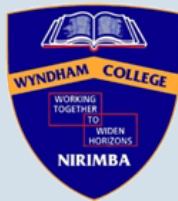


STD 1: Measurement (Std 1)

M4 Rates (Y12)

Teacher: Kirtana Hariharan

Exam Equivalent Time: 72 minutes (based on HSC allocation of 1.5 minutes approx. per mark)



IMPORTANT FEATURES AND TIPS FROM 2UG EXAM HISTORY

- *MS-M4 Rates* is the new syllabus category for a wide range of previous Gen2 content such as best buys, energy consumption, speed calculations, and fuel consumption.
- *MS-M4 Rates* has an obvious overlap with *M1 Mass and Energy* and *A2 Linear Relationships*. Questions that fit into two categories are included in both by program design.

ANALYSIS - What to Expect and Common pitfalls

- *Rates* is a very broad topic area, although students who have a good conceptual understanding should expect to score highly.
- Speed, distance and time questions are well covered in the database, along with fuel consumption (overlapping with *MS-A2 Linear Relationships*) and other related "rate" contexts.
- The syllabus explicitly states that heart rates and blood pressure are very important applications of this topic area, which is reflected in supplementary questions.

Questions

1. FS Driving, 2UG 2017 HSC 14 MC

⚡ RAP Data - Bottom 20%: School result (97%) was 6% above state average (91%)

Kate is comparing two different models of car. Car A uses fuel at the rate of 9 L/100 km. Car B uses 3.5 L/100 km.

Suppose Kate plans on driving 8000 km in the next year.

How much less fuel will she use driving car B instead of car A?

- A. 280 L
 - B. 440 L
 - C. 720 L
 - D. 1000 L
-

2. FS Health, 2UG 2016 HSC 11 MC

The concentration of a drug in a certain medication is 100 mg / 5 mL. A patient is prescribed 2000 mg of the drug.

How much medication should be given to the patient?

- (A) 4 mL
 - (B) 25 mL
 - (C) 100 mL
 - (D) 400 mL
-

3. Measurement, 2UG 2016 HSC 9 MC

An old washing machine uses 130 L of water per load. A new washing machine uses 50 L per load.

How much water is saved each year if two loads of washing are done each week using the new machine?

- (A) 2600 L
 - (B) 4160 L
 - (C) 5200 L
 - (D) 8320 L
-

4. Measurement, 2UG 2018 HSC 5 MC

The driving distance from Alex's home to his work is 20 km. He drives to and from work five times each week. His car uses fuel at the rate of 8 L/100 km.

How much fuel does he use driving to and from work each week?

- A. 16 L
 - B. 20 L
 - C. 25 L
 - D. 40 L
-

5. Measurement, STD2 M7 SM-Bank 4 MC

A car travels 350 km on 40 L of petrol.

What is its fuel consumption?

- A. 7.8 L/100 km
 - B. 8.4 L/100 km
 - C. 8.8 L/100 km
 - D. 11.4 L/100 km
-

6. FS Driving, 2UG 2014 HSC 22 MC

Heather's car uses fuel at the rate of 6.6 L per 100 km for long-distance driving and 8.9 L per 100 km for short-distance driving.

She used the car to make a journey of 560 km, which included 65 km of short-distance driving.

Approximately how much fuel did Heather's car use on the journey?

- (A) 37 L
 - (B) 38 L
 - (C) 48 L
 - (D) 50 L
-


7. FS Comm, 2UG 2016 HSC 15 MC

Calls on a mobile phone plan are charged at the rate of 54 cents per 30 seconds, or part thereof.

What is the cost of a call lasting 2 minutes and 15 seconds?

- (A) \$2.16
 - (B) \$2.32
 - (C) \$2.43
 - (D) \$2.70
-

8. FS Resources, 2UG 2014 HSC 20 MC

 *RAP Data - Bottom 18%: School result (44%) was 5% above state average (39%)*

In a household of 4, each member uses an average of 13 minutes of hot water per day.

The household uses a 9 kW hot water unit.

Electricity is charged at 11.97 c/kWh when the hot water unit is being used.

What is the electricity cost for the hot water used by this household in one week?

