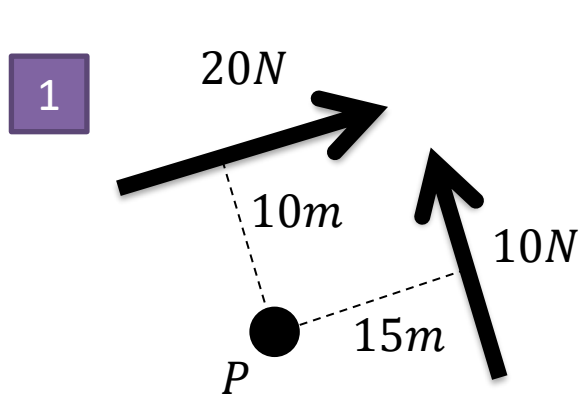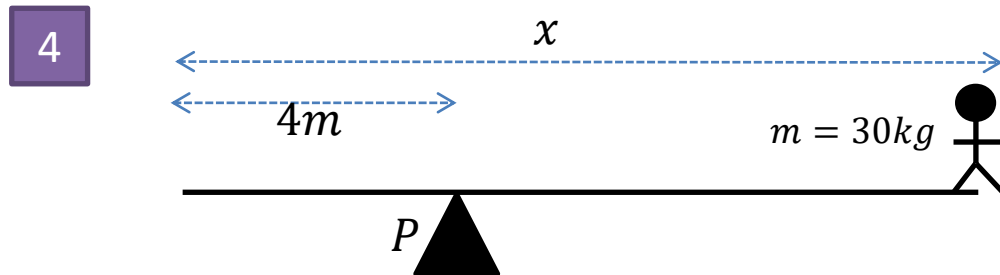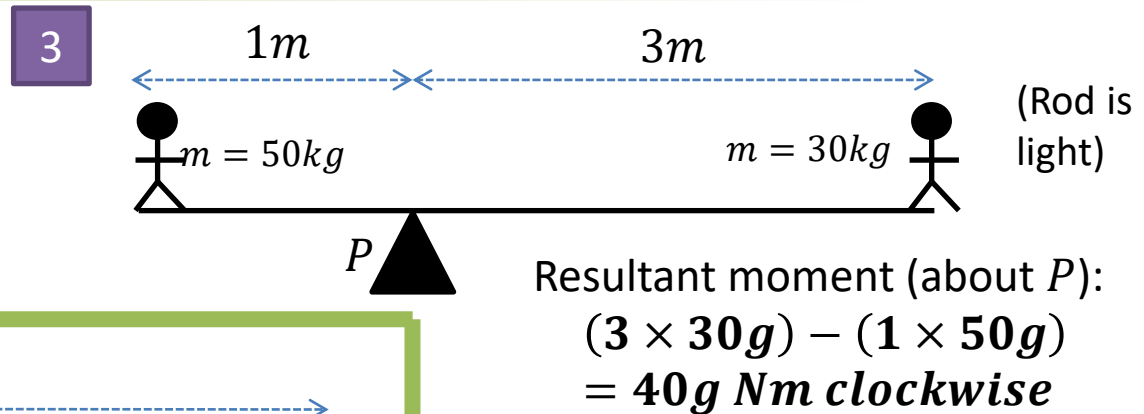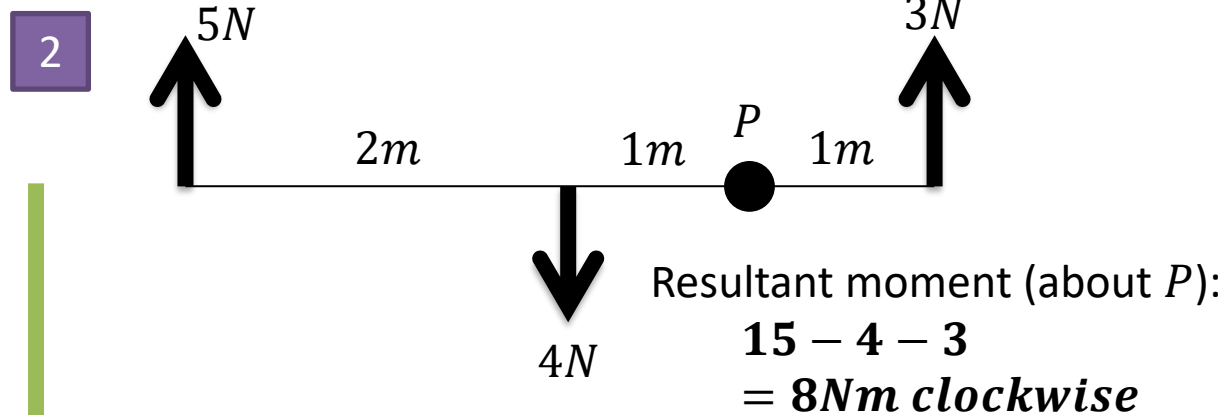# M2 Chapter 4: Moments

