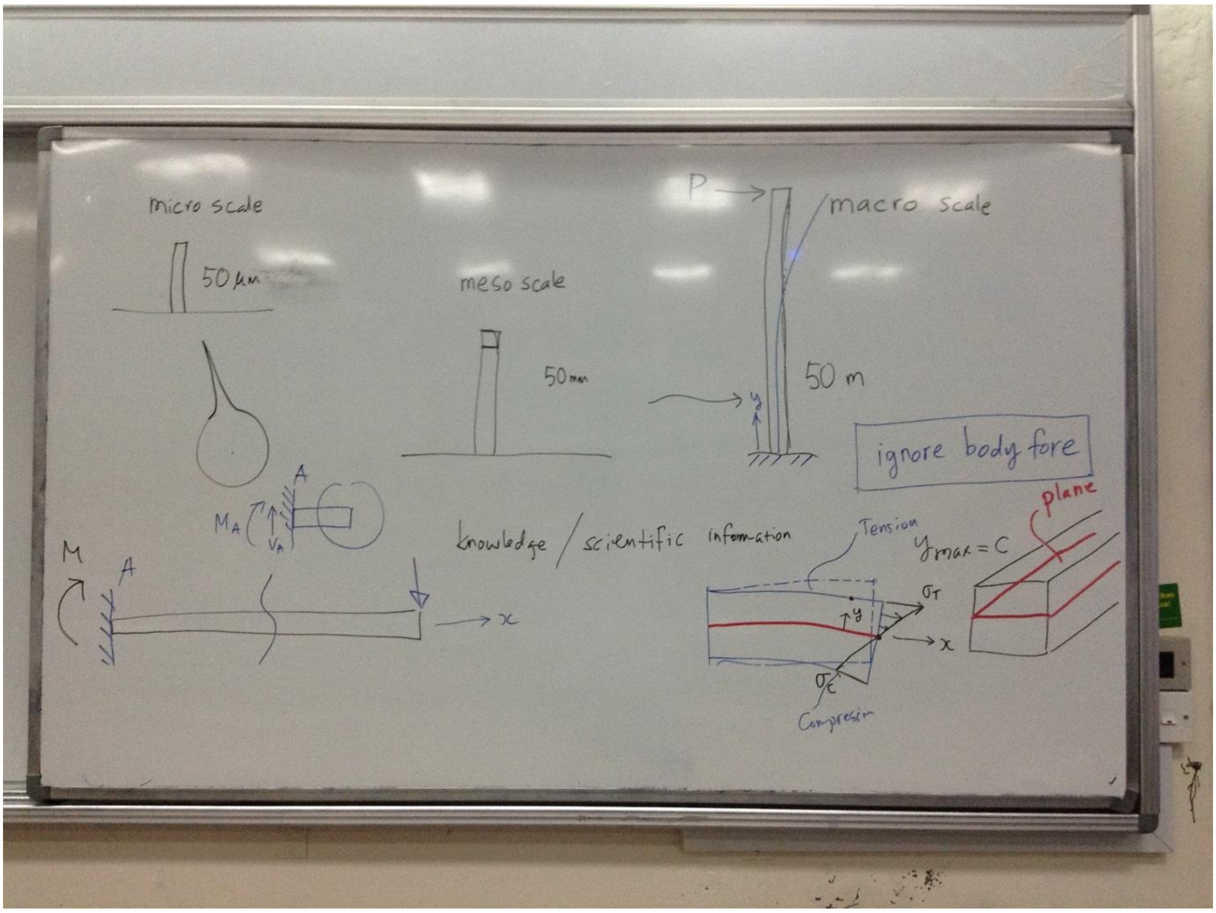
