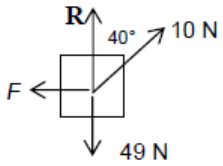
# Answers - Forces and Equilibrium 1

1.

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|---|---|---|---|---|
| (i) | $R = mg$ so 49 N | B1 | Equating to weight. Accept $5g$ (but not $mg$) | 1 |
| (ii) |  | B1<br><br>B1 | All except $F$ correct (arrows and labels) (Accept $mg$, $W$ etc and no angle). Accept cpts instead of 10N. No extra forces.<br>$F$ clearly marked and labelled | 2 |
| (iii) | $\uparrow \quad R + 10\cos 40 - 49 = 0$<br><br>$R = 41.339\ldots$ so 41.3 N (3 s. f.)<br>$F = 10\sin 40 = 6.4278\ldots$ so 6.43 N (3 s. f.) | M1<br>B1<br><br>A1<br>B1 | Resolve vertically. All forces present and 10N resolved<br>Resolution correct and seen in an equation. (Accept $R = \pm 10\cos 40$ as an equation)<br><br>Allow –ve if consistent with the diagram. | 4 |

2.

| | | | | |
|---|---|---|---|---|
| (i) | $\rightarrow \quad 40 - P\cos 60 = 0$<br><br>$P = 80$ | M1<br><br>A1<br>A1 | For any resolution in an equation involving $P$. Allow for $P = 40\cos 60$ or $P = 40\cos 30$ or $P = 40\sin 60$ or $P = 40\sin 30$<br>Correct equation<br>cao | 3 |
| (ii) | $\downarrow \quad Q + P\cos 30 = 120$<br><br>$Q = 40\left(3 - \sqrt{3}\right) = 50.7179\ldots$ so 50.7 (3 s. f.) | M1<br><br>A1 | Resolve vert. All forces present. Allow $\sin \leftrightarrow \cos$ No extra forces. Allow wrong signs.<br><br>cao | 2 |

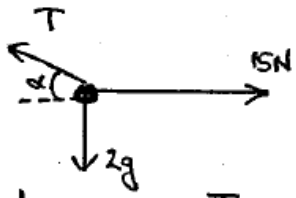
3.

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|---|---|---|---|---|
| | Take $F$ +ve up the plane<br>$F + 40\cos 35 = 100\sin 35$<br><br>$F = 24.5915\ldots$ so 24.6 N (3 s. f.)<br><br>up the plane | M1<br><br><br>B1<br>A1<br><br>A1 | Resolve // plane (or horiz or vert). All forces present.<br>At least one resolved. Allow $\sin \leftrightarrow \cos$ and sign errors. Allow $100g$ used.<br>Either $\pm 40\cos 35$ or $\pm 100\sin 35$ or equivalent seen<br>Accept $\pm 24.5915\ldots$ or $\pm 90.1237\ldots$ even if inconsistent or wrong signs used.<br>24.6 N up the plane (specified or from diagram) or equiv all obtained from consistent and correct working. | 4 |

4.

| | | |
|---|---|---|
| Diagram | B1<br>B1 | Weight, friction and 121 N present with arrows.<br>All forces present with suitable labels. Accept $W$, $mg$, $100g$ and 980. No extra forces. |
| Resolve $\rightarrow$ $121\cos 34 - F = 0$<br>$F = 100.313\ldots$ so 100 N (3 s. f.) | M1<br>E1 | Resolving horiz. Accept s $\leftrightarrow$ c .<br>Some evidence required for the *show*, e.g. at least 4 figures. Accept $\pm$ . |
| Resolve $\uparrow$ $R + 121\sin 34 - 980 = 0$<br><br>$R = 912.337\ldots$ so 912 N (3 s. f.) | M1<br>B1<br>A1 | Resolve vert. Accept s $\leftrightarrow$ c and sign errors.<br>All correct |

5.




a) ONE Hydrostatics equation e.g. $T\cos\alpha = 15$ OR $T\sin\alpha = 2g$ are most likely but $T = 15\cos\alpha + 2g\sin\alpha$, $2g\cos\alpha = 15\sin\alpha$ also possible as is also Hamis theorem. M1

