1.1 Measurements in Physics

Mark Schemes

Course	DP IB Physics
Section	1. Measurement & Uncertainties
Topic	1.1 Measurements in Physics
Difficulty	Easy

To be used by all students preparing for DP IB Physics SL
Students of other boards may also find this useful

1

The correct answer is **A** because:

- The SI base units that you need to know are:
  - metre (m)
  - kilogram (kg)
  - second (s)
  - ampere (A)
  - kelvin (K)
  - mole (mol)
- Answer **A** is the only answer that is not an SI base unit

The volt is a derived unit. Derived units can be derived from SI base units. You might already be familiar with the SI base units from IGCSE. You need to know them all, and be able to derive common units (such as the newton, the joule, the watt etc) from SI base units.

Remember that when units are named after scientists, the symbol will be a capital letter, but the name of the unit will not be capitalised.

For example: The unit for force, the **n**ewton (**N**), is named after the famous scientist Isaac **N**ewton.

2

The correct answer is **B** because:

- The unit for frequency, *f*, is hertz (Hz)
- Frequency is the number of oscillations per second
- Therefore, the SI base unit for *f* is s^{-1}

Per is a really important concept in physics. Per signifies a division in an equation, or the denominator of a fraction. From IGCSE you may be more familiar with the notation in the form of m/s but beyond GCSE level we use $m\,s^{-1}$ to mean the same thing. In this case, per second refers to $\frac{1}{s}$ or s^{-1}.

3

The correct answer is **D** because:

- The metric multipliers in order of increasing value are
  - Pico- p
  - Nano- n
  - Micro- μ
  - Milli- m
  - Centi- c
  - Kilo- k
  - Mega- M
  - Giga- G
  - Tera- T
- Answer **D** is the only option where the multipliers increase in value

You will be given the metric multipliers in the data booklet so you not have to memorise them all, however, it is best to familiarise yourself with the more commonly used ones such as micro through to mega.

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The correct answer is **D** because:

- The prefixes listed have the following values
  - pico = 10^{-12}
  - nano = 10^{-9}
  - micro = 10^{-6}
  - milli = 10^{-3}
  - kilo = 10^{3}
  - mega = 10^{6}
  - giga = 10^{9}
  - tera = 10^{12}
- Therefore, milli × tera is equal to $10^{-3} \times 10^{12} = 10^{9}$
  - Answer **D** has the greatest magnitude

A is incorrect as	**pico × mega** is equal to $10^{-12} \times 10^{6} = 10^{-6}$
B is incorrect as	**nano × kilo** is equal to $10^{-9} \times 10^{3} = 10^{-6}$
C is incorrect as	**micro × giga** is equal to $10^{-6} \times 10^{9} = 10^{3}$

If you need a reminder about how to multiply and divide powers of 10:

When you multiply a power of 10, you add the exponents (powers)

$$10^{4} \times 10^{5} = 10^{4+5} = 10^{9}$$

When you divide a power of 10, you subtract the exponents:

$$\frac{10^{6}}{10^{2}} = 10^{6-2} = 10^{4}$$

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The correct answer is **C** because:

- The zeros after the decimal place are only included in scientific notation if they are significant
  - This rules out option **A**
- Zeros after non-zero digits are not significant if there is no decimal place
  - This rules out options **B** and **D**
- Zeros after non-zero digits but before the decimal place are significant
- Zeros following non-zero digits after the decimal place are also significant
  - Therefore, 6230.00 is correct to 6 significant figures
  - Hence, option **C** is the only answer that is not given to 3 significant figures

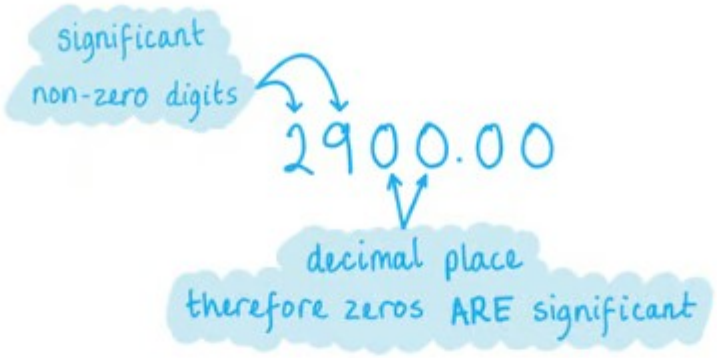
Zeros between significant non-zero digits are always significant

