

Revision (GDC) [150 marks]

1. [Maximum mark: 6]

SPM.1.SL.TZ0.5

Professor Vinculum investigated the migration season of the Bulbul bird from their natural wetlands to a warmer climate.

He found that during the migration season their population, P could be modelled by

$$P = 1350 + 400(1.25)^{-t}, t \geq 0, \text{ where } t \text{ is the number of days since the start of the migration season.}$$

(a.i) Find the population of the Bulbul birds at the start of the migration season.

[1]

| |
|-----------------|
| Markscheme |
| 1750 <i>A1</i> |
| <i>[1 mark]</i> |

(a.ii) Find the population of the Bulbul birds after 5 days.

[2]

| |
|-------------------------------------|
| Markscheme |
| $1350 + 400(1.25)^{-5}$ <i>(M1)</i> |
| = 1480 <i>A1</i> |
| Note: Accept 1481. |
| <i>[2 marks]</i> |

(b) Calculate the time taken for the population to decrease below 1400.

[2]

| |
|--|
| Markscheme |
| $1400 = 1350 + 400(1.25)^{-t}$ <i>(M1)</i> |
| 9.32 (days (9.31885...)) (days) <i>A1</i> |
| <i>[2 marks]</i> |

(c) According to this model, find the smallest possible population of Bulbul birds during the migration season.

[1]

| |
|----------------|
| Markscheme |
| 1350 <i>A1</i> |

Note: Accept 1351 as a valid interpretation of the model as $P = 1350$ is an asymptote.

[1 mark]

2. [Maximum mark: 4]

SPM.1.SL.TZ0.8

The intensity level of sound, L measured in decibels (dB), is a function of the sound intensity, S watts per square metre (W m^{-2}). The intensity level is given by the following formula.

$$L = 10 \log_{10} (S \times 10^{12}), S \geq 0.$$

- (a) An orchestra has a sound intensity of $6.4 \times 10^{-3} \text{ W m}^{-2}$. Calculate the intensity level, L of the orchestra.

[2]

Markscheme

$$10 \log_{10} (6.4 \times 10^{-3} \times 10^{12}) \quad (M1)$$

$$= 98.1(\text{dB}) (98.06179\dots) \quad A1$$

[2 marks]

- (b) A rock concert has an intensity level of 112 dB. Find the sound intensity, S .

[2]

Markscheme

$$112 = 10 \log_{10} (S \times 10^{12}) \quad (M1)$$

$$0.158 (\text{W m}^{-2}) (0.158489\dots (\text{W m}^{-2})) \quad A1$$

[2 marks]

3. [Maximum mark: 6]

SPM.1.SL.TZ0.2

The Osaka Tigers basketball team play in a multilevel stadium.



The most expensive tickets are in the first row. The ticket price, in Yen (¥), for each row forms an arithmetic sequence. Prices for the first three rows are shown in the following table.

| Ticket pricing per game | |
|-------------------------|----------|
| 1st row | 6800 Yen |
| 2nd row | 6550 Yen |
| 3rd row | 6300 Yen |

- (a) Write down the value of the common difference, d [1]

| |
|-------------------------|
| Markscheme |
| $(d =) - 250$ A1 |
| [1 mark] |

- (b) Calculate the price of a ticket in the 16th row. [2]

| |
|--|
| Markscheme |
| $(u_{16} =) 6800 + (16 - 1)(-250)$ M1 |
| (¥)3050 A1 |
| [2 marks] |

- (c) Find the total cost of buying 2 tickets in each of the first 16 rows. [3]

| |
|--|
| Markscheme |
| $(S_{16} =) \left(\frac{16}{2}\right) (2 \times 6800 + (16 - 1)(-250)) \times 2$ M1M1 |
| Note: Award M1 for correct substitution into arithmetic series formula. Award M1 for multiplication by 2 seen. |

OR

$$(S_{16} =) \left(\frac{16}{2}\right) (6800 + 3050) \times 2 \quad M1M1$$

Note: Award **M1** for correct substitution into arithmetic series formula.
Award **M1** for multiplication by 2 seen.

(¥)158 000 (157 600) **A1**

[3 marks]

4. [Maximum mark: 17]

SPM.2.SL.TZ0.1

In this question, give all answers to two decimal places.

Bryan decides to purchase a new car with a price of €14 000, but cannot afford the full amount. The car dealership offers two options to finance a loan.

