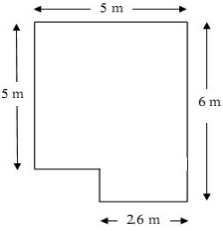


Real World Application

1 Mrs Wong has a budget of \$2000 to spend on buying new kitchen flooring. A sketch of the kitchen floor plan is shown below. All angles shown in the diagram are right angles.



Mrs Wong planned to use either tiles or single colored vinyl floor covering to cover the whole kitchen floor.

Each square tile measure 20 cm by 20 cm. A box of 25 floor tiles costs \$66.25. Floor tiles are only sold in complete boxes. The vinyl floor covering is cut to the required length from a roll. A roll of vinyl floor covering is 1.8 meters wide and is sold at a price of \$118.70 per meter length. It is sold in lengths measured in a whole number of meters only.

(a) Are both types of flooring materials within Mrs Wong's budget? Show all your working and give reasons for your answers.

Mrs Wong saw an advertisement for a refrigerator and bought it using a payment plan. The total price of the payment plan is 12% more than the advertised price. The payments are calculated as shown.

- Deposit of one-third of total price
- 8 equal installments of \$92.60 per month
- Final payment of \$200

(b) Find the advertised price.

(c) Mrs Wong also bought a washer which cost \$569.24, inclusive of 7% Goods and Services Tax (GST). Find the amount of GST paid by Mrs Wong.

[SCGS P2 2018]

Answer:

(a) No of boxes tile required

$$= \frac{5 \times 5 + 2.6}{0.2 \times 0.2} \div 25$$

$$= 27.6$$

$$= 28 \text{ (whole number)}$$

Total cost

$$= 28 \times 66.25$$

$$= \$1855$$

Length Required

$$= \frac{27.6}{1.8}$$

$$= 15.333$$

$$= 16 \text{ (whole number)}$$

Cost of vinyl flooring

$$= 16 \times 118.7$$

$$= \$1899.20$$

Both types of floorings are within Mrs Wong's budget.

(b) Let advertised price be A

$$\frac{1}{3} \times \frac{112A}{100} + 8 \times 92.6 + 200 = \frac{112A}{100}$$

$$940.8 = \frac{56A}{75}$$

$$A = \$1260$$

(c) $\frac{569.24}{107} \times 7$

$$= \$37.24$$

- 2 For a Parent Teacher Conference, a school has to convert the parade square into a parking lot. The parade square is a rectangular plot of land 40 m by 30 m.



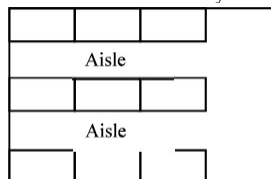
ENTRANCE / EXIT

There is an 6 m wide entrance/exit at one corner of the parade square as shown in the sketch above. You are required to do the parking arrangements.

The Land Transport Authority recommends the following guidelines.

A **Parking Stall** refers to the space for parking of one motorcar, that is, a car parking lot. The space of the stall should be rectangular. The longer side is known as the length and the shorter side is the width.

A **Parking Aisle** refers to an access lane or driveway with adjacent parking stalls.

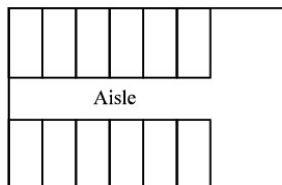


In parallel parking, the longer side is parallel to the parking aisle or driveway. The aisle

for cars to move must be at least 3.6 m.

For two-way traffic flow, the width of the aisle must be at least 6 m.

Each parking stall is 5.4 m by 2.4 m.



In 90° parking, the longer side is perpendicular to the parking aisle or driveway. The aisle or lane for cars to move must be at least 6 m for one-way traffic flow and at least 6.6 m for two-way traffic flow. Each parking stall is 4.8 m by 2.4 m.

Propose a possible parking arrangement that would maximise the use of space, showing your calculations clearly. Your proposal must include a sketch, not drawn to scale, indicating the location of the parking stalls, the aisles and the type(s) of parking. You should allow for cars to enter and leave the parade square at any time. You can assume that the cars will not leave in large numbers at any one time, and the parking will be supervised by security guards.

Answer:

$$\text{Number of lots in Row A} = \frac{40}{2.4} = 16\frac{2}{3} \approx 16$$

$$\text{Number of lots in Row B or C} = \frac{40 - 6.6}{2.4} = 13\frac{11}{12} \approx 13$$

$$\text{Length of Row A} = 16 \times 2.4 = 38.4 \text{ m} < 40 \text{ m}$$

$$\text{Length of Row B} = 13 \times 2.4 = 31.2 \text{ m} < 40 \text{ m}$$

$$\text{Length of Row C} = 13 \times 2.4 = 31.2 \text{ m} < 40 \text{ m}$$

$$\text{Number of lots for parallel parking} = \frac{40 - 6}{5.4} = 6\frac{8}{27} \approx 6$$

$$\text{Length of parallel parking} = 6 \times 5.4 = 32.4 \text{ m} < 36 \text{ m}$$

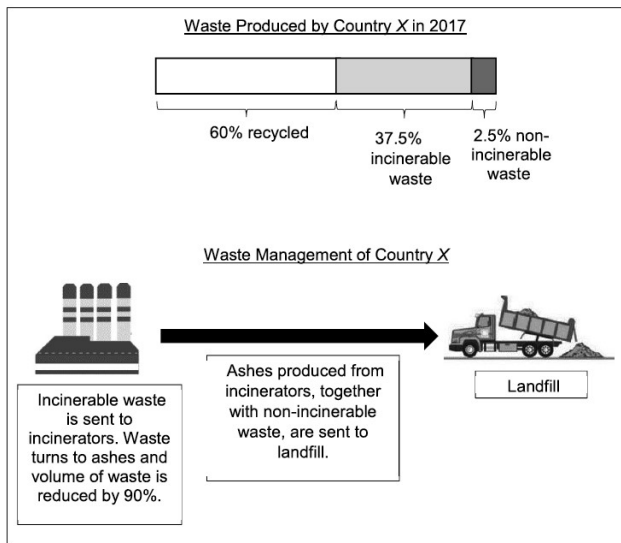
$$\begin{aligned} \text{Width of the rows of parking stalls and aisles} \\ &= 4.8 \times 3 + 2.4 + 2 \times 6.6 \\ &= 30 \text{ m} \end{aligned}$$

$$\text{Total number of parking stalls} = 16 + 2 \times 13 + 6 = 48$$

Remarks – Students who consider only parallel parking or 90° parking but not both get a maximum of 8 marks.

[Anglican High School, 2018 Q11]

- 3 Country X produces 3 million tonnes of waste in 2017. The infographic below shows more information on the waste produces and the waste management of Country X.



Images from: <https://www.dreamstime.com/illustration/dumptruck.html>,
<https://www.mecw.gov.sg/topic/landfill>

- (a) Given that the density of waste is 125 kg/m^3 and $1 \text{ tonne} = 1000 \text{ kg}$, calculate the volume of waste, in m^3 , that was incinerated in 2017.
 Give your answer in standard form.

The landfill used by Country X has a total capacity of $42\,000\,000 \text{ m}^3$.
 By the end of 2017, 30% of the landfill has already been used.
 A news article claims it will take another 32 years before the landfill is completely used.

- (b) Is the news article correct?
 Justify your decision with calculations.
 (c) State one assumption you made in your calculations in (b).

[CHIJ St. Nicholas Girls' School, 2018 Q11]

Answer:

$$\begin{aligned} \text{(a) Mass of incinerable waste} &= 3\,000\,000 \times 37.5\% \text{ tonnes} \\ &= 1\,125\,000 \text{ tonnes} \\ &= 1.125 \times 10^9 \text{ kg} \\ \text{Volume of incinerable waste} &= \frac{1.125 \times 10^9}{125} \text{ m}^3 \\ &= 9\,000\,000 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{(b) Volume of non-incinerable waste} &= \frac{3\,000\,000 \times 1000 \times 2.5\%}{125} \\ &= 600\,000 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume of ashes from incinerated waste} &= 9\,000\,000 \times 10\% \\ &= 900\,000 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Total volume of waste to be landfilled} &= 600\,000 + 900\,000 \\ &= 1\,500\,000 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Volume of landfill left} &= 42\,000\,000 \times 70\% \\ &= 29\,400\,000 \text{ m}^3 \end{aligned}$$

$$\begin{aligned} \text{Years left} &= \frac{29\,400\,000}{1\,500\,000} \\ &= 19.6 \end{aligned}$$

No, the news article is incorrect.

