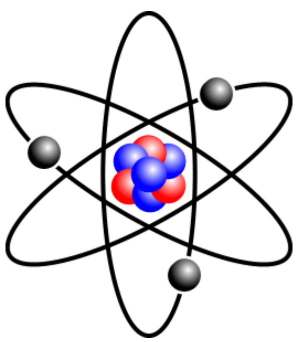
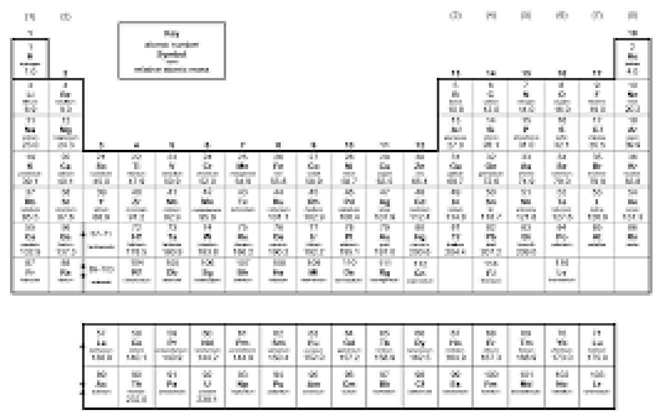
A Level Chemistry

TRANSITION WORK





Student: ___________________________________

This booklet is designed to help embed some skills you learned at GCSE that are essential for success at A Level. The topics covered include chemical formulae, equations and atomic structure.

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Activity 1 Chemical formulae

We can use the periodic table to predict the formulae of ions –

Group 1 Li, Na, K, Rb, Cs	1+
Group 2 Mg, Ca, Sr, Ba	2+
Group 3 Al	3+
Group 5 N, P	3-
Group 6 O, S	2-
Group 7 F, Cl, Br, I	1-

When a compound is formed it is neutral so ions combine so that the number of positive charges = number of negative charges.
For example –
Sodium chloride Na^+ and Cl^- so NaCl
Sodium oxide Na^+ and O^{2-} so Na_2O
Sodium nitride Na^+ and N^{3-} so Na_3N

Practice writing formulae for these compounds

1. Magnesium oxide

2. Lithium bromide

3. Aluminium phosphide

4. Calcium chloride

5. Barium sulphide

6. Aluminium iodide

7. Potassium oxide

8. Sodium fluoride

9. Magnesium nitride

10. Aluminium oxide

You need to learn the formulae of these ions because they cannot be worked out from the Periodic table-

Hydroxide	OH^-
Nitrate	NO_3^-
Sulphate	SO_4^{2-}
Carbonate	CO_3^{2-}
Ammonium	NH_4^+
Zinc	Zn^{2+}
Silver	Ag^+

For example

Sodium nitrate Na^+ and NO_3^- so $NaNO_3$

Sodium sulphate Na^+ and SO_4^{2-} so Na_2SO_4

Zinc hydroxide Zn^{2+} and OH^- so $Zn(OH)_2$

3 key points –

1. Note the need for brackets when you need more than one of a compound ion (an ion with more than one symbol).

2. Take care with naming – ide means the element on its own sulphide S^{2-} nitride N^{3-}
-ate means it is also combined with oxygen sulphate SO_4^{2-} nitrate NO^{3-}

3. Metals which are in the central block of the Periodic Table, Transition Elements, can form ions with different charges. Roman numerals in the name tell us the charge on the metal ion.
For example, iron II chloride contains Fe^{2+} so the formula is $FeCl_2$
but iron III chloride is $FeCl_3$ because the iron is Fe^{3+}.

