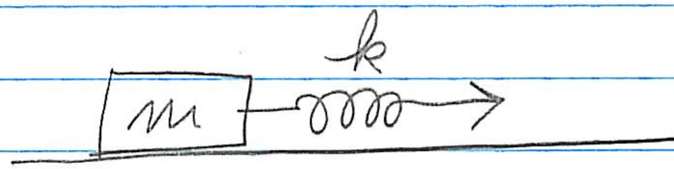
Chapter 10

10-5



$$F = ma = kx$$

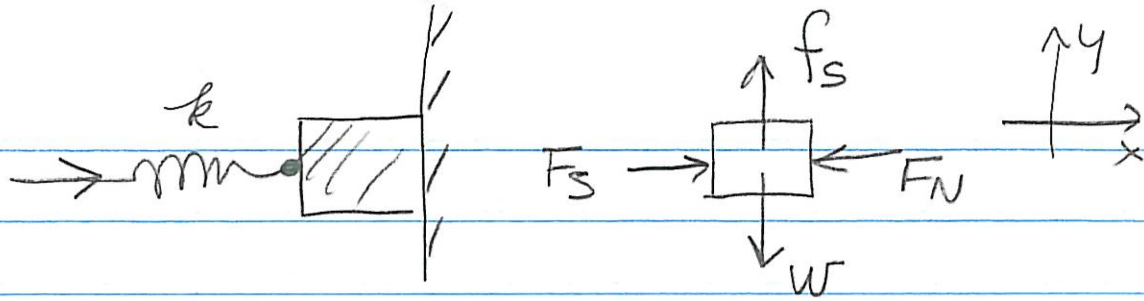
$$x = \frac{ma}{k}$$

$$= \frac{92\,kg \times 0.3\,m/s^2}{2300\,N/m}$$

$$= 0.012\,m$$

or 1.2 cm

10-10



$m = 1.6\ kg$
$k = 510\ N/m$

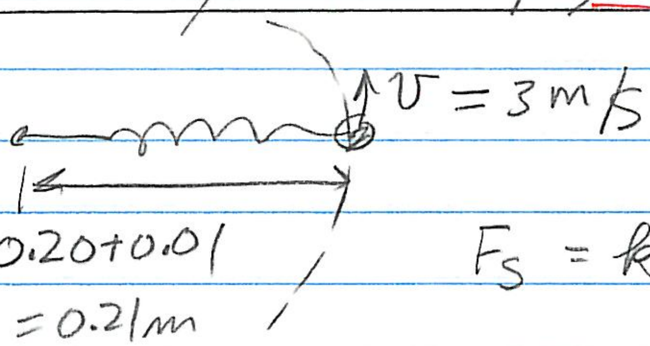
$f_s - w = 0$
$F_s - F_N = 0$

$F_s = kx = 510(0.039\,m)$
$= 20\,N = F_N$

$f_s = \mu_s F_N = \mu_s \cdot 20 = w = 1.6 \times 9.8$

$20\mu_s = 15.7$, $\mu_s = 0.78$

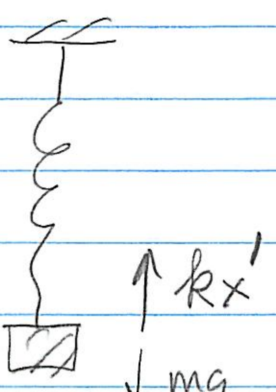
10-11



$$F_s = kx = \frac{mv^2}{r}$$

$$k(0.01) = \frac{m(3)^2}{0.21}$$

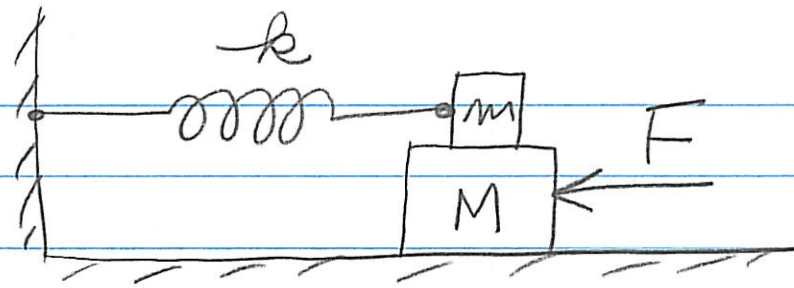
$$m/k = \frac{0.01 \times 0.21}{9} = 2.3 \times 10^{-4}$$