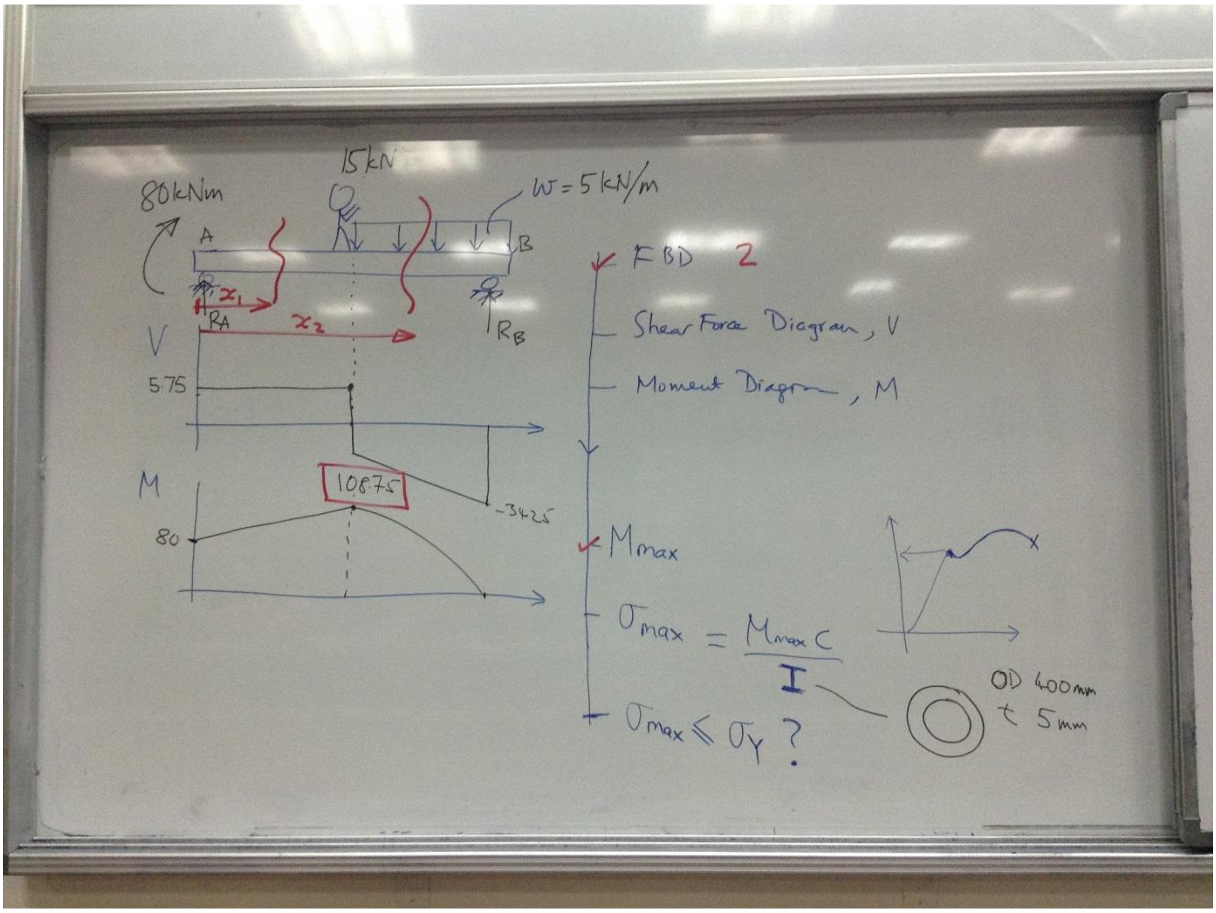
