CP1 Revision Mat – Grade 4 - Grade 5

physical quantity	unit name	unit symbol
length	metre	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
temperature	kelvin	K
amount of substance	mole	mol
frequency	hertz	Hz
force	newton	N
energy	joule	J
power	watt	W
pressure	pascal	Pa
Electric charge	coulomb	C
Electric potential difference	volt	V
Electric resisitance	ohm	Ω
Magnetic flux density	tesla	T

9. An estimate for the thickness of a layer of graphene is 0.335 nanometres.
1 nanometre is the same as 10^{-9} metres.
What is the thickness of a sheet made from 6 500 layers of graphene?
Give your answer in metres, to 3 significant figures, in standard form. (3)

9. An estimate for the thickness of a layer of graphene is 0.335 nanometres.
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What is the thickness of a sheet made from 6 500 layers of graphene?
Give your answer in metres, to 3 significant figures, in standard form. (3)

Thickness of one layer in metres: $0.335 \times 1 \times 10^{-9} = 3.35 \times 10^{-10}$ m

Thickness of 6 500 layers in metres: $3.35 \times 10^{-10} \times 6\,500 = 2.1775 \times 10^{-6}$ m

To 3 significant figures: = 2.18×10^{-6} m

1. Describe what a physical quantity is. (2)

A physical property that can be quantified by measurement

A physical quantity can be expressed using a number and a unit

2. Describe what SI base and derived units are. (2)

SI base units are a set of 7 standard units from which all others can be derived

A derived unit is one obtained by multiplying and dividing SI base units together

3. Recall the SI base units (6) and derived units (9) for physical quantities including the unit symbols.

SI base units		
physical quantity	unit name	unit symbol
distance	metre	m
mass	kilogram	kg
time	second	s
current	ampere	A
temperature	kelvin	K
amount of substance	mole	mol

Derived units		
physical quantity	derived unit	abbreviation
frequency	hertz	Hz
force	newton	N
energy	joule	J
power	watt	W
pressure	pascal	Pa
electric charge	coulomb	C
electric potential difference	volt	V
electric resistance	ohm	Ω
magnetic flux density	tesla	T

4. Put the following prefixes for multiples and submultiples in the correct order of size with the largest first. (3)

micro, nano, kilo, giga, mega, milli, centi

giga, mega, kilo, centi, milli, micro, nano

5. Write the following in the shortest form using multiples and submultiples e.g. 45 000W = 45kW (5)

a. 0.000 05 V = 0.5 mm
b. 12000 g = 12 kg
c. 0.000025 m = 25 μm
d. 11 000 000 V = 11 MV
e. 0.000 0079 A = 7.9 μA

6. Write the following values without using multiples or submultiples e.g. 5.2 kW = 5200 W (5)

a. 6.8 kV = 6800 V
b. 15 mA = 0.015 A
c. 30 μ Ω = 0.00003 Ω
d. 20 kHz = 20 000 Hz
e. 17.5 nA = 0.0000000175 A

7. Convert the following. (5)

a. 7.5 minutes into seconds $7.5 \times 60 = 450$ s
b. 3.5 hours into seconds $3.5 \times 60 \times 60 = 12\,600$ s
c. 12 minutes into seconds $12 \times 60 = 720$ s
d. 4.25 hours into seconds $4.25 \times 60 \times 60 = 15\,300$ s
e. 0.45 hours into seconds $0.45 \times 60 \times 60 = 1620$ s

8. The masses of the four "gas giants" are given in the table. (4)

Planet	Jupiter	Saturn	Uranus	Neptune
Mass (kg)	1.90×10^{27}	5.96×10^{26}	8.68×10^{25}	1.02×10^{26}

a. Arrange the four planets by order of mass, from the lightest to the heaviest.

Uranus, Neptune, Saturn, Jupiter

b. The mass of the Earth is 5.98×10^{24} kg. (2)

Approximately how many times greater is Saturn's mass than that of the Earth?

$\frac{\times 10^{26}}{\times 10^{24}} = \times 10^{2} = 100$

Saturn's mass is approximately 100x greater than that of the Earth

c. i. The radius of Neptune is 2.43×10^{7} m.
Use the equation

volume of a sphere $= \frac{4}{3} \times \pi r^3$

to find the volume of Neptune in m^3.
Use 3.14 as the value for π. (2)

$\frac{4}{3} \times 3.14 \times (2.43 \times 10^{7})^3 = 6.01 \times 10^{22}$

ii. Calculate the density of Neptune.
Give your answer in kg/m^3. (3)

$\text{density} = \frac{\text{mass}}{\text{volume}} = \frac{1.02 \times 10^{26}}{6.01 \times 10^{22}} = 1700\ kg/m^3$

1	$d = s \times t$	d	distance	m
		s	speed	m/s
		t	time	s
2	$a = \frac{\Delta v}{t}$	a	acceleration	m/s^2
		Δv	change in velocity	m/s
		t	time	s
3	$F = m \times a$	a	acceleration	m/s^2
		F	force	N
		m	mass	kg
4	$W = m \times g$	g	gravitational field strength	N/kg
		m	mass	kg
		W	weight	N
5	$p = m \times v$	m	mass	kg
		p	momentum	kg m/s
		v	velocity	m/s
6	$E_P = m \times g \times \Delta h$	h	change in height	m
		g	gravitational field strength	N/kg
		E_P	gravitational potential energy	J
		m	mass	kg
7	$E_K = \frac{1}{2} \times m \times v^2$	E_K	kinetic energy	J
		m	mass	kg
		v	velocity	m/s
8	$efficiency = \frac{useful\ energy\ out}{total\ energy\ in}$			
9	$v = f \times \lambda$	f	frequency	Hz
		λ	wavelength	m
		v	wave speed	m/s
10	$v = \frac{d}{t}$	d	distance	m
		t	velocity	m/s
		v	time	s
11	$W = F \times d$	d	distance	m
		F	force	N
		W	work done/energy transferred	J

12	$P = \frac{E}{t}$	E	energy	J
		P	power	W
		t	time	s
13	$M = F \times d$	d	distance	m
		F	force	N
		M	moment	Nm
14	$E = V \times Q$	Q	charge	C
		E	energy	J
		V	potential difference	V
15	$Q = I \times t$	Q	charge	C
		I	current	A
		t	time	s
16	$V = I \times R$	I	current	A
		V	potential difference	V
		R	resistance	Ω
17	$P = I \times V$	I	current	A
		P	power	W
		V	potential difference	V
18	$P = I^2 \times R$	I	current	A
		P	power	W
		R	resistance	Ω
19	$\rho = \frac{m}{V}$	ρ	density	kg/m^3
		m	mass	kg
		V	volume	m^3
20	$F = k \times e$	e	extension	m
		F	force	N
		k	spring constant	N/m
21	$P = \frac{F}{A}$	A	area	m^2
		F	force	N
		P	pressure	Pa

22	$v^2 - u^2 = 2 \times a \times d$	a	acceleration	m/s^2
		d	distance	m
		v	final velocity	m/s
		u	initial velocity	m/s
23	$F = \frac{(mv - mu)}{t}$	F	force	N
		mv	final momentum	kg m/s
		mu	initial momentum	kg m/s
		t	time	s
24	$E = V \times I \times t$	I	current	A
		E	energy transferred	J
		V	potential difference	V
		t	time	s
25	$F = B \times I \times l$	I	current	A
		F	force	N
		l	length	m
		B	magnetic field strength	T
26	$\frac{V_p}{V_s} = \frac{N_p}{N_s}$	N_P	number of turns (primary coil)	
		N_S	number of turns (secondary coil)	
		V_P	potential difference (primary coil)	V
		V_S	potential difference (secondary coil)	V
27	$V_p \times I_p = V_s \times I_s$	I_P	current (primary coil)	A
		I_S	current (secondary coil)	A
		V_P	potential difference (primary coil)	V
		V_S	potential difference (secondary coil)	V
28	$E = m \times c \times \theta$	θ	change in temperature	K
		E	energy transferred	J
		m	mass	kg
		c	specific heat capacity	J / kg K
29	$E = m \times L$	E	energy transferred	J
		m	mass	kg
		L	specific latent heat	J / kg
30	$P_1 \times V_1 = P_2 \times V_2$	P_1	pressure (1)	Pa
		P_2	pressure (2)	Pa
		V_1	volume (1)	m^3
		V_2	volume (2)	m^3
31	$E = \frac{1}{2} \times k \times e^2$	E	energy	J
		e	extension	m
		k	spring constant	N/m
32	$p = h \times \rho \times g$	ρ	density	kg / m^3
		g	gravitational field strength	N/kg
		h	depth	m
		p	pressure	Pa