$kx' = mg$

$$x' = \frac{m}{k} g = 2.3 \times 10^{-4} \times 9.8$$
$$= 2.3 \times 10^{-3}\,m$$

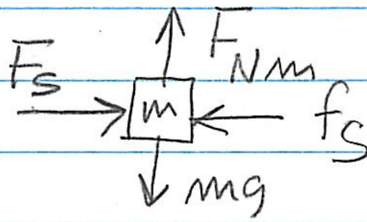
10-13



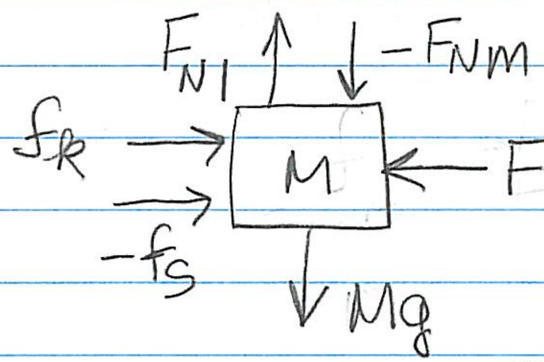
$k = 325\ N/m$

$M = 30\ kg$

$m = 15\ kg$



$\mu_s = 0.9$



$\mu_k = 0.6$

now $a = 0$ so $\sum_m \vec{F} = \sum_M \vec{F} = 0$

$F_{Nm} = mg$ ① | $F_{N1} = Mg + F_{Nm}$ ②

$F_s = f_s$ ③ | $f_k + f_s = F$ ④

$f_s = \mu_s F_{Nm} = \mu_s mg$ ⑤ , $f_k = \mu_k F_{N1}$ ⑥

$F_s = kx$ ⑦

(a) ③ and ⑦ $kx = f_s = \mu_s mg$

$$x = \frac{\mu_s mg}{k} = \frac{0.9 \times 15 \times 9.8}{325} = \underline{0.41\ m}$$