- (d) Amount of incinerated and non-incinerable waste remains the same every year.

Or

The percentage breakdown of waste remains the same every year.

- 4 The Central Provident Fund (CPF) is a comprehensive social security savings scheme funded by contributions from **both** employers and employees. It is a key pillar of Singapore's social security system, and served to meet the citizen's retirement, housing and healthcare needs.
- The table shows the current monthly CPF contribution rates for Singapore Citizens and Permanent Residents.

Employee's age (years)	Monthly Contribution Rates from 1 Jan 2016 (for gross monthly income $\geq$ \$750)		
	By Employer (% of income)	By Employee (% of income)	Total (% of income)
55 and below	17	20	37
Above 55 to 60	13	13	26
Above 60 to 65	9	7.5	16.5
Above 65	7.5	5	12.5

(a) Brandon, a Singapore Citizen, aged 25 years, earns a gross monthly income of \$3650. Calculate the **total** amount that contributes to Brandon's CPF account every month

(b) The monthly CPF contribution goes into three accounts.

The table below provides information on the accounts and the ratio of contribution.

Account Type	Ratio of Contribution
Ordinary Account (OA) <i>Primarily for housing needs.</i>	0.6217
Special Account (SA) <i>Primarily for retirement needs.</i>	0.1621
Medisave Account (MA) <i>Primarily for healthcare needs.</i>	0.2162

Calculate the monthly amount that goes into Brandon's OA, giving your answer to the nearest cent.

(c) Brandon is planning to purchase a new 3-room flat. He found the following information online.

Average Price of New Flats in 3 rd Quarter of 2018		
3-room	4-room	5-room/Executive
\$270000	\$350000	\$410000

***Administration Fees Payable for Purchase of a New Flat**

Type of fee	Amount
Option Fee <i>Option Fee is paid when you book your flat. It is based on the flat type that is booked.</i>	4/5-room and Executive Flat : \$2000 3-room : \$1000 2-room : \$1000
Downpayment	10% of purchase price of flat
Stamp Duty on Agreement for Lease <i>A duty levied on the legal recognition of certain documents. It is based on the purchase price of the flat.</i>	First \$180,000 : 1% Next \$180,000 : 2% Remaining Amount : 3%
Conveyancing fee for sale of flat <i>Legal costs involved when buying/selling a flat. It is based on the purchase price of the flat.</i>	First \$30,000 : \$0.90 per \$1000 Next \$30,000 : \$0.72 per \$1000 Remaining Amount : \$0.60 per \$1000
Caveat registration fee <i>A caveat is lodged with the Singapore Land Authority to protect your interest in the flat. This is done by giving notice of your interest pending the Lease registration.</i>	Please note that conveyancing fees are subjected to 7% GST. \$64.45 (Inclusive of GST)
* These administration fees can be paid using funds in the CPF OA.	

Brandon wishes to pay the administration fees completely from his OA and has \$6000 in his OA.

Suggest the number of years that Brandon will need to accumulate sufficient money in his OA to pay for the administration fees.

[Chung Cheng High School, 2018 Q10]

Answer:

(a)
monthly contribution

$$= \$ \frac{37}{100} \times 3650$$

$$= \$1350.50$$

(b)

Amount in OA

$$= \$ 0.6217 \times 1350.50$$

$$= \$839.605...$$

$$= \$839.61 \text{ (nearest cents)}$$

(c)

Administrative Fees for 3 room flat

(1) option fee : \$1000

$$(2) \text{ Downpayment} = \$ \frac{10}{100} \times 270\,000$$

$$= \$27\,000$$

$$(3) \text{ Stamp duty} = \$1800 + \left(\frac{2}{100} \times \$90\,000 \right)$$

$$= \$3600$$

$$(4) \text{ Conveyancing fee : First } \$30000 : \$0.90 \times 30 = \$27$$

$$\text{Next } \$30000 : \$0.72 \times 30 = \$21.60$$

$$\text{Remaining amount : } \$0.60 \times 210 = \$126$$

$$\text{Total including GST} = (\$27 + \$21.60 + \$126) \times 1.07$$

$$= \$186.82$$

$$\text{Total amount payable} = \$1000 + \$27\,000 + \$3600 + \$186.82 + \$64.45$$

$$= \$31851.27$$

$$\text{Amount that Brandon needs} = \$31851.27 - \$6000$$

$$= \$25851.27$$

Number of years needed

$$= \left(\frac{\$25851.27}{\$839.61} \right) \div 12$$

$$= 2.565.. \text{ years}$$

≈ 3 years

Brandon will need about 3 years to accumulate sufficient money.

5 Mrs Tan, a mother of two children, saw a newspaper article as shown.

Price of formula milk in Singapore has soared

The average price of a 900g tin of formula milk has increased sharply over the last 5 years, outstripping the price increases of other dairy products and household staples.

On Monday, the Government announced it is tightening rules to encourage greater price competition.

The table below shows the price (in SGD) per 100 grams of different brands of formula milk in year 2012 and 2017.

Brand Date	Similac	Friso	Nan	S26	Mamil
Dec 2012	5.71	5.22	5.20	5.13	4.96
Mar 2017	7.05	6.56	7.45	6.36	6.41
% increase			43.3	24.0	29.2

Coffee stain was found on the newspaper article covering some of the information.

(a) (i) Calculate the percentage increase in the price of the

Similac and Friso formula

milk covered by the coffee stain.

(ii) Hence, do you agree with the headline of the newspaper article? Support your answer with a reason.

A few days later, Mrs Tan saw another article regarding the price of similar brands of formula milk sold in Singapore, Malaysia and China.

Brand Country	Similac	Friso	Nan	S26	Mamil
Singapore	7.05	6.56	7.45	6.36	6.41
Malaysia	3.92	3.54	4.29	4.13	3.51
China	4.79	5.58	9.06	4.25	4.00

Price (in SGD) per 100 grams of formula milk in Singapore, Malaysia and China.

Upon seeing the article, Mrs Tan intends to purchase some cans of formula milk in China and ship them back during her holidays.

Mrs Tan did online research and found the following shipping rate from China to Singapore by SHIPPER Company.

Weight of parcel, x kg	Shipping Rate
	1 st kg 150 RMB follow by
$x \leq 10$	75 RMB/kg
$10 < x \leq 20$	35 RMB/kg
$20 < x \leq 50$	31 RMB/kg
$50 < x \leq 75$	27 RMB/kg
$75 < x \leq 100$	25 RMB/kg
$100 < x \leq 200$	24 RMB/kg
$x > 200$	22 RMB/kg

The information below shows a can of the 900 g formula milk that Mrs Tan intends to purchase in China and the online currency conversion.



1 Singapore Dollar equals	
4.89 Chinese Yuan Renminbi (RMB)	
1	Singapore Dollar
4.89	Chinese Yuan Renminbi

Mrs Tan intends to spend at most S\$650 for both the formula milk and shipping fee.

(b) Calculate the maximum number of cans of formula milk that Mrs Tan can buy.

[Crescent Girls' School, 2018 Q12]

Answer:

(a) (i) Percentage increase of Similac = $\frac{7.05 - 5.71}{5.71} \times 100\%$
 $= 23.5\%$ B1
 Percentage increase of the Friso = $\frac{6.56 - 5.22}{5.22} \times 100\%$
 $= 25.7\%$ B1

(ii) Mean of percentage increase = $\frac{23.5 + 25.7 + 43.3 + 24.0 + 29.2}{5}$
 $= 29.14\%$

Agree. B1
 as the mean of percentage increase is greater than 29% which is much higher than price increase of general food consumption items. B1
 (accept any logical answer)

(b) S\$650 = 4.89×650
 $= 3178.50$ RMB

Let x be the number of can of milk powder.

$4.25 \times 4.89 \times 9 \times x + 150 + 35 \left(\frac{900x}{1000} \right) \leq 3178.50$
 M1

$187.0425x + 31.5x \leq 3028.50$
 $218.5425x \leq 3078.50$
 $x \leq 13.857$
 $x = 13$ tins of formula milk

Or working in term of Singapore Dollar

Shipping rate of
 150 RMB = S\$30.675
 35 RMB = S\$7.157

Let x be the number of can of milk powder.

$4.25 \times 9 \times x + 30.675 + 7.157 \left(\frac{900x}{1000} \right) \leq 650$
 M1

$44.6913x \leq 619.325$
 $x \leq 13.857$
 $x = 13$ tins of formula milk

- 6 Singapore adopts a progressive tax structure.
The table shows the tax rates for various annual income brackets.

