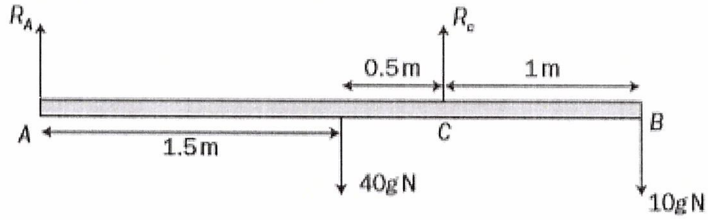
Godalming College

# Mechanics 9 – Statics 1: Solutions

## Section 1

| Question Number | Scheme |
|---|---|
| **1.** (a) |  |
| (b) | Taking moments about A:<br>$40g \times 1.5 + 10g \times 3 = R_c \times 2$<br>$882 = 2R_c$<br>$R_c = 441$ N<br>Resolving vertically:<br>$R_A + R_C = 40g + 10g$<br>$R_A = 50g - 441$<br>$R_A = 49$ N |
| (c) | $R_A = 0$ on point of tipping about C.<br>Taking moments about C:<br>$40g \times 0.5 = (mg) \times 1$<br>$20g = mg$<br>$m = 20$ kg |
| **2.** (a) | (i) Taking moments about B:<br>$(20g \times 2) + (8g \times 3) = 4R \Rightarrow R = 156.8$ N<br>(ii) Resolving vertically: $R + T = 28g \Rightarrow T = 117.6$ N |
| (b) | If $T = 170$N, $R = 28g - 170 = 104.4$ N<br>Taking moments about B:<br>$104.4 \times 4 - 20g \times 2 = 8gx$<br>$x = 25.6 \div 8g = 0.327$ m from B |

**3.** (a) Q1 = 0.8, Q3 = 11.5 so interquartile range = 11.5 – 0.8 = 10.7

Q1 – 1.5 x IQR = 0.8 – 16.05 = -15.25

Q3 + 1.5 x IQR = 11.5 + 16.05 = 27.55 so no outliers

(b) Either answer possible as long as reason justifies it – e.g. yes, as there are some extreme values in the Perth data and a sample may consist of lots of values close to zero and one or two relatively extreme values or e.g. no, as the vast majority of values are close to zero so we are less likely to select an extreme value.

## Section 2

1. (i) Resolving vertically, $P\cos30 - 10 = 0$, so $P = 10/\cos30 = \frac{20}{\sqrt{3}}$ N (oe)

   Resolving horizontally $X - P\sin30 = 0$, so $X = 0.5 \times P = \frac{10}{\sqrt{3}}$ N (oe) **(4 marks)**

   (ii) Resolving vertically, $6 + 8\cos\theta - 10 = 0$, so $\cos\theta = 0.5$ and $\theta = 60^0$

   Resolving horizontally $8\sin\theta - W = 0$, so $W = 8\sin60 = 4\sqrt{3}$ N **(4 marks)**

   (iii) Resolving perpendicular to the plane:

   $R - 30\cos20 = 0$ so $R = 30\cos20 = 28.2$ N (3sf)

   Resolving parallel to the plane:

   $F - 30\sin20 = 0$, so $F = 30\sin20 = 10.3$ N (3sf) **(4 marks)**

   (iv) Resolving parallel to the plane:

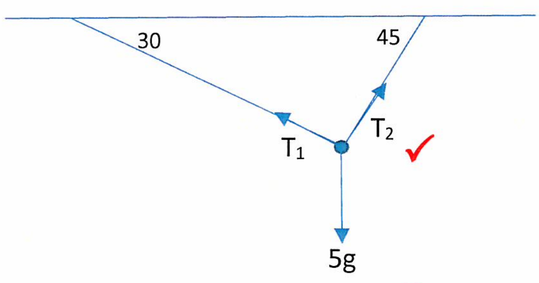
   $T\cos\theta - 7 - 10\sin30 = 0$, so $T\cos\theta = 12$ (I)

   Resolving perpendicular to the plane:

   $5 + T\sin\theta - 10\cos30 = 0$, so $T\sin\theta = 5\sqrt{3} - 5$(II)

   Dividing (II) by (I) gives $\tan\theta = \frac{5\sqrt{3}-5}{12}$ so $\theta = 17.00$ (3sf)

   Substituting into (I) gives $T = 12/\cos\theta = 12.5$ N (3sf) **(6 marks)**

2. 

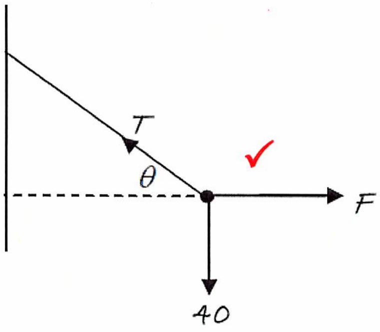

   Resolving vertically: $T_2\sin45 + T_1\sin30 = 5g$

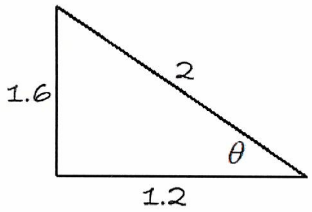
   Resolving horizontally: $T_1\cos30 = T_2\cos45$

   But $T_2\sin45 = T_2\cos45$, so $T_1\cos30 + T_1\sin30 = 5g$ so $T_1 = \frac{10g}{\sqrt{3}+1} = 35.9$ N (3sf)

   So $T_2 = \frac{35.9+\cos 30}{\cos 45} = 43.9$ N (3sf) **(8 marks)**

3.




Resolving vertically: $T\sin\theta - 40 = 0$

$$\frac{1.6}{2}T = 40$$

$$T = 50$$

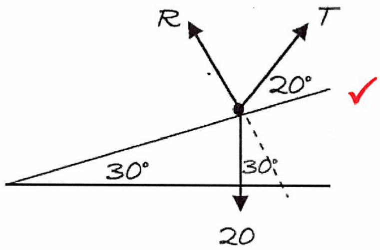
Resolving horizontally: $F - T\cos\theta = 0$

$$F = T\cos\theta = 50 \times \frac{1.2}{2} = 30$$

The magnitude of F is 30 N and the tension in the string is 50 N.

**(7 marks)**

4.




Resolving parallel to the plane: $T\cos 20^\circ - 20\sin 30^\circ = 0$

$$T\cos 20^\circ = 20 \times \tfrac{1}{2}$$

$$T = \frac{10}{\cos 20^\circ} = 10.64$$

Resolving perpendicular to the plane: $R + T\sin 20^\circ - 20\cos 30^\circ = 0$

$$R = 20\cos 30^\circ - T\sin 20^\circ$$

$$R = 13.7$$

The tension in the rope is 10.64 N and the reaction at the plane is 13.7 N.

**(7 marks)**

5.

| | |
|---|---|
| (a) Resolving horizontally: $5 = T\cos 65°$<br>$T =$ 12, 11.8, or better (N) | **M1A1**<br>**A1**<br>**(3)** |
| | |
| (b) Resolving vertically: $W = T\cos 25°$<br>$= 11.8\cos 25° =$ 11, 10.7 or better (N) | **M1A1**<br>**A1**<br>**(3)** |
| | **[6 marks]** |

6. (a) R (→): $T\cos 60 = 50\cos 30$ **M1 A1**

$T = \underline{86.6 \text{ N}}$ **A1**

*(3)*

(b) R(↑): $W = 50\sin 30 + T\cos 30$ **M1 A1**

$= \underline{100 \text{ N}}$ **A1**

*(3)*

**(6 marks)**

**TOTAL 52 MARKS**