6 A company rents out tower cranes of many different sizes.

A tower crane is illustrated in Fig. 6.1. This type of tower crane is called a flat-top tower crane because the jib and counter jib are horizontal.

A crane can be constructed to different arrangements of height, jib and counter-jib length, and balancing load.

The size of the base can be varied to cope with different maximum loads lifted by the crane.

Note: The masses of the loads in Fig. 6.1 and in Table 6.1 are given in tonnes (t).
One tonne is 1000 kg.

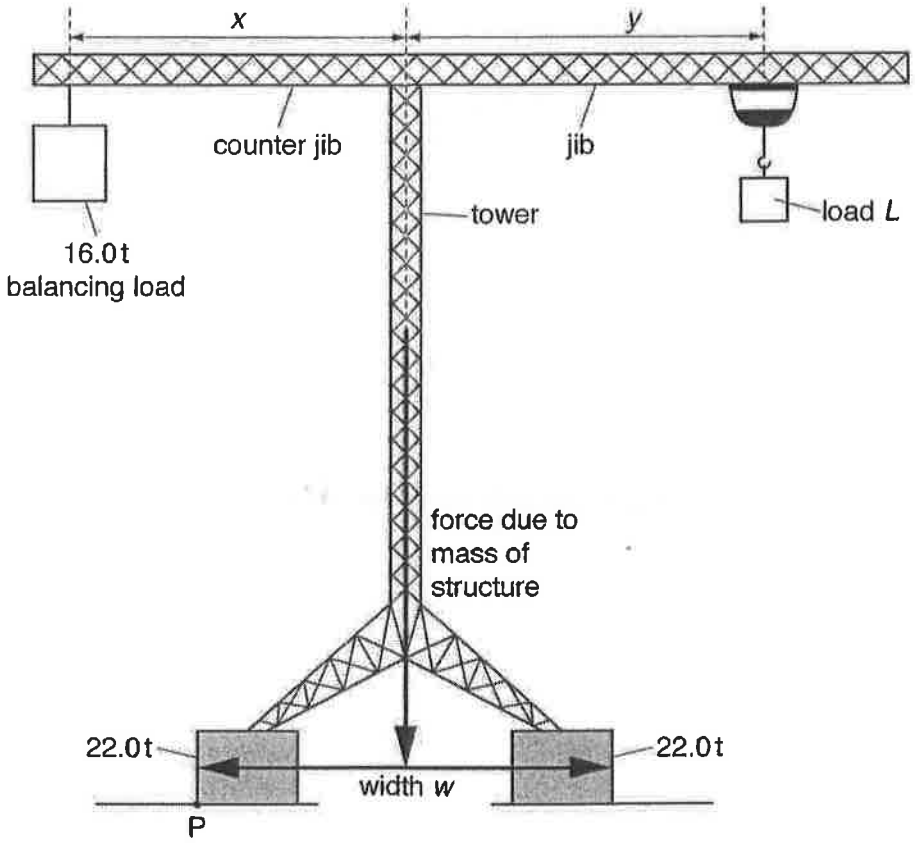

Fig. 6.1 (not to scale)

Distance x is the fixed distance. This is a different distance for each different crane arrangement.

Distance y is variable and changes as the load L is moved in and out from the tower, along the jib.

Table 6.1 lists information for four different crane arrangements.

The maximum load L in tonnes that can be lifted for different distances y from the centre of the tower for each arrangement is also shown.

Table 6.1

crane arrangement	total length of jib and counter jib/m	distance x to 16.0t balancing load/m	maximum load L at different distances y/t		
			$y = 30$ m	$y = 52$ m	$y = 75$ m
A	95.0	17.3	8.48	4.31	2.60
B	75.0	19.4	9.79	5.15	–
C	75.0	21.1	10.81	5.77	–
D	55.0	22.3	11.53	–	–

(a) (i) Calculate the weight of the 16.0t balancing load.

weight = ... unit ..... [2]

(ii) Using the data in Table 6.1, explain why there is no detail provided for crane D when $y = 52$ m.

.....

.....[1]

(b) (i) Show, for crane A, that the load and the balancing load given in the table can never put the crane into equilibrium.

.....

.....

.....[3]

(ii) When in use, crane A is in equilibrium. Suggest how this is achieved.

.....

.....

.....

.....[2]

(c) The width *w* of the base of a crane is important in providing stability.

For crane C, the foundations of the base are two identical large cubic concrete masses, each of mass 22.0 t. These masses are firmly attached to the crane.

The total mass of the crane structure is 17.0 t and the force due to the mass of the crane acts through the centre of the legs.

The balancing load is 16.0 t and is 21.1 m from the centre of the tower.

By taking moments about point P in Fig. 6.1, determine, for zero load, the minimum possible value of *w* before the right hand concrete mass lifts from the ground.

minimum value of w = ... m [3]

(d) (i) A motor on the crane lifts a load from the ground into position.

The motor needs to lift a load of 12000 kg a distance of 80 m.

Suggest a suitable time period for the duration of the lift and hence make a calculation to estimate the output power of the motor.

Suggested time = ... s

output power = ... W [3]

(ii) The efficiency of the motor is 65%. Calculate the electrical power input required for your answer to **(d)(i)**.

power input = ... W [2]

[Total: 16]