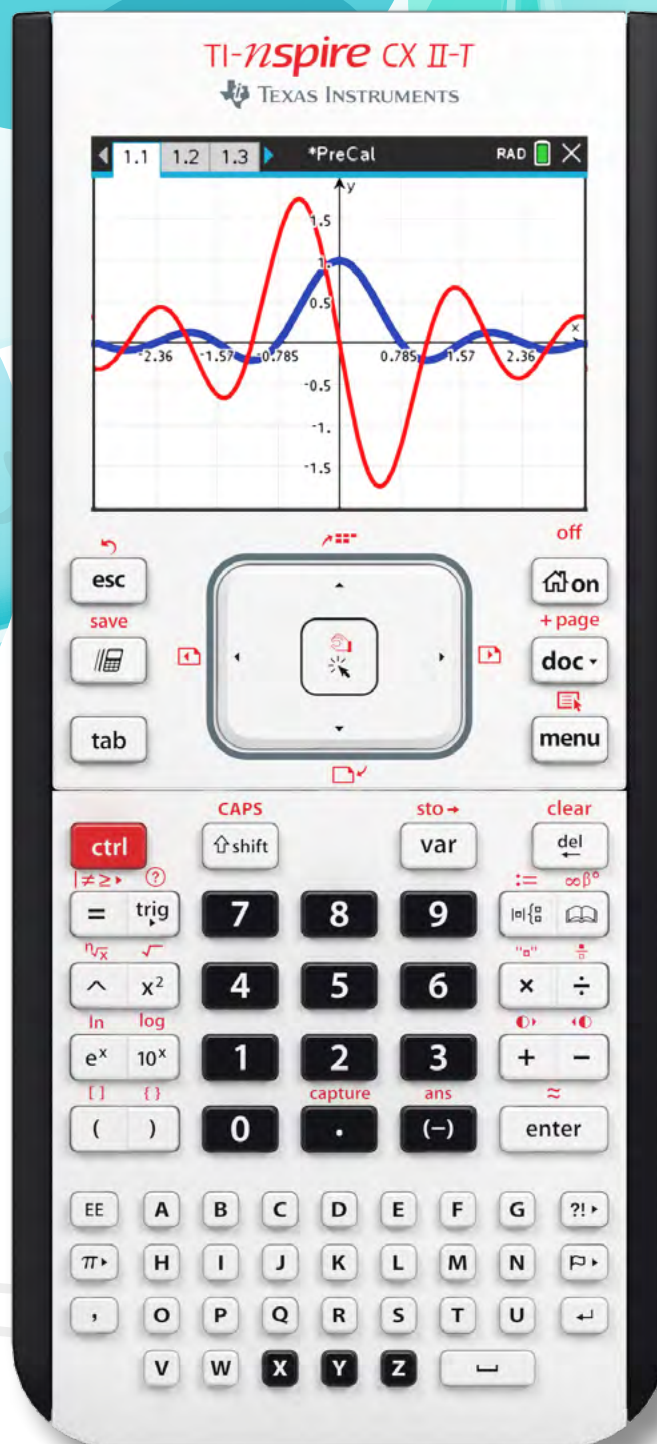


2025 QCE Mathematical Methods Examination 2 Solutions *with*

TI-Nspire CX II-T graphing calculator



Teachers Teaching with Technology™
Professional Development from Texas Instruments



For more QCE Resources, visit:
www.education.ti.com/aus/qld

LUI

--	--	--	--	--	--	--	--	--	--

School code

--	--	--	--

School name

--

Given name/s

--

Family name

--

Attach your
barcode/ID label here

Book

--

of

--

books used

External assessment 2025

Question and response book

Mathematical Methods

Paper 2 — Technology-active

Time allowed

- Perusal time — 5 minutes
- Working time — 90 minutes

General instructions

- Answer all questions in this question and response book.
- QCAA-approved calculator **permitted**.
- QCAA formula book provided.
- Planning paper will not be marked.

Section 1 (10 marks)

- 10 multiple choice questions

Section 2 (45 marks)

- 9 short response questions





DO NOT WRITE ON THIS PAGE

THIS PAGE WILL NOT BE MARKED



External assessment 2025

Multiple choice question book

Mathematical Methods

Paper 2 — Technology-active

General instruction

- Work in this book will not be marked.