1. **If a force of 13N is applied over a distance of 71m, how much work is done?** $W = F \times d = 13 \times 71 = 923\ J$
2. **A frog covers 17metres in 34 seconds, what is its speed?** $s = \frac{d}{t} = \frac{17}{34} = 0.5\ m/s$
3. **If a circuit has a potential difference of 6V and a current of 4A what is the circuit's resistance?** $R = \frac{V}{I} = \frac{6}{4} = 1.5\ \Omega$
4. **If the force applied to a spring is 300N and the spring extends by 2metres, what is the spring constant?** $k = \frac{F}{e} = \frac{300}{2} = 150\ m$
5. **A 200W toaster takes 2 minutes to toast some bread. How much energy was used?** $E = P \times t = 400\ J$
6. **A 2kg box was lifted onto a 3metre shelf (g =10N/kg) how much Gravitational potential energy has it gained?** $E = mgh = 2 \times 10 \times 3 = 60\ J$
7. **A 110kg rugby player runs at a velocity of 6 metres per second, what is his momentum?** $p = m \times v = 110 \times 6 = 660\ kg\ m/s$
8. **A 12kg dog has an acceleration of 2m/s², how much force was needed for this acceleration?** $F = a \times m = 2 \times 12 = 24\ N$
9. **Usain Bolt has a mass of 90kg and runs at a velocity of 11m/s, what is his kinetic energy?** $E = \frac{1}{2} \times m \times v^2 = \frac{1}{2} \times 90 \times 11^2 = 5445\ J$
10. **A washing machine uses a 3A current and runs on a potential difference of 230V, what is the power rating of the machine?** $P = I \times V = 3 \times 230 = 690\ W$
11. **A lorry of mass 20 000kg produces a force of 30kN, calculate the acceleration.** $a = \frac{F}{m} = \frac{30\ 000}{20\ 000} = 1.5\ m/s^2$
12. **A Bugatti covers 32km in 20minutes, what is its speed in a) m/s b) km/h?** a) $s = \frac{d}{t} = \frac{32\ 000}{20 \times 60} = 27\ m/s$ → b) $27\ m/s = 0.027\ km/s = 97.2\ km/h$
13. **How much does a 71kg girl weigh on the moon? (g=1.kN/kg)** $W = m \times g = 71 \times 1.6 = 114\ N$
14. **A cricket ball of mass 200g travels at 20m/s, what is it's a) momentum b) kinetic energy?**
15. **How much work must be done to push a 1750kg car back home, a distance of 3.4km?**

a) $p = m \times v = 0.2 \times 20 = 4\ kg\ m/s$ b) $0.5 \times m \times v^2 = 0.5 \times 200 \times 400 = 40\ 000\ J$

$Weight = mass \times g = 1750 \times 10 = 17500\ N$
$W = F \times d = 17\ 500 \times 3400 = 59\ 500\ 000\ J$

1. **If a force of 71 N is applied over a distance of 110m, how much work is done?** 7810 J
2. **A frog covers 0.5 km in 25 seconds, what is its speed?** 20 m/s
3. **If a circuit has a potential difference of 6kV and a current of 400mA what is the circuit's resistance?**
4. **If the force applied to a spring is 316MN and the spring extends by 0.2metres, what is the spring constant?** 1580 MN / m
5. **A 0.34kW toaster takes 21 seconds to toast some bread. How much energy was used?** 7140 J
6. **A 2g box was lifted onto a 300mm shelf (g =10N/kg) how much Gravitational potential energy has it gained?** 0.006 J
7. **A 150 000g rugby player runs at a velocity of 10km/h, what is his momentum?** 417 kg m/s
8. **A 15 000 000 mg dog has an acceleration of 4.5 m/s², how much force was needed for this acceleration?** 67.5 N
9. **Usain Bolt has a mass of 90kg and runs at a velocity of 30km/h, what is his kinetic energy?** 3125 J
10. **A washing machine uses a 6000 mA current and runs on a potential difference of 0.4kV, what is the power rating of the machine?** 2400 W

CP2 Revision Mat – Grade 4 - Grade 5

Explain the difference between vector and scalar quantities and provide specific examples.

Vector: has a magnitude (size) **and** direction, e.g. velocity, acceleration
Scalar: has a magnitude (size) **only**, e.g. speed, distance, mass

Define velocity

Speed in a given direction

Calculate the speed travelled between a) 0s-6s b) 6s-15s c) 15s-20s in Figure 1.

a) $s = \frac{18}{6} = 3$ m/s b) $s = \frac{0}{9} = 0$ m/s c) $s = \frac{32-18}{5} = \frac{14}{5} = 2.8$ m/s

Analyse Figure 2 to:

a. Calculate the acceleration between a) 0s-6s b) 6s-15s c) 15s-20s

a) $a = \frac{34}{6} = 5.67$ m/s^2 b) $a = \frac{0}{9} = 0$ m/s^2 c) $a = \frac{-34}{5} = -6.8$ m/s^2

b. Calculate the distance travelled between a) 0s-6s b) 6s-15s c) 15s-20s

a) $d = \frac{34 \times 6}{2} = 102$ m b) $d = 34 \times 9 = 306$ c) $d = \frac{34 \times 5}{2} = 85$ m

Describe three methods for measuring the speed of an object.

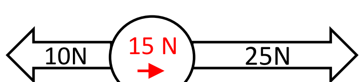
1. use a rolling tape measure, markers, and a stopwatch
2. record a video of known frames per second, see how far the object moves per frame
3. use calibrated light gates

State the acceleration due to gravity $10\ m/s^2$.

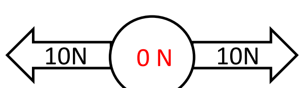
State Newton's First Law

An object at rest or moving at a constant velocity will continue to do so unless acted upon by an external resultant force

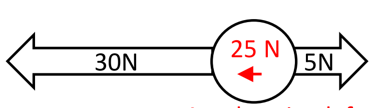
Calculate the resultant force on these objects and describe the motion of the object.

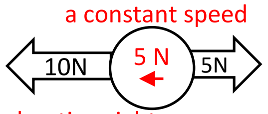


Accelerating right



Stationary or moving at a constant speed





Accelerating left or decelerating right

Define weight

Force on an object due to gravity

Describe how weight is measured

Suspend object from a calibrated spring balance OR a newton meter
Read off weight value from scale

Describe how the weight of an astronaut changes during a trip to the surface of the moon and back.

Weight greatest on surface of Earth, decreases to a minimum value as astronaut moves away from Earth, then begins to increase again.
Weight is lower on the moon than the Earth. Reverse on return trip.