Practise writing formulae for these compounds -

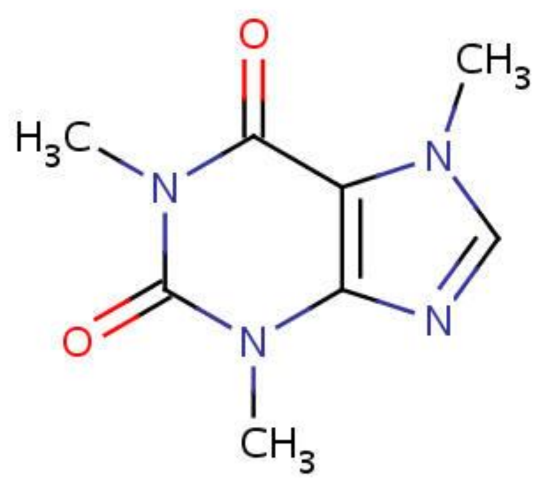
1. Calcium carbonate
2. Silver nitrate
3. Copper II sulphate
4. Zinc chloride
5. Potassium hydroxide
6. Ammonium chloride
7. Magnesium hydroxide
8. Ammonium sulphate
9. Iron II sulphate
10. Iron III oxide
11.

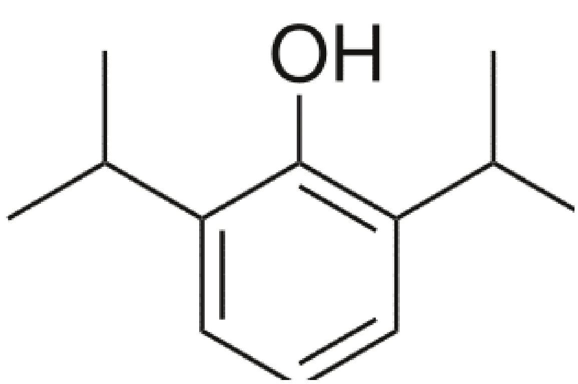
Learn the following chemical formulae -

Hydrogen	H_2	Hydrochloric acid	HCl
Oxygen	O_2	Nitric acid	HNO_3
Water	H_2O	Sulphuric acid	H_2SO_4
Carbon dioxide	CO_2	Phosphoric acid	H_3PO_4
Carbon monoxide	CO	Sodium hydroxide	$NaOH$
Ammonia	NH_3	Potassium hydroxide	KOH
Ozone	O_3	Copper II oxide	CuO
Nitrogen	N_2	Sodium carbonate	Na_2CO_3
Chlorine	Cl_2	Calcium carbonate	$CaCO_3$
Bromine	Br_2	Sodium chloride	$NaCl$

1. Carry out research on 4 different molecules – find out the formula, chemical structure, what the chemical is used for and any other interesting information about the molecule. Present this information on an A3 poster. (Keep to information that you can understand!) Choose any 4 molecules from the list below.

(a) citric acid
(b) ethane -1,2-diol
(c) limonene
(d) aspirin
(e) sucrose
(f) octadecanoic acid
(g) ibuprofen
(h) lactic acid
(i) trichlorophenol
(j) cyclodextrin





What are these?

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Physical Quantities - Questions

1) The unit of energy is the joule. Find out what this unit is expressed in terms of the base SI units.

2) 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

3) Convert these quantities into standard form:
   a) 65345 N
   b) 765 s
   c) 486856 W
   d) 0.987 cm^2
   e) 0.000567 F
   f) 0.0000605 C
   g) 0.03000045 J

4) Write down the solutions to these problems, giving your answer in standard form:
   a) $(3.45 \times 10^{-5} + 9.5 \times 10^{-6}) \div 0.0024$
   b) $2.31 \times 10^5 \times 3.98 \times 10^{-3} + 0.0013$

5) Calculate the following:
   a) 20mm in metres
   b) 3.5kg in grams
   c) 589000 μm in metres
   d) 1m^2 in cm^2 (careful)
   e) 38 cm^2 in m^2

6) Find the following:
   a) 365 days in seconds, written in standard form
   b) 3.0×10^4 g written in kg
   c) 2.1×10^6 Ω written in MΩ
   d) 5.9×10^{-7} m written in μm
   e) Which is bigger? 1452 pF or 0.234 nF

Mark = /27

1. Significant Figures

Number in Physics also show us how certain we are of a value. How sure are you that the width of this page is 210.30145 mm across? Using a ruler you could not be this precise. You would be more correct to state it as being 210 mm across, since a ruler can measure to the nearest millimetre.