Zeros that come before non-zero digits are never significant

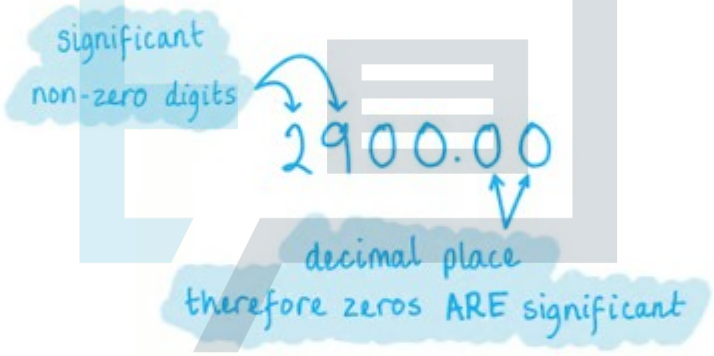
Zeros that come after non-zero digits are a little more complicated:

- If there is no decimal place, the zeros are not significant

- If the zeros are between the non-zero digits and the decimal place, the zeros are significant



- If the zeros come after the decimal place, the zeros are significant



6

The correct answer is **B** because:

- All the answers have zeros before the non-zero digits
- Zeros that come before non-zero digits are never significant
- Therefore, answer **B** is the only answer correct to 4 significant figures

A is incorrect as	0.0028 is 2 significant figures
C is incorrect as	0.003 is 1 significant figure
D is incorrect as	0.0028935 is 5 significant figures

Zeros between significant non-zero digits are always significant

Zeros that come before non-zero digits are never significant

Zeros that come after non-zero digits are a little more complicated:

- If there is no decimal place, the zeros are not significant

- If the zeros are between the non-zero digits and the decimal place, the zeros are significant

- If the zeros come after the decimal place, the zeros are significant

7

The correct answer is **B** because:

- Force (weight) and gravitational field strength are related by the following equation:
  - $F = mg$
- Comparing this to Newton's Second Law:
  - $F = ma$
  - $g = a$
- Therefore, gravitational field strength, g, has the same units as acceleration, a:
  - $m\,s^{-2}$

A & **D** are incorrect as	**N** and **J kg^{-1}** are incorrect units for gravitational field strength, and neither N or J are SI base units
C is incorrect as	whilst **N kg^{-1}** is a valid unit for gravitational field strength, N is not an SI base unit

Gravitational field strength, *g*, has the units newton per kilogram (N kg^{-1}). The acceleration of free fall, *g*, has the units metres per second squared (m s^{-2}). These are one and the same thing, just a different way of looking at it. Gravitational field strength is defined as the force applied per unit mass in a gravitational field, whereas the acceleration of free fall is the rate of change in the velocity of a mass that occurs because it is moving through a gravitational field. So the units are interchangeable because they are just different ways of measuring the same phenomenon.

If you need a reminder, the SI base units that you need to know are:

- metre (m)
- kilogram (kg)
- second (s)
- ampere (A)
- kelvin (K)
- mole (mol)

8

The correct answer is **D** because:

- The speed of sound can be obtained by carrying out an experiment which measures the time it takes for sound to be detected by two microphones a known distance apart
    - Therefore, the speed of sound is a measurable quantity

A is incorrect as	the length of a football field is a measurable quantity because it can be measured with a trundle wheel
B is incorrect as	the age of the universe is not directly measurable, it can only be estimated by looking at the rate of expansion of the universe and extrapolating back to the Big Bang
C is incorrect as	the potential difference of a mains supply is a measurable quantity as it can be measured directly with a voltmeter

9

The correct answer is **C** because:

- 3.8×10^{8} rounds down
  - The order of magnitude is 10^{8}
- 2×10^{-6} rounds down
  - The order of magnitude is 10^{-6}
- The difference between the orders of magnitude is:
  - 10^{8--6}
  - 10^{8+6}
  - 10^{14}
- Hence, answer **C** gives the only correct difference in the order of magnitude

10

The correct answer is **B** because:

- 9 700 000 in scientific notation is 9.7×10^{6}
- 9.7 rounds up
  - Therefore the order of magnitude is 10^{7}

Remember that for a number to be correct in scientific notation, the mantissa (the base number) has to have one non-zero digit before the decimal place. When we are working with orders of magnitude, we round this number up or down to the nearest power of 10.