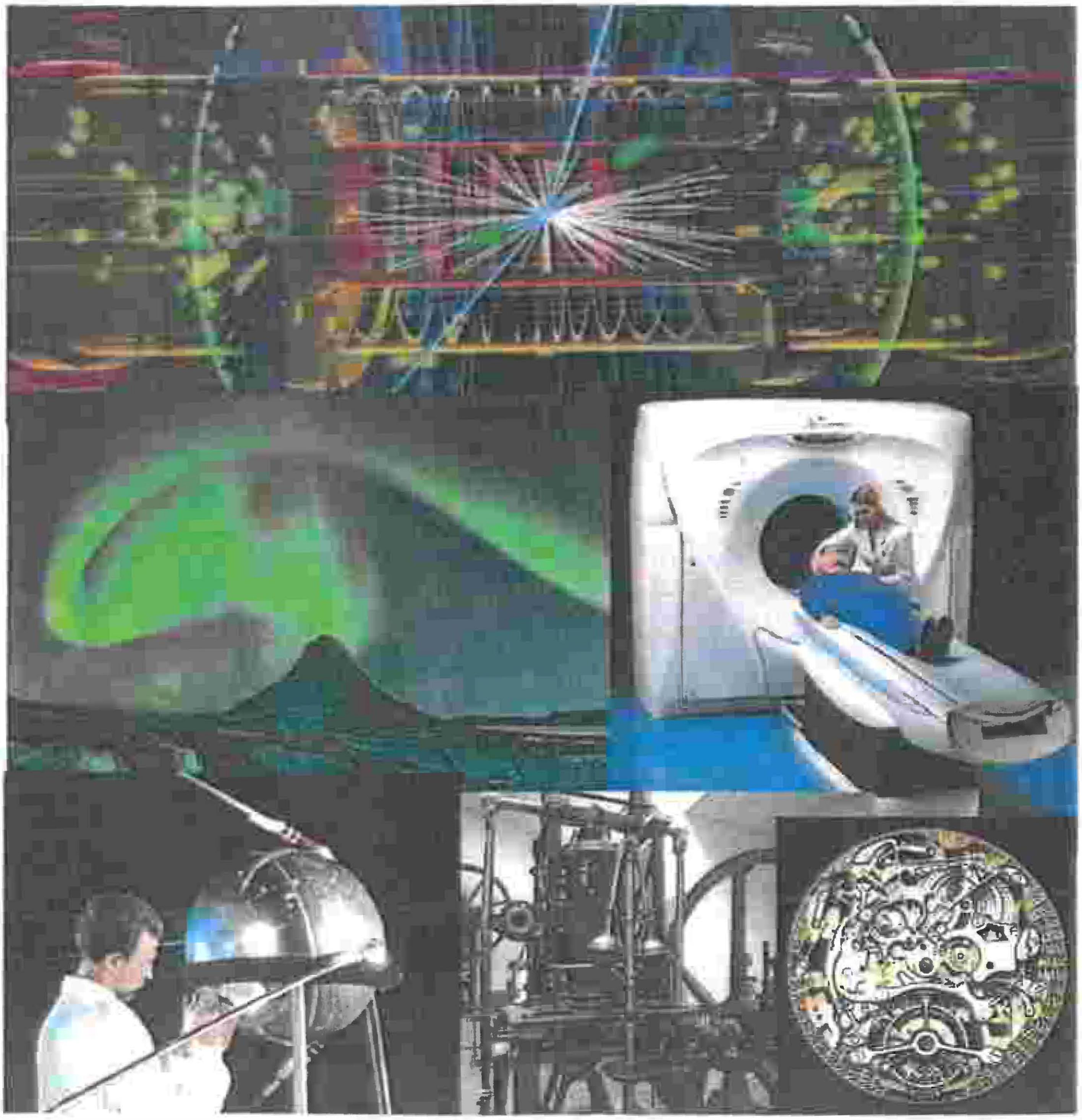
LITTLE HEATH SCHOOL

A Level Summer Work 2024

PHYSICS



Name: ____

School you did your GCSEs at: ______________________________

GCSE Results:

