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TAMPINES SECONDARY SCHOOL

Secondary Four Express / Five Normal Academic
PRELIMINARY EXAMINATION 2023

NAME

CLASS | | | | **REGISTER NUMBER** | |

MATHEMATICS **4052/02**

Paper 2 **25 August 2023**

2 hours 15 minutes

Candidates answer on the Question Paper.

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	**Total**

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.

Answer **all** the questions.
If working is needed for any question it must be shown with the answer.
Omission of essential working will result in loss of marks.
The use of an approved scientific calculator is expected, where appropriate.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value of 3.142, unless the question requires the answer in terms of π.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total number of marks for this paper is **90**.

Mathematical Formulae

Compound Interest

$$\text{Total amount} = P\left(1+\frac{r}{100}\right)^n$$

Mensuration

Curved surface area of a cone = πrl

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

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

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

Area of a triangle ABC = $\frac{1}{2}ab\sin C$

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

$$\text{Mean} = \frac{\Sigma fx}{\Sigma f}$$

$$\text{Standard deviation} = \sqrt{\frac{\Sigma fx^2}{\Sigma f} - \left(\frac{\Sigma fx}{\Sigma f}\right)^2}$$

[Turn over for Question 1]

1 **(a)** It is given that $p = \sqrt{\dfrac{64 - qr}{q}}$ where q is non-zero.

(i) Find p when $q = 4$ and $r = -9$.

Answer $p =$ .....[1]

(ii) Express q in terms of p and r.

Answer $q =$ .....[3]

(b) Solve $\dfrac{5}{6-x} + \dfrac{4}{x-6} = 2$.

Answer $x =$ .....[3]

(c) Solve the inequality $3x - 7 \leq \frac{50}{3}x + 6$.

Answer .....[2]

(i) Represent your answer in part **(c)** on the number line below.

Answer

[1]

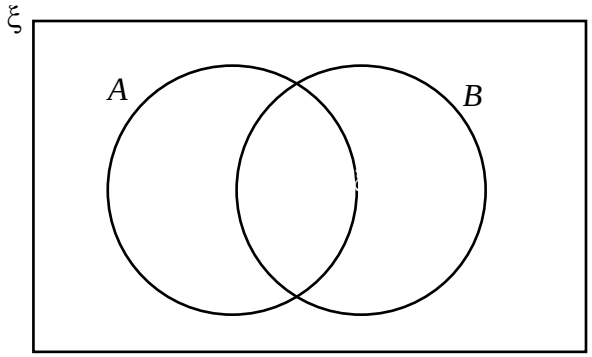
(ii) Hence state the least integer value of x.

Answer $x =$ .....[1]

2 **(a)** $\xi = \{\text{integers } x\text{: } 0 < x \leq 10\}$
$A = \{\text{prime numbers}\}$
$B = \{(x - 5)(4 - x) = 0\}$

(i) Complete the Venn Diagram to illustrate this information.

Answer



[1]

(ii) List the elements in $(A \cup B)'$.

Answer .....[1]

(iii) C is a proper subset of A. Anthony claims that $n(C) \leq 4$.
Explain with reasons if Anthony's claim is valid.

Answer

.....

.....

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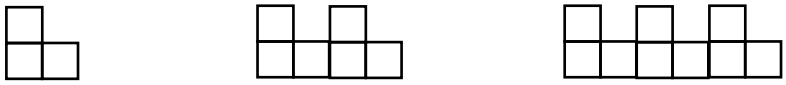
.....[2]

(b) A L-shaped block is made of 3 squares of 1-cm^2 each and has a perimeter of 8 cm.
The following pattern shows L-shaped blocks joined together.



1 L-shaped block 2 L-shaped blocks 3 L-shaped blocks

The values for the perimeter of the 1 L-shaped block and 2 L-shaped blocks are given below.

Number of L-shaped blocks	1	2	3	4
Perimeter (cm)	8	14	***a***	***b***

(i) Find *a* and *b*.

Answer $a =$ ..... $b =$ .....[2]

(ii) Write down the perimeter of a *n* L-shaped block in terms of *n*.

Answer .....[1]

(iii) If the perimeter of a *n* L-shaped block is 2258 cm, find the number of squares in this *n* L-shaped block.

Answer .....[2]

3 **(a)** The population of Singapore was estimated at 5 985 000 in June 2023.

(i) Write 5 985 000 in standard form.

Answer .....[1]

The land area of Singapore is 734.3 km^2.

(ii) Find the population of Singapore per km^2. Write your answer in standard form, correct to 2 significant figures.

