Stage 1 Physics
Exam Revision Booklet

What you need to know and do …
The concepts and knowledge you will be tested on are

- How to use the average velocity formula $v_{av} = \frac{s}{t}$ to find velocity, time ($t = \frac{s}{v_{av}}$) and displacement ($s = v_{av}t$)
- Convert between ms^{-1} and km/h using 3.6 divide or times.
- State that the difference between a scalar quantity and a vector quantity is that vector quantities have a direction and an amount.
- Determine that you will need to measure a distance and a time to find average speed and discuss the ways you can do this.
- Identify errors that can occur in a practical investigation and classify them as systematic – affects all results equally (changes accuracy) and random errors that cause some results to not match the others (changes precision)
- Identify that distance time graphs with a raising or falling gradient show uniform speed and with a curved line show changing speed.
- Identify that velocity time graphs with a horizontal line show constant speed and with a raising or falling gradient show uniform acceleration and with a curved slope show changing acceleration.
- Draw graphs from data correctly.
- Identify independent variable (the one we change)
- Dependent variable (the one that changes because of this)
- Use constant acceleration due to gravity to determine final velocities or times of falls and to explain why the velocity of an object launched into the air changes over time. (often given as a negative value -10 m/s/s
- Use $a = \frac{v_f - v_i}{t}$ to find acceleration, time ($t = \frac{v_f - v_i}{a}$), final velocity ($v_f = v_i + at$), initial velocity ($v_i = v_f - at$)
- Use $s = v_i t + \frac{1}{2}at^2$ to find displacement, acceleration ($a = \frac{2(s - v_i t)}{t^2}$), initial velocity ($v_i = \frac{s - \frac{1}{2}at^2}{t}$) and time if $v_i = 0$ $t = \sqrt{\frac{2s}{a}}$
- Use $v_f^2 = v_i^2 + 2as$ to find final velocity, initial velocity $v_i^2 = v_f^2 - 2as$, acceleration $\frac{v_f^2 - v_i^2}{2s} = a$ or displacement $s = \frac{v_f^2 - v_i^2}{2a}$
- Know and use the SI units for displacement m, time s, velocity ms^{-1}, acceleration ms^{-2}
- Use scientific notation (e,g. 5.2×10^6 = 5200000) to express numbers and be able to use scientific notation comfortably on your calculator.
- Terminology for waves –amplitude – height or energy of the wave, frequency- how many waves per second (Hz), wavelength – distance between two equivalent points on a wave (m), crest (highest point of a wave), trough (lowest point of a wave).
- Wave theory $v = f\lambda$, $f = \frac{1}{T}$
- Longitudinal waves oscillate in the direction of propagation, Transverse waves oscillate at right angles to the direction of propagation.

