



ST CHRISTOPHER'S SIXTH FORM

PHYSICS

BRIDGING UNIT

Physics

A-Level Physics Pre-Course Assignment

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*"The important thing is not to stop questioning.
Curiosity has its own reason for existing."*

Albert Einstein

Be Curious

As a physicist you should be curious, you should explain the things around you and enjoy discovering how and why things happen. To help answer some of your questions and encourage more, here are a few resources to help you.

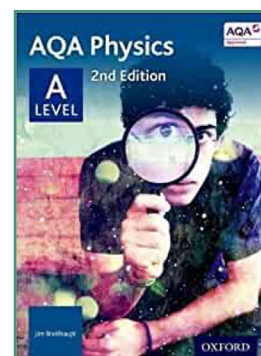
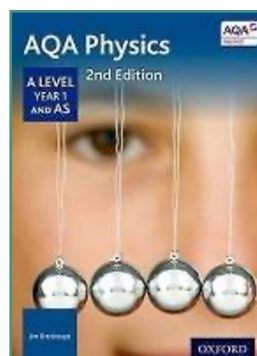
Youtube

- **Minute Physics** - <https://www.youtube.com/user/minutephysics>
Minute Physics can be advanced, but their videos are clear and tackle some amazing physics!
- **Smarter every day** - <https://www.youtube.com/user/destinws2>
Brilliant channel especially for engineering
- **Physics Girl** - https://www.youtube.com/results?search_query=physicsgirl
Great Physics only channel. Tackles big physics and explains things you see every day.
- **Veritasium** - <https://www.youtube.com/user/1veritasium>
Great channel to explain some tricky concepts addressing misconceptions
- **Up and Atom** - <https://www.youtube.com/channel/UCS1vk78tK2TiviLQn4fSHaw>
Great small channel tackles some really advanced physics.

Books

- **Textbook:**
AQA A level Physics Student Book Year 1 or Year 1 and 2 combined.
This is the book we will loosely follow on the course, the book is around £25 for the year 1 book and £40 for the two years. Amazon links below but feel free to buy elsewhere second hand they can be very cheap.

First year book - <https://www.amazon.co.uk/Physics-Level-Year-Student-Book/dp/0198351860/>
Second year book - <https://www.amazon.co.uk/AQA-Physics-Level-Student-Book/dp/0198351879>



- **Short History of Nearly Everything**, Bill Bryson - A great starting point into science reading
- **Brief History of Time**, Steven Hawking - A very popular book aiming to explain the formation and evolution of the universe.
- **What if?** - Randal Monroe - A less serious look at interesting questions
- **Any title by Richard Feynman** - I love Feynman, his writing and lectures are great for those wanting to understand complex topics.

There are many more I could share, especially if you're interested in learning more academically about Physics. If you are curious about certain parts of physics and want recommendations to help answer questions or you have any other questions please email t.maryon@st-christophers.org

The rest of this booklet covers some of the skills you need mathematically and in problem solving. We will use many of these skills in A level Physics. Many of these extend and develop ideas you will have come across at GCSE in science and maths. You will need to use a combination of **careful reading, research, logic and persistence**. You should expect to find some parts difficult, but if you persevere you will often find you can do them!

Physics

1. Unit Prefixes

Prefixes are written in front of units to indicate multiplication or division by multiples factors of 1000. So mega means $\times 1,000,000$. (One exception is 'centi', as in cm, which means divide by 100)

YOU MUST LEARN THE PREFIXES BY HEART AND BECOME ADEPT AT WORKING WITH THEM.

1. Complete the following table. (You will need to research some of the missing units).

Symbol		Multiplier	Which means...
	terra		
		$\times 10^9$	
M			$\times 1,000,000$
k			$\times 1000$
(None)	---	---	$\times 1$
m			
	micro		$/ 1,000,000$
n			
		$\times 10^{-12}$	
f			

2. Expand each of these quantities to write out the answer in full (i.e. without the prefixes)

- a. 900 mV = b. 12 MJ =
- c. 1.67 mm = d. 3.456 km =
- e. 700 nm = f. 0.72 pA =

3. Write each of the following using an appropriate prefix:

- g. 0.005 A = h. 30000 s =
- i. 5×10^5 m = j. 1001 m =
- k. 0.006 V = l. 2,100,000 N =

4. Convert each of the following to the indicated units:

- a. 34 nm = mm
- b. 0.012 s = [s
- c. 4.5 MJ = kJ

2. UNITS (a) The SI system of units

1. Look up the following terms and write a few sentences about each:

SI Units	
Base Units	
Derived Units	

2. In physics all units can be derived from six base units. Research how the base units are defined.

Base Quantity	Base Unit	Definition (Note: you do not need to learn these definitions)
Length	metre (m)	
Mass	kilogram (kg)	
Time	second (s)	
Temperature	kelvin (K)	
Current	ampere (A)	

2. UNITS (b) Derived units

In physics all non-base quantities are called derived quantities and are defined by equations.

