Name: ....

Class Teacher: ....

Module P5: Space for Reflection

Revision Booklet for Examination 18th June 2010

P5a: Satellites, Gravity and Circular Motion

Learning objectives
Revision Technique 1: use the statements from the specification as a check list.
Use colour to traffic light them first to tell you what you need to revise the most.
Then tick them off once you are happy you have revised them properly.

Low Demand:	Standard Demand:	High Demand:
❑State and recognise that a satellite is an object that orbits a larger object in space. ❑State that gravitational force keeps a satellite in orbit. ❑State and recognise the difference between artificial and natural satellites.	❑Describe gravity as a universal force of attractions between masses. ❑Explain that the Moon remains in orbit around the Earth and the Earth in orbit around the Sun due to gravitational forces between them.	❑Describe the variation of gravitational force with distance. ❑Explain the variation in speed of a periodic comet during its orbit around the sun. ❑Explain that the orbit period of a planet depends upon its distance from the sun.

Low Demand:	Standard Demand:	High Demand:
❑Recognise that height above the Earth's surface affects the orbit of an artificial satellite. ❑State that height of orbit of an artificial satellite determines it's use.	❑Describe that a geostationary artificial satellite orbits the Earth once every 24 hours around the equator. ❑State that a geostationary artificial satellite remains in a fixed position above the Earth's surface. ❑Describe that the orbital period of an artificial satellite increases with height above the Earth's surface. ❑Know that circular motion requires a centripetal force and that gravity provides the centripetal force for orbital motion.	❑Explain that artificial satellites in lower orbits travel faster because the gravitational force is stronger. ❑Explain the variation in the speed of a periodic comet during it's orbit around the sun. ❑Explain that the orbit period of a planet depends upon its distance from the sun.

Low Demand:	Standard Demand:	High Demand:
❑State and recognise some of the applications of artificial satellites as: ★ Comminucations ★ Weather forecasting ★ Military uses ★ Scientific Research ★ GPS	❑Describe how satellites in low polar orbits can be used for ★ weather forecasting; ★imaging the Earth's surface. ❑Describe how satellites in high geostationary orbit are used for: ★ communications; ★ weather forecasting.	❑Explain why: ★ Low polar orbit satellites orbit in a few hours; ★ Geostationary satellites orbit more slowly with a period of 24 hours.

Revision technique 2: Drawing mind maps or spider diagrams to help collate your revision notes, or complete these boxes with notes/diagrams.

Revision technique 3: Ensure you know the meaning of the key words:

Key Word	Meaning
satellite	
orbit	
natural satellite	
artificial satellite	
gravitational force	
geostationary	
comet	
polar orbit	
centripetal force	

Revision technique 4: Answer these questions on the topic of satellites gravity and circular motion

Question 1:

Delete the incorrect words...

(a) A geostationary satellite is in a **high/low** orbit over the Earth's **equators/poles**. This occurs **many times/ once** per day.

(b)A polar satellite is in a **high/low** orbit over the Earth's **equators/poles**. This occurs **many times/once** per day.

(c)Give a use for a geostationary satellite: ....

(d)Give two uses for polar orbit satellite. ....

....

Question 2:

Complete the paragraph below using some the following words:

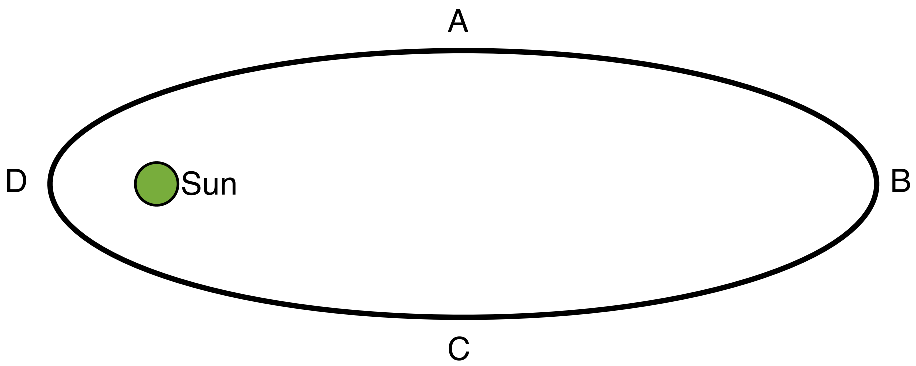
orbit, energy, galaxy, nearer, gravity, distance,

A planet moving past a star has it's path pulled into a curve by the star's .... If the planet is moving at just the right speed its path will back on itself and form an .... To stay in orbit at a particular .... , a planet must move at a particular speed.