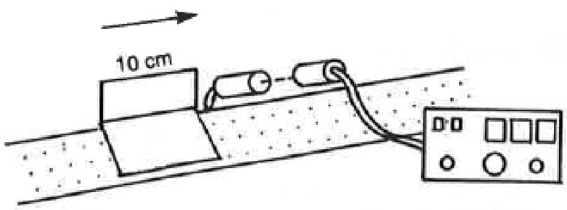
- That waves can be added by the process of superposition and through this process waves undergo constructive and destructive interference.
- That waves can reflect, refract as they change medium (because they change speed) and diffract through gaps (bend around corners if the gap is about the same size as the wavelength.)
- The Doppler effect which applies to sound waves and to light waves.
- Resonance – vibrating objects cause other objects to vibrate if their frequency matches the resonance frequency of the other object. Resonance can be used to determine the speed of sound or to amplify the sound of a small vibrating object (string). Resonating chambers are of a size and shape to support the frequencies made by the instrument. (practical report)
- Electromagnetic radiation can be described as travelling as transverse waves – it experiences reflection, refraction and diffraction (radio signals). There exists a very wide range of frequencies for EM radiation – we will use a small part, visible light, as an example of them all.
- To make coloured objects some colours are absorbed and some are reflected. (a red object reflects red light and absorbs blue and green. If all light is absorbed – black. Adding red, blue and green light gives white (Spectroscope and fluorescent lights). White light is made from colours – the spectrum of visible light (refraction through a prism).
- For reflection $\angle i = \angle r$ - remember the normal!
- Images in a mirror undergo lateral inversion and "exist" the same distance behind the mirror as the object is in front. The image is virtual.
- This knowledge can be made to create curved mirrors that produce real and magnified images.
- Rays parallel to the principal axis reflect through the focus, rays that pass through the focus reflect parallel to the principal axis. The distance between the mirror and the focus is the focal length. The focus is the point through which multiple parallel rays will converge.
- For refraction Snell's law $n = \frac{\sin i}{\sin r} = \frac{v_1}{v_2} = \frac{n_2}{n_1}$, This can be used with information about speeds of light in different mediums and the absolute refractive indexes of the mediums to make predictions about the path of light through a material
- This knowledge can be used to create curved lenses that can refract light to produce magnified real or virtual images.
- Rays parallel to the principal axis refract through the focus, rays passing through the optical centre do not refract, rays passing through the focus refract parallel to the principal axis.
- The focal length of a lens is the distance between the centre of the lens and the focal point
- EM waves are used in astronomy in a number of ways – Radio Waves to carry messages, Light to analyse spectra from distant objects to identify the material.
- Be able to state the differences between force, energy and power.
- Work $w = F \times d(\cos\theta)$,
- Derive potential gravitational energy $E = mgh$
- Derive kinetic energy $E = \frac{1}{2}mv^2$

- Write a flow chart to show energy conversions through a system.
- Power $P = \frac{E}{t}$, $P = \frac{\Delta w}{t}$, derive $P = Fv_{av}$
- Know the units Units of Joules, Watts, Newtons
- Understand that energy is conserved in systems and use this to determine the energy at different points in the motion of an object. Roller coasters.
- Understand that energy can be converted to a variety of different forms to do work.
- Explain that energy is lost during energy transfers (Primarily discuss heat and friction)
- Discuss various methods that can be used to store energy. (Based on your research)

Some practice Questions

An electronic timer is connected to a photoelectric gate and arranged over a linear air track. A glider of length 10 cm passes through the gate causing the timer to operate.

(a) If the timer measured 0.1 s for the glider to pass, what was the velocity for the glider?
(b) If the glider's velocity was 2 $m s^{-1}$, what time would the timer register?



A bus starts from rest at a bus terminal and accelerates at 1 $m s^{-2}$ for 10 s. It then continues with a constant velocity for 60 s before coming to rest at the first bus stop with a deceleration of 2.5 $m s^{-2}$.

(a) Graph
  (i) acceleration versus time for the bus
  (ii) velocity versus time for the bus
  (iii) change in position versus time for the bus
(b) From the graph compute the distance between the terminal and bus stop.
(c) Does the bus exceed the speed limit of 60 $km\,hr^{-1}$?
(d) How long does the bus take to reach the first stop and hence what is the average speed for the bus over the journey?

Draw sketch graphs to illustrate distance–time graphs for an object moving with

(i) constant velocity
(ii) constant acceleration.

A runner travels with a constant velocity of 5 $m s^{-1}$ for 30 s to the east, turns around and travels with a constant velocity of 3 $m s^{-1}$ to the west for 50 s.

(a) Calculate the total distance travelled by the runner.
(b) Calculate the total displacement of the runner.
(c) Find the average velocity and average speed for the runner.
Comment on your answer.

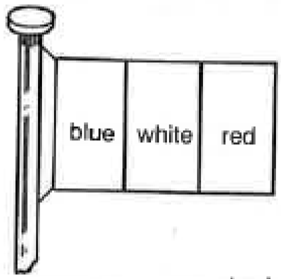
Derive the formula $s = vt - \frac{1}{2}at^2$.