Eg. (a) Define speed. (b) Define charge.

(a) **speed = distance / time** (b) **charge = current × time.**

The units of these new quantities are derived units and are established from these same equations. So,

(b) **The unit of speed = unit of distance / unit of time = m / s = $m \cdot s^{-1}$** ('metres per second')*

(c) **The unit of charge = the unit of current × the unit of time = $A \cdot s$** ('amp second')

***NOTE: At A level we write divided units, such as 'metres per second' as ms^{-1} not m/s.**

In the SI system, many of these derived units get their own name. For example, the SI unit of charge is the coulomb (C). So we can say that one coulomb is equal to one amp second.

or **C = A s**

Any SI unit can be expressed in terms of base units. To find the base units work through the defining equations one by one, until you end up with the base units. For example, what are the base units of a Joule? This requires two steps:

- Energy (Work) = Force × distance moved, So one joule = one newton metre (**J = N·m**)
- Force is defined from $F = m a$, so one newton = one kilogram metre per second squared (**or N = $kg \cdot m \cdot s^{-2}$**)
- Therefore, a joule = **N m = $(kg \cdot m \cdot s^{-2}) m = kg \cdot m^2 \cdot s^{-2}$**

1. Complete the table below.

Try working these out rather than looking them up. You can use the earlier answers to help with the harder ones.

Derived quantity	Defining equation	Standard SI unit (if applicable)	Equivalent base units
speed	$S = d / t$	n/a	$m \cdot s^{-1}$
momentum	$p = m v$	n/a	$kg \cdot m \cdot s^{-1}$
acceleration	$a = (v - u) / t$	n/a	
Force	$F = m a$	newton (N)	
Power	power = work/time $P = W/t$		
frequency	frequency = 1/time period $f = 1 / T$		s^{-1}
Charge	charge = current × time $Q = I t$	coulomb (C)	$A \cdot s$
potential difference	voltage = work/charge $V = W/Q$		
resistance	$R = V / I$		
specific heat capacity	SHC = Energy / (mass × temperature change) $c = Q / (m \times \Delta t)$		

3. MATHS – Powers of 10 and standard form (aka scientific notation)

You need to be able to use your calculator to work in standard form or use power of ten notation to replace unit suffixes.

Tip: you should use the [x10x] button on your calculator for entering powers of ten.

1. Rewrite these numbers in standard form, removing any unit prefixes:

- | | | |
|-------------------------------|--|-------------------------------|
| a) 3141
..... | b) .00055
..... | c) 2.0002
..... |
| d) 120000 (2sf)
..... | e) 120000 (6sf)
..... | f) 843×10^4
..... |
| g) $1.5 \mu\text{m}$
..... | h) $12.0 \times 10^{-2} \text{ nm}$
..... | i) 999 MJ
..... |
| j) 245 mg
..... | k) 16 pF
..... | l) 97.237 GN
..... |

All of the equations we use in Physics require variables to be converted to standard SI units. This means any prefixes must first be removed. For example to calculate resistance in ohms (Λ) you divide the p.d. in volts (V) by the current in amps (A), If current = 8.0 mA (milliamps) and the voltage was 12 kV (kilovolts) the correct calculation would be:

$$R = V/I = 12 \times 10^3 / 8.0 \times 10^{-3} = 1.5 \times 10^6 \Lambda$$

Try the above on your calculator before you continue.

