Name:	School:	Target Grade:

PARADIGM

MOCK O LEVEL PAPER 2023
SECONDARY

READ THESE INSTRUCTIONS FIRST

INSTRUCTIONS TO CANDIDATES

1. Find a nice comfortable spot without distraction.

2. Be fully focused for the whole duration of the test.

3. Speed is KING. Finish the paper as soon as possible then return-back to Check Your Answers.

4. As you are checking your answers, always find ways to VALIDATE your answer.

5. Avoid looking through line by line as usually you will not be able to see your Blind Spot.

6. If there is no alternative method, cover your answer and REDO the question.

7. Give non-exact answers to 3 significant figures, or 1 decimal place for angles in degree, or 2 decimal place for $$$, unless a different level of accuracy is specified in the question.

Wish you guys all the best in this test.

You can do it.

I believe in you.

Team Paradigm

PARADIGM [Turn Over]

MATHEMATICAL FORMULAE

Compound Interest

$$Total\ Amount = P(1 + \frac{r}{100})^n$$

Mensuration

Curved surface area of a cone = πrl

Surface area of a sphere = $4\pi^2$

Volume of a cone = $\frac{1}{3}\pi r^2 h$

Volume of a sphere = $\frac{4}{3}\pi r^3$

Area of triangle ABC = $\frac{1}{2}absinC$

Arc length = $r\theta$, where θ is in radians

Sector area = $\frac{1}{2}r^2\theta$, where θ is in radians

Trigonometry

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$a^2 = b^2 + c^2 - 2bc\cos A$$

Statistics

Mean = $\frac{\sum fx}{\sum f}$

Standard Deviation = $\sqrt{\frac{\sum fx^2}{\sum f} - (\frac{\sum fx}{\sum f})^2}$

E Maths O Level Mock Paper 2023

1	**[Algebra]** **(a)** Solve the inequality $\frac{3-x}{5} < 1 + \frac{2x+1}{4}$. **(b)** Express as a single fraction in its simplest form $\frac{4y}{3-2y} - \frac{y}{(2y-3)^2}$. **(c)** Simplify $\frac{(-3h)^2}{8h^3j^5} \div \frac{27h^4j^2}{4j^3}$. **(d)** Simplify $\left(\frac{256p^{16}}{q^{20}r^{-4}}\right)^{-\frac{1}{4}}$. **(e)** Solve the equation $\frac{10}{x^2-9} - \frac{3}{x+3} = 1$.	[2] [2] [2] [2] [2]
2	**[HCF & LCM]** Written as a product of its prime factors, $264 = 2^3 \times 3 \times 11$ and $1980 = 2^2 \times 3^2 \times 5 \times 11$. (a) $1980k$ is a perfect cube. Find the smallest possible value of k, leaving your answer in index notation. The highest common factor and the lowest common multiple of 264, 1980 and *A* are 12 and 59400 respectively. (b) Find the largest possible value of *A*.	 [2] [2]
3	**[Maps and Scale]** A map of Thailand has a scale of 1 : 500 000. (a) The length of the river Kwai on the map is 76 cm. Calculate the actual length, in kilometres, of the river Kwai. (b) The area of Thailand is 513 120 km^2. Calculate the area, in square centimetres, of Thailand on the map. Leave your answer in standard form, correct to 4 significant figures.	 [2] [2]
4	**[Proportions]** (a) The radius of the base of a cylinder was increased by 30% and its height was decreased by 30%. Find the percentage change, if any, in its volume. (b) It is given that y is inversely proportional to x^2. Find the percentage decrease in y when x is increased by 150%.	 [2] [2]