Queensland
Government

QCAA

Queensland Curriculum
& Assessment Authority

Section 1

Instructions

- This section has 10 questions and is worth 10 marks.
- Use a 2B pencil to fill in the A, B, C or D answer bubble completely.
- Choose the best answer for Questions 1–10.
- If you change your mind or make a mistake, use an eraser to remove your response and fill in the new answer bubble completely.

	A	B	C	D
Example:	☒	☐	☐	☐

	A	B	C	D
1.	☐	☐	☐	☐
2.	☐	☐	☐	☐
3.	☐	☐	☐	☐
4.	☐	☐	☐	☐
5.	☐	☐	☐	☐
6.	☐	☐	☐	☐
7.	☐	☐	☐	☐
8.	☐	☐	☐	☐
9.	☐	☐	☐	☐
10.	☐	☐	☐	☐

Ensure you have filled an answer bubble for each question.

Do not write outside this box.

Section 1

Instruction

- Respond to these questions in the question and response book.
-

QUESTION 1

Determine $\int 10.4x^3 dx$

Find the indefinite integral using the power rule.

(A) $2.6x^4 + c$

(B) $6.4x^4 + c$

(C) $14.4x^4 + c$

(D) $41.6x^4 + c$

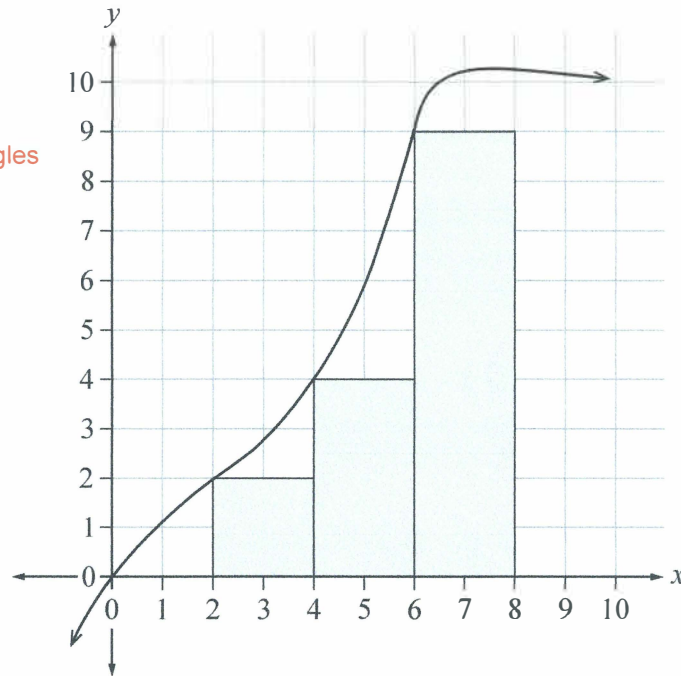
$$\begin{aligned}\int 10.4x^3 dx \\&= \frac{10.4}{4} x^4 + c \\&= 2.6x^4 + c\end{aligned}$$

QUESTION 2

Determine the **approximate area** (units²) between the curve and the x -axis for $0 \leq x \leq 8$ by calculating the area of the shaded rectangles.

Press ctrl menu to access | the 'with' or 'given' key.

Calculate the area of the 3 rectangles and add them together.



(A) 15

(B) 28

(C) 30

(D) 31

$$A = (4-2) \times 2 + (6-4) \times 4 + (8-6) \times 9 \\ = 30$$

1.1	MCQ2	RAD	X
$(4-2) \cdot 2 + (6-4) \cdot 4 + (8-6) \cdot 9$			30

QUESTION 3

The sample proportion is 0.6. $\hat{p} = 0.6$

A streaming service surveyed a random sample of 100 customers, and 60 customers said that they prefer to watch movies rather than miniseries.

Based on these results, the 95% confidence interval for the proportion of customers who prefer to watch movies was (0.5, 0.7).

Which statement shows the correct interpretation of this outcome?

If the survey was repeated 100 times, about 95 of the calculated intervals would contain the population proportion p .

- (A) The streaming service can be 95% confident that the proportion of customers who prefer to watch movies is between 50% and 70%.
- (B) There is a probability between 50% and 70% that most customers prefer to watch movies 95% of the time.
- (C) 60% of the sampled customers prefer to watch movies between 50% and 70% of the time.
- (D) 60 customers in the random sample prefer to watch movies 95% of the time.