- (A) \$1.63
 - (B) \$6.54
 - (C) \$392.14
 - (D) \$653.56
-

9. Measurement, 2UG 2018 HSC 27a

Jenny used her mobile phone while she was overseas for one month.

Her mobile phone plan has a base monthly cost of \$50. While overseas, she is also charged 33 cents per SMS message sent and 26 cents per MB of data used.

During her month overseas, Jenny sent 120 SMS messages and used 1400 MB of data.

What was her mobile phone bill for the month overseas? (2 marks)

10. FS Driving, 2UG 2016 HSC 26c

Peta's car uses fuel at the rate of 5.9 L/100 km for country driving and 7.3 L/100 km for city driving. On a trip, she drives 170 km in the country and 25 km in the city.

Calculate the amount of fuel she used on this trip. (2 marks)

11. FS Driving, 2UG 2014 HSC 27b

⚡ RAP Data - Bottom 24%: School result (92%) was 7% above state average (85%)

Xuso is comparing the costs of two different ways of travelling to university.

Xuso's motorcycle uses one litre of fuel for every 17 km travelled. The cost of fuel is \$1.67/L and the distance from her home to the university car park is 34 km. The cost of travelling by bus is \$36.40 for 10 single trips.

Which way of travelling is cheaper and by how much? Support your answer with calculations. (2 marks)

12. FS Health, 2UG 2015 HSC 27b

A patient requires 2400 mL of fluid to be delivered at a constant rate by means of a drip over 12 hours. Each mL of fluid is equivalent to 15 drops.

How many drops per minute need to be delivered? (2 marks)

13. FS Resources, 2UG 2016 HSC 28b

The cost of buying a new heater is \$990. It has an energy consumption of 505 kWh per year.

Energy is charged at the rate of \$0.35 kWh.

How much will it cost in total to purchase and then run this heater for five years? (2 marks)

14. Measurement, STD2 M7 SM-Bank 8

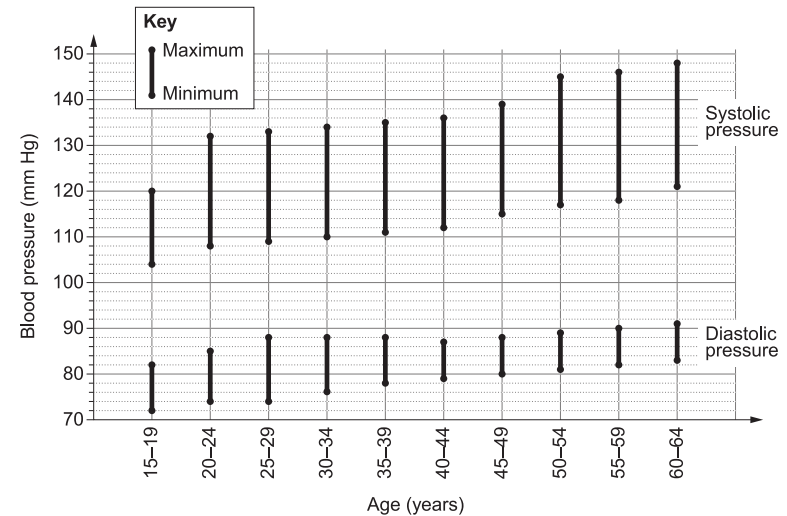
A patient is to receive 1.8 L of pain killer medication by intravenous drip that will take 1.5 hours to administer.

Given 1 mL = 4 drops, calculate the amount of drops per minute the machine must be set on. (2 marks)

15. Measurement, STD2 M7 SM-Bank 04

Blood pressure is measured using two numbers: systolic pressure and diastolic pressure. If the measurement shows 120 systolic and 80 diastolic, it is written as 120/80.

The bars on the graph show the normal range of blood pressure for people of various ages.



a. What is the normal range of blood pressure for a 53-year-old? (2 marks)

b. Ralph, aged 53, had a blood pressure reading of 173 over 120. A doctor prescribed Ralph a medication to reduce his blood pressure to be within the normal range. To check that the medication was being effective, the doctor measured Ralph's blood pressure for 10 weeks and recorded the following results.