34 A student on planet PHYS dropped an object in order to find the acceleration due to gravity. On this planet, time is measured in zos and distance in zees. The data obtained is

time (zo)	distance (zee)
0.0	0.0
0.5	0.4
1.0	1.6
1.5	3.6
2.0	6.4
2.5	10.0
3.0	14.4

(a) Calculate the acceleration due to gravity in zee zo^{-2}. (Draw an s vs t^2 graph.)
(b) A visitor from the Earth determines that 1 zo = 1.16 s and 1 zee = 4.11 m.
What is the acceleration on PHYS in $m\,s^{-2}$?
What can you say about PHYS?

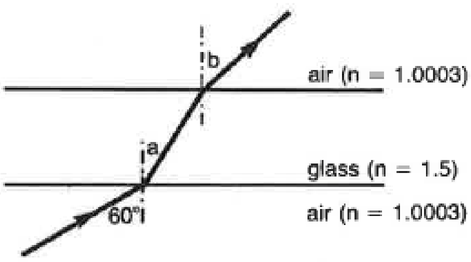
Draw a French flag and colour it as it would appear in
(a) sunlight
(b) red light
(c) yellow light
(d) blue light.



In each case find by accurate geometrical construction the size, position, magnification and nature of the image formed in a concave mirror.

	Object size	Object distance	Focal length
(a)	10 mm	25 mm	30 mm
(b)	15 mm	10 mm	20 mm
(c)	10 cm	30 cm	20 cm
(d)	50 cm	50 cm	40 cm
(e)	10 m	20 m	20 m
(f)	10 m	15 m	12 m

(a) A single ray of light is transmitted through a slab of glass as shown in the diagram. Calculate angles a and b.

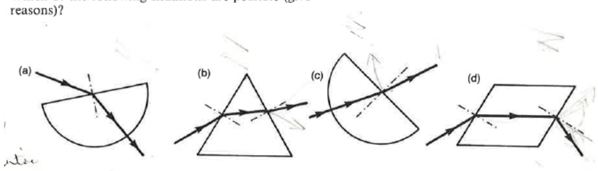


Given that light travels at 3.0×10^5 km s^{-1}, how long will it take light to travel
(a) from Adelaide to Darwin (distance 3000 km)?
(b) from Adelaide to London (distance 21 000 km)?
(c) from the Earth to Mars (distance 81 million km)?
(d) a distance of 6.0×10^5 km?
(e) a distance of 3.0×10^9 m?

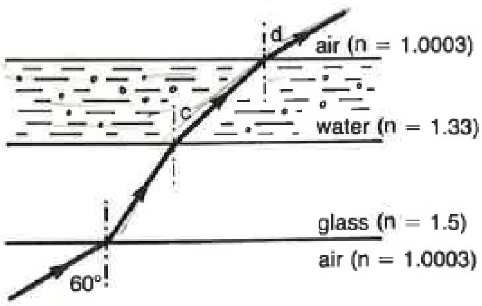
Sketch the object and image if the following letters are reflected in a plane mirror
(a) O
(b) X
(c) E
(d) S

A ray of light falls on a plane mirror and the reflected ray is observed. When the mirror is rotated through 5° the reflected ray is observed to rotate through 10°. Use diagrams to help explain this.

Which of the following situations are possible (give reasons)?



(b) A layer of water is now added as shown. Calculate the value of angles c and d.



Calculate the angle of incidence of a ray of light that enters a block of glass (n = 1.5) from air (n = 1.0003) and has the angle of refraction measured as 25°.

Draw a diagram of a convex lens and label on it the
(a) optical centre.
(b) principal axis.
(c) focal length.

Describe how you would experimentally find the focal length of a convex lens.

At a popular surfing beach, Physics Cove, 20 waves are observed to reach the coast in 2 minutes:
(a) Find the period of the waves.
(b) Find the frequency of the waves.
(c) Comment on whether you feel it would be a good day for surfing.

(a) A particular species of bat emits sound waves of frequency 10^5 Hz. What is the wavelength of these waves in air (v = 330 m s^{-1})
(b) Comment on the reasons for the size of the waves.

An organ pipe has a length *l*. Draw the standing wave patterns for the fundamental, first and second overtones if the pipe is
(a) open at both ends
(b) closed at one end.