Answer .....[2]

(b) The value of a painting in 2022 was 20% more than its value in 2021 but 16% less than its value in 2023. If the painting is valued at $20 000 in 2023, find its value in 2021.

Answer $.....[3]

(c) Mr and Mrs Raj are travelling from Singapore to Malaysia.
In Singapore, the exchange rate is 100 Singapore Dollars ($) = 335 Malaysian Ringgit (RM) .
In Malaysia, the exchange rate is 100 Malaysian Ringgit (RM) = 33.5 Singapore Dollars ($).

Mr Raj wants to change $1000 into Malaysian Ringgit in Singapore. Mrs Raj claims that there is no difference whether Mr Raj changes the money in Singapore or Malaysia.
Do you agree with Mrs Raj? Justify your answer, showing all workings clearly.

Answer

[3]

4 **(a)** $\overrightarrow{PQ} = \begin{pmatrix} 11 \\ 2 \end{pmatrix}$ and $\overrightarrow{QR} = \begin{pmatrix} -3 \\ 4 \end{pmatrix}$.

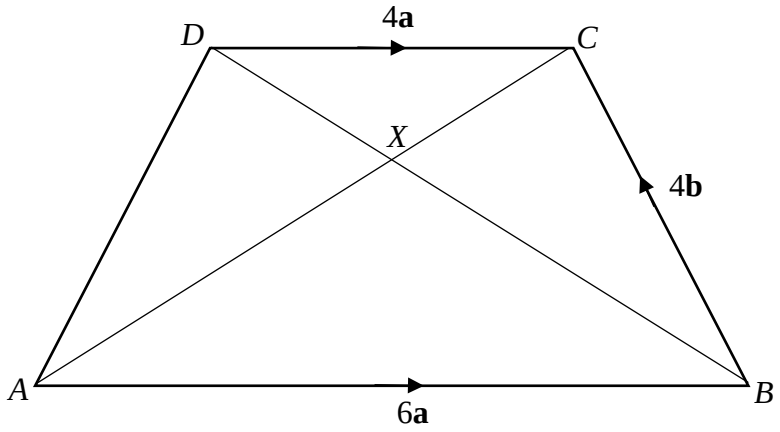
(i) Find $\left|\overrightarrow{PR}\right|$.

Answer ..... units [2]

(ii) Q is the point (2, 3). Find the position vector of P.

Answer ..... [2]

(b) $ABCD$ is a trapezium where AB is parallel to DC. The diagonals AC and BD intersect at X. $\overrightarrow{AB} = 6\mathbf{a}$, $\overrightarrow{DC} = 4\mathbf{a}$ and $\overrightarrow{BC} = 4\mathbf{b}$.



(i) Find the ratio $AX : XC$.

Answer ..... : .....[1]

(ii) Express as simply as possible, $\overrightarrow{AD}$ in terms of **a** and/or **b**.

Answer $\overrightarrow{AD}$ = ...[1]

(iii) *E* is a point on *DC* extended.
Given $\overrightarrow{AE}$ = 8**a** + 4**b**, show that *ABED* forms a parallelogram.

Answer

[1]

(iv) Hence find the ratio

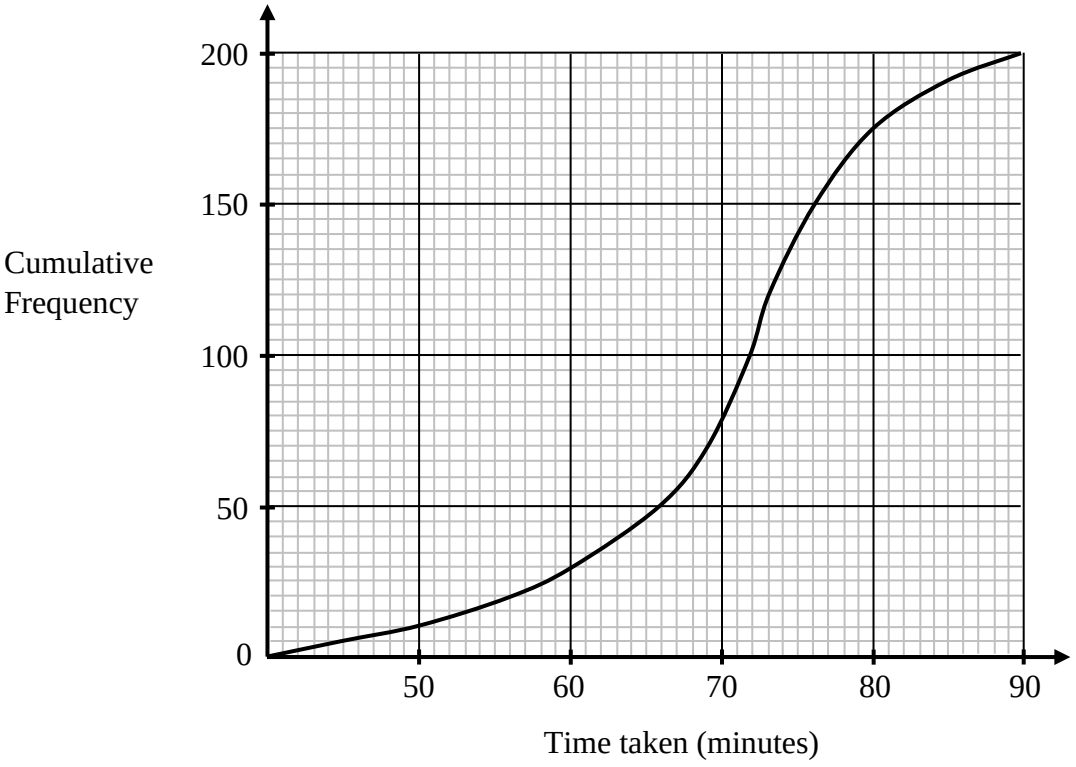
(a) area triangle *ABE* : area parallelogram *ABED*,

