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At the end of section **1.1 Motion – Equations and Graphs** you should be able to :

❑ 1 state that acceleration is the change in velocity per unit time.

❑ 2 describe the principles of a method for measuring acceleration.

❑ 3 use the terms ‘constant velocity’ and ‘constant acceleration’ to describe motion represented in graphical or tabular form.

❑ 4 draw and interpret velocity–time graphs.

❑ 5 draw and interpret acceleration–time graphs using information obtained from a velocity–time graph for motion with a constant acceleration.

❑ 6 draw and interpret displacement–time graphs using information obtained from a velocity–time graph for motion with a constant acceleration.

❑ 7 interpret motion-time graphs for bouncing objects and objects thrown vertically.

❑ 8 show how the following relationships - the equations of motion - can be derived from basic definitions in kinematics:

$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$
$$v^2 = u^2 + 2as$$

❑ 9 carry out calculations using the above kinematic relationships.

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At the end of section **1.2 Forces, Energy and Power** you should be able to :

❑ 1 explain the motion of an object by using Newton's laws.

❑ 2 define the newton.

❑ 3 carry out calculations involving the relationship between unbalanced force (F), mass (m) and acceleration (a) in situations where resolution of forces is not required.

$$F = ma$$

❑ 4 use free body diagrams to analyse the forces acting upon an object in one dimension.

❑ 5 explain terminal velocity.

❑ 6 identify on a velocity-time graph of a falling object when the forces are balanced or unbalanced.

❑ 7 identify and calculate forces acting at an angle to the direction of motion, and interpret the resultant motion.

❑ 8 resolve a force into two perpendicular components.

❑ 9 resolve the weight of an object on a slope into a component acting down the slope and a component acting normal to the slope.

❑ 10 use the principle of conservation of energy and appropriate relationships to solve problems involving work done, potential energy, kinetic energy and power.

$$E_w = Fd$$
$$E_p = mgh$$
$$E_k = \frac{1}{2}mv^2$$
$$P = \frac{E}{t}$$

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At the end of section **1.3 Collisions, Explosions and Impulse** you should be able to :

- ❑ 1 define the momentum (p) of an object as a vector quantity that is the product of the mass (m) and velocity (v) of the object.

$$p = mv$$

- ❑ 2 define the law of conservation of linear momentum as the total momentum before a collision is equal to the total momentum after a collision in the absence of net external forces.
- ❑ 3 state that the law of conservation of linear momentum can be applied to the interaction of two objects moving in one dimension.
- ❑ 3 define an elastic collision as one in which both momentum and kinetic energy are conserved.
- ❑ 4 define an inelastic collision as one in which momentum is conserved but kinetic energy is lost.
- ❑ 5 carry out calculations concerned with collisions in which the objects move in only one dimension.
- ❑ 6 carry out calculations concerned with explosions in one dimension.
- ❑ 7 apply the law of conservation of momentum to the interaction of two objects moving in one dimension to show that:
  (a) the changes in momentum of each object are equal in size and opposite in direction.
  (b) the forces acting on each object are equal in size and opposite in direction.
- ❑ 8 define impulse acting upon an object as a vector quantity that is the product of the force acting upon the object and the time of interaction.
- ❑ 9 define impulse as the change in momentum of an object.
- ❑ 10 carry out calculations involving the relationships between impulse, force, time and momentum.

$$Ft = mv - mu$$

- ❑ 11 explain that the force acting during an interaction is not constant.
- ❑ 12 explain the effects of changing the interaction time between objects on the force acting during the interaction.
- ❑ 13 find the impulse from the area under a force-time graph.

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At the end of section **1.4 Gravitation** you should be able to :

- ☐ 1 describe the principles of a method for measuring the acceleration of a falling object.
- ☐ 2 describe projectiles as objects in free-fall with a constant horizontal velocity component.
- ☐ 3 state that the horizontal motion and vertical motion of a projectile are independent of each other.
- ☐ 4 resolve the initial velocity of a projectile into horizontal and vertical components.
- ☐ 5 carry out calculations, using the equations of motion, for projectiles.
- ☐ 6 explain the link between satellite motion and projectile motion.
- ☐ 7 understand the factors that determine the gravitational field strength of planets, natural satellites etc.
- ☐ 8 use Newton's Universal Law of Gravitation to calculate the gravitational force between two objects of known mass.

$$F = G\frac{m_1 m_2}{r^2}$$

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At the end of section **1.5 Special Relativity** you should be able to :

❑ 1 state that the speed of light in a vacuum is the same for all observers in all reference frames.

❑ 2 state that the measurements of space, time and distance for a moving observer are changed relative to those for a stationary observer, giving rise to time dilation and length contraction.

❑ 3 explain how the constancy of the speed of light led Einstein to derive his theory of Special Relativity.

❑ 4 use the time dilation formula to analyse real and observed times.

$$t' = \frac{t}{\sqrt{1 - \frac{v^2}{c^2}}}$$

❑ 5 use the length contraction formula to analyse real and observed lengths.

$$l' = l\sqrt{1 - \frac{v^2}{c^2}}$$

❑ 5 explain that relativistic effects are only observed when objects are moving with velocities close to the speed of light.

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At the end of section **1.6 The Expanding Universe** you should be able to :

- ❑ 1 describe the Doppler Effect in terms of the changing frequencies of sound and light for moving objects.

- ❑ 2 use the Doppler Effect equation for calculations involving the sound emitted by moving objects.

$$f_o = f_s \left[\frac{v}{v \pm v_s} \right]$$

- ❑ 3 understand that light from distant galaxies is moved to longer wavelengths (red-shifted) because they are moving away from the Earth.

- ❑ 4 state that the Doppler Effect equations used for sound cannot be used with light from fast moving galaxies because relativistic effects need to be taken into account.

- ❑ 5 use appropriate relationships to solve problems involving red-shift, observed wavelength, emitted wavelength and the recessional velocity of a distant galaxy.

$$z = \frac{\lambda_{observed} - \lambda_{rest}}{\lambda_{rest}} \qquad z = \frac{v}{c}$$

- ❑ 6 explain Hubble's law as the relationship between the recessional velocity of a galaxy and its distance from the observer.

- ❑ 7 use Hubble's Law to solve problems involving the Hubble constant, the recessional velocity of a galaxy and its distance from us.

$$v = H_o d$$

- ❑ 8 explain how the Hubble-Lemaitre Law allows us to estimate the age of the universe.

- ❑ 9 state that measurements of the velocities of galaxies and their distance from us lead to the theory of the expanding Universe.

- ❑ 10 state that the mass of a galaxy can be estimated by the orbital speed of the stars within it.

- ❑ 11 explain that the measurements of the mass of our galaxy and others lead to the conclusion that there is significant mass that cannot be detected - dark matter.

- ❑ 12 explain that the measurements of the accelerating rate of the expansion of the universe lead to the conclusion that there is something that overcomes the force of gravity – dark energy.

- ❑ 13 describe the relationship between the temperature of a stellar object and the distribution of emitted radiation over a wide range of wavelengths.

- ❑ 14 state that the peak wavelength of the distribution of emitted radiation is shorter for objects with a greater temperature.

- ❑ 15 state that objects with greater temperature emit more radiation per unit surface area per unit time. The greater the temperature of a star, the greater the irradiance.

- ❑ 16 provide evidence to support the Big Bang theory and subsequent expansion of the Universe.