OCR
Oxford Cambridge and RSA

AS Level Mathematics B (MEI)

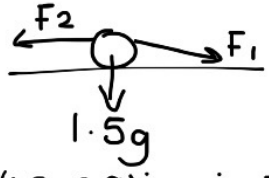
H630/01 Pure Mathematics and Mechanics

Question Set 6

1. In this question, the x and y directions are horizontal and vertically upwards respectively.

A particle of mass 1.5 kg is in equilibrium under the action of its weight and forces $\mathbf{F}_1 = \begin{pmatrix} 4 \\ -2 \end{pmatrix}$ N and $\mathbf{F}_2$.

(a) Find the force $\mathbf{F}_2$. **[3]**



$-(1.5\times 9.8)\mathbf{j} + 4\mathbf{i} - 2\mathbf{j} + x\mathbf{i} + y\mathbf{j} = \mathbf{0}$

$(-14.7 - 2 + y)\mathbf{j} = 0\mathbf{j}$ $\quad (4 + x)\mathbf{i} = 0\mathbf{i}$

$-16.7 + y = 0$ $\quad 4 + x = 0$

$y = 16.7$ $\quad x = -4$

$\therefore -4\mathbf{i} + 16.7\mathbf{j} = \mathbf{F}_2$

(b) The force $\mathbf{F}_2$ is changed to $\begin{pmatrix} 2 \\ 20 \end{pmatrix}$ N.

Find the acceleration of the particle. **[2]**

$F = ma$

$4\mathbf{i} - 2\mathbf{j} + 2\mathbf{i} + 20\mathbf{j} = 1.5\mathbf{a}$

$6\mathbf{i} + 18\mathbf{j} = 1.5\mathbf{a}$

$\frac{6\mathbf{i} + 18\mathbf{j}}{1.5} = \mathbf{a}$

$4\mathbf{i} + 12\mathbf{j} = \mathbf{a}$

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

A particle moves in a straight line. Its velocity v ms^{-1} after ts is given by $v = t^3 - 5t^2$.

(a) Find the times at which the particle is stationary. **[2]**

$0 \rightarrow t^3 - 5t^2$

$v = 0$

$\therefore 0 = t^3 - 5t^2$

$0 = t^2(t-5)$

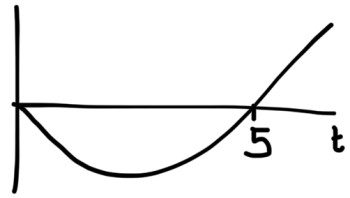
$t^2 = 0 \quad \therefore t = 0$

or

$t - 5 = 0 \quad t = 5$

(b) Find the total distance travelled by the particle in the first 6 seconds. **[3]**

S
V
A



area underneath = distance moved

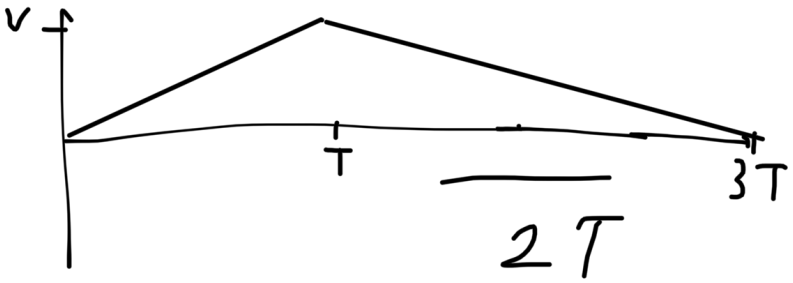
$\int_0^5 t^3 - 5t^2 \, dt + \int_5^6 t^3 - 5t^2$

$-\left[\frac{1}{4}t^4 - \frac{5}{3}t^3\right]_0^5 + \left[\frac{1}{4}t^4 - \frac{5}{3}t^3\right]_5^6$

$\frac{625}{12} + \frac{193}{12} = \frac{409}{6} = 68\text{m}$

3 A car travelling in a straight line accelerates uniformly from rest to V ms^{-1} in Ts. It then slows down uniformly, coming to rest after a further $2T$s.

(a) Sketch a velocity-time graph for the car. **[2]**



(b) Calculate the values of V and T. **[4]**

$S_1 = \frac{Vt}{2}$ $S_2 = \frac{V2t}{2} = Vt$

$Vt + \frac{Vt}{2} = S$

S	S_1
U	0
V	V
A	a
T	T

S	S_1
U	V
V	0
A	$-\frac{1}{2}a$
T	2T

$V = aT$

$0 = V - \frac{1}{2}a \times 2T$

$0 = V - aT$

4 An astronaut on the surface of the moon drops a ball from a point 2 m above the surface.

(a) Without any calculations, explain why a standard model using $g = 9.8\,\text{ms}^{-2}$ will not be appropriate to model the fall of the ball. **[1]**

Because on the moon the gravitational field strength is less therefore the value of g will be lower as 9.81 only applies to the Earth.

The ball takes 1.6 s to hit the surface.

(b) Find the acceleration of the ball which best models its motion. Give your answer correct to 2 significant figures. **[2]**

S	2	+ ↓
U	0	
V		
A	x	
T	1.6	

$S = Ut + \frac{1}{2}at^2$

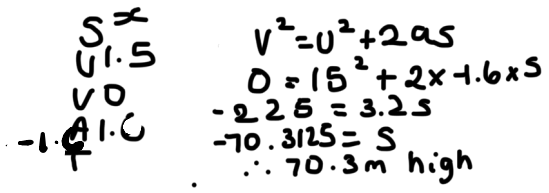
$2 = 0.5a \times 1.6^2$

$\frac{2}{0.5 \times 1.6^2} = 9$

$1.5625 = a$

$1.6\,\text{ms}^{-2} = 9$

(c) Use this value to predict the maximum height of the ball above the point of projection when thrown vertically upwards with an initial velocity of $15 ms^{-1}$. **[2]**



Total Marks for Question Set 6: 21 marks