

## MECHANICS 1 (A) TEST PAPER 3 : ANSWERS AND MARK SCHEME

1. (a)  $(t\mathbf{i} + 2t\mathbf{j}) \text{ ms}^{-1}$  (b)  $\sqrt{(7^2 + 14^2)} = 7\sqrt{5}$  or  $15.7 \text{ ms}^{-1}$  M1 A1; M1 A1  
 on bearing  $\tan^{-1} 0.5 = 026.6^\circ$  (c)  $2.5\sqrt{5} = 5.59 \text{ N}$  A1; M1 A1 7
2. (a)  $M(A) : 1.4W = 3.15 \times 12$   $W = 27 \text{ N}$  M1 A1 M1 A1  
 (b)  $R + 12 = 27$   $R = 15 \text{ N}$  M1 A1  
 (c) Bar stays rigid (in a straight line); weight not acting at centre B1 7
3. (a) Resolve perp. and // plane:  $R = 1.2g \cos \alpha$ ,  $8.4 = 1.2g \sin \alpha + \frac{1}{8}R$  M1 A1 M1 A1  
 $1.2g(\sin \alpha + \frac{1}{8} \cos \alpha) = 8.4$   $7(8 \sin \alpha + \cos \alpha) = 40$  M1 A1  
 (b) Acc. down plane  $= g \sin 38^\circ - \frac{1}{8}g \cos 38^\circ = 5.07 \text{ ms}^{-2}$  M1 M1 A1 A1 10
4. (a)  $420 = \frac{1}{2}(20 + 8)t$   $t = 30 \text{ s}$  M1 A1  
 (b)  $20 = 8 + 30a$   $30a = 12$   $a = 0.4 \text{ ms}^{-2}$  M1 A1  
 (c)  $s = ut + \frac{1}{2}at^2 : 240 = 8t + 0.2t^2$   $t^2 + 40t - 1200 = 0$  M1 A1  
 $(t - 20)(t + 60) = 0$   $t = 20$  M1 A1  
 (d)  $F = ma : 900 - R = 1200(0.4)$   $R = 900 - 480 = 420 \text{ N}$  M1 A1 A1 11
5. (a) Momentum conserved :  $6x = \pm 2x + 3y$   $4x = 3y$  or  $8x = 3y$  M1 A1 A1  
 $x : y = 3 : 4$  or  $x : y = 3 : 8$  M1 A1 A1  
 (b) Modelled as particles B1  
 (c)  $2x - ky = vx$  where  $v < 0$ .  $X$  moving towards  $Y$ , so  $x : y = 3 : 4$  M1 A1  
 Hence  $2 - \frac{4}{3}k < 0$   $k > 1.5$  M1 A1 11
6. (a)  $2g \cos 30^\circ - T = 2a$ ,  $T - 3g \cos 60^\circ = 3a$  M1 A1 A1  
 Add :  $g(\sqrt{3} - 1.5) = 5a$   $a = 0.455 \text{ ms}^{-2}$  M1 A1  
 (b)  $T = 3a + 1.5g = 16.1 \text{ N}$  M1 A1  
 (c)  $v^2 = u^2 + 2as = 0 + 2a(0.8) = 0.728$   $v = 0.853 \text{ ms}^{-1}$  M1 A1 A1  
 (d) String inextensible, so acceleration the same for both particles B1 B1  
 Pulley smooth, so tension is constant throughout the string B1 B1 14
7. (a)  $s_A = 98t - 4.9t^2$   $s_B = 24.5t$  M1 A1 B1  
 (b)  $d^2 = (4.9t(20 - t))^2 + (24.5t)^2 = 4.9^2(t^2(t^2 - 40t + 400) + (5t)^2)$  M1 A1 A1  
 $= 24.01t^2(t^2 - 40t + 400 + 25) = 24.01(t^4 - 40t^3 + 425t^2)$  M1 M1 A1  
 (c)  $\frac{d}{dt}(d^2) = 24.01(4t^3 - 120t^2 + 850t) < 0$  for decreasing function M1 A1  
 When  $4t^2 - 120t + 850 = 0$ ,  $t = 11.5$  or  $t = 18.5$ , so range is M1 A1 A1  
 $11.5 \leq t \leq 18.5$  A1 15