Answer ..... : .....[1]

(b) area triangle *ABE* : area triangle *ACD*.

Answer ..... : .....[1]

5 The cumulative frequency curve shows the distribution of the time taken by 200 Secondary One boys to complete a task in January.



(a) Use the graph to find

(i) the 15th percentile,

Answer .....minutes [1]

(ii) the median time,

Answer .....minutes [1]

(iii) the interquartile range.

Answer .....minutes [2]

(b) 12.5% of the boys took more than n minutes.
Find n.

Answer $n =$ .....[2]

(c) With practice, each boy uses 5 less minutes to complete the same task in June.
Describe how the cumulative frequency curve would have been different.

Answer .....

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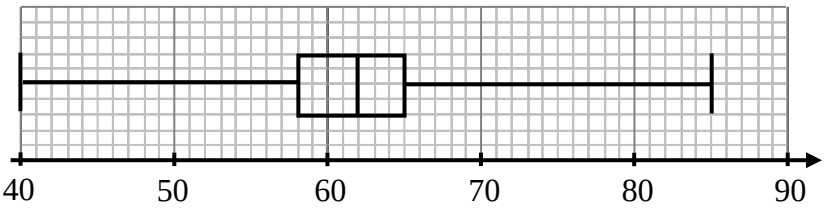
..... [1]

(d) The box-and-whiskers plot below shows the time taken by 200 Secondary One girls to complete the same task in January.



Time taken (minutes)

Make two comments comparing the times taken by the boys and girls to complete the task.

Answer

1. .....

.....

.....

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2. .....

.....

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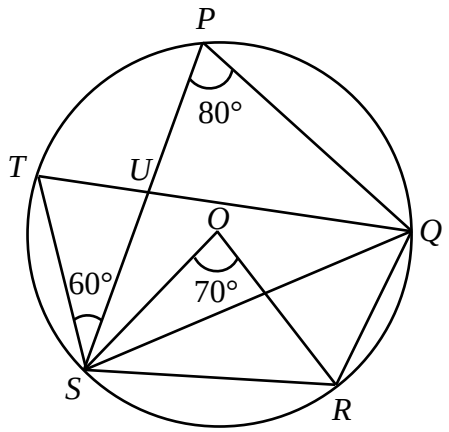
..... [2]

6 **(a)** In the diagram, *P*, *Q*, *R*, *S* and *T* are points on a circle, centre *O*.

Angle *SPQ* = 80°, angle *PST* = 60° and angle *SOR* = 70°.



(i) Find angle *TUS*.
Give a reason for each step of your working.

Answer Angle *TUS* = ... ° [2]

(ii) Find angle *SQR*.
Give a reason for each step of your working.

Answer Angle *SQR* = ... ° [1]

(iii) Find angle *ORS*.
Give a reason for each step of your working.

Answer Angle *ORS* = ... ° [1]

(iv) Find angle *ORQ*.
Give a reason for each step of your working.

Answer Angle *ORQ* = ... ° [2]

(v) Explain, with clear workings and reasonings, whether lines *OS* and *QR* are parallel.
Answer

……

……

……

……...[2]

(b) There are $(2n + 3)$ red marbles, $(4n – 1)$ green marbles and $(18 – 2n)$ blue marbles in a bag.

(i) Given that the probability of drawing a red or green marble is $\frac{19}{22}$, show that $n = 6$.

