

Candidate Name	Centre Number	Candidate Number
		2



**GCE AS/A level**

543/01-A

**PHYSICS**

**Assessment Unit PH3:**

**EXPERIMENTAL PHYSICS**

TEST 1 - WEDNESDAY, 14 May 2008

Sessions 1 & 2

Time Allowed 2 hours

For Examiner's use only	
<b>1</b>	
<b>2</b>	
<b>3</b>	
<b>Total</b>	

**ADDITIONAL MATERIALS**

In addition to this paper you may require a calculator.

**INSTRUCTIONS TO CANDIDATES**

Write your name, centre number and candidate number in the spaces at the top of the page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet.

**INFORMATION FOR CANDIDATES**

The total number of marks available for this paper is 60.

The number of marks is given in brackets at the end of each question or part question.

You are reminded of the necessity for good English and orderly presentation in your answers.

You are reminded to show all working. Credit is given for correct working even when the final answer given is incorrect.

For supervisor's use only.
Experiment 1: 80 cm – 40 cm time = ..... s
Experiment 2: $R_v = \dots\dots\dots \Omega$
Experiment 3: $A = \dots\dots\dots \text{cm}^2$ $t = \dots\dots\dots \text{mm}$

**SPECIFIC ADVICE FOR CANDIDATES**

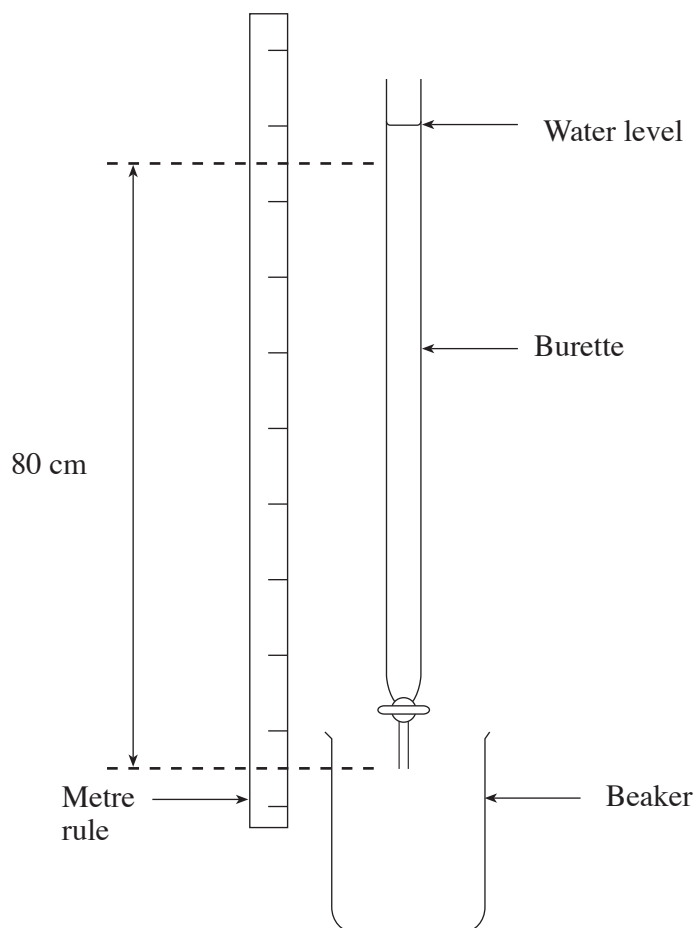
- Before commencing any question read the **whole** question through completely.
- You will be allowed **30 minutes** to use the apparatus for each of these questions. You will have a further **10 minutes** to complete writing up each question before moving on to the next.
- Where possible, readings should always be repeated and the averages taken in order to reduce uncertainty. If repeat readings are **not** required the question will state so.
- The estimated uncertainty,  $u$ , in a set of repeated readings should be taken as half the spread:

$$u(x) = \frac{x_{\max} - x_{\min}}{2}$$

- The percentage uncertainty =  $\frac{\text{Estimated uncertainty}}{\text{Average value}} \times 100\%$
- Ensure that all readings, including repeat readings, are recorded and that you have not neglected to quote the appropriate units.
- Any gradients of graphs which are measured should be expressed to sensible significant figures and accompanied by the appropriate units.
- Any fundamental constant which may be required will be given in the appropriate question.

**Question 1**

You are going to investigate the rate of flow of water through a burette.



Fill the burette with water so the level is **more than 80.0 cm** above the bottom.  
Allow the water to drain **continuously** from the burette by **fully** opening the nozzle.

Start timing as the water reaches a height of 80.0 cm and measure how long it takes the water to fall to 70.0 cm, 60.0 cm, 50.0 cm, 40.0 cm, 30.0 cm and 20.0 cm from the bottom of the burette.

