4728 Mark Scheme January 2010

## 4728 Mechanics 1

| 1 i     | $v = 4.2 + 9.8 \times 1.5$   | M1   | Uses $v = u + gt$                                 |
|---------|--|------|---|
| 1       | $v = 18.9 \text{ ms}^{-1}$ .   | A1   | 18.9(15) from $g = 9.81$                          |
|         | v = 10.5 ms .  | [2]  | 10.5(15) Holli g = 5.01                           |
|         |  |      |   |
| ii      | $s = 4.2 \times 1.5 + 9.8 \times 1.5^{2}/2 \text{ or}$<br>$18.9^{2} = 4.2^{2} + 2 \times 9.8s$ | M1   | Uses $s = ut + gt^2/2$ or $v^2 = u^2 + 2gs$       |
|         | $18.9 = 4.2 + 2 \times 9.88$<br>s = 17.325 m   | A1   | Accept 17.3                                       |
|         | 5 - 17.525 M   | [2]  | _   |
| iii     | $v^2 = 4.2 + 2 \times 9.8 \times (17.3(25) - 5)$   | M1   | $18.9^2 = u^2 + 2 \times 9.8 \times 5$            |
|         | $v = 16.1 \text{ ms}^{-1}$   | A1   | $u = 16.1 \text{ ms}^{-1}$ .                      |
|         |  | [2]  | Accept answers close to 16.1 from correct         |
|         |  |      | working   |
| 2 i     | Resolves a force in 2 perpendicular  | M1   | Diagram for vector addition/subtraction           |
|         | directions   |      |   |
|         | Uses Pythagoras  | DM1  | Uses Cosine Rule                                  |
|         | $R^2 = (12 + 19\cos 60)^2$   | A1   | $R^2 = 12^2 + 19^2 -$                             |
|         | $+(19\sin 60)^2$   | A1   | $2 \times 12 \times 19 cos 120$                   |
|         | R = 27.1  N  | A1   | R = 27.1  |
|         | $\{R = \sqrt{((19+12\cos 60)^2 + (12\sin 60)^2}) = 27.1\}$                                     | [5]  |   |
| <u></u> | TD: 1:1.: 1.6  | 3.61 | Fid. D.d.   |
| ii      | Trig on a valid triangle for correct angle   | M1   | Either Pythagoras or vector add/sub triangle      |
|         | $\tan\theta = (19\sin 60)/(12 + 19\cos 60)$ etc  | A1   | $sin\theta/19 = sin120/(27.1)$ etc                |
|         | Angle is 37.4°, 37.5°  | A1   |   |
|         |  | [3]  |   |
| 3ia     | $+/-(9m + 2 \times 0.8)$ { $+/-(3.5 \times 0.8 - 2 \times 0.8)$ }                              | B1   | Before mom, or mom change Q, OK with g            |
| Ju      | $+/-(-3.5m + 3.5 \times 0.8)$ { $+/-(9m + 3.5m)$ }   | B1   | After mom, or mom change P, OK with g             |
|         | $+/-(9m + 2 \times 0.8) = +/-(-3.5m + 3.5 \times 0.8)$   | M1   | Equates moms, or changes, accept with g           |
|         | m = 0.096  kg  | A1   | Do not award if g used                            |
| ib      |  | [4]  |   |
|         | +/-0.096(9+/-3.5) <i>OR</i> +/-0.8(3.5 -2)   | M1   | Using before & after speeds of P or Q, no g       |
|         | +/-1.2 kgms <sup>-1</sup>  | A1ft | ft $12.5 \times cv(0.096)$                        |
|         | -  | [2]  |   |
| ii      | (0.8+0.4)v or $0.8v + 0.4v$  | M1   | Using Q and R common speed after, no g            |
|         | $3.5 \times 0.8 + 0.4 \times 2.75 = (0.8 + 0.4)v$  | A1   | 2.8 + 1.1 = 1.2v                                  |
|         | $v = 3.25 \text{ ms}^{-1}$   | A1   |   |
|         |  | [3]  |   |
| 4ia     | 0.3gcos 60 and 0.3gsin60   | B1   | Accept use of " $m = 0.1 \text{ kg}$ " for M1 and |
|         | 0.4gcos60 and 0.4gsin60  | B1   | 0.1gcos60 (B1) 0.1gsin60 (B1)                     |
|         | Calculates either relevant difference  | M1   |   |
|         | Perp = 0.1gcos60  and  Para = +/-0.1gsin60   | A1   | = 0.49  and = 0.849  (accept  0.85  and  0.84)    |
|         |  | [4]  |   |
| ib      | $0.1 g \sin 60 = \mu 0.1 g \cos 60$  | M1   | $F = \mu R, F > R > 0$                            |
|         | $=1.73 \ (=\sqrt{3})$  | A1   | From correct R, F values                          |
|         |  | [2]  |   |