5	**[Number Patterns]** The first four terms in a sequence of numbers are given below. $$T_1 = 2^2 + 5 = 9$$ $$T_2 = 4^2 + 3 = 19$$ $$T_3 = 6^2 + 1 = 37$$ $$T_4 = 8^2 - 1 = 63$$ **(a)** Find T_5. **(b)** Explain why the value of T_n must be odd for all values of *n*. **(c)** Show that the nth term of sequence, T_n is given by $4n^2 - 2n + 7$. **(d)** $T_k \; and \; T_{k+1}$ are consecutives terms on the sequence. Find and simplify an expression, in term of *k*, for $T_{k+1} - T_k$. **(e)** Explain why two consecutive terms of the sequence cannot have a difference of 6.	[2] [2] [2] [2] [2]
6	**[Finance]** Dr. Ng invested \$8000 in a savings account with Bank A. The savings account pays *R*% interest per annum, compounded half yearly. At the end of 2 years, the interest earned was \$96.43. (a) Calculate the value of *R*. To purchase a washing machine, Jamie had to pay a deposit of 15 % of the cash price. The hire-purchase price of the washing machine is \$2106 which comprises the deposit plus 12 equal monthly payments of \$153. (b) Find the cash price of the washing machine.	[2] [2]
7	**[Quadratic Equation]** Derrick and Elle went on a cycling expedition using different routes. Derrick travelled by route A, which is 115 km long, at an average speed of x km/h. Meanwhile Elle travelled by route *B*, which is 5 km shorter, but has more challenging terrain. She covered the distance at an average speed that was slower than Derrick by 3 km/h. **(a)** Write down an expression, in terms of x for the time taken by Derrick. **(b)** Write down an expression, in terms of x for the time taken by Elle. **(c)** Given that Derrick waited 40 minutes before Elle arrived at the same destination, form an equation and show that it reduces to $$2x^2 + 9x - 1035 = 0$$ **(d)** Solve the equation $2x^2 + 9x - 1035 = 0$, giving both answers correct to 2 decimal places. **(e)** Explain why one of the solutions in part (**d**) must be rejected. **(f)** Hence, calculate the total time taken by the two cyclists.	[1] [1] [2] [2] [1] [1]

8 **[Coordinate Geometry]**

The variables x and y are connected by the equation $y = \frac{x}{5}(4 + 4x - x^2)$.
Some corresponding values of x and y correct to 1 decimal place, are given below.

x	-2	-1	-0.5	0	1	2	3	4	5
y	3.2	0.2	p	0	1.4	3.2	4.2	3.2	-1

(a) Find the value of p. [1]

(b) On the grid given, using an appropriate scale, draw the graph for $y = \frac{x}{5}(4 + 4x - x^2)$ for $-2 \leq x \leq 5$. [3]

(c) Use your graph to write an inequality in x to describe the range of values where $y > 3$. [1]

(d) By drawing a tangent, estimate the gradient of the curve when $x = -1$. [1]

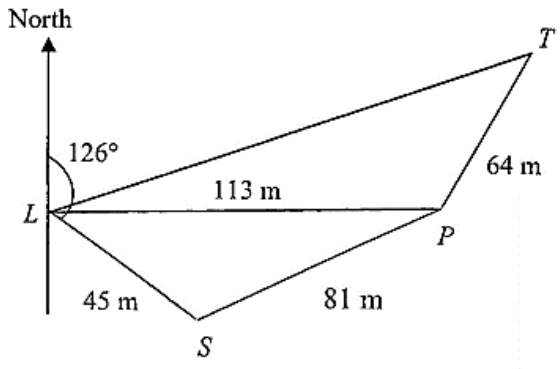
(e) The equation $4x + 4x^2 - x^3 = 20$ only has only 2 solutions for $-2 \leq x \leq 5$. Explain how this can be seen from your graph. [1]

(f) (i) On the same grid, draw the graph $2y + x = 4$ for $-2 \leq x \leq 5$. [2]
(ii) Write down the x-coordinates of the points when the line & curve intersect. [2]
(iii) The value of x obtained in **(f)(ii)** are solutions of the equation

$$2x^3 + Ax^2 + Bx + 40 = 0.$$

Determine the values of A and B.