2. Calculate the following showing your working, giving the answers in appropriate units. (This means removing suffixes, except for grams which need to be converted to kg)

- | | |
|--|---|
| a) Area (m^2) = $120 \text{ mm} \times 250 \text{ mm}$
..... | b) Area (m^2) = $2.4 \text{ m} \times 60 \text{ cm}$
..... |
| c) Density ($\text{kg} \cdot \text{m}^{-3}$) = $48 \text{ g} / 12 \text{ cm}^3$
..... | d) Charge in coulombs, $Q = I t$
.....
= $3.0 \times \text{kA} \times 20 \text{ s}$ |
| e) Speed squared, $v^2 = (16 \text{ m} \cdot \text{s}^{-1})^2$
..... | f) Force, $F = m a = 923000\text{g} \times 9.8 \text{ m} \cdot \text{s}^{-2}$
..... |

4. Rules for Significant figures (sig fig or sf)

Read from the left and start counting sig figs when you encounter the first non-zero digit

- All non zero numbers are *significant* (meaning they count as sig figs)
 - 613 has three sig figs
 - 123456 has six sig figs
- Zeros located between non-zero digits are significant (they count)
 - 5004 has four sig figs
 - 602 has three sig figs
 - 600000000000002 has 16 sig figs!
- Trailing zeros (those at the end) are significant only if the number contains a decimal point; otherwise they are insignificant (they don't count)
 - 5.640 has four sig figs
 - 120000. has six sig figs
 - 120000 has two sig figs – unless you're given additional information in the problem
- Zeros to left of the first nonzero digit are insignificant (they don't count); they are only placeholders!
 - 0.000456 has three sig figs
 - 0.052 has two sig figs
 - 0.00052 also has two sig figs!

Rules for calculations

When you perform a calculation the answer should be given to the same number of significant figures as the weakest piece of data that was used in the calculation. For example if a piece of card is 11.3 cm long and 2.4 cm wide then the area = 27.12 cm² (on the calculator), but should be written as 27 cm² (i.e. 2 sig fig) because the width (2.4) was only given to 2 sig fig.

C. Practice Questions

1. State the number of sig figs in each of the following numbers:

- (a) 0.0000055 g (c) 1.6402 g (b) 3.40×10^3 mL

2. Compare the following numbers:

370 000 v 3.70×10^6 (standard form)

Explain the advantage of giving an answer in standard form

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3. Complete each of the following calculations using your calculator, giving your answer in standard form with the correct number of significant figures, with your answer in the units indicated.

(a) $\rho = m / V = 0.542 \text{ g} / 0.027 \text{ cm}^3 = \dots\dots\dots \text{g}\cdot\text{cm}^{-3}$

(b) $E = m c^2 = 231.5 \times 10^{-3} \times (3.00 \times 10^8)^2 = \dots\dots\dots \text{J}$

(c) Mean time = $(23 + 20 + 21 + 22 + 25) / 5 = \dots\dots\dots \text{s}$

(d) Height difference = $2.32\text{m} - 2.07\text{m} = \dots\dots\dots \text{m}$

4. Complete the following calculations using a calculator, showing your working and giving an answer in standard form to the correct number of significant figures, in appropriate units:

a) $\frac{2.3 \times 6.5}{3.7 \times (9.1)^2}$

.....

b) $(314)^3 / (9.9^2)$

.....

c) $(12 \times 45\text{g}) / 12 \text{ cm}^3$

.....

d) $1.2 \times 10^{-6} \times 1.5 \times 10^{-4}$

.....

e) $(16 \text{ m}\cdot\text{s}^{-1})^2$

.....

f) $923\text{Kg} \times 9.8 \text{ m}\cdot\text{s}^{-2}$

.....

5. Rearranging Equations

Rearrange these equations to express them in the terms that follow:

1. $v = x / t$

a. $x = ?$

b. $t = ?$

2. $F = m a$

a. $m = ?$

b. $a = ?$

3. $a = (v - u) / t$

a. $t = ?$

b. $v = ?$

c. $u = ?$

4. $v^2 = u^2 + 2as$

a. $v = ?$

b. $a = ?$

c. $u = ?$

5. $s = ut + \frac{1}{2} a t^2$

a. $u = ?$

b. $a = ?$

c. $t = ?$

6. $\frac{1}{R_{\text{tot}}} = \frac{1}{R_1} + \frac{1}{R_2}$

a. $R_{\text{tot}} = ?$

b. $R_1 = ?$



6. Showing your working clearly

When answering physics questions you need to lay out your working clearly showing all the steps, working left to right and top to bottom. Your final answer should be found to the bottom right of your working and should be underlined. Below is an example for you to base your own answer style on.

Ch6, Q4

A white snooker ball with a kinetic energy of 15J collides with a red ball. On impact the white ball stops, transferring all of its KE to the red ball. The mass of the red ball is 120 g. What would be the velocity of the red ball immediately following the collision?