Week	1	2	3	4	5	6	7	8	9	10
Blood pressure	175/120	175/120	165/110	149/98	145/92	140/90	138/88	136/88	130/85	126/84

With reference to the data provided, comment on the effectiveness of the medication during the 10-week period in returning Ralph's blood pressure to the normal range. (3 marks)

16. Measurement, STD2 2017 HSC 26b

Toby's mobile phone plan costs \$20 per month, plus the cost of all calls. Calls are charged at the rate of 70 cents per 30 seconds, or part thereof. There is also a call connection fee of 50c per call.

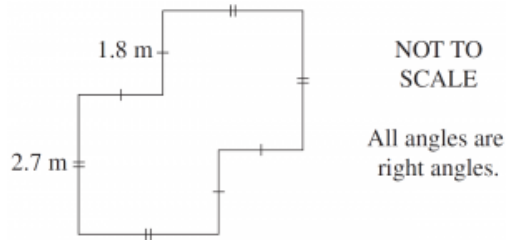
Here is a record of all his calls in July.

Date	Call duration
5 July	20 seconds
12 July	40 seconds
23 July	2 minutes 15 seconds

How much is Toby's mobile phone bill for July? (2 marks)

17. Measurement, 2UG 2009 HSC 23c

The diagram shows the shape and dimensions of a terrace which is to be tiled.



- Find the area of the terrace. (2 marks)
- Tiles are sold in boxes. Each box holds one square metre of tiles and costs \$55. When buying the tiles, 10% more tiles are needed, due to cutting and wastage.

Find the total cost of the boxes of tiles required for the terrace. (2 marks)

18. Measurement, 2UG 2008 HSC 23c

An alcoholic drink has 5.5% alcohol by volume. The label on a 375 mL bottle says it contains 1.6 standard drinks.

- How many millilitres of alcohol are in a 375 mL bottle? (1 mark)
 - It is recommended that a fully-licensed male driver should have a maximum of one standard drink every hour.
Express this as a rate in millilitres per minute, correct to one decimal place. (2 marks)
-

19. Measurement, 2UG 2018 HSC 28c

Every day, a 1200-watt microwave oven is used for 45 minutes at 40% power. Electricity is charged at \$0.25 per kWh.

What is the cost of running this microwave oven for 180 days? (3 marks)

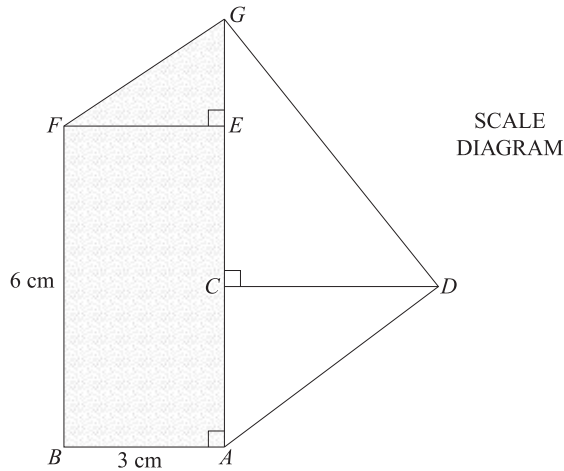
20. Measurement, STD2 M7 SM-Bank 01

Bikram runs a hot yoga studio.

If it costs 34 cents for 1-kilowatt (1000 watts) for 1 hour, how much does it cost him to run three 3200-watt heaters from 9:00 am to 12:30 pm on a single day? (Give your answer to the nearest cent) (2 marks)

21. Measurement, 2UG 2018 HSC 26g

A field diagram of a block of land has been drawn to scale. The shaded region $ABFG$ is covered in grass.



The actual length of AG is 24 m.

- i. If the length of AG on the field diagram is 8 cm, what is the scale of the diagram? (1 mark)
- ii. How much fertiliser would be needed to fertilise the grassed area $ABFG$ at the rate of 26.5 g/m^2 ? (3 marks)

22. FS Resources, 2UG 2013 HSC 26d

A section of Jim's electricity bill is shown.

