PART III

marks

Note that there is no strict dividing line between the preparation and working stages and that the examiners will be flexible in giving you credit for correct answers even if they are not partitioned in exactly the same way as on the model solution.

Also, the suggested checks are for illustrative purposes only. Examiners will consider any check on its merits, so full marks may be obtained using different arguments than those given here.

Question 17

Preparation

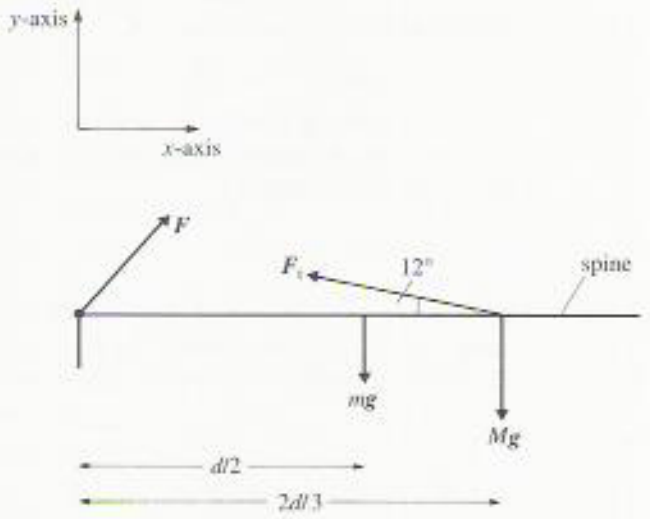

Figure 3

Known quantities: $m = 50\,\text{kg}$

$M = 10\,\text{kg}$ 1

$g = 10\,\text{m s}^{-2}$

Unknowns: d (to be eliminated)

$|\boldsymbol{F}_t|$ (to be found)

The unknown force $\boldsymbol{F}$ at the pivot, which can be resolved into horizontal and vertical components, F_x and F_y (to be found). 1

Principles: For equilibrium

balance of torques: $\sum_i \Gamma_i = 0$

balance of forces: $\sum_i \boldsymbol{F}_i = 0$ 2

Marks for preparation: 5

Working

The unknown force $\boldsymbol{F}$ will cause no torque about the pivot. Therefore balancing torques about this point perpendicular to the diagram requires

$-(50\,\text{kg} \times 10\,\text{m s}^{-2} \times \tfrac{1}{2}d) - (10\,\text{kg} \times 10\,\text{m s}^{-2} \times \tfrac{2}{3}d) + (F_t \sin 12° \times \tfrac{2}{3}d) = 0.$ 1

Therefore $$\frac{2F_t \sin 12°}{3} = \frac{500 \times 3 + 100 \times 4}{6}\ \text{N}$$

and hence $$F_t = \frac{475}{\sin 12°}\ \text{N} = 2\,285\ \text{N}.$$ 2

Balancing forces:

Vertically $F_y + F_t \sin 12° - (50 + 10\,\text{kg}) \times 10\,\text{m s}^{-2} = 0.$ 1

Therefore $F_y = (600 - 2\,285 \sin 12°)\,\text{N} = 125\,\text{N}.$ 1

Horizontally $F_x = -F_t \cos 12°$

$= (-2\,285 \cos 12°)\,\text{N} = -2\,235\,\text{N}.$ 1