One equation correct; second independent eqn. correct (omission of g loses A1 only) A1 + A1

$\tan\alpha = \frac{2g}{15}$ or $\frac{2}{15}$ [$\tan\alpha = \frac{15}{2g}$ scores M1 A0] M1 A1ft

Answer for $\alpha$ as $53^\circ$ OR $52.6^\circ$ A1 (6)

b) Using valid equation (first M1 required) to extract value of T (or eliminating $\alpha$ from valid eqns) M1

$T = 24.7$ or 25 A1 (2)

6.

| | | | | |
|---|---|---|---|---|
| **(i)** | $m \times 9.8 = 58.8$<br>so $m = 6$ | M1<br>A1 | $T = mg$. Condone sign error.<br>cao. CWO. | 2 |
| **(ii)** | Resolve $\rightarrow$ $58.8\cos 40 - F = 0$<br><br>$F = 45.043\ldots$ so 45.0 N (3 s. f.) | M1<br><br>B1<br>A1 | Resolving **their** tension. Accept $s \leftrightarrow c$. Condone sign errors but not extra forces.<br>(**their** $T$) $\times \cos 40$ (or equivalent) seen<br>Accept $\pm$ 45 only. | 3 |
| **(iii)** | Resolve $\uparrow$ $R + 58.8\sin 40 - 15 \times 9.8 = 0$<br><br>$R = 109.204\ldots$ so 109 N (3 s. f.) | M1<br><br>A1<br>A1 | Resolving **their** tension. All forces present. No extra forces. Accept $s \leftrightarrow c$. Condone errors in sign.<br>All correct<br>cao | 3 |

7.

| | | | | |
|---|---|---|---|---|
| **(i)** | Up the plane $T - 4g\sin 25 = 0$<br><br>$T = 16.5666\ldots$ so 16.6 N (3 s. f.) | M1<br><br>A1 | Resolving parallel to the plane. If any other direction used, all forces must be present. Accept s $\leftrightarrow$ c.<br>Allow use of $m$. No extra forces. | 2 |
| **(ii)** | Down the plane,<br>$(4 + m)$g sin25 $- 50 = 0$<br><br>$m = 8.0724\ldots$ so 8.07 (3 s. f.) | M1<br><br>A1<br>A1 | No extra forces. Must attempt resolution in at least 1 term. Accept s $\leftrightarrow$ c. Accept $M$g sin25. Accept use of mass.<br>Accept $Mg$sin25 | 3 |
| **(iii)** | Diagram | B1<br><br>B1 | Any 3 of weight, friction normal reaction and $P$ present in approx correct directions with arrows.<br>All forces present with suitable directions, labels and arrows. Accept $W$, $mg$, 4g and 39.2. | 2 |
| **(iv)** | Resolving up the plane<br><br>$P\cos 15 - 20 - 4g\sin 25 = 0$<br><br>$P = 37.8565\ldots$ so 37.9 N (3 s. f.) | M1<br><br>B1<br>B1<br><br>A1<br>A1 | Or resolving parallel to the plane. All forces must be present. Accept s $\leftrightarrow$ c. Allow use of $m$. At least one resolution attempted and accept wrong angles. Allow sign errors.<br>$P\cos 15$ term correct. Allow sign error.<br>Both resolutions correct. Weight used. Allow sign errors. ft use of $P$ sin 15.<br>All correct but ft use of $P$ sin 15. | 5 |

| | | | | |
|---|---|---|---|---|
| (v) | Resolving perpendicular to the plane | M1 | May use other directions. All forces present. No extras.<br>Allow s ↔ c . Weight not mass used.<br>Both resolutions attempted. Allow sign errors. | |
| | $R + P\sin 15 - 4g\cos 25 = 0$ | B1 | Both resolutions correct. Allow sign errors. Allow use of $P\cos 15$ if $P\sin 15$ used in (iv). | |
| | | F1 | All correct. Only ft **their** $P$ and their use of $P\cos 15$. | |
| | $R = 25.729\ldots$ so 25.7 N | A1 | c.a.o. | 4 |