Assessable annual income	Chargeable income	Income tax rate (%)	Gross tax payable
$\leq \$20\,000$	0	0	0
\$20 001 – \$30 000	First \$20 000	0	0
	Next \$10 000	2	\$200
\$30 001 – \$40 000	First \$30 000	—	\$200
	Next \$10 000	3.50	\$350
\$40 001 – \$80 000	First \$40 000	—	\$550
	Next \$40 000	7	\$2800

(Adapted from www.iras.gov.sg.)

Note: For “—” under Income tax rate, refer to Gross tax payable for the amount of tax.

- (a) Calculate the amount of tax a manager has to pay if his assessable annual income is \$55 000.
- (b) To reduce the amount of tax payable, the manager makes use of the Supplementary Retirement Scheme (SRS). Each dollar deposited into the SRS reduces the assessable annual income by a dollar.
- Calculate the amount of tax savings the manager enjoys if he deposits \$15 300 into the SRS.
- (c) Suppose the manager further invests the \$15 300 he had deposited in the SRS in a savings bond which provides a compound interest of 2.63% per year for 10 years. Calculate the amount of money he has in the SRS after 10 years. Give your answer correct to the nearest dollar.

[CHIJ Katong Convent, 2018 Q24]

Answer:

(a)

First \$40 000, tax = \$550

$$\text{Next } \$15\,000, \text{ tax} = \frac{7}{100} \times 15\,000 \\ = \$1050$$

$$\text{Total Tax} = \$550 + \$1050 \\ = \$1600$$

(b)

If manager deposits \$15 300 into SRS,
his assessable annual income becomes \$39 700

First \$30 000, tax = \$200

Next \$9700, tax = \$339.50

Total tax = \$539.50

$$\text{Amount saved} = \$1600 - \$539.50 = \underline{\$1060.50}$$

(c)

$$A = P \left(1 + \frac{R}{100} \right)^n \\ = 15300 \left(1 + \frac{2.63}{100} \right)^{10} \\ = \$19835.11 \\ = \$19835$$

- 7 Mr and Mrs Tan bought a 3-bedroom unit at a newly launched condominium project at Serangoon. The unit has a floor area of 1152 square foot (sqft). The selling price for the unit is at \$1494 per sqft. The developer gives a 5% early bird discount to all buyers.

(a) Calculate the price that they paid for the unit.

Mr and Mrs Tan are both Singapore citizens and they also owned a HDB 5-room flat and they do not have any intention of selling their flat. As such, they will have to pay Additional Buyer's Stamp Duty (ABSD) to the government on top of the Buyer's Stamp Duty (BSD). Table 1 shows the BSD rate and Table 2 shows the ABSD rate.

Table 1. BSD

Based on purchase price	Rate
First \$180 000	1%
Next \$180 000	2%
Next \$640 000	3%
Remaining amount	4%

Table 2. ABSD

Based on purchase price	Rate
SC ¹ buying first residential property	NA
SC ¹ buying second residential property	12%
SC ¹ buying third and subsequent residential property	15%

SC¹ denoted Singapore Citizens

(b) Calculate the total Buyer's Stamp Duty paid by Mr and Mrs Tan.

Mr and Mrs Tan made a 20% down-payment based on the amount paid for the unit obtained in (a). For the remaining amount, which exclude the total Buyer's Stamp Duty, they had decided to sign up either for a 20-years Home Loan plan from CBCO Bank or a 30-years Home Loan plan from BSOP Bank.

(c) Determine which bank they should sign up if they can only afford a monthly instalment of not more than \$6000.

Support your answer with appropriate workings.

Simple Interest Rate for CBCO

Bank

Loan period: 20 years

1 st year:	2 nd year:
2.18% p.a.	2.18% p.a.
Thereafter: 2.68% p.a.	

Simple Interest Rate for BSOP

Bank

Loan period: 30 years

1 st year:	2 nd year:
1.95% p.a.	1.95% p.a.
Thereafter: 2.15% p.a.	

[Nan Chiau High School, 2018 Q10]

Ans:

(a) Amount paid
 $= 1152 \times 1494 \times 0.95$
 $= \$1\,635\,033.60$ [B1]

(b) BSD paid
 $= 0.01 \times 180\,000 + 0.02 \times 180\,000 + 0.03 \times 640\,000 + 0.04 \times 635\,033.60$ [M1 – First 1 mil][M1 – remaining amount]
 $= 50\,001.344$

ABSD paid
 $= 0.12 \times 1\,635\,033.60$ [M1]
 $= 196\,204.032$

Total stamp duty
 $= 50\,001.344 + 196\,204.032$
 $= \$246\,205.38$ [A1]

(c) Loan amount
 $= 0.8 \times 1\,635\,033.60$ [M1]
 $= \$1\,308\,026.88$

CBCO Bank

Interest

$= 2.18\% \times 2 \times 1\,308\,026.88 + 2.68\% \times 18 \times 1\,308\,026.88$ [M1]
 $= 688\,022.1389$

Monthly instalment

$= (688\,022.1389 + 1\,308\,026.88) \div (20 \times 12)$
[M1 for either of the monthly instalments]
 $= \$8316.87 > \6000

BSOP Bank

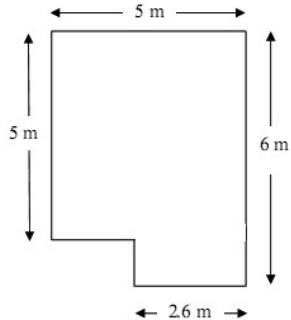
Interest

$= 1.95\% \times 2 \times 1\,308\,026.88 + 2.15\% \times 28 \times 1\,308\,026.88$ [M1]
 $= 838\,445.2301$

Monthly instalment

$= (838\,445.2301 + 1\,308\,026.88) \div (30 \times 12)$
 $= \$5962.42 < \6000

Mr and Mrs Tan should sign up with BSOP Bank as the monthly instalment is less than \$6000. [A1]

- 8 (a) Mrs Wong has a budget of \$2000 to spend on buying new kitchen flooring. A sketch of the kitchen floor plan is shown below. All angles shown in the diagram are right angles.
- 
- Mrs Wong planned to use either tiles or single colored vinyl floor covering to cover the whole kitchen floor.
- Each square tile measure 20 cm by 20 cm.
A box of 25 floor tiles costs \$66.25.
Floor tiles are only sold in complete boxes.
- The vinyl floor covering is cut to the required length from a roll.
A roll of vinyl floor covering is 1.8 meters wide and is sold at a price of \$118.70 per meter length.
It is sold in lengths measured in a whole number of meters only.
- Are both types of flooring materials within Mrs Wong's budget?
Show all your working and give reasons for your answers.
- (b) Mrs Wong saw an advertisement for a refrigerator and bought it using a payment plan. The total price of the payment plan is 12% more than the advertised price. The payments are calculated as shown.
- Deposit of one-third of total price
 - 8 equal installments of \$92.60 per month
 - Final payment of \$200
- Find the advertised price.
- (c) Mrs Wong also bought a washer which cost \$569.24, inclusive of 7% Goods and Services Tax (GST).
Find the amount of GST paid by Mrs Wong.
- [SCGS 2018 P2 Q10]

- Ans:
(a) No of boxes of tiles required
- $$= \frac{5 \times 5 + 2.6}{0.2 \times 0.2} \div 25$$
- $$= 27.6$$
- $$= 28 \text{ (whole number)}$$
- Total cost
- $$= 28 \times 66.25$$
- $$= \$1855$$
- Length required
- $$= \frac{27.6}{1.8}$$
- $$= 15.333$$
- $$= 16 \text{ (whole number)}$$
- Cost of vinyl flooring
- $$= 16 \times 118.7$$
- $$= \$1899.20$$
- Both types of floorings are within Mrs Wong's budget.
- (b) Let advertised price be A
- $$\frac{1}{3} \times \frac{112A}{100} + 8 \times 92.6 + 200 = \frac{112A}{100}$$
- $$940.8 = \frac{56A}{75}$$
- $$A = \$1260$$
- (c)
- $$\frac{569.24}{107} \times 7$$
- $$= \$37.24$$

- 9 Peter plans to buy a new car. He must successfully obtain the Certificate of Entitlement (COE) through bidding before he can own a car. Information on the current COE prices, quota and bids received for the different category of cars are in Table 1.

Table 1:

CAT A Cars up to 1600cc and 130bhp [View Past CAT A Results]			
Quota Premium	Change	Quota	Bids Received
\$25,000	↓ \$9,110	1,435	1,626

Table 2:

CAT B Cars above 1600cc or 130bhp [View Past CAT B Results]			
Quota Premium	Change	Quota	Bids Received
\$31,000	↓ \$2,900	1,288	1,637

Peter has shortlisted two cars. The specification and price details are in the Table 2.

