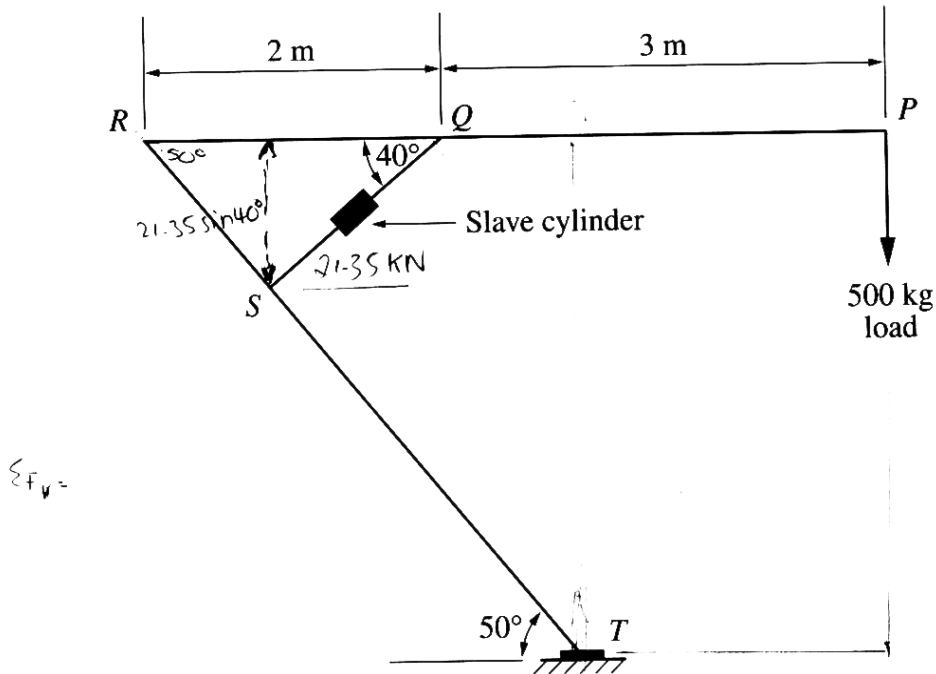


**Question 14 — Lifting Devices (10 marks)**

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

Force at  $P = 500 \times 9.8 = 4900$

~~Force at P = 5000~~

$\Sigma F_v = -4900 + Q_{sv}$

$Q_{sv} = 4900$

~~$Q_{sv} = 5000$~~

$\sin 40^\circ = \frac{Q_{sv}}{QS}$

$\frac{Q_{sv}}{\sin 40^\circ} = QS$

$QS = \frac{4900}{\sin 40^\circ}$

~~$QS = \frac{5000}{\sin 40^\circ} = 7786$~~

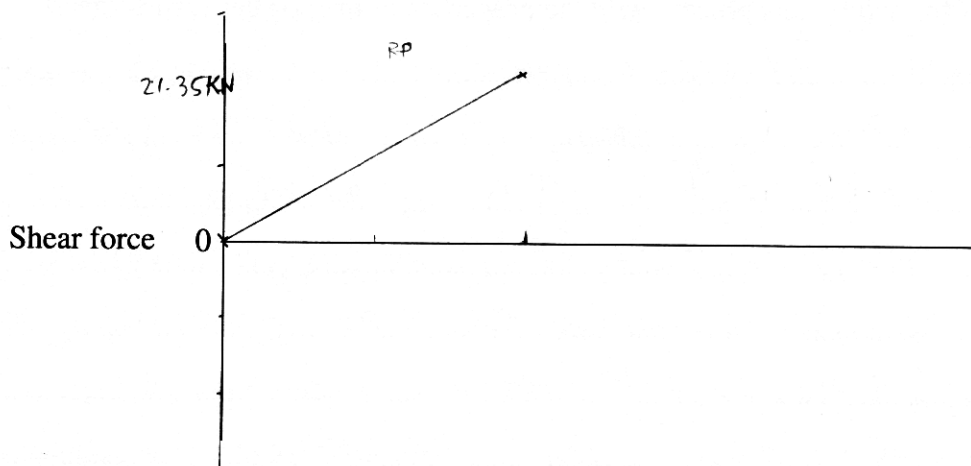
Minimum force = 7623 N

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

~~$A = 2800$~~   
 ~~$\frac{d^2 \pi}{4} = 2800$~~   
 ~~$2800 \times 4 = d^2 \pi$~~   
 ~~$2800 \times 4 = d^2$~~   
 ~~$\frac{2800 \times 4}{\pi} = d^2$~~   
 ~~$\sqrt{\frac{2800 \times 4}{\pi}} = d$~~   
 ~~$d =$~~

$A = 2800 \text{ mm}^2$   
 $A = 2.8 \text{ m}^2$   
 ~~$\frac{d^2 \pi}{4} = 2800$~~       $d^2 = \frac{2.8 \times 4}{\pi}$   
 $d = \sqrt{\frac{2.8 \times 4}{\pi}}$   
 $d = 1.88813948$   
 but this system has mechanical advantage of 3.  
 $\therefore \frac{d}{3} = \frac{1.8813948}{3}$   
 $= 0.629379829$

Diameter = 629 mm

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.

Another alternative manufacturing process would be die-casting. This method can not produce an article that would be as detailed as an article produced by powder-forming. This is because the ~~metal~~ mould can not be designed with such complexity as the melted metal are unable to flow evening. Powderformed gears would have a ~~much~~.

End of Question 14