- (a) Explain briefly how you intend to do this, in order to ensure accurate results. [2]

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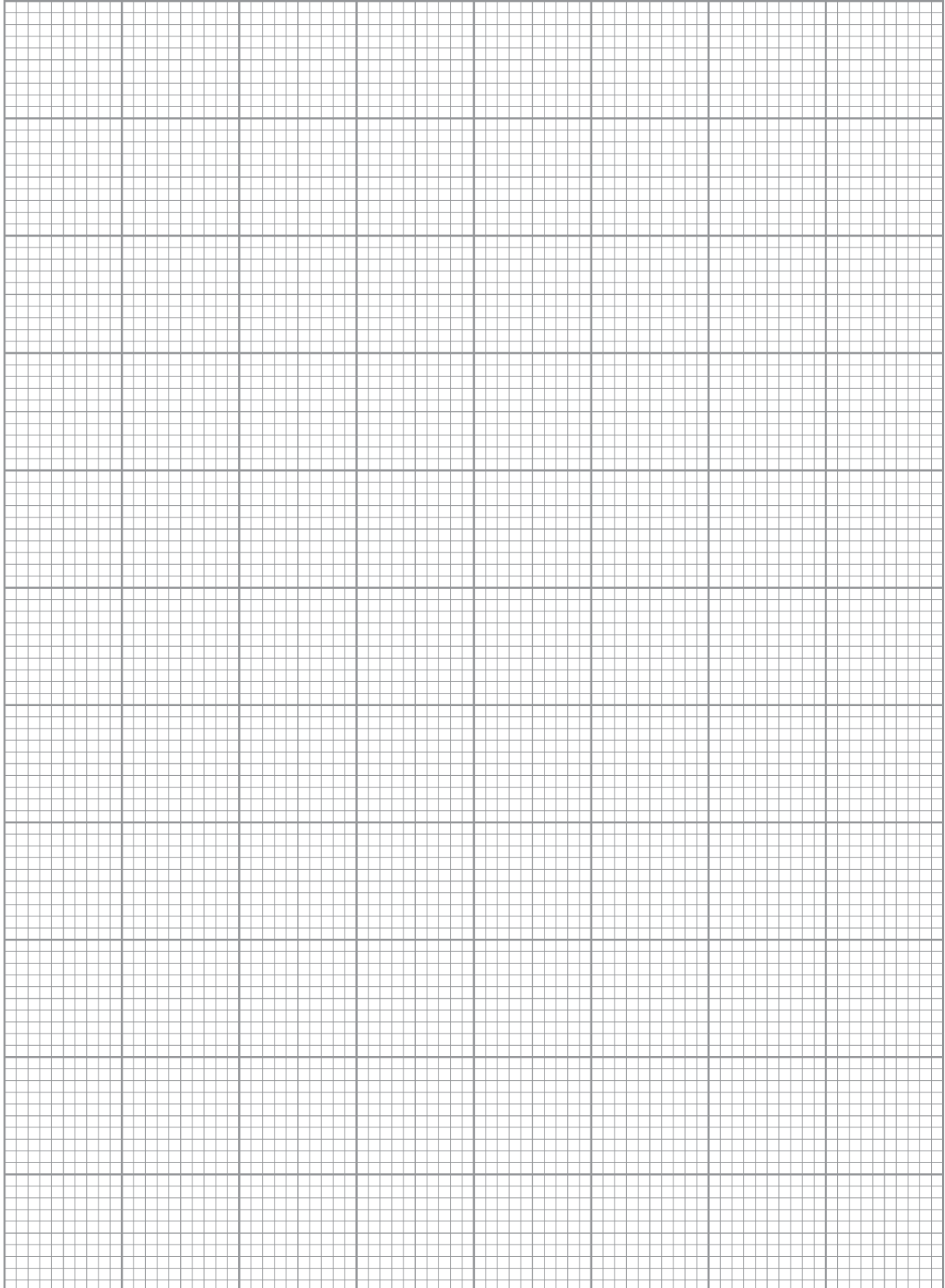
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- (c) Plot a graph of water level (on the vertical axis) against time (on the horizontal axis). [5]



- (d) (i) The time it takes the water to fall to half its original height can be called the half life,  $T_{1/2}$  of the experiment. Use your graph to determine the half life. [1]

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- (ii) Your answer to (d)(i) should be the same as the time it takes to fall from 40.0 cm to 20.0 cm, or from 60.0 cm to 30.0 cm. Use your graph to see if this is correct. [2]

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- (iii) Calculate an average (mean) value for the half life of the experiment. [1]

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- (iv) Find the percentage uncertainty in your result. (Use an expression given on page 2) [2]

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(e) (i) State the main cause of uncertainty in your result.

