AS Level Mathematics B (MEI)

H630/01 Pure Mathematics and Mechanics

Question Set 4

1 In this question, the unit vectors **i** and **j** are horizontal and vertically upwards respectively.

A particle has mass 2.5 kg.

(a) Write the weight of the particle as a vector. **[1]**

The particle moves under the action of its weight and two external forces $(3\mathbf{i}-2\mathbf{j})$ N and $(-\mathbf{i}+18\mathbf{j})$ N.

(b) Find the acceleration of the particle, giving your answer in vector form. **[2]**

2 Fig. 2 shows a train consisting of an engine of mass 80 tonnes pulling two trucks each of mass 25 tonnes.

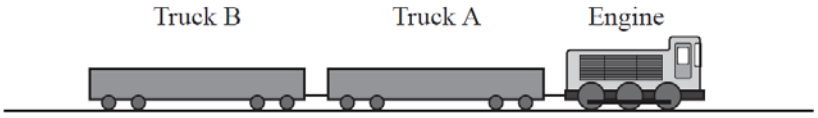
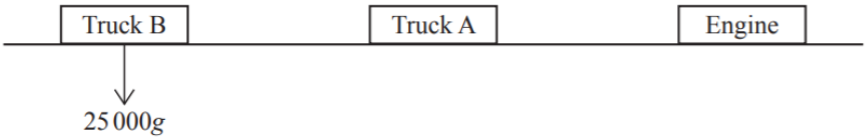


Fig. 2

The engine exerts a driving force of D N and experiences a resistance to motion of 2000 N. Each truck experiences a resistance of 600 N. The train travels in a straight line on a level track with an acceleration of 0.1 m s^{-2}.

(a) Complete the force diagram below to show all the forces acting on the engine and each of the trucks. **[3]**



Force diagram

(b) Calculate the value of D. **[2]**

(c) The tension in the coupling between the engine and truck A is larger than that in the coupling between the trucks. Determine how much larger. **[2]**

3 **In this question you must show detailed reasoning.**

A car accelerates from rest along a straight level road. The velocity of the car after 8 s is 25.6 m s^{-1}.

In one model for the motion, the velocity v m s^{-1} at time t seconds is given by $v = 1.2t^2 - kt^3$, where k is a constant and $0 \leqslant t \leqslant 8$.

(a) The model gives the correct velocity of 25.6 m s^{-1} at time 8 s. Show that $k = 0.1$. **[2]**

A second model for the motion uses constant acceleration.

(b) Find the value of the acceleration which gives the correct velocity of $25.6\,\text{m s}^{-1}$ at time 8 s. **[2]**

(c) Show that these two models give the same value for the displacement in the first 8 s. **[5]**

Total Marks for Question Set 4: 19 marks

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