

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

1. $2m(-1, 5) + 3m(0, 6) + 5m(3, -2) = 10m(\bar{x}, \bar{y})$ (1.3, 1.8) M1 M1 A1 A1 4
2. $P = (2200 + 5000 \times 0.8)v = 6200 \times 10 = 62 \text{ kW}$ M1 A1 M1 A1 4
3. (a) Momentum : $0.05u = M(0.008u)$ $m = 6.25 \text{ kg}$ M1 A1
 (b) K.E. given to bullet $= \frac{1}{2}(0.05)u^2 = \frac{1}{40}u^2 \text{ J}$ M1 A1
 K.E. given to gun $= \frac{1}{2}(6.25)(0.008u)^2 = \frac{1}{5000}u^2 \text{ J}$ M1 A1
 (c) $u^2(\frac{1}{40} + \frac{1}{5000}) = 5100$ $u = 450$ M1 A1 8
4. (a) $v = 4e^t i - e^t j + j$ When $t = 2$, $v = 4e^2 i + (1 - e^2)j$ M1 A1 M1
 $= 29.56i - 6.39j$ $|v| = 30.2 \text{ ms}^{-1}$ A1 A1
 (b) Need $4e^t/(1 - e^t) = -5$ $4e^t = 5e^t - 5$ M1 A1 A1
 $e^t = 5$ $t = \ln 5 = 1.61 \text{ s}$ 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 $3g = \frac{1}{2}(3\sqrt{3} + 1)S$ $S = 6g/(3\sqrt{3} + 1) = 9.49 \text{ N}$ A1 M1 A1
 (b) $M(B) : 3g/2 = Sd$ $d = 1.55 \text{ m}$ M1 A1 A1 10
6. (a) Momentum : $1.2 - 1.6 = 0.4v_A + 0.8v_B$ $v_A + 2v_B = -1$ M1 A1
 Elasticity : $(v_B - v_A)/(-2 - 3) = -0.8$ $v_A - v_B = -4$ 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 $= 0.2(9) + 0.4(4) - 0.2(9) - 0.4(1) = 1.2 \text{ J}$ M1 A1 A1 11
7. (a) $v(6) = 18 - 24 + 10 = 4 \text{ ms}^{-1}$ B1
 (b) $a = t - 4 = -3 \text{ ms}^{-2}$ when $t = 1$ magnitude $= 3 \text{ ms}^{-2}$ M1 A1 A1
 (c) When $a = 0$, $t = 4$ $v(4) = 8 - 16 + 10 = 2 \text{ ms}^{-1}$ M1 A1 A1
 (d) $s = \int_3^4 v dt = [\frac{1}{6}t^3 - 2t^2 + 10t]_3^4 = 18.67 - 16.5 = 2.17 \text{ m}$ M1 A1 A1 M1 A1 12
8. (a) $y = (392 \sin \alpha)t - 4.9t^2 = 19.6t - 4.9t^2$ M1 A1
 15 m above ground, $y = 9.8$ $19.6t - 4.9t^2 = 9.8$ 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 $19.6 - 9.8t = 0$ $t = 2$ $y = 19.6$ M1 A1
 Height above ground $= 24.8 \text{ m}$ A1
 (c) $x = (392 \cos \alpha)t = 391.5 \times 2 = 783 \text{ m}$ 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