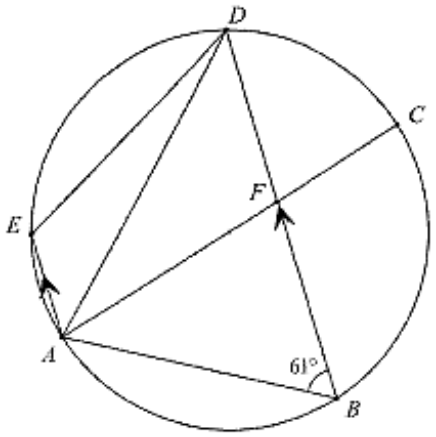
9 **[Trigonometry]**



A pirate ship, P, is 113 m due east of the lighthouse L. It is detected by a coast guard S which is 45 m away and at a bearing of 126° from L. The distance between the pirate ship and the coast guard is 81 m.
Find
(a) the bearing of the pirate ship from the coast guard. [2]
An island T is located at a bearing of 015° from P and the distance PT is 64 m.
Find
(b) the length of LT, [2]
(c) the area of ΔPLT. [2]
(d) A helicopter is flying at a constant height of 85 m along a straight path above LT. Find the greatest angle of depression of the pirate ship from the helicopter. [2]

10 **[Circles]**

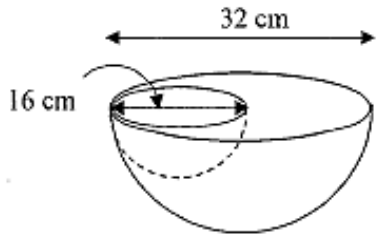
A, B, C, D and E lie on a circle. AC is a diameter of the circle and AE is parallel to BD. F is the point of intersection of AC and BD and angle $ABF = 61°$. Find,



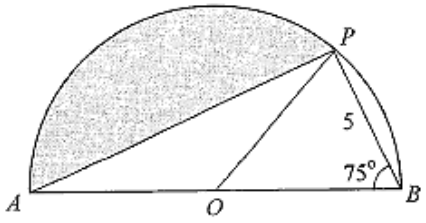
(a) angle ABC, [2]
(b) angle CBD, [2]
(c) angle CAD, [2]
(d) angle AED. [2]

11 **[Mensuration & Arc Sector]**

(a)



The diagram shows an ornament made up of a hemispherical block of wood of diameter 32 cm, that has a smaller hemispherical block of diameter 16 cm, carved out of it.
(i) Calculate the surface area of the ornament, leaving your answer in terms of π.
(ii) Calculate the volume of the ornament. [2]
(b) [3]



The figure shows a semicircle with centre O.
AB is the diameter and point P is on the circumference of the circle.
Angle $OBP = 75°$ and $BP = 5$ cm.
(i) Show that $OA = 9.66$ cm, correct to three significant figures. [2]
(ii) Calculate the area of the shaded region. [2]

12 **[Matrices]**

The following table shows the number of property transactions of an agent from January to March 2019.

Types of Property	Sale Transaction	Rental Transaction
HBD Flats	6	8
Private Condominiums	4	2
Landed House	3	1

The information above is represented by the matrix $P = \begin{pmatrix} 6 & 8 \\ 4 & 2 \\ 3 & 1 \end{pmatrix}$ and $Q = \begin{pmatrix} 1 \\ 1 \end{pmatrix}$.

(a) Evaluate $\mathbf{W} = \mathbf{PQ}$ and explain the significance of the elements in *W*. [2]

The commission received and the government tax charged under each type of transaction is shown in the table below.

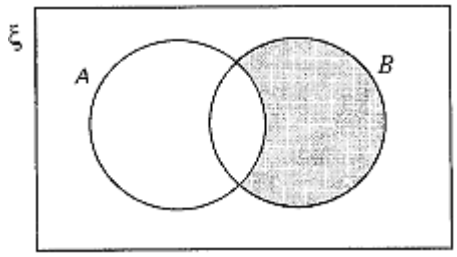
	HBD Flats	Private Condominiums	Landed House
Commission	\$3000	\$7000	\$11000
Government Tax	\$800	\$1800	\$2500

(b) Represent the above information with matrix **R** and evaluate **S** = **RW**. [2]
Explain the significance of the elements in **S**.

