1 A particle B of mass 5 kg is at rest on a smooth horizontal table. A particle A of mass 2.5 kg moves on the table with a speed of $6\,\text{m}\,\text{s}^{-1}$ and collides directly with B. In the collision the two particles coalesce.

(a) Find the speed of the combined particle after the collision. [2]

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(b) Find the loss of kinetic energy of the system due to the collision. [3]

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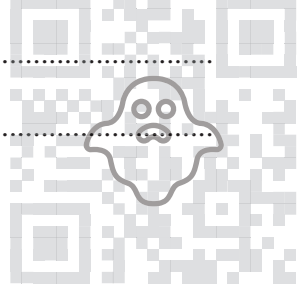

2 A car of mass 1400 kg is moving along a straight horizontal road against a resistance of magnitude 350 N.

(a) Find, in kW, the rate at which the engine of the car is working when it is travelling at a constant speed of $20\,\text{m}\,\text{s}^{-1}$. [2]

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(b) Find the acceleration of the car when its speed is $20\,\text{m}\,\text{s}^{-1}$ and the engine is working at 15 kW. [3]

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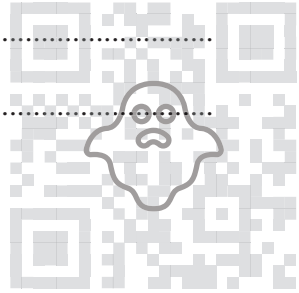

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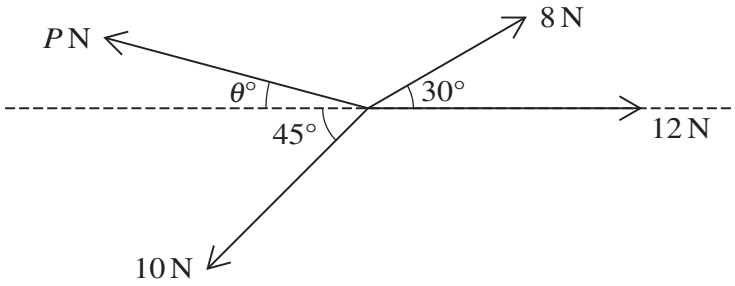

Coplanar forces of magnitudes 8 N, 12 N, 10 N and P N act at a point in the directions shown in the diagram. The system is in equilibrium.

Find P and θ. [6]

4 A particle P moves in a straight line. It starts from rest at a point O on the line and at time t s after leaving O it has acceleration a m s^{-2}, where $a = 6t - 18$.

Find the distance P moves before it comes to instantaneous rest. [6]

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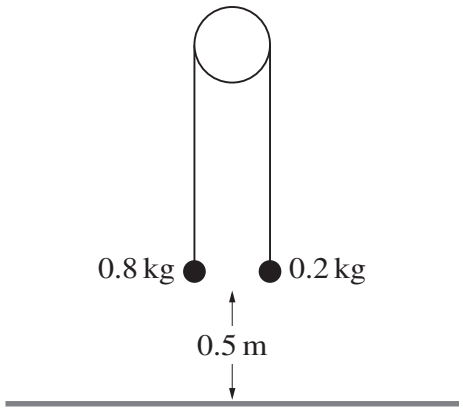

Two particles of masses 0.8 kg and 0.2 kg are connected by a light inextensible string that passes over a fixed smooth pulley. The system is released from rest with both particles 0.5 m above a horizontal floor (see diagram). In the subsequent motion the 0.2 kg particle does not reach the pulley.

(a) Show that the magnitude of the acceleration of the particles is $6\,\text{m}\,\text{s}^{-2}$ and find the tension in the string. [4]

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(b) When the 0.8 kg particle reaches the floor it comes to rest.

Find the greatest height of the 0.2 kg particle above the floor. [3]

6 A car of mass 1500 kg is pulling a trailer of mass 750 kg up a straight hill of length 800 m inclined at an angle of $\sin^{-1} 0.08$ to the horizontal. The resistances to the motion of the car and trailer are 400 N and 200 N respectively. The car and trailer are connected by a light rigid tow-bar. The car and trailer have speed 30 m s^{-1} at the bottom of the hill and 20 m s^{-1} at the top of the hill.

(a) Use an energy method to find the constant driving force as the car and trailer travel up the hill. [5]

After reaching the top of the hill the system consisting of the car and trailer travels along a straight level road. The driving force of the car's engine is 2400 N and the resistances to motion are unchanged.

(b) Find the acceleration of the system and the tension in the tow-bar. [4]

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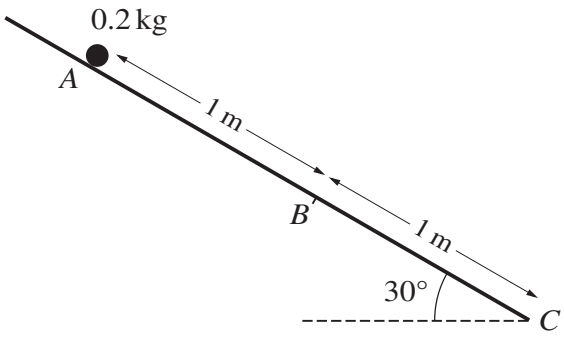

Three points A, B and C lie on a line of greatest slope of a plane inclined at an angle of 30° to the horizontal, with $AB = 1$ m and $BC = 1$ m, as shown in the diagram. A particle of mass 0.2 kg is released from rest at A and slides down the plane. The part of the plane from A to B is smooth. The part of the plane from B to C is rough, with coefficient of friction μ between the plane and the particle.

(a) Given that $\mu = \frac{1}{2}\sqrt{3}$, find the speed of the particle at C. [8]

(b) Given instead that the particle comes to rest at C, find the exact value of μ. [4]