Double (Trilogy) Science: ______________________________

Triple Science (Physics): ______________________________

Mathematics: ______________________________

English Language: ______________________________

A Level Choices:

1) ______________________________

2) ______________________________

3) ______________________________

4) ______________________________

Why do you want to do Physics A Level? (Answer in at least 50 words)

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What do you want to do after Sixth Form at Little Heath? (eg University, Apprenticeship, Career plans etc)

____

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COMPLETING YOUR SUMMER WORK

We need to start teaching he A level course as quickly as possible in September. For that reason, it is vital that you have read through, completed and completed all the questions and fully understood this booklet. We would recommend that you do a few questions over several sessions over the holidays to keep the ideas fresh in your mind rather than leaving it all to the last day before the autumn term starts.

Section 1; General Course INFORMATION

At Little Heath School we study A-Level OCR Physics A course (code H556)

The course Text book is below, it will be possible to order these in September through school.

You can buy both or just the book 1 for yr 12 to start with.

A Level Physics A for OCR Student Book

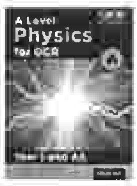
Author: Series Editor Gurinder Chadha, Author Graham Bone, and Author Nigel Saunders

ISBN: 9780198352181

Publisher: Oxford University Press

Date: July 2015

Written by curriculum and specification experts and produced in collaboration with OCR, this Resource Partner textbook is the only two-year textbook for the OCR A specification. It provides complete support through the linear course, delivering the breadth, depth, and skills needed to succeed.



A Level Physics A for OCR Year 1 and AS Student Book

Author: Graham Bone,Gurinder Chadha

ISBN: 9780198352174

Publisher: Oxford University Press

Date: March 2015

Written by curriculum experts, this new Resource Partner Student Book has been tailored for the new 2015 OCR A AS Physics specification. Designed to support and extend your students through the new linear assessment, increased maths requirements and the new practical endorsement.

Section 2 – Prefixes

Often the value of the quantity we are interested is very big or small. To save space and simplify these numbers, we write them in a form of standard form where the power of ten is a multiple of 3. (The exception being centi which is 10 to the power of -2).

For example a person could be 1,000,000,000 (1 trillion) metres away from you and therefore could be said to be 1 x 10^9 metres or 1 Gigametre, or alternatively we could say they are 1,000 x 10^6 metres which is 1,000 Megametres or, of course we could say it is 1,000,000 x 10^3 or 1,000,000 Kilometres.

Prefix	Symbol	Standard Form
peta	P	10^{15}
tera	T	10^{12}
giga	G	10^{9}
mega	M	10^{6}
kilo	k	10^{3}
milli	m	10^{-3}
micro	µ	10^{-6}
nano	n	10^{-9}
pico	p	10^{-12}
femto	f	10^{-15}

Rewrite each of the following in its simplest form with an appropriate prefix

a) 10,000 m

b) 5,075 K

c) 0.000000087 m

d) 960,000,000,000 W

e) 0.0000345 A

f) 7,600,000 J

g) 0.000000074 N

h) 1,000,000 kg

i) 0.00000000005 Mm

j) 0.000200 ms

Section 3 – Significant Figures

The Earth has a diameter of approximately 12,742 km. This does not mean it has precisely a diameter of 12,742,000 metres, but we have rounded to the nearest kilometre or, we could say, we have given the value to 5 significant figures. When we round numbers to significant figures, the easiest way to do so is to write the number in standard form to the correct number of significant figures and then (if necessary) write it out again in full.

For example, with the diameter of the Earth at 1.2742×10^7 metres we would say it is:

1.2742×10^7 m to 5 significant figures (12,742,000 m)

1.274×10^7 m to 4 significant figures (12,740,000 m)

1.27×10^7 m to 3 significant figures (12,700,000 m)

1.3×10^7 m to 2 significant figures (13,000,000 m) – note that the 2 rounds up to 3 when we go from 3 to 2 significant figures here.