(c) Write down another matrix **T** such that their product **TS** gives the amount of money earned by the agent after deducting the government tax from January to March 2019. [2]
Hence, find the amount of money earned by the agent.

13 **[Sets]**

(a) Write down the set represented by the following shaded region. [1]



$\xi = \{\text{integers } x: 2 \leq x < 16\}$
$A = \{\text{integers that are prime numbers}\}$
$B = \{\text{integers } x: 2x^2 - 10x + 12 = 0\}$

(b) Draw a Venn diagram to illustrate this information. [2]
(c) List the elements in $A \cap B'$. [1]

14	**[Probability]** A bag contains five counters, numbered **1, 2, 3, 4** and **5.** Two counters are taken from the bag at random, one after the other, **without replacement.** (a) Draw a possibility diagram to represent the outcomes. (b) Find, in the simplest form, the probability that (i) both counters have a number less than 3, (ii) neither counter has an even number, (iii) the sum of the numbers is 10,	[2] [1] [1] [1]
15	**[Statistics]** The stem-and-leaf diagram shows the distribution of distances, in km, covered by a taxi over 16 consecutive days. Stem | Leaf 2 | 7 9 3 | 4 5 8 9 4 | 1 2 4 5 6 7 8 8 9 5 | 6 | 8 Key: 2 | 7 means 27 km (a) Write down the median of the distances. (b) Find the interquartile range of the distribution. (c) It was discovered that the distances had been incorrectly measured. Each actual distance is 300 m more than what was recorded. Explain how the median of the recorded distances is affected by this error.	[1] [1] [1]

Answers:

1	(a) $x > -\frac{13}{14}$ (b) $\frac{4y}{3-2y} - \frac{y}{(2y-3)^2} = \frac{y(11-8y)}{(2y-3)^2}$ or $\frac{y(11-8y)}{(3-2y)^2}$ (c) $\frac{(-3h)^2}{8h^3j^5} \div \frac{27h^4j^2}{4j^3} = \frac{1}{6h^5j^4}$ (d) $\left(\frac{256p^{16}}{q^{20}r^{-4}}\right)^{-\frac{1}{4}} = \frac{q^5}{4p^4r}$ or $\frac{q^5r^{-1}}{4p^4}$ or $\frac{1}{4}p^{-4}q^5r^{-1}$ (e) $x = -7$ or $x = 4$
2	$k = 2 \times 3 \times 5^2 \times 11^2$ $A = 2^3 \times 3^3 \times 5^2$ $= 5400$
3	(a) 380 $Actual\ length\ of\ River\ Kwai = 500000 \times 76\ cm$ $= 38000000\ cm$ $= 380\ km$ (b) 2.052×10^4 cm^2 $1\ cm : 500000\ cm$ $1\ cm : 5\ km$ $1\ cm^2 : 25\ km^2$ $Area\ of\ Thailand\ on\ map = \frac{513120}{25}$ $= 20524.8$ $= 2.052 \times 10^4\ cm^2$