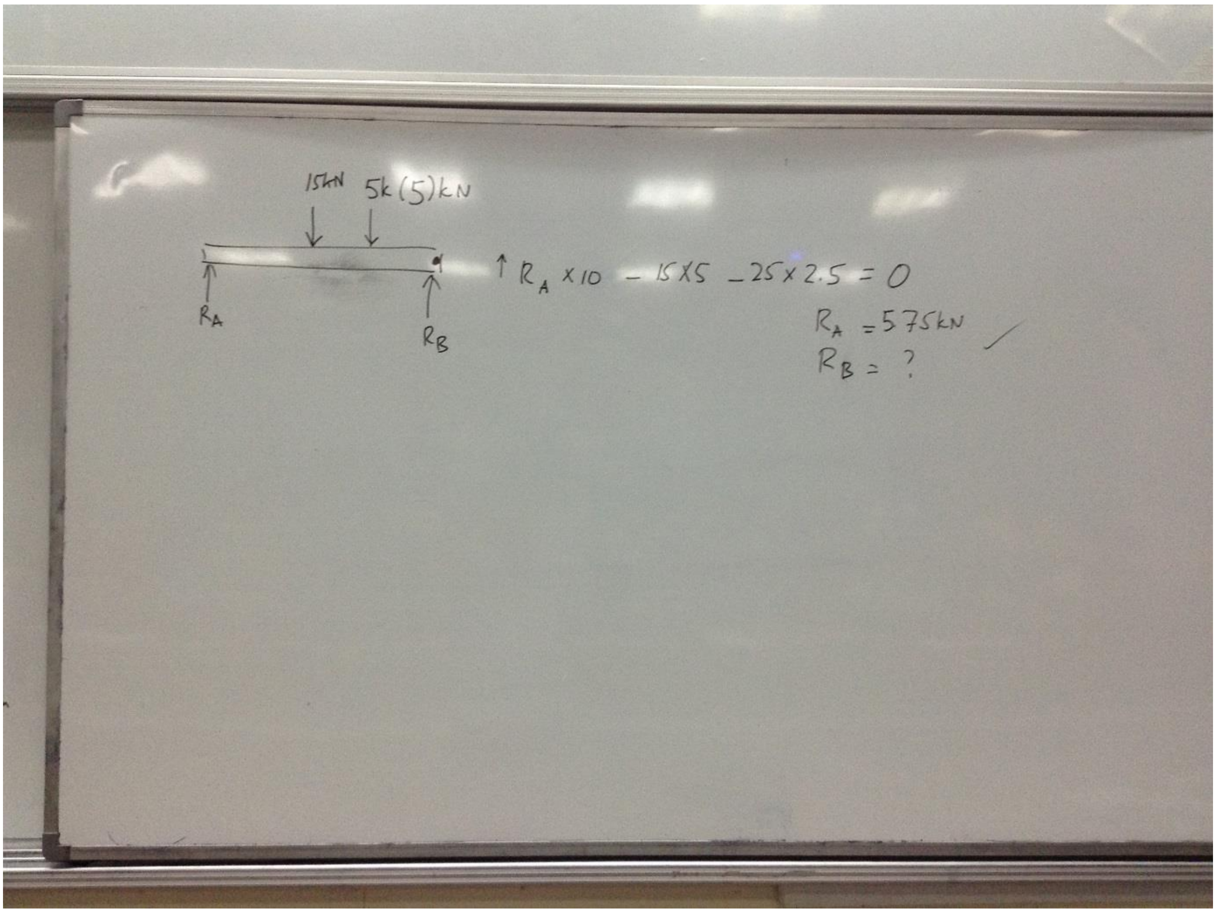

