

**MECHANICS 1 (A) TEST PAPER 7 : ANSWERS AND MARK SCHEME**

1. (i) 2-D rigid body (ii) 1-D rigid body, centre of mass at mid-pt. B1 B1  
 (iii) No frictional force (iv) Mass concentrated at a point B1 B1 4
  
2. (a)  $\mathbf{R} = \mathbf{F} + \mathbf{G} = 9\mathbf{i} + 12\mathbf{j}$   $|\mathbf{R}| = \sqrt{(9^2 + 12^2)} = 15 \text{ N}$  M1 A1 A1  
 (b)  $\tan^{-1}(4/3) = 53.1^\circ$  M1 A1  
 (c)  $OP = 5 \text{ cm}$  Moment =  $5 \times 15 = 75 \text{ Ncm}$  or  $0.75 \text{ Nm}$  M1 A1 A1 8
  
3. (a) Resolve :  $R + 50 \sin 35^\circ = 12g$ ,  $50 \cos 35^\circ = \mu R$  M1 A1 A1  
 $\mu(12g - 50 \sin 35^\circ) = 50 \cos 35^\circ$   $\mu = 0.461$  M1 A1  
 (b) Resolve :  $R + F \sin 35^\circ = 12g$ ,  $F \cos 35^\circ - \mu R = 12a$  M1 A1  
 $a = 0.5$  :  $F(\cos 35^\circ + 0.461 \sin 35^\circ) = 6 + 0.461(12g)$   $F = 55.5$  B1 M1 A1  
 (c) Case = particle (does not topple); string light and inextensible B1 B1 12
  
4. (a)  $M(S) : a \times 4g = 2a \times R_T + a \times xg$  M1 A1 A1  
 $+ a : 2R_T = 4g - xg = (4 - x)g$   $R_T = (2 - \frac{1}{2}x)g$  M1 A1  
 $R_S = (4 + x)g - (2 - \frac{1}{2}x)g = (2 + \frac{3}{2}x)g$  M1 A1  
 (b)  $R_S = 5R_T : 2 + 1.5x = 10 - 2.5x$   $4x = 8$   $x = 2$  M1 A1 A1  
 (c) When  $R_T = 0$ ,  $x = 4$  M1 A1 12
  
5. (a) New momentum of B =  $-3km + 7km = 4km$ , so speed =  $4 \text{ ms}^{-1}$  M1 A1 A1  
 (b)  $5m - 3km = mv_A + 4km$   $v_A = 5 - 7k < 0$  as  $k > 1$ , M1 A1  
 so speed =  $(7k - 5) \text{ ms}^{-1}$  and direction is reversed M1 A1 A1  
 (c) B's speed is now increased by  $\frac{u}{k}$  and its direction changed, M1  
 so must have  $\frac{u}{k} - 4 > 7k - 5$   $\frac{u}{k} > 7k - 1$   $u > k(7k - 1)$  M1 A1 A1 12
  
6. (a) Total distance = sum of areas =  $4x + 64 + 24y + 18y + 42$  M1 A1  
 Hence  $4x + 42y + 106 = 496$   $2x + 21y = 195$  M1 A1  
 (b) Total time =  $x + 2y + 11$ , so  $496 = 15.5(x + 2y + 11)$  M1 A1  
 $x + 2y + 11 = 32$   $x + 2y = 21$  A1  
 (c) Solving :  $x = 3, y = 9$  (d)  $\frac{8}{3}, 4, 0, -\frac{4}{3}, -\frac{12}{7} \text{ ms}^{-2}$  M1 A1 A1; B3 13
  
7. (a) Modelling assumption : string is inextensible B1  
 $F = ma : T = 2ma$ ,  $3mg \sin \theta - \frac{1}{6}(3mg \cos \theta) - T = 3ma$  M1 A1 A1  
 Add :  $3mg(0.8) - 0.5mg(0.6) = 5ma$   $5a = 2.1g$   $a = \frac{21g}{50}$  M1 A1 A1  
 (b) Dist =  $1 \text{ m} : v^2 = 2(\frac{21g}{50})(1)$   $v = 2.87 \text{ ms}^{-1}$  M1 A1  
 (c) Time for Q to reach floor is  $t$  where  $1 = 0.21gt^2$   $t = 0.697 \text{ s}$  M1 A1  
 $0.2 \text{ m}$  at  $2.87 \text{ ms}^{-1}$  takes  $0.0697 \text{ s}$ , so total time =  $0.767 \text{ s}$  M1 A1 A1 14