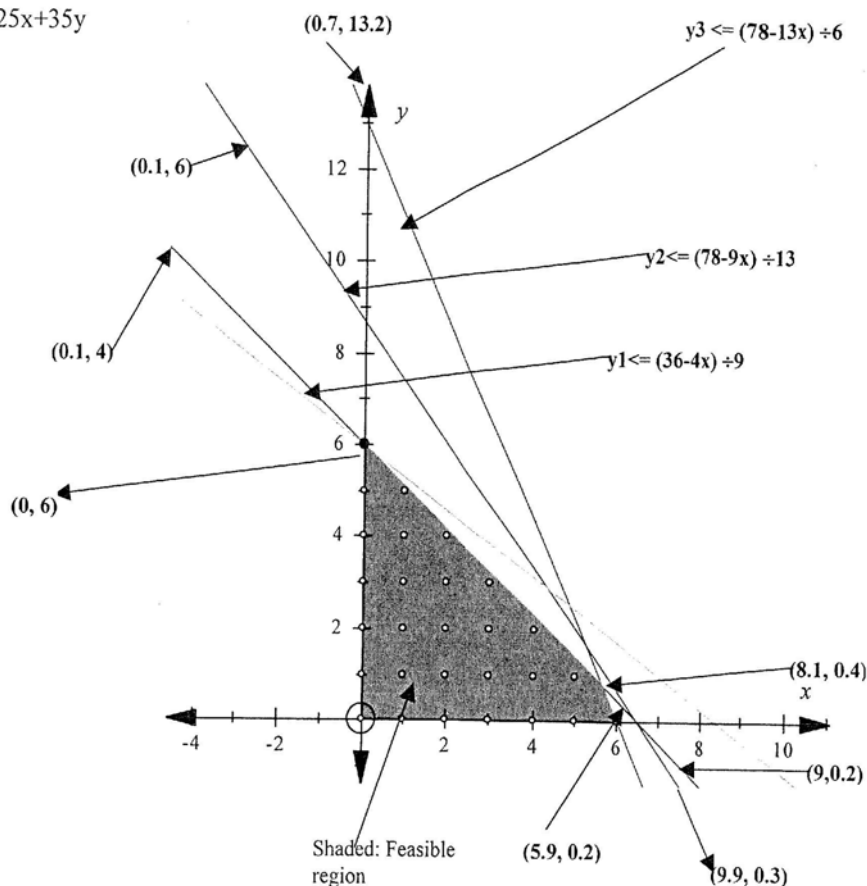
$$6y \leq 78 - 13x$$

Optimum solution:

\$210

$$= 0x$$

$$= 6y$$



Objective function: $25x + 35y$

The constraints values	Re-order the constraints $y =$ to put into the graphic calculator
$x \geq 0$ $y \geq 0$	$x \geq 0$ $y \geq 0$
4. $4x + 9y \leq 36$ 5. $9x + 13y \leq 78$ 6. $13x + 6y \leq 78$	4. $y \leq (36 - 4x) \div 9$ 5. $y \leq (78 - 9x) \div 13$ 6. $y \leq (78 - 13x) \div 6$

Mathematical Knowledge and Skills and Their Application

The changes made to the original problem provide evidence of generally competent knowledge of linear programming and understanding of associated relationships.

Wastage: Change amount of ingredient

$$\text{Saultana: } 4 \times 0 + 9 \times 6 = 0 + 54$$

$$= 54$$

An extra 18 gram of saultana was used. (over used)

$$\text{Apricots: } 12 \times 0 + 9 \times 6 = 0 + 54$$

$$= 54$$

24 grams of apricots was wasted

$$\text{Nuts: } 13 \times 0 + 6 \times 6 = 0 + 36$$

$$= 36$$

42 grams of nuts was wasted.

As the result of chaging the ingredients the investagtion shows over use of saultana and a major increase in apricots. However, there is still a significant wastage of nuts of 42 grams. This will be a very bad idea to used if jenny wannted to change her ingrdients.

Analysis/ discussion

Comparing the original data jenny ~~sold~~ 4 small bars and 2 large bars and made a profit of \$170, however by changing the objective function jenny ^{can} made more profit. However, jenny ~~sold~~ none large bars only 6 small bars, making a profit of \$210. In addition by changing the objective function $(35x+25y)$ jenny made more money. Looking on the bad side, the original data had a wastage of 34 out 36 for sultanas, 74 out of 78 for apricots and 68 out of 78 of nuts, wasting 10 grams of nuts, 2 grams of sultanas and 4 grams of apricots. Comparing to the change in objective function, jenny wasted 24 out of 36 for sultanas, 72/ 78 for apricots and no wastage of nuts which is a good thing meaning jenny wasted 11 grams of sultanas and 6 grams of apricots, altogether 17 grams of ingredient is wasted in change the objective function, although the original data wasted 10 grams of nuts but together it only wasted 16 grams of ingredients, that is 1 gram less from the objective function.

Mathematical Modelling and Problem-solving
Generally appropriate interpretation of the mathematical results in the context of the problem is evident as each scenario is investigated and summarised here. Wastage calculations are completed, but no interpretation is provided in the context of the problem.

By changing in what's available jenny ~~sold~~ 3 small bars and 3 large bars, making \$180 profit. The result shows that they all ~~sold~~ 6 bars each. However, by change what's available comparing to the original data jenny made \$20 dollars extra.

