	Y13 Applied	CH07 7.5,7.6	Mechanics Dynamics of a particle	Lessons 4

Essential Knowledge Milestones	Teaching Points
• know and understand the meaning of Newton's second law; • be able to formulate the equation of motion for a particle in 1-dimensional motion where the resultant force is mass × acceleration; • be able to formulate the equation of motion for a particle in 2-dimensional motion where the resultant force is mass × acceleration; • be able to formulate and solve separate equations of motion for connected particles, where one of the particles could be on an inclined and/or rough plane.	• This topic is a natural extension of AS Mathematics which considers dynamics for systems whose forces are perpendicular (and do not need resolving at any angle) and **i**, **j** vector examples. • Recall the previous definition of dynamics: the *vector sum of the forces = mass × acceleration*, so the sum of their resolved parts in any direction can now be represented as a *single* force. This force is called the resultant and is equal to *mass × acceleration* (Newton's second law). • We can use the equations of motion for constant acceleration to describe the motion in more detail e.g. time taken to come to rest etc. • The basic mathematical modelling is identical to that of setting up a statics problem, except when you resolve in the direction of motion; there will be a 'winning' resultant force. • For inclined plane problems stress, that it is often easier, to resolve along and perpendicular to the plane. Some students find it hard to understand that even though the particle is moving up/down, the forces are 'balanced' if we resolve perpendicular to the plane. • Make sure you cover examples in which a force 'pushing' up the plane is removed at a certain point. This means the frictional force and component of weight now influence the subsequent motion and act as 'braking forces' causing a retardation, bringing the particle to instantaneous rest (and then the friction changes direction, as the particle wants to slide back down the plane). • Provide some examples where the forces are given in terms of **i** and **j**. These are solved by applying Newton's Second Law in vector form, hence $\mathbf{F} = m\mathbf{a}$. • Connected particle problems (previously covered in AS Mathematics – Mechanics content, see SoW Unit 8b) can now be extended so at least one of the particles is placed on a rough or smooth inclined plane and/or a rough horizontal plane. This introduces the resolving and frictional concepts from the previous unit. • For 'car and caravan' type questions, the tow rope or tow-bar can now be modelled at an angle rather than horizontally.
Success Criteria	
❑ You can find the unknown force when a system it is in equilibrium ❑ You can calculate the resultant moment of a set of forces acting on a rigid body ❑ You can solve static problems involving wait tension and pulleys ❑ You can solve problems involving limiting equilibrium	
Assumed Prior Knowledge/ Links / Interleaving	
<u>AS Mathematics – Mechanics</u> • Kinematics (constant acceleration) (See Unit 7 of the SoW) • Newton's laws of motion (See Unit 8 of the SoW) • Basic equilibrium (See Unit 8 of the SoW)	

Potential Barriers to Access /Misconceptions	**Opportunities for Reasoning/Problem Solving/Proofs**
• Common errors candidates make include: confusing the terms 'resultant' and 'reaction'; incorrectly treated the scenario as a statics problem and assuming the forces are in equilibrium; omitting *g* from the weight term; and, more rarely, including *g* in the '*ma*' term.	• To make this dynamics topic more real, you could set up experiments, involving connected particles for example, and video the motions. You can then see that when one particle hits the ground, the second particle continuing to move up and the string become slack. • The guidance on the specification document states 'Connected particle problems could include problems with particles in contact e.g. lift problems**.'** • Students may be required to resolve a vector into two components or use a vector diagram, e.g. problems involving two or more forces, given in magnitude–direction form

Key Mathematical Vocabulary	Force, resultant, component, resolving, plane, parallel, perpendicular, weight, tension, thrust, friction, air resistance, reaction, driving force, braking force, force diagram, equilibrium, inextensible, light, negligible, particle, rough, smooth, incline, uniform, friction, coefficient of friction, concurrent, coplanar.

Personal Development	Notes	Resources
Independence & resolve need to be nurtured. Execute unaided after being shown a demonstration of how to approach problem solving. Prepare them to work through a problem independently in life.		