Finance option A:

A 6 year loan at a nominal annual interest rate of 14 % **compounded quarterly**. No deposit required and repayments are made each quarter.

(a.i) Find the repayment made each quarter.

[3]

Markscheme

$N = 24$
 $I \% = 14$
 $PV = -14000$
 $FV = 0$
 $P/Y = 4$
 $C/Y = 4 \quad (M1)(A1)$

Note: Award **M1** for an attempt to use a financial app in their technology, award **A1** for all entries correct.
Accept $PV = 14000$.

(€)871.82 **A1**

[3 marks]

(a.ii) Find the total amount paid for the car.

[2]

Markscheme

$4 \times 6 \times 871.82 \quad (M1)$

(€) 20923.68 **A1**

[2 marks]

(a.iii) Find the interest paid on the loan.

[2]

Markscheme

$20923.68 - 14000$ **(M1)**

(€) 6923.68 **A1**

[2 marks]

Finance option B:

A 6 year loan at a nominal annual interest rate of $r\%$ **compounded monthly**. Terms of the loan require a 10% deposit and monthly repayments of €250.

(b.i) Find the amount to be borrowed for this option.

[2]

Markscheme

$0.9 \times 14000 (= 14000 - 0.10 \times 14000)$ **M1**

(€) 12600.00 **A1**

[2 marks]

(b.ii) Find the annual interest rate, r .

[3]

Markscheme

$N = 72$

$PV = 12600$

$PMT = -250$

$FV = 0$

$P/Y = 12$

$C/Y = 12$ **(M1)(A1)**

Note: Award **M1** for an attempt to use a financial app in their technology, award **A1** for all entries correct.
Accept $PV = -12600$ provided $PMT = 250$.

12.56(%) **A1**

[3 marks]

(c) State which option Bryan should choose. Justify your answer.

[2]

Markscheme

EITHER

Bryan should choose Option A **A1**

no deposit is required **R1**

Note: Award **R1** for stating that no deposit is required. Award **A1** for the correct choice from that fact. Do not award **ROA1**.

OR

Bryan should choose Option B **A1**

cost of Option A (6923.69) > cost of Option B ($72 \times 250 - 12600 = 5400$) **R1**

Note: Award **R1** for a correct comparison of costs. Award **A1** for the correct choice from that comparison. Do not award **ROA1**.

[2 marks]

(d) Bryan's car depreciates at an annual rate of 25 % per year.

Find the value of Bryan's car six years after it is purchased.

[3]

Markscheme

$$14\,000 \left(1 - \frac{25}{100}\right)^6 \quad (M1)(A1)$$

Note: Award **M1** for substitution into compound interest formula. Award **A1** for correct substitutions.

$$= (\text{€})2491.70 \quad A1$$

OR

$$N = 6$$

$$I\% = -25$$

$$PV = \pm 14\,000$$

$$P/Y = 1$$

$$C/Y = 1 \quad (A1)(M1)$$

Note: Award **A1** for $PV = \pm 14\,000$, **M1** for other entries correct.

$$(\text{€})2491.70 \quad A1$$

[3 marks]

5. [Maximum mark: 6]

EXN.1.SL.TZ0.5

The pH of a solution is given by the formula $pH = -\log_{10} C$ where C is the hydrogen ion concentration in a solution, measured in moles per litre (Ml^{-1}).

(a) Find the pH value for a solution in which the hydrogen ion concentration is 5.2×10^{-8} . [2]

Markscheme

* This sample question was produced by experienced DP mathematics senior examiners to aid teachers in preparing for external assessment in the new MAA course. There may be minor differences in formatting compared to formal exam papers.

$$pH = -\log_{10}(5.2 \times 10^{-8}) = 7.29 \quad (7.28399\dots) \quad (M1)A1$$

[2 marks]

(b.i) Write an expression for C in terms of pH . [2]

Markscheme

$$C = 10^{-pH} \quad (M1)A1$$

Note: Award **M1** for an exponential equation with 10 as the base.