4	18.3% Let the radius of the cylinder be *r* cm and the height be *h* cm. $Original\ Volume = \pi r^2 h$ $New\ Volume = \pi(1.3r)^2(0.7h)$ $= \frac{1183}{1000}\pi r^2 h$ $Percentage\ change\ in\ Volume = \frac{\frac{1183}{1000}\pi r^2 h - \pi r^2 h}{\pi r^2 h} \times 100\%$ $= 18.3\%$ $y = \frac{k}{x^2}$ $x_1 = 2.5x$ $y_1 = \frac{k}{{x_1}^2}$ $y_1 = \frac{k}{(2.5x)^2}$ $y_1 = \frac{k}{6.25x^2}$ $y_1 = \frac{y}{6.25}$ $y_1 = 0.16y$ $\%\ decrease = \frac{y - o.16y}{y} \times 100\%$ $= 84\%$
5	(a) $T_5 = 10^2 - 3 = 97$ (b) The square number of an even number is always even. Hence, adding/subtracting an odd number with/from an even number will always result in an odd number. (c) Shown $T_n = (2n)^2 + [5 - 2(n-1)]$ $= 4n^2 + 5 - 2n + 2$ $= 4n^2 - 2n + 7$ (shown) (d) $8k + 2$ $T_{k+1} - T_k = [4(k+1)^2 - 2(k+1) + 7] - (4k^2 - 2k + 7)$ $= 4(k^2 + 2k + 1) - 2k - 2 + 7 - 4k^2 + 2k - 7$ $= 8k + 2$ (e)Since $k \geq 1$, then $8k + 2 \geq 10$ Hence the difference cannot be 6.

6

(a) $R = 0.600$ or 0.6

$$8000\left(1+\frac{R/_2}{100}\right)^4 = 8000 + 96.43$$

$$\left(1+\frac{R/_2}{100}\right)^4 = \frac{8096.43}{8000}$$

$$1+\frac{R/_2}{100} = \sqrt[4]{\frac{8096.43}{8000}}$$

$$R = 0.600 (3\ sf)$$

(b) The cash price of the washing machine is \$1800.

Deposit $= 2106 - (12 \times 153) = \$270$

$15\% \rightarrow \$270$

$1\% \rightarrow \$18$

$100\% \rightarrow \$1800$

7

(a) $\frac{115}{x}$

(b) $\frac{110}{x-3}$

(c) Shown

$$\frac{110}{x-3} - \frac{115}{x} = \frac{40}{60}$$

$$\frac{110}{x-3} - \frac{115}{x} = \frac{2}{3} [multiply\ by\ 3x(x-3)]$$

$$330x - 345(x-3) = 2x(x-3)$$

$$330x - 345x + 1035 = 2x^2 - 6x$$

$$2x^2 + 9x - 1035 = 0 (shown)$$

(d) $x \approx 20.61$ or -25.11 (2d.p.)

$$x = \frac{-(9) \pm \sqrt{(9)^2 - 4(2)(1035)}}{2(2)}$$

$$\approx 20.61\ or\ -25.11\ (2\ d.p.)$$

(e) $x = -25.11$ must be rejected because average speed cannot be negative.