Table 2:

Brand of car	Phantom Series X	Sky Hawk V
Engine capacity (cc)	1496	1598
Fuel type	Diesel (Euro V)	Petrol
Power (bph)	114	165
Fuel consumption (km/l)	23.8	17.8
CO2 emission (g/km)	110	130
Car Price (S\$) *excludes VES rebate / surcharge	152,888	147,999
OMV (S\$)	31,410	26,239
Road Tax per 6 months (S\$) *excludes Special Tax if any	372	372

- (i) Peter said that he has a higher chance of obtaining COE for brand Phantom as compared to Sky Hawk. Do you agree? Explain why.
A special tax is levied on diesel cars and is payable in addition to the Road Tax of the vehicle. The charge is S\$0.20 per cc for 6 months.
- (ii) Find the total amount of tax payable for 6 months for brand Phantom. Car buyers can either be granted rebates or imposed surcharge based on how clean the vehicle's emissions are. Vehicle Emission Scheme (VES) is based on a vehicle's carbon dioxide (CO₂) emissions, plus emissions of other pollutants.

Table 3:

Bands	CO ₂ (g/km)	HC (g/km)	CO (g/km)	NO _x (g/km)	Rebate/surcharge(-/+) for cars (\$)
A1	A1 ≤90	A1 ≤0.020	A1 ≤0.150	A1 ≤0.007	-20,000
A2	90< A2 ≤125	0.020< A2 ≤0.036	0.150< A2 ≤0.190	0.007< A2 ≤0.013	-10,000
B	125< B ≤160	0.036< B ≤0.052	0.190< B ≤0.270	0.013< B ≤0.024	0
C1	160< C1 ≤185	0.052< C1 ≤0.075	0.270< C1 ≤0.350	0.024< C1 ≤0.030	+10,000
C2	C2 >185	C2 >0.075	C2 >0.350	C2 >0.030	+20,000

- (i) Use Tables 2 and 3 to determine the price of brand Phantom car, including the VES rebate / surcharge, if any.

Peter decided to take a 5-year bank loan for purchase of the car.

The interest rate is at 2.78% per annum.

The Maximum Loan Amount will be dependent on the Open Market Value (OMV) of the car.

Cars with OMV exceeding \$20,000 will be entitled to a maximum loan value of 60% of car price with minimum 40% down payment.

- (ii) Calculate the minimum down payment Peter has to pay if he decides to buy brand Phantom.
- (iii) Peter decides to take a 60% loan. Suggest which car Peter should buy. Justify the decision you make and show your calculations clearly.

[Tanjong Katong Secondary School, 2018 P33 Q10]

	Answer: (i) $P(\text{brand Phantom}) = \frac{1435}{1626} \times 100\% = 88.3\%$ $P(\text{brand Sky Hawk}) = \frac{1288}{1637} \times 100\% = 78.7\%$ I agree with Peter. (ii) $\\$372 + (0.20 \times 1496)$ $= \\$671.20$ (iii) $\\$152\,888 - \\$10\,000$ $= \\$142\,888$ (iv) $0.4 \times 142\,888$ $= \\$571\,55.20$ (v) <u>For Phantom:</u> Interest = $0.6 \times \text{their (iii)} \times 2.78 \times 5$ $= \\$11\,916.86$ Total repayment (balance + interest) $= 0.6 \times \text{their (iii)} + \\$11\,916.86$ $= \\$97\,649.66$ Monthly instalment = $\\$1627.50$ <u>For Sky Hawk:</u> Interest = $0.6 \times 147\,999 \times 2.78 \times 5$ $= \\$12\,343.12$ Total repayment (balance + interest) $= 0.6 \times 147\,999 + \\$12\,343.12$ $= \\$101\,142.52$ Monthly instalment = $\\$1685.71$ Since the monthly instalment is lower / total repayment amount with interest is lower, brand Phantom is a better buy.
--	--

10

Meg would like to buy an air conditioner.

(a) Meg writes down how long she would use the air conditioning in the following table.

Monday to Thursday	6 hours each day
Friday	7 hours 15 minutes
Saturday and Sunday	8 hours each day

Find the mean length of time that she would use the air conditioner each day.

Meg is deciding between two models of air conditioner.

The next page shows information that she needs, including the electricity consumptions of the two models.

(b) Based on her usage, Meg estimates that the electricity consumptions in 1 year will be 1755 kWh for Model S and 1066.5 kWh for Model E.

Explain how she found these estimates.

(c) The total cost of an air conditioner includes its price, the cost of the electricity it consumes and the cost of servicing it.

Electricity costs 25.3 cents per kWh, including GST.

Meg would like the air conditioner to be serviced once every 4 months.

Based on her usage, which model will have a lower total cost after 7 years of use? Justify your decision with calculations.

(You should assume that the costs of electricity and servicing remain the same.)

Residential Air Conditioners

	Model S (Standard)	Model E (Energy Efficient)
Price of air conditioner	\$650	\$1300
Electricity consumption in one year	2080 kWh	1264 kWh

Notes:

- Prices include GST
- Electricity consumptions are based on 8 hours of use each day

Service Contracts

Frequency	Price per service before 7% GST
1 service every 2 months	\$25
1 service every 3 months	\$30
1 service every 4 months	\$35

Offer: **40% discount on service contract** with purchase of Model S

Answer:

$$(a) \frac{6 \times 4 + 7.25 + 8 \times 2}{7} = 6.75 \text{ hours}$$

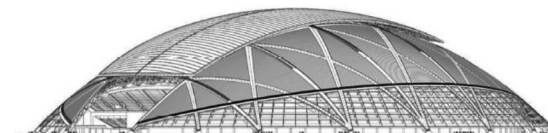
$$(b) \text{ Meg multiplied the given annual electricity consumptions by } \frac{6.75}{8}.$$

[CHIJ Katong Convent, 2018 P47 Q10]

11

(a) The National Day Parade will be held at the National Stadium in August this year.

The stadium dome shown below, may be modelled as a spherical cap (part of a hemisphere). Its volume is approximately 17.5% of the volume of a hemisphere of radius 192 metres and its surface area is approximately 33.9% of the curved surface area of the same hemisphere. The stadium is equipped with a state-of-the-art retractable roof which has two panels, each of area 10,000 m².
Source: www.static.dezeen.com



Calculate

- the estimated volume of the dome,
 - the surface area of the dome when its retractable roof is fully open.
- (b) The organizers of the 2018 National Day Parade are deciding between two companies' drinking water for the expected 55,000 maximum-capacity spectators.

The table below summarizes some information for the two brands.

	Brand A	Brand B
Packaging type	Tetra pak rectangular prism with dimensions 5.7cm × 5.3cm × 10cm	Cylindrical with radius 2.75 cm and height 12.8 cm
Material	Recycled paperboard	Plastic
Fill volume	Nearest 10 ml of pack volume	Nearest 10 ml of bottle volume
Unit cost per package	60 cents	55 cents
Bulk refund for empty packages	\$11000	\$5200

Additional information:

- Each spectator is projected to require an average of 600 ml of water during the Parade.
- The chosen package is to be environmentally-friendly where possible.
- Cost effectiveness to be taken into consideration.

Determine, with clear calculations, which brand of water should be awarded the contract. State an assumption you made to support your decision.

[Methodist Girls' School, 2018 P45 Q10]

Answer:

(c) Model S:

$$\begin{aligned} \text{Cost of electricity per year} &= 25.3 \times 1755 \\ &= 44401.5 \text{ cents} \\ &= \$444.02 \end{aligned}$$

$$\begin{aligned} \text{Cost of servicing per year before discount} &= \$35 \times \frac{12}{4} \times \frac{107}{100} \\ &= \$112.35 \end{aligned}$$

$$\begin{aligned} \text{Total cost of servicing per year} &= \$112.35 \times \frac{100 - 40}{100} \\ &= \$67.41 \end{aligned}$$

$$\begin{aligned} \text{Total cost of Model S} &= \$650 + 7 \times (\$444.02 + \$67.41) \\ &= \$4230.01 \end{aligned}$$

Model E:

$$\begin{aligned} \text{Cost of electricity per year} &= 25.3 \times 1066.5 \\ &= 26982.45 \text{ cents} \\ &= \$269.82 \end{aligned}$$

$$\begin{aligned} \text{Total cost of Model E} &= \$1300 + 7 \times (\$269.82 + \$112.35) \\ &= \$3975.19 \end{aligned}$$

Since \$3975.19 is less than \$4230.01, Model E has a lower total cost.