To show the precision of a value we will quote it to the correct number of significant figures. But how can you tell which figures are significant?

The Rules

1. All non-zero digits are significant.
2. In a number with a decimal point, all zeros to the right of the right-most non-zero digit are significant.
3. In a number without a decimal point, trailing zeros may or may not be significant, you can only tell from the context.

Examples

Value	# of S.F.	Hints
23	2	There are two digits and both are non-zero, so are both significant
123.654	6	All digits are significant – this number has high precision
123.000	6	Trailing zeros after decimal are significant and claim the same high precision
0.000654	3	Leading zeros are only placeholders
100.32	5	Middle zeros are always significant
5400	2, 3 or 4	Are the zeros placeholders? You would have to check how the number was obtained

When taking many measurements with the same piece of measuring apparatus, all your data should have the same number of significant figures.

For example, measuring the width of my thumb in three different places with a micrometer:

20.91×10^{-3} m 21.22×10^{-3} m 21.00×10^{-3}m **all to 4 s.f**

Significant Figures in Calculations

We must also show that calculated values recognise the precision of the values we put into a formula. We do this by giving our answer to the same number of significant figures as the least precise piece of data we use.

There is no way we can state the runners speed this precisely.

For example: A man runs 110 m in 13 s. Calculate his average speed.

Speed = Distance / Time = 110 m / 13 s = 8.461538461538461538461538461538 m/s

= 8.5 m/s to 2 s.f.

This is the same number of sig figs as the time, which is less precise than the distance.

Significant Figures - Questions

1) Write the following lengths to the stated number of significant figures:
   a) 5.0319 m to 3 s.f.
   b) 500.00 m to 2 s.f.
   c) 0.9567892159 m to 2 s.f.
   d) 0.000568 m to 1 s.f.

2) How many significant figures are the following numbers quoted to?
   a) 224.4343
   b) 0.000000000003244654
   c) 344012.34
   d) 456
   e) 4315.0002
   f) 200000 stars in a small galaxy
   g) 4.0

3) For the numbers above that are quoted to more than 3 s.f, convert the number to standard form and quote to 3 s.f. ↑

4) Calculate the following and write your answer to the correct number of significant figures:
   a) 2.65 m x 3.015 m
   b) 22.37 cm x 3.10 cm
   c) 0.16 m x 0.02 m
   d) $\frac{54.401 \text{ m}^3}{4 \text{ m}}$

Mark = /19

2. Using Equations

You are expected to be able to manipulate formulae correctly and confidently. You must practise rearranging and substituting equations until it becomes second nature. We shall be using quantity symbols, and not words, to make the process easier.

Key points

- Whatever mathematical operation you apply to one side of an equation must be applied to the other.
- Don't try and tackle too many steps at once.

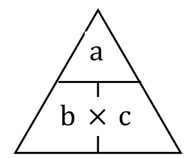
Simple formulae

The most straightforward formulae are of the form $a = b \times c$ (or more correctly $= bc$).

Rearrange to set b as the subject: Divide both sides through by c $\frac{a}{c} = \frac{b \times c}{c}$ therefore $\frac{a}{c} = b$

Rearrange to set c as the subject: Divide both sides through by b $\frac{a}{b} = \frac{b \times c}{b}$ therefore $\frac{a}{b} = a$

Alternatively you can use the formula triangle method. From the formula you know put the quantities into the triangle and then cover up the quantity you need to reveal the relationship between the other two quantities. This method only works for simple formulae, it doesn't work for some of the more complex relationships, so you must learn to rearrange.



