FORM 5
CHAPTER 8

Self Test 1

1 (a) What is the value of *t* if Sudin and Ibrahim are at the same distance from toll plaza *A*?
(b) **Assumptions**: Sudin and Ibrahim travel at a constant speed throughout the journey.
Sudin and Ibrahim did not stop throughout the journey.
Variables: Travelling time, *t*, distance of cars from toll plaza *A*, the speed of Sudin's and Ibrahim's cars

2 (a) Linear function
(b) Quadratic function
(c) Exponential function

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1. **Identifying and defining the problems**	• The time Madam Chin departs from her house to reach the office 10 minutes earlier. • Madam Chin needs to reach the office at 8.50 a.m.
2. **Making assumptions and identifying variables**	• **Assumptions:** Speed remains at 75 km/h No unusual traffic jams • **Variables:** Duration of the travelling time, distance between the house and the office, average speed of the car
3. **Applying mathematics to solve problems**	Use the formula: Average speed = $\frac{\text{Total distance}}{\text{Total time}}$ Total time, $t = \frac{25\text{ km}}{L}$ $= \frac{25\text{ km}}{75\text{ km/h}}$ $= \frac{1}{3}\text{h}$ $= \frac{1}{3} \times 60$ minutes = 20 minutes 0850 hours – 20 minutes = 0830 hours
4. **Verifying and interpreting solutions in the context of the problem**	This model, $t = \frac{25}{L}$ may not be used to represent the actual situation. Factors such as traffic jams due to heavy vehicles or traffic light malfunction causes different travel durations from the time obtained from this formula. The formula is suitable as reference only to estimate the travelling time.
5. **Refining the mathematical model**	We cannot refine the model because the information provided is limited. This problem is affected by various uncontrollable external factors such as heavy vehicles that slow down the journey or traffic light malfunctions.
6. **Reporting the findings**	Report the findings of the problem solving based on the interpretation of solutions as shown in the preceding sections.

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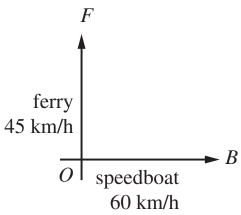
1. **Identifying and defining the problems**	• The rate of change in distance between a ferry and a speedboat.
2. **Making assumptions and identifying variables**	• **Assumptions:** The speed of ferry and speedboat are remained at 45 km/h and 60 km/h respectively. The route of ferry and speedboat remained unchanged. • **Variables:** Travelling duration, *t*, the rate of change of distance between ferry and speedboat, speed of ferry and speedboat

<table>
<tr><td>3. Applying mathematics to solve problems</td><td>

Travelling distance = speed × time
$OB = 60t$
$OF = 45t$
$FB = \sqrt{(60t)^2 + (45t)^2}$
$= \sqrt{5\,625t^2}$
$= 75t$
Rate of change in distance of $FB = \dfrac{75t}{t}$ km/h
= 75 km/h</td></tr>
<tr><td>4. Verifying and interpreting solutions in the context of the problem</td><td>This model may not be used to represent the actual situation. The speed of ferry and speedboat may vary throughout the movement due to seawater resistance. The direction of movement may be deflected from the original path.</td></tr>
<tr><td>5. Refining the mathematical model</td><td>We cannot refine the model because the information provided is limited.</td></tr>
<tr><td>6. Reporting the findings</td><td>Report the findings of the problem solving based on the interpretation of solutions as shown in the preceding sections.</td></tr>
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1. **Identifying and defining the problems**	• What is the minimum dividend received by Puan Sofia? • Let the lowest dividend rate = 5.2%
2. **Making assumptions and identifying variables**	• **Assumptions:** The minimum dividend rate is 5.2% Puan Sofia does not withdraw any EPF money during those 5 years after her retirement. • **Variables:** number of years, dividend received

3. **Applying mathematics to solve problems**

Year	Principal (RM)	Dividend received (RM)	Principal + Dividend (RM)	Total EPF (RM)
1	450k	450k × 0.052	450k + 450k × 0.052	450k(1 + 0.052)
2	450k(1 + 0.052)	450k(1 + 0.052) × 0.052	450k(1 + 0.052) + 450k(1 + 0.052) × 0.052	$450k(1 + 0.052)^2$
3	$450k(1+ 0.052)^2$	$450k(1 + 0.052)^2 \times 0.052$	$450k(1 + 0.052)^2$ + $450k(1 + 0.052)^2 \times 0.052$	$450k(1 + 0.052)^3$

4. **Verifying and interpreting solutions in the context of the problem**	Based on the table, it is found that the total amount of EPF at the end of each year form a pattern which can be represented by the following exponential function. $A(t) = P(1 + r)^t$ such that $A(t)$ is the total amount of EPF at t-th year.. $A(5) = 450\,000(1 + 0.052)^5$ = RM579 817.36
5. **Refining the mathematical model**	This model does not need to be refined if it is only used to estimate the total amount of EPF because the dividend rate may differ from 5.2%.
6. **Reporting the findings**	A full report is written following the above modelling framework structure.