12

Jewel Changi Airport is set to become an iconic landmark of Singapore and a key tourist attraction. The building occupies an area of about $134\,000 \text{ m}^2$ on the ground.



- (a) A map has a scale of 1 : 7500. Calculate the area of the building on the map.
 (b) The diagram below shows the view of the building from the top. A Skytrain Bridge runs through the building at about 18 m above the ground of Forest Valley

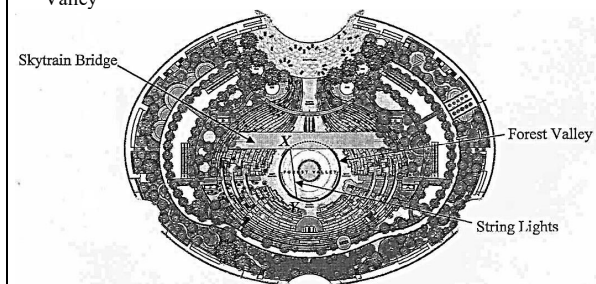


Diagram 1 [Source: Jewel Changi Development & Straits Times Graphic]

- (i) The actual circumference of the whole circular Forest Valley is about 105 m. Find the actual radius of the whole circular Forest Valley in terms of π , in metres.
 (ii) Mr. Yap, a lighting designer, plans to hang string lights from point X on the skytrain bridge, down to point Y on the ground, which is on the circumference of the Forest Valley as illustrated in diagram 1. Assuming XY is taut, he claims that he will need at least 34 m of string lights.
 Given that Z is another point on the ground, which is also on the circumference of the Forest Valley, vertically below point X , and the minor arc length ZY is 35 m, verify if his claim is true or false, by showing your working clearly.

[Commonwealth Secondary School, 2019 P29 Q11]

Answers:

(a) Area of building on the map = 23.8 cm^2 (3 sig. fig)

1 cm : 75 m

1 cm^2 : 5625 m^2

Area of building on the map = $\frac{134000}{5625}$
 $= 23.8 \text{ cm}^2$ (3 sig. fig)

(b)(i) Actual radius = $\frac{105}{2\pi} \text{ m}$

actual circumference = 105 m

$2\pi r = 105$

Actual radius = $\frac{105}{2\pi} \text{ m}$

(ii) His claim is false. (shown)

Let the centre of forest valley be O and angle ZOY be θ radian

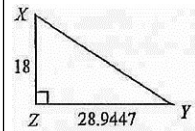
$\left(\frac{105}{2\pi}\right)\theta = 35$

$\theta = \frac{2\pi}{3}$

Using Cosine Rule,

$$YZ^2 = \left(\frac{105}{2\pi}\right)^2 + \left(\frac{105}{2\pi}\right)^2 - 2\left(\frac{105}{2\pi}\right)\left(\frac{105}{2\pi}\right)\cos\frac{2\pi}{3}$$

$YZ = 28.9447 \text{ m}$



By Pythagoras Theorem,

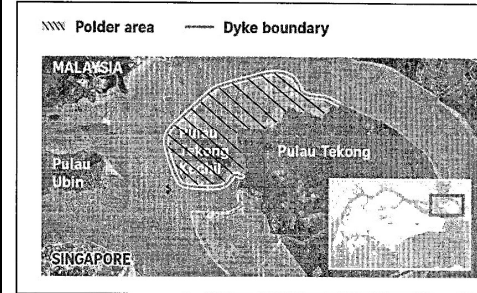
$$XY^2 = 18^2 + YZ^2$$

$XY = 34.1 \text{ m}$ (3 sig. fig)

His claim is false.

13

New Method in Land Reclamation!

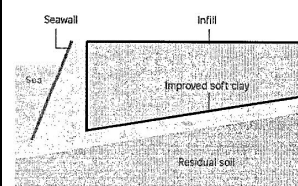


The Straits Times
Nov 16, 2016

A new method of land reclamation, known as empoldering, will be used at the north-western tip of Pulau Tekong. This method involves building a dike (embankment) around the area to be reclaimed and draining water from it, creating a low-lying tract of land below sea level, called a polder. The polder is buffered from the sea by a dike, and water levels in the polder are controlled by drains and pumps.

The dike will measure 10 km long, up to 15 m wide at its crest and stand about 6 m above sea level.

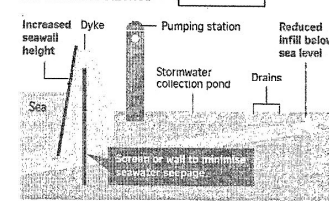
TRADITIONAL LAND RECLAMATION



How it works

"Infill" such as sand is poured into the reclaimed area above the existing seabed, which is made up of improved soft clay and residual soil.

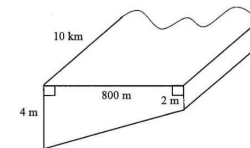
EMPOLDERING METHOD



How it works

- A dike is built around the area to be reclaimed and water is drained from it.
- This forms a low-lying tract of land called a polder, which is buffered from the sea by the dike.

The proposed land to be reclaimed using the impoldering method can be modelled using a trapezoid with uniform cross-sectional area as shown below.



- (a) Calculate the volume of sand, in cubic metres, needed to reclaim this proposed land.
- (b) This impoldering method reduces the amount of sand used by 40%. What is the estimated volume of sand needed if the traditional method is used?
- The following table shows some information about the proposed reclaimed land.

FACTS AND FIGURES	
810ha	Total polder land area is about twice the size of Toa Payoh Town.
29km	Total length of drains to be constructed.
21km	Total length of roads to be constructed, about the length of East Coast Parkway.
10km	Total length of dyke to be constructed, about the length of Bukit Timah Expressway.
Source: HOUSING & DEVELOPMENT BOARD PHOTO: GOOGLE EARTH STRAITS TIMES GRAPHICS	

- (c) Assuming the roads to be constructed on this reclaimed land are straight and of width 12 metres, express the area designated for these roads as a percentage of the polder land area.
(1 hectare = 10000 m²)
- (d) Singapore needs to purchase sand from Country *X* or Country *Y* in order to carry out the proposed reclamation work. The following shows the cost details of these two countries.

Country	Cost of Sand (\$S per tonne)	Distance from Singapore by Sea (nautical mile)	Shipment cost (\$S per every 1000 tonne per nautical mile)
Country <i>X</i>	26.37	230	65
Country <i>Y</i>	15.85	591	70

Useful Information

1 nautical mile = 1.852 km
1 tonne = 1000 kg
Density of sand = 144 kg/m³

Which country should Singapore purchase sand from?
Justify your answer.

[Nan Hua High School, 2020 P62 Q11]

Answers:

(a) Volume of sand = 24 000 000 m³

$$\text{Volume of sand} = \frac{1}{2}(2+4) \times 800 \times 10000$$

$$= 24\,000\,000\text{ m}^3$$

(b) Volume of sand = 40 000 000 m³

$$\text{Volume of sand} = \frac{100}{60} \times 24\,000\,000$$

$$= 40\,000\,000\text{ m}^3$$

(c) 3.11% (3 sf)

$$\frac{21 \times 1000 \times 12}{810 \times 10000} \times 100\% = 3.11\% \text{ (3 sf)}$$

(d) Should purchase sand from Country *X*

Cost of sand plus shipment from Country *X*

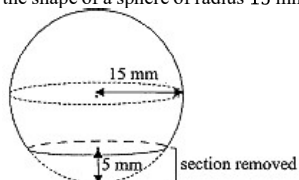
$$= \frac{24000000 \times 1442}{1000} \times \left(26.37 + \frac{65 \times 230}{1000} \right) = \$1.43 \text{ billion}$$

Cost of sand plus shipment from Country *Y*

$$= \frac{24000000 \times 1442}{1000} \times \left(15.85 + \frac{70 \times 591}{1000} \right) = \$1.98 \text{ billion}$$

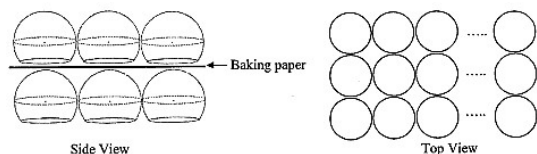
Since the cost of sand plus shipment from Country *X* is lower as compared to Country *Y*, Singapore should purchase sand from Country *X*.

- 14 Mr Samad owns a bakery that specialises in pineapple tarts. Each pineapple tart is in the shape of a sphere of radius 15 mm with its bottom part removed as shown below.



