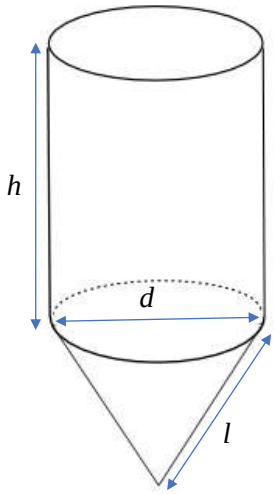
EQUITY
LEARNING PLACE

Elementary Math Topical (Real World Context)

Question 1:

A water tower can be modelled by a three-dimensional figure. The water tower is made of a cylinder and a cone.



Height of cylinder (h): 20.8 m

Diameter (d): 6.4 m

Slant height (l): 8.5 m

Mass of empty tower: 5 000 kg

Safety Regulation:

The support structure should only hold 90% of its maximum load.

a) Find the height of the cone.

b) The supporting structure for the tower is able to support a total mass of 700000kg. If water weighs approximately 1000 kg per m^3, determine if the water tower is abiding by safety regulations if the tank is filled up to 80% of its capacity. Recommend what is the maximum capacity the tank should be filled with water.

a)

$$l^2 = r^2 + h^2$$

$$8.5^2 = 3.2^2 + h^2$$

$$h = 7.87464 \approx 7.87 \text{ m}$$

b)

$$\text{Load Support Structure can hold} = \frac{90}{100} \times 700000 = 630000 \text{ kg}$$

$$630000 \text{ kg} = \frac{630000}{1000} = 630 \text{ m}^3$$

$$\text{Volume of tank} = \frac{1}{3} \times \pi(3.2)^2(7.87464) + \pi(3.2)^2(20.8) = 753.57628 \text{ m}^3$$

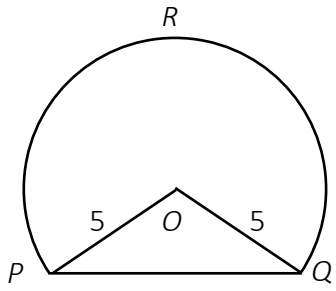
$$80\% \text{ of tank} = \frac{80}{100} \times 753.57628 = 602.86 \text{ m}^3$$

Yes, the water tower is within the safety regulation. The maximum capacity is 630 m^3.

Elementary Math Topical (Real World Context)

Question 2:

The cross-section of a tunnel, shown in the figure below, is a major segment of a circle with centre *O* and radius 5 m. The total perimeter of the major sector *POQR* is 29 m.

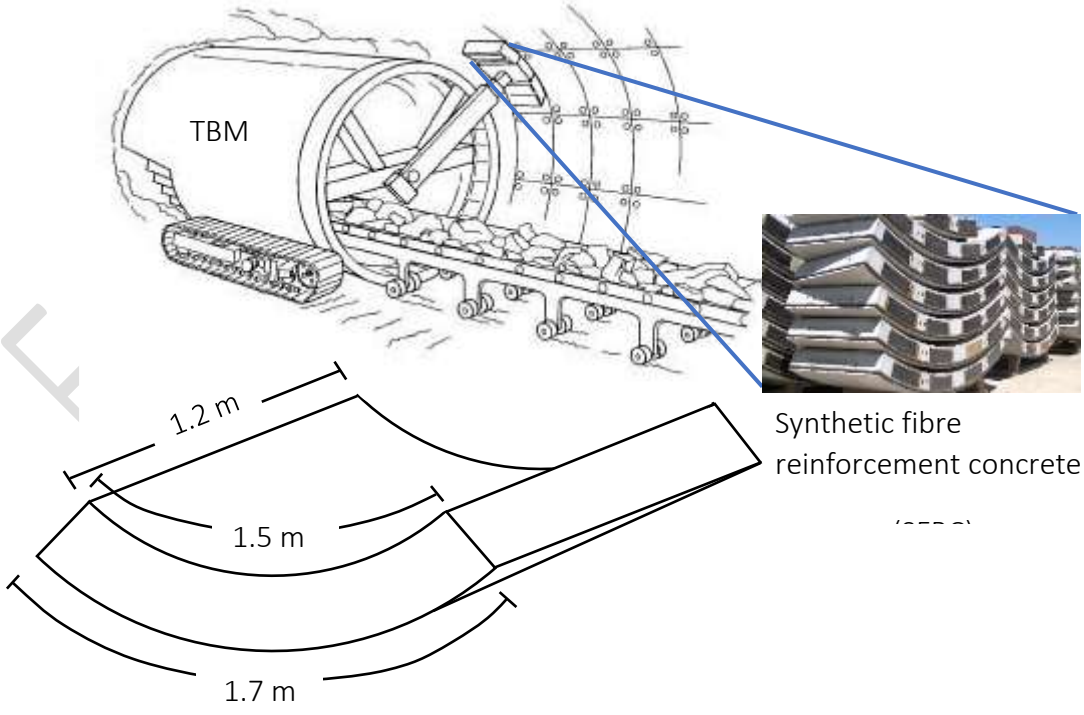


a) Show that the magnitude, in radian, of reflex angle *POQ* = 3.8 radians

b) Calculate the area of triangle *POQ*,

c) Calculate the total cross-section area of the tunnel.

d) Underground tunneling requires the use of a tunnel-boring machine (TBM) to slice into the rock and at the same time provide support. A permanent lining is installed to provide support and to keep the tunnel in place. The permanent lining involved layering prefabricated synthetic fibre reinforcement concrete (SFRC) at the curved surface of the tunnel.



d) The SFRC has length, inner rim and outer rim 1.2 m, 1.5 m and 1.7 m respectively. SFRCs are sold in a cartons of 18. Given that a construction company needs to complete a 26-km long tunnel using the TBM machine, suggest the number of SFRC cartons needed. Justify your answer and show your calculations clearly.

a)

$$29 = 5\theta + 5 + 5$$

$$\theta = 3.8 \text{ radians}$$

b)

$$\angle POQ = 2\pi - 3.8$$

$$\text{Area of triangle} = \frac{1}{2}(5)(5)\sin(2\pi - 3.8) = 7.682236 \approx 7.68 \text{ m}^2$$

c)

$$\text{Area of cross sectional} = \frac{1}{2}(5)^2(3.8) + 7.682236 = 55.14822 \approx 55.1 \text{ m}^2$$

d)

$$\text{Major arc length } PRQ = 29 - 5 - 5 = 19 \text{ m}$$

$$\text{Number of SFRC required for every 1.2 m} = 19 \div 1.7 = 11.176 \approx 12$$

$$\text{Number of pieces for 26 km} = \frac{26000}{1.2} = 21666.666 \approx 21667$$

$$\text{Total SFRC} = 12 \times 21667 = 260004$$

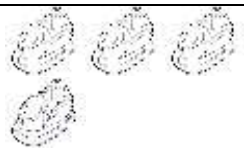
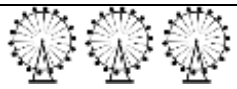
$$\text{Number of carton} = \frac{26004}{18} = 14444.666 \approx 14445 \text{ cartons}$$

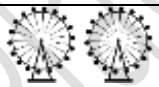
Assuming SFRC can be cut and once cut remaining SFRC cannot be reused.