Question 3:

Out of the points A- D where, on it's orbit, is the comet traveling:

i) the most slowly? .... ii) the most quickly? ....



iii) Why is there a difference?

....

....

P5b: Vectors and Equations of Motion

Learning objectives
Use the statements from the specification as a check list. use colour to traffic light them and tick them off once you are happy you have revised them properly.

Low Demand	Standard Demand	High Demand
❏ Recognise that direction is important when describing the motion of an object. ❏ State and recognise that for two cars traveling along a straight road: ★ their relative speed is lower if that are moving in the same direction; ★ their relative speeds are higher if they are moving in opposite directions.	❏ Know the difference between a vector and a scalar quantities in that for some quantities (e.g. force); direction is important whereas for other quantities (e.g. mass), direction is not important. ❏ Calculate the vector sum from vector diagrams parallel vectors (limited to force and velocity).	❏ Calculate the resultant of two vectors by adding vectors that occur in parallel or at right angles to each other.

Low Demand	Standard Demand	High Demand
❏ State and recognise that: ★ speed is a measure of how fast an object is moving; ★ direction is not important when measuring speed ❏ Recognise that for any journey: ★ speed can change during the journey; ★ average speed can be calculated.	❏ Use the equations: ★ $v = u + at$ ★ $s = (u+v)t / 2$ Change of subject not required.	❏ Use the equations: ★ $v^2 = u^2 + 2as$ ★ $s = ut + 1/2\ at^2$ To include a change of subject.

Definitions: What do the letters used in the equations of motion stand for?

Symbol	Description	Unit
s		
u		
v		
a		
t		

What is the difference between a scalar and a vector?

Complete the Question as Exam Practice:

Question 1:

Michael Johnson won the 200m at the 1996 Olympic Games in a new World record time of 19.32s.

(a) Write down the equation you could use to work out his average speed in the race. [1]

(b) Calculate his average speed.

[3]

(c) He reached a velocity of 7.5 m/s 2 seconds after the start of the race.
How far had he run in the first 2s? (You may assume he accelerates at a constant rate.)

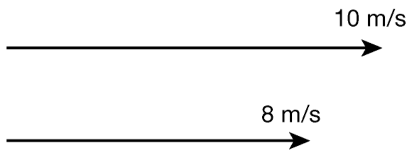
[3]

(d) What was his average acceleration 2s after the start of the race?

[3]

Calculate the combinations of these vectors:

(a)



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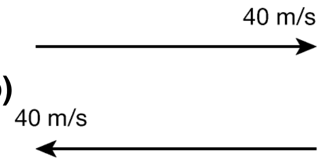

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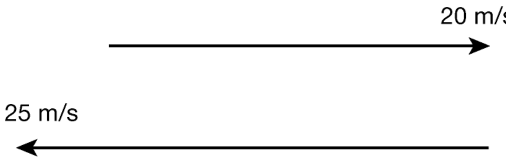

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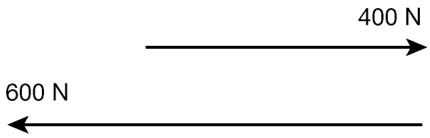

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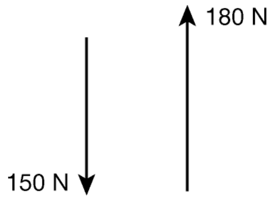

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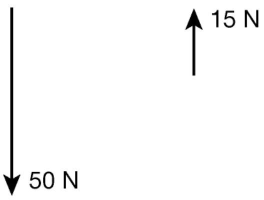

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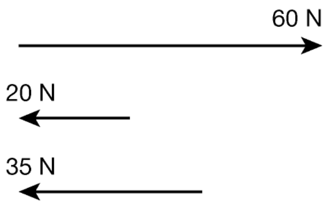
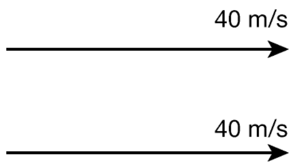
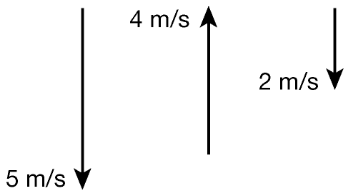