Figure 1. Distance-Time graph

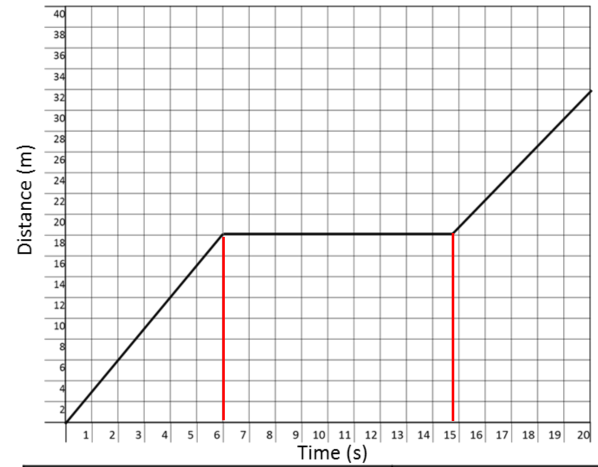
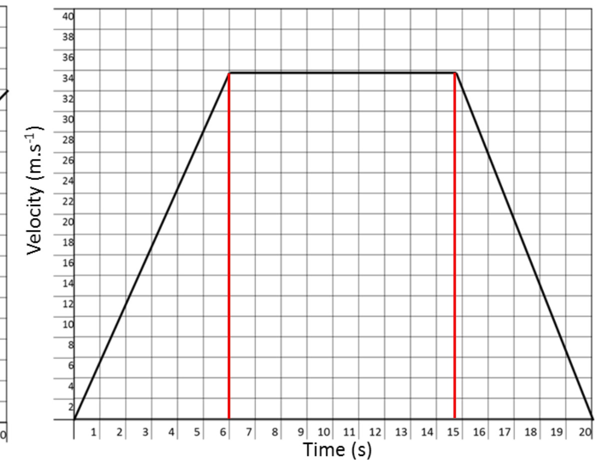
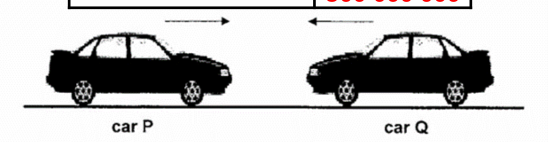


Figure 2. Velocity-Time graph



Everyday Experience	Speed (m.s^{-1})
Walking	1
Running	3
Cycling	6
Driving	12
Sound	340
Wind	15
Light	300 000 000

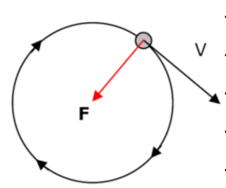


Factor effecting Stopping Distance	Effect on Stopping Distance & Explanation
Mass of the vehicle	Greater mass -> greater stopping distance
Speed of the vehicle	Greater speed -> greater stopping distance
Drivers reaction time	Faster reaction time -> smaller stopping distance
Quality of brakes	Greater quality -> smaller stopping distance
State of the road	Worse condition -> smaller stopping distance
Amount of friction between tyres and road	More friction -> smaller stopping distance

Describe a method to investigate the relationship between force, mass and acceleration by varying the masses added to trolleys.

1. Set up equipment: ramp, trolley, card, light gates, unit masses, hanging hook, string, clamp and stand, pulley
2. Measure length of card on trolley and input into light gates
3. Mark line on ramp just before first light gate, adjust height of ramp until trolley just starts to move
4. Attach trolley to the hanging mass using string, hold the trolley still at the start line, then let go of trolley
5. Record the speed reading on the light gates
6. Repeat three+ times and calculate an average
7. Repeat for different values of mass attached to hanging hook

Explain why we say this object is accelerating.



Velocity is speed **in a direction**
An object travelling in a circle is constantly changing direction
So constantly changing velocity
Acceleration is rate of change of **velocity**, $a = \frac{\Delta v}{\Delta t}$
So the object is accelerating

Explain methods of measuring human reaction times and recall typical results

Typical reaction time: 0.2 – 0.6s
Have one person drop a vertical ruler, the second person catches it
Reaction time is related to distance the ruler fell before being caught

Define the term stopping distance.

stopping distance = thinking distance + braking distance
Total distance a vehicle covers between a driver spotting a hazard and the vehicle coming to a complete stop

Describe how stimulants, depressants and distractions effect reaction time.

Stimulants decrease reaction times (driver reacts faster)
Depressants increase reaction times (driver reacts slower)
Distractions increase reaction times (driver reacts slower)

Explain the dangers caused by large decelerations and estimate the forces involved in typical situations on a public road

A large deceleration is dangerous because it requires a large force ($F = a \times m$)
A car is ~ 1000 kg, stops in ~ 1 s, typical speed of a car is ~ 13 m/s. ($a = \frac{v-u}{t}$)

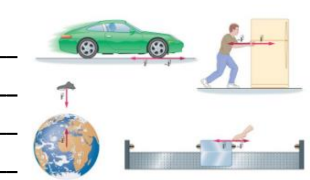
Describe in full, the term inertial mass.

A measure of how difficult it is to change the velocity of an object
The ratio of force over acceleration (inertial mass = force ÷ acceleration)

State Newton's third law

Every action has an equal and opposite reaction

Identify the action reaction pairs.



A Driving force and friction
B Push force and contact force
C Gravity and air resistance OR lift

Describe the conservation of momentum in collisions

Total momentum before a collision = total momentum after a collision in a closed system

Describe examples of momentum in collisions

e.g. snooker, car crash – two objects collide (hit each other). Momentum is transferred between them but the total momentum is conserved.

In a crash test two identical cars of mass 900 kg move towards each other. Before impact, Car P has a speed of 14 m/s and Car Q has a speed of 18 m/s.

i) Work out the total momentum of the two cars before impact.

$p = m \times v$ P: $p = 900 \times 14 = 12{,}600\ kg\ m/s$
Q: $p = 900 \times -18 = -16{,}200\ kg\ m/s$ 12,600 – 16,200 = **-3600 kg m/s**

ii) After impact the cars move off together to the left. Calculate the speed that the two cars move off at after impact.

$v = \frac{p}{m} = \frac{3600}{900+900} = \frac{3600}{1800} = 2\ m/s$ **to the left**

d	s	t
420	15	28
119	7	17
700	20	35
500	8.33	60
200	8	25
1700	75	22.7

d	s	t
54	0.3	180
22.2	55.5	0.4
450	20.45	22
320	20	16
52 000	64.5	806
6400	330	19.4

a	Δv	t
3	30	10
8	40	5
2	60	30
10	190	19
6	84	14
3	24	8

a	Δv	t
0.8	4	5
0.16	8	50
5.3	117	22
4	24.8	6.2
30	9	0.3
5	1250	250

g	m	W
5	400	2000
26.3	1.9	50
1.6	21.25	34
10	8.2	82
10	5	50
10	90	900

g	m	W
10.4	175	1825
1.375	0.4	0.55
9.81	25.9	254
2.5	4800	12 000
9.81	0.05	0.49
23	45.3	1042

a	F	m
5	35	7
14	84	6
5	50	10
7	658	94
8	64	8
10	125	12.5

a	F	m
6.25	4	0.64
0.0298	7.1	238
6.8	8412	1237
9.42	5.28	0.56
3.5	20.5	5.86
7.25	109	15

1	$d = s \times t$	d	Distance Travelled	m
		s	Speed	m/s
		t	Time Taken	s
2	$a = \frac{\Delta v}{t}$	a	Acceleration	m/s^2
		Δv	Change in Velocity	m/s
		t	Time Taken	s
3	$F = m \times a$	a	Acceleration	m/s^2
		F	Force	N
		m	Mass	kg
4	$W = m \times g$	g	Gravitational Field Strength	N/kg
		m	Mass	kg
		W	Weight	N
5	$p = m \times v$	m	Mass	kg
		p	Momentum	kg m/s
		v	Velocity	m/s

m	p	v
20	100	5
14	98	7
7	21	3
5	60	12
50	125	2.5
15	105	7

m	p	v
30667	460 000	15
0.003	0.27	90
20 000	90000	4.5
0.0056	0.460	82
325	7.5×10^4	231
1.3×10^3	351	0.27

1. Weight – assume g=9.8N/kg on Earth:

a. Calculate the weight of a 45kg girl 441N

b. A box weighs 49N. What is its mass? 4.59kg

c. A 85kg astronaut in orbit weighs only 23mN. What is the gravitational field strength? 0.271mN/kg or 2.71x10^{-4}N/kg

