# Equilibrium

1. A uniform 1200kg steel girder is supported horizontally at its endpoints as shown in the diagram.

 Steel girder

 Container

Support A Support B

 8.0m 24.0m

What are the upward forces at the girder end points when it is bearing a 370kg shipping container 8.0m from support A?

2. A uniform beam has a mass of 3.5kg. Its length is 1.6m and a pivot is placed 0.50m from end P, as shown in the diagram below. The beam is balanced by suspending an object at P.

 1.6m

 P Q

 0.50m

 Object

What is the mass of the object?

A. 1.1kg B. 2.1kg C. 5.8kg D. 7.7kg E. 8.2kg

3. A 4.60kg mass, P, is held in equilibrium by a horizontal string, gravity and a rigid beam, of negligible mass.

 24.0o  Beam

 P string

What is the tension in the string?

A. 5.03N B. 41.2N C. 49.3N D. 111N E. 262N F. 20.0N G. 101N

4. A uniform boom, hinged at P, is held stationary as shown in the diagram below.

 cord

 Boom

 60.0o

 P

If the tension in the supporting cord, attached three-quarters of the way along the boom from P. is 720N. What is the weight of the boom?

A. 720N B. 1080N C. 1440N D. 2160N E. 3360N

5. The 1.3m long beam shown below is **NOT IN EQUILIBRIUM**. Find the magnitude, direction and location of a **single** additional force needed to place the beam in static equilibrium. **The weight and thickness of the beam are not significant.**

 **7.0N**

 **3.0N**

 **8.0N**

 **30.0o**

 **6.0N**

 **0.80 0.20m**

 **9.0N**

6. A uniform beam of mass 25kg rests on supports P and Q, as shown in the diagram below.

 8.0m

 6.0m

 P Q

What force is exerted by support Q on the beam?

7. A mass suspended by a string is held 24o from vertical by a force of 13.8N as shown. Find the mass.

string

24o

13.8N

8. A 3.0m uniform beam of mass 15kg is pivoted 1.0m from the end as shown below

1.0m

3.0m

d

A 35kg child sets 0.60m from the pivot. How far d from the pivot must a 20kg child sat in order for the beam to be in equilibrium?

9. Two forces act on an object as shown. Find the magnitude of the third force required to achieve translational equilibrium.

 F1=25N

 F2=40N

A. 15N B. 33N C. 47N D. 65N E. 76N

10. A 25kg block is pulled by a horizontal force. The supporting rope can withstand a maximum tension force of 620N.

θ

rope

25kg

To what maximum angle can the block be pulled without the rope breaking?

11. In which direction should a force act as point p to hold the boom in equilibrium so that the force will be minimum? D

 C

 B

 A

 P

12. A uniform 16.0kg boom of length 4.0m is supported by a rope as shown

 rope

 32

 3.0m

Find the tension of the rope

A. 1.0 x 102 N B. 1.2 x 102N C. 2.0 x 102N D. 3.0 x 102N

13. An artist must push with a minimum force of 75N at an angle of 45o to a picture to hold it in equilibrium. The coefficient of friction between the wall and the picture frame is 0.30. What is the mass of the picture?

 F=75N

 45o

A. 1.6kg B. 2.3kg C. 3.8kg D. 7.0kg

14. What are the units of torque?

A. kgm2/s2 B. kgm/s C. kg/s2 D. N/m

15. A uniform 1.60m board rests on two bricks as shown below. The left brick exerts an upward force of 12N on the board. Find the upward force from the right brick.

 1.20m 0.40m

What is the force from the right hand brick?

A. 3.0N B. 12N C. 24N D. 36N E. Must know mass of board to answer.

16. The following diagram (not drawn to scale) shows a 420N object attached by two wires

 P θ Φ R

 283N 283N

 420N

a) If the force in each wire is 283N, what are angles θ and Φ ?

b) The points of attachment R and P are now moved outwards to points Y and X respectively as shown below.

X P R Y

 Q

 420N

1) Does the tension in PQ increase, decrease, or stay the same?

2) Using the conditions of equilibrium, give supporting reasons for your choice in (b1)

17. A uniform beam 6.0m long, and with a mass of 75kg, is hinged at A. The supporting cable keeps the beam horizontal.

 cable

 A

 37o

 load

 2.0m

 3.5m

 6.0m

If the maximum tension the cable can withstand is 2.4 x 103N. What is the maximum mass of the load?

18. A 0.75kg board of length 2.60m initially rests on two supports as shown.

  0.40m 1.4 m x

a) What maximum distance is from the right-hand support can a 1.20kg bird walk before the board begins to leave the left-hand support?

b) What force does the right-hand support exert on the board at that instant.

19. A uniform 350kg beam of length 4.2m is held stationary by a horizontal cable. The cable is attached to a point on the beam 3.0m from the hinge.

 cable

 40o

 hinge m

a) Draw and label a free body diagram showing the forces on the beam.

b) If the max tension the cable can withstand is 1.3 x 104, what max mass, m can be suspended from the cable?

c) Find the force that the hinge exerts on the beam.

20. A 25kg droid rests on a 5.0m long shelf supported by two cables as shown. The mass of the shelf is 12kg.

 Droid (R2-D2)

 0.60m 0.80m 0.60m

 3.8m

Find the tension in each cable.

**21. Good Test Question!**

The following object is **NOT** in equilibrium. Find the magnitude, direction AND location of a single additional force that will put the object into equilibrium. Assume the thickness and mass of the beam are negligible.

 9.0N

32cm 40.0cm

 5.0N

 7.0N

 30.0o

 1.0m

 12N

22. For each of the following state whether the object is in rotational equilibrium, translational equilibrium, neither or both. Forces may have any magnitude but zero.

 a. b.

 c. d.

 e.

23. A. What is the net torque provided by these four forces on this object about the pivot shown?

 0.50m

 140N

 120N

 0.15m

 130N 110N

 B. What is the net force?