Resultant Moments

Resultant moments

If we have multiple coplanar forces, we can also find the overall moment by adding them – just treat one of the directions (clockwise or anticlockwise) as negative. This is similar to finding **resultant force**.
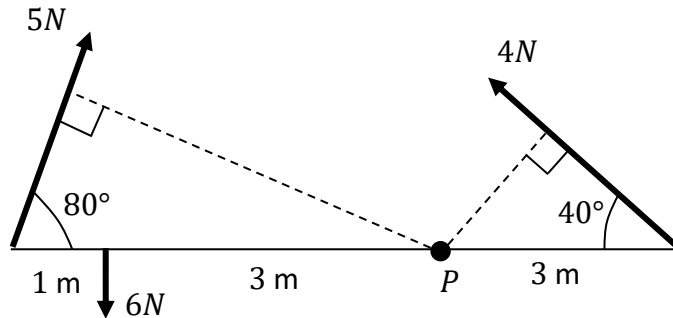
1

$20N$

$10m$

$10N$

$15m$

P

Resultant moment (about P)
$$= 200 - 150$$
$$= 50Nm \text{ clockwise}$$

2

$5N$

$3N$

$2m$ $\quad$ $1m$ $\quad P \quad$ $1m$

$4N$

Resultant moment (about P):
$$15 - 4 - 3$$
$$= 8Nm \text{ clockwise}$$

3

$1m$ $\qquad$ $3m$

$m = 50kg$ $\qquad$ $m = 30kg$ $\qquad$ (Rod is light)

P

Resultant moment (about P):
$$(3 \times 30g) - (1 \times 50g)$$
$$= 40g \ Nm \text{ clockwise}$$

4

$5N$

x

$4m$

$m = 30kg$

P

Resultant moment (about P):
$$30g(x - 4) \ Nm$$

[Textbook] The diagram shows a set of forces acting on a light rod. Calculate the resultant moment about the point P.
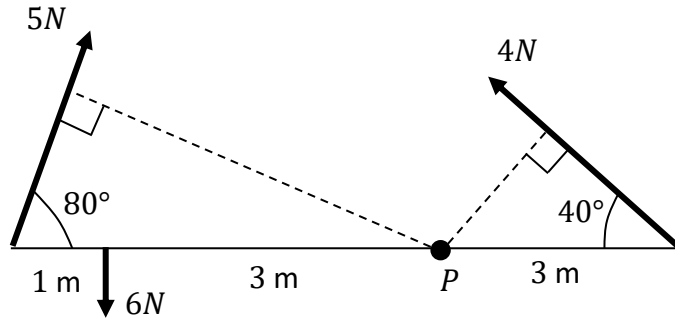

Always start by drawing in perpendicular distances.

?

Angled examples

[Textbook] The diagram shows a set of forces acting on a light rod. Calculate the resultant moment about the point P.
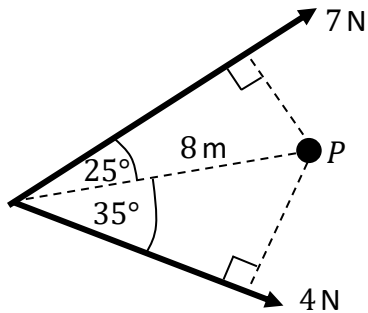

Always start by drawing in perpendicular distances.

