

AS Level Mathematics B (MEI)
H630/01 Pure Mathematics and
Mechanics

Question Set 2

1. A particle is in equilibrium under the action of three forces in Newtons given by

$$F_1 = \begin{pmatrix} 8 \\ 0 \end{pmatrix}, F_2 = \begin{pmatrix} 2a \\ -3a \end{pmatrix} \text{ and } F_3 = \begin{pmatrix} 0 \\ b \end{pmatrix}.$$

Find the values of the constants a and b . **(3)**

2. Fig. 2 shows a block of mass $4m\text{kg}$ and a particle of mass $m\text{kg}$ connected by a light inextensible string passing over a smooth pulley. The block is on a horizontal table, and the particle hangs freely. The part of the string between the pulley and the block is horizontal. The block slides towards the pulley and the particle descends. In this motion, the friction force between the table and the block is $\frac{1}{2}mgN$.

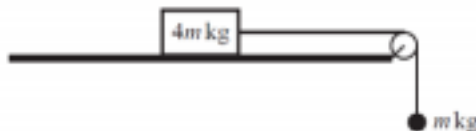


Fig. 2

Find expressions for

- the acceleration of the system
 - the tension in the string
- (4)**

3. A toy boat of mass 1.5kg is pushed across a pond, starting from rest, for 2.5 seconds. During this time, the boat has an acceleration of 2ms^{-2} . Subsequently, when the only horizontal force acting on the boat is a constant resistance to motion, the boat travels 10m before coming to rest. Calculate the magnitude of the resistance to motion.

(6)

4. Rory runs a distance of 45m in 12.5s . He starts from rest and accelerates to a speed of 4ms^{-1} . He runs the remaining distance at 4ms^{-1} .

Rory proposes a model in which the acceleration is constant until time T seconds.

- (i) Sketch the velocity-time graph for Rory's run using this model. **(2)**
- (ii) Calculate T . **(2)**
- (iii) Find an expression for Rory's displacement at time $t\text{s}$ for $0 \leq t \leq T$. **(2)**
- (iv) Use this model to find the time taken for Rory to run the first 4m . **(1)**

Rory proposes a refined model in which the velocity during the acceleration phase is a quadratic function of t . The graph of Rory's quadratic goes through $(0,0)$ and has its maximum point at $(S, 4)$. In this model the acceleration phase lasts until time S seconds, after which the velocity is constant.

- (v) Sketch a velocity-time graph that represents Rory's run using this refined model. **(1)**
- (vi) State, with a reason, whether S is greater than T or less than T . (You are not required to calculate the value of S .) **(1)**

Total Marks for Question Set 2: 22

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