QUESTION 4

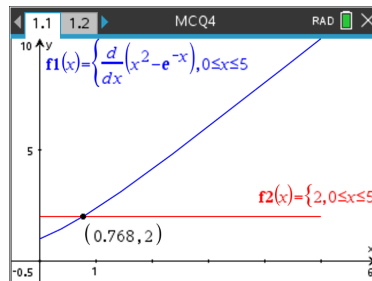
An object moves in a straight line such that its velocity (m s^{-1}) is given by $v(t) = t^2 - e^{-t}$ for $0 \leq t \leq 5$, where t represents time (s).

Determine the time, t , when the acceleration of the object is 2 m s^{-2} .

Numerical solve can be used as there is only one solution. It is best to solve graphically. The derivative of velocity is acceleration.

- (A) 0.768
- (B) 1.157
- (C) 3.865
- (D) 4.135

Solving $v'(t) = 2$ for t with $0 \leq t \leq 5$ gives $t = 0.768$ (s).



Press shift and then the subtraction key to access the derivative template. Press ctrl menu to access | the 'with' or 'given' key. Press menu > Analyse Graph > Intersection.



QUESTION 5

Which statement best describes a feature of the graph of the exponential function $y = e^x$, $x \in \mathbb{R}$?

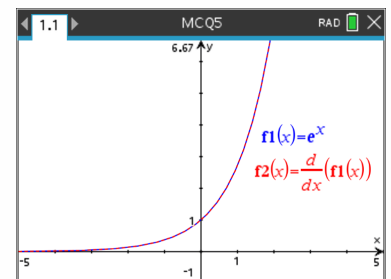
- (A) $\lim_{x \rightarrow \infty} (e^x) = e$

Evaluate each statement.

- (B) When $x = 0$, $y = e$

$\frac{d}{dx}(e^x) = e^x$ and so the gradient of the graph has the same value as the function at all points on the graph.

- (C) The graph has an asymptote with the equation $x = 0$



- (D) The gradient of the graph has the same value as the function at all points on the graph.

Note that: $\lim_{x \rightarrow \infty} (e^x) = \infty$ and hence not (A).

$e^0 = 1$ and so not (B).

The graph of $y = e^x$ has an asymptote with equation $y = 0$. Hence not (C).

QUESTION 6

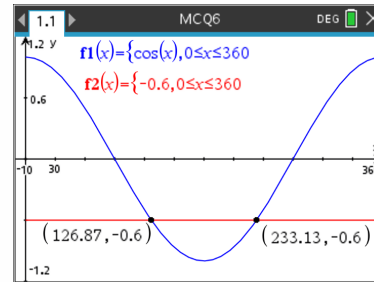
The two solutions must add to 360 degrees.
Change to DEG mode.

Solve the equation $\cos(\theta) = -0.6$ for $0^\circ \leq \theta \leq 360^\circ$

- (A) 53.13° and 126.87°
- (B) 53.13° and 233.13°
- (C) 126.87° and 306.87°
- (D) 126.87° and 233.13°

As $\cos \theta$ is negative,
the solutions will be
in the 2nd and 3rd
quadrants.

Press ctrl menu to access | the 'with' or 'given' key.
Press menu > Geometry > Points & Lines > Intersection Points.



QUESTION 7

An object starts from rest at the origin with acceleration (m s^{-2}) given by $a(t) = 16 - t^2 + t^3$ for $t \geq 0$, where t represents time (s).

Determine the displacement from the origin of the object 1.5 seconds after it starts moving.

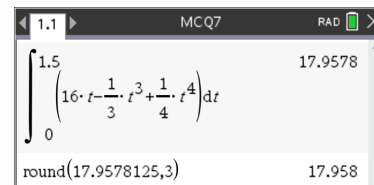
- (A) 7.0
- (B) 17.125
- (C) 17.958
- (D) 24.141

Integrate and use the initial condition to find $v(t)$.
The displacement from O can be evaluated using a definite integral.
Press shift and then the addition key to access the integral template.

$$\begin{aligned} v(t) &= \int a(t) dt \\ &= \int (16 - t^2 + t^3) dt \\ &= 16t - \frac{1}{3}t^3 + \frac{1}{4}t^4 + C \end{aligned}$$