Moments anticlockwise:
$$(6 \times 3) + (4 \times 3\sin 40°) - (5 \times 4sin80°)$$
$$= 6.02 \; Nm \text{ anticlockwise}$$

[Textbook] The diagram shows two forces acting on a lamina.
Calculate the resultant moment about the point P.

7 N

8 m

25°

35°

P

4 N
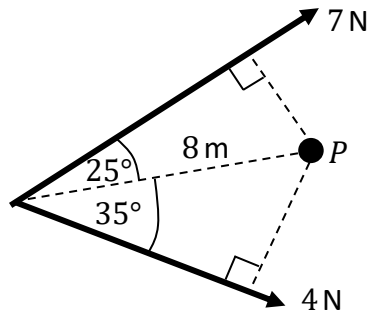
Click to sketch
perpendicular distances

?

[Textbook] The diagram shows two forces acting on a lamina.
Calculate the resultant moment about the point P.

Moments clockwise:
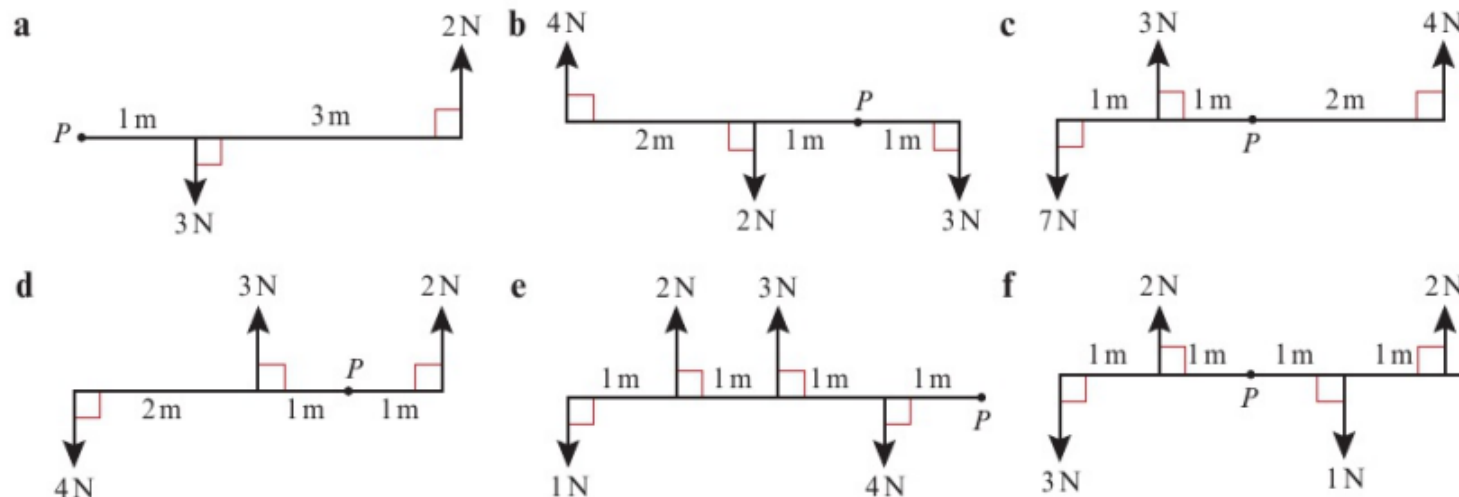$(7 \times 8 \sin 25°) - (4 \times 8 \sin 35°)$
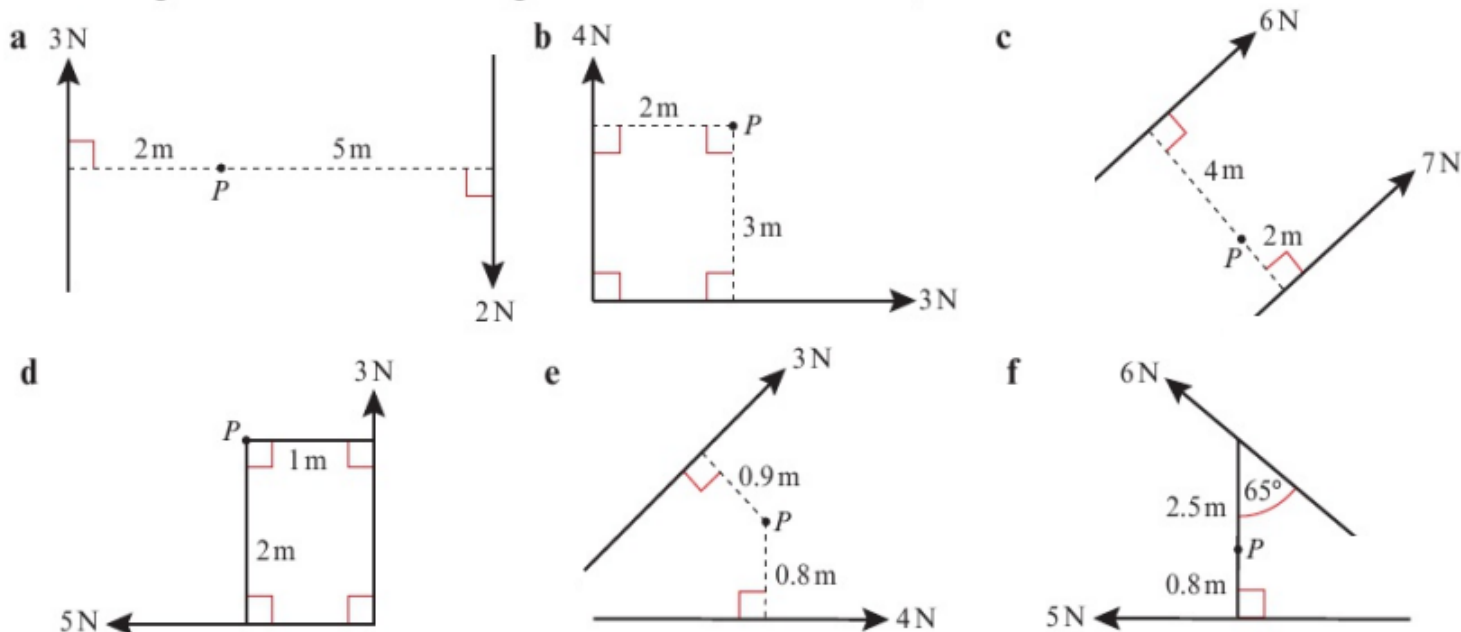$= 5.31 \ Nm$ clockwise