More complex formulae

Formulae with more than 3 terms		Formulae with additions or subtractions		Formulae with squares or square roots	
Find ρ	$R = \frac{\rho l}{A}$	**Find h**	$Ek = hf - \Phi$	**Find *g***	$T = 2\pi\sqrt{\frac{l}{g}}$
Divide by l	$\frac{R}{l} = \frac{\rho l}{Al}$	Add Φ	$Ek + \Phi = hf - \Phi + \Phi$	Square	$T^2 = 4\pi^2 \frac{l}{g}$
Cancel l	$\frac{R}{l} = \frac{\rho l}{Al}$	Cancel Φ	$Ek + \Phi = hf$	Multiply by g	$gT^2 = 4\pi^2 l$
Multiply by A	$\frac{R}{l} = \frac{\rho l}{Al}$	Divide by f	$\frac{Ek+\Phi}{f} = \frac{hf}{f}$	Divide by T^2	$g = \frac{4\pi^2 l}{T^2}$
Cancel A	$\frac{R}{l} = \frac{\rho l}{Al}$	Cancel f	$\frac{Ek+\Phi}{f} = h$		

Symbols on quantities

Sometimes the symbol for a quantity may be combined with some other identifying symbol to give more detail about that quantity. Here are some examples.

Symbol	Meaning
Δx	A change in x (difference between two values of x)
$\Delta x/\Delta t$	A rate of change of x
$\langle x \rangle$ or $\bar{x}$	Mean value of x
$\vec{x}$	Quantity x is a vector
x_1 x_2	Subscripts distinguish between same types of quantity

Using Equations - Questions

1) Make t the subject of each of the following equations:

    a) $V = u + at$

    b) $S = \frac{1}{2} at^2$

    c) $Y = k(t - t_0)$

    d) $F = \frac{mv}{t}$

    e) $Y = \frac{k}{t^2}$

    f) $Y = 2t^{1/2}$

    g) $v = \frac{\Delta s}{\Delta t}$

2) Solve each of the following equations to find the value of *t*:

    a) $30 = 3t - 3$

    b) $4(t + 5) = 28$

    c) $\frac{5}{t^2} = 10$

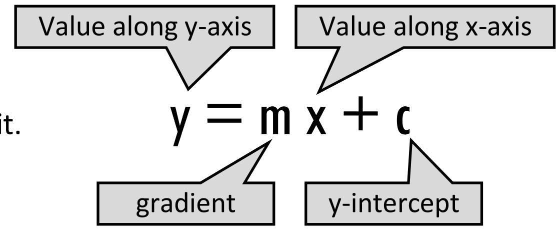
    d) $3t^2 = 36$

    e) $t^{-1/2} = 6$

    f) $t^{1/3} = 3$

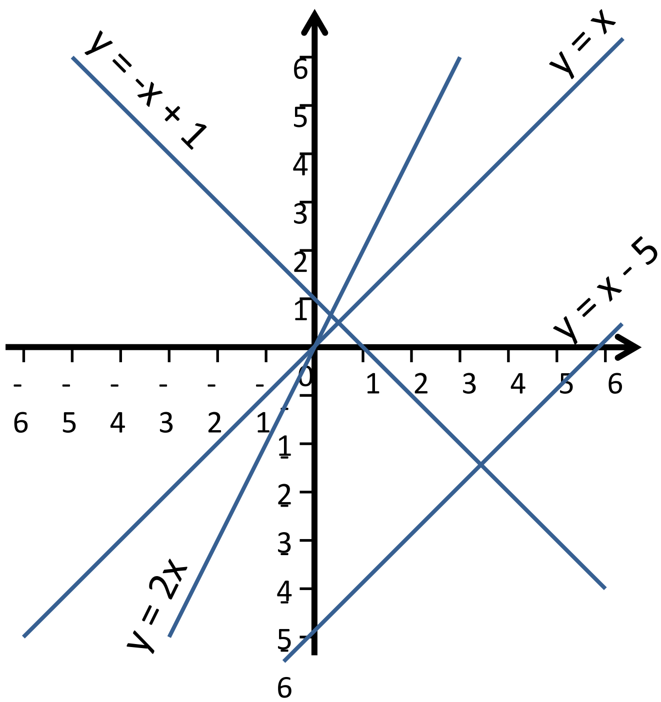
Mark = /13

3. Straight Line Graphs



If a graph is a straight line, then there is a formula that will describe it.