Energy Used and Costs					
METER ID	THIS READING	LAST READING	ENERGY USED	RATE (per kWh)	COST
Peak Energy Charge					
TMV04221/01	531.2	274.8	256.4 kWh	47.7700c	\$122.48
Shoulder Energy Charge					
TMV04221/02	A	560.9	523.5 kWh	19.4000c	\$101.56
Off-peak (Night) Energy Charge					
TMV04221/03	242.5	0.0	242.5 kWh	9.6000c	\$23.28

- (i) What is the value of A ? (1 mark)
- (ii) How much will Jim save if he uses 154 kWh of energy at the Off-peak rate rather than at the Peak rate? (2 marks)

23. FS Resources, 2UG 2015 HSC 30a

The energy consumption of a computer in standby mode is 21 watts. The cost of electricity is 31 cents per kWh.

A school computer room has 20 computers.

How much will the school save by switching off all 20 computers during 11 weeks of school holidays? (2 marks)

Worked Solutions

1. FS Driving, 2UG 2017 HSC 14 MC

Fuel used by car *A*

$$\begin{aligned} &= \frac{8000}{100} \times 9 \\ &= 720 \text{ L} \end{aligned}$$

Fuel used by car *B*

$$\begin{aligned} &= \frac{8000}{100} \times 3.5 \\ &= 280 \text{ L} \end{aligned}$$

\therefore Fuel saved using car *B*

$$\begin{aligned} &= 720 - 280 \\ &= 440 \text{ L} \end{aligned}$$

\Rightarrow B

2. FS Health, 2UG 2016 HSC 11 MC

Volume required

$$\begin{aligned} &= \frac{2000}{100} \times 5 \\ &= 100 \text{ mL} \end{aligned}$$

\Rightarrow C

Worked Solutions

3. Measurement, 2UG 2016 HSC 9 MC

Water used by old machine

$$\begin{aligned} &= 130 \times 2 \times 52 \\ &= 13\,520 \text{ L} \end{aligned}$$

Water used by new machine

$$\begin{aligned} &= 50 \times 2 \times 52 \\ &= 5200 \text{ L} \end{aligned}$$

$$\begin{aligned} \therefore \text{Water saved} &= 13\,520 - 5200 \\ &= 8320 \text{ L} \end{aligned}$$

\Rightarrow D

4. Measurement, 2UG 2018 HSC 5 MC

Total distance travelled each week

$$\begin{aligned} &= 5 \times 2 \times 20 \\ &= 200 \text{ km} \end{aligned}$$

\therefore Total fuel used

$$\begin{aligned} &= \frac{200}{100} \times 8 \text{ L} \\ &= 16 \text{ L} \end{aligned}$$

\Rightarrow A

5. Measurement, STD2 M7 SM-Bank 4 MC

Fuel consumption (L/100 km)

$$\begin{aligned} &= \frac{350}{40} \\ &= 8.75 \\ &= 8.8 \text{ L/100 km} \end{aligned}$$

\Rightarrow C

6. FS Driving, 2UG 2014 HSC 22 MC

Fuel used in short distance

$$= \frac{65}{100} \times 8.9 \text{ L} = 5.785 \text{ L}$$

Fuel used in long distance

$$= \frac{495}{100} \times 6.6 \text{ L} = 32.67 \text{ L}$$

$$\begin{aligned} \therefore \text{Total Fuel} &= 5.785 + 32.67 \\ &= 38.455 \text{ L} \end{aligned}$$

$\Rightarrow B$

7. FS Comm, 2UG 2016 HSC 15 MC

5 \times 30 second blocks

$$\begin{aligned} \therefore \text{Cost} &= 5 \times 0.54 \\ &= \$2.70 \end{aligned}$$

◆ Mean mark 44%.

