Key

relative atomic mass **atomic symbol** name atomic (proton) number

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112 – 116 have been reported but not fully authenticated						

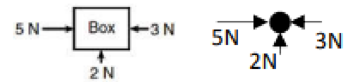
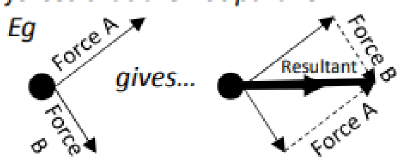
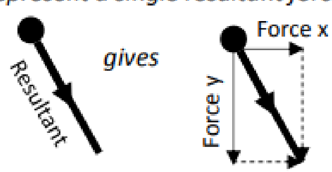
* The Lanthanides (atomic numbers 58 – 71) and the Actinides (atomic numbers 90 – 103) have been omitted.

Relative atomic masses for **Cu** and **Cl** have not been rounded to the nearest whole number.

Key points to learn

1. Scalar	Magnitude only eg speed
2. Vector	Magnitude and direction eg velocity, force
	Can be drawn as an arrow →
3. Displacement	Distance away from start point in a straight line
4 Magnitude	Size of a quantity
5 Force, F [N]	Push or a pull acting on an object
6. Contact force	Forces that act though touch eg friction, air resistance, tension
7. Non-contact force	Forces that act without need for touch eg magnetic force, gravity, electrostatic force
8. Newton's Third Law	When two objects interact they exert an equal and opposite force on each other
9. Driving force	A force that makes a vehicle move
10. Friction	A force that tries to stop an object moving. Generates heat
11. Resultant force	The force you have if you replaced all the forces on an object with one single force
	If it is zero, forces are balanced
12. Newton's First Law	If the forces on an object are balanced the object will either: 1. Remain still 2. Keep moving same velocity

Key points to learn

13. Free body force diagram	*Shows the forces as arrows acting on an object. Object represented as a dot on centre of mass*
	Eg 
14. Centre of mass	Point at which mass of an object appears to be concentrated
	All objects will hang with their centre of mass below the pivot
	The centre of mass of a regular shape is at the centre
15. The parallelogram of forces	*Used to find the resultant of two forces that are not parallel.* Eg 
16. Resolving forces	*Drawing two forces at right angles to represent a single resultant force* Eg 
17. Weight, W [N]	Force acting on a mass due to gravity (Weight = mass x gravity)
18 Mass, m [kg]	The amount of matter in an object
19. Normal contact force	Push between solids. Acts at right angle to the surface at the point of contact

Trilogy P7: Forces in balance

Collins rev guide: Forces

Knowledge Organiser

Big picture (Physics Paper 2)

- Forces in action
  - **Forces in balance**
  - Motion
  - Forces and motion
- Waves and electromagnetism
  - Wave properties
  - Electromagnetic waves
  - Electromagnetism

Background

Anything that changes direction, speed or shape does so because of unbalanced forces. They are the reason we go to bed up to 2cm shorter than we are when we wake up. Weird? That's forces.

Maths skills

Drawing scale diagrams to find the diagonal of a parallelogram (see Fact 15) or drawing a scale parallelograms around a diagonal (see Fact 16)

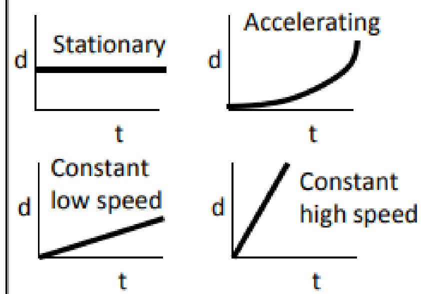
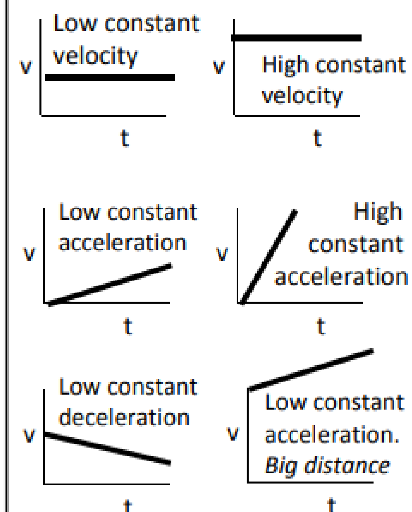
Additional information

Content in *italics* is Higher Tier only.

