MECHANICS 2 (A) TEST PAPER 10 : ANSWERS AND MARK SCHEME

1. $2m\,(-1, 5) + 3m\,(0, 6) + 5m\,(3, -2) = 10m(\bar{x}, \bar{y})$ $(1{\cdot}3, 1{\cdot}8)$ M1 M1 A1 A1 4

2. $P = (2200 + 5000 \times 0.8)v = 6200 \times 10 = 62$ kW M1 A1 M1 A1 4

3. (a) Momentum : $0{\cdot}05u = M(0{\cdot}008u)$ $m = 6{\cdot}25$ kg M1 A1
   (b) K.E. given to bullet $= \frac{1}{2}(0{\cdot}05)u^2 = \frac{1}{40}u^2$ J M1 A1
   K.E. given to gun $= \frac{1}{2}(6{\cdot}25)(0{\cdot}008u)^2 = \frac{1}{5000}u^2$ J M1 A1
   (c) $u^2(\frac{1}{40} + \frac{1}{5000}) = 5100$ $u = 450$ M1 A1 8

4. (a) $\mathbf{v} = 4e^t\mathbf{i} - e^t\mathbf{j} + \mathbf{j}$ When $t = 2$, $\mathbf{v} = 4e^2\mathbf{i} + (1 - e^2)\mathbf{j}$ M1 A1 M1
   $= 29{\cdot}56\mathbf{i} - 6{\cdot}39\mathbf{j}$ $|\mathbf{v}| = 30{\cdot}2$ ms^{-1} A1 A1
   (b) Need $4e^t/(1 - e^t) = -5$ $4e^t = 5e^t - 5$ M1 A1 A1
   $e^t = 5$ $t = \ln 5 = 1{\cdot}61$ s M1 A1 10

5. (a) Resolve vert : $3g = R + \frac{1}{2}S$ Resolve horiz : $\frac{1}{3}R = \frac{\sqrt{3}}{2}S$ M1 A1 M1 A1
   Hence $3g = \frac{1}{2}(3\sqrt{3} + 1)S$ $S = 6g/(3\sqrt{3} + 1) = 9{\cdot}49$ N A1 M1 A1
   (b) M(B) : $3g/2 = Sd$ $d = 1{\cdot}55$ m M1 A1 A1 10

6. (a) Momentum : $1{\cdot}2 - 1{\cdot}6 = 0{\cdot}4v_A + 0{\cdot}8v_B$ $v_A + 2v_B = -1$ M1 A1
   Elasticity : $(v_B - v_A)/(-2 - 3) = -0{\cdot}8$ $v_A - v_B = -4$ M1 A1
   Solve : $v_A = -3$, $v_B = 1$ M1 A1 A1
   A has speed 3 ms^{-1}, B has speed 1 ms^{-1}, both directions reversed A1
   (b) K.E. lost $= 0{\cdot}2(9) + 0{\cdot}4(4) - 0{\cdot}2(9) - 0{\cdot}4(1) = 1{\cdot}2$ J M1 A1 A1 11

7. (a) $v(6) = 18 - 24 + 10 = 4$ ms^{-1} B1
   (b) $a = t - 4 = -3$ ms^{-2} when $t = 1$ magnitude $= 3$ ms^{-2} M1 A1 A1
   (c) When $a = 0$, $t = 4$ $v(4) = 8 - 16 + 10 = 2$ ms^{-1} M1 A1 A1
   (d) $s = \int_3^4 v\,dt = [\frac{1}{6}t^3 - 2t^2 + 10t]_3^4 = 18{\cdot}67 - 16{\cdot}5 = 2{\cdot}17$ m M1 A1 A1 M1 A1 12

8. (a) $y = (392 \sin\alpha)t - 4{\cdot}9t^2 = 19{\cdot}6t - 4{\cdot}9t^2$ M1 A1
   15 m above ground, $y = 9{\cdot}8$ $19{\cdot}6t - 4{\cdot}9t^2 = 9{\cdot}8$ M1
   $t^2 - 4t + 2 = 0$ $(t - 2)^2 - 2 = 0$ $t = 2 \pm \sqrt{2}$ M1 A1
   Times are from 0·586 s to 3·41 s A1
   (b) y is maximum when $19{\cdot}6 - 9{\cdot}8t = 0$ $t = 2$ $y = 19{\cdot}6$ M1 A1
   Height above ground = 24·8 m A1
   (c) $x = (392 \cos\alpha)t = 391{\cdot}5 \times 2 = 783$ m M1 A1 A1
   (d) Bullet = particle; assumed no air resistance Include this B1 B1
   (e) As bullet is small and moving fast, probably little difference B1 B1 16