$\Rightarrow D$

8. FS Resources, 2UG 2014 HSC 20 MC

Usage per day = 4 \times 13 = 52 mins

Usage per week = 7 \times 52 = 364 mins

Converting to kWh

$$\begin{aligned} &= (\text{hours of usage}) \times 9 \text{ kW} \\ &= \frac{364}{60} \times 9 \\ &= 54.6 \text{ kWh} \end{aligned}$$

◆ Mean mark 39%.

$$\begin{aligned} \therefore \text{Cost} &= 54.6 \times 11.97\text{c} \\ &\approx 654\text{c} \\ &\approx \$6.54 \end{aligned}$$

$\Rightarrow B$

9. Measurement, 2UG 2018 HSC 27a

SMS charge = 120 \times 33c = \$39.60

Data charge = 1400 \times 26c = \$364.00

$$\begin{aligned} \therefore \text{Total bill} &= 50 + 39.60 + 364 \\ &= \$453.60 \end{aligned}$$

10. FS Driving, 2UG 2016 HSC 26c

Fuel used in country

$$\begin{aligned} &= 170 \times \frac{5.9}{100} \\ &= 10.03 \text{ L} \end{aligned}$$

Fuel used in city

$$\begin{aligned} &= 25 \times \frac{7.3}{100} \\ &= 1.825 \text{ L} \end{aligned}$$

$$\begin{aligned} \therefore \text{Total fuel used} &= 10.03 + 1.825 \\ &= 11.855 \text{ L} \end{aligned}$$

11. FS Driving, 2UG 2014 HSC 27b

Compare cost of a 1-way trip

Motorcycle

$$\text{Fuel used} = \frac{34}{17} = 2 \text{ L}$$

$$\text{Cost} = 2 \times \$1.67 = \$3.34$$

Bus

$$\text{Cost} = \frac{36.40}{10} = \$3.64$$

$$\text{Difference} = \$3.64 - 3.34 = \$0.30$$

\therefore Motorcycle is \$0.30 cheaper per 1-way trip.

12. FS Health, 2UG 2015 HSC 27b

Fluid rate of delivery

$$= \frac{2400}{12}$$

$$= 200 \text{ mL per hour}$$

$$= \frac{200}{60}$$

$$= 3\frac{1}{3} \text{ mL per minute}$$

Since each mL has 15 drops

$$\# \text{ Drops} = 15 \times 3\frac{1}{3}$$

$$= 50 \text{ per minute}$$

13. FS Resources, 2UG 2016 HSC 28b

Cost to run heater for 5 years

$$= 5 \times 505 \times 0.35$$

$$= \$883.75$$

\therefore Total purchase and running cost

$$= 883.75 + 990$$

$$= \$1873.75$$

14. Measurement, STD2 M7 SM-Bank 8

Total drops required = 1800×4

$$= 7200 \text{ drops}$$

Time (in minutes) = 1.5×60

$$= 90 \text{ minutes}$$

Drops per minute = $\frac{7200}{90}$

$$= 80$$

\therefore The machine must be set to 80 drops per minute.

15. Measurement, STD2 M7 SM-Bank 04

a. Normal range (systolic): 117 - 145

Normal range (diastolic): 81 - 89

b. Effectiveness of medication

- systolic and diastolic pressure reduced below original readings from week 3 onwards.
 - systolic pressure in normal range from week 5 onwards.
 - diastolic pressure in normal range from week 7 onwards.
 - blood pressure only in the normal range from week 7.
-

16. Measurement, STD2 2017 HSC 26b

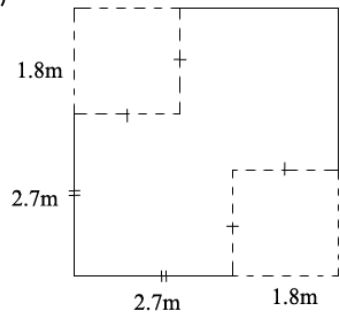
$$\text{Call cost} = 0.70 + (2 \times 0.70) + (5 \times 0.70) = \$5.60$$

$$\text{Connection fees} = 3 \times 0.50 = \$1.50$$

$$\begin{aligned} \therefore \text{Total bill} &= 5.60 + 1.50 + 20 \\ &= \$27.10 \end{aligned}$$

17. Measurement, 2UG 2009 HSC 23c

(i)



$$\begin{aligned} \text{Area} &= \text{Area of big square} - \text{Area of 2 cut-out squares} \\ &= (2.7 + 1.8) \times (2.7 + 1.8) - 2 \times (1.8 \times 1.8) \\ &= 20.25 - 6.48 \\ &= 13.77 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \text{(ii) Tiles required} &= (13.77 + 10\%) \times 13.77 \\ &= 15.147 \text{ m}^2 \end{aligned}$$