(i)



(j)



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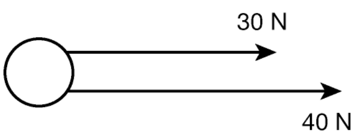

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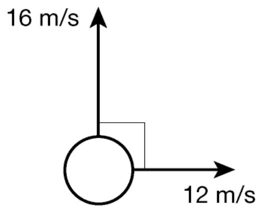
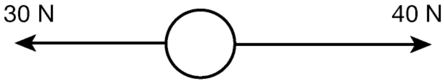
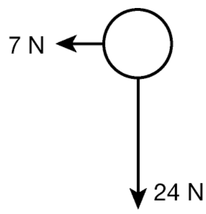


(m)



(n)



(Take the acceleration due to gravity as 10 m/s^2.)

1 A car starts to move and accelerates at 4 m/s^2 for 8 seconds. How fast is it moving then?

How far does it travel in this time?

2 A train accelerates from 10 m/s to 40 m/s in 2 minutes. How far does it travel while accelerating?

3 A stone is dropped down a deep well and takes 2 seconds to reach the bottom. How fast is it moving when it reaches the bottom of the well?

How deep is the well?

4 A stone falls from the top of a 125-m high cliff. How long does it take to reach the sea?

5 A sprinter starts from rest and reaches a speed of 10 m/s after travelling 40 m. Calculate her acceleration, assuming that it is constant.

6 A bullet is fired vertically upwards with a speed of 60 m/s. How high does it rise?

How long does it take to reach this height?

P5c Projectile Motion

Learning objectives
Use the statements from the specification as a check list. Use colour to traffic light them and tick them off once you are happy you have revised them properly.

Low Demand
❏State and recognise that the path of an object projected horizontally in the Earth's gravitational field is curved. ❏ State, recognise and desribe the trajectory of an object projected in the Earth's gravitational field as parabolic. ❏ State that the path of a projectile is called the trajectory.

Low Demand	Standard Demand	High Demand
❏ Describe and recognise that missiles and cannon balls when fired in the air are projectiles. ❏ State and recognise that golf balls, footballs, netballs darts and long jumpers moving through the air are further examples of projectile motion. ❏ Recognise everyday examples of projectiles.	❏ Explain that an object projected horizontally in the Earth's gravitational field, ignoring air resistance: ★ has constant horizontal velocity ★ is accelerating towards the ground so has steadily increasing vertical velocity.	❏ Use the equations of motion for an object projected horizontally above the Earth's surface where the gravitational field is still uniform.

Standard Demand	High Demand
❏ Explain that, ignoring air resistance the only force acting on a ball during flight is gravity. ❏ Explain that projectiles have a downward acceleration and that this only affects the vertical velocity.	❏ Explain that the horizontal and vertical velocities of a projectile are vectors. ❏ Explain that the resultant velocity of a projectile is the vector sum of the horizontal and vertical velocities. ❏ Explain that for a projectile there is no acceleration ion the horizontal direction.

1 A ball is pushed off the end of a laboratory bench 0.8 m high.

How long does it take to reach the floor?

If the ball hits the floor 2.0 m from the bench, calculate the speed at which it left the bench.

2 An aeroplane flying horizontally at a speed of 150 m/s at a height of 500 m drops emergency supplies to a remote village cut off by an earthquake.

How long does the package take to reach the ground?

How far from the village must the pilot release the package if it is to hit its planned landing site?

3 A bullet is fired horizontally at a target 100 m away at a speed of 200 m/s.
How far has the bullet fallen when it hits the target?

Take the acceleration due to gravity as 10 m/s^2.

4 Tim threw a ball horizontally from the top of a tower 45 m high with a velocity of 30 m/s.

How long did it take to reach the ground?

What was its vertical velocity when it hit the ground?

What was its horizontal velocity when it hit the ground?

What was its resultant velocity when it hit the ground?
(Remember to give its size and direction.)

How far did it land from the bottom of the tower?