[1]

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(ii) How could you change the experiment to reduce the uncertainty of your result?

[2]

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**Question 2**

It is usually assumed that a voltmeter has an infinite resistance. However, in practice its resistance, although very high, is measurable. You are going to investigate the electrical resistance of a digital voltmeter.

- (a) Draw the circuit that has been set up for you. [2]

- (b) Theory shows that

$$\frac{1}{V} = \frac{R}{ER_v} + \frac{1}{E},$$

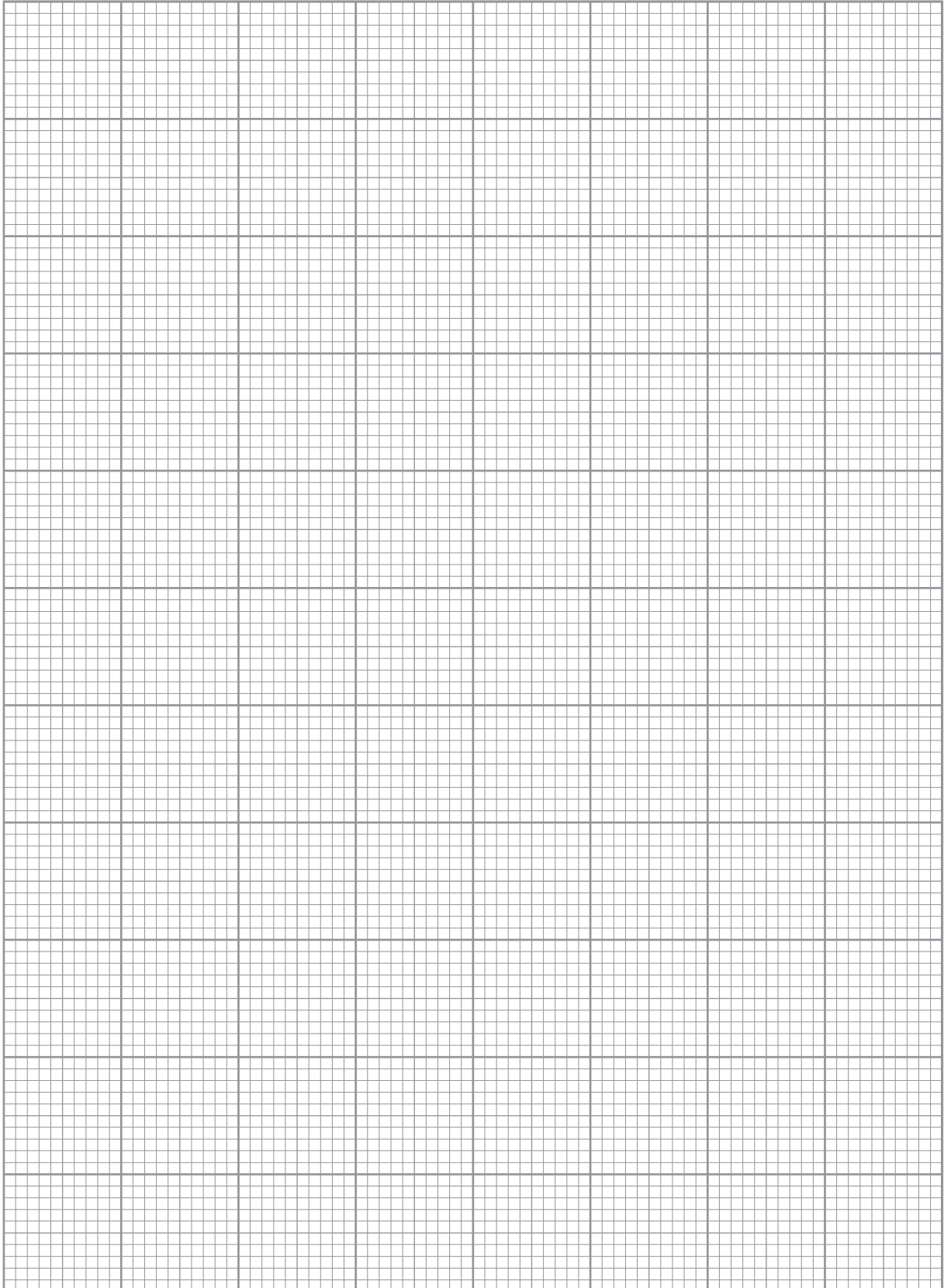
where  $V$  = voltage across the voltmeter (i.e. the reading on voltmeter)  
 $E$  = e.m.f. of the cell  
 $R_v$  = resistance of the voltmeter.  
 $R$  = resistance of the resistor in series with the voltmeter.