Elementary Math Topical (Real World Context)

Question 3:

Puteri and Ray decided to spend the evening at their neighbourhood funfair amusement rides. The two rides are Bumper Car and Ferris Wheel. Their tickets are stamped each time they ride the Bumper car or the Ferris wheel. At the end of the evening, they have the following tickets

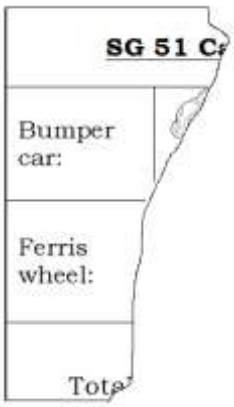
SG 51 Carnival	
Bumper Car:	
Ferris Wheel:	
Total cost: $27.50	

SG 51 Carnival	
Bumper Car:	
Ferris Wheel:	
Total cost: $19.50	

a) Given that *x* represents the cost of a Bumper Car ride and *y* represents the cost of a Ferris Wheel ride, show that $8x + 6y = 55$.

Form another equation and find the cost of one Bumper Car ride and one Ferris Wheel ride.

While queuing up to pay, Puteri overheard an argument between a staff and a funfair visitor, Mr Wong. His ticket was torn and the information on the ticket was not complete as shown below.



b) Mr Wong claims that he has a total of 11 stamp chops on his ticket and the total cost is $42.

Do you think Mr Wong's statement is valid? Justify your answer.

a)

$$4x + 3y = 27.5$$

$$8x + 6y = 55 - -(1)$$

$$3x + 2y = 19.5$$

$$9x + 6y = 58.5 - -(2)$$

$$(2) - (1): \quad x = 3.5$$

$$y = 4.5$$

Bumper Car ride: \$3.50 and Ferris Wheel ride: \$4.50.

b) Let z be the number of Bumper Car ride

$$3.5z + (11 - z)(4.5) = 42$$

$$3.5z + 49.5 - 4.5z = 42$$

$$z = 7.5$$

Since z is not a whole number, Mr Wong's claim is invalid.

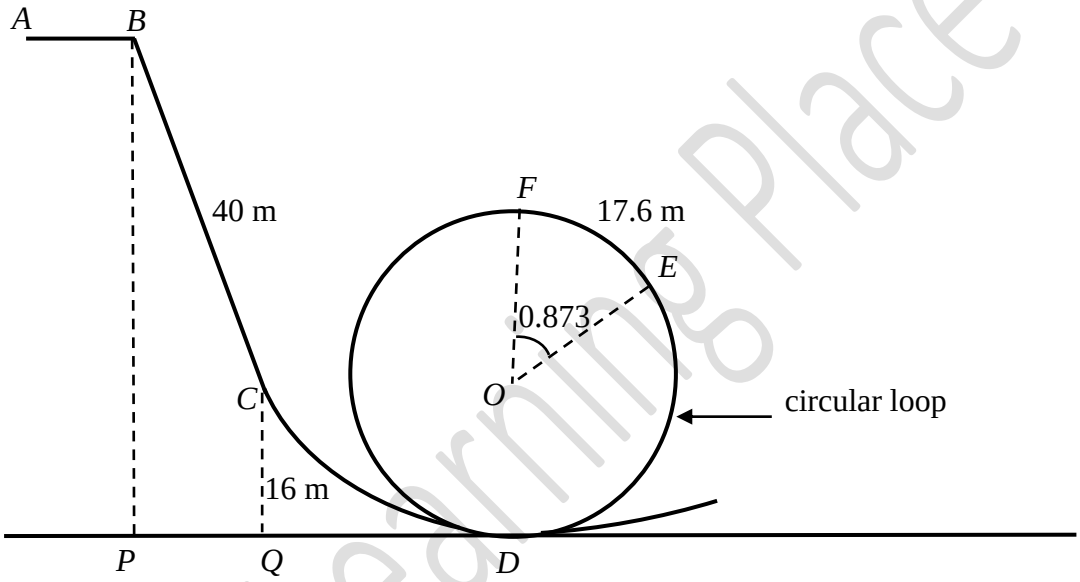
Elementary Math Topical (Real World Context)

Question 4:

A new roller coaster ride is under construction in an amusement park.

Part of the initial section of the roller coaster ride can be modelled by a simplified framework *ABCDEF.*

AB is a horizontal line and *BC* is a straight line. *D, E* and *F* are points on the circular loop with centre *O*. *P, Q* and *D* are points on horizontal ground. *BC* = 40 m and *C* is at a vertical height of 16 m above the ground.



a) For this framework, when the roller coaster turns through an angle of 0.873 radians from *E* to *F*, the distance covered is 17.6 m. Calculate the radius of the circular loop.

b) At the top of the loop, the normal force, F_N, exerted by the tracks on the roller coaster depends on the centripetal force as well as on the weight of the roller coaster and the passengers. F_N can be modelled by the formula

$$F_N = \frac{mv^2}{r} - mg$$

where the centripetal force is $\frac{mv^2}{r}$ and the weight is mg.

[*m* is the total mass, *v* is the speed of the roller coaster, *r* is the radius of the loop and *g* is the acceleration due to gravity]. The roller coaster must move fast enough such that $F_N \geq 0$ to prevent people on the roller coaster from falling off.

i) State the value of F_N at which the minimum required speed of the roller coaster occurs.

ii) Given that g = 9.8 m/s^2, show that the minimum required speed of the roller coaster is 14.1 m/s.

c) At the start of the ride, the roller coaster is at *B* and has potential energy, mgH , where *H* metres is the starting height *BP*. At the top of the circular loop, the roller coaster has energy $mgh+\frac{1}{2}mv^2$, where *h* metres is the height of *F* above the ground.

Based on **conservation of energy,** assuming negligible friction,

$$mgH = mgh+\frac{1}{2}mv^2$$

i) Express *H* in terms of *g, h* and *v*.

