1 A light elastic string has natural length 1.5 m and modulus of elasticity 60 N. The string is stretched between two fixed points $A$ and $B$, which are at the same horizontal level and 2 m apart.

(i) Find the tension in the string. [2]

A particle of weight $W$ N is now attached to the mid-point of the string and the particle is in equilibrium at a point 0.75 m vertically below the mid-point of $AB$.

(ii) Find the value of $W$. [4]

2

![Diagram of rod AB with points A, B, C, and dimensions labeled: 1.2 m, 0.5 m, and vertical line between A and C.]

A uniform rod $AB$ of length 1.2 m and weight 30 N is in equilibrium with the end $A$ in contact with a vertical wall. $AB$ is held at right angles to the wall by a light inextensible string. The string has one end attached to the rod at $B$ and the other end attached to a point $C$ of the wall. The point $C$ is 0.5 m vertically above $A$ (see diagram). Find

(i) the tension in the string, [3]

(ii) the horizontal and vertical components of the force exerted on the rod by the wall at $A$. [3]

3 A car of mass 1000 kg is moving on a straight horizontal road. The driving force of the car is $\frac{28000}{v}$ N and the resistance to motion is $4v$ N, where $v$ m s$^{-1}$ is the speed of the car $t$ seconds after it passes a fixed point on the road.

(i) Show that $\frac{dv}{dt} = \frac{7000 - v^2}{250v}$. [2]

The car passes points $A$ and $B$ with speeds 10 m s$^{-1}$ and 40 m s$^{-1}$ respectively.

(ii) Find the time taken for the car to travel from $A$ to $B$. [4]

4 A particle is projected from a point $O$ on horizontal ground with speed 50 m s$^{-1}$ at an angle $\theta$ to the horizontal. Given that the speed of the particle when it is at its highest point is 40 m s$^{-1}$,

(i) show that $\cos \theta = 0.8$, [2]

(ii) find, in either order,

(a) the greatest height reached by the particle,

(b) the distance from $O$ at which the particle hits the ground. [5]
One end of a light elastic string of natural length 0.4 m and modulus of elasticity 16 N is attached to a fixed point $O$ of a horizontal table. A particle $P$ of mass 0.8 kg is attached to the other end of the string. The particle $P$ is released from rest on the table, at a point which is 0.5 m from $O$. The coefficient of friction between the particle and the table is 0.2. By considering work and energy, find the speed of $P$ at the instant the string becomes slack.

A horizontal turntable rotates with constant angular speed $\omega \text{ rad s}^{-1}$ about its centre $O$. A particle $P$ of mass 0.08 kg is placed on the turntable. The particle moves with the turntable and no sliding takes place.

(i) It is given that $\omega = 3$ and that the particle is about to slide on the turntable when $OP = 0.5 \text{ m}$. Find the coefficient of friction between the particle and the turntable.

(ii) Given instead that the particle is about to slide when its speed is 1.2 m s$^{-1}$, find $\omega$.

A light container has a vertical cross-section in the form of a trapezium. The container rests on a horizontal surface. Grain is poured into the container to a depth of $y \text{ m}$. As shown in the diagram, the cross-section $ABCD$ of the grain is such that $AB = 0.4 \text{ m}$ and $DC = (0.4 + 2y) \text{ m}$.

(i) When $y = 0.3$, find the vertical height of the centre of mass of the grain above the base of the container.

(ii) Find the value of $y$ for which the container is about to topple.