MECHANICS 2 (A) TEST PAPER 7 : ANSWERS AND MARK SCHEME

1. $a = 2 - 16t^{-3} = 0$ when $t^3 = 8$ $\quad t = 2$ — M1 A1 M1 A1 A1 — 5

2. $8\pi(3) + 8(10) + 3(13{\cdot}5) = (11 + 8\pi)\bar{x}$ — M1 M1 A1 A1
   $\bar{x} = (24\pi + 120{\cdot}5) \div (8\pi + 11) = 5{\cdot}42$ cm — M1 A1 A1 — 7

3. (a) Net resisting force $= 2000 - 1600g \sin 7° = 89{\cdot}1$ N — M1 A1 A1
   $1500 = 89{\cdot}1v$ $\quad v = 16{\cdot}8$ ms^{-1} — M1 A1
   (b) Now accelerating force $= 100$ N $= 1600a$ $\quad a = 0{\cdot}0625$ ms^{-2} — M1 A1 — 7

4. (a) Displacement $= 12\mathbf{i} + 15\mathbf{j}$ $\quad$ Distance $= 3\sqrt{41}$ — M1 A1 A1
   $|\mathbf{F}| = \sqrt{41}$, so work done $= 3\sqrt{41} \times \sqrt{41} = 123$ J — M1 A1
   (b) $\mathbf{a} = 4\mathbf{i} + 5\mathbf{j}$ $\quad 12\mathbf{i} + 15\mathbf{j} = \frac{1}{2}(4\mathbf{i} + 5\mathbf{j})t^2$ $\quad t = \sqrt{6}$ — B1 M1 A1
   $\mathbf{v} = \sqrt{6}(4\mathbf{i} + 5\mathbf{j})$ $\quad |\mathbf{v}| = \sqrt{246} = 15{\cdot}7$ ms^{-1} — M1 A1 — 10

5. (a) (i) Momentum : $30mu + 15mu = 6mv + 5mkv$ — M1 A1
   $45u = (6 + 5k)v$ $\quad v = \frac{45u}{5k+6}$ — M1 A1
   (ii) Elasticity : $(kv - v) / (3u - 5u) = -e$ — M1 A1
   $(k - 1)v = (-2u)(-e)$ $\quad v = \frac{2eu}{k-1}$ — M1 A1
   (b) $\frac{45u}{5k+6} = \frac{2eu}{k-1}$ $\quad e = \frac{45(k-1)}{2(5k+6)}$ — M1 A1
   $0 \le e \le 1$, so $0 \le 45k - 45 \le 10k + 12$ $\quad 1 \le k \le \frac{57}{35}$ — M1 A1 A1 — 13

6. (a) $s = \frac{1}{2}gt^2 = \frac{1}{2} \times 9{\cdot}8 \times 3{\cdot}3^2 = 53{\cdot}4$ m — M1 A1
   (b) Ball, being lighter, may be affected by air resistance : include this — B1 B1
   (c) $x = (7 \cos 30°)t = \frac{7\sqrt{3}}{2}t$ $\quad y = (7 \sin 30°)t - \frac{1}{2}gt^2 = \frac{7}{2}t - 4{\cdot}9t^2$ — M1 A1 M1 A1
   (d) $t = \frac{2x}{7\sqrt{3}}$ $\quad y = \frac{x}{\sqrt{3}} - 4{\cdot}9\left(\frac{2x}{7\sqrt{3}}\right)^2 = \frac{\sqrt{3}}{3}x - \frac{2}{15}x^2$ — M1 A1 A1
   (e) When $x = 10$, $t = 1{\cdot}65$ $\quad v_x = 3{\cdot}5\sqrt{3}$, $v_y = 3{\cdot}5 - 1{\cdot}65g = -12{\cdot}67$ — M1 A1 A1
   $v = \sqrt{(6{\cdot}062^2 + 12{\cdot}67^2)} = 14{\cdot}0$ ms^{-1} — M1 A1 — 16

7. (a) $R = mg$, $F = S$ $\quad$ M(B) : $mga \cos \alpha = 2a\,S \sin \alpha$ — B1 B1 M1 A1
   $S = mg / 2 \tan \alpha = \frac{2mg}{3} = F$ — A1
   Resultant force at $B = \sqrt{[(mg)^2 + (\frac{2mg}{3})^2]} = \frac{\sqrt{13}}{3}mg$ — M1 A1
   (b) Angle $= \tan^{-1}(3/2) = 56°$ to horizontal — M1 A1 A1
   (c) M(B) : $mga \cos \alpha + 6mgx \cos \alpha = 2a\,S \sin \alpha$ — M1 A1 A1
   $S = \frac{2mg(a+6x)}{3a}$ $\quad$ When $S = 2mg$, $\quad a + 6x = 3a$ — A1 M1 A1
   $6x = 2a$ $\quad x = \frac{a}{3}$ — A1 — 17