Unit G484: *The Newtonian World*

Define	
linear momentum (and appreciate the vector nature of momentum)	as the product of mass and velocity
net force on a body	as equal to rate of change of its momentum; Force changes the momentum of / accelerates / decelerates the object.
impulse of a force	Area under a force/time graph. Force x time for which the force acts / duration of collision
a *perfectly elastic collision*	A collision with no change/loss of kinetic energy. Kinetic energy is conserved,
an *inelastic collision*	Total energy is conserved though some loss of kinetic energy (during collision). The magnitude of the impulse on each object is the same.
the *radian*	The angle where the arc of a circle equals the radius.
gravitational field strength (g)	Force per unit mass (at a point in a gravitational field)
the *period* of an object describing a circle	The time taken for the object to describe a complete circle/orbit
geostationary orbit of a satellite	Equatorial orbit Same period as Earth (fixed point above the Earth's surface)
displacement	Is the distance of a body from the equilibrium position and is directed in the opposite direction to the displacement (equilibrium when the resultant force is zero)
amplitude	Is the maximum displacement
period	Time taken to compete one oscillation/cycle
frequency	Number of oscillations/cycles per unit time
angular frequency	Product of 2π x frequency or 2π/period
phase difference	The angle, in radians between subsequent wave peaks.
simple harmonic motion	Acceleration is (directly) proportional to displacement (from the equilibrium position) and is always acting towards the equilibrium position.
pressure	Of a gas: Collisions with surface of large numbers of particles travelling randomly exerts a force (or each collision has a change of momentum) Pressure = Force / Area
internal energy	The sum of the randomly (distributed) kinetic and potential energies associated with the molecules/atoms of a system
specific heat capacity	Energy required to raise the temperature of a unit mass of a substance by unit temperature rise
The newton	The force which gives a mass of 1kg an acceleration of 1 ms^{-2}
Kilowatt-hour	1kWh is the energy used/provided by a 1 kW device in 1 hour
Resonance	Where the driving frequency equals the natural frequency
Non-geostationary satellite	Weather/Spying/Surveying/Mapping (Ignore communication/TV/radio)

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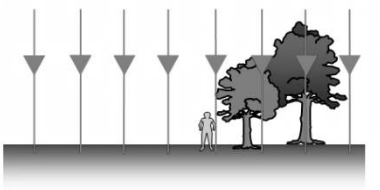
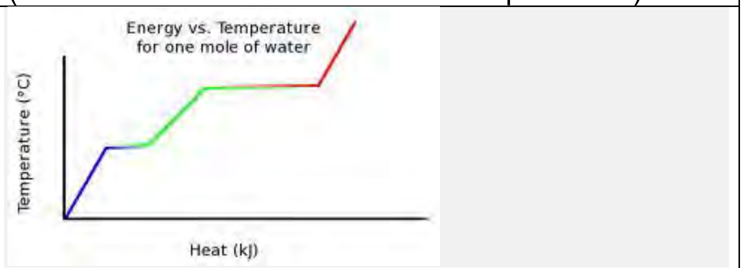
State	
The uses of geostationary satellites	Communication/Weather
Newton's three laws of motion	1st: A body will remain at rest or continue to move with constant velocity unless acted upon by a force 2nd: Force is proportional to rate of change of momentum and takes place in the direction of that force 3rd: When one body exerts a force upon another, the other body exerts and equal bot opposite force on the first body
the principle of conservation of momentum	(linear momentum) Total momentum is conserved. For a closed system / no external forces
Newton's law of gravitation	Force between two (point) masses is proportional to the product of masses and inversely proportional to the square of the distance between them.
Boyle's law	Pressure is inversely proportional to volume for a fixed mass of gas at a constant temperature
That absolute zero is the temperature at which a substance has minimum internal energy.	
the basic assumptions of the kinetic theory of gases;	• Volume of particles negligible compared to volume of container OR molecules much smaller than distance between them. • No intermolecular forces (except during collision) OR molecules only have kinetic energy. • Elastic collisions • Particles travel at a constant, rapid velocity (in straight lines) between collisions OR effect of gravity is small • Time of collision is much smaller than time between collision. • Gas consists of a large number of molecules moving randomly
That one mole of any substance contains 6.02×10^{23} particles and that 6.02×10^{23} mol^{-1} is the Avogadro constant N_A	
State Kepler's Law	Not in syllabus but in Jan 2012 paper! The cube of the planets distance (from the Sun) divided by the square of the (orbital) period is the same (for all planets)