Looking at the wastage changing what's available she wasted 39/ 36 of sultanas, jenny has a result of ~~over using 2 grams of sultanas~~, 75/78 of apricots and a significant in nuts up to 36 grams.

Change amount of ingredient jenny made the same as the objective function \$210 but ~~selling~~ 6 large bars then small bars. By changing the ingredients jenny had a significant ~~over used~~ of sultans up to 18 grams that 54/36, and a significant wasted of 25 grams of apricots and a significant wasted in nuts up to 42 grams that's. Jenny should not change in what's available.

Conclusion:

In conclusion, Jenny wanted to find out the impact of the cost if she changes the objective function, in what's available and change in ingredients. She wants to find out the impact on the profit, if she chooses to making theses changes.

As the result of the original data and the objective function which has the most wastage but objective function made more money of \$210 compared to original data making only \$170, even though the change of ingredients made \$210 it has a significant wasted of ingredients. In changing what's available Jenny had an over used of sultanas and a lot of nuts that has been wasted but making only \$180.

However, if jenny had to pick there are 2 to choose from, original data or objective function. They both sell the same amount of bars, but original data sold small bars and large bar but making less profit, unlike objective function jenny only sold small bars but had no wastage in nuts but had more wastage in sultana and apricots.

Mathematical Modelling and Problem-solving

A comparison of amounts of wastage is indicative of some awareness of the reasonableness and possible limitations of the results.

Additional Comments

A review of the student's response provides evidence of:

Communication of Mathematical Information

- appropriate communication of mathematical ideas and reasoning to develop some logical arguments.

	Mathematical Knowledge and Skills and Their Application	Mathematical Modelling and Problem-solving	Communication of Mathematical Information
A	Comprehensive knowledge of content and understanding of concepts and relationships. Appropriate selection and use of mathematical algorithms and techniques (implemented electronically where appropriate) to find efficient solutions to complex questions. Highly effective and accurate application of knowledge and skills to answer questions set in applied and theoretical contexts.	Development and effective application of mathematical models. Complete, concise, and accurate solutions to mathematical problems set in applied and theoretical contexts. Concise interpretation of the mathematical results in the context of the problem. In-depth understanding of the reasonableness and possible limitations of the interpreted results, and recognition of assumptions made. Development and testing of reasonable conjectures.	Highly effective communication of mathematical ideas and reasoning to develop logical arguments. Proficient and accurate use of appropriate notation, representations, and terminology.
B	Some depth of knowledge of content and understanding of concepts and relationships. Use of mathematical algorithms and techniques (implemented electronically where appropriate) to find some correct solutions to complex questions. Accurate application of knowledge and skills to answer questions set in applied and theoretical contexts.	Attempted development and appropriate application of mathematical models. Mostly accurate and complete solutions to mathematical problems set in applied and theoretical contexts. Complete interpretation of the mathematical results in the context of the problem. Some depth of understanding of the reasonableness and possible limitations of the interpreted results, and recognition of assumptions made. Development and testing of some reasonable conjectures.	Effective communication of mathematical ideas and reasoning to develop mostly logical arguments. Mostly accurate use of appropriate notation, representations, and terminology.
C	Generally competent knowledge of content and understanding of concepts and relationships. Use of mathematical algorithms and techniques (implemented electronically where appropriate) to find mostly correct solutions to routine questions. Generally accurate application of knowledge and skills to answer questions set in applied and theoretical contexts.	Appropriate application of mathematical models. Some accurate and generally complete solutions to mathematical problems set in applied and theoretical contexts. Generally appropriate interpretation of the mathematical results in the context of the problem. Some understanding of the reasonableness and possible limitations of the interpreted results and some recognition of assumptions made. Development and testing of one or more reasonable conjectures.	Appropriate communication of mathematical ideas and reasoning to develop some logical arguments. Use of generally appropriate notation, representations, and terminology, with some inaccuracies.
D	Basic knowledge of content and some understanding of concepts and relationships. Some use of mathematical algorithms and techniques (implemented electronically where appropriate) to find some correct solutions to routine questions. Sometimes accurate application of knowledge and skills to answer questions set in applied or theoretical contexts.	Application of a mathematical model, with partial effectiveness. Partly accurate and generally incomplete solutions to mathematical problems set in applied or theoretical contexts. Attempted interpretation of the mathematical results in the context of the problem. Some awareness of the reasonableness and possible limitations of the interpreted results. Attempted development or testing a reasonable conjecture.	Some appropriate communication of mathematical ideas and reasoning. Some attempt to use appropriate notation, representations, and terminology, with occasional accuracy.
E	Limited knowledge of content. Attempted use of mathematical algorithms and techniques (implemented electronically where appropriate) to find limited correct solutions to routine questions. Attempted application of knowledge and skills to answer questions set in applied or theoretical contexts, with limited effectiveness.	Attempted application of a basic mathematical model. Limited accuracy in solutions to one or more mathematical problems set in applied or theoretical contexts. Limited attempt at interpretation of the mathematical results in the context of the problem. Limited awareness of the reasonableness and possible limitations of the results. Limited attempt to develop or test a conjecture.	Attempted communication of emerging mathematical ideas and reasoning. Limited attempt to use appropriate notation, representations, or terminology, and with limited accuracy.