Revision summary

Use the following summary of syllabus dot points and key knowledge within Module 5 to ensure that you have thoroughly reviewed the content. Provide a brief definition or comment for each item to demonstrate your understanding or code them using the traffic light system – green (all good); amber (needs some review); red (priority area to review). Alternatively, write a follow-up strategy.

Projectile motion	
Define 'projectile' and 'trajectory'.	
Identify the forces acting on a projectile after launch (ignoring air resistance for any calculations).	
Identify that the trajectory of a projectile is influenced only by its initial velocity and gravity.	
Describe the horizontal and vertical components of a projectile: • horizontal – constant velocity, no acceleration, no forces • vertical – acceleration due to gravity	
Calculate the initial horizontal and vertical velocity components of a projectile using: • $u_x = u\cos\theta$ • $u_y = u\sin\theta$	
Show, using diagrams, how the above formulae are derived.	
Identify that horizontal velocity is constant throughout flight.	
Identify that vertical velocity is a maximum at the start and the end of the flight, zero at the top of the flight and equal magnitude at the same height in the flight.	
Identify that the trajectory of a projectile launched and retrieved at the same height is symmetrical and parabolic and explain reasons for this.	

››

9780170465304

››

Use subscript notation to indicate horizontal and vertical velocity and distance (s_y = height, s_x = range) and use the equations of motion (from Year 11): • $v = u + at$ • $s = ut + \frac{1}{2}at^2$ • $v^2 = u^2 + 2as$ to relate variables listed in syllabus points and derive the following equations: • $v_x = u_x$ • $v_y = u_y + a_yt$ • $s_x = u_xt$ • $s_y = u_y + \frac{1}{2}a_yt^2$	
Solve problems, using the equations above to calculate variables involved with projectile motion, including initial velocity, launch angle, time of flight, final velocity, velocity at a point in the flight, launch height, maximum height and horizontal range.	
Circular motion	
Define 'uniform circular motion'.	
Identify that period (T) is the time taken to complete one revolution around the circumference.	
Derive the formula for the speed of an object in uniform circular motion: $v = \frac{2\pi r}{T}$.	
Explain how an object in uniform circular motion has constant speed but changing velocity.	
Draw vectors on a diagram to show the velocity of an object in uniform circular motion at various points on the circular path.	
Explain why an object in uniform circular motion is accelerating, and identify this as centripetal acceleration.	
Identify the direction of centripetal acceleration as towards the centre of the circular path.	
Use $a_c = \frac{v^2}{r}$ to solve problems involving centripetal acceleration.	

››

››

Define 'centripetal force'.	
Identify that the direction of centripetal force is the same as the direction of centripetal acceleration.	
Identify that a force acting at right angles to the velocity of an object will cause uniform circular motion.	
Use $F_c = \frac{mv^2}{r}$ to solve problems involving centripetal force.	
Define 'angular displacement'.	
Identify the relationship between degrees and radians and perform conversions between them.	
Show why angular displacement can be found by $\Delta\theta = \frac{s}{r}$. (Note: units of $\Delta\theta$ = radians *not* degrees.)	
Define 'angular velocity'.	
Identify instances in which the following forces/situations provide the centripetal force: tension, friction, electrostatic, gravitational, sloped surface.	
Draw force diagrams to show the forces (gravity and centripetal) acting on an object moving with uniform circular motion in a horizontal circle.	
Derive and use equations for the horizontal and vertical components of the tension force: $F_{Tx} = F_T \cos\theta$ and $F_{Ty} = F_T \sin\theta$.	
Draw a diagram of an object moving with uniform circular motion in a vertical circle. Show the forces that act at various points on the circle.	
Show why the net force on an object at any point on the circle is $F_c = F_g + F_T = mg + F_T$.	
Use the equation for net force above to solve problems related to vertical uniform circular motion.	

