Mechanical Systems
Checklist

Use this alongside our Walkthrough Guides to tick off the concepts you're confident with to plan your study and find areas of improvement!

Circular Motion and Gravity

- ◯ I can define **centripetal force**
- ◯ I can draw and label the circular motion of an object on a diagram showing the direction of the centripetal force and the velocity
- ◯ I can discuss what happens to an object when centripetal force is removed, in terms of speed and direction
- ◯ I can calculate the centripetal acceleration, velocity, or radius using the equation: $a_c = \frac{v^2}{r}$
- ◯ I can calculate the centripetal force, mass, velocity, or radius using the equation: $F_c = \frac{mv^2}{r}$
- ◯ I can calculate the distance travelled in one lap by calculating the perimeter of a circle
- ◯ I can describe what provides centripetal force based on a real-world example given
- ◯ I understand that the velocity of the object is at 90°, or tangential, to the centripetal force
- ◯ I can state where on a vertical circle speed, kinetic energy and potential energy are at their maximum and minimum values
- ◯ I can discuss the energy changes in vertical circular motion
- ◯ I can calculate the tension force of a string at various points when string is used to swing an object in a vertical circular motion
- ◯ I can draw a free-body diagram showing the weight force and reaction force of an object on a curved bank
- ◯ I can calculate the reaction force of an object on a curved bank
- ◯ I know how to calculate the velocity of an object to stay on a circular path on a curved bank

Translational Motion

- ◯ I can define the **centre of mass**
- ◯ I can calculate the position of the centre of mass with multiple objects using the formula:
  $X_{cm} = \frac{(x_1 m_1 + x_2 m_2 + \ldots)}{m_1 + m_2 + \ldots}$
- ◯ I can describe the path of the centre of mass before and after a collision
- ◯ I can explain the importance of an object's centre of mass when discussing how forces act on an object.
- ◯ I can calculate the force due to gravity using the formula:
  $F_g = \frac{G(m_1 m_2)}{d^2}$
- ◯ I can define **escape velocity** and **orbital velocity**
- ◯ I can describe a **geostationary satellite**
- ◯ I can discuss the relationship between distance and gravitational force, and explain how the force due to gravity on Earth changes depending on how high an object is
- ◯ I can calculate the orbital velocity of an object circling the earth
- ◯ I can calculate the height for a satellite to be geostationary
- ◯ I can state the unit and symbol of momentum
- ◯ I can calculate the momentum of an object from its mass and velocity
- ◯ I can calculate the change in momentum, force or change in time from the equation: $\Delta p = F \times t$
- ◯ I can calculate the total momentum of multiple objects before a collision
- ◯ I can explain the concept of **apparent weight**, and compare this to **weight**
- ◯ I can explain the difference between an elastic and an inelastic collision
- ◯ I can calculate the velocity of an object after a collision using the total momentum before and after the collision
- ◯ I can define **impulse**, in terms of the momentum
- ◯ I can state if momentum is conserved during a collision
- ◯ I can calculate the resulting velocity of their combined mass when two objects of known size and velocity collide and stick together.
- ◯ I can discuss how seat belts, airbags and crumple zones in cars protect the passengers, referring to change in momentum, time and force

Rotating Systems

- ◯ I can state the symbols and units used for angular position, angular velocity, angular acceleration, inertia, and momentum
- ◯ I can convert radians per second to revolutions per minute, and vice versa
- ◯ I can define **inertia**
- ◯ I can calculate torque using the equations: $\tau = F \times d$ or $\tau = I \times \alpha$
- ◯ I can describe **angular momentum** in terms of inertia and angular velocity
- ◯ I can calculate the rotational kinetic energy of an object
- ◯ I can explain why a solid object will have a greater rotational kinetic energy than a hollow object of the same mass, and therefore why the solid object will move faster
- ◯ I can explain how angular velocity of a rotating system can be increased or decreased
- ◯ I can link linear momentum with angular momentum

Oscillating Systems

- ◯ I can list examples of simple harmonic motion
- ◯ I can describe **periodic**, or **harmonic motion**
- ◯ I can define the **time period** in simple harmonic motion, and calculate it using $T = \frac{2\pi}{\omega}$
- ◯ I can calculate the time period for a pendulum using $T = 2\pi\sqrt{\frac{I}{g}}$
- ◯ I can calculate the time period for a spring system using $T = 2\pi\sqrt{\frac{m}{k}}$
- ◯ I can explain how the time period can be increased or decreased in simple harmonic motion (and in a pendulum or spring system)
- ◯ I can calculate the displacement, velocity and acceleration of an object in simple harmonic motion at a specific time from starting in the middle
- ◯ I can calculate the displacement, velocity and acceleration of an object in simple harmonic motion at a specific time from starting at one of the ends of the motion
- ◯ I can describe the process of dampening in oscillating systems
- ◯ I can explain resonance in simple harmonic motion
- ◯ I can explain the relationship between kinetic energy and potential energy in a simple harmonic system