For the roller coaster to make it around the loop safely, there is a **minimum starting height requirement** such that the roller coaster will be able to make it to the top of the circular loop with the minimum required speed. Given that the angle of depression of *C* from *B* is $70°$, determine if the starting height *BP*, based on the given model, satisfies the minimum height requirement for the roller coaster to go around the loop safely.

a)

$$17.6 = r(0.873)$$

$$r = 20.16036 \approx 20.2 \text{ m}$$

bi)

$$F_N = 0$$

bii)

$$0 = \frac{mv^2}{20.16036} - m(9.8)$$

$$\frac{v^2}{20.16036} = 9.8$$

$$v = 14.0560 \approx 14.1 \text{ m/s}$$

ci)

$$mgH = mgh+\frac{1}{2}mv^2$$

$$H = h+\frac{v^2}{2g}$$

Starting height $BP = 40 \sin 70 + 16 = 53.58770$ m

Min. starting height to achieve minimum velocity $= H = 40.32072 + \frac{(14.0560)^2}{2(9.81)} = 50.390$ m

Yes, the height BP is greater than the minimum height required.

Elementary Math Topical (Real World Context)

Question 5:

a) Susan decided to have her lunch at McDonald's. She is on a special diet and wants a meal that consists of a main, a side and a drink such that:

- the energy is more than 500 kcal,
- the dietary fibre is at least 4 g, and
- the total fat is less than 20 g.

You are given the information below:

Mains	Energy	Total Fat	Dietary Fibres
Fish-O-Fillet	332 kcal	13 g	2 g
Hamburger	252 kcal	8 g	2 g
McChicken	385 kcal	17 g	3 g
Sides	**Energy**	**Total Fat**	**Dietary Fibres**
Apple Slices	30 kcal	0 g	1 g
Corn Cup 3 oz	66 kcal	1 g	2 g
Small French Fries	283 kcal	14 g	2 g
Drinks	**Energy**	**Total Fats**	**Dietary Fibres**
Small Coke	153 kcal	0 g	0 g
Small Milo	228 kcal	6 g	0 g
Small Orange Juice	145 kcal	0 g	0 g

Suggest a meal to Susan such that it satisfies her criteria. You must show your working clearly.

b) An individual weighing around 46 kg can burn an average of 86 kcal by walking 2.4 km. Susan weighs 46 kg and walks 2.4 km a day as her form of exercise. How many complete days must she take to burn the amount of calories in a packet of Small French Fries by walking? Ignore the metabolic effect from other physical activities.

c) The body mass index (BMI) is commonly used as an indicator to determine whether one's weight is in the healthy range or not. **BMI can be derived by dividing one's weight over the square of one's height.** The categories for the BMI scores, according to the National Institute of Health, are as follows:

BMI Score	Categories
Below 18.5	Underweight
18.5 to 24.99	Healthy
25 to 30	Overweight
Over 30	Obese

i) Susan weighs 46 kg and is 1.57 m tall. Based on her BMI, is she in the healthy range? Show your working clearly.

ii) If Susan wants to be very sure that she is within the healthy BMI range, what is the range of her weight that she must maintain?

a) Filet-O-Fish + Corn + Coke

$$\text{Energy} = 332 + 66 + 153 = 551 \text{ kCal}$$

$$\text{Fat} = 13 + 1 = 14 \text{ g}$$

$$\text{Dietary Fibre} = 2 + 2 = 4 \text{ g}$$

b)

$$\text{Number of days} = \frac{283}{46} = 6.15 \approx 7 \text{ days}$$

ci)

$$\text{BMI} = \frac{46}{1.57^2} = 18.7$$

Yes, she is in the healthy range.

cii)

$$18.5 < \frac{x}{1.57^2} < 24.99$$

$$45.6 < x < 61.6$$

Elementary Math Topical (Real World Context)

Question 6:

James owns a t-shirt printing company. James provides self-collection or delivery options for the completed printed t-shirts. Each t-shirt will be packed in a clear self-seal plastic bag.

James receives an order for 45 t-shirts with the following requirements:

- Vinyl Printing
- Dry Fit
- Same design for all pieces on the front of t-shirt only
- Number of colours: 1

Any additional information that James needs is on the next page.

a) How much will it cost to print 45 t-shirts?

James can only accept 400 of such t-shirt orders per month.

b) Calculate the total cost for vinyl paper for one month.

In the month of March, there was a bulk order of 400 t-shirts for a cohort camp with the above requirements. The school requires the shirts to be delivered. The completed t-shirt order will weigh approximately 55 kg.

James needs to decide how much he should charge for the t-shirt order. He must make sure that he charges enough to cover all of his costs and still make a profit of $200.

c) How much will it cost to deliver the order?

d) Calculate the total cost of the t-shirt printing supplies.

e) Suggest a sensible amount for James to charge per t-shirt.

Justify the decision you make and show your calculations clearly.

Information is on the next page.

Elementary Math Topical (Real World Context)

T-Shirt Printing Supplies (costs excluding 7% GST)

Item	Description	Unit Cost
T-Shirt	Dry Fit Round Neck	
	Bulk price (10+ shirts)	$5.50
	Bulk price (30+ shirts)	$5.20
Vinyl Paper	1 small roll	
	Average yield 50 t-shirt prints	$60
	1 large roll	
	Average yield 80 t-shirt prints	$95
Single Colour	Average yield 50 t-shirt prints	$120
Ink Cartridges	Average yield 150 t-shirt prints	$200
Plastic bags	Clear self-seal plastic bags	
(1 per t-shirt)	Pack of 50	$25
	Pack of 200	$80

Charges for Delivery (costs including 7% GST)

Type of Delivery	Description	Charges
Self-collection	Pick up at warehouse	$0
Delivery Courier	2 boxes (maximum 40 kg)	$18
	3 boxes (maximum 50 kg)	$23
	4 boxes (maximum 60 kg)	$28

a)

$$\text{Total cost for 45 shirts} = [5.20 \times 45 + 60 + 120 + 25] \times \frac{107}{100} = \$440.75$$

b)

$$\text{Total vinyl paper} = 5 \times 95 \times \frac{107}{100} = \$508.25$$

c)

$$\text{Delivery cost} = \$28$$

d)

$$\text{Total cost for 400 shirts} = [400 \times 5.2 + 95 \times 5 + 3 \times 200 + 2 \times 80] \times \frac{107}{100} = \$3547.05$$

e)

$$\text{Minimum total selling price} = 3546.05 + 28 + 200 = \$3775.05$$

$$\text{Selling price per shirt} = 3775.05 \div 400 = \$9.44$$

Elementary Math Topical (Real World Context)

Question 7:

The Central Provident Fund (CPF) is a social security savings plans for Singaporeans and permanent residents. The table below gives the contribution rate in 2015 for the various age groups.