In calculations, we can never give an answer to more significant figures than the number in the question with the fewest number of significant figures.

For example, in Physics, the answer to the question 1.00 ÷.3.00000 must be given to no more than 3 significant figures. (as 1.00 is to 3 significant figures). Therefore the answer is 0.333 rather than 0.33333333 (this number is to 8 significant figures which makes the answer more accurate than the question) or ⅓ (although fine in Maths, in Physics a fraction has infinite accuracy) or $0.\dot{3}$ (the recurring sign means it has an infinite number of decimal places). Please be careful in all the questions that you are not being too accurate in your answers.

Write the following to the stated number of significant figures:

1) 5.0319 m to 3sf

2) 500.00 s to 2sf

3) 0.95678545 J to 5 sf

4) 0.00006532 A to 1sf

5) 536,214 V to 3sf

6) 24.65984 to 4 sf

Write how many significant figures the following numbers are quoted to:

7) 224.26415

8) 0.00000000002458

9) 456

10) 200,000

11) 4.54

12) 3.00

Calculate the following and write your answer to the correct number of significant figures:

13) 2.65 m x 3.015 m

14) 22.37 cm x 3.10 cm

15) 0.16 m x 0.02 m

16) 54.401 m ÷ 4 m

17) 6000 A ÷ 378 A

18) 6.84 V ÷ 0.04 V

Section 4 – Classical Mechanics

One of the first topics you will do in September is Classical Mechanics, the study of forces and motion. To prepare for this, please read the following pages and answer the questions at the bottom of each page.

In Physics it is often more important that we know where the answers came from rather than whether we have the correct answer, so more than ever at A Level, it is vital therefore that you show your workings clearly and logically. Unlike GCSE, you will lose marks if your workings are confused or untidy and cannot be easily understood by an examiner. A small note explaining what you are doing is much better than endless lines of maths with no discernible point. For all questions, please set your workings out in the answer space, leave plenty of space and make your answer legible and clear.

Speed, Displacement and Velocity

Distance, Time and Speed are all Related

Points A and B are separated by a **distance** in **metres**. Now imagine a spider walking from A to B — you can measure the **time** it takes, in **seconds**, for it to travel this distance.

You can then work out the spider's **average speed** between A and B using this **equation**:

speed (in metres per second) = **distance travelled** (in metres) ÷ **time taken** (in seconds)

This is a very useful equation, but it does have a couple of **limitations**:

1) It only tells you the **average** speed. The spider could **vary** its speed from fast to slow and even go **backwards**. So long as it gets from A to B in the **same time** you get the **same answer**.
2) We assume that the spider takes the **shortest possible path** between the two points (a straight line), rather than **meandering** around.

Displacement is a Vector Quantity

To get from point A to point B you need to know what **direction** to travel in — just knowing the **distance** you need to travel **isn't enough**.

This information, **distance plus direction**, is known as the **displacement** from A to B and has the symbol *s*. It's a **vector** quantity — **all** vector quantities have both a **size** and a **direction**.

There is a Relationship Between Displacement and Velocity

Velocity is another **vector quantity** — velocity is the **speed** and **direction** of an object. The **velocity** of an object is given by the following equation:

velocity (in metres per second) = **displacement** (in metres) ÷ **time taken** (in seconds)

Or, in symbols: $v = \frac{s}{t}$

This equation is very similar to the one relating **speed** and **distance**, except that it includes information about the **direction of motion**.

Displacement's in a relationship with velocity now, it's so over time...

1) An athlete runs a 1500 m race in a time of 210 seconds. What is his average speed?
2) The speed of light is 3.0×10^8 ms^{-1}. If it takes light from the Sun 8.3 minutes to reach us, what is the distance from the Earth to the Sun?
3) A snail crawls at a speed of 0.24 centimetres per second. How long does it take the snail to travel 1.5 metres?
4) How long does it take a train travelling with a velocity of 50 ms^{-1} north to travel 1 km?
5) If someone has a velocity of 7.50 ms^{-1} south, what is their displacement after 15.0 seconds?

