# 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 $15\cdot7\,\text{ms}^{-1}$      M1 A1; M1 A1

       on bearing $\tan^{-1} 0\cdot5 = 026\cdot6°$      (c) $2\cdot5\sqrt{5} = 5\cdot59\,\text{N}$      A1; M1 A1      7

2.   (a) $\text{M}(A) : 1\cdot4W = 3\cdot15 \times 12$      $W = 27\,\text{N}$      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: $R = 1\cdot2g \cos \alpha$,   $8\cdot4 = 1\cdot2g \sin \alpha + \frac{1}{8}R$    M1 A1 M1 A1

       $1\cdot2g(\sin \alpha + \frac{1}{8} \cos \alpha) = 8\cdot4$      $7(8 \sin \alpha + \cos \alpha) = 40$      M1 A1

       (b) Acc. down plane $= g \sin 38° - \frac{1}{8} g \cos 38° = 5\cdot07\,\text{ms}^{-2}$      M1 M1 A1 A1      10

4.   (a) $420 = \frac{1}{2}(20 + 8)t$      $t = 30\,\text{s}$      M1 A1

       (b) $20 = 8 + 30a$      $30a = 12$      $a = 0\cdot4\,\text{ms}^{-2}$      M1 A1

       (c) $s = ut + \frac{1}{2} at^2 : 240 = 8t + 0\cdot2t^2$      $t^2 + 40t - 1200 = 0$      M1 A1

       $(t - 20)(t + 60) = 0$      $t = 20$      M1 A1

       (d) $F = ma : 900 - R = 1200(0\cdot4)$      $R = 900 - 480 = 420\,\text{N}$      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 $2 - \frac{4}{3}k < 0$      $k > 1\cdot5$      M1 A1      11

6.   (a) $2g \cos 30° - T = 2a$,    $T - 3g \cos 60° = 3a$      M1 A1 A1

       Add : $g(\sqrt{3} - 1\cdot5) = 5a$      $a = 0\cdot455\,\text{ms}^{-2}$      M1 A1

       (b) $T = 3a + 1\cdot5g = 16\cdot1\,\text{N}$      M1 A1

       (c) $v^2 = u^2 + 2as = 0 + 2a(0\cdot8) = 0\cdot728$      $v = 0\cdot853\,\text{ms}^{-1}$      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) $s_A = 98t - 4\cdot9t^2$      $s_B = 24\cdot5t$      M1 A1 B1

       (b) $d^2 = (4\cdot9t(20 - t))^2 + (24\cdot5t)^2 = 4\cdot9^2(t^2(t^2 - 40t + 400) + (5t)^2)$      M1 A1 A1

       $= 24\cdot01t^2(t^2 - 40t + 400 + 25) = 24\cdot01(t^4 - 40t^3 + 425t^2)$      M1 M1 A1

       (c) $\frac{\text{d}}{\text{d}t}(d^2) = 24\cdot01(4t^3 - 120t^2 + 850t) < 0$ for decreasing function      M1 A1

       When $4t^2 - 120t + 850 = 0$, $t = 11\cdot5$ or $t = 18\cdot5$, so range is      M1 A1 A1

       $11\cdot5 \le t \le 18\cdot5$      A1      15

---