Employee's Age (Years)	Contribution by Employer (% of wage)	Contribution by Employee (% of wage)	Total Contribution (% of wage)	Ordinary Account (% of wage)	Medisave Account (% of wage)
35 & below	17	20	37	23	8
Above 35-45	17	20	37	21	9
Above 45-50	17	20	37	19	10
Above 50-55	16	19	35	14	10.5
Above 55-60	12	13	25	12	10.5
Above 60-65	8.5	7.5	16	3.5	10.5
Above 65	7.5	5	12.5	1	10.5

a) Mr Lim is 28 years old and he works as a supervisor in a factory earning a monthly income of $1850.

i) Calculate his take home pay after deducting CPF.

ii) How much will be credited into his ordinary account per month?

b) Madam Alimah is 47 years old and she works as a marketing executive earning $2580 per month. Calculate the amount that will be credited into her Medisave account from January 2015 to March 2016.

c) Mr Rajakumar is 56 years old and he works as a lawyer earning $10 800 per month. Calculate the amount credited into his Ordinary account for the whole of 2015 assuming that he also gets 5 months year-end bonus.

d) A trading company has a staff strength of 67 consisting of 43 employees aged 50 years old and below, 9 employees aged between 50 and 55 years, 6 employees aged between 55 and 60 and the remaining staff are over 65 years old. Calculate the total monthly CPF contribution amount the company must contribute to all the 67 employees. Assuming each employee earns an average of $2500 per month.

ai)

$$\text{Take home pay} = \frac{80}{100} \times 1850 = \$1480$$

aii)

$$\text{Ordinary Account} = \frac{23}{100} \times 1850 = \$425.50$$

b)

$$\text{Monthly Medisave contribution} = \frac{10}{100} \times 2580 = \$258$$

$$\text{Total from Jan 15 to Mar 16} = 15 \times 258 = \$3870$$

c)

$$\text{Monthly Ordinary account contribution} = \frac{12}{100} \times 10800 = \$1296$$

$$\text{Total contribution} = 1296 \times 17 = \$22032$$

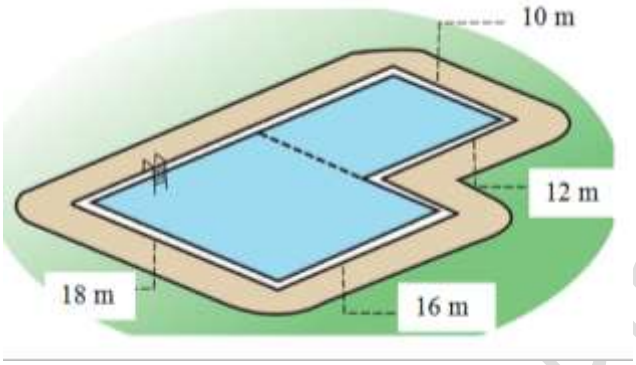
d)

$$\text{Total contribution} = \frac{17}{100} \times 2500 \times 43 + \frac{16}{100} \times 2500 \times 9 + \frac{12}{100} \times 2500 \times 6 + \frac{7.5}{100} \times 2500 \times 9$$
$$= \$25362.50$$

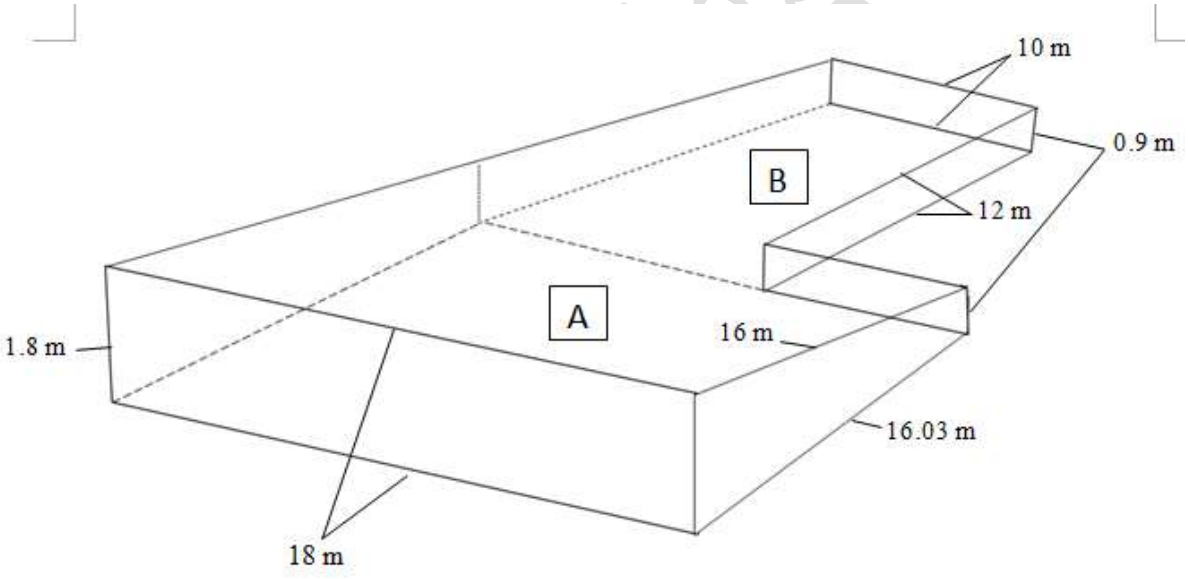
Elementary Math Topical (Real World Context)

Question 8:

The top view of an L-shape swimming pool is shown below. Its surface can be divided into two rectangular shapes, measuring 18 m by 16 m and 10 m by 12 m.



The diagram below (not drawn to scale) shows a three dimensional view of the swimming pool, with some dimensions labelled.



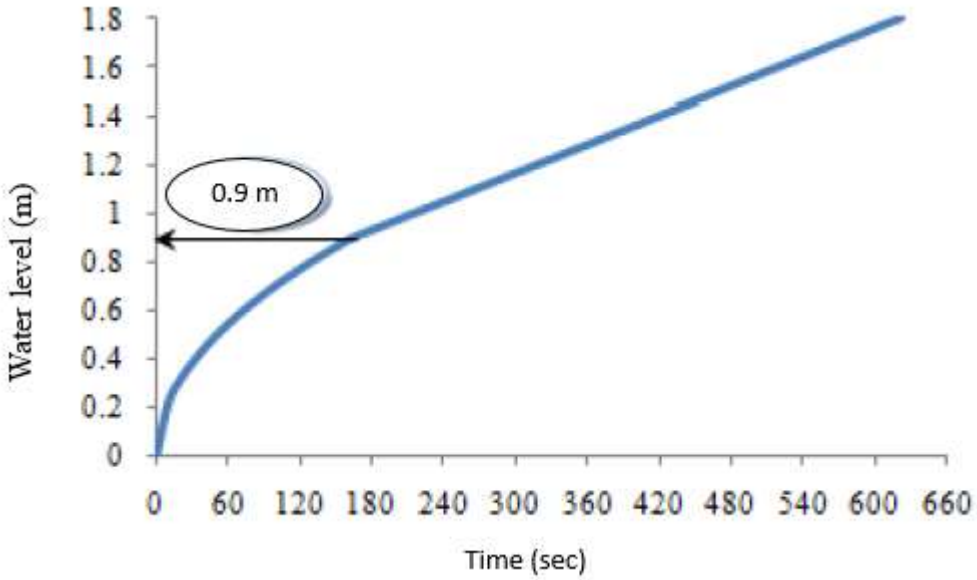
The depth of water in Section A increases gradually from 0.9 m at the shallow end to 1.8 m at the deep end. The depth of water in Section B has a uniform depth of 0.9 m.

a) Find the total surface area of the walls of the swimming pool.

b) Show that the swimming pool can contain 4.968×10^5 litres of water when it is completely filled.

c) Water is pumped into the swimming pool at a rate of 800 litres per minute. Find the time taken to completely fill the pool. Give your answer in hours and minutes.