2. Distance and speed:

a. Calculate the distance a car will travel in 30s when moving at 12m/s. 360 m

b. How long will it take a pupil to walk to a lesson 70m away at 1.5m/s? 47 s

c. What is the speed (in m/s) of a car that travels 30km in 45 minutes? 11.1 m/s

3. Acceleration and speed:

a. Calculate the acceleration of a sprinter who takes 0.70s to reach their maximum speed of 11m/s. 15.7 m/s^2

b. A penny dropped accelerates at 9.8m/s^2. How fast will it travel when it hits the bottom 3.6s later? 35.3 m/s

c. How many seconds will it take a car to accelerate from 45km/hr to 90km/hr at 1.5m/s^2? 8.3 s

4. Force and acceleration:

a. Calculate the force necessary to accelerate a 10kg mass by 17m/s^2. 170 N

b. What acceleration will a car of mass 1100kg experience if a force of 550N acts on it? 0.5 m/s^2

c. An aircraft's engines provide a thrust of 240kN. What is its mass if it accelerates by 8.0m/s^2? 30 000 kg

5. **Momentum:**

a. Calculate the momentum of a bullet of mass 0.010kg travelling at 400m/s. 4 kg m/s

b. A bike and rider have a combined momentum of 1000kgm/s. If their velocity is 12m/s, what is their combined mass? 83.3 kg

c. What is the velocity of a 58g tennis ball with a momentum of 2.4kgm/s? 41 400 m/s

CP3 Revision Mat – Grade 4 - Grade 5

3.3 Draw and annotate diagrams to represent a) a bike pressing the brakes b) a burning match c) a swinging pendulum

Explain what is meant by conservation of energy

Energy can be stored, transferred between stores, and dissipated – but it can never be created or destroyed. The total energy of a closed system doesn't change.

Describe the stores and pathways when:

a an object is projected upwards or up a slope

Kinetic Energy is transferred to Gravitational Potential Energy by a mechanical transfer

b a moving object hitting an obstacle

Kinetic energy of object transferred mechanically to kinetic energy of obstacle, and thermal energy of obstacle and surroundings

c an object being accelerated by a constant force

Work is done by a force on an object. This work is converted to the object's kinetic store mechanically

d a vehicle slowing down

Energy in kinetic store of car transferred mechanically, and then by heating, to thermal stores of car and road

e bringing water to a boil in an electric kettle

Electrical energy is transferred to Thermal Energy by an electrical transfer

When there are energy transfers in a closed system there is No change to the total energy in that system

Explain using the term "dissipate" what happens when a mechanical system is in operation.

In a mechanical system, energy is dissipated when two surfaces rub together. Work is done against friction which causes heating of the two surfaces - so the internal (thermal) energy of the surfaces increases.

Describe the un-useful energy transfers in these systems.

a) Pressing brakes on a bike

Kinetic energy transferred mechanically to Thermal and Kinetic

a) Electricity flowing through power lines

Electrical energy transferred electrically to Thermal and Kinetic

a) A running engine

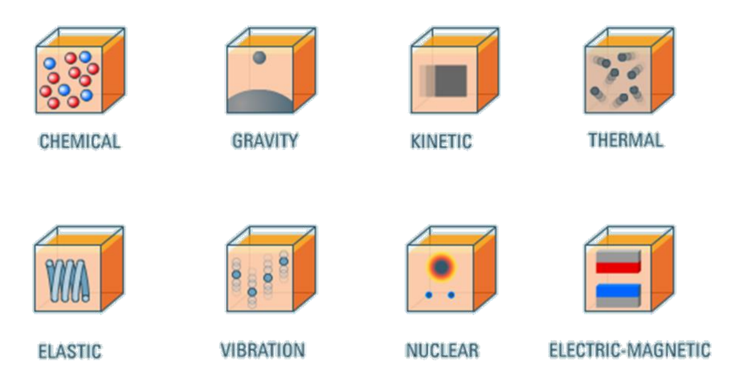
Chemical energy transferred mechanically to Thermal and Kinetic

a) A swinging pendulum

Kinetic transferred mechanically transferred to Thermal and Kinetic

a) A mug of coffee

Particles with a lot energy evaporate with Thermal energy



Explain how lubrication and insulation can stop reduce these un-useful energy transfers.

Lubrication decreases friction, which decreases the energy wasted as heat and sound.
Insulation reduces energy transferred wastefully as heat.

Describe the effects of the thickness and thermal conductivity of the walls of a building on its rate of cooling.

The thicker the wall the slower the rate of cooling
The greater the thermal conductivity the faster the rate of cooling
And vice versa

Explain how efficiency can be increased in energy systems.

Efficiency = useful energy / total energy
So efficiency can be increased by reducing energy wasted
Lubrication reduces energy wasted as friction
Insulation reduces energy wasted heating the surroundings

Explain patterns and trends in the use of energy resources including fossils fuel use and renewable resources.

Currently most energy is produced from fossil fuels (mostly coal and gas) because it's reliable and available
We are moving towards producing more energy from renewable sources but it's expensive and unreliable

Energy Source	Formation / Generation	Uses	Advantages	Disadvantages
Fossil fuels	Millions of years ago fish died, they got crushed by the weight of the ocean and sediment.	Electricity, Heating, Transportation	Cheap Easy to maintain Much of our infrastructure is designed to run using fossil fuels.	Non-renewable Polluting – releases carbon dioxide and sulphur dioxide (greenhouse gases, acid rain)
Nuclear fuels	Undergoes a controlled chain reaction to produce heat energy	Electricity, Transportation, Heating	Non-polluting	Non-renewable Very rare Nuclear waste remains radioactive.
Bio-fuel	Biofuels are fuels made from plant materials, burnt to generate electricity.	Transportation, Heating	Renewable source.. Less carbon emissions. Reduce our reliance on fossil fuels.	Uses land that could be used to grow food. Needs a lot of labour. Bioethanol cannot be used in cars without modifying the engine. Deforestation
			Renewable	Noisy Spoil the view

8	$efficiency = \frac{useful\ energy\ out}{total\ energy\ in}$

Efficiency	*Useful Out*	*Total In*
0.75	1500	2000
0.20	60	300
0.50	1000	2000
0.20	120	600
0.90	200	222.2
0.05	4000	80000

Efficiency	*Useful Out*	*Total In*
5%	10	200
70%	1050	1500
6%	3000	50 000
57%	1442.1	2530
85%	5990	7047
35%	2100	6000

1. Efficiency and energy:
   a. Calculate the efficiency of a device that usefully shifts 20J of energy when supplied with 50J. 0.4
   b. A microwave oven has an efficiency of 60%. How much does the internal energy store of a bowl of baked beans increased when 80 000J of energy is supplied to the oven? 48000J
   c. A wind farm has an efficiency of 0.17. If it supplies 120TJ of energy to the National Grid, how much energy was in the wind's kinetic store? 706TJ
2. Efficiency and power:
   a. Calculate the efficiency of a 60W lightbulb that emits 2.0W of visible light. 0.033
   b. A washing machine has an efficiency of 20%. If the power supplied is 1 200W, how much power is usefully shifted? 240J
   c. Steam trains have very low efficiencies – around 5.0%. If it needed 50MW to pull the carriages, what power must have been supplied? 1GW

CP4 Revision Mat – Grade 4 - Grade 5

Waves transfer ____energy____ and ____information____ without transferring ____matter____.

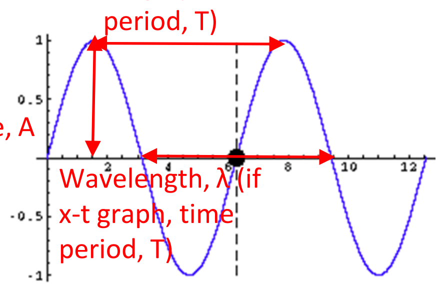
Describe how you could prove that sound waves travel through air, not that air travels from source to receptor

Vibrate the source through a solid as well as air, it will still travel through, air is not needed for the sound to be transmitted. To prove it requires a medium, try passing the sound through a vacuum chamber, it will not pass through as there are not particles to vibrate.

