STD 1: Measurement (Std 1), M1 Applications of Measurement (Y11)

Units and Measurement Error (Std 1)

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Exam Equivalent Time: 30 minutes *(based on HSC allocation of 1.5 minutes approx. per mark)*

IMPORTANT FEATURES AND TIPS FROM 2UG EXAM HISTORY

- *MS-M1 Units and Measurement Error* has been consistently examined in past HSC exams, a trend we expect to continue.
- *Measurement Error* is more prominent within the new Standard Mathematics syllabus vs the Gen2 syllabus, and therefore warrants a greater focus in our view. Our questions and solutions have been adjusted to reflect the "simplified" new syllabus calculation of percentage error (as a positive number, not the previous ± expression).
- *Significant figures* and *scientific notation* are both fair game (note the latter is referred to as "standard form" in the new syllabus which is elaborated upon to cover scientific notation in supporting documents).

ANALYSIS - Common pitfalls

- *Measurement Error* has been examined in 5 of the last 6 years, primarily through multiple choice. Note however that the last time it was examined in a longer answer question *(2013 Q27d)*, it was very poorly answered and close revision is advised here.
- *Significant figures*, although only sporadically examined, has caused major problems when asked. Note *Q1 2015 MC* produced the lowest mean mark of all multiple choice that year! (not a typo, the *first* question in the exam)
- *Scientific Notation* questions have produced volatile mean marks in the past. Pay careful attention to *2009 Q25b* which produced a state mean mark of 20%!
- Converting between units (eg. kilograms → grams) is often required. Few students were able to convert $cm^2 \rightarrow m^2$ which was required in 2009 (*Q12 MC*) and is recommended revision.

Questions

1. Measurement, 2UG 2007 HSC 1 MC

   What is $0.000\,000\,326$ mm expressed in scientific notation?

   (A) 0.326×10^{-6} mm

   (B) 3.26×10^{-7} mm

   (C) 0.326×10^{6} mm

   (D) 3.26×10^{7} mm

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2. Measurement, 2UG 2014 HSC 2 MC

   A measurement of 72 cm is increased by 20% and then the result is decreased by 20%.

   What is the new measurement, correct to the nearest centimetre?

   (A) 46 cm

   (B) 69 cm

   (C) 72 cm

   (D) 104 cm

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3. Measurement, STD2 M1 SM-Bank 25 MC

   A cockroach is measured in a school science experiment and its length is recorded as 5.2 cm.

   What is the upper limit of accuracy of this measurement?

   A. 5:21 cm

   B. 5.25 cm

   C. 5.5 cm

   D. 5.9 cm

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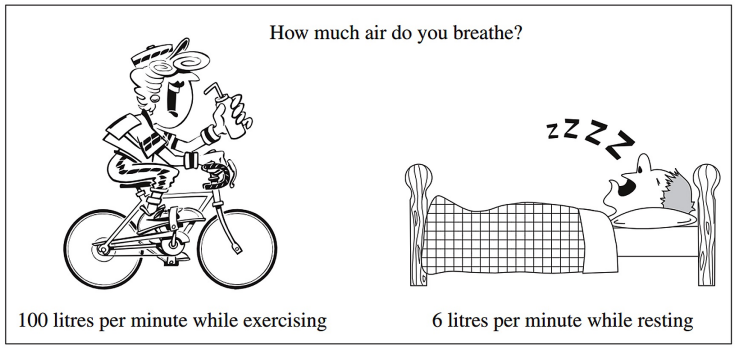
4. Measurement, 2UG 2004 HSC 13 MC



During a ten-minute period, Kath is exercising and Jim is resting.

How much more air would Kath breathe than Jim during this time?

(A) 40 Litres

(B) 94 Litres

(C) 940 Litres

(D) 1060 Litres

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5. Measurement, 2UG 2006 HSC 11 MC

Peter rides his bike at a speed of $27\ \text{km/h}$.

What is this speed in m/s?

(A) 7.5

(B) 18.75

(C) 97.2

(D) 450

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6. Measurement, 2UG 2018 HSC 18 MC

The length of a window is measured as 2.4 m.

Which calculation will give the percentage error for this measurement?

A. $\dfrac{0.05}{2.4} \times 100$

B. $\dfrac{0.05}{100} \times 2.4$

C. $\dfrac{0.5}{2.4} \times 100$

D. $\dfrac{0.5}{100} \times 2.4$

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7. Measurement, 2UG 2015 HSC 1 MC

What is 1 560 200 km written in standard form correct to two significant figures?