››

Identify and label on a diagram the forces acting on a car as it takes a flat circular bend.	
Identify and describe the factors that affect the ability of a car to take a corner safely.	
Identify and label on a diagram the forces acting on a car as it takes a banked circular bend.	
Explain why friction is not necessary for a car to safely take a banked circular bend but is for a flat circular bend.	
Use a vector diagram to show that: $F_{net} = mg\tan\theta = \frac{mv^2}{r}$.	
Use $F_{net} = mg\tan\theta$ to solve problems involving angles of banked circular bends.	
Recall formulae for kinetic and gravitational potential energy and use to solve problems: $K = \frac{1}{2}mv^2$ and $U = mgh$	
Explain why the kinetic energy of an object in uniform circular motion is constant.	
Describe the potential energy for an object in uniform circular motion in a horizontal and vertical plane (constant/changing).	
Explain why the total work done per revolution is zero by using $W = Fs$.	
Solve problems involving energy and work for objects in uniform circular motion in both horizontal and vertical planes.	
Define 'torque', 'pivot point/axis of rotation' and 'lever arm'.	
On a diagram, draw and label vectors to show a torque acting on an object.	
Use the relationship between torque and force, $\tau = rF\sin\theta$, to solve problems.	

›› Identify factors that can be manipulated to increase torque (angle, lever arm, force).	
Identify and explain situations in which torque is zero/maximum.	
Motion in gravitational fields	
Define, in words, Newton's law of universal gravitation: $F = \frac{GMm}{r^2}$.	
Identify the relationships between force, mass and distance for universal gravitation.	
Solve problems using Newton's law of universal gravitation.	
Explain why Newton's law of universal gravitation is an example of Newton's third law.	
Define 'gravitational field' (g).	
Derive the formula for the strength of a gravitational field from Newton's law of universal gravitation: $g = \frac{GM}{r^2}$.	
Describe the factors that affect the strength of the gravitational field on an object.	
Draw a gravitational field diagram to represent the gravitational field around an object.	
Use the formula $g = \frac{GM}{r^2}$ to calculate the strength of a gravitational field around a mass.	
Explain why we can approximate a constant gravitational field over a small variation in altitude.	
Equate Newton's law of universal gravitation and centripetal force to derive $v = \sqrt{\frac{GM}{r}}$.	››

›› Use $v = \sqrt{\frac{GM}{r}}$ and $v = \frac{2\pi r}{T}$ to solve problems involving orbital speed, mass of a planet and period of orbit.	
Show why $T^2 = \frac{4\pi r^3}{GM}$ and use this equation to solve problems involving the period and radius of a satellite.	
Explain the difference between a natural and an artificial satellite.	
Identify uses of geostationary satellites and relate them to features of their orbit.	
Solve mathematical problems involving geostationary satellites.	
Describe features of near low-Earth orbit satellites.	
Identify uses of low-Earth satellites and relate them to features of their orbit.	
Solve mathematical problems involving low-Earth orbit satellites.	
Explain 'eccentricity'.	
Describe Kepler's first law: planets move in elliptical orbits.	
Draw diagrams to show the path of a planet around the Sun with the Sun at one focus.	
Describe, using a diagram, Kepler's second law: the law of equal areas.	
Using Kepler's second law, explain why the speed of a planet changes during its orbit.	

››

Describe Kepler's third law: law of periods $\frac{r^3}{T^2}$ = constant.	
Show how the equation $\frac{r^3}{T^2} = \frac{GM}{4\pi^2}$ is derived using Newton's law of universal gravitation and centripetal force.	
Explain why $\frac{r^3}{T^2}$ = constant for objects orbiting the same star or planet.	
Use Kepler's laws to solve problems involving planetary orbits.	
Explain why the gravitational potential energy formula $U = mgh$ is not suitable when considering objects not close to the surface of Earth.	
Use $W = U = -\frac{GMm}{r}$ to solve problems involving gravitational potential energy for objects above the surface of Earth.	
Explain why gravitational potential energy is negative.	
Describe the energy changes (kinetic and potential) that occur as an object moves within a gravitational field.	
Calculate the work done/change in potential energy as an object moves within a gravitational field.	
Sketch a graph of potential energy of an object with increasing distance from Earth.	
Identify that an object in orbit has total energy that includes its kinetic energy and gravitational potential energy.	
Show that the total energy of an object in orbit is $U + K = -\frac{GMm}{2r}$.	
Solve problems involving total/kinetic/potential energy for an object in orbit.	

››

››	Sketch a graph to show the potential/kinetic/ total energy of objects in orbit at different heights around a planet or the Sun.	
	Define 'escape velocity'.	
	Derive the formula $v_{esc} = \sqrt{\frac{2GM}{r}}$.	
	Use $v_{esc} = \sqrt{\frac{2GM}{r}}$ to solve problems involving escape velocity.	