- (a) Show that the height of a pineapple tart is 25 mm.

The pineapple tarts are arranged such that after each layer, a piece of baking paper, of negligible thickness, is placed to ensure the tarts stay in place. The side and top views of how the tarts are arranged are shown below.



Mr Samad sells his pineapple tarts in rectangular containers that measure 21 cm in length, 9 cm in width and 5 cm in height.

- (b) Calculate the number of pineapple tarts in a rectangular container.

During festive seasons, the pineapple tarts are packed in cylindrical containers. The top view of each layer of the pineapple tarts is shown below.



Top View of each Layer

- (c) Calculate the diameter and the height of the cylindrical container such that it can fit the same number of pineapple tarts in (b).

During one of the festive seasons, Mr Samad received a bulk order of 250 containers of pineapple tarts.

He decided to use a courier service to deliver the pineapple tarts. He has a choice of 2 courier services: GoVan and Singapost. Both courier services offer no weight limit and charge based on the size of goods. The cylindrical containers are packed in cardboard boxes based on the courier service's requirement.

To prevent the pineapple tarts from breaking, Mr Samad packs each cylindrical container upright as shown below.



The rates of the two courier services are as follow.

GoVan	Singapost
Max. 8 boxes per trip Handling fee per box: \$5 Rate per trip: \$25 base charge + \$0.80/km	Max. 8 boxes per trip Handling fee per box: \$3.50 Rate per trip: \$30 base charge + \$0.50/km

- (d) Given that the trip distance is 23.7 km, which courier service should Mr Samad use? Support your answer with clear workings.

[CHIJ St. Nicholas Girls' School, 2020 P52 Q10]

Ans:

- (a) Height of pineapple tart = 25 mm (shown)
 (b) 42
 (c) 15 cm
 Mr Samad should use Singapost as it is cheaper.

Ans:

- (a) Height of pineapple tart = $30 - 5$ or $15 + 10$
 = 25 mm (shown)
 (b)
 No. of pineapple tarts = $(21 \div 3) \times (9 \div 3) \times (5 \div 2.5)$
 = $7 \times 3 \times 2$
 = 42
 (c)
 Diameter = 9 cm
 Height = $\frac{42}{7} \times 2.5$
 = 15 cm

(d)

GoVan

$$\begin{aligned} \text{No. of containers per box} &= (50 \div 9) \times (50 \div 9) \times (50 \div 15) \\ &\approx 5 \times 5 \times 3 \\ &= 75 \\ \text{No. of boxes required} &= 250 \div 75 \\ &= 3\frac{1}{3} \\ &\approx 4 \end{aligned}$$

$$\begin{aligned} \text{Cost} &= \text{handling fee} + \text{base charge} + \text{charge per km} \\ &= (4 \times 5) + 25 + (0.8 \times 23.7) \\ &= \$63.96 \end{aligned}$$

Singapost

$$\begin{aligned} \text{No. of containers per box} &= (55 \div 9) \times (50 \div 9) \times (40 \div 15) \\ &\approx 6 \times 5 \times 2 \\ &= 60 \\ \text{No. of boxes required} &= 250 \div 60 \\ &= 4\frac{1}{6} \\ &\approx 5 \end{aligned}$$

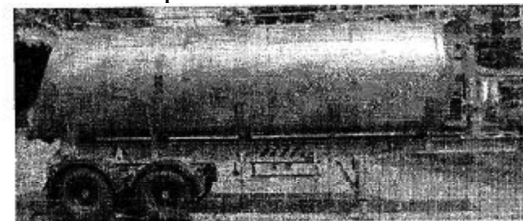
$$\begin{aligned} \text{Cost} &= \text{handling fee} + \text{base charge} + \text{charge per km} \\ &= (5 \times 3.5) + 30 + (0.5 \times 23.7) \\ &= \$59.35 \end{aligned}$$

Mr Samad should use Singapost as it is cheaper.

15

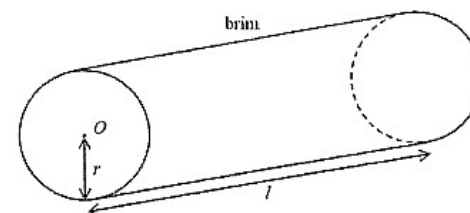
The tables below show the specifications of an empty oil tanker and a pumping pipe.

Specifications of Oil Tanker



(Picture taken from: <http://www.ccsaiz.com/products/fluidic-gas-tail-road-tankers/reinforced-alloy-tankers/>)

- Radius (r) : 0.9 m
- Length (l) : 10.4 m
- Model : cylindrical as shown below. Point O is the centre of circular cross section



- Safety information: the oil tanker can only be filled up to 15 cm from its brim

Specifications of Pumping Pipe

- Radius (r) : 4.8 cm
- Maximum flow of oil : 350 cm/s
- Model : cylindrical

- (a) Calculate the cross-sectional area, in square metres, of the tank.
 (b) To provide an extra protection to the container, the external area has to be painted by a special paint.
 A tin of paint can be used to polish an area of 8.5 m^2 .
 Find the number of tins required to paint the container.
 (c) A pumping pipe is used to fill the container with oil.
 Calculate the minimum time, in minutes, needed to fill the container to its safe volume.

[Zhonghua Secondary School, 2020 P50 Q10]

Answer:

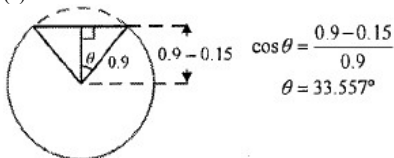
(a)

$$\begin{aligned}\text{cross sectional area} &= \pi(0.9)^2 \\ &= 0.81\pi \\ &= 2.54 \text{ m}^2\end{aligned}$$

(b)

$$\begin{aligned}\text{total surface area} &= 2(0.81)\pi + 2\pi(0.9)(10.4) \\ &= 20.34\pi \\ \text{number of tins required} &= \frac{20.34\pi}{8.5} \\ &= 7.5176 \\ &= 8 \text{ (rounded up to nearest integer)}\end{aligned}$$

(c)



$$\begin{aligned}\text{area of major segment} &= \frac{1}{2}(0.9)^2 \sin(2 \times 33.557^\circ) + \frac{360^\circ - 2 \times 33.557^\circ}{360^\circ} \times \pi(0.9)^2 \\ &= 2.44340\end{aligned}$$

$$\begin{aligned}\text{Volume of fuel required} &= 2.44340 \times 10.4 \\ &= 25.41136\end{aligned}$$

$$\text{Maximum rate flow} = \pi(0.048)^2(3.5)$$

16

A class of students plans to sell breakfast sets during the National Day carnival in order to raise funds for a charity.

Each breakfast set consists of 2 scrambled eggs, 2 slices of toast, 2 sausages, and a cup of coffee.

The estimate that they will sell 250 breakfast sets.

Item	Description	Unit cost
Eggs	Pasar Fresh Eggs(10 per pack)	\$1.80
	Pasar Fresh Eggs(30 per pack)	\$4.35
Bread	Sunshine Enriched soft white Bread(14 slices)	\$1.80
	FairPrice Wholemeal Bread(12 slices)	\$1.55
Sausages	Tierney's Chicken Hot Dog (10 per pack)	\$5.25
	FairPrice Sausages (6 per pack)(\$0.35 offer per 2 packs)	\$3.20
Coffee	Nescafe 3 in 1 Instant coffee (35 per pack)(Buy 5 get 1 free)	\$6.15
	Gold Roast 3 in 1 Coffee mix (25 per pack)	\$3.95

- (a) Find the lowest possible total cost of the ingredients for the breakfast sets.
- (b) The school provides \$200 in funding for the students, and up to 30% of the sales can be used to cover for their expenses, while the remaining goes to the charity.
- The students also wish to raise at least \$600 for charity, Find the minimum they must charge for each breakfast set (to the nearest ten cents)
- Justify your answer, showing all necessary workings clearly.
- State an assumption you have made in your calculations.