[2 marks]

(b.ii) Find the hydrogen ion concentration in a solution with pH 4.2. Give your answer in the form $a \times 10^k$ where $1 \leq a < 10$ and k is an integer. [2]

Markscheme

$$C = 10^{-4.2} = 6.30957\dots \times 10^{-5} \text{ (M1)}$$

$$6.31 \times 10^{-5} \text{ A1}$$

[2 marks]

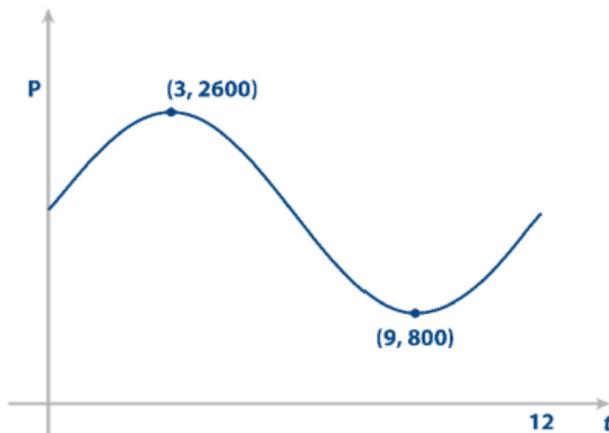
6. [Maximum mark: 7]

EXN.1.SL.TZ0.6

The size of the population (P) of migrating birds in a particular town can be approximately modelled by the equation $P = a \sin(bt) + c$, $a, b, c \in \mathbb{R}^+$, where t is measured in months from the time of the initial measurements.

In a 12 month period the maximum population is 2600 and occurs when $t = 3$ and the minimum population is 800 and occurs when $t = 9$.

This information is shown on the graph below.



(a.i) Find the value of a .

[2]

Markscheme

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$$\frac{2600-800}{2} = 900 \text{ (M1)A1}$$

[2 marks]

(a.ii) Find the value of b .

[2]

Markscheme

$$\frac{360}{12} = 30 \quad \text{(M1)A1}$$

Note: Accept $\frac{2\pi}{12} = 0.524$ (0.523598...).

[2 marks]

(a.iii) Find the value of c .

[1]

Markscheme

$$\frac{2600+800}{2} = 1700 \quad \text{A1}$$

[1 mark]

(b) Find the value of t at which the population first reaches 2200.

[2]

Markscheme

$$\text{Solve } 900 \sin(30t) + 1700 = 2200 \quad \text{(M1)}$$

$$t = 1.12 \text{ (1.12496...)} \quad \text{A1}$$

[2 marks]

7. [Maximum mark: 7]

EXN.1.SL.TZ0.9

Sophia pays \$200 into a bank account at the end of each month. The annual interest paid on money in the account is 3.1% which is compounded monthly.

(a) Find the value of her investment after a period of 5 years.

[3]

Markscheme

*This sample question was produced by experienced DP mathematics senior examiners to aid teachers in preparing for external assessment in the new MAA course. There may be minor differences in formatting compared to formal exam papers.

Number of time periods $12 \times 5 = 60$ (A1)

$N = 60$

$I\% = 3.1$

$PV = 0$

$PMT = 200$

$P/Y = 12$

$C/Y = 12$

Value (\$) 12,961.91 (M1)A1

[3 marks]

The average rate of inflation per year over the 5 years was 2%.

(b) Find an approximation for the real interest rate for the money invested in the account.

[2]

Markscheme

METHOD 1

Real interest rate = $3.1 - 2.0 = 1.1\%$ (M1)A1

METHOD 2

$\frac{1+0.031}{1+0.02} = 1.01078\dots$ (M1)

1.08% (accept 1.1%) A1

[2 marks]

(c) Hence find the real value of Sophia's investment at the end of 5 years.

[2]

Markscheme

$N = 60$

$I\% = 1.1$

$PV = 0$

PMT = 200
P/Y = 12
C/Y = 12
(\$12,300 (12,330.33...)) (M1)A1

Note: Award A1 for \$12,300 only.

[2 marks]

8. [Maximum mark: 6]

EXM.1.SL.TZ0.6

Yejin plans to retire at age 60. She wants to create an annuity fund, which will pay her a monthly allowance of \$4000 during her retirement. She wants to save enough money so that the payments last for 30 years. A financial advisor has told her that she can expect to earn 5% interest on her funds, compounded annually.

- (a) Calculate the amount Yejin needs to have saved into her annuity fund, in order to meet her retirement goal.

[3]

Markscheme

Use of finance solver M1

$N = 360, I = 5\%, \text{Pmt} = 4000, \text{FV} = 0, \text{PpY} = 12, \text{CpY} = 1$ A1

\$755000 (correct to 3 s.f.) A1

[3 marks]

- (b) Yejin has just turned 28 years old. She currently has no retirement savings. She wants to save part of her salary each month into her annuity fund.

