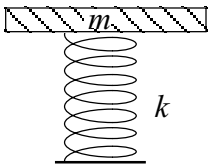
Homework Problems

1. A person with a mass m = 70 kg stands on the ground. What is the value of the compression force generated by each foot acting on the ground? What is the compression force the earth applies back to each foot?

Each foot acts on the earth with a force 350 N ; the earth acts on each foot with a force 350 N.

$$W = mg = (70\text{ kg})(10\text{ N/kg}) = 700\text{ N}$$
$$\text{(each foot) } F = W/2 = 350\text{ N}$$

A unit mass made with a thin mass, m, attached to a massless spring, (31 cm normal length and a spring constant, k = 15 N/cm) is shown at the right. When a stack of six unit masses is assembled on the ground, one on top of the other, the bottom spring is fully compressed.



unit mass

2. In the box to the right, draw a picture of the stack if the bottom spring has compressed by 30 cm (almost fully compressed)

3. What is the weight and mass m , of each unit mass?

$$W_1 = mg, \quad W_T = 6W_1 = 6mg \text{ (total)}$$
$$F = kx = (15\text{ N/cm})(30\text{ cm}) = 450\text{ N}$$
$$W_T = F \quad , \quad 6mg = 450\text{ N}$$
$$W_1 = mg = (450\text{ N})/6 = 75\text{ N}$$
$$m = W_1/g = (75\text{ N})/(10\text{ N/kg}) = 7.5\text{ kg}$$

4. What is the compression force acting on the top and bottom surfaces of the masses, from the top (1) to the bottom (6) in the stack?

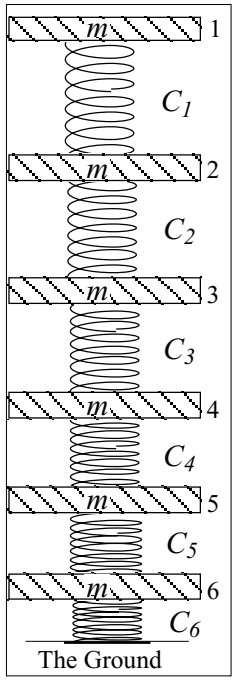


Fig. for problems 2-4
See course pack Fig. 6.9

Force vectors are the same as Fig. 6.9, 6 masses instead of 5.

Mass 1: Compression force on top 0 ; bottom 75 N

Mass 2: Compression force on top 75 N ; bottom 150 N

Mass 3: Compression force on top 150 N ; bottom 225 N

Mass 4: Compression force on top 225 N ; bottom 300 N

Mass 5: Compression force on top 300 N ; bottom 375 N

Mass 6: Compression force on top 375 N ; bottom 450 N

Compression force in spring (#) is :

$C_1 = mg =$ 75 N; $C_2 = 2mg =$ 150 N; $C_3 = 3mg =$ 225 N;

$C_4 = 4mg =$ 300 N ; $C_5 = 5mg =$ 375 N ; $C_6 = 6mg =$ 450 N

In a stack of springs and masses, the second mass from the top, shown at the right, has three forces acting **on** it. They are: the spring compression forces C_1, and C_2, and the gravitational force, W. (note: the gravitational force acts on the whole mass)

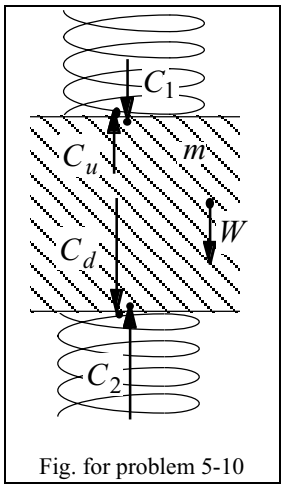
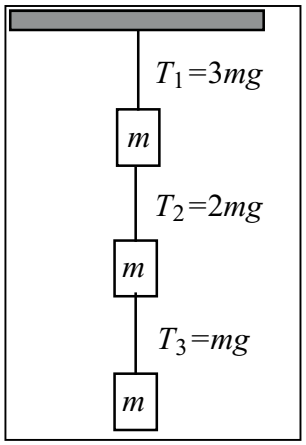


