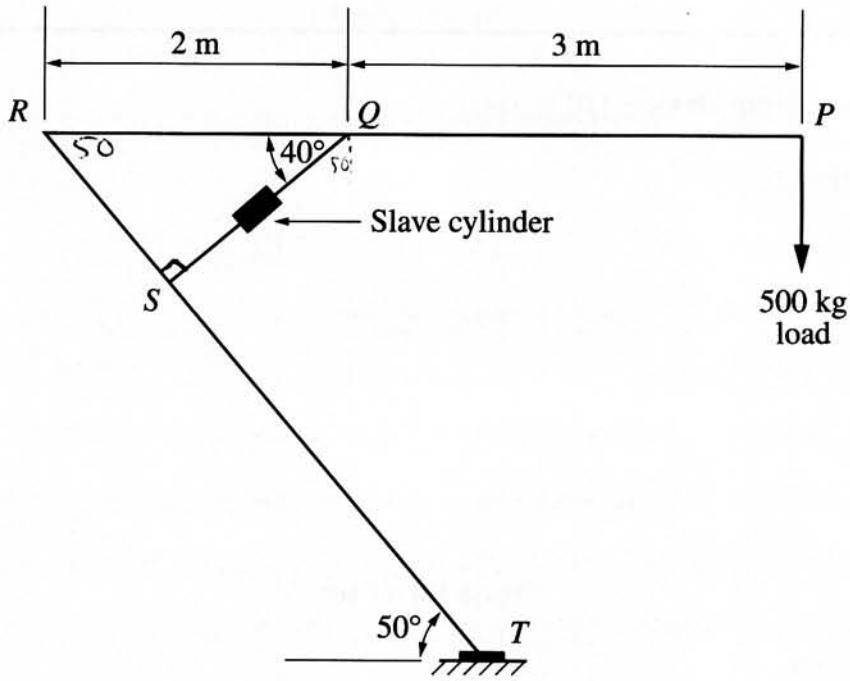
Marks

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**

taking $g = 10$

$M_R + 1 = 0$

$0 = -(500 \times 10) \times 5 + 2 \times (QS \sin 40°)$

$0 = 5 \times -5000 + 2\,QS \sin 40$

$25000 = 2QS \sin 40$

$QS = \frac{25000}{2 \sin 40}$

$QS = 19446.55\,N$

$0 = (-50 - P) \times 5 + 2 \times (21.35 \sin 40)$

$50P = 42.7 \sin 40$

$P = \frac{42.7 \sin 40}{5}$

$P = 5.489\,kN$

Minimum force = 19446.55N

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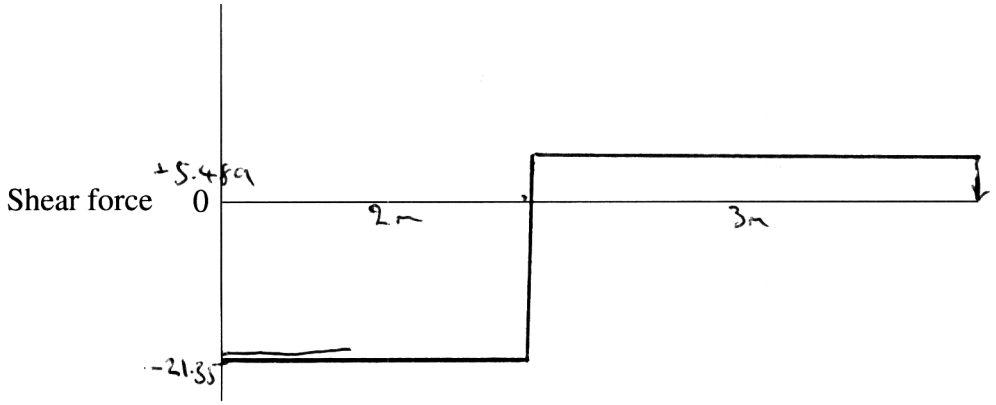
Marks

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^2. **3**

$\frac{M_A}{S_A} = 3$

$\frac{M_A}{2800\,mm^2} = 3$

$M_A = 3 \times 2800\,mm^2$

$M_A = 8400\,mm^2$

$A = \pi r^2$

$8400 = \pi r^2$

$r^2 = \frac{8400}{\pi}$

$r^2 = 2673.803\,mm$

$r = 51.709$

$2 \times r = D$

$D = 2 \times 51.71$

$= 103.42\,mm$

Diameter = 103.42mm

Question 14 continues on page 20

Marks

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.

gears can also be machined by specially designed machines. Machined gears however do not have as great a strength as powder-formed gears as the grain of the machined gears is not perpendicular to the surface & therefore has plans of weakness, where as powder-formed gears have the grain perpendicular to the surface & no plans of weakness

End of Question 14