Pearson Stats/Mechanics Year 2
Page 34-35

Homework Exercise

1 These diagrams show sets of forces acting on a light rod. In each case, calculate the resultant moment about P.
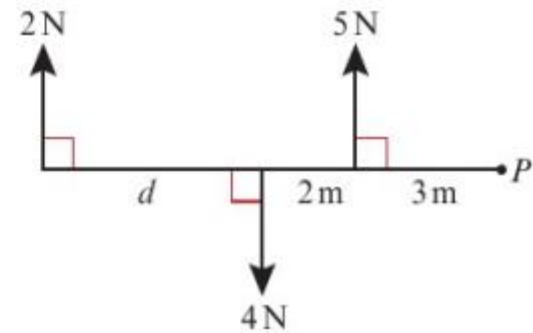

2 These diagrams show forces acting on a lamina. In each case, find the resultant moment about P.
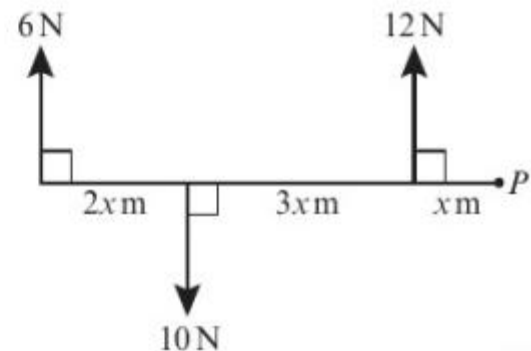
3 The diagram shows a set of forces acting on a light rod. The resultant moment about P is $17\,\text{Nm}$ clockwise. Find the length, d.