Key points to learn

1. Distance-time (d-t) graph	A graph showing how distance changes with time	
	Gradient represents speed	
2. Speed, *v* [m/s]	Scalar. Distance travelled in one second Speed = $\frac{\text{distance travelled, s [m]}}{\text{time taken, t [s]}}$	
3. Average speed [m/s]	Considers the total distance travelled and the total time taken	
4. Velocity, v [m/s]	Vector. Speed in a given direction. Uses the same formula as speed	
5. Displacement	Vector. Distance travelled in a certain direction	
6. Acceleration, a [m/s²]	Any change in velocity. Can be either speed or direction	
	Change in velocity per second. eg 10m/s² means velocity changes by 10m/s every second	
	Acceleration = $\frac{\text{change in velocity}}{\text{time taken for change}}$ $a = \frac{\Delta v}{t}$ [m/s²] [m/s] / [s]	
7 Deceleration a [m/s²]	When acceleration is negative. Object slows down	
10. Scalar	Magnitude only eg speed	
11. Vector	Magnitude and direction eg velocity	
12. Velocity-time (v-t) graph	A graph showing how velocity changes with time	
	Gradient represents acceleration	
	Area under a v-t graph line represents distance travelled	

Key points to learn

13. Typical speeds	Walking ~1.5m/s Running ~1.5m/s Cycling ~6m/s Sound ~330m/s
14. Slopes of d-t graphs	
15. Slopes of v-t graphs	
16 Gravitational acceleration	Acceleration due to gravity on Earth is ~9.8m/s²
17. Equation of motion	You need to be able to use this equation. It is given in the exam. $v^2 \quad u^2 = 2as$ *v* = final velocity in m/s *u* = start velocity in m/s *a* = acceleration in m/s² *s* = distance travelled in m

Trilogy P8: Motion

Collins rev guide: Forces

Knowledge Organiser

Big picture (Physics Paper 2)

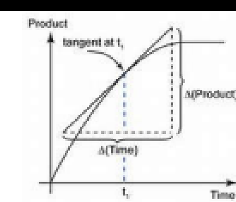
- Forces in action
  - Forces in balance
  - **Motion**
  - Forces and motion
- Waves and electromagnetism
  - Wave properties
  - Electromagnetic waves
  - Electromagnetism

Background

We all know about acceleration and speed, but how are they really related. The ideas on this page are essential in the use of vehicle design and tectonic movement. They can be used to describe any journey by any object.

Maths skills

Graph skills:



- Finding the steepness (gradient) of a curved line at a point using a tangent.

  Gradient = rise ÷ run

- Find the area under a straight line graph. Using areas of triangles and rectangle

Rearrange the speed equation v = s ÷ t

Trilogy P9: Force and motion

Collins rev guide: Forces

Knowledge Organiser

Key points to learn

1. Newton's Second Law	Acceleration is directly proportional to force and indirectly proportional to mass
	Resultant Force = mass x acceleration $F = m \times a$ [N] [kg] [m/s²]
	Greater resultant force leads to greater acceleration
2. Inertial mass	*How difficult it is to change the velocity of an object.*
	Ratio of Force ÷ acceleration
3. Inertia	*Tendency of objects to maintain same motion*
4 Force, F [N]	Push or a pull acting on an object
5. Acceleration, a [m/s²]	Any change in velocity. Can be either speed or direction
	Change in velocity per second. eg 10m/s² means velocity changes by 10m/s every second
	Acceleration = change in velocity / time taken for change $a = \frac{\Delta v}{t}$ [m/s²] [m/s] [s]
6. Resultant force, F [N]	The force you have if you replaced all the forces on an object with one single force
	If it is zero forces are balanced
7 Mass, m [kg]	Amount of matter in something
8 Gravitational field strength	Constant on each planet. Symbol of g. On Earth it is ~9.8 N/kg