Calculate the amount Yejin needs to save each month, to meet her retirement goal.

[3]

Markscheme

$N = 384, I = 5\%, \text{PV} = 0, \text{FV} = 754638, \text{PpY} = 12, \text{CpY} = 1$ M1A1

\$817 per month (correct to 3 s.f.) A1

[3 marks]

9. [Maximum mark: 15]

EXM.2.SL.TZ0.2

Sophie is planning to buy a house. She needs to take out a mortgage for \$120000. She is considering two possible options.

Option 1: Repay the mortgage over 20 years, at an annual interest rate of 5%, compounded annually.

Option 2: Pay \$1000 every month, at an annual interest rate of 6%, compounded annually, until the loan is fully repaid.

(a.i) Calculate the monthly repayment using option 1.

[2]

| |
|---|
| Markscheme |
| evidence of using Finance solver on GDC <i>M1</i> |
| Monthly payment = \$785 (\$784.60) <i>A1</i> |
| <i>[2 marks]</i> |

(a.ii) Calculate the total amount Sophie would pay, using option 1.

[2]

| |
|---|
| Markscheme |
| $240 \times 785 = \$188000$ <i>M1A1</i> |
| <i>[2 marks]</i> |

(b.i) Calculate the number of months it will take to repay the mortgage using option 2.

[3]

| |
|-----------------------------------|
| Markscheme |
| $N = 180.7$ <i>M1A1</i> |
| It will take 181 months <i>A1</i> |
| <i>[3 marks]</i> |

(b.ii) Calculate the total amount Sophie would pay, using option 2.

[2]

| |
|--|
| Markscheme |
| $181 \times 1000 = \$181000$ <i>M1A1</i> |
| <i>[2 marks]</i> |

Give a reason why Sophie might choose

(c.i) option 1.

[1]

Markscheme

The monthly repayment is lower, she might not be able to afford \$1000 per month. **R1**

[1 mark]

(c.ii) option 2.

[1]

Markscheme

the total amount to repay is lower. **R1**

[1 mark]

Sophie decides to choose option 1. At the end of 10 years, the interest rate is changed to 7%, compounded annually.

(d.i) Use your answer to part (a)(i) to calculate the amount remaining on her mortgage after the first 10 years.

[2]

Markscheme

\$74400 (accept \$74300) **M1A1**

[2 marks]

(d.ii) Hence calculate her monthly repayment for the final 10 years.

[2]

Markscheme

Use of finance solver with $N = 120$, $PV = \$74400$, $I = 7\%$ **A1**

\$855 (accept \$854 – \$856) **A1**

[2 marks]

10. [Maximum mark: 13]

EXM.2.SL.TZ0.3

Urvashi wants to model the height of a moving object. She collects the following data showing the height, h metres, of the object at time t seconds.

| | | | |
|---------------|----|----|----|
| t (seconds) | 2 | 5 | 7 |
| h (metres) | 34 | 38 | 24 |

She believes the height can be modeled by a quadratic function, $h(t) = at^2 + bt + c$, where $a, b, c \in \mathbb{R}$.

(a) Show that $4a + 2b + c = 34$.

[1]

Markscheme

$$t = 2, h = 34 \Rightarrow 34 = a2^2 + 2b + c \quad M1$$

$$\Rightarrow 34 = 4a + 2b + c \quad AG$$

[1 mark]

(b) Write down two more equations for a, b and c .

[3]

Markscheme

attempt to substitute either (5, 38) or (7, 24) *M1*

$$25a + 5b + c = 38 \quad A1$$

$$49a + 7b + c = 24 \quad A1$$

[3 marks]

(c) Solve this system of three equations to find the value of a, b and c .

[4]

Markscheme

$$a = -\frac{5}{3}, b = 13, c = \frac{44}{3} \quad M1A1A1A1$$

[3 marks]

Hence find

(d.i) when the height of the object is zero.

[3]

Markscheme

$$-\frac{5}{3}t^2 + 13t + \frac{44}{3} = 0 \quad M1$$

$$t = 8.8 \text{ seconds} \quad M1A1$$

[3 marks]

(d.ii) the maximum height of the object.