Answer

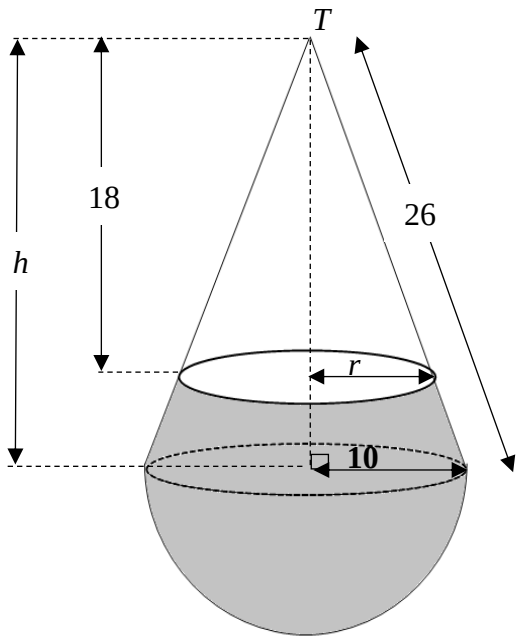
[2]

(ii) Hence find the probability of drawing 2 red marbles, one after another without replacement.

Answer ..... [2]

7 The diagram shows a container formed from a cone and a hemisphere.
The cone has base radius 10 cm, vertical height h cm and slant height 26 cm.
The hemisphere has radius 10 cm.

Water enters the container through a tiny hole, T at the top of the cone.
The water reaches a height 18 cm from T and forms a circular top with radius r cm.



(a) Find the height of the cone.

Answer ..... cm [1]

(b) Using similar triangles, show that $r = 7\frac{1}{2}$.

Answer

[2]

(c) Find the surface area of the container that is in contact with the water.

Answer ..... cm^2 [3]

(d) Find the volume of the water in the container.

Answer ..... cm^3 [3]

8 **(a)** Complete the table of values for $y = \frac{x^3}{2} - 3x + 2$.

x	–3	–2	–1	0	1	2	3
y		4	4.5	2	–0.5	0	6.5

[1]

(b) On the grid on the next page, draw the graph of $y = \frac{x^3}{2} - 3x + 2$ for $-3 \leq x \leq 3$. [3]

(c) Use your graph to write down an inequality in x to state the range of values of x where $y > 5$.

Answer .....[1]

(d) By drawing a straight line, find the gradient of the graph at $x = 2$.

Answer .....[2]

(e) **(i)** On the same grid, draw the graph of $y = x - 1$. [1]

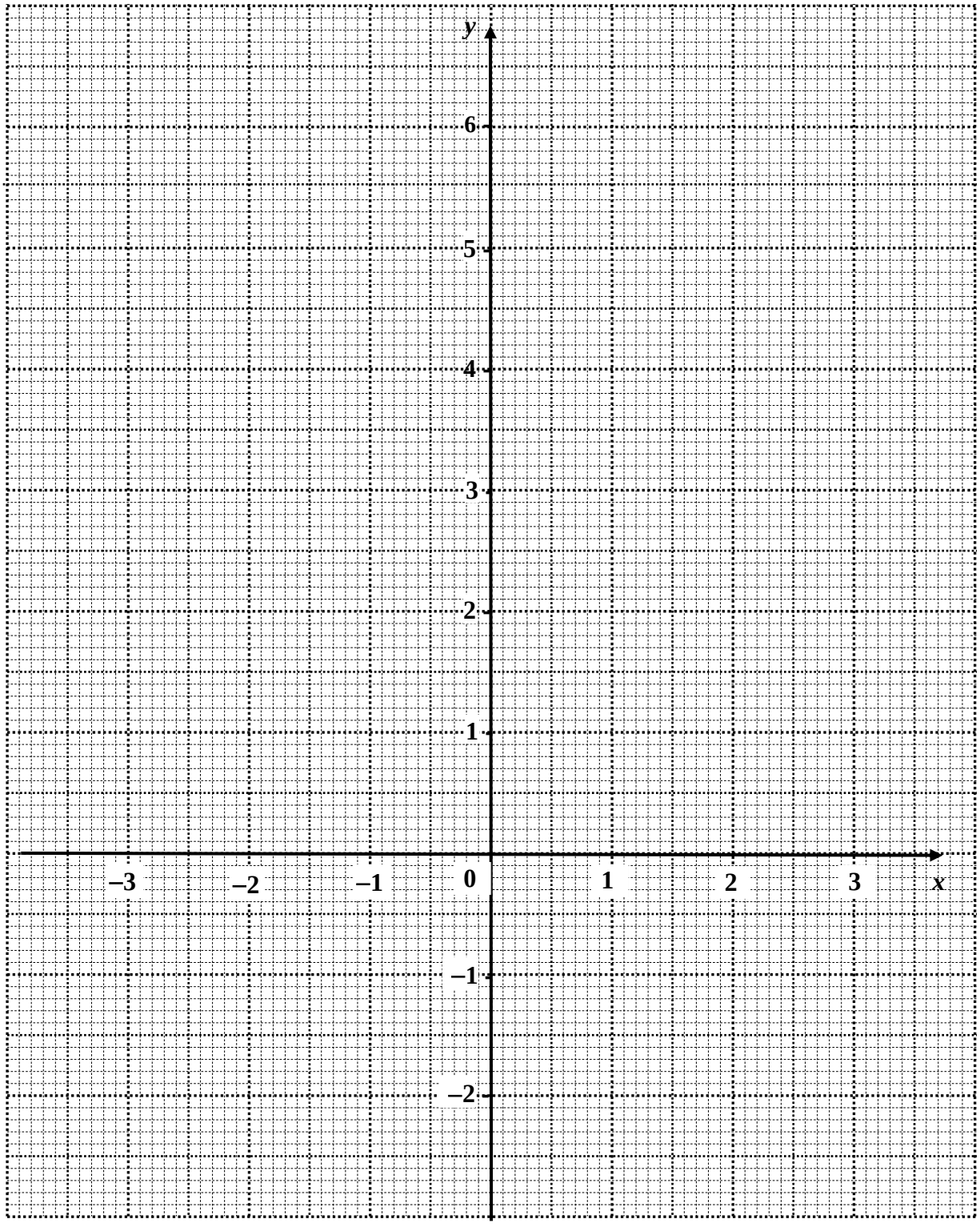
(ii) Show that the points of intersection of the line $y = x - 1$ and the curve $y = \frac{x^3}{2} - 3x + 2$ give the solutions of $x^3 - 8x + 6 = 0$.