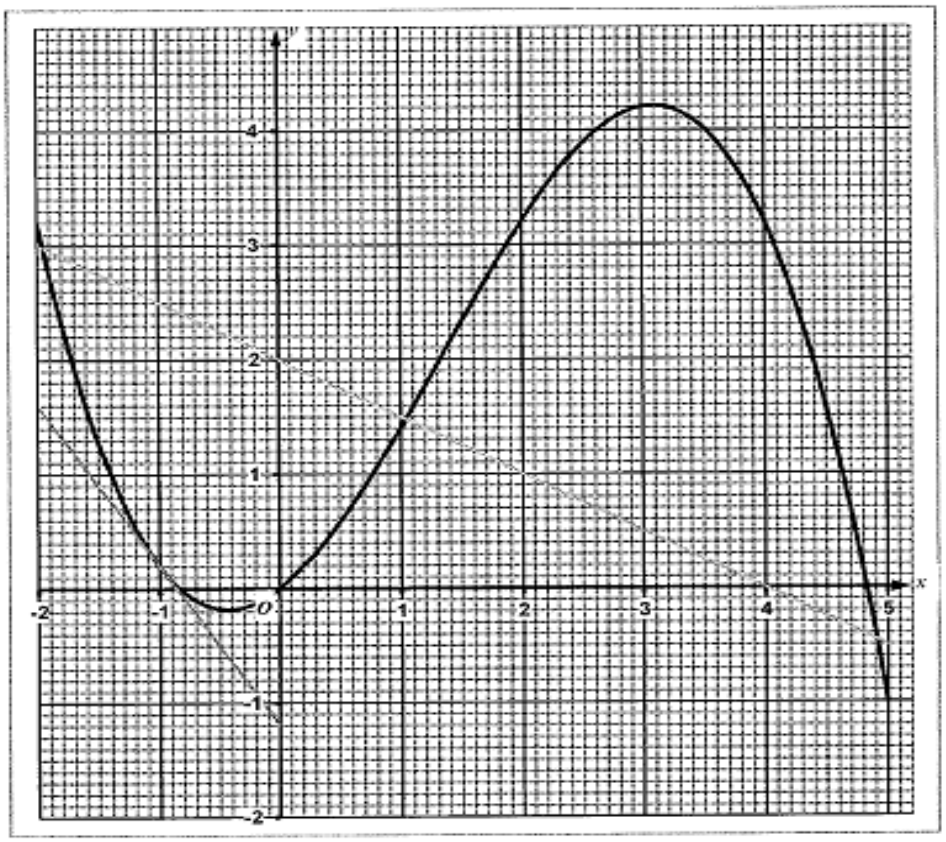
(f) Total time taken ≈ 11.8 hrs

Total time taken = $\frac{115}{20.61} + \frac{110}{20.61-3} \approx 11.8$ hrs

8

(a) -0.175

(b) , f(i)



(c) $1.9 < x < 4.1$ or $x < -1.95$

(d) Points are (-2, 1.6) and (0, -1.2)

$$gradient = \frac{1.6 - (-1.2)}{-2 - 0} = -1.4$$

(e) $\frac{x}{5}(4 + 4x - x^2) = 4$

(f) (i) $x = -1.95, 1.05, 4.9$

(ii) Sub $y = -\frac{1}{2}x + 2$ *into* $y = \frac{x}{5}(4 + 4x - x^2)$,

$-\frac{1}{2}x + 2 = \frac{x}{5}(4 + 4x - x^2)$

$-5x + 20 = 8x + 8x^2 - 2x^3$

$2x^3 - 8x^2 - 13x + 20 = 0$

$A = -8 \qquad B = -13$

9

(a) 070.9° or 071.0°

$$\frac{sin\angle PSL}{113} = \frac{sin\ 36^\circ}{81}$$

$$sin\angle PSL = \frac{113sin\ 36^\circ}{81}$$

$\angle PSL = 124.92^\circ$(since $\angle PSL$ is obtuse)

$\therefore$Bearing of ship from coast guard $= 124.92^\circ - (180^\circ - 126^\circ)$

$$= 070.9^\circ(1\ dp)$$

(b) 144 m (3 s.f.)

$$LT = \sqrt{64^2 + 113^2 - 2(64)(113)cos105^\circ}$$
$$= \sqrt{20608.55867}$$
$$= 143.5568$$
$$= 144\ m\ (3\ s.f.)$$

(c) 3490 m^2 (3 s.f.)

$$Area\ of\ \Delta PLT = \frac{1}{2}(64)(113)sin105^\circ$$
$$= 3492.7878$$
$$= 3490\ m^2(3\ s.f.)$$

(d) 60.2°

Let the shortest distance of *P* to *TL* be *x* m.

$$3492.7878 = \frac{1}{2} \times 143.5568 \times x$$

$$x = 48.6607$$

Let the angle of depression be θ.

$$tan\theta = \frac{85}{48.6607}$$

$$\theta = 60.21^\circ$$

Greatest angle of depression is 60.2°

10

(a) $\angle ABC = 90°$ (angle in semi-circle)

(b) $\angle CBD = 29°$ (complementary angles)

(c) $\angle CAD = 29°$ (angles in the same segment)

(d) $\angle AED = 180 - 61$ (angles in the opposite segment)

$$= 119°$$

11

(a) (i)Surface area $= 2\pi(16)^2 + 2\pi(8)^2 + \pi(16)^2 - \pi(8)^2 = 832\pi\ cm^2$

(ii) Volume $= \frac{2}{3}\pi(16^3 - 8^3) = 7506.31 = 7510\ cm^3$

(b) (i) Method 1

ΔOPB is an isosceles traingle.