[Beatty Secondary School, 2019 P41 Q11]

Answers:

(a) Total Cost = \$428.65

	Cost		
Eggs	<u>10 per pack</u> (50)(1.80) = 90	<u>30 per pack</u> (17)(4.35) = 73.95	<u>Mix</u> (16)(4.35) + (2)(1.80) = 73.20
Bread	<u>Sunshine</u> (36)(1.80) = 64.80	<u>FairPrice</u> (42)(1.55) = 65.10	<u>Mix</u> (35)(1.80) + (1)(1.55) = 64.55 (28)(1.80) + (9)(1.55) = 64.35 (34)(1.80) + (2)(1.55) = 64.30 (10)(1.80) + (30)(1.55) = 64.50
Sausages	<u>Tierney's</u> (50)(5.25) = 262.50	<u>FairPrice</u> (84)(3.20)- (42)(0.35) =254.10	<u>Mix</u> (82)(3.20)- (41)(0.35)+(1)(5.25) =253.30 (80)(3.20)- (40)(0.35)+(2)(5.25) =252.5
Coffee	<u>Nescafe</u> (7)(6.15) = 43.05	<u>Gold Roast</u> (10)(3.95) = 39.50	<u>Mix</u> (5)(6.15)+(2)(3.95) = 38.65

Total Cost = 73.20 + 64.30 + 252.50 + 38.65 = \$428.65
(not lowest cost per item used: M1 for each correct item, no A1)
(insufficient quantities purchased: M0)

(b) $\therefore$ charge = \$3.40

Assume no cost incurred for cooking. (or any reasonable)

$$\text{min charge to raise \$600} = \frac{(428.65 - 200) + 600}{250} = \$3.3146 \quad \text{--- M1 (ECF their (a))}$$

$$\left(\frac{30}{100}\right)(3.3146)(250) = 248.595 > 431.60 - 200 \quad \text{--- M1 (ECF their (a))}$$

$$\therefore \text{min charge} = \$3.40 \quad \text{--- A1}$$

Assume no cost incurred for cooking. (or any reasonable)

OR

$$\text{min charge to raise \$600} = \frac{(428.65 - 200) + 600}{250} = \$3.3146 \quad \text{--- 1}$$

$$\text{min charge to cover expenses} = \left[\frac{(428.65 - 200)}{30} \times 100 \right] + 250 = \$3.048$$

$$\therefore \text{charge} = \$3.40$$

Assume no cost incurred for cooking. (or any reasonable)

Alternative assumptions:

- 1) No accidents that result in wastage during the event
- 2) No free samples were given out
- 3) All 250 sets were sold

- 17 Insurance company Anova is offering life insurance priced at \$50 000 which covers a person for life. A client has the option of paying the insurance over 15 years at an annual simple interest rate of 3%.

(a) Calculate the amount of money Mr Tan has to pay over 15 years.

Anova is offering an insurance savings plan which pays out an interest rate of 5.6% compounded annually. Mr Tan decides to invest \$27 500 in the insurance savings plan at the age of 44 and the amount in the savings plan will commence paying off his premium at the age of 59.

He further decides to invest a certain sum of money in a foreign Government Bond which pays out 2% compounded annually over the next 20 years.

(b) Calculate the amount in his insurance savings plan after 15 years.

The insurance savings plan can be used to pay the insurance premium of the client after 15 years. The insurance premium paid for year is shown in the table below. The insurance premium will commence deduction from the amount in the savings plan at the 15th year (on 1st January). After the amount in the insurance savings plan is used up, the client can top up with their own money to continue funding the insurance premium.

A client born in 1976 is taken to be 44 years old on 1st January 2020 regardless of date of birth.

Age Range	Premium Per Year (\$)
40-44	4 000
45-49	4 250
50-54	4 500
55-59	4 750
60-64	5 000
65-69	5 250
70-74	5 500
75-79	5 750
80-84	6 000
85-89	6 250

To insure himself, Mr Tan can either take up

Option 1: the life insurance plan or

Or Option 2: take up the insurance savings plan on top of investing in the foreign Government Bond.

The average life expectancy of a male in Singapore is reported to be 81 years.

(c) By working out the amount of money Mr Tan has to invest in the foreign Government Bond, provide a reasonable financial advice to Mr Tan on which option he should take up to insure himself up to his expected lifespan.

[Tanglin Secondary School, 2020 P47 Q17]

Answers:

(a) Amount he has to pay over 15 years = \$72500

Amount he has to pay over 15 years

$$= 50000 + \frac{50000 \times 3 \times 15}{100}$$

$$= \$72500$$

(b) Amount in his savings plan after 15 years = \$62271.81

Amount in his savings plan after 15 years

$$= 27500 \left(1 + \frac{5.6}{100} \right)^{15}$$

$$= \$62271.81$$

(c) He should go for insurance savings plan since he plays less than life insurance.

Duration the savings plan can pay the premium

$$\$62271.81 - 4750 - 5(5000) - 5(5250) - 5500 = \$771.81$$

Means can pay until 70 years old with a remaining amount of \$771.81

(Student assumes Mr. tan will live till 81 years old)

Remaining amount of premium to be paid till Mr. Tan dies at 81 years old.

$$= 4(5500) + 5(5750) + 2(6000)$$

$$= \$62750$$

Amount he needs to invest in the foreign government bond

$$= \$62750 - \$771.81$$

$$= \$61978.19$$

$$P(1 + 0.2)^{20} = 61978.19$$

$$P = \$41709.55$$

Total amount of money invested in insurance savings plan and foreign bonds

$$= \$27500 + \$41709.55 = \$69209.55$$

He should go for insurance savings plan since he plays less than life insurance.

- 18 Mr. and Mrs. Tan decided to bring their two children of age 8 and 12 years-old to Bali during December holiday, from 1 December 2020 to 3 December 2020.

Mr Tan found the following two flights information from www.skyscanner.com.

Option A:

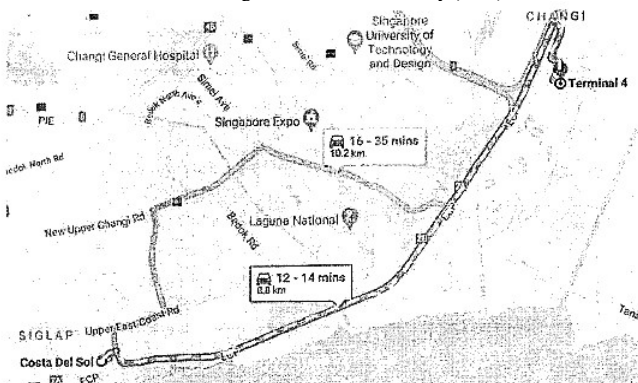
10:30 SIN	2h 50 Direct	13:20 DPS	2 nights from \$229 \$710 total
22:20 DPS	2h 40 Direct	01:00 ⁺ SIN	Select

Option B:

15:20 SIN	2h 45 Direct	18:05 DPS	2 nights from \$229 \$710 total
22:20 DPS	2h 40 Direct	01:00 ⁺ SIN	Select

Mr Tan would like to reach Bali Denpasar (DPS) International Airport by 4 pm.

- (a) Which option will you advise Mr Tan to choose? Justify your answer.
(b) According to Google Maps, Changi Airport Terminal 4 is 8.8 km away from their home at Costa Del Sol using the East Coast Parkway (ECP).



Using the information provided by Google Maps, calculate the **minimum average speed in km/h** of the taxi traveling from Costa Del Sol to Changi Airport Terminal 4 using the East Coast Parkway (ECP).

Mr Tan found the following information online while planning for the holiday. The family intends to stay in one of the two accommodations below and visit the waterpark, Waterbom.

Figure 1. Accommodation information from www.agoda.com.

SINGLE DAY PASS		Start from IDR 327,000	CLOSE
CHILD	2-11 years old	IDR 327,000	0
ADULT	12 years and above	IDR 455,000	0
FAMILY	2 Adults 2 Children (2-11 years old)	IDR 1,435,000	0

Figure 2. Waterbom Admission Ticket prices.

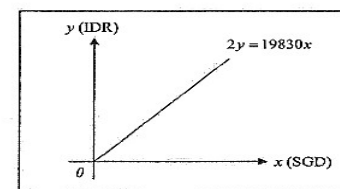


Figure 3. Exchange Rate between Singapore Dollars (SGD) and Indonesian Rupiah (IDR).

- (c)
- The exchange rate between SGD and IDR is in the form $\text{IDR } 1000 = \text{SGD } k$.
 - Mr Tan intends to book the accommodation for 2 nights and purchase the Waterbom admission tickets online. Will both accommodation allow him to **keep the total cost** (excluding food and transportation) under SGD \$430? Justify your answer and show your calculations clearly. (You may continue your working in the next page if needed)

[Peicai Secondary School, 2020 P54 Q17]

Answers:

(a) Answers:

(a) Option A, as taking Option B will cause him to reach after 6 pm.

