

MECHANICS 2 (A) TEST PAPER 9 : ANSWERS AND MARK SCHEME

1. $m(5\mathbf{i} + 6\mathbf{j}) + 2m\mathbf{u} = m(-3\mathbf{i} + 2\mathbf{j}) + 2m(\mathbf{i} - 3\mathbf{j})$ M1 A1
 $5\mathbf{i} + 6\mathbf{j} + 2\mathbf{u} = -\mathbf{i} - 4\mathbf{j}$ $2\mathbf{u} = -6\mathbf{i} - 10\mathbf{j}$ $\mathbf{u} = (-3\mathbf{i} - 5\mathbf{j}) \text{ ms}^{-1}$ M1 A1 A1 5
2. Gain in K.E. = $\frac{1}{2} \times 55 \times (2.5^2 - 1.5^2) = 110 \text{ J}$ M1 A1
 Gain in P.E. = $55g(80 \sin 6^\circ) = 4507 \text{ J}$ M1 A1
 Work done = total energy gain = 4617 J M1 A1 6
3. (a) $\mathbf{r} = t^2 \mathbf{i} - \frac{2}{3}t^3 \mathbf{j} - 10\mathbf{i} + \mathbf{j} = (t^2 - 10)\mathbf{i} + (1 - \frac{2}{3}t^3)\mathbf{j}$ M1 M1 A1 A1
 (b) When $t = 4$, $\mathbf{r} = -6\mathbf{i} - \frac{13}{3}\mathbf{j}$ $|\mathbf{r}| = 7.40 \text{ m}$ M1 A1 A1 7
4. (a) $s = \frac{1}{2}at^2$: if time is doubled, acceleration is divided by 4 M1
 so net acc. = $\frac{1}{4}g$ $mg - R = ma$ $R = \frac{3}{4}g(0.6) = 4.41 \text{ N}$ A1 M1 A1
 (b) $v^2 = 2as = \frac{1}{2}g(2) = 9.8$ $v = 3.13 \text{ ms}^{-1}$ M1 A1 A1 7
5. (a) $M(2.5) + 2m(1) = (M + 2m)\bar{x}$ $\bar{x} = \frac{5M + 4m}{2M + 4m}$ M1 A1 M1 A1
 (b) $5M + 4m = 2.2(2M + 4m)$ $0.6M = 4.8m$ $M : m = 8 : 1$ M1 A1 A1 7
6. (a) $x = (u \cos \theta)t$, $y = h + (u \sin \theta)t - \frac{1}{2}gt^2$ B1 M1 A1
 $y = h + x \tan \theta - \frac{g}{2u^2 \cos^2 \theta} x^2$ $0 = h + d \tan \theta - \frac{gd^2}{2u^2 \cos^2 \theta}$ M1 A1 M1
 $\frac{gd^2}{2u^2} \sec^2 \theta - d \tan \theta - h = 0$ A1
 (b) Let $\tan \theta = T$ Subst. given values : $4.9(1 + T^2) - 14T - 7 = 0$ M1 A1
 $7T^2 - 20T - 3 = 0$ $(7T + 1)(T - 3) = 0$ $T = 3$ $\theta = 71.7^\circ$ M1 A1 A1 12
7. (a) $P = Fv = 210 \text{ W}$ M1 A1
 (b) $210 = v(42 + 84g \sin \alpha)$ $v = 210 \div (42 + 4g) = 2.59 \text{ ms}^{-1}$ M1 A1 M1 A1
 (c) $R = kv$ $42 = 5k$, so $k = 8.4$ M1 A1
 $210 = v(8.4v + 4g)$ $8.4v^2 + 39.2v - 210 = 0$ M1 A1 A1
 $3v^2 + 14v - 75 = 0$ $v = (-14 + \sqrt{1096})/6 = 3.18 \text{ ms}^{-1}$ A1 M1 A1 14
8. (a) Momentum : $m\mathbf{u} - k m \mathbf{u} = -m\frac{u}{5} + km\mathbf{v}$ $\frac{6u}{5} - ku = kv$ M1 M1 A1
 $v = u(\frac{6}{5k} - 1)$ A1
 (b) Elasticity : $(v + \frac{u}{5}) / (-u - u) = -e$ $v = 2eu - \frac{u}{5} = u(2e - \frac{1}{5})$ M1 A1 M1 A1
 (c) $v > 0$, so $\frac{6}{5k} > 1$ $k < \frac{6}{5}$ Also $2e > \frac{1}{5}$ $e > \frac{1}{10}$ M1 A1 M1 A1
 Hence $\frac{1}{10} < e \leq 1$, so $0 < v \leq \frac{2u}{5}$ $0 < \frac{6}{5k} - 1 \leq \frac{2}{5}$ M1 A1
 $\frac{6}{5k} \leq \frac{14}{5}$ $14k \geq 6$ $k \geq \frac{3}{7}$ $p = \frac{3}{7}, q = \frac{6}{5}$ M1 A1 A1 17