Unit G484: *The Newtonian World*

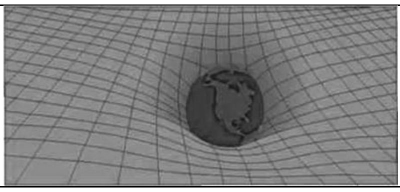
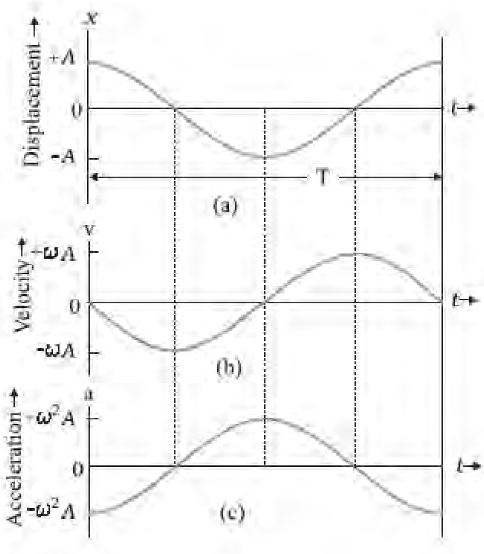
Explain	
that *F* = *ma* is a special case of Newton's Second Law	When the mass is constant, the rate of change of momentum (mass x velocity / time) can be expressed as mass x acceleration.
using the kinetic model explain the pressure exerted by gases	See 'pressure' definition earlier
That whilst the momentum of a system is always conserved in the interaction between bodies, some change in kinetic energy usually occurs.	Changes in kinetic energy occur because not all collisions are perfectly elastic, some energy is lost in deformation, thermal changes etc
that a force perpendicular to the velocity of an object will make the object describe a circular path;	(Resultant) force acts perpendicular to velocity (towards the centre)
what is meant by centripetal acceleration and centripetal force;	Velocity or direction is always changing Acceleration is in the direction of the force OR towards the centre/perpendicular to velocity
that close to the Earth's surface the gravitational field strength is uniform and approximately equal to the acceleration of free fall;	 www.tap.iop.org Field lines are parallel to each other. Field lines are evenly/uniformly/constantly spaced Field line are perpendicular/vertical/right angles (to surface of earth)
that the period of an object with simple harmonic motion is independent of its amplitude;	$T = 2\pi\sqrt{m/k}$
that the rise in temperature of a body leads to an increase in its internal energy;	The total internal energy of a substance is the kinetic energy and the potential energy. Only kinetic energy contributes to temperature.
that a change of state for a substance leads to changes in its internal energy but not its temperature;	Internal energy of a solid when it melts increases. Potential energy increase and the kinetic energy remain constant. (Also see latent heats of fusion and vaporisation)
that thermal energy is transferred from a region of higher temperature to a region of lower temperature;	 http://en.wikibooks.org/wiki/General_Chemistry/Phase_Changes
that regions of equal temperature are in thermal equilibrium;	No net heat flow between objects
that the mean translational kinetic energy of an atom of an ideal gas is directly proportional to the temperature of the gas in kelvin;	$E = 3/2kT$ $KE = 1/2mv^2$ $3/2kT = 1/2mv^2$ (3/2k is a constant) T is proportional to KE

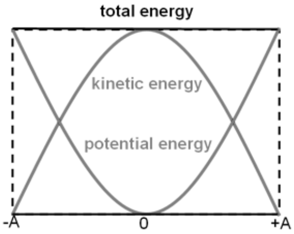
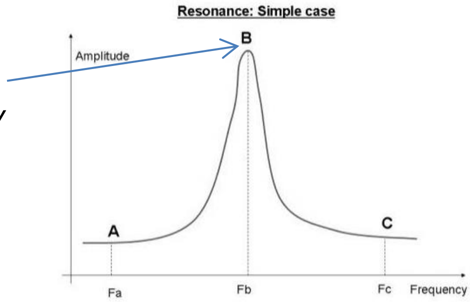
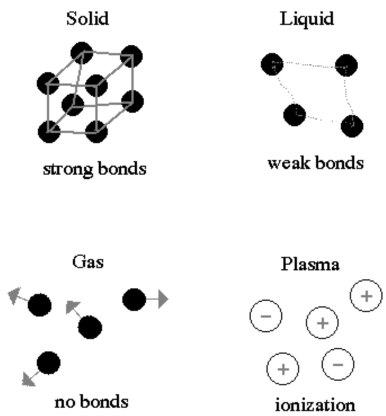
Unit G484: *The Newtonian World*