(b) min. average speed = $\frac{8.8}{14 \div 60} = 37.7$ km/h

(c)(i) $k = 0.1008 = 0.10$

(ii)

Bali Rani Hotel

Accommodation = \$262

Waterbom admissions = $3(455\,000) + 327\,000 = 1692\,000$ IDR

In SGD, Waterbom = \$170.55

Total = \$432.55 > 430

Bintang Bali

Accommodation = \$296

Waterbom admissions = $0.75 \times 170.55 = \$127.91$

Total = \$423.91 > 430

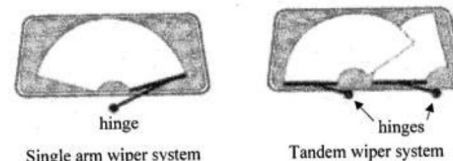
Conclusion

No, only Bintang Bali will allow Mr Tan to keep the total cost under SGD \$430.

19

A windscreen wiper helps clear away water or snow from the windscreen so that drivers can see the road clearly.

There are two types of wipers, namely the single arm wiper system or the tandem wiper system.



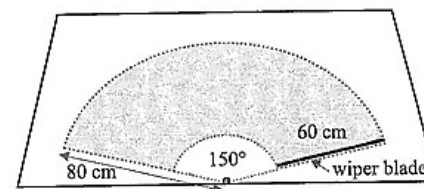
Single arm wiper system

Tandem wiper system

In both systems, wipers rotate about a hinge.

Areas covered by the two systems are different.

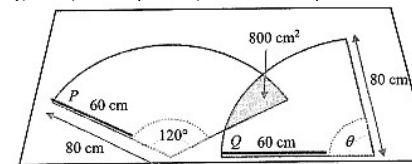
- (a) In a single arm wiper system, the wiper blade length is 60 cm.
The length from the tip of the wiper to the hinge is 80 cm.
The angle subtended at the hinge during one full swipe is 150° .



Single arm wiper system

Show that the perimeter of the region (shaded portion) covered by wiper blade is 382 cm, correct to the nearest cm.

- (b) In a tandem wiper system, wiper blades P and Q of lengths 60 cm each clean the windscreen simultaneously. The tip of each blade is 80 cm from the hinge.
The angles subtended at the hinge during one full swipe by P and Q are 120° and θ respectively.
The total area covered by both wipers is 9980 cm^2 .
The intersecting area (shaded portion) of the two wipers is 800 cm^2 .

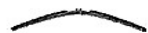


Tandem wiper system

Calculate the area covered by wiper Q .

- (c) Both wiper blade and arm have to be replaced periodically due to wear and tear. Mr Smith is currently driving a large family car which uses the tandem wiper system (2 wiper arms and 2 wiper blades). Wiper blades have to be replaced every 6 months. The combined length of wiper and arm should cover about 80% of the height of the windscreen. Mr Smith uses the following information to work out the replacement cost.

Dimension of Windscreen				
Car Type	Mini	Small family	Large family	SUV
Height	60 cm	75 cm	85 cm	100 cm

Wiper Blade 		Wiper Arm 		
Length of blade and arm combined (inches)	Cost of wiper blade	Material of wiper arm	Cost of wiper arm	Durability
22	\$24	Plastic	\$12	6 months
25	\$28	Stainless Steel	\$16	1 year
27	\$32	Aluminium	\$30	2 years
30	\$34			
33	\$36			
35	\$38			
37	\$40			
39	\$42			
42	\$45			

1 inch = 2.54 centimetres

Mr. Smith has the loyalty card which entitles him a 5% discount for wiper arm only.
Please advise Mr Smith what to purchase and why?
Assuming that both wiper blades have the same length.

[Queenstown Secondary School, 2020 P45 Q10]

Answers:

(a) Shown
Perimeter covered =

$$\frac{150}{360} \times 2\pi(80) + \frac{150}{360} \times 2\pi(20) + 60 + 60$$

$$= 381.7993878$$

$$\approx 382 \text{ cm (shown)}$$

(b) Area (Q) $\approx 4500 \text{ cm}^2$
Area covered by wiper P

$$= \frac{120}{360} \times \pi(80)^2 - \frac{120}{360} \times \pi(20)^2$$

$$= 6283.185307 \text{ cm}^2$$

$$6283.185307 + \text{Area(Q)} - 800 = 9980$$

$$\text{Area(Q)} = 9980 - 6283.185307 + 800$$

$$= 4496.814693$$

$$\approx 4500 \text{ cm}^2$$

- (c) He should purchase 27 inch blades and aluminium arms.

$$\text{Height of windscreen} = \frac{1}{2.54} \times 85 \approx 33.46 \text{ inches}$$

$$80\% \times 33.46 \approx 26.8 \text{ inches}$$

Recommended combined length he should purchase is 27 inches.

Cost of blades + plastic arms

$$= \$32 \times 2 + \$12 \times 2 \times 0.95 = \$86.80 \text{ (for 6 months)}$$

Cost of blades + steel arms

$$= \$32 \times 4 + \$16 \times 2 \times 0.95 = \$158.40 \text{ (for 1 year)}$$

$$= \$79.20 \text{ (for 6 months)}$$

Cost of blades + aluminium arms

$$= \$32 \times 8 + \$30 \times 2 \times 0.95 = \$313 \text{ (for 2 years)}$$

$$= \$78.25 \text{ (for 6 months)}$$

- 20 The cash price of a new motorcycle is \$25 120. Jack paid a down payment of 20% of the price of the motorcycle and the balance with a fixed simple interest rate of 4% per annum for a period of 3 years.

(a) Calculate his monthly instalment.

The technical specification of his new motorbike, as stated by the manufacturer, is shown in

Table 1

Fuel capacity:	3.7 gallons
Fuel efficiency:	6 litres /100 km
Dimension front tyre:	120 / 70 R17
Dimension rear tyre:	180 / 55 R17
Recommended replacement:	Front tyre, every 6000 km
	Rear tyre, every 2900 km

Conversions:

1 gallon = 3.785 litres

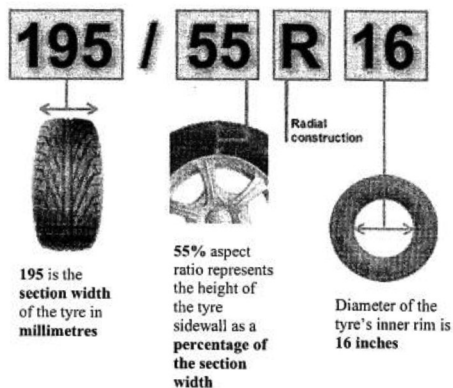
1 inch = 2.54 cm

(b) Find the fuel capacity of his motorbike, correct to the nearest litre.

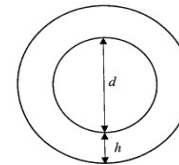
Jack starts riding with a full tank of petrol. After riding for a total distance of 190 km, he filled up the petrol tank to the brim again, by pumping 13 litres of petrol.

(i) Determine if the fuel efficiency stated by the manufacturer in Table 1 is true.

An **example** of the dimensions for a motorbike tyre **195 / 55 R16** is explained below.



The cross-section of a wheel can be presented in **Diagram II**, where d is the diameter of inner rim, and h height of the sidewall.



- (c) Jack replaces his tyres at the recommended distance travelled. What would be the number of complete revolutions made, when Jack has to **first** replace a **front tyre**? Use the information in **Table 1** and show your calculations clearly.

[Tanjong Katong Secondary School, 2020 P54 Q12]

Answers:

(a) \$625.21

Principal = 0.8×25120

= \$20096

Monthly instalment

$$= \frac{(Their_P + Their_P \times 0.04 \times 3)}{36}$$

= \$625.21

(b)(i) $3.785 \times 3.7 = 14l$

(ii)

6l → 100 km

13l → 216.67 km

It is not true because he travelled less than 216.67 km. fuel efficiency is lower than stated.

Or

190km → 13l

100km → 6.84l

It is not true because it consumes more than 6 litres. Fuel efficiency is lower than stated.

Or

100 km used 6 litres.

190 km used 11.4 litres

It is not true because he should have just used 11.4 litres, not 13 litres. Since he used up more than 11.4 litres, fuel efficiency is lower than stated.

Or

13 litres travel 190km

6 litres travel 87.7km

It is not true as he only travelled 87.7km instead of 100km with 6 litres. Fuel efficiency is lower than stated.

Or comparison for how much distance can be travelled per 1 litre:

13 litres travel 190km (actual)

1 litre travel 14.61km (actual)

6 litres travel 100km (as stated)

1 litre travel 16.67km (as stated)

Since he can only travel 14.61km per litre of petrol instead of 16.67 km per litre of petrol as stated, fuel efficiency is actual lower.