MECHANICS 2 (A) TEST PAPER 4 : ANSWERS AND MARK SCHEME

1. $m(7\mathbf{i} + 12\mathbf{j}) + 0{\cdot}4(-\mathbf{i} + 7\mathbf{j}) = m(-3\mathbf{i} + 4\mathbf{j}) + 0{\cdot}4(6{\cdot}5\mathbf{i} + 13\mathbf{j})$ M1 A1

   $7m - 0{\cdot}4 = -3m + 2{\cdot}6$ $\quad 10m = 3$ $\quad m = 0{\cdot}3$ M1 A1 — 4

2. Reaction at $X = R = 0{\cdot}75g$ $\quad$ Friction $= 0{\cdot}6R = 0{\cdot}45g$ B1 B1

   Reaction at $Y = S = 0{\cdot}45g$ B1

   M(X) : $0{\cdot}75g(a\cos\alpha) = 0{\cdot}45g(2a\sin\alpha)$ $\quad \tan\alpha = 0.83$ $\quad \alpha = 39{\cdot}8°$ M1 A1 A1 — 6

3. (a) $P = 15(35\,000 + 20\,000g\sin 10°) = 1\,035\,525{\cdot}6$ W ≈ 1040 kW M1 M1 A1 A1

   (b) $1\,035\,525{\cdot}6 = v \times 35\,000$ $\quad v = 29{\cdot}6$ ms^{-2} M1 A1 A1 — 7

4. (a) When $t = 4$, $\mathbf{r} = 12\mathbf{i} + (16k - 5)\mathbf{j}$ $\quad 16k - 5 = 1$ $\quad k = 0{\cdot}375$ M1 A1 A1

   (b) $\mathbf{v} = 2\mathbf{i} + 0{\cdot}75t\,\mathbf{j}$ $\quad \mathbf{a} = 0{\cdot}75\mathbf{j}$ $\quad |\mathbf{a}| = 0{\cdot}75$ ms^{-2}, due North M1 A1 A1 A1 — 7

5. $v_A + v_B = 7$ $\quad (v_B - v_A)/(0 - 7) = -e$ $\quad 2v_B = 7(e + 1)$ B1 M1 A1

   $4 + v'_B = v_B$ $\quad (4 - v'_B)/(0 - v_B) = -e$ $\quad 8 = v_B(e + 1)$ B1 M1 A1 A1

   $16 = 7(e + 1)^2$ $\quad e = 0{\cdot}512$ M1 A1 A1 — 10

6. (a) $360(15) = 12{\cdot}5\pi(25) + (360 - 12{\cdot}5\pi)\bar{x}$ $\quad \bar{x} = 13{\cdot}8$ M1 A1 A1

   $360(6) = 12{\cdot}5\pi(20/3\pi) + (360 - 12{\cdot}5\pi)\bar{y}$ $\quad \bar{y} = 6{\cdot}47$ M1 M1 A1 A1

   (b) $\tan\alpha = 13{\cdot}78 \div (12 - 6{\cdot}475) = 2{\cdot}494$ $\quad \alpha = 68{\cdot}2°$ M1 A1 M1 A1 — 11

7. (a) $500 = 25p + 5q$, $\quad 12\,000 = 900p + 30q$ B1 B1

   Solve : $750p = 9000$ $\quad p = 12$, $q = 40$ M1 A1 (both)

   (b) Graph : parabola, increasing from $t = 0$ B2

   (c) $a = 24t + 40$ $\quad t = 0 : a = 40$ ms^{-2} $\quad$ (or their q) M1 A1

   (d) $s = \int_0^{30} v\,dt = [4t^3 + 20t^2]_0^{30} = 126\,000$ m M1 A1 M1 A1

   (e) Travels a further $20 \times 12\,000 = 240\,000$ m B1

   Average speed $= 366\,000 \div 50 = 7320$ ms^{-1} M1 A1 — 15

8. (a) $x = (u\cos 45°)t$, $\quad y = (u\sin 45°)t - 4{\cdot}9t^2$ $\quad y = x - \frac{g}{u^2}x^2$ M1 M1 A1

   Need $15 \le 30 - 900\frac{g}{u^2}$ $\quad u \ge 60g$ $\quad u \ge 24{\cdot}2$ ms^{-1} M1 A1 M1 A1

   (b) At max. height, $u\sin 45° - gt = 0$ $\quad t = 1{\cdot}75$ $\quad y_{max} = 15$ M1 A1 M1 A1

   (c) When $t = 3{\cdot}5$, $x = 60$ m M1 A1

   (d) Ball modelled as particle; constant gravity; etc. B1 B1 — 15