Describe how you could prove that water waves travel through water, not that water travels from source to receptor.

Place a bob in the water, as the wave passes the bob moves up and down with the water, but does not move horizontally, which is the direction that the wave is moving in. Therefore the water itself is not travelling.

Identify and define the terms: frequency, wavelength, amplitude, period, wave velocity and wave-front as applied to waves. Annotate the diagram appropriately.



Frequency – the number of complete waves or cycles which pass a point per second.

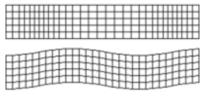
Wavelength – Distance between two adjacent peaks or troughs., or compression to compression.

Amplitude - - maximum displacement from the rest position

Wave velocity - how fast a wave travels in a certain direction

Wave-front – points on a wave that vibrate together, i.e. the same point on neighbouring cycles.

Describe longitudinal waves:



Particles vibrate parallel to the direction of energy transfer

Describe transverse waves:

Particles vibrate perpendicular (at right angles) to the direction of energy transfer.

Describe the difference between longitudinal and transverse waves by referring to sound, electromagnetic, seismic and water waves

Transverse waves, particles vibrate perpendicular to the direction of the wave, e.g. water particles move perpendicular to the waves direction, as do seismic s-waves.

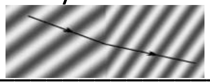
EM waves are made of magnetic and electric fields oscillating perpendicular to one another.

Longitudinal, particles vibrate, though don't travel, in the same direction as the wave moves. For example, sound waves and seismic p-waves.

Describe how to measure the velocity of sound in air and ripples on water surfaces.

Measure a distance of 300m, have one person stand there with a stopwatch and another with a starting gun 300m away. This is the displacement, x. When the person fires the gun, giving a signal with their arm, time how long it takes to hear the gun, t. Repeat and average, use $v = \frac{f}{t}$ to find the velocity.

Explain how waves will be refracted at a boundary in terms of the change of direction and speed



If a wave enters a more optically dense medium, then it will slow down and bend towards the normal.

If it enters a less optically dense medium the wave speeds up and bends away from the normal.

Explain why different object have different colours.

Different wavelengths of light have different colours, objects absorb all the wavelengths of light *except* the one we see.

Explain why white objects are white and black objects are black.

White objects reflect all wavelengths of light so appear

Explain why some objects are translucent and some are transparent.

Translucent objects absorb more of the light and is scattered inside the object. In transparent objects almost all the light is transmitted and passes straight through.

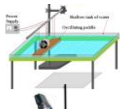
Explain how colour filters work.

They only transmit light of the colour filter they are and absorb all other colours of light. For example, a blue filter only transmits blue light, all other wavelengths are abosorbed.

What would a blue and yellow jersey look like underneath a yellow filter. Explain your answer.

Yellow with black, the yellow light is able to pass through the filter but all other wavelengths of light, including blue, are absorbed by the filter. Therefore we only see the yellow part, the blue becomes black.

Explain how to measure the speed, frequency and wavelength of a wave in a solid bar and waves in a ripple tank. Include a simple apparatus list and the calculations you would use.



Equipment: a metal rod, ruler, microphone and computer, rubber bands, clamps and stands, hammer.

Set up the equipment, the rod is suspended by the two bands from clamp stands so it can swing, the microphone is near the rod and attached to a computer so it can measure the peak frequency.

Measure the length of the rod, this is $\frac{\lambda}{2}$.

Tap the rod and measure the peak frequency, repeat three times and average. This gives us f, the frequency

Use $v = f\lambda$ to find the wave speed.

Equipment: strobe light, ripple tank, ruler, clamp and stand.

Set up the ripple tank with the strobe light directly above, held by a clamp and stand.

Set up the ripple tank so it creates waves, adjust the strobe light until the waves appear to be stationary. The frequency of the strobe light now matches the frequency of the waves, f.

Measure the distance between two adjacent peaks on the waves to get the wavelength, λ.

Use $v = f\lambda$ to find the wave speed.

1. Calculate the following, giving your answer in standard form, correct to three significant figures.

(a) $6.7 \times 10^3 + 4.8 \times 10^4$ ...5.47×10^4...

(b) $1.62 \times 10^7 - 9.83 \times 10^5$ ...1.52×10^7...

(c) $2.04 \times 10^9 \times 3.66 \times 10^3$ ...7.47×10^{12}...

(d) $3.427 \times 10^8 \div 6.841 \times 10^4$ ...5×10^3...

(4 Marks)

2. Calculate the following, giving your answer in standard form, correct to three significant figures.

(a) $9.5 \times 10^{-3} + 7.3 \times 10^{-2}$ ...8.25×10^{-2}...

(b) $4.82 \times 10^{-9} - 6.31 \times 10^{-11}$ ...4.76×10^{-9}...

(c) $4.12 \times 10^4 \times 9.59 \times 10^{-8}$ ...3.95×10^{-3}...

(d) $1.01 \times 10^{-7} \div 2.37 \times 10^3$ ...2.37×10^3...

(4 Marks)

3. Grains of sand range in size from $2 \times 10^{-3}m$ to $64 \times 10^{-2}m$

(a) What is the difference between the smallest and largest grains of sand?

Give your answer in metres, in standard form.

$64 \times 10^{-2} - 2 \times 10^{-3} = 0.638$ m ...6.38×10^{-1} m...

(b) What is your answer to part (a), when written in **millimetres**?

0.638 m = 638 mm ...638 mm...

(2 Marks)

5. The sun is approximately $1.5 \times 10^{11}m$ from Earth. Given speed of light is approximately $3 \times 10^8 ms^{-1}$, how long does it take light from the sun to reach Earth?

Give your answer in minutes and seconds.

$$s = \frac{d}{t} \rightarrow t = \frac{d}{s} = \frac{1.5 \times 10^{11}}{3 \times 10^8} = 500\ s$$

= 8 mins 20 seconds

...8 mins 20 s...

(2 marks)

6. The formula that links wavelength (λ) and frequency (*f*), is

$$\lambda \times f = 3 \times 10^8 ms^{-1}$$

(a) Green light has a wavelength of approximately $5 \times 10^{-7}m$. Calculate its frequency giving your answer in standard form.

$$f = \frac{3 \times 10^8}{\lambda} = \frac{3 \times 10^8}{5 \times 10^{-7}} = 6 \times 10^{14}\ Hz$$

...6×10^{14}... Hz

(b) Red light has a frequency of approximately $4 \times 10^{14}Hz$. Calculate its wavelength giving your answer in standard form.

$$\lambda = \frac{3 \times 10^8}{f} = \frac{3 \times 10^8}{4 \times 10^{14}} = 7.5 \times 10^{-7}\ m$$

...7.5×10^{-7}... m

(4 marks)

7. If $x = 4.1 \times 10^5$, $y = 7.7 \times 10^{-2}$ and $z = 3.9 \times 10^7$, calculate the following, giving your answers in standard form to 3 sig. fig.

(a) $\frac{x+y}{z}$

$$\frac{4.1 \times 10^5 + 7.7 \times 10^{-2}}{3.9 \times 10^7} = 0.0105$$

...1.05×10^{-2}...

(b) $\frac{y^2}{x}$

$$\frac{(7.7 \times 10^{-2})^2}{4.1 \times 10^5} = 1.45 \times 10^{-8}$$

...1.45×10^{-8}...

(c) $\sqrt{\frac{xy}{(z-x)}}$

$$\sqrt{\frac{4.1 \times 10^5 \times 7.7 \times 10^{-2}}{3.9 \times 10^7 - 4.1 \times 10^5}} = 0.0286$$

...3.86×10^{-2}...