Drawing Displacements and Velocities

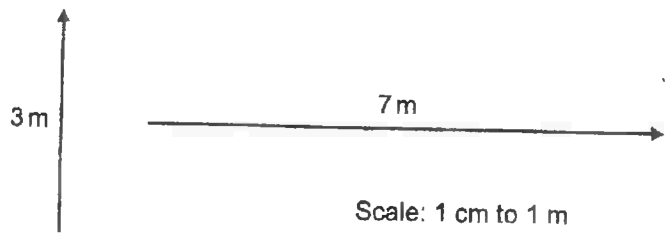
You can use Scale Drawings to Represent Displacement

The simplest way to draw a vector is to draw an **arrow**. So for a displacement vector the **length** of the arrow tells you the **distance**, and the way the arrow **points** shows you the **direction**.

You can do this even for very large displacements so long as you **scale down**. Whenever you do a scale drawing, make sure you **state the scale** you are using.

EXAMPLE: Draw arrows to scale to represent a displacement of 3 metres upwards and a displacement of 7 metres to the right.

A displacement of 3 metres upwards could be represented by an arrow of length 3 centimetres. Using this same scale (1 cm to 1 m) a displacement of 7 metres to the right would be an arrow of length 7 centimetres.

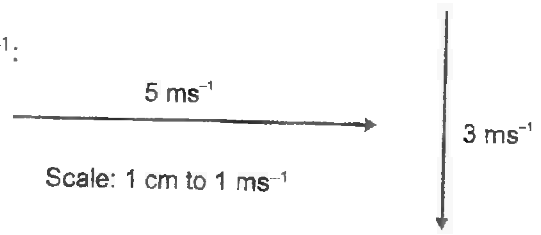


You can also Represent Velocities with Arrows

Velocity is a **vector**, so you can **draw arrows** to show velocities too. This time, the **longer** the **arrow**, the **greater** the **speed** of the object. A typical scale might be 1 cm to 1 ms^{-1}.

EXAMPLE: Draw arrows to scale to represent velocities of 5 metres per second to the right and 3 metres per second downwards.

Draw the velocities like this with a scale of 1 cm to 1 ms^{-1}:



Drawing displacements — not about leaving your sketchbook at home...

1) Draw arrows representing the following displacements to the given scale:
   a) 12 m to the right (1 cm to 2 m)
   b) 110 miles at a bearing of 270° (1 cm to 20 miles)
2) Draw an arrow to represent each velocity to the given scale. Take north to be up the page.
   a) 60 ms^{-1} to the south-east (1 cm to 15 ms^{-1})
   b) 120 miles per hour to the west (1 cm to 30 miles per hour)

Speed, Distance and Velocity

1)

2)

3)

4)

5)

Drawing Displacements and Velocities

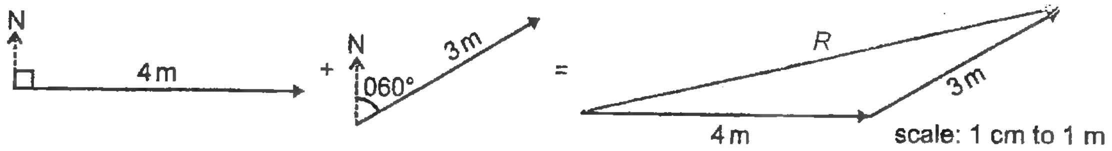
Combining Displacements and Velocities

You can use Arrows to Add or Subtract Two Vectors...

To **add** two velocity or displacement vectors, you **can't** simply add together the two distances as this doesn't account for the **different directions** of the vectors. What you do is:

1) **Draw** arrows representing the two vectors.
2) **Place** the arrows **one after the other** "tip-to-tail".
3) Draw a **third** arrow from start to finish. This is your **resultant vector**.