\Rightarrow 16 boxes are needed

$$\begin{aligned} \therefore \text{Total cost of boxes} &= 16 \times \$55 \\ &= \$880 \end{aligned}$$

18. Measurement, 2UG 2008 HSC 23c

$$\begin{aligned} \text{(i) Alcohol} &= \frac{5.5}{100} \times 375 \\ &= 20.625 \text{ mL} \end{aligned}$$

(ii) Since 1.6 standard drinks = 375 mL
 \Rightarrow 1 standard drink

$$\begin{aligned} &= \frac{375}{1.6} \\ &= 234.375 \text{ mL} \end{aligned}$$

$$\begin{aligned} \therefore \text{Rate} &= \frac{234.375}{60} \\ &= 3.90625 \\ &= 3.9 \text{ mL/min} \end{aligned}$$

19. Measurement, 2UG 2018 HSC 28c

$$\begin{aligned} \text{Daily usage} &= 1200 \times \frac{45}{60} \times 40\% \\ &= 360 \text{ watts} \end{aligned}$$

$$\begin{aligned} 180 \text{ day usage} &= 180 \times 360 \\ &= 64\,800 \text{ watts} \\ &= 64.8 \text{ kW} \end{aligned}$$

$$\begin{aligned} \therefore \text{Cost over 180 days} &= 64.8 \times 0.25 \\ &= \$16.20 \end{aligned}$$

20. Measurement, STD2 M7 SM-Bank 01

Total energy usage

$$\begin{aligned} &= 3 \times 3200 \times 3.5 \text{ hours} \\ &= 33\,600 \text{ watts} \end{aligned}$$

$$\begin{aligned} \therefore \text{Cost} &= \frac{33\,600}{1000} \times 0.34 \\ &= 11.424 \\ &= \$11.42 \text{ (nearest cent)} \end{aligned}$$

21. Measurement, 2UG 2018 HSC 26g

i. Scale 8 cm : 24 m
1 cm : 3 m

♦♦ Mean mark 32%.

ii. Area of rectangle $ABFE$

$$\begin{aligned} &= 6 \text{ cm} \times 3 \text{ cm} \\ &= 18 \text{ m} \times 9 \text{ m} \\ &= 162 \text{ m}^2 \end{aligned}$$

Area of $\triangle EFG$

$$\begin{aligned} &= \frac{1}{2} \times 3 \text{ cm} \times 2 \text{ cm} \\ &= \frac{1}{2} \times 9 \times 6 \\ &= 27 \text{ m}^2 \end{aligned}$$

$$\begin{aligned} \therefore \text{Fertiliser needed} &= (162 + 27) \times 26.5 \\ &= 5008.5 \text{ grams} \end{aligned}$$

22. FS Resources, 2UG 2013 HSC 26d

$$\begin{aligned} \text{(i) } A &= \text{Last reading} + \text{Energy used} \\ &= 560.9 + 523.5 \\ &= 1084.4 \end{aligned}$$

$$\begin{aligned} \text{(ii) Cost at off-peak} &= 154 \times 9.6 \\ &= 1478.4 \text{ cents} \end{aligned}$$

$$\begin{aligned} \text{Cost at peak} &= 154 \times 47.77 \\ &= 7356.58 \text{ cents} \end{aligned}$$

$$\begin{aligned} \text{Saving} &= 7356.58 - 1478.4 \\ &= 5878.18 \\ &= \$58.78 \text{ (nearest cent)} \end{aligned}$$

♦ Mean mark part (i) 43% and part (ii) 46%.

23. FS Resources, 2UG 2015 HSC 30a

21 watts usage per computer per hour.

Watts used by 20 computers in 11 weeks

$$\begin{aligned} &= 21 \times 20 \times 24 \times 7 \times 11 \\ &= 776\,160 \text{ watts} \\ &= 776.16 \text{ kW} \end{aligned}$$

♦ Mean mark 49%.

$$\begin{aligned} \therefore \text{Cost of energy} &= 776.16 \times \$0.31 \\ &= \$240.6096 \\ &= \$240.61 \text{ (nearest cent)} \end{aligned}$$

\therefore The school will save \$240.61 by switching off all the computers.