(6 marks)

9	$v = f \times \lambda$	f	Frequency	Hz
		λ	Wavelength	m
		v	Wave Speed	m/s
10	$v = \frac{d}{t}$	d	Distance	m
		t	Time	s
		v	Wave Speed	m/s

f	λ	v
23.3	0.3	7
12.5	0.4	5
25	10.2	256
450	0.73	330
2	12	24
125	20	2500

f	λ	v
0.27	1500	400
4×10^{13}	7.5×10^{-7}	30 000 000
525	0.410	215
7×10^{14}	4.3×10^{-8}	30 000 000
1.2	256	307
360 000	0.0004	140

d	t	v
150 000	300	500
20	0.25	80
30 000	40	750
10 680	24	445
144 000	720	0.005
2112	6	352

d	t	v
340	20	17
150	10	15
1062	16.6	64
336	24	14
500	25	20
59	0.05	1180

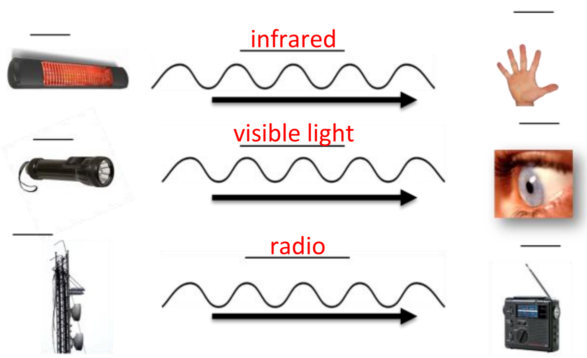
1. Wave speed equation:
   a. Calculate the speed of a water wave with a wavelength of 10m and a frequency of 0.25Hz. $v = f \times \lambda = 0.25 \times 10 = 2.5\ m/s$
   b. The speed of sound is 340m/s. What is the wavelength of a sound wave with a frequency of 256Hz? $\lambda = \frac{v}{f} = \frac{340}{256} = 1.3\ m$
   c. All electromagnetic waves travel at the same speed: 3.0×10^8m/s. What is the frequency of green light, having a wavelength of 540nm?

$$\lambda = \frac{v}{f} \rightarrow f = \frac{v}{\lambda} = \frac{3 \times 10^8}{540 \times 10^{-9}} = 5.56 \times 10^{14}\ Hz$$

CP5 Revision Mat – Grade 4 - Grade 5

All electromagnetic waves are transverse, that they travel at 300 000 000 m/s, in a vacuum

Identify the sources and receivers of the examples below.



5.9 Describe an investigation into the angles of incidence and refraction in a perspex block.

Equipment: Perspex block, ray box, ruler, pencil, protractor, paper.

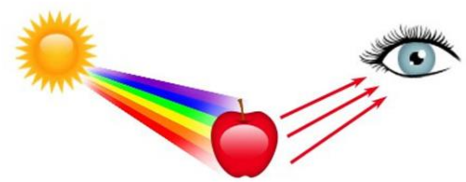
Place the block on the centre of a sheet of paper, draw around.
Shine a ray of light into the block and mark where the ray is on the paper and measure its angle of incidence from the normal, which is a line drawn perpendicular to where the light crosses two media, e.g. air and Perspex. Draw another normal and mark where the light leaves the block and measure the angle of refraction, how it bends after leaving the Perspex. If you draw a line between the two normals and measure the angle it refracted by when going in, we get the angle of refraction.
Repeat this for a variety of angles, increasing 5° each time, and the plot a graph of angle of incidence against angle of refraction.

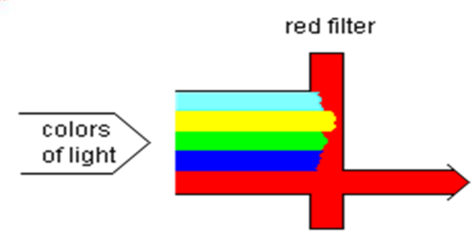
Explain how radio waves can be generated, transmitted and received using electrical circuits.

An alternating current is oscillating electrons
Moving electrons produce electric and magnetic fields, i.e. EM waves
Frequency of waves produced = frequency of the alternating current
So a transmitter with an alternating current will produce EM (radio) waves
Waves travel between transmitter and receiver, transferring energy
The waves cause electrons to oscillate in the receiver at the same frequency as in the transmitter
If the receiver is connected to a complete circuit, an alternating current will flow. The current will be the same as in the transmitter.

Fill in the table and indicate which type of E.M. radiation can be seen with the naked eye.

F & λ	Type	Application
Low	radio	communication, broadcasting
Long	microwaves	communication, cooking
↕	infrared	temperature control, communication (optical fibres)
	visible light	communication, photography
	ultraviolet	sterilisation (water), fluorescent lights, security pens
High	x-rays	medical scanning, airport scanners
Short	gamma	sterilisation (medical equipment, food), medical scanning, cancer treatment





Explain how and why different substances absorb, transmit, refract or reflect electromagnetic waves in ways that vary with wavelength

Waves with shorter wavelengths, like blue or violet, slow down more when they enter a substance than waves with a longer wavelength, like red. Therefore they refract more and so their angle of refraction is larger.
An object appears a certain colour because it absorbs all the colours of visible light except the one we see, which is reflected, e.g. trees absorb all light *except* green, which is reflected.
A filter absorbs all colours of light except the colour of the filter, this colour is able to be transmitted, so makes the light appear that colour.

Explain what happens when atomic nuclei change
a regarding radiations over a wide frequency range
b the result of absorption of a range of radiations

If a nucleus is unstable, it may have too much energy inside it. This excess energy is emitted as an EM wave, the energy of the wave depends on the amount of energy released by the nucleus, e.g. gamma radiation is an example of this.
Electrons are found in energy levels, if they gain the right amount of energy from a single EM wave, they can 'jump' up to another energy level and become excited. As they fall back down to a lower level it will release excess energy as an EM wave. The differences between levels vary, so the amount of energy emitted and so the radiation also vary.

Explain the effects of difference in the velocities of electromagnetic waves in different substances

Different substances can be harder for a wave to travel through than others. As an EM wave enters one of these substances, they slow down and their wavelengths get longer, though their frequency stays the same.
The more optically dense, which is a measure of how hard it is for light to pass through something, an object is, the lower the velocity of an EM travelling through it.

E.M.	Associated Dangers
microwaves	causes heating of cells
infrared	cause skin burns
ultraviolet	cause sun burns, skin cancer, damage to eyes, blindness
x-rays and gamma rays	cause cancer as they are ionising

1. Calculate the following, giving your answer in standard form, correct to three significant figures.

(a) $6.7 \times 10^3 + 4.8 \times 10^4$

5.47×10^4

(b) $1.62 \times 10^7 - 9.83 \times 10^5$

1.52×10^7

(c) $2.04 \times 10^9 \times 3.66 \times 10^3$

7.47×10^{12}

(d) $3.427 \times 10^8 \div 6.841 \times 10^4$

5×10^3

(4 Marks)

2. Calculate the following, giving your answer in standard form, correct to three significant figures.

(a) $9.5 \times 10^{-3} + 7.3 \times 10^{-2}$

8.25×10^{-2}

(b) $4.82 \times 10^{-9} - 6.31 \times 10^{-11}$

4.76×10^{-9}

(c) $4.12 \times 10^4 \times 9.59 \times 10^{-8}$

3.95×10^{-3}

(d) $1.01 \times 10^{-7} \div 2.37 \times 10^3$

2.37×10^3

(4 Marks)

3. Grains of sand range in size from $2 \times 10^{-3} m$ to $64 \times 10^{-2} m$

(a) What is the difference between the smallest and largest grains of sand?

Give your answer in metres, in standard form.

$64 \times 10^{-2} - 2 \times 10^{-3} = 0.638$ m

6.38×10^{-1} m

(b) What is your answer to part (a), when written in **millimetres**?

0.638 m = 638 mm

638 mm

(2 Marks)

5. The sun is approximately $1.5 \times 10^{11} m$ from Earth. Given speed of light is approximately $3\times 10^8 ms^{-1}$, how long does it take light from the sun to reach Earth?