The graph below shows the change in the water level as water is pumped into the pool.



d) Is the rise in the water level getting faster or slower before reaching 0.9 m? Explain your answer.

e) Given that *x* denotes the water level measured from the deepest end of the swimming pool in Section A, find an expression in terms of *x*, for the amount of water in m^3, contained in the swimming pool **before** it reaches 0.9 m.

a)

$$\text{Total Surface Area} = 1.8 \times 18 + \frac{1}{2}(1.8 + 0.9) \times 16 \times 2 + 8 \times 0.9 + 12 \times 0.9 \times 2 + 10 \times 0.9$$

$$= 113.4 \text{ m}^2$$

b)

$$\text{Total Volume} = \frac{1}{2}(1.8 + 0.9) \times 16 \times 18 + 10 \times 12 \times 0.9$$

$$= 496.8 \text{ m}^3$$

$$= 496800000 \text{ cm}^3$$

$$= 496800000 \text{ m}l$$

$$= 496800\ l$$

$$= 4.968 \times 10^5\ l$$

c)

$$\text{Time taken} = \frac{496800}{800} = 621 \text{ mins} = 10 \text{ h } 21 \text{ mins}$$

d) Slower, the graph is concave downwards. The gradient get smaller.

e)

$$\text{Volume at } 0.9\text{m} = \frac{1}{2}(0.9)(16) \times 18 = 129.6 \text{ m}^3$$

$$\left(\frac{x}{0.9}\right)^2 = \frac{V}{129.6}$$

$$V = 160x^2$$

Elementary Math Topical (Real World Context)

Question 9:

Ms Ain plans to get a second hand car, Toyota Vios.

Apart from the selling price, she also needs to pay for a transfer fee (to register the car in her name), registration fee and basic administrative fee.

TOYOTA VIOS	
Selling Price	$29,888 [Cost excluding 7% GST]
Availability	Available
Car Registered Date	30 Jun 2010 [2 years 10 months left to drive]
Transfer Fee	$11 [inclusive of GST]
Registration & Admin Fee	$140 [inclusive of GST]
Transmission	Automatic
Engine Cap	1,591 cc
Mileage	108,066 km
Fuel Type	Petrol
No. of previous Owners	1
Car Type	Sedan

a) What is the total amount Ms Ain must pay to get the car?

b) She compares the total cost of her car with its marked price in 2010. The marked price of the car in 2010 is $125 000 (with all the fees and GST included), calculate the percentage decrease in the cost of the car.

If Ms Ain's father decides to gift her Toyota Vios, she only has to pay for its usage.

However, she is unsure if it is worthwhile to drive a car versus taxi for all her rides

Information that Ms Ain needs for this part of the question is given on the next page.

c) Recommend which mode of transportation Ms Ain should choose.

Justify the decision you make and show your calculations clearly.

[Ms Ain's calculation is based on the assumption that there are 20 working days and 4 weekends each month]

** TAXI TRIPS
Weekday Trips via Grab
Daily weekday trips cost $27
Weekend Trips via Uber
Weekly weekend spending of $50

More information on the next page.

**CAR EXPENDITURE

[Ms Ain's calculation is based on the assumption that there are 20 working days and 4 weekends each month]

Fixed Payment	
Yearly insurance fee	$1584.27
Half yearly road tax	$320
Yearly car maintenance Fee	$250
Monthly ERP costs	$6
Parking Fee	
Monthly parking at Ms Ain's HDB flat	$107
Daily parking in school	Free
Weekly parking for miscellaneous uses	$8.40
Distance Travelled	
Daily distance travelled on weekdays	12.4 km
Weekly distance travelled on weekends	81.6 km
Fuel Costs	

SPC&U Members Discount	POSB Everyday Card Discount^
10%	5%

LEVO92, LEVO95 and LEVO98 are different types of petrol that can be purchased at SPC.

SPC&U Card Member discount is given when the membership card is presented.

^Additional 5% discount is applicable when petrol purchase is charged to POSB Everyday Card.

Ms Ain's car has a fuel tank capacity of 45 litres which allows her to drive 495 kilometres.
She is a SPC member and often pumps the cost saving petrol. She also holds a POSB everyday card.

** *All the prices are inclusive of 7% GST*

9a)

$$\text{Total amount} = 29888 \times \frac{107}{100} + 11 + 140 = \$32131.16$$

9b)

$$\text{Percentage decrease} = \frac{32131.16 - 125000}{125000} \times 100\% = -74.3\%$$

$$\therefore \text{ it decreases by } 74.3\%$$

9c)

$$\text{Annual taxi cost} = 20 \times 27 \times 12 + 50 \times 4 \times 12 = \$8880$$

$$\text{Annual car cost without petrol} = 1584.27 + 320 \times 2 + 250 + 6 \times 12 + 107 \times 12 + 8.4 \times 48$$

$$= \$4233.47$$

$$\text{Fuel consumption per km} = \frac{45}{495} = \frac{1}{11}\ l \text{ per km}$$

$$\text{Total annual distance} = 12.4 \times 20 \times 12 + 81.6 \times 4 \times 12 = 6892.8 \text{ km}$$

$$\text{Annual Petrol Cost} = \frac{1}{11} \times 6892.8 \times \frac{90}{100} \times \frac{95}{100} \times 2.07 = \$1109.02$$

$$\text{Total cost} = 1109.02 + 4233.47 = \$5342.49$$

Ms Ain should purchase the car as the annual cost is lower than taxi.

Elementary Math Topical (Real World Context)

Question 10:

Mark is starting up his new company and plans to buy 10 computer systems from an online store for his office. There is a special price of US$492.77 per piece for bulk purchase of 10 computer systems or more. The other details of the computer system are shown in the diagram below.

Newest 14 inch All-in-One Computer Workstations C1037u with 10 point touch capacitive touch 4G RAM 16G SSD 320G HDD

Price: ~~US $546.00 / piece~~

Discount Price: **US $518.70** / piece -5% 23h:26m:14s

Get our app to see exclusive prices | Bulk Price

Shipping

Calculate your shipping cost by country/region and quantity.