Here are some examples:



y = x   A positive line through the origin
Gradient, m = 1   y-intercept, c = 0

y = x – 5 Parallel to y = x but transposed by -5.
Gradient, m = 1   y-intercept, c = -5

y = 2x   A positive line through the origin
Gradient, m = 2   y-intercept, c = 0

y = -x + 1 A negative line, parallel to y = -x
Gradient, m = -1   y-intercept, c = 1

> DIRECTLY PROPORTIONAL describes any straight line **through the origin**. Both y α x and Δy α Δx
>
> LINEAR describes any other straight line. Only Δy α Δx.

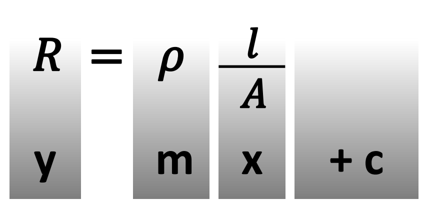
If asked to plot a graph of experimental data at GCSE, you would plot the *independent variable* along the x-axis and the *dependent variable* up the y-axis. Then you might be able to say something about how the two variables are related.

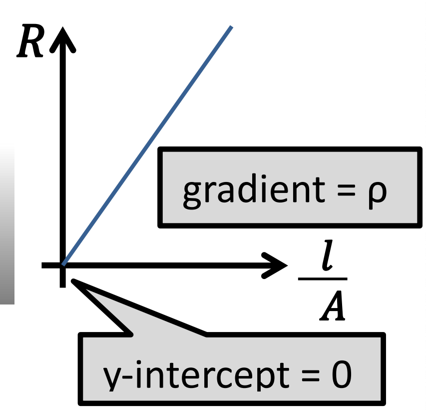
At A-Level, we need to be cleverer about our choice of axes. Often we will need to find a value which is not easy to measure. We take a relationship and manipulate it into the form y = mx + c to make this possible.

Example: $R = \frac{\rho l}{A}$ is the relationship between the resistance R of a conductor, the resistivity ρ of the material which it is made of, its length l, and its area A.

We do an experiment to find R, l and A, which are all easy to measure.
We want to find the resistivity ρ, which is harder.

This example doesn't need rearranging,
just rewriting $R = \frac{\rho l}{A}$ into the shape y = mx + c:





So it is found that by plotting R on the y-axis and l/A on the x-axis, the resitivity ρ will be the gradient of the graph.

Straight Line Graphs - Questions

1) For each of the following equations that represent straight line graphs, write down the gradient and the y intercept:

   a) $y = 5x + 6$

   b) $y = -8x + 2$

   c) $y = 7 - x$

   d) $2y = 8x - 3$

   e) $y + 4x = 10$

   f) $3x = 5(1-y)$

   g) $5x - 3 = 8y$

Mark = /14

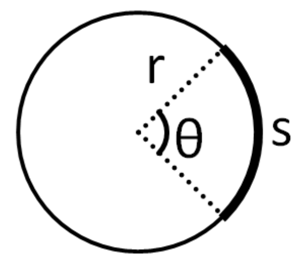
4. Trigonometry

When dealing with vector quantities or systems involving circles, it will be necessary to use simple trigonometric relationships.

Angles and Arcs

There are two measurements of angles used in Physics.

- **Degrees** There are 360º in a circle
- **Radians** There are 2π radians in a circle



Whichever you use, make sure your calculator is in the correct mode!