[2]

Markscheme

attempt to find maximum height, e.g. sketch of graph *M1*

$$h = 40.0 \text{ metres } \textit{A1}$$

[2 marks]

11. [Maximum mark: 11]

EXM.2.SL.TZ0.1

Paul wants to buy a car. He needs to take out a loan for \$7000. The car salesman offers him a loan with an interest rate of 8%, compounded annually. Paul considers two options to repay the loan.

Option 1: Pay \$200 each month, until the loan is fully repaid

Option 2: Make 24 equal monthly payments.

Use option 1 to calculate

(a.i) the number of months it will take for Paul to repay the loan.

[3]

Markscheme

evidence of using Finance solver on GDC *M1*

$$N = 39.8 \quad \textit{A1}$$

It will take 40 months *A1*

[3 marks]

(a.ii) the total amount that Paul has to pay.

[2]

Markscheme

$$40 \times 200 = \$8000 \quad \textit{M1A1}$$

[2 marks]

Use option 2 to calculate

(b.i) the amount Paul pays each month.

[2]

Markscheme

Monthly payment = \$316 (\$315.70) **M1A1**

[2 marks]

(b.ii) the total amount that Paul has to pay.

[2]

Markscheme

$24 \times 315.7 = \$7580$ (\$7576.80) **M1A1**

[2 marks]

Give a reason why Paul might choose

(c.i) option 1.

[1]

Markscheme

The monthly repayment is lower, he might not be able to afford \$316 per month. **R1**

[1 mark]

(c.ii) option 2.

[1]

Markscheme

the total amount to repay is lower. **R1**

[1 mark]

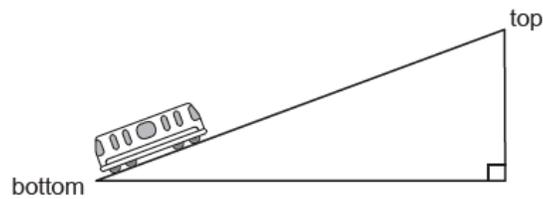
12. [Maximum mark: 4]

24N.1.SL.TZ1.1

One of the steepest train tracks in the world is in Tennessee, USA.

This track is 1.52 km long, and the angle of elevation from the bottom of the track to the top is 36.1° .

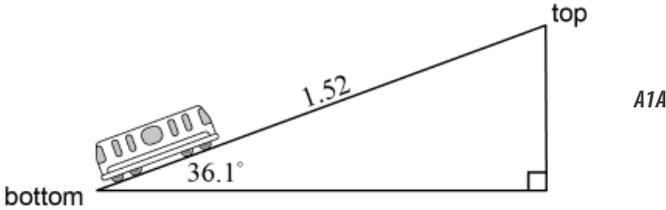
diagram not to scale



- (a) Label the diagram with the given values for the track length and the angle of elevation.

[2]

Markscheme



A1 for correct angle of elevation labelled as 36. 1

A1 for hypotenuse labelled as 1. 52 (km)

[2 marks]

- (b) Find the vertical change in height from the bottom of the track to the top.

[2]

Markscheme

$1.52 \times \sin 36.1^\circ$ (*A1*)

0. 896 (km) (0. 895578 ... (km), 896 m) *A1*

[2 marks]

13. [Maximum mark: 6]

24N.1.SL.TZ1.6

Radioactive carbon is a material that decays over time.

The mass, $m(t)$ (in nanograms), of radioactive carbon in a fossil of a plant, after t years, can be modelled by the function

$$m(t) = 120e^{-0.000121t}$$

where t is the time since the plant died.

- (a) Write down the initial mass of the radioactive carbon.

[1]

Markscheme

120 (ng) *A1*

Note: Only accept an exact answer of 120.

[1 mark]

- (b) Find the mass of the radioactive carbon after 20 000 years.

[2]

Markscheme

$$(m(20000) =) 120e^{-0.000121 \times 20000} \quad (M1)$$

$$10.7 \quad (10.6705 \dots) \text{ (ng)} \quad A1$$

[2 marks]

- (c) Calculate the smallest number of complete years it takes for more than half the sample to decay.

[3]

Markscheme

attempt to write or solve an inequality (or equality) with a value of 60 seen *(M1)*

$$(m(t) =) 120e^{-0.000121t} \leq 60 \quad \text{OR sketch} \quad \text{OR table of values}$$

$$(t >) 5728.489 \dots \quad (A1)$$

$$5729 \text{ (years)} \quad A1$$

Note: Do not accept 5728 or 5730 for the final *A1*.

