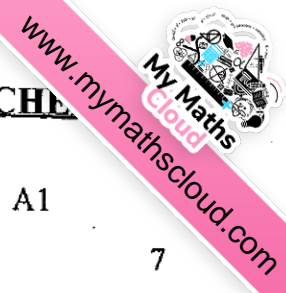


# MECHANICS 2 (A) TEST PAPER 5 : ANSWERS AND MARK SCHE



1. (a)  $v = \int a dt = 4t^2 - 18t + c$   $v(3) = 2 : c = 20$   $v = 4t^2 - 18t + 20$  M1 A1 M1 A1  
 (b)  $v = 0 : 2(t-2)(2t-5) = 0$   $t = 2, t = 2.5$  M1 A1 A1 7
  
2. (a) Volume per second =  $12\pi(0.04)^2 = 0.0603 \text{ m}^3$  Mass = 60.3 kg M1 A1  
 P.E. gained per sec. =  $60.3 \times g \times 25 = 14778 \text{ J}$  A1  
 K.E. gained per sec. =  $\frac{1}{2} \times 60.3 \times 12^2 = 4342 \text{ J}$  M1 A1  
 (b) Power = total energy per second =  $19120 \text{ Js}^{-1} = 19.1 \text{ kW}$  M1 A1 7
  
3. (a)  $v = (4t-4)\mathbf{i} - 2t\mathbf{j}$   $t = 3 : v = (8\mathbf{i} - 6\mathbf{j}) \text{ ms}^{-1}$  M1 A1 A1  
 (b)  $\mathbf{a} = 4\mathbf{i} - 2\mathbf{j}$   $|\mathbf{a}| = \sqrt{20}$ , constant  $F = 3\sqrt{20} = 13.4 \text{ N}$  M1 A1 M1 A1 7
  
4. (a)  $750(12.5) = 180(21) + 570\bar{y}$   $\bar{y} = 9.82 \text{ cm}$  M1 A1 M1 A1  
 (b) Must have centre of mass 12.5 cm from ED B1  
 $9.816m + 13M = 12.5(m + M)$   $0.5M = 2.684m$   $M = 5.37m$  M1 A1 M1 A1 9
  
5. (a)  $F - 700 = 1650 \times 1.2$   $F = 700 + 1980 = 2680 \text{ N}$  M1 A1 A1  
 (b)  $F - 500 - T = 1100 \times 1.2$   $T = 2180 - 1320 = 860 \text{ N}$  M1 A1 A1  
 (c)  $P = 2680 \times 18 = 48.2 \text{ kW}$  M1 A1  
 (d)  $48240 = 18(700 + 1650g \sin 6^\circ + 1650a)$   $a = 0.176 \text{ ms}^{-2}$  M1 A1 A1  
 (e) For trailer,  $T - 200 - 550g \sin 6^\circ = 550(0.176)$   $T = 860 \text{ N}$  M1 A1 A1 14
  
6. (a)  $y = (52 \sin \theta)t - \frac{1}{2}gt^2 = 20t - 5t^2$  M1 A1 A1  
 (b) Lands when  $y = 15$   $t^2 - 4t + 3 = 0$   $(t-1)(t-3) = 0$  M1 A1 A1  
 Ball is coming down, so  $t = 3$  A1  
 (c)  $x = (52 \cos \theta)t = 52 \times \frac{12}{13}t = 48t$  When  $t = 3$ ,  $x = 144 \text{ m}$  M1 A1 A1  
 (d)  $y = 20 \times \frac{x}{48} - 5 \times \left(\frac{x}{48}\right)^2 = \frac{5}{12}x - \frac{5}{2304}x^2$  M1 M1 A1  
 (e) Have ignored air resistance, which would make answer larger B1 B1 15
  
7. (a) Momentum :  $3mu = 3mv_A + 4mv_B$   $3v_A + 4v_B = 3u$  M1 A1  
 Elasticity :  $(v_B - v_A) / (-u) = -e$   $3v_B - 3v_A = 3eu$  M1 A1  
 Add :  $3u(1 + e) = 7v_B$   $v_B = \frac{3}{7}u(1 + e)$  M1 A1  
 (b) If  $v_A = 0$ ,  $v_B = eu$  and  $4v_B = 3u$ , so  $e = 0.75$  M1 A1 A1  
 (c) Now A has speed  $\frac{1}{3}ku$   $(v'_B - v'_A) / (0.75u - \frac{1}{3}ku) = -0.75$  M1 A1  
 and  $kmv'_A + 3mu = 3mv'_A + 4mv'_B$  M1 A1  
 $ku + 3u = 3v'_A + 4(v'_A - 0.75(0.75 - \frac{1}{3}k)u) = 7v'_A - 2.25u + ku$  M1 A1  
 $v'_A = 0.75u$ , which is independent of  $k$  A1 16