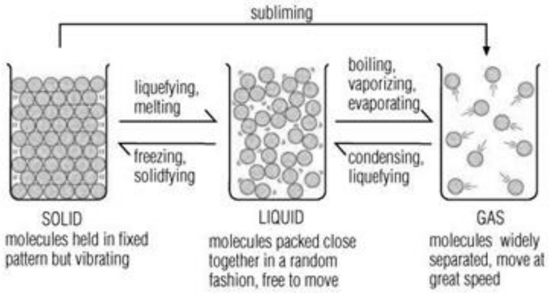
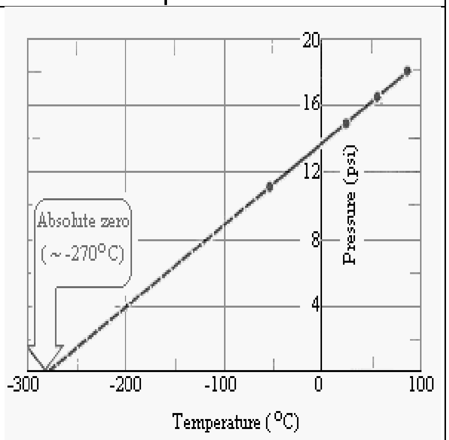
Recall
that the area under a force against time graph is equal to impulse;
the equation: impulse = change in momentum.
n= number of moles N = number of atoms/molecules

Use	
gravitational field lines to represent a gravitational field;	 www.tap.iop.org

Derive	
the equation $T^2=\{4\pi^2/GM\}\, r^3$ from first principles;	$F = GMm/r^2 = mv^2/r$ ($v^2 = GM/r$) $T = 2\pi r/v$ hence $T^2 = 4\pi^2r^2/v^2$ Substitute for v^2: $T^2 = 4\pi^2r^2r/GM$ etc

Describe	
how a mass creates a gravitational field in the space around it;	 $F = GM/r^2$
simple examples of free oscillations;	Pendulum, mass on a spring
Describe, with graphical illustrations, the changes in displacement, velocity and acceleration during simple harmonic motion;	 http://physicspractice.blogspot.com

the interchange between kinetic and potential energy during simple harmonic motion;	 tap.iop.org Remember potential energy may include both gravitational and elastic potential energy.
the effects of damping on an oscillatory system;	Damping an effect that reduces the amplitude of oscillations
practical examples of forced oscillations and resonance;	Where a force is continually applied resulting in resonance. For example Barton's pendulums or a wine glass.
graphically how the amplitude of a forced oscillation changes with frequency near to the natural frequency of the system;	*Natural/ resonant frequency*  Description Resonance occurs when the driving frequency matches natural/resonant frequency. The amplitude of vibrations/energy is then a maximum.
Examples where resonance is useful and other examples where resonance should be avoided.	Useful: microwaves cause water molecules to vibrate. Woodwind reed/lips cause air column to resonate. MRI radio waves cause nuclei to vibrate Problem: walking in step on a bridge. Engine vibrations causing car to shake. Earthquake ground vibrations causing buildings to collapse, poorly designed washing machine. Note: Explain that this occurs at a specific frequency
solids, liquids and gases in terms of the spacing, ordering and motion of atoms or molecules;	 Motion of atoms within a solid: Vibrate

a simple kinetic model for solids, liquids and gases;	See previous
an experiment that demonstrates Brownian motion and discuss the evidence for the movement of molecules provided by such an experiment;	Movement of smoke particles caused by being hit by randomly moving, different speed, air molecules Smoke particles are constantly moving because the air particles are continuously moving Smoke particles are visible but air molecules aren't hence air molecules must be very small Small movement of smoke particles is due to the large numbers of air molecules hitting from all sides
Describe, using a simple kinetic model for matter, the terms melting, boiling and evaporation.	 http://www.talktalk.co.uk Greater amplitude/ greater frequency in atoms at increase in temperature.
how there is an absolute scale of temperature that does not depend on the property of any particular substance (ie the thermodynamic scale and the concept of absolute zero);	http://nothingnerdy.wikispaces.com 
an electrical experiment to determine the specific heat capacity of a solid or a liquid;	Must show liquid in vessel with electrical heater with thermometer, ammeter and voltmeter Measure mass of liquid, temperature change, values of I, V & t. Rearrange $E=mc\Delta\theta$ Identify uncertainties Note 'specific' means 'per unit mass'. **Comparing experiment with insulation and without insulation:** Without insulation there would be more heat lost to the air. The specific heat capacity will be higher without insulation because more energy would be required to rise it to the final temperature.

what is meant by the terms *latent heat of fusion* and *latent heat of vaporisation*.	**Latent Heat of Fusion:** Thermal energy required to change (a substance) from solid into a liquid (at constant temperature). **Latent Heat of vaporisation:** Thermal energy required to change (a substance) from liquid into a gas / vapour (at constant temperature)