$cos75^\circ = \dfrac{2.5}{OB}$

$OA = OB = \dfrac{2.5}{cos75^\circ}$

$OA = 9.659 = 9.66\ (3sf)$

Method 2

Angle $APC = 90°$ ($rt \angle$ in semicircle)

$cos75° = \dfrac{5}{AB}$

$AB = \dfrac{5}{cos75°}$

$AB = 19.318$

$OA = \dfrac{1}{2}AB$

$OA = 9.659$

$OA = 9.66\ (3sf)$

Method 3

angle $BOP = 180^\circ - 2(75^\circ) = 30^\circ$(sum of isos Δ)

$OB = \frac{5}{sin30^\circ} \times sin75°$

$OB = OA = 9.66\ (3sf)$

(ii) $\angle AOP = 150°$

Either $75° \times 2(ext\ \angle of\ \Delta)$ or

$180° - (180° - 75° \times 2)$ or

$180° - (90° - 75°) \times 2$

Shaded Area$= \frac{1}{2}(9.659)^2\left(\frac{150}{360} \times 2\pi - sin150^\circ\right)$ or

$= \dfrac{1}{2}\pi(9.659)^2 - \dfrac{1}{2}(9.659)^2 sin150° - \dfrac{1}{2}(9.659)^2\left(\dfrac{30}{360} \times 2\pi\right)$

$= 98.8\ cm^2$

12

The elements in **W** represent the total no. of transactions for each type of property.

$$W = \begin{pmatrix} 6 & 8 \\ 4 & 2 \\ 3 & 1 \end{pmatrix}\begin{pmatrix} 1 \\ 1 \end{pmatrix}$$

$$= \begin{pmatrix} 14 \\ 6 \\ 4 \end{pmatrix}$$

(b) $R = \begin{pmatrix} 3000 & 7000 & 11000 \\ 800 & 1800 & 2500 \end{pmatrix}$, $S = \begin{pmatrix} 128000 \\ 32000 \end{pmatrix}$

The elements in **S** represent total amount of commission earned and total the total government tax paid for each type of transaction.

(c) $\mathbf{T} = (1, -1)$ $\mathbf{TS} = (96000)$, Total amount paid = \$96000

$T = (1 - 1)$

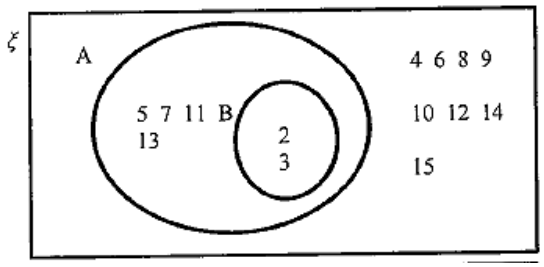
$TS = (1 - 1)\begin{pmatrix} 128000 \\ 32000 \end{pmatrix} = (128000 - 32000) = (96000)$

Total amount earned = \$96000

13

(a) $A' \cap B$

(b)



(c) $A \cap B' = \{5, 7, 11, 13\}$

14

(a)

	1	**2**	**3**	**4**	**5**
1	X	(2, 1)	(3, 1)	(4, 1)	(5, 1)
2	(1, 2)	X	(3, 2)	(4, 2)	(5, 2)
3	(1, 3)	(2, 3)	X	(4, 3)	(5, 3)
4	(1,4)	(2, 4)	(3, 4)	X	(5, 4)
5	(1, 5)	(2, 5)	(3, 5)	(4, 5)	X

(b) (i) $\frac{1}{10}$ (ii) $\frac{3}{10}$ (iii) 0

15

(a) 43

(b) 27 29 34 **35 38** 39 41 42 44 45 46 **47 48** 48 49 68

$47.5 - 36.5 = 11$ km

(c) Due to this error, the median of the recorded distances is **<u>300 m less</u>** than the median of the actual distances due to this error.