8.

| | | | | |
|---|---|---|---|---|
| **(i)** | 20cos 15 = 19.3185….<br>so 19.3 N (3 s. f.) in direction BC | B1 | Accept no direction. Must be evaluated | 1 |
| **(ii)** | Let the tension be $T$<br>$T\sin 50 = 19.3185\ldots$<br>so $T = 25.2185\ldots$ so 25.2 N (3 s. f.) | M1<br>F1 | Accept sin ↔ cos but not (i) × sin 50<br>FT **their** 19.3… only. cwo | 2 |
| **(iii)** | $R + 20\sin 15 - 2.5g - 25.2185\ldots \times \cos 50 = 0$ | M1 | Allow 1 force missing or 1 tension not resolved. FT $T$.<br>No extra forces. Accept mass used.<br>Accept sin ↔ cos . | |
| | | B1 | Weight correct | |
| | | A1 | All correct except sign errors. FT **their** $T$ | |
| | $R = 35.5337\ldots$ so 35.5 N (3 s. f.) | A1 | cao. Accept 35 or 36 for 2. s.f. | 4 |
| **(iv)** | The horizontal resolved part of the 20 N force is not changed. | E1 | Accept no reference to vertical component but do not accept 'no change' to both components.<br>No need to be explicit that value of tension in AB depends only on horizontal component of force at C | 1 |

9.

| | | | | |
|---|---|---|---|---|
| **(i)** | Component of weight down the plane is $1.5\times 9.8\times \frac{2}{7} = 4.2$ N | M1 | Use of $mgk$ where $k$ involves an attempt at resolution | |
| | | E1 | Accept $1.5\times 9.8\times \frac{2}{7} = 4.2$ or $14.7\times \frac{2}{7} = 4.2$ seen | 2 |
| **(ii)** | Down the plane. Take $F$ down the plane.<br>$4.2 - 6.4 + F = 0$ | M1 | Allow sign errors. All forces present. No extra forces. | |
| | so $F = 2.2$. Friction is 2.2 N down the plane | A1 | Must have direction. [Award 1 for 2.2 N seen and 2 for 2.2 N down plane seen] | 2 |

10.

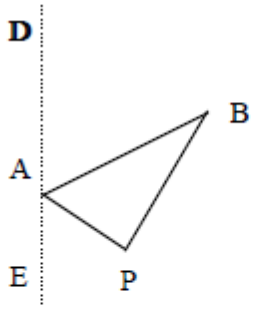
| | | | |
|---|---|---|---|
| (i) | Resolving | M1 | Resolving in at least 1 of horiz or vert. Accept sin ↔ cos . No extra terms. |
| | ← $250\sin 70 = 234.92...$ so 235 N (3 s. f.) | A1 | Either both expressions correct (neglect direction) or one correct in correct direction |
| | ↑ $250\cos 70 = 85.5050...$ so 85.5 N (3 s. f.) | A1<br>3 | cao Both evaluated and directions correct |
| (ii) | $250 \div 2 = 125$ N | B1<br>1 | Accept $125g$ only if tension taken to be $250g$ in (i) |

11.

| | | |
|---|---|---|
| (i) | | B1<br><br>B1<br><br>2 |
| (ii) | **Either** Up the plane<br>$P\cos 20 - 15 \times 9.8 \times \sin 20 = 0$<br><br>$P = 53.50362...$ so 53.5 (3 s. f.) | M1<br><br>A1<br>A1<br>3 |

12.

(i)




$\angle BAD = 60°$ and $\angle PAE = 60° \Rightarrow \angle PAB = 60°$ (Angles on straight line)

$\angle PAB = 60°$ and $\angle ABP = 30° \Rightarrow \angle APB = 90°$ (Angles in triangle)

B1

[1]

(ii)

Tension in string BP is 17.3 N

Tension in string AP is 10 N