

MECHANICS 2 (A) TEST PAPER 3 : ANSWERS AND MARK SCHEME

1. $m(5\mathbf{i} - 3\mathbf{j}) - 2\mathbf{i} - 4\mathbf{j} = m(3\mathbf{i} + k\mathbf{j})$ $5m - 2 = 3m$ $m = 1$ M1 A1 M1 A1
 $-3m - 4 = km$ $k = -7$ M1 A1 6
2. (a) $v = \int a \, dt = 6t^2 - 15t + c$ $v(0) = 0 : c = 0$ $v = 6t^2 - 15t$ M1 A1 A1
 (b) $6t^2 - 15t - 36 = 0$ $3(2t + 3)(t - 4) = 0$ $t = 4$ M1 A1 A1 6
3. Let reactions be R at ground, S at wall
 $M(A) : W(2a \cos \alpha) = S(3a \sin \alpha)$ $S = 2W \div 3 \tan \alpha = \frac{3}{7}W$ M1 A1 A1
 Resolve : $R = W$, $\mu R = S$ $\mu = S \div W = \frac{3}{7}$ B1 B1 M1 A1 7
4. (a) $a(60^2) = 90$ $a = \frac{1}{40}$ $b(60) = 30$ $b = \frac{1}{2}$ M1 A1 A1
 (b) $\mathbf{v} = \frac{1}{20}t\mathbf{i} + \frac{1}{2}\mathbf{j}$ $t = 60 : \mathbf{v} = 3\mathbf{i} + \frac{1}{2}\mathbf{j}$ $|\mathbf{v}| = 3.04 \text{ ms}^{-1}$ M1 A1 M1 A1
 (c) Sketch of parabola between (0, 0) and (90, 30) B2 9
5. (a) $2400 = 20k$ $k = 120$ $84000 = v(120v)$ $v = 26.5 \text{ ms}^{-1}$ M1 A1 M1 A1
 (b) $P = v(600g + 120v)$ $120v^2 + 5880v - 84000 = 0$ M1 M1 A1
 $v^2 + 49v - 700 = 0$ $v = (-49 + \sqrt{5201})/2 = 11.6 \text{ ms}$ M1 A1 A1 10
6. (a) Momentum : $4mu - 5mu = mv_P + mv_Q$ $v_P + v_Q = -u$ M1 A1
 Elasticity : $(v_Q - v_P)/(-5u - 4u) = -e$ $v_Q - v_P = 9eu$ M1 A1
 Add : $2v_Q = 9eu - u$ $v_Q = \frac{1}{2}(9e - 1)u$ M1 A1
 (b) $v_Q > 0$, so $9e > 1$ $e > \frac{1}{9}$ M1 A1
 (c) $v_P = -\frac{1}{2}(9e + 1)u$ After hitting wall, speed of $Q < \frac{1}{2}(9e - 1)u$ M1 A1
 which is clearly less than $|v_P|$, so there is no further collision A1 11
7. (a) (i) $168(10.5) + 94.5(7) = 262.5\bar{x}$ $\bar{x} = 9.24$ M1 M1 A1 A1
 (ii) $168(4) + 94.5(11) = 262.5\bar{y}$ $\bar{y} = 6.52$ M1 M1 A1 A1
 (b) $\tan \alpha = (21 - 9.24)/6.52 = 1.804$ $\alpha = 61.0^\circ$ M1 A1 A1 11
8. (a) $7 = \frac{1}{2}gt^2$ $t^2 = 14 \div 9.8$ $t = 1.195$ M1 A1
 In 1.195 s, stone travels $4 \times 1.195 = 4.78 \text{ m}$ M1 A1
 (b) When $x = 2.39$, $t = 0.598$ $y = 7 - \frac{1}{2}gt^2 = 5.25 \text{ m}$ M1 A1 M1 A1
 (c) $mgh = 1.5 \times 9.8 \times 7 = 102.9 \text{ J}$ M1 A1
 (d) $\frac{1}{2}mv^2 = mgh$ $v = \sqrt{2gh} = \sqrt{14g} = 11.7 \text{ ms}^{-1}$ M1 A1 A1
 (e) Modelled stone as particle, ignored air resistance, etc. B1 B1 15