2 N

5 N

d 2 m   3 m

P

4 N

4 The diagram shows a set of forces acting on a light rod. The resultant moment about P is $12.8\,\text{Nm}$ clockwise. Find the value of x.

6 N

12 N

$2x\,\text{m}$ $3x\,\text{m}$ $x\,\text{m}$

P

10 N

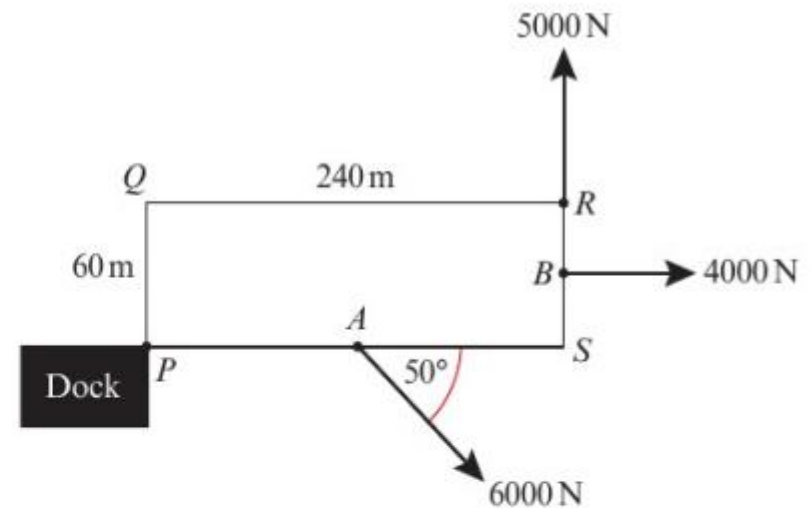**(3 marks)**

**5** A cruise ship is tethered to a dock and is being moved by three tugs. The cruise ship is modelled as a rectangular lamina *PQRS* fixed at *P* under the action of three coplanar forces. *A* is the midpoint of *PS* and *B* is the midpoint of *RS*.

Determine the direction of the rotation of the cruise ship and the magnitude of the resultant moment about *P*.　　**(5 marks)**

6 The diagram shows a drawbridge inclined at an angle of θ to the horizontal, where $0 < \theta < 90°$. The drawbridge is modelled as a uniform rod of weight 8000 N. A horizontal force of magnitude 6000 N is applied at the top of the drawbridge. Given that the drawbridge is rising, prove that $\tan\theta > \frac{2}{3}$　　**(5 marks)**
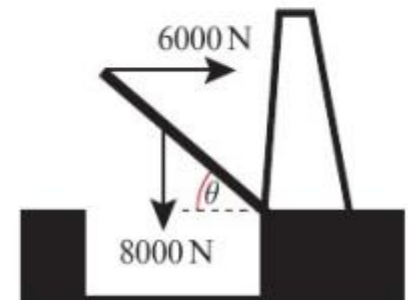
Hint　The drawbridge is modelled as a uniform rod so its weight acts at its midpoint.

1 a 5 Nm anticlockwise   b 13 Nm clockwise
   c 19 Nm anticlockwise   d 11 Nm anticlockwise
   e 4 Nm clockwise   f 7 Nm anticlockwise
2 a 16 Nm clockwise   b 1 Nm anticlockwise
   c 10 Nm clockwise   d 7 Nm clockwise
   e 0.5 Nm anticlockwise   f 9.59 Nm anticlockwise
3 6 m
4 1.6
5 528 448 Nm anticlockwise
6 $6000 \times x \sin \theta > 8000 \times \frac{1}{2} x \cos \theta$
   $6000 \sin \theta > 4000 \cos \theta$
   $\frac{\sin \theta}{\cos \theta} > \frac{4000}{6000}$
   $\tan \theta > \frac{2}{3}$