[3 marks]

14. [Maximum mark: 6]

24N.1.SL.TZ1.10

When Humberto retires, he invests \$300 000 in an annuity fund that earns interest at a nominal rate of 3.8% per year, compounded monthly.

Humberto then withdraws \$2800 at the end of every month to pay for his living expenses.

- (a) Find how much is in the annuity fund after 8 years.

[3]

Markscheme

$$N = 96, I = 3.8, PV = +300\,000, PMT = -2800, P/Y = 12, C/Y = 12 \quad (M1) \\ (A1)$$

Note: Award *M1* for use of Finance solver with any 2 entries correct. Award *A1* for all correct.

$$FV = \$92\,800 \quad (\$92\,828.2\dots) \quad A1$$

[3 marks]

(b) Calculate how many times Humberto is able to make these withdrawals.

[3]

Markscheme

$$I = 3.8, PV = +300\,000, PMT = -2800, FV = 0, P/Y = 12, C/Y = 12 \\ (A1)(A1)$$

Note: Award *A1* for $FV = 0$, award *A1* for all correct.

$$N = 131 \text{ (months)} \quad A1$$

[3 marks]

15. [Maximum mark: 7]

24N.1.AHL.TZ0.8

The amount of daylight, L (in hours), in London in 2024 can be modelled by

$$L = a \sin (b(t - c)) + d,$$

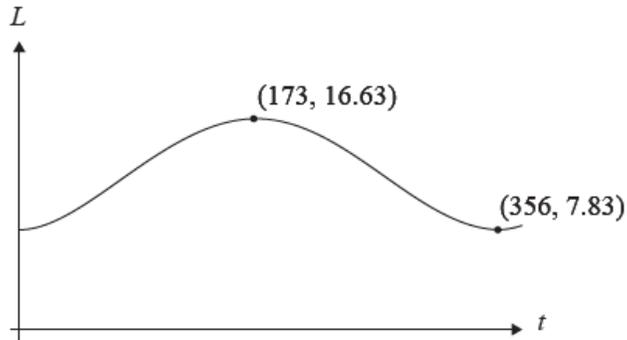
where $a, b, c, d > 0$ and t is the day of the year.

For example, day 1 = 1 January, day 2 = 2 January, and so on.

The maximum value of L is 16.63 hours on day 173 (21 June 2024).

The minimum value of L is 7.83 hours on day 356 (21 December 2024).

This information is shown in the following diagram.



Find the value of

- (a) d [2]

Markscheme

$$d = \frac{16.63+7.83}{2} \quad (A1)$$

$$(d =) 12.2 \quad (12.23) \quad A1$$

[2 marks]

- (b) a [1]

Markscheme

$$(a =) 4.4 \quad A1$$

[1 mark]

- (c) b [2]

Markscheme

$$\text{period} = 2(356 - 173) \quad (= 366) \quad (A1)$$

$$(b =) \frac{2\pi}{366} = \frac{\pi}{183} \quad (= 0.0171671\dots) \quad (\text{Accept } b = \frac{360}{366} \quad (= 0.983606\dots)) \quad A1$$

[2 marks]

- (d) c . [2]

Markscheme

EITHER

attempt to find midpoint of x values of max and min (M1)

$$c = \frac{-10+173}{2}$$

OR

substitute values and solve (M1)

$$b(173 - c) = \frac{\pi}{2} \text{ OR } 16.63 = 4.4 \sin(b(173 - c)) + 12.23$$

THEN

$$(c =) 81.5 \quad A1$$

Note: Accept other possible positive values of $c = 81.5 + 366n$.

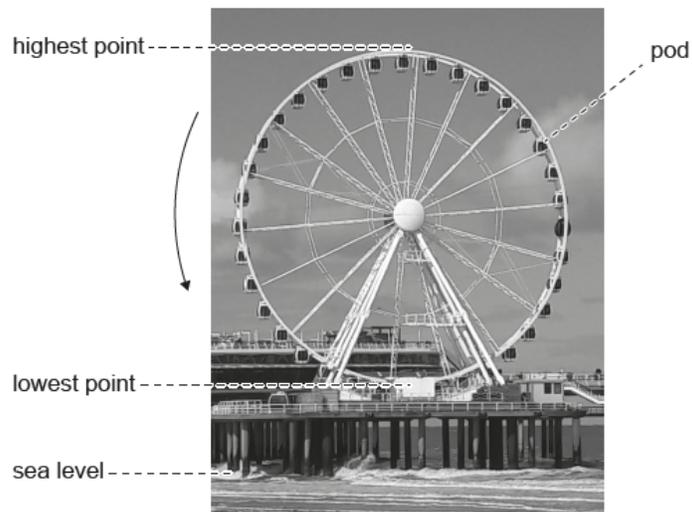
FT from their *//c//* consistent with their *//a//*.