Key points to learn

9. Weight, W [N]	The force on a mass due to gravity
	Weight = mass x gravitational field strength $W = m \times g$ [N] [kg] [N/kg]
10. Terminal velocity [m/s]	Maximum velocity of a falling object. When fluid drag increases until it balances weight
11. Stopping distance [m]	Shortest distance a vehicle can safely stop
	Split into two parts: 1. Thinking distance – travelled during reaction time 2. Braking distance – travelled once brakes applied Stopping distance = Thinking distance + Braking distance
12. Reaction time [s]	Time it takes a person to react. Differs for everyone from 0.2 - 0.9s
	Affected by: tiredness, drugs, alcohol and distractions
13. Factors affecting braking distance	1. Road and weather conditions 2. Condition of vehicle brakes or tyres
14. Momentum, p [kg m/s]	Momentum = mass x velocity $p = m \times v$ [kg m/s] [kg] [m/s]
15 Conservation of momentum	In a closed system, total momentum before an event is the same as the total momentum after
16. Elastic	Will return to original shape
17. Inelastic	Will not return to original shape

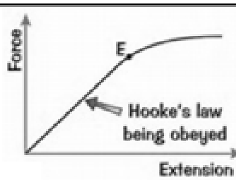
Big picture (Physics Paper 2)

- Forces in action
  - Forces in balance
  - Motion
  - **Forces and motion**
- Waves and electromagnetism
  - Wave properties
  - Electromagnetic waves
  - Electromagnetism

Background

Forces can make things change how they move or make them change shape. Every time one of these things happens it is down to a resultant force.

Key points to learn

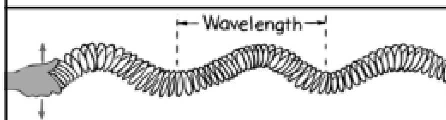
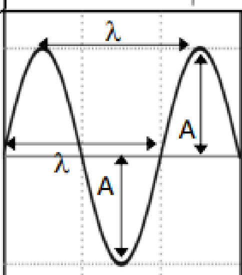
18. Hooke's Law	A springs extension/compression is proportional to the force on it
	The gradient of this graph is known as k, the spring constant. 
	Force = spring constant x extension $F = k \times e$ [N] [N/m] [m]

Trilogy P10: Wave properties

Collins rev guide: Waves

Knowledge Organiser

Key points to learn

1 Oscillations	Vibrations of a wave
2. Waves	Carry energy using oscillations
	Can reflect - bounce off a boundary
	Can refract - change direction at a boundary as they change speed
	Two types: transverse and longitudinal
3. Transverse waves	Oscillate at right angles to direction that the wave transfers energy
	Eg Electromagnetic waves, such as light, radio, ripples on water
	
4. Longitudinal waves	Oscillate in same direction as the wave transfers energy eg sound
	
5. Drawing waves	 Wavelength, λ Amplitude, A Both measured in metres (m)
6 Mechanical waves	Need particles to move eg sound, water, Mexican
7. Vacuum	No particles. Space is a vacuum

