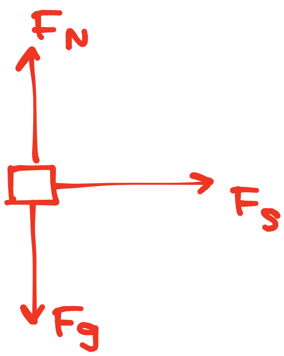
SPRINGS AND HOOKE'S LAW - SOLUTIONS

1. $F_s = kx$

$= (240)(0.050)$

$= 12\ \text{N}$

2.



$F_{NET} = ma$

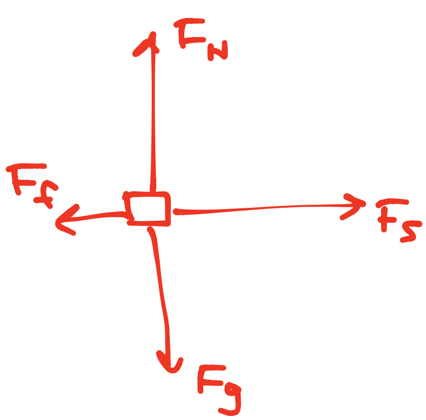
$kx = ma$

$a = \frac{kx}{m}$

$= \frac{(320)(0.40)}{4.0}$

$= 32\ \frac{m}{s^2}$ RIGHT

3.



$F_N = F_g$

$= mg$

$F_{NET} = ma$

$F_s - F_f = ma$

$kx - \mu F_N = ma$

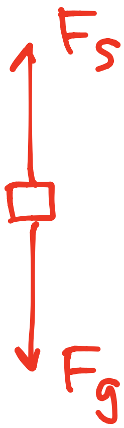
$kx - \mu mg = ma$

$a = \frac{kx - \mu mg}{m}$

$= \frac{(440)(0.12) - (0.55)(4.0)(9.8)}{4.0}$

$= 7.8\ \frac{m}{s^2}$ RIGHT

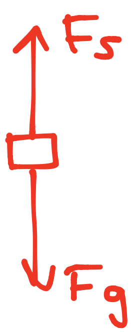
4.



$a = 0$

$$F_{NET} = m\cancel{a}$$
$$F_s - F_g = 0$$
$$F_s = F_g$$
$$kx = mg$$
$$x = \frac{mg}{k}$$
$$= \frac{(0.050)(9.8)}{140}$$
$$= 0.0035\ \text{m}$$
$$= 3.5\ \text{mm}$$

5.
- LET ℓ_{eq} BE THE EQUILBRIUM POSITION.
- LET ℓ BE THE LENGTH OF THE STRETCHED SPRING (WITH THE HANGING MASS)
- THEN $x = \ell - \ell_{eq}$, THE DISPLACEMENT FROM ITS EQUILBRIUM POSITION.



$a = 0$

$$F_{NET} = m\cancel{a}$$
$$F_s - F_g = 0$$
$$F_s = F_g$$
$$kx = F_g$$
$$k(\ell - \ell_{eq}) = F_g$$

FOR 10N:

$$k(0.2-l_{eq})=10 \quad ①$$

FOR 20N:

$$k(0.3-l_{eq})=20 \quad ②$$

SYSTEM OF 2 EQUATIONS WITH 2 UNKNOWNS

→ SOLVE USING SUBSTITUTION:

USING ①

$$k=\frac{10}{0.2-l_{eq}} \quad ③$$

③ INTO ②

$$k(0.3-l_{eq})=20$$

$$\frac{10}{0.2-l_{eq}}(0.3-l_{eq})=20$$

$$10(0.3-l_{eq})=20(0.2-l_{eq})$$

$$3-10l_{eq}=4-20l_{eq}$$

$$10l_{eq}=1$$

$$l_{eq}=0.1\ m$$

$$10\ cm$$

SUB INTO ③

$$k=\frac{10}{0.2-l_{eq}}$$

$$=\frac{10}{0.2-0.1}$$

$$=100\frac{N}{m}$$

6. LET x_1 BE HOW MUCH SPRING 1 IS COMPRESSED.

THEN $(0.16-x_1)$ IS THE COMPRESSED LENGTH OF SPRING 1

$0.20-(0.16-x_1)$ IS THE COMPRESSED LENGTH OF SPRING 2

$0.12-[0.20-(0.16-x_1)]$ IS HOW MUCH SPRING 2 IS COMPRESSED. (x_2)

$$= 0.12-[0.04+x_1]$$
$$= 0.08-x_1$$

AT THE POINT WHERE THE SPRINGS MEET:

$$F_{s2} \longleftarrow \square \longrightarrow F_{s1}$$

$a = 0$

$$F_{NET} = m a$$
$$F_{s_2} - F_{s_1} = 0$$
$$F_{s_1} = F_{s2}$$
$$k_1 x_1 = k_2 x_2$$
$$120\, x_1 = 240\,(0.08 - x_1)$$
$$120\, x_1 = 19.2 - 240 x_1$$
$$x_1 = 0.053\,m$$
$$= 5.3\,cm$$

SPRINGS WILL BE COMPRESSED IN SUCH A WAY THAT THE FORCES ARE BALANCED.

SPRING 1 IS COMPRESSED BY 5.3 cm.

$$x_2 = 0.08 - x_1$$
$$= 0.08 - 0.053$$
$$= 0.027 \text{ m}$$
$$= 2.7 \text{ cm}$$

SPRING 2 IS COMPRESSED BY 2.7 cm.