MECHANICS 2 (A) TEST PAPER 5 : ANSWERS AND MARK SCHEME

1. (a) $v = \int a\,dt = 4t^2 - 18t + c$ $v(3) = 2 : c = 20$ $v = 4t^2 - 18t + 20$ M1 A1 M1 A1
   (b) $v = 0 : 2(t-2)(2t-5) = 0$ $t = 2,\ t = 2{\cdot}5$ M1 A1 A1 — 7

2. (a) Volume per second $= 12\pi(0{\cdot}04)^2 = 0{\cdot}0603\ m^3$ Mass $= 60{\cdot}3$ kg M1 A1
   P.E. gained per sec. $= 60{\cdot}3 \times g \times 25 = 14\,778$ J A1
   K.E. gained per sec. $= \frac{1}{2} \times 60{\cdot}3 \times 12^2 = 4342$ J M1 A1
   (b) Power = total energy per second $= 19\,120\ Js^{-1} = 19{\cdot}1$ kW M1 A1 — 7

3. (a) $\mathbf{v} = (4t-4)\mathbf{i} - 2t\,\mathbf{j}$ $t = 3 : \mathbf{v} = (8\mathbf{i} - 6\mathbf{j})\ ms^{-1}$ M1 A1 A1
   (b) $\mathbf{a} = 4\mathbf{i} - 2\mathbf{j}$ $|\mathbf{a}| = \sqrt{20}$, constant $F = 3\sqrt{20} = 13{\cdot}4$ N M1 A1 M1 A1 — 7

4. (a) $750(12{\cdot}5) = 180(21) + 570\bar{y}$ $\bar{y} = 9{\cdot}82$ cm M1 A1 M1 A1
   (b) Must have centre of mass 12·5 cm from ED B1
   $9{\cdot}816m + 13M = 12{\cdot}5(m + M)$ $0{\cdot}5M = 2{\cdot}684m$ $M = 5{\cdot}37m$ M1 A1 M1 A1 — 9

5. (a) $F - 700 = 1650 \times 1{\cdot}2$ $F = 700 + 1980 = 2680$ N M1 A1 A1
   (b) $F - 500 - T = 1100 \times 1{\cdot}2$ $T = 2180 - 1320 = 860$ N M1 A1 A1
   (c) $P = 2680 \times 18 = 48{\cdot}2$ kW M1 A1
   (d) $48240 = 18(700 + 1650g \sin 6° + 1650a)$ $a = 0{\cdot}176\ ms^{-2}$ M1 A1 A1
   (e) For trailer, $T - 200 - 550g \sin 6° = 550(0{\cdot}176)$ $T = 860$ N M1 A1 A1 — 14

6. (a) $y = (52 \sin\theta)t - \frac{1}{2}gt^2 = 20t - 5t^2$ M1 A1 A1
   (b) Lands when $y = 15$ $t^2 - 4t + 3 = 0$ $(t-1)(t-3) = 0$ M1 A1 A1
   Ball is coming down, so $t = 3$ A1
   (c) $x = (52 \cos\theta)t = 52 \times \frac{12}{13}t = 48t$ When $t = 3$, $x = 144$ m M1 A1 A1
   (d) $y = 20 \times \frac{x}{48} - 5 \times (\frac{x}{48})^2 = \frac{5}{12}x - \frac{5}{2304}x^2$ M1 M1 A1
   (e) Have ignored air resistance, which would make answer larger B1 B1 — 15

7. (a) Momentum : $3mu = 3mv_A + 4mv_B$ $3v_A + 4v_B = 3u$ M1 A1
   Elasticity : $(v_B - v_A)/(-u) = -e$ $3v_B - 3v_A = 3eu$ M1 A1
   Add : $3u(1+e) = 7v_B$ $v_B = \frac{3}{7}u(1+e)$ M1 A1
   (b) If $v_A = 0$, $v_B = eu$ and $4v_B = 3u$, so $e = 0{\cdot}75$ M1 A1 A1
   (c) Now A has speed $\frac{1}{3}ku$ $(v'_B - v'_A)/(0{\cdot}75u - \frac{1}{3}ku) = -0{\cdot}75$ M1 A1
   and $kmu + 3mu = 3mv'_A + 4mv'_B$ M1 A1
   $ku + 3u = 3v'_A + 4(v'_A - 0{\cdot}75(0{\cdot}75 - \frac{1}{3}k)u) = 7v'_A - 2{\cdot}25u + ku$ M1 A1
   $v'_A = 0{\cdot}75u$, which is independent of k A1 — 16