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= 8 mins 20 seconds

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6. The formula that links wavelength (λ) and frequency (*f*), is

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(a) Green light has a wavelength of approximately $5 \times 10^{-7} m$. Calculate its frequency giving your answer in standard form.

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6×10^{14} Hz

(b) Red light has a frequency of approximately $4 \times 10^{14} Hz$. Calculate its wavelength giving your answer in standard form.

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7.5×10^{-7} m

(4 marks)

7. If $x = 4.1 \times 10^5$, $y = 7.7 \times 10^{-2}$ and $z = 3.9 \times 10^7$, calculate the following, giving your answers in standard form to 3 sig. fig.

(a) $\frac{x+y}{z}$

$$\frac{4.1 \times 10^5 + 7.7 \times 10^{-2}}{3.9 \times 10^7} = 0.0105$$

1.05×10^{-2}

(b) $\frac{y^2}{x}$

$$\frac{(7.7 \times 10^{-2})^2}{4.1 \times 10^5} = 1.45 \times 10^{-8}$$

1.45×10^{-8}

(c) $\sqrt{\frac{xy}{(z-x)}}$

$$\sqrt{\frac{4.1 \times 10^5 \times 7.7 \times 10^{-2}}{3.9 \times 10^7 - 4.1 \times 10^5}} = 0.0286$$

3.86×10^{-2}

(6 marks)

9	$v = f \times \lambda$	f	Frequency	Hz
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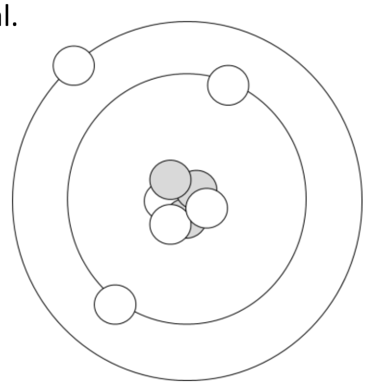
1. Wave speed equation:
   a. Calculate the speed of a water wave with a wavelength of 10m and a frequency of 0.25Hz. $v = f \times \lambda = 0.25 \times 10 = 2.5\ m/s$
   b. The speed of sound is 340m/s. What is the wavelength of a sound wave with a frequency of 256Hz? $\lambda = \frac{v}{f} = \frac{340}{256} = 1.3\ m$
   c. All electromagnetic waves travel at the same speed: 3.0×10^8m/s. What is the frequency of green light, having a wavelength of 540nm?

$$\lambda = \frac{v}{f} \rightarrow f = \frac{v}{\lambda} = \frac{3 \times 10^8}{540 \times 10^{-9}} = 5.56 \times 10^{14}\ Hz$$

CP6 Revision Mat – Grade 4 - Grade 5

Label the atom with the names, masses and charges of the subatomic particles and the general areas of the atom. The atom is neutral.



The diameter of a nucleus is 1×10^{-15} m and the diameter of an atom is 1×10^{-10} m.

Define the term isotope and complete the table below:

Element	Mass No	Atomic No	Protons	Neutrons	Electrons
$^{12}_{6}C$	12	6	6	6	6
$^{14}_{6}C$	14	6	6	8	6
$^{35}_{17}Cl$	35	17	17	18	17
$^{37}_{17}Cl$	37	17	17	20	17

Explain why isotopes can still be neutral.

They have a different number of neutrons to other atoms of the element, but the same number of protons and electrons.

Neutrons have no charge, so don't affect the overall charge.

Protons are positive and electrons are negative, they cancel giving an overall charge of 0

Explain why some electrons can change orbits.

Electrons are in energy levels.

If they gain energy by absorbing an EM-wave with the right amount of energy they can move to a higher energy level

If it returns to a lower level, it emits this energy as EM-radiation

Explain how atoms can become ionised referring to the electron orbits only.

Electrons are in energy levels.

If they gain enough energy from a single EM-wave, then they will be able to leave the atom entirely.

The atom now has more protons than electrons, so is an ion.

Type of nuclear decay	Symbol	Cause of Decay	Structure	Charge	Mass	Ionisation (High – Low)	Penetration (High – Low)
Alpha	$^{4}_{2}\alpha$	Too many nucleons	2 protons and 2 neutrons (helium nucleus)	+2	4	High	Low
Beta minus	$^{0}_{-1}\beta^{-}$	Too few protons	Electron	-1	$\frac{1}{1835}$	Lower	Higher
Positron	$^{0}_{+1}\beta^{+}$	Too many protons	Positron	+1	$\frac{1}{1835}$	Lower	Higher
Gamma	$^{0}_{0}\gamma$	Too much energy in nucleus	EM-Wave	0	0	Low	High

Explain what is meant by background radiation including the most common sources.

Background radiation is the low-level of radiation around us in the environment.

It comes from unstable isotopes in objects like food and buildings, as well as other human activities e.g. nuclear testing

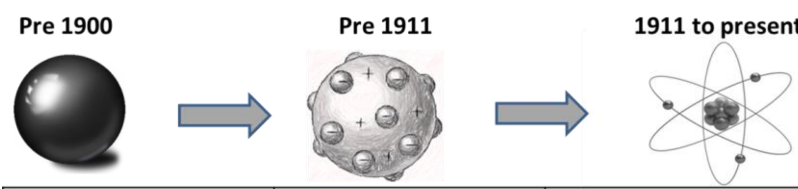
It also comes from cosmic rays from the sun.

Describe a method for measuring and detecting radioactivity using Photographic film and a Geiger–Müller tube

Photographic film changes colour, becoming darker when exposed to radiation, the higher the activity, the darker it goes.

A Geiger-Müller tube will click every time a radioactive particle hits it, count the number of clicks in one minute and divide by 60 to find the activity.

Complete the table below describing the changing atomic model.



Dalton's Atom	Plum Pudding Model	Modern Atom
Dalton, and earlier Democritus, proposed that all matter was made of small spheres which couldn't be broken up	JJ Thompson discovered negative electrons, he said they were inside a positive sphere, like in a plum pudding	Rutherford's gold foil experiment discovered the tiny nucleus and protons, later, Chadwick discovered the neutron

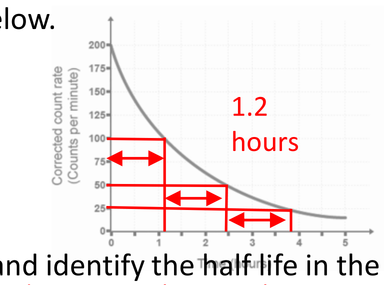
Decay	Effect on Mass Number	Effect on Proton Number
Alpha	-4	-2
Beta minus	0	+1
Positron	0	-1
Gamma	0	0
Neutron		

Balance the nuclear equations below.

$$^{238}_{92}U \longrightarrow {}^{234}_{90}Th + {}^{4}_{2}He$$

$$^{14}_{6}C \longrightarrow {}^{14}_{7}N + {}^{0}_{-1}e$$

$$^{99}_{43}Tc \longrightarrow {}^{99}_{43}Tc + \gamma$$



Define the term half life and identify the half life in the

The time taken for half of the radioactive nuclei in a substance to decay randomly.

Explain how half life can be predicted and the conditions required for this to occur.

Half-life can be predicted from a graph, by seeing the time needed for the activity to halve. Otherwise, it can be predicted by measuring activity over a long period of time and how the activity falls. This only really works for short half-lives.

A frozen mammoth body has been found in ice in Norway. The Norwegian government has given you a 1 kg sample of the body. For 1 kg of living mammoth flesh, the activity would be 4000 becquerel (Bq) from carbon-14 decay. Your sample gives a reading of 250 Bq. Half life is 5700 years.

A How many half-lives must have passed for the activity to change from 4000 Bq to 250 Bq?