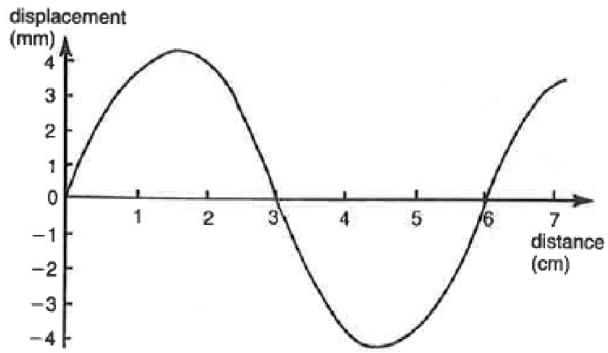
Waves in the deep region of a ripple tank have a velocity of 20 mm s^{-1} and a wavelength of 10 mm. They pass into a shallow region where their speed reduces to 15 mm s^{-1}. Find:
(a) the frequency of the water waves in the deep and shallow regions.

Water falls from a cliff and it is found to be 1°C hotter at the base of the cliff after its fall.
(a) List all the energy changes in this situation.
(b) Explain why the water has heated up.

In each case use accurate geometrical construction to find the
(a) size
(b) position
(c) nature
(d) magnification
of the image produced.

Lens type	Focal length	Distance of object from lens	Height of object
convex	25 cm	40 cm	1 cm
convex	25 cm	30 cm	1 cm
convex	25 cm	20 cm	1 cm
convex	10 mm	30 mm	20 mm
concave	10 mm	30 mm	20 mm
concave	25 cm	20 cm	1 cm

For the wave drawn below, find the following:
(a) The wavelength of the disturbance.
(b) The amplitude of the wave.
(c) Given the speed of the wave is 100 cm s^{-1}, find its frequency.
(d) What is its period?



The frequency of the whistle of a moving train is heard to be 720 Hz. When stationary, however, the whistle frequency is only 660 Hz. If the speed of sound in air is 330 m s^{-1}, find
(a) The speed of the moving train.
(b) The direction of movement of the train relative to the observer.
(c) Another frequency that the stationary listener could hear. How may this occur?

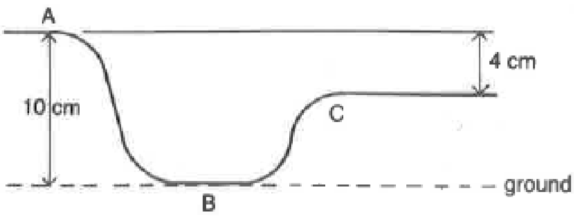
Define the terms
(a) node
(b) antinode
(c) superposition.

A 5000 kg truck travelling at 15 m s^{-1} slams into a cement wall, stopping in a distance of 6 m.
(a) What energy changes take place?
(b) What is the energy lost by the truck?
(c) What is the average force on the truck?

(a) A motor is to lift a 750 kg elevator from the ground to a height of 200 m. What is the work done by the motor?
(b) When the elevator is at this height, how much potential energy does it have?
(c) The cable holding the elevator now snaps and the elevator falls to the earth. What is the speed of the elevator after falling through a height of 100 m?
(d) The elevator crashes without bouncing. If it stops in a distance of 1.5 m, calculate the average force acting.
(e) What has happened to the initial energy supplied by the motor?

A motor lifts an elevator with mass 1000 kg through a height of 50 m in 15 s. What is the power of such a motor in W and kW?

Consider the toy roller coaster in the diagram. A 1.5 kg trolley leaves point A with an initial speed of zero and travels without friction to B and C.
(a) What is the total energy of the trolley at B and C?
(b) What is the speed of the trolley at B and C?



A pendulum is arranged to collide with another as shown. The 70 g mass falls through 10 cm. When it hits, it stops instantly. The second pendulum has a mass of 70 g also.
(a) What is the speed of the pendulum just before it collides?
(b) Assuming the collision is elastic, what is the
  (i) speed of the second pendulum?
  (ii) height the second pendulum will reach after impact?