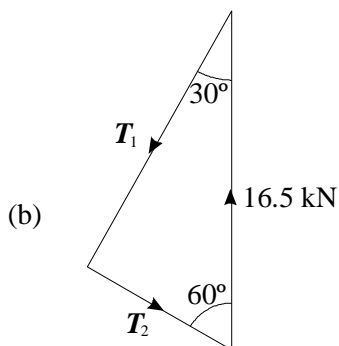


1. (a) $F \cos 20 = 300$ gives $F = 319 \text{ N}$ (1) 1
- (b) (i) work done = force \times distance moved in direction of force (1)
 F is not in the direction of motion (1)
- (ii) work done = force \times distance = $300 \times 8000 = 2.4 \times 10^6 \text{ J}$
- (iii) power = $\frac{\text{work done}}{\text{time taken}}$ (1)
 $= \frac{2.4}{5.0 \times (60 \times 60)} \times 10^6$ (1) (allow e.c.f. for work done in (ii))
 $= 133 \text{ W}$ (1) (allow e.c.f. for incorrect time conversion) 6
- (c) on the level, work is done only against friction (1)
 uphill, more work must be done to increase in potential energy (1)
 sensible conclusion drawn
 (e.g. increased work at constant power requires longer time) (1) 3

[10]

2. (a) resultant force = zero
 (or the forces can be represented in magnitude and direction by the
 three sides of a triangle taken in order) (1) 1



scale drawing:
 sensible scale used and stated (1)
 arrows shown correctly (1)
 one length measurement correctly stated (1)
 both scale conversions correct to give $T_1 = 14 \text{ kN}$, $T_2 = 8 \text{ kN}$ (1)
 [or by calculation: $T_1 = 16.5 \sin 60$ (1) 14.3 kN (1)
 $T_2 = 16.5 \cos 60$ (1) 8.3 kN (1)

[or by resolving forces vertically and horizontally:

$$T_1 \sin 30 = T_2 \sin 60 \text{ (1)}$$

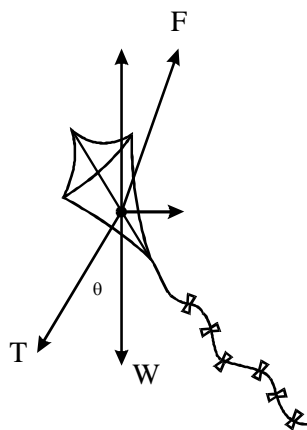
$$T_1 \cos 30 + T_2 \cos 60 = 16.5 \text{ (kN)} \text{ (1)}$$

gives $T_1 = 14.3 \text{ kN}$ (1) and $T_2 = 8.3 \text{ kN}$ (1)

4

[5]

3. (a)



2

components at right angles (1)
 vertical component in line with the weight (1)
 vertical components to start from the ●)

(b) (i) (horizontal component) = $25 \sin \theta = 12$ (or 13) N (12.5) (1)
 ($\pm 0.5 \text{ N}$ if scale drawing)

(ii) (vertical component) = $25 \cos \theta = 22 \text{ N}$ (21.7) (1)
 ($\pm 0.5 \text{ N}$ if scale drawing)

2

(c) (i) vertical component of $F = 21.7 + 2.5 = 24 \text{ N}$ (24.2)
 [or 25 (24.5)] (1)
 (allow C.E. from (b))

(ii) horizontal component of $F = 12$ (or 13) N (1) (12.5)
 (allow C.E. from (b))

- (iii) $F = \sqrt{(12.5^2 + 24.2^2)}$ (1) (allow C.E. from parts (i) and (ii))
 $= 27 \text{ N (27.2) [or 28 (28.2)]}$ (1) (26 N to 29 N if scale drawing)
 [if θ measured on diagram and $F \cos\theta$ used, (1) (1)
 (same tolerance)]

4

[8]

4. (a) (i) horizontal component of the tension in the cable (1)
 (ii) vertical component of the tension in the cable (1)