When $t=0$, $v=0$ and so $C=0$.

$$s = \int_0^{1.5} (16t - \frac{1}{3}t^3 + \frac{1}{4}t^4) dt = 17.958 \text{ (m)}.$$



QUESTION 8

The table shows the probability distribution for a random variable X in a Bernoulli experiment. The random variable has only two possible values: 0 represents failure and 1 represents success.

x	0	1
$P(X = x)$	0.6	0.4

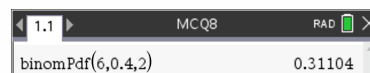
If six Bernoulli experiments are conducted, determine the probability of getting exactly two successes.

- (A) 0.138
- (B) 0.160
- (C) 0.311
- (D) 0.360

Press menu > Probability > Distributions > Binomial Pdf.

$$X \sim B(6, 0.4)$$

$$P(X=2) = 0.311$$



QUESTION 9

Determine the gradient of the normal line at the point.

Determine the gradient of the line perpendicular to the tangent to the graph of $y = \ln(4x)$ at the point $(0.8, 1.163)$.

(A) -1.25

(B) -0.80

(C) 0.80

(D) 1.25

Assign m as the gradient of the tangent.

Press shift and then the subtraction key to access the derivative template.

Press ctrl menu to access | the 'with' or 'given' key.

The gradient of the tangent to the curve at $x=0.8$ is $\frac{1}{0.8} = 1.25$.The gradient of the line $\perp$ to the tangent is $-\frac{1}{1.25} = -0.80$.

1.1	MCQ9	RAD	X
$m := \frac{d}{dx}(\ln(4 \cdot x)) _{x=0.8}$			1.25
$\frac{-1}{1.25}$			-0.8

QUESTION 10

The outside air temperature, $T(^{\circ}\text{C})$, on a particular day at a certain location is modelled by the function

$$T = 25 - 7 \cos\left(\frac{\pi t}{12}\right), 0 \leq t \leq 24,$$

where t is the time (hours) since 6:00 am.

The rate of change of temperature at 11:30 am is

Press shift and then the subtraction key to access the derivative template.

Press ctrl menu to access | the 'with' or 'given' key.

(A) 1.833

(B) 1.817

(C) 0.334

(D) 0.239

 $\frac{dT}{dt}$ when $t=5.5$ is
 $1.817^{\circ}\text{C/hr.}$

1.1	MCQ10	RAD	X
$\frac{d}{dt}\left(25 - 7 \cdot \cos\left(\frac{\pi \cdot t}{12}\right)\right) _{t=5.5}$			1.81692
round(1.8169176042099,3)			1.817



© State of Queensland (QCAA) 2025

Licence: <https://creativecommons.org/licenses/by/4.0> | Copyright notice: www.qcaa.qld.edu.au/copyright — lists the full terms and conditions, which specify certain exceptions to the licence. | Attribution: © State of Queensland (QCAA) 2025

Section 2

Instructions

- Write using black or blue pen.
 - Questions worth more than one mark require mathematical reasoning and/or working to be shown to support answers.
 - If you need more space for a response, use the additional pages at the back of this book.
 - On the additional pages, write the question number you are responding to.
 - Cancel any incorrect response by ruling a single diagonal line through your work.
 - Write the page number of your alternative/additional response, i.e. See page ...
 - If you do not do this, your original response will be marked.
 - This section has nine questions and is worth 45 marks.
-

DO NOT WRITE ON THIS PAGE

THIS PAGE WILL NOT BE MARKED

Do not write outside this box.

QUESTION 11 (6 marks)

It is a good idea to assign $f(x)$ with c and then again with c determined.

- a) Determine the equation of $f(x)$ if $f'(x) = \cos(x) - 4\sin(2x + \pi)$ and $f(\pi) = 2$.

[4 marks]

$$f(x) = \int (\cos(x) - 4\sin(2x + \pi)) dx$$

$$= \sin(x) + 2\cos(2x + \pi) + c$$

Handwritten solution for part a):

$$f(x) = \sin(x) + 2\cos(2x + \pi) + c$$

$$\text{nSolve}(f(\pi)=2, c)$$

$$f(\pi) = 2 \Rightarrow 2 = \sin(\pi) + 2\cos(3\pi) + c$$

$$2 = -2 + c \Rightarrow c = 4$$

$$\text{So } f(x) = \sin(x) + 2\cos(2x + \pi) + 4$$

- b) Use your result from Question 11a) to determine the value of x where $f(x) = 4.8$, for $2 \leq x \leq 4$.