Quantity: 10 Ship to: Singapore

Shipping Company	Shipping Cost	Estimated Delivery Time
Fedex IE	~~US $827.55~~ US $331.02 You save: US $496.53 (60%)	8-14 days
EMS	~~US $777.35~~ US $349.81 You save: US $427.54 (about 55%)	10-24 days
DHL	~~US $1,208.94~~ US $362.68 You save: US $846.26 (about 70%)	6-13 days

a) Calculate the amount, in US dollars, that Mark will need to pay for 10 computer systems.

b) Mark intends to pay for the online purchase with his credit card. Using the bank rates for the currency conversion for the day of his online transaction shown below, calculate the amount, in Singapore dollars (SGD), that Mark has to pay for the computer systems

Bank of Singapore		
	Bank Selling Rate	Bank Buying Rate
1 US dollar	1.3704 Singapore dollars	1.3509 Singapore dollars

c) Insurance fee charged by shipping companies on total cost of goods shipped.

Fedex IE	DHL	EMS
2.5%	1.5%	Free

The total cost of purchasing the computer systems includes the cost of the goods, shipping charges and insurance.

If Mark intends to move into his new office within 16 days, suggest a sensible amount that he will need to pay for the 10 computer systems. Justify the decision(s) you make and show your calculations clearly.

a)

$$\text{Total amount} = 492.77 \times 10 = \text{USD}4927.70$$

b)

$$\text{Amount in SGD} = 4927.7 \times 1.3704 = \text{S\$}6752.92$$

c)

$$\text{Fedex shipping} = 331.02 \times \frac{102.5}{100} = \text{USD}339.30$$

$$\text{DHL shipping} = 362.68 \times \frac{101.5}{100} = \text{USD}368.12$$

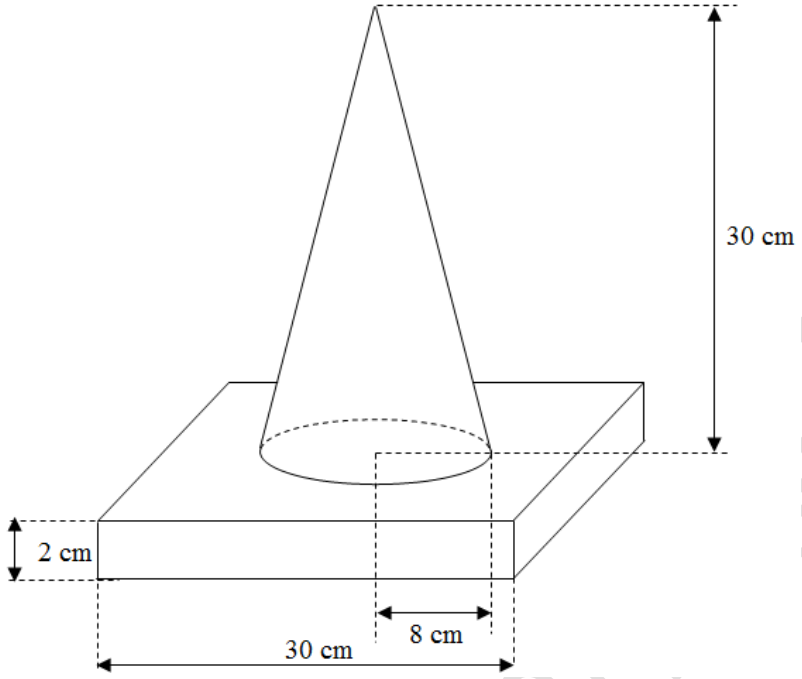
$$\text{Total amount} = 4927.70 + 339.30 = \text{USD}5267$$

$$\text{Total amount in SGD} = 5267 \times 1.3704 = \text{S\$}7217.90$$

Elementary Math Topical (Real World Context)

Question 11:

A traffic marker consists of a solid cone of height 30 cm and radius 8 cm with a solid square base of length 30 cm and thickness 2 cm.



a) Show the slant height of the cone is 31.0483 cm.

b) Find the curved surface area of the cone.

c) A primer sealer undercoat needs to be applied on all the exposed surfaces of the traffic marker including the base area. A buyer has ordered a quantity of 1 000 traffic markers. Suggest a suitable amount of money that the seller should charge per traffic marker. Justify the decision you make, showing your calculations clearly.

	Nippon Paint Primer Sealer Undercoat	Dulux Paint Primer Sealer Undercoat
Theoretical Coverage	10 000 cm^3/litre	12 000 cm^3/litre
Size	5 litre	2 litre
Price	$65.10	$31.40
Labour Cost	$50 for painting every 80 traffic markers	
** Note: The traffic marker can only be painted with one type of paint **		

a)

$$l^2 = 30^2 + 8^2$$

$$l = 31.04834939 \approx 31.0483 \text{ cm}$$

b)

$$\text{Curve surface area} = \pi(8)(31.0483) = 780.3301 \approx 780 \text{ cm}^2$$

c)

$$\text{Total surface area 1 cone} = 30 \times 30 + 4 \times 2 \times 30 + 30 \times 30 - \pi(8)^2 + 780.3301$$

$$= 2619.2682 \text{ cm}^2$$

$$\text{Total for 1000 cones} = 2619268.2 \text{ cm}^2$$

$$\text{Number of litre of Nippon} = \frac{2619268.2}{10000} = 261.9268\ l \approx 262\ l$$

$$\text{Number of tins} = \frac{262}{5} = 52.4 \approx 53$$

$$\text{Cost Nippon} = 53 \times 65.10 = \$3450.30$$

$$\text{Number of litre of Dulux} = \frac{2619268.2}{12000} = 218.3\ l$$

$$\text{Number of tins} = \frac{219}{2} = 109.5 \approx 110$$

$$\text{Cost Dulux} = 110 \times 31.40 = \$3454$$

$$\text{Total cost of 1000 cones} = 3450.3 + \frac{1000}{80} \times 50 = 4075.30$$

$$\text{Cost of a cone} = 4075.30 \div 1000 = \$4.08$$

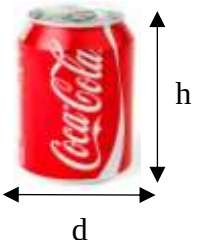
$$\text{Profit of } 50\% = 1.5 \times \$4.08 = \$6.12$$

The seller should charge $6.12 to have a profit of 50% of the cost.

Elementary Math Topical (Real World Context)

Question 12:

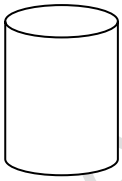
Here is some information about a can of soft drink. In this question the can of soft drink can be modelled as a cylinder.



Diameter (d): 5.5 cm

Height (h): 15 cm

Total mass of 1 can of soft drink
= mass of soft drink + mass of tin can



a) Calculate the volume of the cylinder in cubic centimetres.