5 Tim threw another ball with a horizontal velocity of 15 m/s. What would the answers to question **4** be now?

P5d Momentum

Learning Objectives:

Low Demand	Standard Demand
☐ Describe and recognise that every action has an equal and opposite reaction.	☐ Describe the opposite reactions in a number of static including examples involving gravity.

Low Demand	Standard Demand	High Demand
☐ Describe and recognise the opposite reactions in a simple collision. (ie velocities parallel).	☐ Describe that the greater the mass of an object and/or the greater velocity, the more momentum the object has in that direction. ☐ Use the equation: momentum = mass x velocity to calculate momentum.	☐ Explain that when an object collides with another object, the two objects exert an equal and opposite force on each other. ☐ Use the equation: $\text{force} = \frac{\text{change in momentum}}{\text{time}}$ to calculate: ★force; ★change in momentum; ★time taken.

Low Demand	Standard Demand	High Demand
☐ Describe that a ball struck by an object in sport (e.g. cricket ball and bat) is an example of a collision. ☐ Recognise everyday examples of collisions.	☐ Describe that injuries in vehicle collision and many sporting injuries are due to a very rapid acceleration of parts of the body. ☐ Explain, using the ideas about momentum, the use of: ★ crumple zones; ★ seatbelts; ★ airbags in cars.	☐ Explain that spreading the change in momentum over a longer time: ★ reduces the forces required to act; ★ reduces the injury.

High Demand
☐ Explain that momentum is a property that is always conserved and use that to explain: ★ explosions; ★ recoil; ★ rocket propulsion ☐ Interpret the principle of conservation of momentum to collisions of two objects moving in the same direction (including calculations of mass, speed or momentum).

1 Calculate the momentum of a toy train of mass 1.5 kg travelling at 0.2 m/s due west.

2 Which has greater momentum – a car of mass 1000 kg travelling at 32 m/s or a van of mass 1800 kg travelling at 20 m/s?

3 What is the momentum of a boy of mass 60 kg running on a circular track at a steady speed of 12 m/s when he is running due north?

What is his momentum when he is travelling at the same speed due east?

4 Calculate the momentum of a bullet of mass 15 g travelling north at 200 m/s.

5 What is the momentum of an oil tanker of mass 250 tonnes (250 000 kilograms) which is
moving west at a speed of 20 m/s?

Conservation of Momentum

1 A dynamics trolley of mass 1.5 kg is travelling at 8 m/s towards a stationary trolley of mass 2.5 kg. After colliding, the trolleys stick together. What is their common velocity?

2 Greg hits a golf ball with a force of 4000 N. He keeps his club in contact with the ball for 0.005 seconds. How much momentum does the golf ball gain?

3 A model train of mass 3 kg moving at 5 m/s collides with a wagon of mass 7 kg moving at 1 m/s in the same direction. The two join together on impact. What is their common speed?

4 A snooker player hits a stationary ball of mass 0.20 kg with a force of 50 N. It leaves the cue with
a velocity of 0.40 m/s. For how long did the force act on the ball?

5 An air rifle fires a pellet of mass 0.004 kg at a speed of 100 m/s.

Explain why the air rifle moves backwards.

Calculate the momentum of the pellet.

Write down the momentum of the rifle.

If the mass of the rifle is 2 kg, find its recoil velocity.

1 A car travelling at 20 m/s collides with a wall and is brought to rest in 0.5 seconds.
The mass of the car and occupants is 1000 kg.

Calculate the average force on the car during the collision.

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What is the average force on the wall during the collision?

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2 A horizontal force of 60 N acts on a stationary snooker ball of mass 0.2 kg. The cue is in contact with the ball for 8 milliseconds (0.008 seconds). Calculate the speed of the ball after impact.

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3 A rock of weight 30 N falls vertically downwards off a cliff for 5 seconds. How much momentum does it gain?

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4 For how long must a force of 60 N act on a box of mass 200 kg to increase its velocity from
2 m/s to 5 m/s?

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5 Calculate the average force a golf club must apply to a golf ball if the ball leaves the club at a
speed of 80 m/s and the club is in contact with the ball for 0.5 milliseconds (0.0005 seconds).
The mass of the golf ball is 50 g.