(A) $1.56 \times 10^4\ \text{km}$

(B) $1.6 \times 10^5\ \text{km}$

(C) $1.56 \times 10^6\ \text{km}$

(D) $1.6 \times 10^6\ \text{km}$

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8. Measurement, 2UG 2016 HSC 1 MC

What is 208.345 correct to two significant figures?

(A) 208

(B) 210

(C) 208.34

(D) 208.35

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9. Measurement, 2UG 2014 HSC 10 MC

The top of the Sydney Harbour Bridge is measured to be 138.4 m above sea level.

What is the percentage error in this measurement?

(A) 0.036%

(B) 0.050%

(C) 0.072%

(D) 0.289%

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10. Measurement, 2UG 2015 HSC 12 MC

The length of a fish was measured to be 49 cm, correct to the nearest cm.

What is the percentage error in this measurement, correct to one significant figure?

(A) 0.01%

(B) 0.5%

(C) 1%

(D) 2%

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11. Measurement, 2UG 2017 HSC 21 MC

The length of a netball court is measured to be 30.50 metres, correct to the nearest centimetre.

What is the lower limit for the length of the netball court?

A. 30.45 m

B. 30.49 m

C. 30.495 m

D. 30.499 m

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12. Measurement, 2UG 2009 HSC 12 MC

How many square centimetres are in 0.0075 square metres?

(A) 0.75

(B) 7.5

(C) 75

(D) 7500

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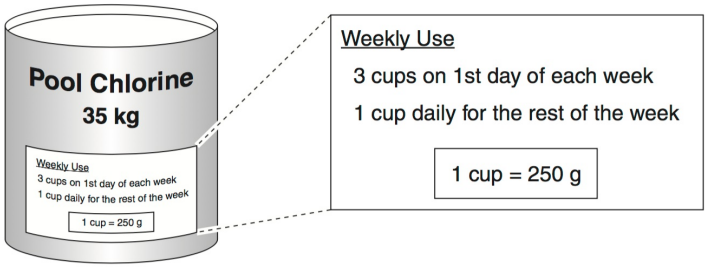
13. Measurement, 2UG 2012 HSC 26g

RAP Data - Bottom 12%: School result (70%) was 2% above state average (68%)

Bhawana purchases pool chlorine in a new container which holds 35 kg.



She begins using this new container on the first day of a week.

How many full weeks should this container last? ***(2 marks)***

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14. Measurement, 2UG 2008 HSC 23b

The capacity of a bottle is measured as 1.25 litres correct to the nearest 10 millilitres.

What is the percentage error for this measurement? ***(1 mark)***

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15. Measurement, 2UG 2013 HSC 27d

A rectangular wooden chopping board is advertised as being 17 cm by 25 cm, with each side measured to the nearest centimetre.

(i) Calculate the percentage error in the measurement of the longer side. ***(1 mark)***

(ii) Between what lower and upper limits does the actual area of the top of the chopping board lie? ***(2 marks)***

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16. Measurement, 2UG 2009 HSC 25b

The mass of a sample of microbes is 50 mg. There are approximately 2.5×10^6 microbes in the sample.

In standard form, what is the approximate mass in grams of one microbe? ***(2 marks)***

Worked Solutions

1. Measurement, 2UG 2007 HSC 1 MC

$0.000\ 000\ 326 \text{ mm}$

$= 3.26 \times 10^{-7} \text{ mm}$

$\Rightarrow B$

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2. Measurement, 2UG 2014 HSC 2 MC

$72 \text{ increased by } 20\%$

$= 72 + (20\% \times 72) = 86.4 \text{ cm}$

$86.4 \text{ decreased by } 20\%$

$= 86.4 - (20\% \times 86.4) = 69.12 \text{ cm}$

$\Rightarrow B$

STRATEGY: Students confident in this area could save time in the calculations as follows: $72 \times 1.2 \times 0.8 = 69.12$

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3. Measurement, STD2 M1 SM-Bank 25 MC

$\text{Absolute error} = 0.05 \text{ cm}$

$\text{Upper limit} = 5.2 + 0.05$

$= 5.25 \text{ cm}$

$\Rightarrow B$

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4. Measurement, 2UG 2004 HSC 13 MC

Kath's air volume

$= 10 \times 100$

$= 1000 \text{ L}$

Jim's air volume

$= 10 \times 6$

$= 60\text{L}$

$\therefore \text{ Extra air that Kath breathes}$

$= 1000 - 60$

$= 940 \text{ L}$

$\Rightarrow C$

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5. Measurement, 2UG 2006 HSC 11 MC

$27 \text{ km/h} = 27\ 000 \text{ metres per hour}$

$= \dfrac{27\ 000}{60} \text{ metres per minute}$

$= \dfrac{27\ 000}{60 \times 60} \text{ metres per second}$

$= 7.5 \text{ m/s}$

$\Rightarrow A$

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6. Measurement, 2UG 2018 HSC 18 MC

$\text{Absolute error} = 0.05 \text{ m}$

$\% \text{ error} = \dfrac{0.05}{2.4} \times 100$

$\Rightarrow A$

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7. Measurement, 2UG 2015 HSC 1 MC

$1\ 560\ 200$

$= 1.5602 \times 10^6$

$= 1.6 \times 10^6 \text{ km} \quad (2 \text{ sig})$

$\Rightarrow D$

♦♦ *Mean mark 30%.*
COMMENT: Incredibly, the first MC question in 2015 had the lowest mean mark of all MC questions in the exam!