Press menu > Analyse Graph > Intersection.

[1 mark]

Numerical solve can be used as there is only one solution. It is best to solve graphically. Press ctrl menu to access | the 'with' or 'given' key.

Solving $f(x) = 4.8$ for x

With $2 \leq x \leq 4$ gives $x = 2.3364$.

Handwritten solution for part b):

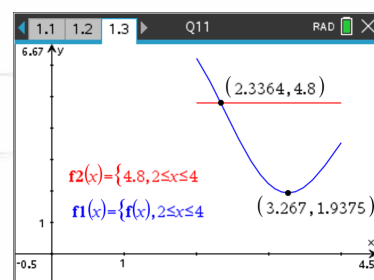
$$\text{nSolve}(f(x)=4.8, x) | 2 \leq x \leq 4$$

- c) Use your result from Question 11a) to determine the **minimum** value of $f(x)$, for $2 \leq x \leq 4$.

[1 mark]

Press menu > Analyse Graph > Minimum.

The minimum value of $f(x)$ is 1.9375.



Do not write outside this box.

QUESTION 12 (7 marks) It is a good idea to assign $p(t)$ with k and assign again with k determined in exact form.

A cockroach population is modelled by the function $P(t) = P_0 e^{kt}$, where P is the population after t weeks and k is a population constant. Initially, 100 cockroaches were counted. After three weeks, there were 120.

a) Determine the constant k .

[2 marks]

Numerical solve can be used as there is only one solution.

When $t=0$, $P=100$ and so $P_0=100$.

Hence $P(t) = 100 e^{kt}$.

TI-84 Plus calculator screen showing the assignment of $p(t) := 100 \cdot e^{k \cdot t}$ and the numerical solve for k using $nSolve(p(3)=120,k)$, resulting in 0.060774 . It also shows the assignment of $p(t) := 100 \cdot e^{\frac{1}{3} \cdot \ln(\frac{6}{5}) \cdot t}$.

Solving $p(3)=120$ for k gives

$$k = \frac{1}{3} \ln\left(\frac{6}{5}\right) \quad (k = 0.06077\dots)$$

$$\text{So } P(t) = 100 e^{\left(\frac{1}{3} \ln\left(\frac{6}{5}\right)\right)t}$$

b) Determine the function $P'(t)$. Use the chain rule.

[1 mark]

$$P'(t) = \frac{100}{3} \ln\left(\frac{6}{5}\right) e^{\left(\frac{1}{3} \ln\left(\frac{6}{5}\right)\right)t}$$

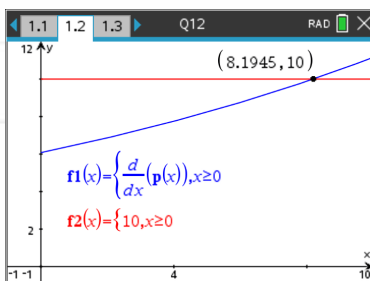
c) Determine when the rate of population growth would reach 10 cockroaches per week.

[1 mark]

Numerical solve can be used as there is only one solution. It is best to solve graphically.

Solving $P'(t)=10$ for t gives $t=8.1945$ weeks.

Press shift and then the subtraction key to access the derivative template. Press ctrl menu to access the 'with' or 'given' symbol.



TI-84 Plus calculator screen showing the numerical solve for the derivative using $nSolve\left(\frac{d}{dt}(p(t))=10,t\right)$, resulting in 8.19449 . It also shows the rounded value $\text{round}(8.194487142052,4)$ as 8.1945 .

Press menu > Analyse Graph > Intersection.

Do not write outside this box.

To decrease the growth rate of the cockroach population, a pest control treatment was trialled.
The new function to model the cockroach population t weeks after using the treatment is

$$I(t) = c \ln(t+8) + 172,$$

where c is a constant.

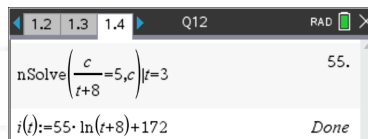
Three weeks after using the treatment, the rate of population growth was five cockroaches per week.

d) Determine the value of c .