To swap from one to the other you need to find what fraction of a circle you are interested in, and then multiply it by the number of degrees or radians in a circle.

$$\theta_{\text{radians}} = \frac{\theta_{\text{degrees}}}{360} \times 2\pi \qquad \text{or} \qquad \theta_{\text{degrees}} = \frac{\theta_{\text{radians}}}{2\pi} \times 360$$

For example: To convert 90º into radians: $\theta_{\text{radians}} = \frac{\theta_{\text{degrees}}}{360} \times 2\pi = \frac{90}{360} \times 2\pi = \frac{1}{4} \times 2\pi = \frac{\pi}{2}$ radians
(We tend to leave answers in radians as fractions of π)

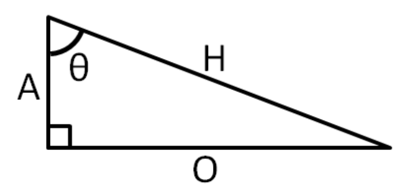
To find the length of an arc, use $s = \theta r$. The angle must be in radians. What would the relationship be if you wanted the entire circumference? Compare to this formula.

Sine, Cosine, Tangent

Recall from your GCSE studies the relationships between the lengths of the sides and the angles of right-angled triangles.

Using SOHCHATOA:

$$\sin\theta = \frac{\text{O}}{\text{H}} \qquad \cos\theta = \frac{\text{A}}{\text{H}} \qquad \tan\theta = \frac{\text{O}}{\text{A}}$$



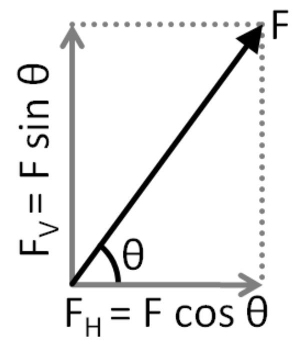
Vector Rules

A **vector** is a quantity which has two parts: SIZE and DIRECTION
(e.g. force, velocity, acceleration)

A **scalar** is a quantity which just has SIZE
(e.g. temperature, length, time, speed)

We represent vectors on diagrams with arrows.

To simplify problems in mechanics we will separate a vector into horizontal and vertical components. This is done using the trigonometry rules.



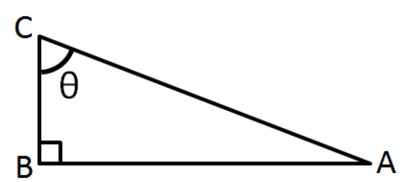
Trigonometry - Questions

1) Calculate:
   a) The circumference of a circle of radius 0.450 m

   b) the length of the arc of a circle of radius 0.450m for the following angles between the arc and the centre of the circle:
      i. 340°

      ii. 170°

      iii. 30°



2) For the triangle ABC shown, calculate:
   a) Angle θ if AB = 30cm and BC = 40cm

   b) Angle θ if AC = 80cm and AB = 35cm

   c) AB if θ = 36° and BC = 50 mm

   d) BC if θ = 65° and AC = 15 km

3) Calculate the horizontal component A and the vertical component B of a 65 N force at 40° above the horizontal.

Mark = /10

5. Problem Solving Technique

It is vital that you are able to communicate a numerical answer clearly.

Students will often make these mistakes in questions that involve calculations:

- Copying values or equations incorrectly from the question or the data sheet.
- Mistakes when rearranging formulae.
- Ignoring prefixes to units.
- Inputting into calculator wrong, especially standard form and accurate use of brackets.
- Having the calculator in the wrong mode (radians/degrees)
- If asked for, not writing final answer to the correct number of significant figures or writing the unit.
- Writing down a value which would be silly in the context of the question.
- Messy working that is difficult to decipher.

A method for numerical questions

Example question:

Calculate the wavelength of a quantum of electromagnetic radiation with energy of 1.99 J.

Data sheet:

Speed of electromagnetic radiation in free space,

$c = 3.00 \times 10^{6}$ m s^{-1}

Planck's constant, $h = 6.63 \times 10^{-34}$ J s

(1) Write down the values of everything you are given.

(2) Convert all the values into SI units (e.g. put time into seconds, distance in meters...) and replace unit prefixes with their equivalent values in standard form.

(3) Pick the equation you need. If you need to find it on the data sheet, look for one that contains the quantities you know and the quantity you are trying to work out.

(4) Rearrange the formula so the quantity you want is the subject of the equation.