Fig. for problem 5-10

5. What is the weight of the mass? $W = mg$
6. Are the forces acting on this piece of mass balanced? balanced
7. If this mass were massless what would be the value of C_2? $C_2 = C_1$
8. What is the relationship between the compressions C_1, C_2, and W?

$$C_2 = C_1 + W$$

9. Draw the compression force vector within the mass acting upward on the top spring. What is its magnitude compared to C_1? $C_u = C_1$
10. Draw the compression force vector within the mass acting on the lower spring. What is its magnitude compared to C_2? $C_d = C_2$
11. Three equal masses hang from the ceiling by strings as shown at the right. If the tension in the top string is T, what is the magnitude of the tension in the lowest string?



a) $T/3$ b) $-T/3$ c) $-mg/3$ d) T e) $3mg$

$T = T_1 = 3mg$
$T_3 = mg = T/3$

Three masses, m, $2m$, and $3m$, hang from the ceiling by strings as shown at the right.

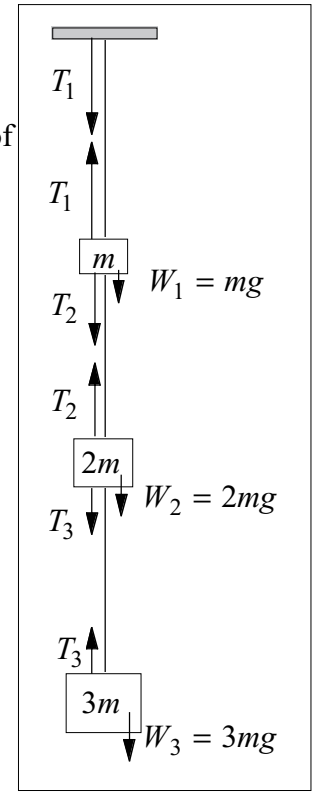


Fig. for Prob. 12-15

12. Draw on the figure to the right the tension vectors generated at the ends of the three strings and the weight vectors acting on each mass. Label the tensions from the top as T_1, T_2, and T_3. Label each weight vector with its magnitude in units of mg.
13. What is the magnitude of T_3, the tension in the lowest string?

a) 2 mg b) 3 mg c) 4 mg d) 5 mg e) 6 mg

Weight W_3 is balanced by tension $T_3 = 3mg$.

14. What is the magnitude of T_2, the tension in the middle string?

a) 2 mg b) 3 mg c) 4 mg d) 5 mg e) 6 mg

Weight W_2 + tension T_3 is balanced by tension $T_2 = 5mg$.

15. From these masses, what is the magnitude of the vector sum of gravitational (not electromagnetic) forces acting on the earth?

a) zero b) 3 mg c) 4 mg d) 5 mg e) 6 mg

16. A mass, m = 15 kg , in a stationary stack of masses, has a spring with compression force $C_1 = 300\,\text{N}$ acting on its top face. What is the compression force, C_2, in the spring acting on the bottom face of the mass?

a) 50 N b) 150 N c) 250 N d) 350 N e) 450 N

$$W = mg = (15\ \text{kg})(10\ \text{N/kg}) = 150\ \text{N}$$
$$C_2 = C_1 + W = 300\ \text{N} + 150\ \text{N} = 450\ \text{N}$$

17. A mass weighs 10,000 N on the planet Mongo ($g_{\text{Mongo}} = 25\,\text{N/kg}$). What is its weight on the Earth?

a) 250,000 N b) 400 N c) 2.5 N d) 4000 N e) 2500 N

$$W_{mongo} = mg_{mongo}$$
$$m = W_{mongo} / g_{mongo} = (10{,}000\ \text{N})/(25\ \text{N/kg}) = 400\ \text{kg}$$
$$W_{earth} = mg_{earth} = (400\ \text{kg})(10\ \text{N/kg}) = 4{,}000\ \text{N}$$