OCR
Oxford Cambridge and RSA

AS Level Mathematics A

H230/02 Pure Mathematics and Mechanics

Question Set 6

1 A particle is in equilibrium under the action of the following three forces:

$(2p\mathbf{i} - 4\mathbf{j})$ N, $(-3q\mathbf{i} + 5p\mathbf{j})$ N and $(-13\mathbf{i} - 6\mathbf{j})$ N.

Find the values of p and q. **[3]**

$F_1 + F_2 + F_3 = 0$ $2p - 3q - 13 = 0$ $-4 + 5p - 6 = 0$

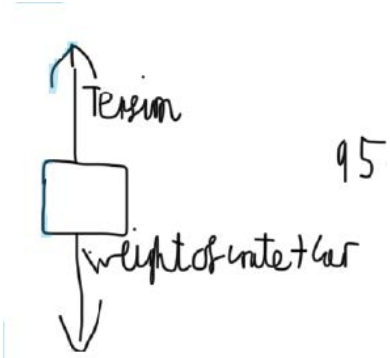
$p = 2$ $q = -3$

2 A crane lifts a car vertically. The car is inside a crate which is raised by the crane by means of a strong cable. The cable can withstand a maximum tension of 9500 N without breaking. The crate has a mass of 55 kg and the car has a mass of 830 kg.

(a) Find the maximum acceleration with which the crate and car can be raised. **[2]**

$9500 - 55g - 830g = 885a$ $a = 0.934\ \text{ms}^{-2}$

(b) Show on a clearly labelled diagram the forces acting on the crate while it is in motion. **[1]**



(c) Determine the magnitude of the reaction force between the crate and the car when they are ascending with maximum acceleration. **[3]**

$R - 830g = 830a$ $R = 8910$ N

3 A particle P is moving in a straight line. At time t seconds P has velocity $v\,\text{ms}^{-1}$ where $v = (2t+1)(3-t)$.

(a) Find the deceleration of P when $t = 4$. **[2]**

$v = -2t^2 + 5t + 3$
$a = -4t + 5$
$= 9\,\text{m/s}^2$

(b) State the positive value of t for which P is instantaneously at rest. **[1]**

$v = 0$ $t = 3$

(c) Find the total distance that P travels between times $t = 0$ and $t = 4$. [3]

$s = \int_0^4 v\,dt = \int_0^4 -2t^2+5t+3\,dt = \left[-\frac{2}{3}t^3+\frac{5}{2}t^2+3t\right]_0^4 = \left(-\frac{2}{3}\times 64+\frac{5}{2}\times 16+3\times 4\right)-0 = \frac{28}{3}$

4 A car starts from rest at a set of traffic lights and moves along a straight road with constant acceleration $4\,\text{m s}^{-2}$. A motorcycle, travelling parallel to the car with constant speed $16\,\text{m s}^{-1}$, passes the same traffic lights exactly 1.5 seconds after the car starts to move. The time after the car starts to move is denoted by t seconds.

for bike $s = 16(t-1.5)$

(a) Determine the two values of t at which the car and motorcycle are the same distance from the traffic lights. [6]

Car

$s =$

$u = 0$ $s = 2t^2$

$v =$

$a = 4$ ↑

$T = t$

$s = ut + \frac{at^2}{2}$

$16t - 24 = 2t^2$

$t^2 - 8t + 12 = 0$ $t = 2$, $t = 6$ ($s_{bike} = s_{car}$)

(b) Describe the relative positions of the car and the motorcycle when $t_1 < t < t_2$. [1]

Motor bike infront of car

(c) Determine the maximum distance between the car and the motorcycle when $t_1 < t < t_2$. [3]

$2t^2 - 16t - 24 = s$ ↓

$\frac{ds}{dt} = 4t - 16$ max at $t = 4$

s for car at $t = 4 = 32$

s for bike at $t = 4 = 40$

∴ max distance between $= 8\,\text{m}$

Total Marks for Question Set 6: 25