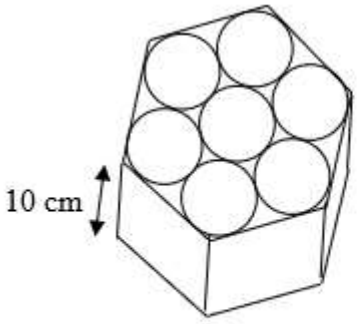


Diagram I

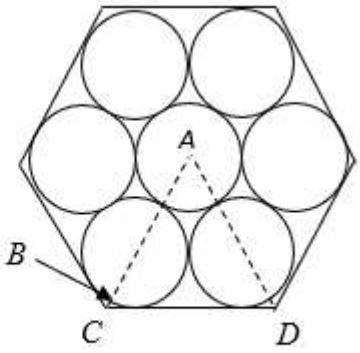


Diagram II

7 cans of the soft drink are then packed into an open-top regular hexagonal gift box, as shown in the **Diagram I**. **Diagram II** shows the top view of the gift box.

a) Show that the length of *AC* can be approximated to 8.25 cm. [Assume that length *BC* is negligible].

b) Show that the area of triangle *ACD* is 29.5 cm^2, correct to 3 significant figures.

Useful Information

- 1 cm^3 = 1 millilitre.
- Density of soft drink = 1.05 grams per millilitre
- Mass of tin can = 15 grams
- Assume that each can is 95% filled with soft drink

The regular hexagonal base of the container is made of cardboard material. It will require special reinforcement if its total mass per square centimetre is greater than 13 g/cm^2. Does the base of the container require special reinforcement? Justify your decision with calculations.

a)

$$\text{Vol of cylinder} = \pi(2.75)^2(15) = 356.3744 \approx 356 \text{ cm}^3$$

b)

$$AC = 5.5 + 2.75 = 8.25 \text{ cm}$$

c)

$$\text{Area} = \frac{1}{2}(8.25)(8.25)\sin 60 = 29.471 \approx 29.5 \text{ cm}^2$$

d)

$$\text{Vol of soft drink} = 7 \times 356.3744 \times \frac{95}{100} = 2369.889 \text{ cm}^3$$

$$\text{Mass of soft drinks} = 1.05 \times 2369.889 = 2488.3842 \text{ g}$$

$$\text{Total area of hexagon base} = 6 \times 29.471 = 176.826 \text{ cm}^2$$

$$\text{Mass per area} = \frac{2488.3842}{176.826} = 14.1 \text{ g/cm}^2$$

Yes, it requires special reinforcement.

Elementary Math Topical (Real World Context)

Question 13:

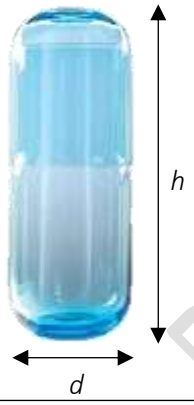
The diagram shows a water bottle designed by a company.

Capsule Water Bottle

Height, h : 240 mm

Diameter, d : 80 mm

Mass : 50 grams



The water bottle can be modelled as a cylinder with a hemisphere at the top and bottom.

Calculate

a) the surface area of the water bottle,

b) the volume of the water bottle, in cubic centimetres.

c) The water bottle is made up of a plastic material that costs 22 cents per gram. Calculate the cost of the water bottle if there is a profit of 120%.

d) The company produces a similar water bottle for commercial use. It has a height of 36 cm. Calculate the volume of the water bottle.

a)

$$\text{Surface area} = \pi(40)^2 + 2\pi(40)(240) = 65345.1271 \approx 65300 \text{ mm}^2$$

b)

$$\text{Volume} = \frac{4}{3}\pi(4)^3 + \pi(4)^2(24) = 1474.454 \approx 1470 \text{ cm}^3$$

c)

$$\text{Cost} = 22 \times 50 \times \frac{120}{100} = 1320 \text{ cents} = \$13.20$$

d)

$$\left(\frac{36}{24}\right)^3 = \frac{V}{1470}$$

$$V = 4961.25 \approx 4960 \text{ cm}^3$$

Question 14:

For its 94th anniversary celebration, the school planning committee is considering customizing a marble coaster to sell at its carnival in June 2018. By December 2017, the school wants to order 5000 pieces of coasters.

The coaster is in the form of a square of length 8 cm and 1 cm thick.

A local manufacturer is called to give its quotation.

Each coaster weighs 20g.

He has 2 machines which can produce 10 coasters each per hour.

The energy consumption of each machine is 2000 Watts per hour. Each machine is operated by 2 workers. In order that the workers do not have to work overtime, the orders must be made 2 months in advance.

The manufacturer wants to make a profit of at least 20% above his cost.

An overseas online shop also manufactures customized coaster. The shop charges $5.50 per piece of coaster. However the customer has to bear the shipping charges.

Using the information in the table provided, answer the following questions showing clear calculations.

a) How much will a piece of imported coaster cost (including shipping)?

b) What is the minimum price that the local manufacturer would charge for each piece of coaster?

c) Based on the cost per piece of coaster alone, which shop should the school order from, the local manufacturer or the overseas online shop?

Information for local manufacturer provided on next page.

Item	Description	Cost
Raw materials	For orders < 400000 cm^3 For orders $\geq$ 400000 cm^3	\$0.50 / 10 cm^3 \$0.40 / 10 cm^3
Labour cost per worker	Wages at normal rate Overtime rate (> 8 hours)	\$8 per hour \$12 per hour
Electricity	Electricity tax	20.72 cents / kWh
Packing	Bubble wrap Boxes for 8 coasters Boxes for 12 coasters	\$0.01 per coaster \$0.20 per box \$0.30 per box

Shipping information for overseas online shop

Item	Description	Cost
Shipping cost	≤ 15 kg >15 kg but ≤ 30 kg >30 kg but ≤ 50 kg >50 kg but ≤ 70 kg $\geq$ 70 kg	\$860.00 \$991.00 \$1192.00 \$1390.30 \$2500

Assume that the weight of the bubble wrap and box are negligible. kWh is a measure of electrical energy equivalent to a power consumption of 1000 Watts in one hour.

a)

$$\text{Total mass} = 5000 \times 20 = 100000\text{ g} = 100\text{ kg}$$

$$\text{Shipping} = \$2500$$

$$\text{Unit cost} = \frac{2500}{5000} + 5.5 = \$6.00$$

b)

$$\text{Total volume} = 8 \times 8 \times 1 \times 5000 = 320000\text{ cm}^3$$

$$\text{Total Raw Material Cost} = \frac{320000}{10} \times \$0.50 = \$16000$$

$$\text{Total Time} = \frac{5000}{20} = 250\text{ hours}$$

$$\text{Total Labour Cost} = 4 \times 250 \times 8 = \$8000$$

$$\text{Total energy consumption} = 2000 \times 2 \times 250 = 1000000\text{ Wh} = 1000\text{ kWh}$$

$$\text{Total electricity cost} = 1000 \times 0.2072 = \$207.20$$

$$\text{Bubble wrap cost} = 0.01 \times 5000 = \$50$$

$$\text{Total Box cost} = \frac{5000}{8} \times 0.2 = \$125$$

$$\text{Total Cost} = 16000 + 8000 + 207.2 + 50 + 125 = \$24382.20$$

$$\text{Selling price} = \frac{120}{100} \times 24382.2 = \$29258.64$$

$$\text{Unit cost} = \frac{29258.64}{5000} = \$5.85$$

c) Local store, because it is cheaper.