Answer

[2]

(iii) Use your graph to solve $x^3 - 8x + 6 = 0$.

Answer $x =$ ..... or ..... [2]



9 Retrieved from The Straits Times, 10 June 2023. *More budget meal options are in the works for Singaporeans. The Housing Board, in collaboration with the Government Technology Agency, launched the BudgetMealGoWhere website to help residents locate HDB coffee shops offering budget meals within 2 km of their residence.*

The diagram below shows part of the map of Singapore. The locations of HDB coffee shops offering budget meals on the map are numbered as shown.

(a) Sally resides at the location marked 'X' in the diagram.

(i) Construct on the diagram, a circle centre X with radius 2 km. [1]

(ii) Using your answer from part **(a)(i)**, write down the coffee shop(s) number within 2 km of Sally's residence.

Answer Coffee shop(s) .....[1]

Mary resides at the location marked 'Y' in the diagram.

(iii) Construct on the diagram, a perpendicular bisector of XY. [1]

(iv) Sally and Mary decide to meet at a coffee shop that is equidistant from their residences. Using your answer from part **(a)(iii)**, write down the coffee shop(s) number that they can meet.

Answer Coffee shop(s) .....[1]

(b) After meeting Mary, Sally needs to run multiple errands to different parts of Singapore. She decides to rent a car from 8am to 12pm for that day.

The tables below show the cost of car rental from two companies, GetCar and FindCar.

GetCar's Rental Charges

Timings	Cost / hour	Remarks
12am – 8am	$4	- Additional mileage charge at $0.39/km - No petrol charge
8am – 6pm	$7	
6pm – 12am	$9	

FindCar's Rental Charges

Timings	Cost / hour	Remarks
12am – 6am	$5	- Additional mileage charge at $0.39/km - Petrol charges to be paid by driver
6am – 9am	$3	
9am – 6 pm	$5	
6pm – 12am	$7	

The table below shows the price per litre of different grades of petrol from three different petrol companies, Company Messo, Company Shore and Company SCP. Each litre of petrol allows 12.5 km of travel.

Petrol Grade	Company Messo	Company Shore	Company SCP
	Price per litre (Discounted price per litre if ABC Bank credit card is used)		
92	$2.70 (NA)	-	$2.70 (NA)
95	$2.75 (NA)	$2.79 ($2.20)	$2.74 (NA)
98	$3.22 (NA)	$3.28 ($2.59)	$3.22 (NA)

Sally estimates that she needs to travel 67 km that day. She carries an ABC Bank credit card. She wants to minimise her costs in the rental. Suggest the company from which Sally should rent the car. Justify any decisions you make and show your calculations clearly.

Answer

[6]

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