micro scale
50 μm
meso scale
50 mm
P
macro scale
50 m
ignore body fore
M
A
M_A
V_A
x
knowledge / scientific information
Tension
$y_{max} = C$
plane
σ_T
y
x
σ_C
Compression


80kNm
15kN
w = 5 kN/m
A
B
x_1
x_2
R_A
R_B
V
5.75
-34.25
M
108.75
80
FBD 2
Shear Force Diagram, V
Moment Diagram, M
M_{max}
$\sigma_{max} = \frac{M_{max} C}{I}$
$\sigma_{max} \leqslant \sigma_Y$?
OD 400mm
t 5mm
x

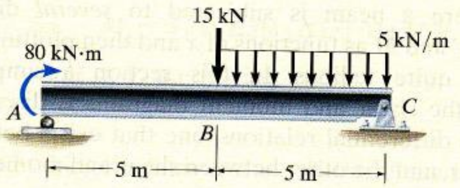


15kN
5k(5)kN
RA
RB
↑ RA x10 - 15x5 - 25x2.5 = 0
RA = 575kN
RB = ?

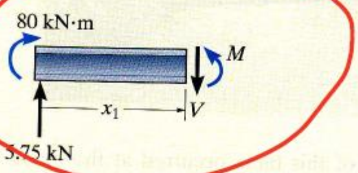
EXAMPLE 6.4

Draw the shear and moment diagrams for the beam shown in Fig. 6–7*a*.

Refer to the Companion Website for the animation of the concepts that can be found in Example 6.4.



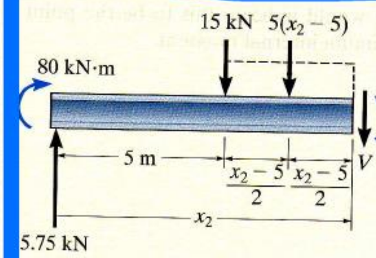
(a)



(b)

SOLUTION

Support Reactions. The reactions at the supports have been determined and are shown on the free-body diagram of the beam, Fig. 6–7*d*.



(c)

Shear and Moment Functions. Since there is a discontinuity of distributed load and also a concentrated load at the beam's center, two regions of x must be considered in order to describe the shear and moment functions for the entire beam.

$0 \le x_1 < 5$ m, Fig. 6–7*b*:

$$+\uparrow \Sigma F_y = 0; \qquad 5.75\text{ kN} - V = 0$$

$$V = 5.75\text{ kN} \qquad (1)$$

$$\circlearrowleft + \Sigma M = 0; \qquad -80\text{ kN}\cdot\text{m} - 5.75\text{ kN}\,x_1 + M = 0$$

$$M = (5.75x_1 + 80)\text{ kN}\cdot\text{m} \qquad (2)$$

$5\text{ m} < x_2 \le 10$ m, Fig. 6–7*c*:

$$+\uparrow \Sigma F_y = 0; \quad 5.75\text{ kN} - 15\text{ kN} - 5\text{ kN/m}(x_2 - 5\text{ m}) - V = 0$$

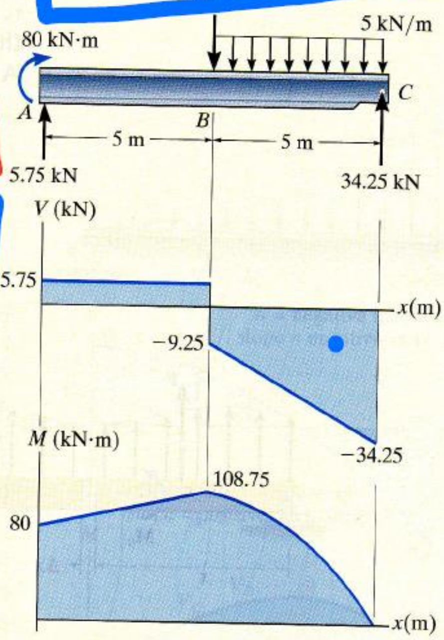
$$V = (15.75 - 5x_2)\text{ kN} \qquad (3)$$

$$\circlearrowleft + \Sigma M = 0; \quad -80\text{ kN}\cdot\text{m} - 5.75\text{ kN}\,x_2 + 15\text{ kN}(x_2 - 5\text{ m}) + 5\text{ kN/m}(x_2 - 5\text{ m})\left(\frac{x_2 - 5\text{ m}}{2}\right) + M = 0$$

$$M = (-2.5x_2^2 + 15.75x_2 + 92.5)\text{ kN}\cdot\text{m} \qquad (4)$$

These results can be checked in part by noting that $w = dV/dx$ and $V = dM/dx$. Also, when $x_1 = 0$, Eqs. 1 and 2 give $V = 5.75$ kN and $M = 80$ kN·m; when $x_2 = 10$ m, Eqs. 3 and 4 give $V = -34.25$ kN and $M = 0$. These values check with the support reactions shown on the free-body diagram, Fig. 6–7*d*.

Shear and Moment Diagrams. Equations 1 through 4 are plotted in Fig. 6–7*d*.



(d)

Fig. 6–7

Calculate the maximum bending stress and verify with yield stress.