SPM PRACTICE

Paper 1

1 A
2 D
3 A
4 B
5 B

Paper 2

Section A

1 P : Making assumptions and identifying variables
Q : Applying mathematics to solve problems
R : Verifying and interpreting solutions in the context of the problem
S : Reporting the findings

2 (a) Determine the duration of the phone call.
(b) **Assumptions:** Call rate does not change
Variables: Call rate, total call charges, duration of phone call

3 (a) $103 = P + 74(0.73)^0$
$P = 103 - 74$
$= 29$
(b) $T = 29 + 74(0.73)^{10}$
$= 29 + 3.18$
$= 32.18°C$

Section B

4 (a) $t = 0$ represents the time at 10.30 a.m., the time Mazni puts the chicken wings into the oven.
(b) If t is sufficiently large, this model represents the final temperature of chicken wings that has achieved the heat equilibrium with the temperature of oven, $S(t) = 170°C$.

(c) When $t \to \infty$, the temperature of chicken wings, $S(\infty) = 170$

$a - b(0.93)^{\infty} = 170$

$a = 170$

When $t = 0$, the temperature of chicken wings, $S(0) = 25$

$170 - b(0.93)^0 = 25$

$b = 170 - 25$

$= 145$

(d) 1105 hours – 1030 hours = 35 minutes

$S(35) = 170 - 145(0.93)^{35}$

$= 158.56°C$

(e) Use table

Time, t (minutes)	Temperature, $S(t)$ (°C)
40	162.04
42	163.12
44	164.05
46	164.85
47	165.21

47 minutes

1030 hours + 47 minutes = 1117 hours

Mazni will smell the burning odour at 11.17 a.m.

5 (a)

Days	Total running distance(km)
1	2.0
2	2.5
3	3.0
4	3.5
5	4.0

(b) Linear function.

$D_1 = 2 \qquad = 2 + 0(0.5)$

$D_2 = 2 + 0.5 \qquad = 2 + 1(0.5)$

$D_3 = 2 + 0.5 + 0.5 \qquad = 2 + 2(0.5)$

$D_4 = 2 + 0.5 + 0.5 + 0.5 \qquad = 2 + 3(0.5)$

$D_5 = 2 + 0.5 + 0.5 + 0.5 + 0.5 \qquad = 2 + 4(0.5)$

$D_n = 2 + (n - 1)(0.5)$

$= 2 + 0.5n - 0.5$

$= 1.5 + 0.5n,\ n = 1, 2, 3, \ldots$

(c) Suresh's stamina is tough enough to run 500 m more than the previous day every day.

(d) $J_n = 20$

$1.5 + 0.5n = 20$

$0.5n = 20 - 1.5$

$n = 37$ days

Suresh can run 20 km for the first time on 37th day.

(e) $1.5 + 0.5n = 22$

$0.5n = 22 - 1.5$

$n = 41$

41 + 14 = 55 days < 2 months

Suresh is ready in terms of fitness to participate in the 20 km run. After two weeks, he still has 5 days before the race.

Section C

6 (a) (i) $2(x + y) = 260$

$x + y = 130$

$y = 130 - x$

$A = xy$

$= x(130 - x)$

$= 130x - x^2$

(ii) $A = 4\,225 \text{ m}^2$

$130x - x^2 = 4\,225$

$x^2 - 130x + 4\,225 = 0$

$(x - 65)(x - 65) = 0$

$x = 65$

$y = 130 - 65$

$= 65$

The maximum number of campsite plots $= 65 \div 5$

$= 13$

(b) Contractor A:

Installation cost = RM550 + 260 × RM2.50

= RM550 + RM650

= RM1 200

Contractor B:

Installation cost = 260 × RM3.50

= RM910

Contractor B should be chosen because his installation cost is lower.