EXAMPLE: Add a displacement of 4 metres on a bearing of 090° to a displacement of 3 metres on a bearing of 060°. Use a scale of 1 cm to 1 m.



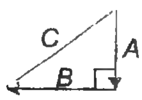
R is the **resultant** vector— it's the sum of the two displacements.
You can find the size of R by measuring the arrow and scaling up.
In this case it's 6.7 cm long which means the displacement is **6.7 m**.

To **subtract** vectors you need to **flip the direction** of the vector you are subtracting.
This **changes the sign** of the vector.
Adding the flipped vector is the **same** as **subtracting** the vector.

For example: 3 m → − 4 m → = 3 m → + ← (− 4 m) = ← −1 m

...Or Use Pythagoras if the Vectors make a Right Angle Triangle

If two vectors, A and B, are at right angles to each other, you can also use Pythagoras' theorem to find the resultant. ⇨ $A^2 + B^2 = C^2$

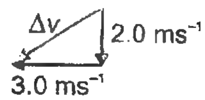


EXAMPLE: An object has an initial velocity of 3.0 ms^{-1} to the right, and a final velocity of 2.0 ms^{-1} down. Find the size of the change in velocity.

Change in velocity = Δv = final velocity – initial velocity.

First, flip the direction and change the sign of the vector that is being subtracted.

↓ 2.0 ms^{-1} − 3.0 ms^{-1} → = ↓ 2.0 ms^{-1} + 3.0 ms^{-1} ← =



$A^2 + B^2 = C^2$, so $C = \sqrt{A^2 + B^2} = \sqrt{2.0^2 + 3.0^2} = 3.605... =$ **3.6 ms^{-1} (to 2 s.f.)**

(This answer is rounded to 2 s.f. to match the data in the question — see page 1.)

Subtracting velocity vectors is easy — subtracting velociraptors, less so...

1) Find the size of the resultant of the following displacements by drawing the arrows "tip-to-tail".
   a) 5.0 m right and 4.0 m up.
   b) 15.0 miles south and 15.0 miles on a bearing of 045°.
2) Initial velocity = 1.0 ms^{-1} west and final velocity = 3.0 ms^{-1} north. Find the size of Δv.

Combining Displacements and Velocities

Combining Displacements and Velocities

Acceleration

Acceleration — the Change in Velocity Every Second

Acceleration is the **rate of change** of **velocity**. Like velocity, it is a **vector quantity** (it has a size and a direction). It is measured in **metres per second squared** (ms^{-2}).

$$\textbf{Acceleration} \text{ (in metres per second}^2\text{)} = \frac{\textbf{change in velocity} \text{ (in metres per second)}}{\textbf{time taken} \text{ (in seconds)}}$$

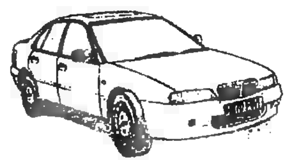
So: $$\textbf{Acceleration} = \frac{\textbf{final velocity} - \textbf{initial velocity}}{\textbf{time taken}}$$

Or in symbols: $a = \frac{v-u}{t} = \frac{\Delta v}{t}$ where u is the initial velocity, v is the final velocity and Δv is the change in velocity.

You'll often only need to think about velocities in **one dimension**, say left to right.
But you still need to recognise the **difference** between velocities from right to left and velocities from left to right.
Choose a direction to be **positive** — below, we'll use **right**. All velocities in this direction will from now on be positive, and all those in the **opposite direction** (left) will be **negative**.
Deceleration is negative acceleration and acts in the **opposite direction** to motion.

EXAMPLE: A car starts off moving to the right at 15.0 metres per second. After 30.0 seconds it is moving to the left at 5.25 metres per second. What was its acceleration during this time?

$u = 15.0\ ms^{-1}$ to the right $= +15.0\ ms^{-1}$
$v = 5.25\ ms^{-1}$ to the left $= -5.25\ ms^{-1}$
So, $a = \frac{v-u}{t} = \frac{-5.25-15.0}{30.0} = \frac{-20.25}{30.0} = \mathbf{-0.675\ ms^{-2}}$
(The acceleration is negative so it's to the left.)