STEPS: Equation being used | rearrange | values inserted
calculated answer | units | sig fig

$$\begin{aligned} KE &= \frac{1}{2}mv^2 & \therefore \frac{2KE}{m} &= v^2 & \therefore \underline{v} &= \sqrt{\frac{2 \times 15J}{0.12kg}} \\ & & & & & = 15.8 \text{ ms}^{-1} = \underline{16 \text{ ms}^{-1} (2sf)} \end{aligned}$$

Eight Steps To Improve The Quality Of Your Working

1. Show all steps
2. Work left to right and top to bottom
3. Rearrange equations before substituting values
4. If a calculation is two step, underline the answer to the first step before proceeding as this may get marks
5. Your writing should be small and neat. Don't scrawl.
6. You should be able to easily check over your working to find mistakes
7. Plan to use the available answer space wisely
8. Try to leave space for correcting mistakes if you go wrong

7. Bringing it all together

Brain-gym for the physics-muscle in your head (It hurts to start with, but gets easier with practise)

These problems will challenge you to work with powers and units, rearrange equations and use your calculator carefully. Helpful formulae for volume and surface area are given on the last page, as are the answers.

Lay out your working clearly, work step by step, and check your answers. If you get one wrong, go back and try again. Do not be disheartened if they seem difficult to start with, persevere and seek help – you will improve. Importantly, have fun!

1. How many mm² are there in

(a) 1cm² ?

(b) 1 m² ?

(c) 1 km² ?

2. How many cm³ are there in

(a) 1 mm³ ?

(b) 1 m³ ?

3. A piece of A4 paper is 210×297 mm. All measurements are to the nearest mm. Calculate its area in (a) mm^2 , (b) cm^2 , (c) m^2 . Give answers to the correct number of significant figures.

a) Area = mm^2

b) Area = cm^2

c) Area = m^2

4. A plastic toy is supplied in a cubic box, 4.0 cm each side. How many of them pack into a carton $80 \times 52 \times 70$ cm? (Students often get the wrong answer and can't see why. Visualise the actual problem don't just rely on maths!)

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5. A copper atom has a diameter of 217 pm (pico-meters). How many of them would fit inside 1mm^3 of copper to 3 sig. fig? (Tip: for simplicity, treat them as cubes of side 217 pm)

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.....

6. Water has a density of 1.0 g cm^{-3} . Express this in (a) kg cm^{-3} , (b) kg m^{-3} , (c) kg mm^{-3}

a) Density = kg cm^{-3}

b) Density = kg m^{-3}

c) Density = kg mm^{-3}

7. A regular block of metal has sides $12.2 \times 3.7 \times 0.95$ cm, and a mass of 107g. Find its density in kg m^{-3} to a suitable number of significant figures.

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Physics

8. A measuring cylinder is filled with 1.00 litres of water. The column of water inside forms a regular cylinder 32.0 cm high. What is (a) the area of the surface of the water (in mm^2)? (b) the internal diameter of the cylinder (in mm)? (TIP: Visualise the problem clearly. Draw a diagram if it helps. Use the equation or the volume of a cylinder)

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9. The diameter of the sun is 1.4×10^6 km. Its average density is 1.4 g cm^{-3} . What is its mass in kg? (TIP: The trick here is to convert the units carefully before you start)

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10. The total energy arriving in the Earth's upper atmosphere from the sun is 174×10^{15} Watts. Given that the Earth's diameter is 12.8×10^3 km, what is the average intensity of this radiation in W m^{-2} ? (TIP: Think about the units carefully. What does W m^{-2} mean?)

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.....

Answers:

- a) 10^2 (100)
b) 10^6 (1,000,000)
c) 10^{12}
- a) 10^{-3} (1/1000)
b) 10^6 (1,000,000)
- a) $6.237 \times 10^4 \text{ mm}^2$ (62,370 mm^2)
b) $6.237 \times 10^2 \text{ cm}^2$ (623.7 cm^2)
c) $6.237 \times 10^{-2} \text{ m}^2$ (0.06237 m^2)
- 4420
- 9.79×10^{19}
- a) $1 \times 10^{-3} \text{ kg cm}^{-3}$
b) $1 \times 10^6 \text{ kg m}^{-3}$
c) $1 \times 10^{-6} \text{ kg mm}^{-3}$
- $2.50 \times 10^3 \text{ kg m}^{-3}$
- a) 3125 mm^2
b) 63.1 mm
- $2.0 \times 10^{30} \text{ kg}$
- 338 W m^{-2}

Geometrical Equations

Arc length	=	$r\theta$
Circumference of circle	=	$2\pi r$
Area of circle	=	πr^2
Surface area of cylinder	=	$2\pi rh$
Volume of cylinder	=	πr^2h
Area of sphere	=	$4\pi r^2$
Volume of sphere	=	$\frac{4}{3}\pi r^3$

KS4 Revision & Extension

8. Energy and Power

Look up definitions for each of the following quantities. Write down the equations and any notes you think are helpful:

Work

.....