Key points to learn

8. Electromagnetic waves	Family of transverse waves.
	Travel through vacuum at speed of light (300 000 km/s)
	The waves in the EM family are: **R**adio, **I**nfra Red, **V**isible light, **U**ltra Violet, **X**-ray and **G**amma
	Rich **M**en **I**n **V**egas **U**se **X**-ray **G**lasses
9. Amplitude, A [cm]	Height/depth of the wave above/below the rest point
10. Wavelength, λ [m]	Length of one wave. Distance on a wave from one point to the next identical point
11. Frequency, f [Hz]	Number of waves in one second. Measure in Hertz *(You are given this in the exam)*
	Frequency = 1 ÷ Period [Hz] $f = \frac{1}{T}$ [s]
12. Period, T [s]	Time for one wave to pass
13. Wave equation	Speed of a wave = frequency x wavelength *(You need to learn this)* $v = f \times \lambda$ [m/s] [Hz] [m]
15. Sound waves	Longitudinal. Cannot travel through a vacuum. Reflections are called echoes
16. Observing waves	We can use these devices: 1. A ripple tank 2. A slinky spring 3. A signal generator
17. Law of reflection	*Angle of reflection is same as angle of incidence.* *Speed and wavelength not changed* 

Big picture (Physics Paper 2)

- Forces in action
  - Forces in balance
  - Motion
  - Forces and motion
- Waves and electromagnetism
  - **Wave properties**
  - Electromagnetic waves
  - Electromagnetism

Background

We are continuously hit with waves in many forms from sound to radio. They are so much more than just ripples on water we can surf on.

Maths skills

You need to be able to use the equation relating f and T (statement number 11). In it you have to divide 1 by a number.
Units of quantities are shown in square brackets [ ].
The wavelength and frequencies of waves varies hugely. You will be expected to use standard form.

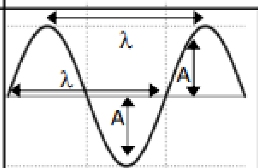
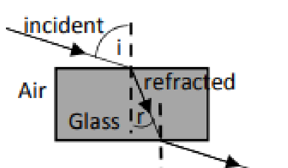
Prefix	Meaning	Standard form
Mega (M)	x 1000000	x 10^6
kilo (k)	x 1 000	x 10^3

Trilogy P11: Electromagnetic waves

Collins rev guide: Waves

Knowledge Organiser

Key points to learn

1. Electro-magnetic waves	Family of transverse waves. Travel through vacuum at speed of light.
	Long (1000 m) ↑ Wavelength, λ — Low ↓ Frequency (Hz): **R**adio, **M**icrowave, **I**nfrared (IR), **V**isible, **U**ltraviolet (UV), **X**-ray, **G**amma ray — Very short ($^1/_{1000000}$)m, High
	Rich **M**en **I**n **V**egas **U**se **X**-ray **G**lasses
2. Drawing waves	 Wavelength, λ Amplitude, A Both measured in metres (m)
3 Transverse wave	Oscillate at right angles to direction that the wave transfers energy
4. Wave equation	Speed of a wave = frequency x wavelength $v = f \times \lambda$ [m/s] [Hz] [m] *(You need to learn this)*
5. Energy of waves	Increases as frequency increases. Gamma have most, radio least
6. Refraction	*Light changing direction as it changes speed at a boundary*
	
7. Ionising	Knocking electrons off atoms
8 Absorbing waves	Waves carry energy so absorbing any wave generates some heat

Key points to learn

9. Radio waves	No known dangers
	Can be made and absorbed by electrical circuits
	Used for television and radio
10. Microwaves	Some can cause burning
	Used for satellite communications, and cooking food
11. Infrared radiation	Can cause burning
	Emitted by hot objects.
	Matt black surfaces are best absorbers and emitters
	Smooth shiny surfaces reflect IR waves so are worst absorbers and emitters
	Used for electric heaters, cooking, infrared cameras
12. Visible light	Very bright light can cause blindness
	We see. Used in fibre optics
13. Ultraviolet	Ionising: can cause skin cancer
	Used in energy efficient lamps, sun tanning and sterilising
14. X-rays and gamma rays	Ionising: can cause cancer
	Used in medical imaging and in radiotherapy treatment and sterilising
15. Carrier waves	*Used in communication. Different amplitudes mean different things*
16 Frequency, f [Hz]	Number of waves in one second. Measure in Hertz

Big picture (Physics Paper 2)

- Forces in action
  - Forces in balance
  - Motion
  - Forces and motion
- Waves and electromagnetism
  - Wave properties
  - **Electromagnetic waves**
  - Electromagnetism

Background

This family of waves is all around us, all the time. They travels at 300million metres a second through space and are some of the building blocks of the Universe. So what are they and how do we use them?