EXAMPLE: A dinosaur accelerates from rest at $4.00\ ms^{-2}$ to the right. If its final velocity is $25.0\ ms^{-1}$ to the right, how long does it accelerate for?

$u = 0.00\ ms^{-1}$ $\quad v = 25.0\ ms^{-1}$ to the right $= +25.0\ ms^{-1}$
$a = \frac{v-u}{t}$, multiplying both sides by t gives $a \times t = v - u$,
and then dividing both sides by a gives $t = \frac{v-u}{a}$. So, $t = \frac{25.0-0}{4.00} = \mathbf{6.25\ s}$

A seller rating is the key thing to check when buying a car online...

1) A train has an initial velocity of $12.8\ ms^{-1}$ to the left. After 22.0 seconds it is moving to the right at $18.3\ ms^{-1}$. What was its average acceleration during this time?
2) A ship accelerates at a uniform rate of $0.18\ ms^{-2}$ east. If its initial velocity is $1.5\ ms^{-1}$ east and its final velocity is $4.5\ ms^{-1}$ in the same direction, how long has it been accelerating for?
3) A rabbit is hopping at a constant speed when he begins decelerating at a rate of $0.41\ ms^{-2}$. What was the rabbit's initial hopping speed if it takes him 3.7 seconds to come to a stop?

Kinetic Energy

Moving Things Have Kinetic Energy

Energy is a curious thing. You can't pick it up and look at it.
One thing's for certain though — if you're **moving** then you have energy.
This movement energy is more properly known as **kinetic energy**,
and there's a formula for working it out:

If a body of **mass** m (in kilograms) is moving with **speed** v (in metres per second) then its **kinetic energy** (in joules) is given by:

kinetic energy = ½ × mass × speed²

Or, in symbols: $E_k = \frac{1}{2} \times m \times v^2$

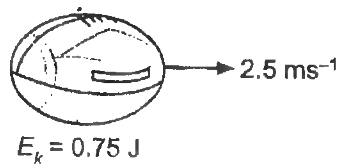
Have a look at the following examples, and then try the questions after them.

EXAMPLE: A car of mass 1000 kg is travelling with a speed of 20 ms^{-1}. What is its kinetic energy?

$E_k = \frac{1}{2} \times m \times v^2$, so $E_k = \frac{1}{2} \times 1000 \times 20^2$
$= \frac{1}{2} \times 1000 \times 400 = 200\,000 = \mathbf{2 \times 10^5}$ **J**

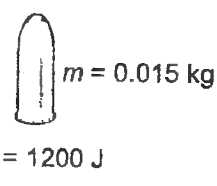
EXAMPLE: A ball has a speed of 2.5 ms^{-1} and has kinetic energy equal to 0.75 J. What is the mass of the ball?

$E_k = \frac{1}{2} \times m \times v^2$
Multiplying both sides by 2 gives $2 \times E_k = m \times v^2$,
then dividing both sides by v^2 gives $\frac{2 \times E_k}{v^2} = m$,
so $m = \frac{2 \times E_k}{v^2} = \frac{2 \times 0.75}{2.5 \times 2.5} = \frac{1.5}{6.25} = \mathbf{0.24\ kg}$



EXAMPLE: A bullet has kinetic energy equal to 1200 J. If its mass is 15 g, what is its speed?

$m = 15$ g $= 0.015$ kg
From the previous example: $2 \times E_k = m \times v^2$
Dividing both sides by m gives $\frac{2 \times E_k}{m} = v^2$,
then taking square roots of both sides gives $\sqrt{\frac{2 \times E_k}{m}} = v$,
so $v = \sqrt{\frac{2 \times E_k}{m}} = \sqrt{\frac{2 \times 1200}{0.015}} = \mathbf{400\ ms^{-1}}$



Kinetic energy — what you need lots of when you're late for the bus...

