1. (a) $F \cos 20 = 300$ gives $F = 319$ N**(1)** 1

(b) (i) work done = force × distance moved <u>in direction of force</u> **(1)**
F is not in the direction of motion **(1)**

(ii) work done = force × distance = $300 \times 8000 = 2.4 \times 10^6$ 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 W **(1)** (allow e.c.f. for incorrect time conversion) 6

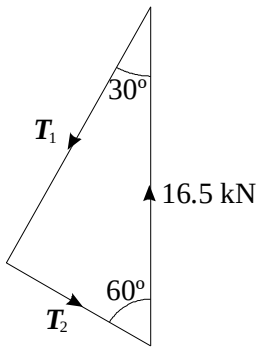
(c) on the level, work is done only against friction **(1)**
uphill, more work must be done to <u>increase in potential energy</u> **(1)**
sensible conclusion drawn

(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

(b)



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 kN, T_2= 8 kN **(1)**
[**or** by calculation: T_1 = 16.5 sin 60 **(1)** 14.3 kN **(1)**

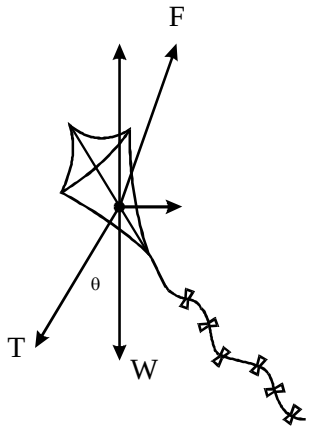
T_2 16.5 cos 60 **(1)** 8.3 kN **(1)**

[**or** by resolving forces vertically and horizontally:

T_1 sin 30 = T_2 sin 60 **(1)**
T_1 cos 30 + T_2 cos 60 = 16.5 (kN) **(1)**
gives T_1 = 14.3 kN **(1)** and T_2 = 8.3 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 θ = 12 (or 13) N (12.5) **(1)**
(± 0.5N if scale drawing)

(ii) (vertical component) = 25 cos θ = 22 N (21.7) **(1)**
(± 0.5 N if scale drawing) 2

(c) (i) vertical component of F = 21.7 + 2.5 = 24 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))
$= 27$ N (27.2) [or 28 (28.2)] **(1)** (26 N to 29 N if scale drawing)
[if θ measured on diagram and F cosθ 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) $T_{vert} = 250 \times 9.81 = 2500$ N **(1)** (2452 N)

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

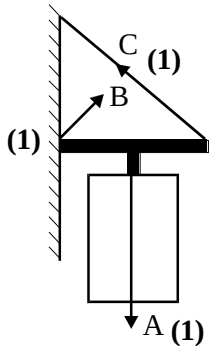
(iii) $T^2 = (1200)^2 + (2500)^2$ **(1)**
$T = (1.44 \times 10^6 + 6.25 \times 10^6)^{1/2} = 2800$ N **(1)** (2773 N)
(if use of $T_{vert} = 2450$ N then $T = 2730$ N)

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

(iv) $\tan \theta = \frac{1200}{2500}$ **(1)**
$\theta = 26°$ **(1)**
(allow C.E. for values from (b) (i) and (b)(ii)) 6

[8]

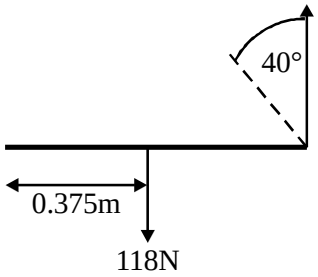
5. (a) (i)



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

(b)



use of *mg* **(1)**
clockwise moments 118 × 0.375 **(1)**

= anticlockwise moments (*T*cos40° **(1)**) × 0.750 **(1)**
T = 77 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 × (0.30 – *d*) = 0.50 × *d* **(1)**
1.5 *d* = 0.30 and *d* = 0.20 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 × 9.81 = 1.2N **(1)** (1.18N)

(iii) (taking moments about P gives)
Q × 0.1 = 0.12 × 9.81 × 0.25 **(1)**
Q = 2.9 N (2.94 N) **(1)**
P = 2.9 – 1.2 = 1.7 N **(1)** (or 2.94 – 1.18 = 1.76 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]