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P5e Satellite Communication

Learning Objectives:

Low Demand	Medium Demand	High Demand
❑Describe that some frequencies of radio waves: ★ pass through the Earth's atmosphere; ★ are stopped by the Earth's atmosphere. ❑Recognise that different frequencies are used for low orbit satellites and geostationary satellites.	❑Describe how information can be transmitted using microwaves to orbiting artificial satellites and then retransmitted back to Earth.	❑Explain that microwaves are sent as a thin beam because they only diffract by a small amount due to their short wavelength.

Low Demand	Medium Demand	High Demand
❑Describe and recognise that the radio waves are reflected by part of the Earth's upper atmosphere. ❑Recognise that radio waves can spread around large objects. ❑Describe a practical example of waves spreading through a gap.	❑ Describe that radio frequencies below 30MHz are reflected by the ionosphere. ❑Describe that above 30GHz rain, dust and other atmospheric effect reduce the strength of the signal due to absorption and scattering. ❑Recall the wave patterns produced by a plane wave passing through different sized gaps.	❑Explain reflection of waves (frequency less than 30MHz) are reflected by he ionosphere. ❑Describe how the amount of diffraction depends upon the size of the wave. ❑State that maximum diffraction occurs when the wavelength equals the size of the gap.

Low Demand	Medium Demand	High Demand
❑Describe and recognise that radio waves have a very long wavelength. ❑Describe and recognise that for reception of radio and TV programs: ★an aerial is needed for radio signals; ★a 'dish' is needed for satellite TV signals.	❑Describe that radio waves are really diffracted so are more suitable for broadcasting. ❑Describe that long wave radio have a very long range because they diffract around hills and over the horizon.	❑Explain how long wavelength radio waves are diffracted around hills and over the horizon. ❑Describe how longwave radio waves carry signals by amplitude modulation. (AM)

Use the space below to draw diagrams and make notes on the topic:

Draw a diagram to show how waves are beamed from the Earth to satellites and back down again.
Draw a diagram to show how radio waves can be transmitted by reflection from the ionosphere.
Draw diagrams of diffraction, showing how the size of the gap and the size of the wave affects the spreading.
Draw diagrams to show radio waves being diffracted over hills, where short-wave radio waves can't be.
Higher: explain how amplitude modulation works

P5f Nature of Waves

Learning Objectives:

Low Demand	Medium Demand	High Demand
❏Describe and recognise that interference is an effect resulting from two waves that overlap. ❏Recognise that when waves overlap there are: ★ areas where the waves add together ★ other areas where the waves subtract from each other. ❏Describe that interference of two waves results in a pattern of reinforcement and cancellation of the waves.	❏Describe a demonstration of interference effects using either sound waves, surface water waves or microwaves. ❏Describe the interference of two waves in terms of reinforcement and cancellation of the waves.	❏Describe and explain interference patterns in terms of constructive and destructive interference. ❏Explain that the number of half wavelengths in the path difference for two waves from the same source is ★an odd number for destructive interference; ★an even number for constructive interference.

Low Demand	Medium Demand	High Demand
❏Recall that light travels in straight lines. ❏Recognise that under certain circumstances light can "bend"	❏Explain that the diffraction of light and its associated interference patterns are evidence for the wave nature of light. ❏Describe that electromagnetic waves are transverse waves and can therefore be plane polarised.	❏Describe and explain a diffraction pattern for light. ❏Explain how polarisation is used in the application of Polaroid sun glasses.

Draw a diagram to explain what Polarisation is and how waves can become plane polarised.

Use this section to write about the circumstances that cause interference and explain what it is.

Speed of radio waves = 300 000 000 m/s (3×10^8 m/s)

1 Radio waves are to be transmitted between two Earth stations, A and B.

Station A is able to transmit and receive signals of the following frequencies:

- 300 kHz (3×10^5 Hz)
- 3 MHz (3×10^6 Hz)
- 30 MHz (3×10^7 Hz)
- 300 MHz (3×10^8 Hz)

State, with reasons, the frequency that would be most suitable for communication by satellite.

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The satellite is 36 000 km above the Earth. Calculate the minimum time for signals to pass from A to B via satellite.

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Calculate the wavelength of the waves you have selected.

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2 Chiltern and Three Counties Radio are both based in the Luton area. Why do the two stations not interfere with each other?