(c) Principal = (RM150 000 – RM50 000) × 80%

= RM80 000

Compounding frequency $= 12 \div 4$

$= 3$

Total savings after 5 years $= P\left(1 + \frac{r}{n}\right)^{nt}$

$= \text{RM}80\,000\left(1 + \frac{0.03}{3}\right)^{3(5)}$

$= \text{RM}80\,000(1.01)^{15}$

= RM92 877.52

7 (a) Total sales revenue, R

= number of baby car seat units sold, J × selling price

$= (70\,000 - 200h)h$

$= 70\,000h - 200h^2$

Total production cost, K

= 675 000 + 110 × number of baby car seats units sold, J

$= 675\,000 + 110 \times (70\,000 - 200h)$

$= 675\,000 + 7\,700\,000 - 22\,000h$

$= 8\,375\,000 - 22\,000h$

(b) Profit from the sales of baby car seats, P

= Total sales revenue – total production cost

$= 70\,000h - 200h^2 - (8\,375\,000 - 22\,000h)$

$= -200h^2 + 92\,000h - 8\,375\,000$

(c) Sketch the graph of profit from the sale of baby car seats, P

$a = -200,\ b = 92\,000,\ c = -8\,375\,000$

Axis of symmetry, $h = -\frac{b}{2a}$

$= -\frac{92\,000}{2(-200)}$

$= -\frac{92\,000}{-400}$

$= 230$

Corresponding profit, P

$= -200(230)^2 + 92\,000(230) - 8\,375\,000$

$= 2\,205\,000$

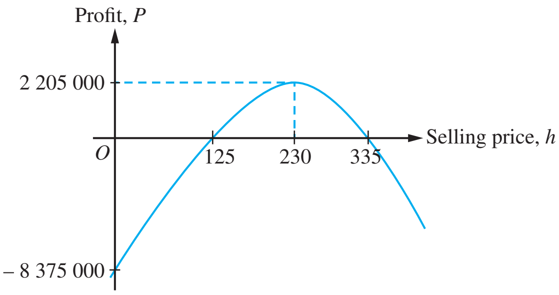
At h-axis $= 0$

$-200h^2 + 92\,000h - 8\,375\,000 = 0$

$h^2 - 460h + 41\,875 = 0$

$(h - 125)(h - 335) = 0$

$h = 125$ or 335



(d) The roots of this function in the real world represent the selling price of the baby car seat which makes the profit of the company becomes zero.

(e) Selling price of each baby car seat to obtain the maximum profit
= Value of h when the value of function is maximum
= RM230

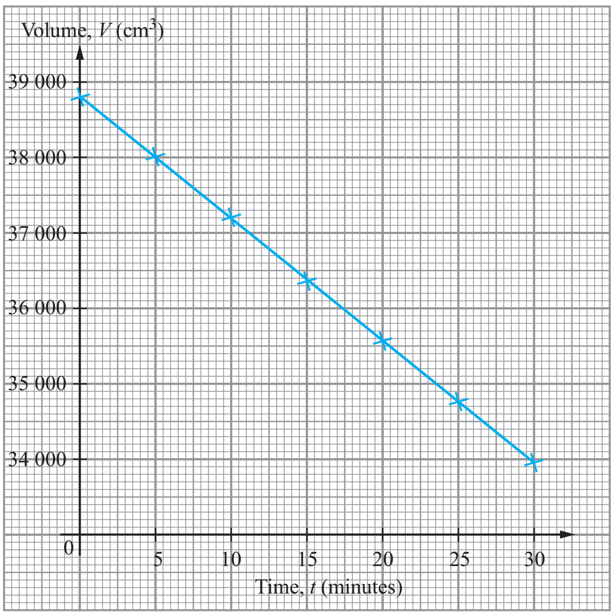
(f) (i) Number of units sold, $J = 70\,000 - 200(230)$
$= 24\,000$

(ii) Total sales revenue, $R = 70\,000(230) - 200(230)^2$
$=$ RM5 520 000

(iii) Total production cost, $K = 8\,375\,000 - 22\,000(230)$
$=$ RM3 315 000

(iv) Total profit from the sales of baby car seats, P
$= R - K$
= RM5 520 000 – RM3 315 000
= RM2 205 000

8 (a)



(b) $m = -\dfrac{38\,808 - 33\,960}{0 - 30}$

$= \dfrac{4\,848}{-30}$

$= -161.6$

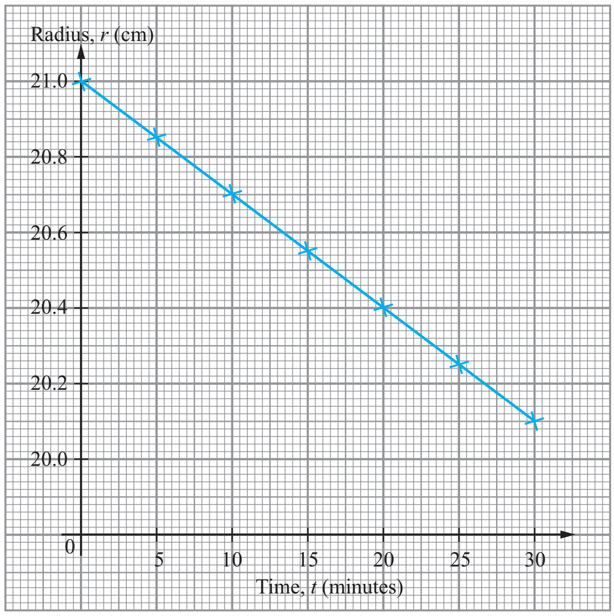
$V = -161.6t + 38\,808$

(c) **Assumptions**: The leaking rate of balloon is consistent.

(d)

Time, *t* (minutes)	0	5	10	15	20	25	30
Radius of balloon, *r* (cm)	21.00	20.85	20.70	20.55	20.40	20.24	20.09

(e)



$m = -\dfrac{21.00 - 20.09}{0 - 30}$

$= \dfrac{0.91}{-30}$

$= -\dfrac{91}{3\,000}$ or -0.03

$r = 21 - \dfrac{91}{3\,000}t$ or $21 - 0.03t$

r is a linear function.