2

(b) (i) $T_{\text{vert}} = 250 \times 9.81 = 2500 \text{ N}$ (1) (2452 N)

(ii) $T_{\text{horiz}} = 1200 \text{ N}$

(iii) $T^2 = (1200)^2 + (2500)^2$ (1)

$T = (1.44 \times 10^6 + 6.25 \times 10^6)^{1/2} = 2800 \text{ N}$ (1) (2773 N)
 (if use of $T_{\text{vert}} = 2450 \text{ N}$ then $T = 2730 \text{ N}$)

(allow C.E. for values from (b) (i) and (b)(ii))

(iv) $\tan \theta = \frac{1200}{2500}$ (1)

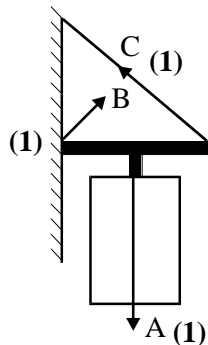
$\theta = 26^\circ$ (1)

(allow C.E. for values from (b) (i) and (b)(ii))

6

[8]

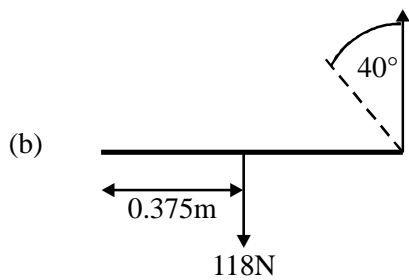
5. (a) (i)



n.b. B must make an appreciable angle with wall and bar

- (ii) A weight of sign and bar (accept gravity) (1)
 B reaction of wall (1)
 C tension in wire (1)

max 5



use of mg (1)
 clockwise moments 118×0.375 (1)
 = anticlockwise moments ($T \cos 40^\circ$) $\times 0.750$ (1)
 $T = 77 \text{ N}$ (1)

max 4

[9]

6. (a) sum of clockwise moments equals sum of anticlockwise moments (1)
 for a body in equilibrium (1) 2

(b) point in the body through which the weight/mass (appears to) acts
 [or point where resultant torque/moment is zero]
 [or point where body would balance] (1) 1

(c) (i) towards A (1)
 so that weight of ruler (1)
 provides balancing moment (1)

(ii) (moments about pivot give) $1.0 \times (0.30 - d) = 0.50 \times d$ (1)
 $1.5 d = 0.30$ and $d = 0.20 \text{ m}$ (1) 5

[8]

7. (a) (i) resultant force acting on tray is zero [or $P + W = Q$] (1)
 resultant torque is zero
 [or correct moments equation
 or anticlockwise moments = clockwise moments] (1)

(ii) $W = 0.12 \times 9.81 = 1.2 \text{ N}$ (1) (1.18 N)

(iii) (taking moments about P gives)
 $Q \times 0.1 = 0.12 \times 9.81 \times 0.25$ (1)
 $Q = 2.9 \text{ N}$ (2.94 N) (1)
 $P = 2.9 - 1.2 = 1.7 \text{ N}$ (1) (or $2.94 - 1.18 = 1.76 \text{ N}$)
 (allow C.E. for values of W and Q) 6

- (b) placed at Q (1)
no additional turning moment about Q (1) 2

[8]

8. (a) for a body in equilibrium (1)
the (sum of the) clockwise moments about a point (1)
are equal to (the sum of) the anticlockwise moments (1)
[or resultant torque about a point (1) is zero (1)] 3

- (b) (i) diagram to show: pivot/fulcrum/balance point (1)
masses or appropriate objects (1)
- (ii) known masses on either side of pivot (1)
move this mass until ruler is in equilibrium/balanced (1)
measure distances (1)
repeat with other masses (1)
- (iii) (calculate) weights of masses (on left and right of pivot) (1)
product of weight and distance to pivot on either side of pivot (1)
hence should be equal (1)

max 7
QWC 2

[10]