(5) Insert the values into your equation, taking care to lay out your working clearly

(6) Use your calculator to accurately input the numbers to find the solution.

(7) Write down the answer to more decimal places than you need at first, in case you need the value for later calculations. Check the answer seems sensible. In this example I got a massive wavelength the first time because I mistyped the energy as $0.199 \times 10^{\mathbf{12}}$ J.

(8) Write your final answer and underline it. All the input values were to 3 s.f., so the answer should be written to the same precision.

$c = 3{\cdot}00 \times 10^{8}\ ms^{-1}$

$h = 6{\cdot}63 \times 10^{-34}\ Js$

$E = 0{\cdot}199\ pJ$

$\quad = 0{\cdot}199 \times 10^{-12}\ J$

$\lambda = ?$

$$E = \frac{hc}{\lambda}$$

$$\lambda = \frac{hc}{E}$$

$$= \frac{6{\cdot}63 \times 10^{-34} Js \times 3{\cdot}00 \times 10^{8}\ ms^{-1}}{0{\cdot}199 \times 10^{-12} J}$$

$= \sout{9{\cdot}9949 \times 10^{11}\ m}$

$= \underline{9{\cdot}99 \times 10^{-13}\ m \text{ to } 3\ s{\cdot}f{\cdot}}$

6. Key Concepts – Conservation of Energy

There are several key ideas in physics that prove useful in many different contexts. They apply to any situation because the laws of physics are universal.

The first of these key ideas is Conservation of Energy
A great video explaining this: https://www.youtube.com/watch?v=ckfqY7gIFIQ

Example: A pen falls off of a desk 1.2m high. How fast will the pen be going when it hits the ground? Assume the energy lost to air resistance is negligible.

As the pen falls, energy is transferred from a gravitational to a kinetic store. Since we are ignoring the small amount of energy dissipated by air resistance, we can say that:

Kinetic energy of pen when it hits the ground = gravitational energy of pen before it fell

Using the formulas for kinetic and gravitational energy:

$$\frac{1}{2}mv^2 = mgh$$

This simplifies to:

$$\frac{1}{2}v^2 = gh$$

So:

$$v = \sqrt{2gh}$$

$$v = \sqrt{2 \times 9.81 \times 1.2}$$

$$v = 4.85\ m/s$$

Your go: A circus acrobat wants to jump and be caught by a net. They will safely land in the net provided they are going no faster than 12m/s. Show that the maximum height they could jump from is about 7.3m.

Your go 2: A catapult uses a spring with a spring constant of 800N/m. The is compressed by 0.5cm then released to launch a projectile which has a mass of 0.2kg. Show that the speed of the object when it leaves the catapult is about 0.3m/s.

Useful energy formulas:

Kinetic energy: $E = \frac{1}{2}mv^2$

Gravitational energy: $E = mgh$

Elastic energy: $E = \frac{1}{2}kx^2$

7. Key Concepts – Conservation of Momentum

Momentum is another quantity that is conserved whenever objects interact with one another.

Momentum has the units "$kg\ m/s$" and is calculated by: $momentum = mass \times velocity$
or in symbols: $p = mv$

Since momentum is conserved, this means that in any interaction between two objects the total momentum before and after the interaction is the same.

Example: A 1000kg car travelling at 7 m/s collides with a stationary second car of mass 1500kg. The two cars move together after the collision. What is the velocity of the cars after the collision?

Total momentum before the collision = $1000 \times 7 + 1500 \times 0 = 7000$kg m/s

Therefore, total momentum after collision = 7000 kg m/s

Using $p = mv$:

$$7000 = (1000 + 1500) \times v$$

$$v = \frac{7000}{2500} = 2.8\ m/s$$

Your go: A 65kg ice skater moving at 6.5 m/s collides and grabs on to a second stationary ice skater of mass 50kg. They move together after the collision. Show that their velocity after the collision is about 3.7 m/s.

Your go 2: A 3kg gun is stationary. It then fires a 0.03kg bullet at a velocity of 1000 m/s. Show that the recoil velocity of the gun is 30 m/s.