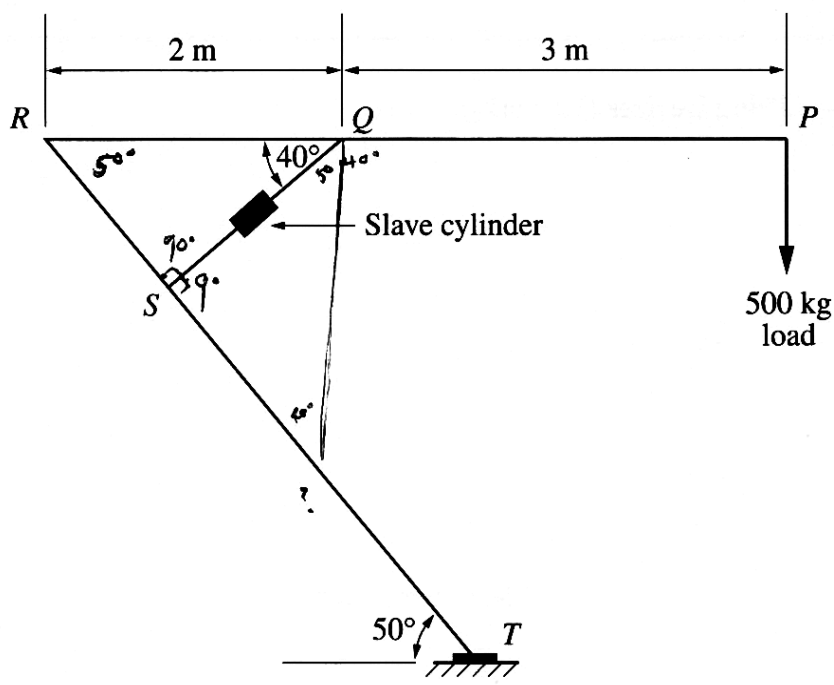


**Question 14 — Lifting Devices (10 marks)**

The diagram shows a lifting device. Arm  $RP$  is raised or lowered by a hydraulic system comprising a master cylinder and a slave cylinder.



- (a) The lifting device is required to hold a load of 500 kg. Determine the minimum force required in member  $QS$  to keep arm  $RP$  horizontal. 2

$\frac{F}{\sin 40} = \frac{14.7}{\sin 90}$   
 $\frac{F}{\sin 40} = 14.7$   
 $F = 14.7 \sin 40$   
 $F = 9.45 \text{ kN}$

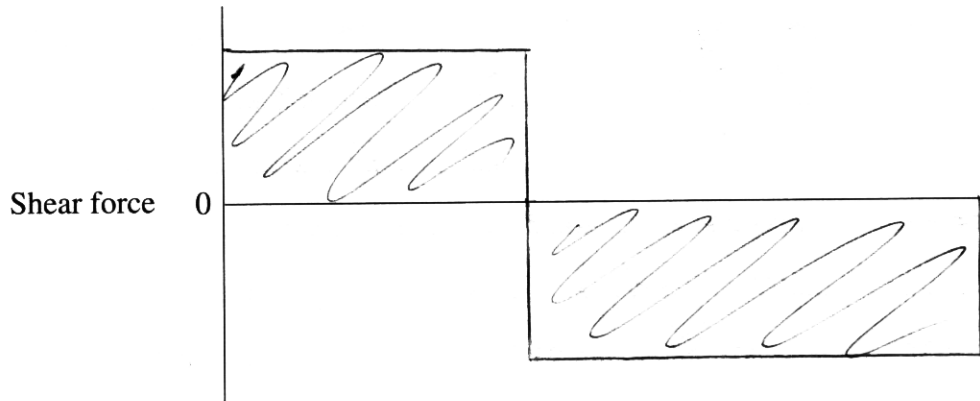
Minimum force = 9.45 kN

Question 14 continues on page 19

Question 14 (continued)

(b) For another set of conditions, the force in member *QS* was found to be 21.35 kN.

- (i) Draw the shear-force diagram for the arm *RP*. Label the values on the diagram. The mass of the arm should not be considered. 2



- (ii) Determine the diameter of the master cylinder if the mechanical advantage of the hydraulic system is 3. The slave cylinder has a cross-sectional area of 2800 mm<sup>2</sup>. 3

Diameter = .....

Question 14 continues on page 20

## Question 14 (continued)

- (c) Gears used in lifting devices can be manufactured by powder-forming or by a variety of other processes.

3

Identify an alternative manufacturing process, and contrast the properties of gears formed by this process with the properties of the powder-formed gears.

~~Prop forging~~ Extending the basic pattern for the gear can produce equiaxed grains if done hot or if done cold can produce work hardened, stiff but brittle gears. Powder formed means that powder metal is compacted into the mold then sintered to smelt the metal powder grains together.

End of Question 14