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8. Measurement, 2UG 2016 HSC 1 MC

$208.345 = 210 \text{ (2 sig.)}$

$\Rightarrow B$

♦♦ *Mean mark 36%!!*

Worked Solutions

9. Measurement, 2UG 2014 HSC 10 MC

$$\text{Absolute error} = 0.05 \text{ m}$$

$$\% \text{ error} = \frac{0.05}{138.4} \times 100$$

$$= 0.036\%$$

$$\Rightarrow A$$

♦ *Mean mark 48%*

10. Measurement, 2UG 2015 HSC 12 MC

$$\text{Absolute error} = 0.5 \text{ cm}$$

$$\therefore \% \text{ error} = \frac{0.5}{49}$$

$$= 1\%$$

$$\Rightarrow C$$

♦ *Mean mark 41%.*

11. Measurement, 2UG 2017 HSC 21 MC

$$\text{Absolute error} = 0.5 \text{ cm}$$

$$= 0.005 \text{ m}$$

$$\therefore \text{Lower limit} = 30.50 - 0.005$$

$$= 30.495 \text{ m}$$

$$\Rightarrow C$$

12. Measurement, 2UG 2009 HSC 12 MC

$$\text{Since } 1 \text{ m}^2 = 100 \text{ cm} \times 100 \text{ cm}$$

$$= 10\,000 \text{ cm}^2$$

$$\therefore 0.0075 \text{ m}^2 = 0.0075 \times 10\,000$$

$$= 75 \text{ cm}^2$$

$$\Rightarrow C$$

♦♦♦ *Mean mark 19%.*

13. Measurement, 2UG 2012 HSC 26g

$$\text{Cups used per week} = 3 + 6 = 9$$

$$\text{Chlorine usage per week} = 9 \times 250\text{g}$$

$$= 2250\text{g}$$

$$\text{Total chlorine available} = 35\text{kg} = 35\,000 \text{ grams}$$

$$\text{Time it will last} = \frac{35\,000}{2250}$$

$$= 15.555...$$

$\therefore$ The container will last 15 full weeks.

MARKER'S COMMENT: Better answers converted all measurements to grams (rather than use decimals and kgs) and realised the answer should be in *full weeks*.

14. Measurement, 2UG 2008 HSC 23b

$$\text{Absolute error} = 5 \text{ mL}$$

$$\therefore \% \text{ error} = \frac{5}{1250} \times 100$$

$$= 0.4\%$$

15. Measurement, 2UG 2013 HSC 27d

(i) $\text{Longer side} = 25 \text{ cm}$

$$\text{Absolute error} = 0.5 \text{ cm}$$

$$\% \text{ Error} = \frac{0.5}{25} \times 100$$

$$= 2\%$$

♦♦ *Mean mark 23%*

MARKER'S COMMENT: Be aware that measurements accurate to the nearest cm have an ***absolute error*** for calculation purposes of 0.5 cm.

(ii) $\text{Area} = l \times b$

$$\text{Area (upper)} = 25.5 \times 17.5$$

$$= 446.25 \text{ cm}^2$$

$$\text{Area (lower)} = 24.5 \times 16.5$$

$$= 404.25 \text{ cm}^2$$

$\therefore$ Area is between 404.25 cm^2 and 446.25 cm^2.

♦ *Mean mark 35%*

16. Measurement, 2UG 2009 HSC 25b

We need to convert 50 mg into grams

$$50 \text{ mg} = \frac{50}{1000} = 0.05 \text{ g} = 5 \times 10^{-2} \text{ grams}$$

♦ ♦ ♦ *Mean mark 20%.*
IMPORTANT: Can you solve: 8 apples weigh 1kg, what does 1 apple weigh? This is ***exactly the same concept***.

$$\therefore \text{ Mass of 1 microbe} = \frac{\text{mass of sample}}{\#\text{ microbes}}$$

$$= \frac{5 \times 10^{-2}}{2.5 \times 10^{6}}$$

$$= 2 \times 10^{-8} \text{ grams}$$