1) An arrow of mass 0.125 kg is travelling at a speed of 72.0 ms^{-1}. What is its kinetic energy?
2) A ship has kinetic energy equal to 5.4×10^7 J when moving at 15 ms^{-1}. What is its mass?
3) A snail of mass 57 g has a kinetic energy of 1.0×10^{-6} J. What is its speed?

Acceleration (Hint, be careful that you give your answers to the same number of significant figures as are given in the question and show ALL your working properly)

1)

2)

3)

Kinetic Energy

1)

2)

3)

Acceleration (Hint, be careful that you give your answers to the same number of significant figures as are given in the question and show ALL your working properly)

1)

2)

3)

Kinetic Energy

1)

2)

3)

Conservation of Energy

The Conservation of Energy Applies to Falling Bodies

The principle of **conservation of energy** states that:

"Energy **cannot** be **created** or **destroyed** — it can only be **converted** into other forms"

So as long as you ignore air resistance...
...for a **falling** object:

kinetic energy gained (in joules) = **gravitational potential energy lost** (in joules)

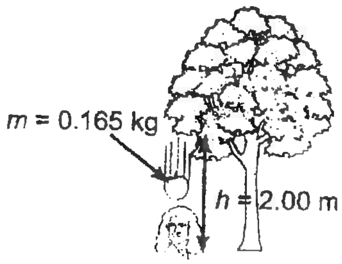
...and for an object **thrown** or **catapulted** upwards:

gravitational potential energy gained (in joules) = **kinetic energy lost** (in joules)

This can be very useful in solving problems.
Read through the examples and then have a go at the questions afterwards.
(In all the questions, you can ignore air resistance.)

EXAMPLE: An apple of mass 0.165 kilograms falls 2.00 metres from a tree. What speed does it hit the ground at?

E_p lost = $m \times g \times h = 0.165 \times 9.81 \times 2.00 = 3.2373$ J
Therefore E_k gained = 3.2373 J. $E_k = \frac{1}{2} \times m \times v^2$.
Rearranging this gives $v = \sqrt{\frac{2 \times E_k}{m}}$, so $v = \sqrt{\frac{2 \times 3.2373}{0.165}} = 6.264...$
= 6.26 ms⁻¹ (to 3 s.f.)



EXAMPLE: A model clown of mass 225 grams is fired straight upwards from a cannon at 10.0 metres per second. How high does it get?

$m = 225$ g $= 0.225$ kg
E_k lost = $\frac{1}{2} \times m \times v^2 = \frac{1}{2} \times 0.225 \times 10.0^2 = 11.25$ J
Therefore, E_p gained = 11.25 J. $E_p = m \times g \times h$.
Rearranging this gives $h = \frac{E_p}{m \times g}$, so $h = \frac{11.25}{0.225 \times 9.81}$
$= 5.096... =$ **5.10 m (to 3 s.f.)**

Today I'm practising conservation of energy — I'm staying in bed all day...

1) A gymnast jumps vertically upwards from a trampoline with 2850 J of kinetic energy. They climb to a height of 5.10 m. What is the gymnast's mass?
2) A book of mass 0.475 kilograms falls off a table top 92.0 centimetres from the floor. What speed is it travelling at when it hits the floor?
3) A bullet of mass 0.015 kilograms is fired upwards at 420 ms⁻¹. What height does it reach?

Gravitational Potential Energy

Gravitational Potential Energy Depends on Height and Mass

When an object **falls**, its speed **increases**. As its speed increases, so does its **kinetic energy**. **Where** does it get this energy from?
Answer — from the **gravitational potential energy** it had before it fell:

If a body of **mass** m (in kilograms) is **raised** through a **height** h (in metres), the **gravitational potential energy** (in joules) it gains is given by:
gravitational potential energy = mass × gravitational field strength × height

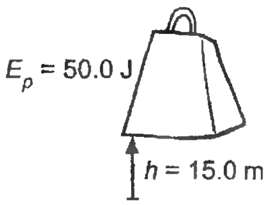
So, in symbols it reads: $E_p = m \times g \times h$

The gravitational field strength, g, is the **ratio** of an object's **weight** to its **mass** (in newtons per kilogram, Nkg^{-1}).
At the surface of the Earth, g has an approximate value of **9.81 Nkg^{-1}**.

