Algebraic Manipulation

1. Simplify the following as far as possible

   a) $3ab + 2a - 3b - ab$ b) $2x^2 + 3x - 4x + 5 + 6x^2$

   c) $2a \times 3a$ d) $e^2 \times 4e^3$

   e) $3ab \times 2a$ f) $\dfrac{2x^2}{x}$

   g) $\dfrac{6ab}{2ac}$ h) $\dfrac{a+b}{c-b}$

2. Multiply out the following brackets, and simplify the answer as far as possible

   a) $3a(2-b)$ b) $x(3x-4)$ c) $-4y(2+5y)$

   d) $-3a^2(4b-a)$ e) $(x+2)(x-3)$ f) $(2x-5)(x-7)$

   g) $(1-4x)(2+7x)$ h) $(x^2+2)(2x+5)$

3. Rearrange each of the following to make the letter indicated the subject

   a) $s = ut + \frac{1}{2}at^2$ u b) $F = \dfrac{GMm}{r^2}$ m

   c) $F = \dfrac{GMm}{r^2}$ r d) $I = \dfrac{Q}{t}$ t

   e) $T = 2\pi\sqrt{\dfrac{L}{g}}$ L f) $y = \dfrac{2-x}{3+x}$ x

   g) $\dfrac{1}{R} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$ R_1 h) $2as = v^2 - u^2$ v

4. In the following examples, the equation is given to you. Rearrange the equation for each of the other quantities. The first line shows an example of this.

Equation	First Rearrangement	Second Rearrangement
(Power of lens) $P = \dfrac{1}{f}$	1 = Pf	$f = \dfrac{1}{P}$
(Magnification of lens) $m = \dfrac{v}{u}$	$v =$	$u =$
(refractive index) $n = \dfrac{c}{v}$	$c =$	$v =$
(current) $I = \dfrac{\Delta Q}{\Delta t}$		
(electric potential) $V = \dfrac{\Delta E}{\Delta Q}$		
(power) $P = \dfrac{\Delta E}{\Delta t}$		
(power) $P = VI$		
(power) $P = I^2 R$		
(power) $P = \dfrac{V^2}{R}$		
(stress) $\sigma = \dfrac{F}{A}$	$F =$	$A =$
(strain) $\varepsilon = \dfrac{x}{l}$	$x =$	$l =$
(resistance) $R = \dfrac{\rho L}{A}$		
	$f =$	$t =$

(phase angle) $\theta = 2\pi f t$		
(displacement) $y = a \sin \theta$	$a =$	$\theta =$
(Young's interference) $x = \dfrac{\lambda L}{d}$		
(electron wavelength) $\lambda = \dfrac{h}{mv}$		

Standard Form

1. Convert these numbers into normal form.

    a) 5.239×10^3 b) 4.543×10^4 c) 9.382×10^2 d) 6.665×10^6

    e) 1.951×10^2 f) 1.905×10^5 g) 6.005×10^3

2. Convert these numbers into standard form.

    a) 65345   b) 28748   c) 548454   d) 486856

    e) 70241   f) 65865758   g) 765

3. Convert these numbers into normal form.

    a) 8.34×10^{-3} b) 2.541×10^{-8} c) 1.01×10^{-5}

    d) 8.88×10^{-1} e) 9×10^{-2} f) 5.05×10^{-9}

4. Convert these numbers to standard form.

    a) 0.000567   b) 0.987   c) 0.0052

d) 0.0000605   e) 0.008   f) 0.0040302

5.   Calculate, giving answers in standard form,

   a) $(3.45 \times 10^{-5} + 9.5 \times 10^{-6}) \div 0.0024$

   b) $(2.31 \times 10^{5} \times 3.98 \times 10^{-3}) + 0.0013$

Making Estimates

1.   Define the term Order of Magnitude

2.   For the following, estimate to the nearest order of magnitude:

Example	Order of Magnitude Estimate
Height of a human in m	
Height of a human in cm	
Mass of a human in kg	
Weight of an apple in N	
Thickness of a piece of paper in m	
Height of a house in m	
Diameter of a dinner plate in m	
The length of a lesson in s	
Volume of a pencil in m^3	
Mass of a standard car in kg	
Wavelength of visible light in m	

3.   Make order of magnitude estimates of the following quantities:

a. Surface area of a door in m^2

b. Volume of a raindrop in m^3

c. Density of wood in kgm^{-3}

d. Work done in lifting a physics textbook in J

e. Energy transferred by passing through a 2kW kettle to make a cup of tea, in J

f. Impact force on a football (F = change in momentum / impact time) in N

Converting Units

Many quantities are commonly represented by units other than their base units, for a variety of reasons. Some examples are displayed below:

Quantity	Quantity	Alternative Unit	Unit Symbol	Value in SI Units
Energy	E	electron volt	eV	1.6×10^{-19} J
Charge	Q	charge on electron	e	1.6×10^{-19} C
Mass	m	atomic mass unit	u	1.67×10^{-27} J
Mass	m	tonne	t	10^3 kg
Time	t	hour	hr	3,600 s
Time	t	year	yr	3.16×10^7 s
Distance	d	miles	miles	1,609 m
Distance	d	astronomical unit	AU	3.09×10^{11} m
Distance	d	light year	ly	9.46×10^{15} m
Distance	d	parsec	pc	3.09×10^{16} m

Convert the following quantities:

1. What is 13.6 eV expressed in joules?

2. What is a charge of 6e expressed in coulombs?

3. An atom of Lead-208 has a mass of 207.9766521 *u, convert this mass into kg.*

4. *What is 2.39×10^8 kg in tonnes?*

5. *It has been 49 years since England won the World Cup, how long is this in seconds?*

6. *A TV program lasts 2,560s, how many hours is this?*

7. *The semi-major axis of Pluto's orbit around the Sun is* 5.91×10^{12} m, what is this distance in AU?

8. Convert 0.023 kms^{-1} into ms^{-1}.

9. Express 3456 m hr^{-1} into km hr^{-1}

10. What is 30 miles hr^{-1} in ms^{-1}?

11. What is 50 ms^{-1} in miles hr^{-1}?

12. Convert 33 km hr^{-1} into ms^{-1}.

13. Express 234 miles hr^{-1} in km hr^{-1}.