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P5g Refraction of Waves

Learning Objectives:

Low Demand	Medium Demand	High Demand
❑Describe a substance that light passes though as being a medium. ❑Describe and recognise that refraction involves a change in direction of a wave due to the wave passing from one medium to another. ❑State and recognise that for a ray of light traveling from air into glass the angle of incidence is usually greater than the angle of refraction.	❑Describe that refraction occurs at the boundary of two mediums due to a change in the wave speed. ❑Describe that when the waves speed decreases the wave bends towards the normal and vice versa. ❑Describe that refractive index is limited to the amount of bending after a boundary.	❑Explain that a change in speed causes a change in wavelength and may cause a change in direction. ❑Calculate refractive index using the equation: ★refractive index = speed of light in a vacuum ÷ speed of light in the medium

Low Demand	Medium Demand	High Demand
❑Describe and recognise that dispersion happens when light is refracted. ❑State that blue light is deviated more than red light.	❑Recall that the amount of bending increases with greater change of wave speed and refractive index. ❑Explain dispersion in terms of spectral colours having different waves speeds. ❑State the order of the spectral colours.	❑Use and manipulate Snells law in terms of angle of incidence and refraction: ★$n = \sin i \div \sin r$ ❑Explain dispersion in terms of refractive indices.

Low Demand	Medium Demand	High Demand
❑Describe and recognise that some, or all, of alight ray can be reflected when travelling from glass or water into air.	❑Describe what happens to the light inceide on a glass/air surface when the angle of incidence is less than, equal to or above the critical angle. ❑Recognise that different media have different critical angles.	❑Explain that the total internal reflection can only occur when a ray of light travels from a medium with higher refractive index into a medium with a lower refractive index, and the angle of incidence is greater than the critical angle. ❑Calculate the critcal angle from the refractive index susing the equation: ★$\sin c = n_r \div n_i$ ❑Explain that the higher the refractive index of a medium the lower is its critical angle.

Draw a diagram to show refraction through a glass block.

Draw a diagram to show total internal reflection.

Under what conditions does total internal reflection occur?

Look at the following table of the speed of light in different materials.

substance	refractive index	speed of light (m/s)
air	1	300 000 000
water	1.33	225 000 000
perspex	1.5	200 000 000
glass	1.5	200 000 000
diamond	2.4	120 000 000

1. Which substance refracts light the most?
2. Which substance refracts light the least?
3. If light travels from perspex to water will light bend towards or away from the normal?

Complete the following sentences:

(a) A ray of light travelling from air into glass is .... or bent .... the normal. A ray of light travelling from water to air is .... or bent .... the normal.

(b)The speed of light in water is .... than the speed of light in air.

(c) A swimming pool looks .... than it really is, because light from the bottom is refracted .... the normal on passing into air.

(d) Total internal reflection takes place in a glass prism if the angle of incidence in the .... is .... than the .... angle.

P5h Optics

Learning Objectives:

Low Demand	Medium Demand	High Demand
❑Recognise the shape of a convex lens. ❑State that convex lenses are also called converging lenses. ❑Describe that light incident on a convex lens parallel to the axis passes through the focal point after passing through the lens. ❑Describe the focal length of a convex lens as being measured from the centre of the lens to a focal point (focus). ❑State and recognise that "fat" lenses have short focal lengths.	❑Describe the effect of a convex lens on: ★ a diverging beam of light; ★a parallel beam of light.	

Low Demand	Medium Demand	High Demand
❑Recognise and state that projectors and cameras produce real images on a screen.	❑Describe how a camera or projector produces a real image on film and screen respectively.	❑Explain how to find the position and size of the real image formed by a convex lens by drawing suitable ray diagrams.

Low Demand	Medium Demand	High Demand
❑State that convex lenses are used: ★as a magnifying glass; ★in cameras; ★in projectors.	❑Describe the use of a convex lens: ★as a magnifying glass; ★in a camera; ★in a projector. ❑Explain how the images produces by cameras and projectors are focused.	❑Describe that real images can be projected on to a screen and are inverted. ❑Explain that virtual images cannot be projected onto a screen but are the right way up. ❑Use the formula for magnification: ★magnification = image size ÷ object size.

Complete the diagrams: