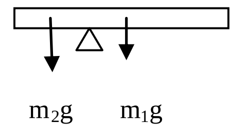
ANSWERS - AP Physics Multiple Choice Practice – Torque

Solution	Answer

1. Mass of stick m_1=0.20 kg at midpoint, Total length L=1.0 m, Pivot at 0.40 m, attached mass m_2=0.50 kg. — **B**

   Applying rotational equilibrium $\tau_{net}=0$
   $(m_1g) \bullet r_1 = (m_2g) \bullet r_2$
   (0.2) (0.1 m) = (0.5)(x)
   x = 0.04 m (measured away from 40 cm mark)
   → gives a position on the stick of 36 cm

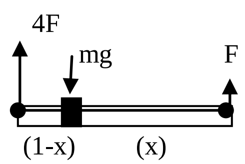


2. As above, apply rotational equilibrium — **A**
   + (300) (30cm) – X (20 cm) – (200) (40 cm) = 0

3. Torque = $(Fr)_\perp$ Choices A and E make zero torque, Of the remaining choices, each has moment arm = r but choice C has the full value of F to create torque (perpendicular) while the others would only use a component of F to make less torque — **C**

4. Applying rotational equilibrium, using location of unknown mass as pivot … — **E**

   4F (1 – x) = (F) (x)
   4F = 5Fx
   x = 4/5 = 0.80 m measured from right side



5. Applying rotational equilibrium ("g" cancels on each side) — **E**
   $(m_1g) \bullet r_1 = (m_2g) \bullet r_2$
   (45) (22.5 cm) = (m) (7.5 cm) → m = 135 g

6. On the left of the pivot τ=Fd, on the right side of the pivot τ = F(2d). So we either have to add 1(Fd) to the left side to balance out the torque or remove 1(Fd) on the right side to balance out torque. Putting an upwards force on the left side at V gives (2Fd) on the left to balance torques, or putting a downwards force on the right side at X give a total of Fd on the right also causing a balance — **C**

7. Apply rotational equilibrium using the corner of the building as the pivot point. Weight of plank (acting at midpoint) provides torque on left and weight of man provides torque on right. — **B**
   $(m_1g) \bullet r_1 = (m_2g) \bullet r_2$
   (100 kg) (0.5m) = (50 kg) (r) → r = 1m

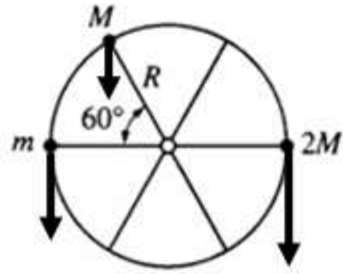
8. Apply rotational equilibrium using the rope as the pivot point. — **C**
   (3.5)(9.8)(L/2) + m(9.8)(L/4) – (5)(9.8)(L/2) = 0 → m = 3 kg

9. To balance the torques on each side, we obviously need to be closer to the heavier mass. — **D**
   Trying point D as a pivot point we have:
   $(m_1g) \bullet r_1$?=? $(m_2g) \bullet r_2$
   (6kg) (40 cm) ?=? (8kg) (30 cm) and we see it works.

10. Applying rotational equilibrium at the center pivot we get: C

$+mg(R) + Mg(R\cos 60°) – 2Mg(R) = 0$.

Using $\cos 60° = ½$ we arrive at the answer 3M/2



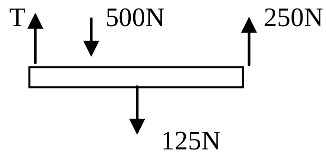
11. Finding the torque in the current configuration we have: A

$(F\sin\theta)(L) = FL \sin \theta$.

To get the same torque with F applied perpendicular we would have to change the L to get $F (L\sin\theta)$

12. Diagram B

T = 375 N



Simple $F_{net(y)} = 0$

$T – 500 + 250 – 125 = 0$

13. Same Diagram B

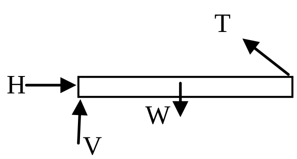
Apply rotational equilibrium using left end as pivot:

$+ (250)(4) – (125)(2) – (500)(r) = 0 \rightarrow r = 1.5m$

14. Definition of Torque D

15. To balance the forces (Fnet=0) the answer must be A or D, to prevent rotation, obviously A would be needed. A

16. FBD B



Since the rope is at an angle it has x and y components of force.

Therefore, H would have to exist to counteract Tx.

Based on $\tau_{net} = 0$ requirement, V also would have to exist to balance W if we were to chose a pivot point at the right end of the bar

17. In the given diagram the torque is = FL. C

Finding the torque of all the choices reveals C as correct.

$(2F\sin 60°) (L) = 2F ½ L = FL$

18. Applying rotational equilibrium to each diagram gives E

DIAGRAM 1: $(mg)(L_1) = (M_1g)(L_2)$

$L_1 = M_1(L_2) /m$

(sub this L_1) into the Diagram 2 eqn, and solve.

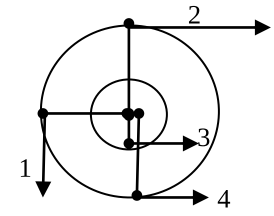
DIAGRAM 2: $(M_2g)(L_1) = mg(L_2)$

$M_2 (L_1) = m (L_2)$

19. Find the torques of each using proper signs and add up. C

$+ (1) – (2) + (3) + (4)$

$+F(3R) – (2F)(3R) + F(2R) +F(3R) = 2FR$



20. Simply apply rotational equilibrium B

$(m_1g) \cdot r_1 = (m_2g) \cdot r_2$

$m_1a = m_2b$

21. Question says meterstick has no mass, so ignore that force. Pivot placed at 0.60 m. Based on the applied masses, this meterstick would have a net torque and rotate. Find the net Torque as follows B

$\tau_{net} = + (m_1g) \cdot r_1 – (m_2g) \cdot r_2$

$+ (2)(10\ m/s^2)(0.6\ m) – (1)(10\ m/s^2)(0.4\ m)$