MECHANICS 1 (A) TEST PAPER 10 : ANSWERS AND MARK SCHEME

1. (a) Weight = 19 – 18 = 1 N, so mass = 1 ÷ g = 0·102 kg = 102 g — M1 A1 A1
   (b) M(0) : 1(15) + 18(10) = 11(5) + 8x 8x = 140 x = 17·5 — M1 A1 A1
   (c) Assumed it is a straight line with weight acting at mid-point — B1 — 7

2. Resolve horizontally : $F\cos 30° = 2\cos 45° + 0{\cdot}25R$ — M1 A1
   Resolve vertically : $R + 2\sin 45° + F\sin 30° = 0{\cdot}3g$ — M1 A1
   $0{\cdot}866F = 1{\cdot}414 + 0{\cdot}25(0{\cdot}3g - 1{\cdot}414 - 0{\cdot}5F)$ — M1 A1
   $0{\cdot}991F = 1{\cdot}796$ $F = 1{\cdot}81$ — A1 — 7

3. (a) $250 = \frac{1}{2}(17 + 33)t$ $t = 500 \div 50 = 10$ s — M1 A1 A1
   (b) $v = u + at$: $33 = 17 + 10a$ $a = 1{\cdot}6$ ms^{-2} — M1 A1
   (c) $s = \frac{1}{2}(33 + 0) \times 6 = 99$ m — M1 A1 — 7

4. (a) $F = ma$ for R : $0{\cdot}5g - 2 = 0{\cdot}5a$ $a = 5{\cdot}8$ ms^{-2} — M1 A1 A1
   (b) $T - 0{\cdot}1g = 0{\cdot}1a$ $T = 0{\cdot}58 + 0{\cdot}98 = 1{\cdot}56$ N — M1 A1
   $2 - T = ma$ $5{\cdot}8m = 0{\cdot}44$ $m = 0{\cdot}0759$ — M1 A1 A1
   (c) String inextensible : if not, accelerations different — B1 B1
   Pulleys smooth : if not, tensions different either side of pulley — B1 B1 — 12

5. (a) Momentum : $18u - 16u = -18(u/2) + 16v$ — M1 A1 A1
   $2u = -9u + 16v$ $11u = 16v$ $v = \frac{11u}{16}$ — M1 A1
   (b) Velocity of Q was negative, now positive, so direction reversed — B1
   (c) Impulse = $16\,000(u + \frac{11u}{16}) = 27\,000u$ Ns — M1 A1 B1
   (d) $108\,000ut = 27\,000u$ $t = 0{\cdot}25$ s — M1 A1 A1 — 12

6. (a) (i) 1·5 ms^{-1} (ii) $-1\frac{1}{3}$ ms^{-1} — B1 B1
   (b) 2 × 7 m = 14 m — M1 A1
   (c) Line from (2, 3) to (4, 7) is $y - 3 = 2(t - 2)$ $y = 2t - 1$ — M1 A1 A1
   (d) Graph sketched : 6 horizontal line segments — B3
   (e) Steepest section has gradient –3, so max. speed = 3 ms^{-1} — M1 A1 A1 — 13

7. (a) $\overrightarrow{SO} = 10\mathbf{i} - 24\mathbf{j}$, having magnitude 26 km — B1 B1
   $\mathbf{v}_S = \frac{52}{26}(10\mathbf{i} - 24\mathbf{j}) = (20\mathbf{i} - 48\mathbf{j})$ km h^{-1} $\mathbf{v}_T = -50\mathbf{j}$ km h^{-1} — M1 A1 A1
   (b) $\mathbf{r}_S = -10\mathbf{i} + 24\mathbf{j} + \frac{t}{60}(20\mathbf{i} - 48\mathbf{j}) = (\frac{1}{3}t - 10)\mathbf{i} + (24 - \frac{4}{5}t)\mathbf{j}$ — M1 A1 A1
   $\overrightarrow{\mathbf{r}_T} = 25\mathbf{j} + \frac{t}{60}(-50\mathbf{j}) = (25 - \frac{5}{6}t)\mathbf{j}$ — M1 A1
   (c) $\overrightarrow{ST} = (10 - \frac{1}{3}t)\mathbf{i} + (1 - \frac{1}{30}t)\mathbf{j}$ $\tan\theta = (10 - \frac{1}{3}t) \div (1 - \frac{1}{30}t) = 10$ — M1 A1 M1 A1
   Bearing = 084·3° — A1
   (d) When $t = 30$, $\mathbf{r}_S = \mathbf{r}_T = \mathbf{0}$, so trains collide at O — M1 A1 — 17