10-13, continued

(b) $F = f_k + f_s$

$= \mu_k F_{N1} - \mu_s mg$

② $F_{N1} = Mg + F_{Nm}$

but $F_{Nm} = mg$ by ①

$F_{N1} = Mg + mg = 45 \times 9.8$

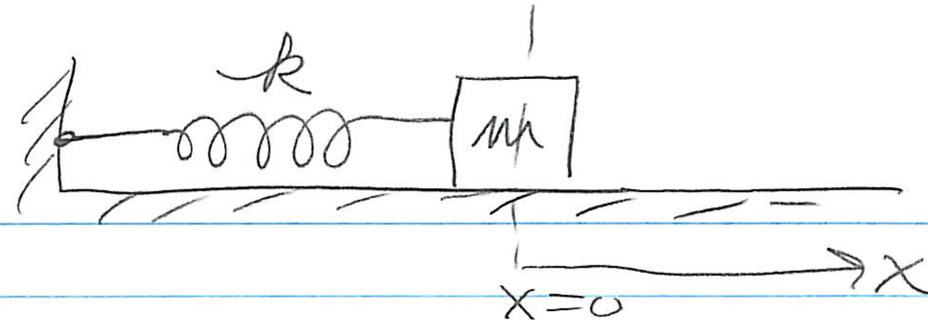
$= 441\ N$

then $F = 0.6 \cdot 441 + 0.9 \times 15 \times 9.8$

$= 264.6 + 132.3$

$= \underline{397\ N}$

10-17



(a) $x = {}^{+}0.12\,m$

$F_s = -kx = -82\,N/m \times 0.12\,m$

$= -9.8\,N$

(b) $\omega = \sqrt{k/m} = \sqrt{82/0.75}$

$\omega = 10.5\,rad/s$

(c) $v_{max} = \omega A$, where $A = 0.12\,m$

$v_{max} = 10.5 \times 0.12 = 1.26\,m/s$

(d) $a_{max} = \omega^2 A$

$= (10.5)^2 \times 0.12$

$= 13.2\,m/s^2$

10-18

(a) $A = 0.08 m$

(b) $T = 4s = \frac{2\pi}{\omega}$

$\omega = \frac{2\pi}{4} = 1.57 \text{ rad/s}$

(c) $\omega = \sqrt{\frac{k}{m}} \Rightarrow k = m\omega^2$

$k = 0.8 \text{ kg} (1.57)^2 \simeq 2 \text{ N/m}$

(d) at t = 1 s, the mass is at its maximum excursion so $v(1s) = 0$

(e) at t = 1 the object experiences maximum acceleration so

$kA = ma \quad (a_{max} = \omega^2 A)$

$a = \frac{kA}{m} = \frac{2 \times 0.08}{0.8}$

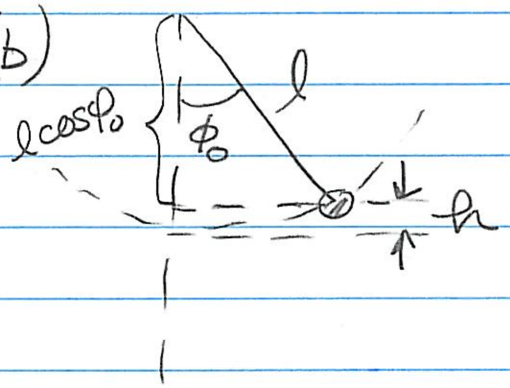
$a = 0.2 \text{ m/s}^2$

10-45 $\ell = 0.79\,m$, $m = 0.24\,kg$

$\varphi_0 = 8.5°$

(a) $\omega = \sqrt{g/\ell} = \sqrt{9.8/0.79} = 3.5\,rad/s$

(b)



The total mechanical energy of the system is its initial PE_g

$$PE_g = mgh$$

$$h = \ell - \ell\cos\varphi_0 = \ell(1-\cos\varphi_0)$$

$$= 0.79 \times (1 - \cos 8.5) = 0.0087\,m$$

$$E_{TOT} = 0.24 \times 9.8 \times 0.0087 = 0.02\,J$$

(C) At its lowest point it has maximum speed

$$\frac{1}{2}mv_{max}^2 = mgh$$

$$v_{max} = \sqrt{2gh}$$

$$= \sqrt{2 \cdot 9.8 \cdot 0.0087}$$

$$= 0.41\,m/s$$

10-46

$T = 1.25\,s$

$T_{NEW} = 1.25 + 0.2\,s = 1.45\,s$

$T = 2\pi\sqrt{l/g}$

or $\dfrac{T^2}{l} = \dfrac{T_{new}^2}{l_{new}}$

$l_{new} = \left(\dfrac{T_{new}}{T}\right)^2 l$

$= \left(\dfrac{1.45}{1.25}\right)^2 \times l = 1.35\,l$

$\Delta l = l_{NEW} - l = 1.35\,l - l$

$= (1.35 - 1)\,l = 0.35\,l$

and $l = \left(\dfrac{T}{2\pi}\right)^2 g = \left(\dfrac{1.25}{2\pi}\right)^2 \times 9.8 = 0.39\,m$

so $\Delta l = 0.13\,m$ longer

10-74

$$f = \frac{\omega}{2\pi} = \frac{7.54 \times 10^4 \text{ rad/s}}{2\pi}$$

$$f = 1.2 \times 10^4 \text{ Hz}$$

or 12 kHZ (kilo hertz)

(1 Hz ≡ 1 cycle / SEC)

Thus in 2.5 s the speaker diaphragm moves in and out

1.2×10^4 per SEC × 2.5 S

= 30,000 times