.....

Kinetic Energy

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.....

Gravitational Energy

.....

.....

Elastic Potential Energy

.....

.....

Efficiency

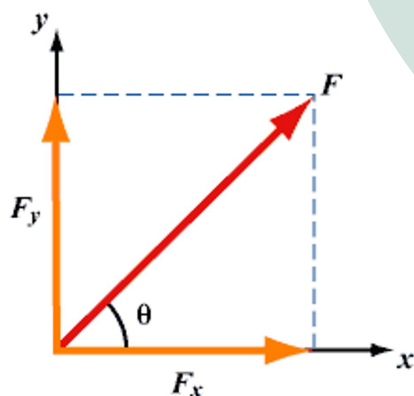
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Power (including electrical power)

.....

.....



Resolving vectors

In A level Physics you will need to work with vectors that act at odd angles. Often the easiest way to deal with this is to convert the diagonal vector into horizontal and vertical components.

For example, in the case of a force F acting at an angle θ , can be treated as two forces acting horizontally (F_x) and vertically (F_y). These can be calculated with trigonometry:

$$F_y = F \sin(\theta) \quad \text{and} \quad F_x = F \cos(\theta)$$

You may need to use this in the following questions.

Work

What is the definition of work?

.....

.....

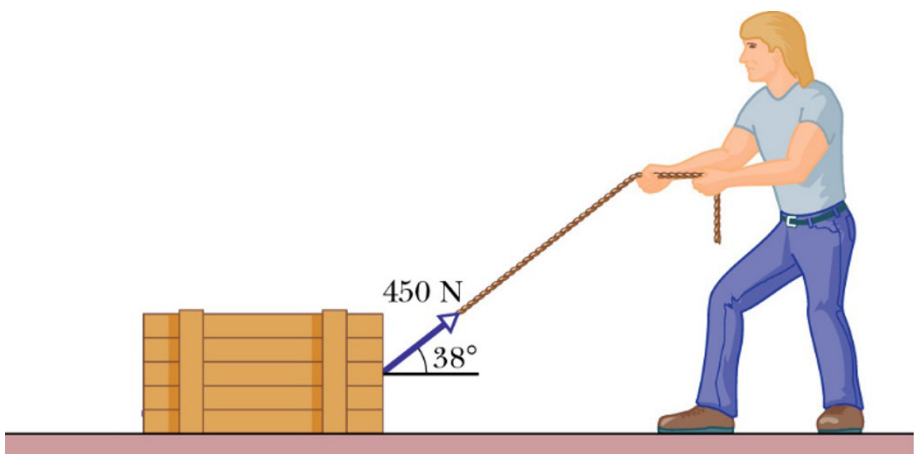
..... (2)

In the following calculations take $g = 9.8 \text{ N kg}^{-1}$

1) Calculate the work done in each of the following situations, stating the final form of the transferred energy.

i) A box is pushed 3m along the floor by a horizontal force of 500N
Work = J Energy is transferred into.....(2)

ii) An electric lift raises 540 kg load through a height of 18.3 metres
Work = J Energy is transferred into.....(3)



iii) A man uses a rope to pull a box along a floor, as shown above. He drags the box 3.0 km.
Work done = J Energy is transferred into.....(4)

iv) A student adds three 100g slotted masses to a spring of spring constant, $k = 6.0 \text{ Nm}^{-1}$. It extends by 14.0 cm.
Work done = J Energy is transferred into.....(4)

Power

What is the definition of power?

.....
.....
..... (1)

2) Which of the following are units of power? (circle all of the correct units)

joule second watt joule second⁻¹ newton metre second⁻¹ amp volt (2)

Explain why power is equal to force × velocity

.....
..... (2)

Explain why power is equal to current × potential difference

.....
..... (2)

3) In two minutes a rocket gained 370 MJ of kinetic energy and 1300 MJ of gravitational potential energy.

i) Find the useful power produced by the rocket engines.