Find $I'(t)$, then solve for c and assign $I(t)$.

[2 marks]

$$I'(t) = \frac{c}{t+8}$$



$nSolve\left(\frac{c}{t+8}-5,c\right)|t=3$ 55.
 $i(t):=55 \cdot \ln(t+8)+172$ Done

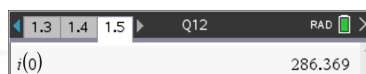
Solving $I'(3) = 5$ for c

give $c = 55$,

e) Determine the cockroach population when the treatment began.

[1 mark]

$$I(0) = 286.369...$$



$i(0)$ 286.369

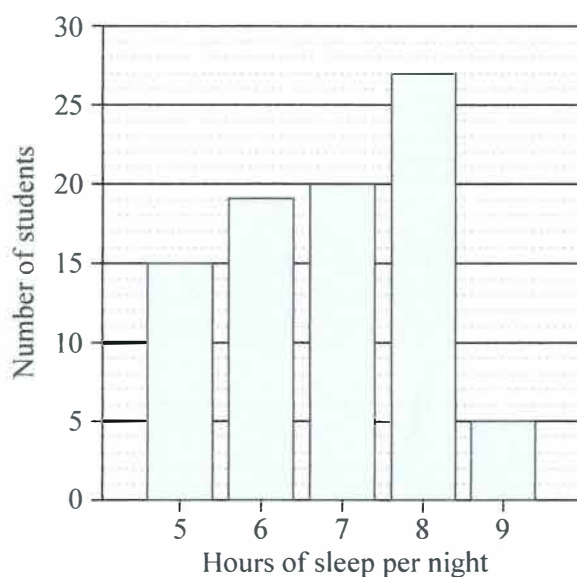
There are 286 cockroaches

when the treatment began.

Do not write outside this box.

QUESTION 13 (4 marks)

A school investigated how many hours students sleep per night. To obtain data, a random sample of students was surveyed. The results are shown.



- a) Use the data to determine the sample proportion of students who had seven or more hours of sleep per night.

[3 marks]

If desired, press ctrl enter to obtain a decimal value.

The number of students in the sample is

$$15 + 19 + 20 + 27 + 5 = 86$$

The number of students having 7 or more hours sleep is $20 + 27 + 5 = 52$.

The sample proportion of students who had more than 7 hours sleep is

$$\frac{52}{86} = 0.605$$

1.1	1.2	Q13	RAD	X
$20+27+5$			$\frac{26}{43}$	
$15+19+20+27+5$				
$20+27+5$			0.604651	
$15+19+20+27+5$				

- b) Use your result from Question 13a) to determine an 80% approximate confidence interval for the proportion of students who get seven or more hours of sleep per night.

[1 mark]

Press menu > Statistics > Confidence Intervals > 1-Prop z Interval.

The ~80% C.I. is (0.537, 0.672).

1.1	1.2	Q13	RAD	X
zInterval_1Prop 52,86,0.8: stat.results				
"Title"		"1-Prop z Interval"		
"CLower"		0.537085		
"CUpper"		0.672217		
"p"		0.604651		
"ME"		0.067566		
"n"		86.		

Do not write outside this box.

QUESTION 14 (6 marks)

The number of tourists visiting a country at any given time is modelled by

$$N(t) = 18000 \sin\left(\frac{\pi}{6}t + 6\right) + 22000, 0 \leq t \leq 12,$$

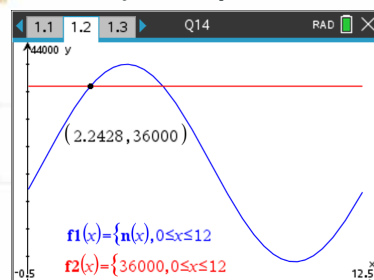
where t is the time (months) from the start of the year.

It is best to solve (a) graphically. Press ctrl menu to access | the 'with' or 'given' symbol. Press menu > Analyse Graph > Intersection.

- a) Determine when the number of tourists first reaches 36 000. Provide your response as a decimal number.

Solving $N(t) = 36000$ for t with $0 \leq t \leq 12$

gives $t = 2.2428$ months.