[2 marks]

16. [Maximum mark: 16]

24N.2.SL.TZ1.2

The Scheveningen Ferris wheel's lowest point is 8 m above sea level, and its highest point is 45 m above sea level.



(a.i) Show that the radius of the Ferris wheel is 18.5 m.

[1]

Markscheme

$$\frac{45-8}{2} \quad A1$$

$$18.5 \text{ (m)} \quad AG$$

Note: Use of 18.5 in the calculation is reverse engineering, and falls short of the demand of the command term 'Show that'. In such cases, award **A0**.

[1 mark]

(a.ii) Calculate the circumference of the Ferris wheel.

[1]

Markscheme

$$(2\pi \times 18.5 =) 116 \quad (116.2389 \dots, 37\pi) \text{ (m)}. \quad A1$$

[1 mark]

There are pods, equally spaced around the wheel, that carry passengers.

(b) When the wheel rotates 10° , find the distance that a pod travels along the circumference.

[3]

Markscheme

recognition the distance is the arc length *(M1)*

$$\frac{10^\circ}{360^\circ} \times 2\pi \times 18.5 \quad \text{OR} \quad \frac{116.2389 \dots}{36} \quad (A1)$$

$$= 3.23 \quad \left(3.228859 \dots, \frac{37\pi}{36} \right) \text{ (m)} \quad A1$$

[3 marks]

The height in metres, above sea level, of a particular pod is modelled by the function:

$$h(t) = a \sin(bt) + d, \text{ for } a, b > 0,$$

where t is the time, measured in minutes.

The wheel takes 15 minutes to complete 1 revolution.

(c.i) Find the value of b .

[1]

Markscheme

$$\left(b = \frac{360}{15} = \right) 24 \quad A1$$

[1 mark]

(c.ii) Find the value of d .

[2]

Markscheme

$$\frac{\text{max}+\text{min}}{2} \quad (A1)$$

$$(d =) \frac{45+8}{2} \quad \text{OR} \quad 45 - 18.5 \quad \text{OR} \quad 8 + 18.5$$

$$= 26.5 \quad A1$$

[2 marks]

(c.iii) Hence, write down the equation of the sinusoidal model.

[2]

Markscheme

$$h(t) = 18.5 \sin(24t) + 26.5 \quad A1A1$$

Note: Award **A1** for 18.5 seen as parameter a , **A1** for a completely correct equation (including LHS).

[2 marks]

(d) Use the model to find the values of t when the height of this pod is **33 m** above sea level for $0 \leq t \leq 15$.

[3]

Markscheme

attempt to equate **33** with $h(t)$ **OR** sketch graph of curve and line **(M1)**

$$h(t) (= 18.5 \sin(24t) + 26.5) = 33$$

$$t = 0.857 \quad (0.857083 \dots) \quad \text{and} \quad t = 6.64 \quad (6.64291 \dots) \quad (\text{minutes}) \quad A1A1$$

[3 marks]

Since the Ferris wheel opened, it has been operating for **3000** days, and each day it rotates nonstop for **8** hours.

(e) Calculate the total number of revolutions that the Ferris wheel has made. Give your answer in the form $a \times 10^k$ where $1 \leq a < 10$ and k is an integer.

[3]

Markscheme

4 (revolutions per hour) seen **OR** 32 (revolutions per day) seen (A1)

$(4 \times 8 \times 3000 =) 96000$ (A1)

9.6×10^4 A1

[3 marks]

17. [Maximum mark: 6]

24M.1.SL.TZ1.5

Maan deposited \$100 000 into a savings account with a nominal annual interest rate of $I\%$ **compounded monthly**. At the end of the eighth year, the amount in the account had increased to \$150 000.

(a) Find the value of I .