Maths skills

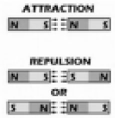
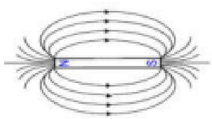
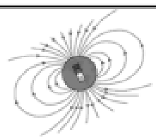
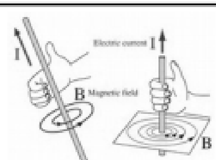
You need to remember and be able to rearrange the Wave Equation. A nice way to check is by finding the frequency of your microwave oven ~2450MHz (usually written on back of oven). Speed of light is 3×10^8m/s. You should be able to calculate that a microwave in your oven is 0.12m long exactly.

Trilogy P12: Electromagnetism

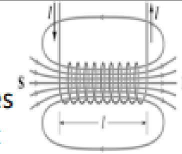
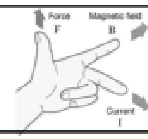
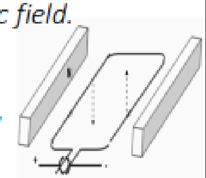
Collins rev guide: Magnetism and electromagnetism

Knowledge Organiser

Key points to learn

1. Magnetic poles	North and South Like poles attract Unlike poles repel 
Permanent 2. magnet	Has its own magnetic field
3. Induced magnet	Becomes a magnet when put in a magnetic field. Loses it when removed
4. Magnetic field, B	Region around a magnet which attracts magnetic material.
	Caused by magnetic field lines
	Strongest at poles of a magnet
	Known as magnetic flux density, B measured in Tesla, T
5. Magnetic field lines	Closer the lines, the stronger the magnetic field 
6. Earth's magnetic field	 Acts like a giant bar magnet
7. Magnetic material	Are attracted by magnetic fields: iron, steel, cobalt and nickel
8. Solenoid	A coil of wire, looks like a spring
9. Magnetic field around a wire	If a wire carries a current it becomes an electromagnet 

Key points to learn

10. Magnetic field around a solenoid	If a wire is coiled and carries a current it becomes an electromagnet 
	Magnetic field inside is strong and uniform
	Outside looks similar to a bar magnet
11.Increasing strength of electromagnet	1. Add an iron core 2. Increase current 3. More coils
12. Motor effect	A wire carrying a current <u>at a right angle</u> through a magnetic field feels a force
13. Size of motor effect force	Force = magnetic flux density x current x length $F = B \times I \times l$ [N] [T] [A] [m] *(You are given this)*
14. Direction of motor force	Is given by Flemings Left Hand rule 
15. Increasing force of a motor	*1. More current* *2. Stronger magnetic field* *3. More coils*
16. Electric motor	*Coil of wire carrying a current inside a magnetic field. Each side moves in different direction causing it to rotate.* 
17 *Commutator*	*Stops motor wires twisting*

Big picture (Physics Paper 2)

Forces in action	Waves and electromagnetism
Forces in balance	Wave properties
Motion	Electromagnetic waves
Forces and motion	**Electromagnetism**

Background

Electromagnetic effects are used in motors to make things move, generators to provide electricity and automatic locks on security doors. Magnetism is far more useful to us than just helping pigeons to navigate.

Additional information

Higher Tier only content is shown in

Maths skills

There is only one formula in this topic and it is only for Higher Tier. It is given to you in the equation sheet but you need to be able to use it.