[1 mark]

- b) Determine the equation of the second derivative of $N(t)$.

[2 marks]

Differentiate twice using the chain rule.

$$N'(t) = 3000\pi \cos\left(\frac{\pi}{6}t + 6\right)$$

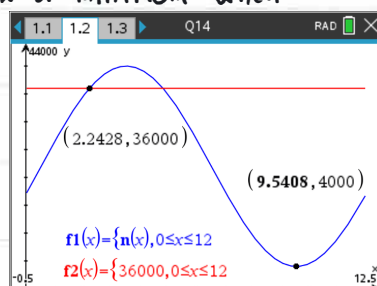
$$N''(t) = -500\pi^2 \sin\left(\frac{\pi}{6}t + 6\right)$$

- c) Determine the value of the second derivative when the number of tourists is a minimum. [2 marks]

The number of tourists is a minimum when

$t = 9.5408$ months.

$$N''(9.5408) = 4934.80$$



Press menu > Analyse Graph > Minimum. To store the t-coordinate at the minimum, press ctrl menu > Store and store as tmin. Press ctrl menu to access | the 'with' or 'given' symbol. Press var to access tmin.



- d) Use your result from Question 14c) to explain how the value of the second derivative is consistent with the number of tourists being a minimum.

[1 mark]

$$N''(t) = 4934.80 > 0$$

The positive value obtained is consistent

with the number of tourists being a minimum.

Do not write outside this box.

QUESTION 15 (3 marks)

A tour operator offers day cruises off the Queensland coast. They advertise that on any given day, customers have a 65% probability of seeing at least one whale.

The tour operator conducts cruises for 40 consecutive days.

Let X be the binomial random variable representing the outcome — success or failure — over the 40 days. A success is customers seeing at least one whale.

Calculate the probability that the number of days with a success will be within one standard deviation of the mean for X .

Press menu > Probability > Distributions > Binomial Cdf.

$$X \sim B(40, 0.65)$$

$$\begin{aligned}\mu &= 40 \times 0.65 \\ &= 26\end{aligned}$$

1.1	Q15	RAD	X
40	0.65	26.	
$\sqrt{40 \cdot 0.65 \cdot (1-0.65)}$		3.01662	
binomCdf(40,0.65,23,29)		0.754656	

$$\begin{aligned}\sigma &= \sqrt{40 \times 0.65 \times (1-0.65)} \\ &= 3.0166\end{aligned}$$

$$\text{So } P(23 \leq X \leq 29) = 0.7547.$$

Do not write outside this box.

QUESTION 16 (4 marks)

A species of fish is being raised in a fish pond. The number of fish, M , in the pond can be modelled by a function $M = 100b^t$, where t is the time (days) since the fish were initially introduced into the pond and b is a constant to be determined.

After seven days, there are 150 fish in the pond.

Find the rate of population growth when the pond contains five times the initial number of fish.

Assign $m(t)$ and $tval$ as shown.
Press shift and then the subtraction key to access the derivative template.
Press ctrl menu to access | the 'with' or 'given' symbol. Press var to access $tval$.

When $t=7$, $m=150$. So $150 = 100b^7$.

Hence $b = (1.5)^{1/7}$ and so $m = 100(1.5)^{\frac{1}{7}t}$.

Solving $100(1.5)^{\frac{1}{7}t} = 500$ for t gives

$t = 27.7855$ days.

$\frac{dm}{dt}$ at this time is 26.9618 fish per day

The calculator screen shows the following steps and results:

Expression	Result
$m(t) := 100 \cdot (1.5)^{\frac{t}{7}}$	Done
$tval := \text{nSolve}(m(t)=500, t)$	27.7855
$\frac{d}{dt}(m(t)) _{t=tval}$	28.9618

Do not write outside this box.

QUESTION 17 (4 marks)

The probability density function approximates the time (s) that people spend viewing a particular photo on a social media page.

$$p(t) = \begin{cases} k e^{-\frac{7t}{50}}, & 0 \leq t \leq 20 \\ 0, & \text{otherwise} \end{cases}$$

Determine the **mean** time people spend viewing the photo.

Press the catalog key and then 5 to access the 2-piece piecewise function template. Assign $p(t)$ and kc as shown. Press shift and then the addition key to access the integral template. Press ctrl menu to access | the 'with' or 'given' symbol. Press var to access kc .