.....
..... Power = W (2)

ii) In the following 30 seconds the rocket travels at a steady speed of 320 ms⁻¹. Assuming the power of the engines to be constant, calculate the thrust force produced by the engines.

.....
..... Force = N (2)

4) A 12V electric motor is used to lift a 50g mass through 1.0m. The overall efficiency of this system is 10%. Whilst in operation it draws a current of 0.25A.

i) Find the useful power output of the electric motor.

.....
..... Power = W (2)

ii) How long does it take the motor to raise the mass 1.0m?

.....
..... Time = s (2)

Physics

Speed

1. A bullet travels 300m in 2.60 seconds what is its velocity in (a) m s^{-1} (b) km h^{-1} ?

.....

.....

.....

2. An alpha particle covers 2.0 cm travelling at 5% the speed of light (speed of light= $3.0 \times 10^8 \text{ m s}^{-1}$). How long does it take to cover this distance?

.....

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.....

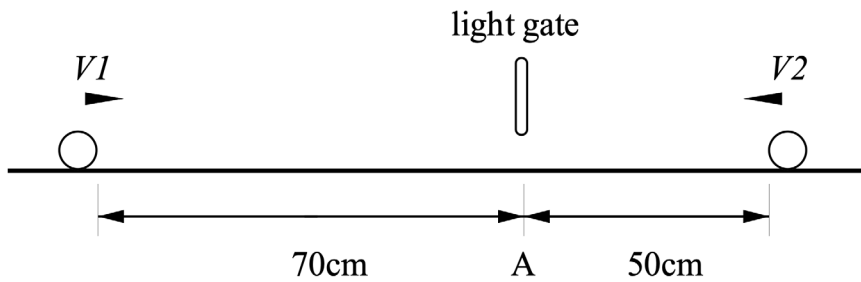
3. A cyclist is racing on a circular track at an average speed of 8.35 m s^{-1} . She completes three laps in 2 minutes 24.36 seconds. What is the radius of the track?

.....

.....

.....

4. Two pool balls are moving towards each other as in the diagram below. At position A is a light gate.



- If $V_1 = 0.60 \text{ m s}^{-1}$ and $V_2 = 0.20 \text{ m s}^{-1}$ then (a) which ball passes through the light gate first and (b) at what time and (c) at what position do they collide and (d) at what time?

.....

.....

.....

5. A light-year is the distance light travels in one year. Calculate this distance in metres to 3 significant figures, given that the speed of light is $3.00 \times 10^8 \text{ m s}^{-1}$.

.....

.....

.....

Acceleration

6. A horse is cantering at 3.1 m s^{-1} and breaks into a gallop reaching a speed of 5.6 m s^{-1} in 3.5 seconds. Calculate its acceleration.

.....
.....

7. A car travelling at 16.0 m s^{-1} , brakes for 3.20 s, decelerating at a rate of 3.125 m s^{-2} . What is its final speed?

.....
.....

8. An Olympic diver strikes the water at a speed of 7.2 m s^{-1} , and comes to rest in 1.2 seconds. What is his acceleration?

.....
.....

9. A falling ball strikes a floor with a velocity of 4.2 m s^{-1} and rebounds with a velocity of -3.8 m s^{-1} . It is in contact with the floor for 0.12 seconds. What was its acceleration?

.....
.....

10. A Porsche is quoted as having a "0-60 time of 4.2 seconds". This means it accelerates from zero to 60 miles per hour in 4.2 seconds. Given that 1 mile = 1.55 km, calculate its acceleration in ms^{-2}

.....
.....

11. At the University of Errors Science Tower, a brick is observed falling past the window of the physics laboratory. A quick thinking physics student records its speed as 4.59 m s^{-1} . A moment later it passes the ground floor windows of the engineering faculty and an alert engineer records its speed as 12.91 m s^{-1} .

- (a) Assuming acceleration due to gravity to be 9.81 m s^{-1} and assuming air resistance to be negligible, how long was the 'moment' between these observations?

.....
.....

- (b) By considering its average speed calculate the height between the Physics and the Engineering labs.

.....
.....





**“For I know the plans I have for you,” declares the Lord,
“plans to prosper you and not to harm you,
plans to give you hope and a future.”**

Jeremiah 29:11

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