

**MECHANICS 2 (A) TEST PAPER 4 : ANSWERS AND MARK SCHE**

1.  $m(7\mathbf{i} + 12\mathbf{j}) + 0.4(-\mathbf{i} + 7\mathbf{j}) = m(-3\mathbf{i} + 4\mathbf{j}) + 0.4(6.5\mathbf{i} + 13\mathbf{j})$  M1 A1  
 $7m - 0.4 = -3m + 2.6$        $10m = 3$        $m = 0.3$  M1 A1      4
  
2. Reaction at  $X = R = 0.75g$       Friction  $= 0.6R = 0.45g$  B1 B1  
 Reaction at  $Y = S = 0.45g$  B1  
 $M(X) : 0.75g(a \cos \alpha) = 0.45g(2a \sin \alpha)$      $\tan \alpha = 0.83$      $\alpha = 39.8^\circ$  M1 A1 A1      6
  
3. (a)  $P = 15(35\,000 + 20\,000g \sin 10^\circ) = 1\,035\,525.6 \text{ W} \approx 1040 \text{ kW}$  M1 M1 A1 A1  
 (b)  $1\,035\,525.6 = v \times 35\,000$        $v = 29.6 \text{ ms}^{-2}$  M1 A1 A1      7
  
4. (a) When  $t = 4$ ,  $\mathbf{r} = 12\mathbf{i} + (16k - 5)\mathbf{j}$      $16k - 5 = 1$      $k = 0.375$  M1 A1 A1  
 (b)  $\mathbf{v} = 2\mathbf{i} + 0.75t\mathbf{j}$      $\mathbf{a} = 0.75\mathbf{j}$      $|\mathbf{a}| = 0.75 \text{ ms}^{-2}$ , due North M1 A1 A1 A1      7
  
5.  $v_A + v_B = 7$        $(v_B - v_A)/(0 - 7) = -e$        $2v_B = 7(e + 1)$  B1 M1 A1  
 $4 + v'_B = v_B$        $(4 - v'_B)/(0 - v_B) = -e$        $8 = v_B(e + 1)$  B1 M1 A1 A1  
 $16 = 7(e + 1)^2$        $e = 0.512$  M1 A1 A1      10
  
6. (a)  $360(15) = 12.5\pi(25) + (360 - 12.5\pi)\bar{x}$        $\bar{x} = 13.8$  M1 A1 A1  
 $360(6) = 12.5\pi(20/3\pi) + (360 - 12.5\pi)\bar{y}$        $\bar{y} = 6.47$  M1 M1 A1 A1  
 (b)  $\tan \alpha = 13.78 \div (12 - 6.475) = 2.494$        $\alpha = 68.2^\circ$  M1 A1 M1 A1      11
  
7. (a)  $500 = 25p + 5q$ ,       $12\,000 = 900p + 30q$  B1 B1  
 Solve :  $750p = 9000$        $p = 12$ ,  $q = 40$  M1 A1 (both)  
 (b) Graph : parabola, increasing from  $t = 0$  B2  
 (c)  $a = 24t + 40$        $t = 0 : a = 40 \text{ ms}^{-2}$  (or their  $q$ ) M1 A1  
 (d)  $s = \int_0^{30} v \, dt = [4t^3 + 20t^2]_0^{30} = 126\,000 \text{ m}$  M1 A1 M1 A1  
 (e) Travels a further  $20 \times 12\,000 = 240\,000 \text{ m}$  B1  
 Average speed  $= 366\,000 \div 50 = 7320 \text{ ms}^{-1}$  M1 A1      15
  
8. (a)  $x = (u \cos 45^\circ)t$ ,     $y = (u \sin 45^\circ)t - 4.9t^2$      $y = x - \frac{g}{u^2}x^2$  M1 M1 A1  
 Need  $15 \leq 30 - 900\frac{g}{u^2}$      $u \geq 60g$      $u \geq 24.2 \text{ ms}^{-1}$  M1 A1 M1 A1  
 (b) At max. height,  $u \sin 45^\circ - gt = 0$      $t = 1.75$      $y_{\max} = 15$  M1 A1 M1 A1  
 (c) When  $t = 3.5$ ,  $x = 60 \text{ m}$  M1 A1  
 (d) Ball modelled as particle; constant gravity; etc. B1 B1      15