EXAMPLE: An 80.0 kilogram person in a lift is raised 45.0 metres. What is the increase in the person's gravitational potential energy?

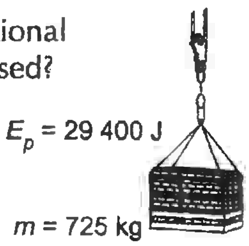
$E_p = m \times g \times h$, so $E_p = 80.0 \times 9.81 \times 45.0 = 35\,316 =$ **35 300 J (to 3 s.f.)**

EXAMPLE: A mass raised 15.0 metres gains gravitational potential energy equal to 50.0 joules. What is that mass?



$E_p = m \times g \times h$. Dividing both sides by g and h gives $\frac{E_p}{g \times h} = m$,
so $m = \frac{E_p}{g \times h} = \frac{50.0}{9.81 \times 15.0} = 0.3397... =$ **0.340 kg (to 3 s.f.)**

EXAMPLE: 725 kilograms of bricks are given 29 400 joules of gravitational potential energy. Through what height have they been raised?



$E_p = m \times g \times h$. Dividing both sides by m and g gives $\frac{E_p}{m \times g} = h$,
so $h = \frac{E_p}{m \times g} = \frac{29\,400}{725 \times 9.81} = 4.1337... =$ **4.13 m (to 3 s.f.)**

Liven up your roasts — pour on some graveytational potential energy...

1) How much more gravitational potential energy does a 750 kg car have at the top of a 350 m high hill than at the bottom?
2) A crate is raised through 7.00 metres and gains 1715 J of gravitational potential energy. What is the mass of the crate?
3) A 65.0 kilogram hiker gains 24 700 joules of gravitational potential energy when climbing a small hill. How high have they climbed?

Gravitational Potential Energy

1)

2)

3)

Conservation of Energy

1)

2)

3)

Section 5 – Mathematics

Mathematics is the language which the laws governing the universe appear to have been written in. In Physics, you need to be very confident with certain parts of the GCSE Maths specification (eg Algebra and Standard Form) although other parts are not used as much (eg Simultaneous Equations and Circle Theorems). The most important bit of Maths for the early stages of Physics is being able to rearrange equations. For each of the expressions below, rearrange them to make c the subject of the equation. (Please note that should be that all of them are "c = something" not "c^3 = something" or "$\sqrt{c}$ = something").

a. $v = t + c$

b. $E = m c T$

c. $r = \frac{m}{c}$

d. $\frac{x}{y} = k c^2$

e. $c^2 = \frac{t}{c}$

f. $t^2 = g^2 + 2cd$

g. $t^2 = c^2 + 2gm$

h. $p = \frac{m}{c^3}$

i. $p = \frac{c^3}{m}$

j. $p = c^{2/3}$

k. $p = \frac{1}{2}c^3 + g$

l. $p = \frac{ck}{2}$

m. $\sqrt{\frac{c}{k}} = he$

Mathematics (Hint: Show any working you need to and leave your answers in their simplest possible forms)

Mathematics (Hint: Show any working you need to and leave your answers in their simplest possible forms)

Section 6 – Glossary

Physics is a very exact Science and therefore we need to be fully confident that you can define words clearly and precisely. Can you find out the precise definitions to the following Physics terms?

Physics Term	Definition
Amp	
Amplitude	
Density	
Frequency (as in Waves)	
Joule	
Kirchoff's First Law	
Longitudinal Wave	
Mass	
Newton (Unit)	
Ohm's Law	
Time Period	
Potential Difference	
Principle of Conservation of Energy	
Scalar	
Transverse Wave	
Watt (Unit)	
Weight	

I do not know what I may appear to the world, but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, whilst the great ocean of truth lay all undiscovered before me.

Sir Isaac Newton