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) $\mathbf{R} = \mathbf{F} + \mathbf{G} = 9\mathbf{i} + 12\mathbf{j}$ $|\mathbf{R}| = \sqrt{(9^2 + 12^2)} = 15$ N M1 A1 A1
   (b) $\tan^{-1}(4/3) = 53{\cdot}1°$ M1 A1
   (c) $OP = 5$ cm Moment $= 5 \times 15 = 75$ Ncm or 0·75 Nm M1 A1 A1 8

3. (a) Resolve : $R + 50\sin 35° = 12g$, $50\cos 35° = \mu R$ M1 A1 A1
   $\mu(12g - 50\sin 35°) = 50\cos 35°$ $\mu = 0{\cdot}461$ M1 A1
   (b) Resolve : $R + F\sin 35° = 12g$, $F\cos 35° - \mu R = 12a$ M1 A1
   $a = 0{\cdot}5$: $F(\cos 35° + 0{\cdot}461\sin 35°) = 6 + 0{\cdot}461(12g)$ $F = 55{\cdot}5$ 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
   $\div a$: $2R_T = 4g - xg = (4 - x)g$ $R_T = (2 - \frac{1}{2}x)g$ M1 A1
   $R_S = (4 + x)g - (2 - \frac{1}{2}x)g = (2 + \frac{3}{2}x)g$ M1 A1
   (b) $R_S = 5R_T$: $2 + 1{\cdot}5x = 10 - 2{\cdot}5x$ $4x = 8$ $x = 2$ 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 ms^{-1} M1 A1 A1
   (b) $5m - 3km = mv_A + 4km$ $v_A = 5 - 7k < 0$ as $k > 1$, M1 A1
   so speed = $(7k - 5)$ 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 $496 = 15{\cdot}5(x + 2y + 11)$ M1 A1
   $x + 2y + 11 = 32$ $x + 2y = 21$ A1
   (c) Solving : $x = 3$, $y = 9$ (d) $\frac{8}{3}$, 4, 0, $-\frac{4}{3}$, $-\frac{12}{7}$ 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 : $3mg(0{\cdot}8) - 0{\cdot}5mg(0{\cdot}6) = 5ma$ $5a = 2{\cdot}1g$ $a = \frac{21g}{50}$ M1 A1 A1
   (b) Dist = 1 m : $v^2 = 2(\frac{21g}{50})(1)$ $v = 2{\cdot}87$ ms^{-1} M1 A1
   (c) Time for Q to reach floor is t where $1 = 0{\cdot}21gt^2$ $t = 0{\cdot}697$ s M1 A1
   0·2 m at 2·87 ms^{-1} takes 0·0697 s, so total time = 0·767 s M1 A1 A1 14