**Center Of Mass - 9.2**

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|  | Teeter Totter Equation: |
| 0.73 Kg | 1. The center of mass between two objects is 12 cm from the one with a mass of 3.4 Kg. What is the mass of the other one if it is 56 cm from the COM? |
| 1.02 x1032 Kg | 2.A star is seen rotating about a point that is 4.2 x 109 m from its center. We can tell by its light output that it has a mass of 7.5 x 1031. What is the mass of the black hole in orbit around the star if it is 3.1 x 109 m from the COM? |
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|  | The COM Equation |
| 22.7 cm | 3. How far is the COM from the larger of a 12 lb bowling ball and a 10 lb bowling ball that are 50 cm distant?  |
| 37.5 cm | 4. A 5 Kg mass is on the 0 end of a meter stick, and a 3 Kg mass is on the 100 and of the stick. Where is the COM? (Neglect the mass of the meter stick) |
| 18.5 feet | 5. A 165 lb and 120 lb person sit on a see saw that is 32 feet long. How far is the balance point from the lighter person? |
| 4.49x102 km | 6. How far is the center of mass of the sun and Earth from the center of the sun? (The Earth-Sun distance is 1.50x1011 m - the sun has a mass of 1.99 x 1030 Kg, and Earth has a mass of 5.97 x 1024 Kg.) |
| At the 36.3 cm mark | 7. Someone clamps a 50 gram mass to the 15 cm mark of a 78 gram meter stick. Where is the center of mass of the meter stick and mass? (Treat the meter stick as a 78 gram mass at the 50 cm mark) More than two objects:  |
| At the 45.2 cm mark | 8. Someone puts a 45 gram clamp at the 12 cm mark and a 75 gram clamp at the 60 cm mark of a 82 gram meter stick. Where is the COM of the system now? (don't forget the meter stick itself) |
| 91.7 cm mark | 9. A 112 g uniform meter stick has a 14.0 g clamp at the 40.0 cm mark. Where would you clamp a 21.0 g clamp to make it balance at the 55.0 cm mark? |
| 36.9 g | 10. A 108 g uniform meter stick balances at the 44.0 cm mark when there is a 13.0 g clamp at the 85.0 cm mark and a what mass clamped at the 12.0 cm mark? |
| 7.98 x 105 m | 11. How far is the COM of the four inner planets and the sun from the center of the sun? (If they all lined up) |
| 7.98 x 105 m | 11. How far is the COM of the four inner planets and the sun from the center of the sun? (If they all lined up) |
| 66 feet from the ground | 12. Where is the COM of a 120 foot, 495 lb ladder with a 220 lb fireman 12 feet up, a 170 lb fireman 50 feet up and a 150 lb fireman all the way at the top? (The COM of the ladder is 80 feet from the ground) |
| 8.4 feet from the stern | 13. Where is the COM of a loaded 89 lb 18 foot canoe when there is a 160 lb person 1.5 feet from the stern, a 90 lb pack 9 feet from the stern, and a 140 lb bow person 15.5 feet from the stern? (Consider the canoe to be symmetric) |
| 55.6 cm mark | 14. Where is the COM of a 121 g uniform meter stick if there is a 12.0 g clamp at the 7.00 cm mark, a 34.0 g at the 23.0 cm mark and a 56.0 gram clamp at the 98.0 cm mark? |
| 9.80 cm mark | 15. A 68.0 g uniform meter stick has a 15.0 g clamp on the 17.0 cm mark, and it balances at the 32.0 cm mark. Where do you need to clamp a 45.0 g clamp to effect this? |
| 137 g | 16. A 145 g meter stick balances at the 66.6 cm mark. There is a 12.0 g clamp on the 92.0 cm mark, and what mass clamped at the 82.0 cm mark? |
|  | 17. (Extra credit) Devise a way to construct the center of mass of any triangle using a straight edge, and a compass. Explain this method. (Cut out your triangle from cardboard, and see if it balances on that point you've found. If it doesn't...try again) |

**Torsional Equilibrium - 9.2**

Find the missing quantity to put the system in torsional equilibrium around the pivot point:

1.20 m

1.60 m

14.0 N

7.20 N

1.90 m

F = ?

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| 21. (1.77 N upward) | 22. (8.17 N downward)6.00 m13.0 m118 N135 N11.0 mF = ? |
| 23. (19.6 cm)13.0 cmx = ?7.40 N1.60 N41.0 cm1.20 N | 24. (60.0 cm - note where the distance is measured.)35.0 cmx = ?6.00 N7.20 N45.0 cm1.20 N |
| 25. The 56.0 kg beam is 12.0 m long, the 16.0 kg box is 5.00 m long. The 24.0 kg box is 3.20 m wide, and the supporting force is exerted 4.00 m from the left side. (1534 N)56.0 kg16.0 kgF = ?24.0 kg | 26. The 62.0 kg window washing scaffold is 9.00 m long, the big 85.0 kg worker is 3.80 m from the left side, and the 64.0 kg worker is 2.50 m from the right. Find the tension in the right cable. (pivot about the left cable) (1110 N)62.0 kgF = ? |
| 27. The 24.0 kg diving board is 5.10 m long, but its center of mass is 2.30 m from the left side. A 45.0 kg diver is 2.00 m from the left side, and a 57.0 kg diver is 0.500 m from the right side. How far from the pivot on the left side must the support be placed if the force on it cannot exceed 2150 N? (1.86 m)24.0 kg2150 N | 28. The stoplights each have a mass of 28.0 kg, with one hanging 1.80 m from the left side, and the other hanging 0.700 m from the right side. The supporting beam is uniform, 6.20 m long with a mass of 16.0 kg. How far from the left side must the supporting cable be attached if the tension is not to exceed 623 N? (4.00 m)16.0 kg623 N |