[3]

Markscheme

EITHER

$$N = 96$$

$$PV = \mp 100\,000$$

$$FV = \pm 150\,000$$

$$P/Y = 12$$

$$C/Y = 12 \quad (M1)(A1)$$

OR

$$N = 8$$

$$PV = \mp 100\,000$$

$$FV = \pm 150\,000$$

$$P/Y = 1$$

$$C/Y = 12 \quad (M1)(A1)$$

OR

$$150\,000 = 100\,000 \left(1 + \frac{I}{100 \times 12}\right)^{12 \times 8}$$

Note: Award M1 for an attempt to use a financial app (at least 3 entries, not necessarily correct) or an attempt to use a compound interest formula.

Award A1 for all entries correct in financial app or correct substitution in compound interest formula.

THEN

$$I = 5.08 \text{ (5.07903 ...)} \quad A1$$

[3 marks]

Maan withdraws the \$150 000 and places it in an annuity, earning a nominal annual interest rate of 6.1% compounded monthly. At the end of each month, Maan will receive a payment of \$1000.

- (b) Find the amount of money remaining in the annuity at the end of 10 years. Express your answer to the nearest dollar.

[3]

Markscheme

$$N = 120$$

$$I\% = 6.1$$

$$PV = \mp 150000$$

$$PMT = \pm 1000$$

$$P/Y = 12$$

$$C/Y = 12 \quad (M1)(A1)$$

Note: Award *M1* for an attempt to use a financial app (at least 3 entries, not necessarily correct). Award *A1* for all entries correct in financial app (condone missing $-/+$ sign if the correct final answer is seen).

$$FV = (\$)110867 \quad A1$$

Note: Answer must be correct to nearest dollar to award the final *A1*. Award *(M1)(A1)A0* for an unsupported final answer to a greater degree of accuracy eg. $(\$)110866.70\dots$

Award *M1A1A0* for a truncated answer of 110866 if no working is shown.

[3 marks]

18. [Maximum mark: 7]

24M.1.SL.TZ1.3

On 1 January 2025, the Faber Car Company will release a new car to global markets. The company expects to sell 40 cars in January 2025. The number of cars sold each month can be modelled by a geometric sequence where $r = 1.1$.

- (a) Use this model to find the number of cars that will be sold in December 2025.

[2]

Markscheme

attempt to substitute into geometric sequence formula for twelfth term **OR** at least three correct terms of the sequence **(M1)**

$$u_{12} = 40 \times 1.1^{12-1} \text{ OR } 40, 44, 48.4 \dots$$

$$114 \text{ (114. 124...)} \quad \mathbf{A1}$$

[2 marks]

(b) Use this model to find the total number of cars that will be sold in the year

(b.i) 2025.

[2]

Markscheme

attempt to substitute into geometric series formula **OR** a sum of at least the first three terms **(M1)**

$$S_{12} = \frac{40(1.1^{12}-1)}{1.1-1} \text{ OR } \sum_1^{12} (40 \times 1.1^{n-1}) \text{ OR } 40 + 44 + 48.4 + \dots$$

Note: Award **M1** for $u_1 = 40$ and $r = 1.1$ seen as part of a geometric series formula, or **M1** for sigma notation and their u_n formula (condone missing limits), or **M1** for the sum of at least the **correct** first three terms of the sequence.

$$S_{12} = 855 \text{ (855. 371...)} \quad \mathbf{A1}$$

[2 marks]

(b.ii) 2026.

[3]

Markscheme

finding $S_{24} = 3539.89 \dots$ or attempt to find the sum between u_{13} and u_{24} **(M1)**

Note: Award **M1** for $S_{24} = 3539.89 \dots$ or sigma notation that includes correct limits and their u_n formula or a substituted geometric series formula that includes $125.537 \dots$ and $n = 12$ or a list of terms that includes at least the 13th term and the 24th term.

$$3539.89 \dots - 855.371 \dots \text{ OR } \sum_{13}^{24} (40 \times 1.1^{n-1}) \text{ OR}$$

$$(S_{13 \text{ to } 24} =) \frac{125.537 \dots (1.1^{12} - 1)}{1.1 - 1} \quad \text{OR} \quad 125.537 + \dots + 358.172 \dots \quad (A1)$$

Note: Accept a calculation using $u_{13} = 125$ or 126 .

2680 (2684.52 . . . , 2684, 2685) *A1*

Note: For $u_{13} = 125$, the sum is 2673.03 . . . and for $u_{13} = 126$, the sum is 2694.41 . . .

[3 marks]