Elementary Math Topical (Real World Context)

Question 15:

Figure 1 shows the information of a certain car model that is fuelled by petrol.

Engine Capacity (cc)	1591
Fuel Consumption (litre / 100km)	6.8
Fuel Tank Capacity (litre)	50
Fuel Type	Petrol

Figure 2 shows the information of a certain car model that is fuelled by diesel.

Engine Capacity (cc)	1591
Fuel Consumption (litre / 100km)	3.8
Carbon Emission	100 g/km
Fuel Type	Diesel (Euro IV compliant)

The road tax of a Singapore-registered car is calculated based on the car's engine capacity. The following table shows the formula of calculating the road tax per annum for cars.

Engine Capacity (x) in cc	6-Monthly Road Tax Formula (From 1 August 2016)
$x \pounds 600$	$S\$200 \times 0.782$
$600 < x \pounds 1000$	$[S\$200 + S\$0.125(x - 600)] \times 0.782$
$1000 < x \pounds 1600$	$[S\$250 + S\$0.375(x - 1000)] \times 0.782$
$1600 < x \pounds 3000$	$[S\$475 + S\$0.75(x - 1600)] \times 0.782$
$x > 3000$	$[S\$1525 + S\$1(x - 3000)] \times 0.782$

The annual Special Tax is imposed on top of the annual Road Tax of all diesel cars. The Special Tax is shown in the following table.

Special Tax	
Emission Standard	**6-Monthly Special Tax Rate**
Pre-Euro IV compliant	6 times the Road Tax of an equivalent petrol-drive car less S$50
Euro IV compliant	S$0.625 per cc for 6 months less S$50, subject to a minimum payment of S$575 per 6 months
Euro V or JPN2009 compliant	S$0.20 per cc for 6 months less S$50, subject to a minimum payment of S$150 per 6 months

Petrol costs $2.69 per litre on average. Diesel costs $1.49 per litre on average.

Trevor plans to buy a car. He estimates that he would need to travel 15 000 km per year.

a) Estimate how much Trevor would have to spend on petrol per year if he plans to buy the petrol-fuelled car. Give your answer to the nearest dollar.

b) Calculate the annual road tax that Trevor must pay if he plans to buy the petrol-fuelled car. Give your answer to the nearest dollar.

c) Assuming that the purchasing costs of the two cars are the same, would it be cheaper for Trevor to own a petrol-fuelled car instead of a diesel-fuelled car?
Show working to support your answer.

a)

$$\text{Petrol Cost} = \frac{15000}{100} \times 6.8 \times 2.69 = \$2743.80 \approx \$2744$$

b)

$$\text{Road Tax} = [250 + 0.375(1591 - 1000)] \times 0.782 = \$368.81 \approx \$369$$

c)

$$\text{Diesel Cost} = \frac{15000}{100} \times 3.8 \times 1.49 = \$849.30$$

$$\text{Special Tax} = 0.625 \times 1591 = (994.375 - 50) \times 2 = \$1888.75$$

$$\text{Total Diesel Cost less Road Tax} = 849.3 + 1888.75 = \$2738.05$$

Since Road Tax is the same, we do not need to include road tax. Diesel fueled car is cheaper.

Question 16:

The water price will be increased in two steps, on 1 July 2017 and on 1 July 2018 as shown in the table below.

Table 1: Phasing of Increase in Potable Water Prices for Domestic Users

		Domestic Potable Water Prices (per cubic metre)					
		Current		From 1 July 2017		From 1 July 2018	
		0-40m^3	> 40m^3	0-40m^3	> 40m^3	0-40m^3	> 40m^3
Potable Water	Tariff	$1.17	$1.40	$1.19	$1.46	$1.21	$1.52
	Water Conservation Tax (% of water tariff)	$0.35 (30% of $1.17)	$0.63 (45% of $1.40)	$0.42 (35% of $1.19)	$0.73 (50% of $1.46)	$0.61 (50% of $1.21)	$0.99 (65% of $1.52)
Used Water	Waterborne Fee	$0.28	$0.28	$0.78	$1.02	$0.92	$1.18
	Sanitary Appliance Fee	$2.80 per fitting*		Combined into Waterborne Fee		Combined into Waterborne Fee	
Total Price		**$2.10**	**$2.61**	**$2.39**	**$3.21**	**$2.74**	**$3.69**

In addition, the electricity tariffs will come down for 3 months from 1 July 2017. For households, the electricity tariff will fall from 21.39 to 20.72 cents per kWh during this period.

The following shows Mr Lim's Electricity, Gas and Water bill for the month of June 2017.

Breakdown of Current Charges	Usage	Rate ($)	Amount ($)	Total ($)
Electricity Services				
Electricity Estimated on 27 Jun 2017	259 kWh	0.2139	55.40	55.40
Gas Services by City Gas Pte Ltd (as Trustee)				
Gas Estimated on 27 Jun 2017	74 kWh	0.1804	13.35	13.35
Water Services by Public Utilities Board				
Reading taken on 27 Jun 2017 : 340.9	19.3 Cu M	1.1700	22.58	
Waterborne Fee	19.3 Cu M	0.2803	5.41	
Water Conservation Tax	$22.58	30%	6.77	
Sanitary Appliance Fee	2 Fittings	2.8037	5.61	40.37
Refuse Removal by SembWaste Pte Ltd	1 Qty	7.71	7.71	7.71
Subtotal			116.83	116.83
GST	$116.83	7%	8.17	8.17
Current Charges: (Inclusive of GST)				$125.00

Given that the usage of electricity, gas and water remain constant for the month of

July, calculate the percentage increase in his bill for the month of July 2017.

$$\text{Electricity bill in July 2017} = 259 \times 20.72 = 5366.48 = \$53.66$$

$$\text{Gas Service} = \$13.35$$

$$\text{Water bill} = 19.3 \times 1.19 \times \frac{130}{100} + 19.3 \times 0.78 = \$44.91$$

$$\text{Refuse} = \$7.71$$

$$\text{Total July 2017 bill} = 53.66 + 13.35 + 44.91 + 7.71 = \$119.63$$

$$\text{Total bill w GST} = 119.63 \times \frac{107}{100} = \$128$$

$$\text{Percentage increase} = \frac{128 - 125}{125} \times 100\% = 2.4\%$$