Solving $\int_0^{20} k e^{-\frac{7}{50}t} dt = 1$ for k
gives $k = 0.1491$.

$$E(T) = \int_0^{20} k t e^{-\frac{7}{50}t} dt \text{ with } k = 0.1491$$
$$= 5.85 \text{ (s)}$$

TI-84 Plus calculator screen showing the definition of the piecewise function $p(t)$ and the calculation of k .

Line 1: $p(t) := \begin{cases} \frac{-7}{50} \cdot t \\ k e^{-\frac{7}{50} \cdot t}, 0 \leq t \leq 20 \\ 0, \text{Else} \end{cases}$

Line 2: $kc := \text{nSolve}\left(\int_0^{20} p(t) dt = 1, k\right)$ (Result: 0.149065)

Line 3: $\text{round}(0.1490646294522, 4)$ (Result: 0.1491)

TI-84 Plus calculator screen showing the calculation of the expected value $E(T)$.

Line 1: $\int_0^{20} (t \cdot p(t)) dt | k = kc$ (Result: 5.84791)

Line 2: $\text{round}(5.8479100782585, 2)$ (Result: 5.85)

Do not write outside this box.

QUESTION 18 (5 marks)

The results of an employee satisfaction survey of 500 employees at a large company are presented to board members.

The results include a 95% confidence interval for the proportion of satisfied employees. The lower end of the confidence interval is 0.648.

A board member would like to use the survey results to make the claim that the proportion of the satisfied employees in the entire company is larger than 75%.

Evaluate the reasonableness of the claim.

Assign the sample proportion as shown.
Press ctrl catalog to access the symbol.

The lower cut-off of the 95% C.I. is 0.648.

Solving $0.648 = \hat{p} - 1.96 \sqrt{\frac{\hat{p}(1-\hat{p})}{500}}$ for $\hat{p}$

gives $\hat{p} = 0.6886$.

Substituting $\hat{p} = 0.6886$ into $\hat{p} + 1.96 \sqrt{\frac{\hat{p}(1-\hat{p})}{500}}$

gives $0.6886 + 1.96 \sqrt{\frac{0.6886(1-0.6886)}{500}}$
 $= 0.729$

TI-84 Plus calculator screen showing the solution for the confidence interval. The screen displays the equation $\hat{p} - 1.96 \sqrt{\frac{\hat{p}(1-\hat{p})}{500}} = 0.648$ and the solution $\hat{p} = 0.68859$. Below this, it shows the upper bound calculation $\hat{p} + 1.96 \sqrt{\frac{\hat{p}(1-\hat{p})}{500}} = 0.72918$.

So the 95% C.I. is (0.648, 0.729).

The survey suggests we can be 95% confident that p is between 64.8% and 72.9%.

The claim of 75% for p is outside the 95% C.I. in the survey.
Hence the board member's claim is not reasonable.

Do not write outside this box.

QUESTION 19 (6 marks)

A scientist is gathering data on two species of horned beetle, species A and B. Horn length is a method of distinguishing the species.

Species A horn lengths are normally distributed with a mean of 20 mm and a standard deviation of 2 mm.

It is known that 14.6% of species B beetles have horns shorter than 18 mm.

In the particular population the scientist is studying, 30% of the beetles are species B and 70% are species A.

$$P(B) = 0.3$$

$$P(A) = 0.7$$

The scientist captures a beetle with a horn length shorter than 18 mm.

Determine the probability that the beetle is from species A.

Press menu > Probability > Distributions > Normal Cdf.

$$L_A \sim N(20, 2^2) \text{ and } P(L_A < 18) = 0.1587$$

1.1	Q19	RAD	X
p:=round(normCdf(-∞,18,20,2),4)		0.1587	
0.7 · p		0.717219	
0.7 · p + 0.3 · 0.146			

$$P(L_B < 18) = 0.146$$

$$P(A | L < 18) = \frac{P(A \cap L < 18)}{P(L < 18)}$$

$$= \frac{P(A) \times P(L_A < 18)}{P(A) \times P(L_A < 18) + P(B) \times P(L_B < 18)}$$

$$= \frac{0.7 \times 0.1587}{(0.7 \times 0.1587) + (0.3 \times 0.146)}$$

$$= 0.717$$

Do not write outside this box.