4

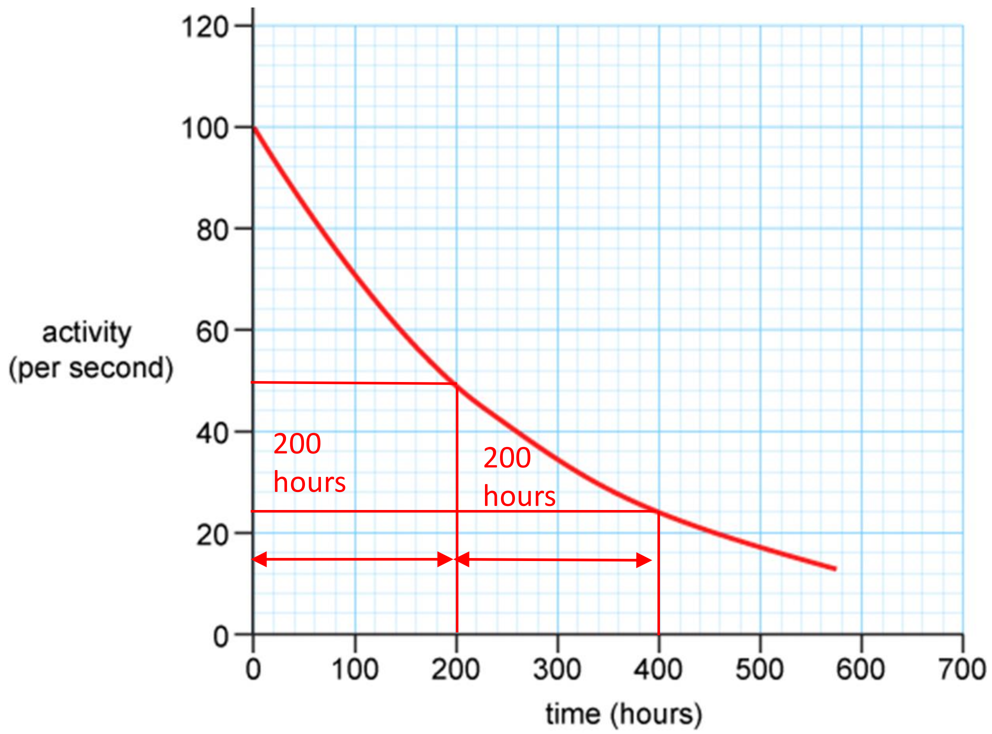
B How long ago did the mammoth die?

4 x 5700 = 22,800 years

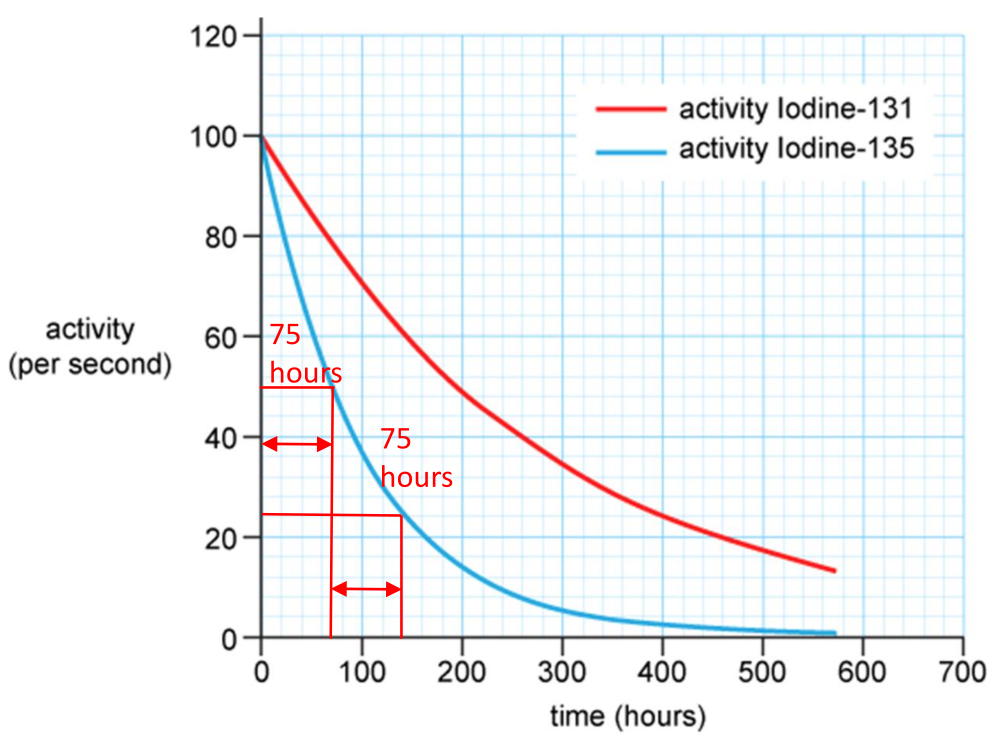
Describe the dangers of ionising radiation in terms of tissue damage and possible mutations and relate this to the precautions needed

Ionising radiation can damage cells and DNA in our body, which can lead to cells dying or mutations occurring in DNA. For example, a cell could be ionised and mutate into a cancer cell.

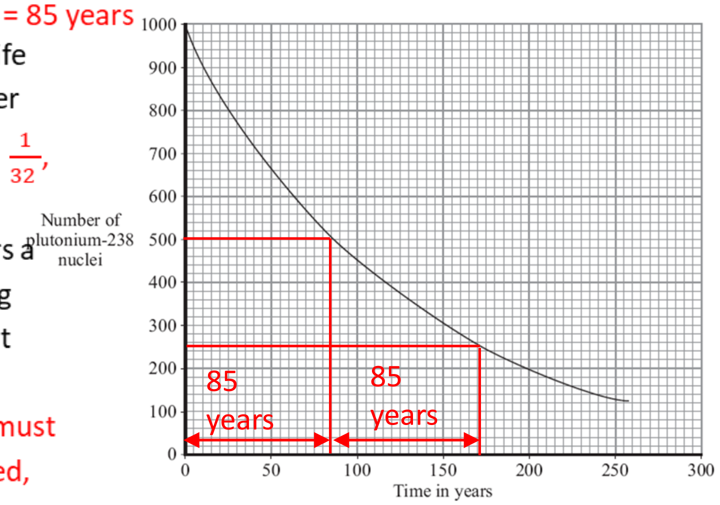
Precautions against this include wearing gloves and using tongs when handling radiation and limiting exposure time.



What is the half-life of these isotopes.



1. What are possible unit for half life? Seconds, hours, days, years
2. A radioactive isotope has a half life of 14 days. It has an initial count rate of 1080Bq. What will the count rate be after 4 weeks? 270 Bq
3. A radioactive isotope has a half life of 15 minutes. It has an initial count rate of 36000 Bq. What will the count rate be after 1.5 hours? 562.5 Bq
4. A radioactive isotope has a half life of 5000 years. What fraction of the radioactive material will remain after 20000 years? Halves every 5000 years, so $\frac{1}{2} x \frac{1}{2} x \frac{1}{2} x \frac{1}{2} = \frac{1}{16}$
5. A radioactive isotope has a count rate 0f 4000Bq and a half life of 12 hours. How long will it take the count rate to drop to 500Bq? 500 = $\frac{1}{8}$ of 4000, so 3 half-lives , so 36 hours
6. Use the graph to find the half-life of Plutonium-238. Half-life = 85 years



1. A radioactive isotope has a count rate 0f 6400Bq and a half life of 4 days. What fraction of the isotope will have decayed after 20 days? What will the count rate now be? Five half-lives, so $\frac{1}{32}$, 200 Bq
2. Before an isotope is placed near the detector a counter givers a reading of 14Bq. When the isotope is placed near the reading increases to 2234Bq. When tested 30 minutes later the count rate has dropped to 569 Bq. What is the half life of the substance? Correct count rates to 2220 Bq and 550 Bq, 550 must be doubled twice to get to 2200, so two half-lives have passed, so the half life is 15 minutes
3. Uranium-238 has a half-life of 4500 million years. Complete the graph to show the number of nuclei in a sample of U-238 will change over time. Initially there are 100,000 nuclei in the sample.