4728 Mark Scheme January 2010

| 4 ii | 0.5g - T = 0.5a<br>T - 0.4g = 0.4a<br>$a = 1.09 \text{ ms}^{-2}$<br>T = 4.36  N   | M1 A1 B1 B1 [4]                   | N2L for either particle no resolving, at least 1 unknown Formula round the pulley, M0A0. But award M1 for T-0.4g = $0.4 \times 1.09$ etc later Both equations correct                          |
|------|---|-----------------------------------|--|
| 5 i  | 11 = 3 + 20a  8 = 3 + (11-3)t/20  t = 12.5  (a = 0.4)   | M1<br>M1<br>A1<br>[3]             | Uses $v = u + at$ , no zero terms<br>Their a>0. $t/20 = (8-3)/(11-3)$ is M1M1  |
| ii   | $s(A,20) = 8 \times 20 \ (=160)$ $s(B,20) = (3+11) \times 20/2 =$ $3 \times 20 + 0.4 \times 20^2/2 \ (=140)$ $8T = (3+11) \times 20/2 + 11 \times (T-20)$ or $(160 - 140) = 11t - 8t$ $T = 26 \ 2/3$            | B1<br>B1<br>M1<br>A1<br>A1<br>[5] | Or $s(A) = 8T$<br>or as stage of $s(B)=(3+11)\times 20/2 + 11\times (T-20)$<br>3 part equation balancing distances<br>Accept 26.6 or 26.7  |
| iii  |   | B1<br>B1<br>B1<br>[3]             | Linear rising graph (for A) starting at B's start Non-linear rising graph for B below A's initially. Accept 2 straight lines as non-linear. Single valued graphs graphs intersect and continue |
| 6 i  | $a = 2 \times 0.006t - 0.18$<br>a = 0.012t - 0.18   | M1<br>A1<br>[2]                   | Differentiates v (not v/t) Award for unsimplified form, accept +c, not +k  |
| ii   | $0.012t - 0.18 = 0$ $t = 15$ $0.006 \times 15^{2} - 0.18 \times 15 + k = 0.65$ $k = 2$ AG   | M1* A1 D*M1 A1 A1 [5]             | Sets a = 0, and solves for t  Substitutes t(v(min)) in v(t)  |
| iii  | $s = 0.006t^{3}/3 - 0.18t^{2}/2 + 2t (+c)$ $(s = 0.002t^{3} - 0.09t^{2} + 2t (+c))$ $t = 0, s = 0 \text{ hence } c = 0$ $L = 0.002 \times 28.4^{3} - 0.09 \times 28.4^{2} + 2 \times 28.4$ $L = 30.0 \text{ m}$ | M1A1 B1 M1 A1 [5]                 | Integrates v (not multiplies by t). Award if +c omitted, accept kt Explicit, not implied (or uses limits 0, 28.4) Substitutes 28.4 or 14.2 in s(t), (and k=2) Accept a r t 30(.0), accept +c   |

## 4728 Mark Scheme January 2010

| 7 i  | $(Fr =) 0.15 \times 600g\cos 10$<br>(Wt cmpt =) 600gsin10     | B1<br>B1 | Implied by $Fr = 0.15 \times 600g\cos 10 \ (=868.6)$                   |
|------|---|----------|--|
|      | $600 \times 0.11 = T - 0.15 \times 600g\cos 10 - 600g\sin 10$ | M1       | N2L. T with at least 1 resolved forces and $600 \times 0.11$           |
|      | (66 = T - 868.6 – 1021)<br>T = 1960 N                         | A1<br>A1 | 1955.6   |
|      | 1 – 1700 IV   | [5]      | 1733.0   |
| ii a | $a(up) = +/-(600g\sin 10 + .15 \times 600g\cos 10)/600$       | M1       | 2 resolved forces and 600a or "unit mass"                              |
|      | $a(up) = +/-3.15 \text{ ms}^{-2}$ AG                          | A1 [2]   | Disregard sign, accept 3.149   |
| b    | $UP 	 v^2 = 2 \times 0.11 \times 10$                          | M1       |  |
| ~    | v = 1.48 when cable breaks                                    | A1       | Correct, need not be accurate  |
|      | t = 1.48/3.149  | M1       | Or $1.48 = 0 + 3.15t$  |
|      | (t = 0.471  time for log to come to rest)                     |          |  |
|      | $s = 1.48^2/(2 \times 3.149)$                                 | M1       |  |
|      | s = 0.349 distance for log to come to                         | A1       | Correct, need not be accurate  |
|      | rest  |          |  |
|      | DOWN  | D.1      | 0.254  |
|      | $a(down) = (600gsin10 - 0.15 \times 600gcos10)/600$           | B1       | = 0.254  |
|      | $10 + 0.349 = 0.254t^2/2$                                     | M1       | Needs a $< 3.15$ , s>10. Or $V^2 =$                                    |
|      | t = 9.025   | A1       | 2×0.254× (10+0.349) [ V= 2.29], V=0.254t Correct, need not be accurate |
|      | T = 9.023<br>T = (9.025 + 0.471) = 9.5  s                     | A1<br>A1 | Accept 9.49  |
|      | 1 - (3.023 + 0.471) - 9.3 8                                   | [9]      | Αιτερί 7.47  |