Complete the following table by using each of the resistors in the circuit, and all possible series combinations of them. **Repeat readings are not needed for this experiment.** [4]

Resistance, $R$ Unit (.....)	Voltage, $V$ Unit (.....)	$\frac{1}{V}$ Unit (.....)

(c) Plot a graph of  $\frac{1}{V}$  (on the vertical axis) against  $R$  (on the horizontal axis)

[5]



(d) The e.m.f. of the cell used can be taken as 1.5 V.

(i) Define the e.m.f. of a cell.

[2]

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(ii) Determine the gradient of your graph.

[2]

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(iii) Using the above value for the e.m.f.  $E$  and the gradient of your graph *calculate*  $R_V$ , the resistance of the voltmeter.

[2]

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(iv) The equation in part (b) of the question ignores the internal resistance of the cell. Explain why this was a reasonable assumption.

[1]

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(e) Use your graph to obtain the actual value for the e.m.f. of the cell.

[2]

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**Question 3**

You are going to use a sheet of aluminium foil to determine the density of aluminium by two different methods.

**Method 1**

- (a) (i) Measure the length,  $l$ , and width,  $w$ , of the foil. Explain how you ensured your values were accurate. [3]

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- (ii) Fold the sheet of aluminium a number of times. Hence determine the average thickness of the foil. [3]

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- (iii) Do you think this method of finding the thickness of the foil sheet is accurate? Explain your answer. [2]

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- (iv) Use the scales to find the mass of the foil. [1]

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- (v) Density can be calculated using the equation

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

Use your results in parts (i) - (iv) to calculate the density of the foil. [2]

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**Method 2**

- (b) Archimedes suggested a different method to find the volume. He stated that the volume of the object was equal to the volume of the water it displaced.

Fill the measuring cylinder with water up to the 30 cm<sup>3</sup> (ml) mark. Roll up your folded piece of foil so that it fits into the measuring cylinder and is completely covered with water.

- (i) What is the new level of the water in the cylinder? [1]

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- (ii) What is the volume of the foil? [1]

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- (iii) Use this new value of volume to calculate the density of aluminium. [1]

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- (iv) A result for this type of experiment can be said to be accurate if it is within 5% of the actual value. Given that the density of the aluminium you used is 2.7 g cm<sup>-3</sup>, comment on the accuracy of your two results. [2]

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- (c) State what you think the biggest uncertainty was in **each** experiment and say, in **each** case, how you could reduce it to improve your results. [4]

**Method 1**

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**Improvement**

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**Method 2**

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**Improvement**

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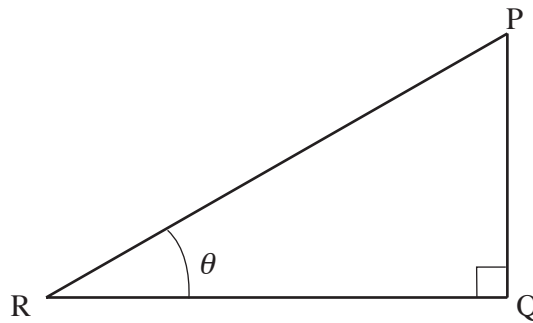
## Mathematical Data and Relationships

### SI multipliers

Multiple	Prefix	Symbol
$10^{-18}$	atto	a
$10^{-15}$	femto	f
$10^{-12}$	pico	p
$10^{-9}$	nano	n
$10^{-6}$	micro	$\mu$
$10^{-3}$	milli	m

Multiple	Prefix	Symbol
$10^{-2}$	centi	c
$10^3$	kilo	k
$10^6$	mega	M
$10^9$	giga	G
$10^{12}$	tera	T
$10^{15}$	peta	P

### Geometry and trigonometry



$$\sin \theta = \frac{PQ}{PR}, \quad \cos \theta = \frac{QR}{PR}, \quad \tan \theta = \frac{PQ}{QR}, \quad \frac{\sin \theta}{\cos \theta} = \tan \theta$$

$$PR^2 = PQ^2 + QR^2$$

### Areas and Volumes

$$\text{Area of a circle} = \pi r^2 = \frac{\pi d^2}{4}$$

$$\text{Area of a triangle} = \frac{1}{2} \text{ base} \times \text{height}$$

Solid	Surface area	Volume
rectangular block	$2(lh + hb + lb)$	$lbh$
cylinder	$2\pi r(r + h)$	$\pi r^2 h$
sphere	$4\pi r^2$	$\frac{4}{3} \pi r^3$