

| Question | | Answer | Marks | AO | Guidance | |
|----------|-----|---|---------------|-------------|--|---|
| 13 | (a) | $R(\text{perp. plane}) : R = mg \cos 36.86\dots$ or $mg \times 0.8$ | B1 | 3.3 | Allow using an angle of 37 or better | soi (possibly in N2L) |
| | | $F = 0.25 \times mg \cos 36.86\dots$ or $0.25 \times mg \times 0.8$ | M1* | 3.4 | $F = 0.25R$ with their R (with $R \neq mg$) – using an angle of 37 or better – allow sin/cos mix | R must be a component of weight soi (possibly in N2L) |
| | | N2L (parallel to plane): $-0.25 \times mg \times 0.8 - mg \times 0.6 = ma$ or $-0.25 \times mg \times \cos 36.86\dots - mg \times \sin 36.86\dots = ma$ | M1dep* | 3.1b | Applying N2L parallel to the plane with correct number of terms and weight term resolved, dimensionally consistent – if down the plane is the positive direction expect $0.25 \times mg \times 0.8 + mg \times 0.6 = ma$ | Allow sign errors and sin/cos mix, using an angle of 37 or better |
| | | $a = -7.84$ or 7.84 | A1 | 1.1 | $\pm 0.8g$ - allow awrt ± 7.84 or awrt ± 7.85 (using an angle of 37) www | Condone ± 7.8 or ± 7.9 www |
| | | $v^2 = 6^2 + 2 \times -7.84 \times 1.375$ | M1dep* | 3.4 | Use of $v^2 = u^2 + 2as$ with correct u and s and their negative a ($\neq -9.8$)- dependent on both previous M marks – must see the values substituted into the formula (as value for v is AG) – therefore just seeing $v^2 = \frac{361}{25}$ or 14.44 is M0 | Condone finding a positive value of a and then using the negative version |
| | | $v^2 = 14.44 \Rightarrow v = 3.8 \text{ (ms}^{-1}\text{)}$ | A1 | 2.2a | AG – do not award this mark if using any non-exact values for $\sin \theta / \cos \theta$ (so seeing e.g. $\cos 36.86\dots$ in their working loses this final A mark) | Must see either $v^2 = 14.44$ or $v^2 = 36 - 21.56$ or $v^2 = 6^2 - 21.56$ or a correct expression for v before given answer |
| | | | [6] | | | |

SC – if m absent throughout (so implying $m = 1$) or m given a numerical value then at most **B0 M1 M1 A1 M1 A0** can be awarded.

| Question | | Answer | Marks | AO | Guidance | |
|----------|-----|---|-------|------|--|--|
| 13 | (b) | Time from A to B is t_1 where $3.8 = 6 + (-7.84)t_1$ | M1 | 3.4 | Use of $v = u + at$ with correct u and v , and their negative a from (a) (or any other complete method e.g. $1.375 = \left(\frac{6+3.8}{2}\right)t_1$) | Give BOD if $6 = 3.8 + 7.84t_1$ seen but if $v = u + at$ stated before then M0 |
| | | $[t_1 =] 0.281$ (s) | A1 | 1.1 | awrt 0.281 or accept 0.28 w/w. If exact then expect $\frac{55}{196}$ | 0.2806122... |
| | | [Height of P at B is] 0.825 (m) | B1 | 3.1b | Must be exact e.g. $\frac{33}{40}$ – allow un-simplified e.g. 1.375×0.6 | Allow negative |
| | | $-0.825 = (3.8 \times 0.6)t_2 + 0.5(-g)t_2^2$ or $-0.825 = (3.8 \times \sin 36.86\dots)t_2 + 0.5(-g)t_2^2$ ($4.9t_2^2 - 2.28t_2 - 0.825 = 0$) | M1 | 3.1b | M1 for an equation for time t_2 (from B to C) with awrt ± 0.83 for s , $a = \pm g$ and either $u = 3.8 \times \sin \theta$ or $u = 3.8 \times \cos \theta$ with $\theta = 37$ (or better) substituted (or corresponding exact value) – condone sign errors | |
| | | $T [= 0.280\dots + 0.704\dots] = 0.985$ | A1 | 1.1 | A1 for a correct (un-simplified) equation for t_2 - must be using 0.825 but allow $\theta = 37$ or better | For reference: $t_2 = 0.704346599\dots$ |
| | | | A1 | 2.2a | awrt 0.985 only – dependent on all previous marks in this part | 0.984958... |
| | | | [6] | | | |

Alternative Energy Approach to 13(a)

R (perp. plane): $R = mg \cos 36.86\dots$ or $mg \times 0.8$

B1 Allow using an angle of 37 or better
soi (possibly in Work-Energy equation)

$F = 0.25 \times mg \cos 36.86\dots$ or $0.25 \times mg \times 0.8$

M1 Use of $F = 0.25R$ with their R (with $R \neq mg$)
– using an angle of 37 or better – allow sin/cos mix
 R must be a component of weight not mass
soi (possibly in W-E equation)

Work done by gravity/PE term = $\pm mg \times (1.375 \times 0.6)$ or $\pm mg \times (1.375 \times \sin 36.86\dots)$

OR Work done by friction $\pm 1.375 \times (0.25 \times mg \times 0.8)$ or $\pm 1.375 \times (0.25 \times mg \times \cos 36.86\dots)$

B1 Correct expression for either WD by gravity or friction
– using an angle of 37 or better
soi (possibly in W-E equation)

$\frac{1}{2}mv^2 - \frac{1}{2}m \times 6^2 = -mg(1.375 \times 0.6) - 1.375 \times (0.25 \times mg \times 0.8)$

M1 Attempt at W-E principle – equation with the correct
number of relevant terms, dimensionally correct,
allow sign errors and sin/cos mix,
M0 if PE term is $\pm 1.375mg$

A1 Correct W-E equation

$v^2 = 14.44 \Rightarrow v = 3.8 \text{ (ms}^{-1}\text{)}$

A1 **AG** – do not award this mark if using any
non-exact values for $\sin \theta / \cos \theta$
Must see either $v^2 = 14.44$ or $v^2 = 36 - 21.56$
or $v^2 = 6^2 - 21.56$ or a correct expression
for v before given answer

SC – if m absent throughout (so implying $m = 1$) or m given a numerical value then at most **B0 M1 B1 M1 A1 A0** can be awarded.