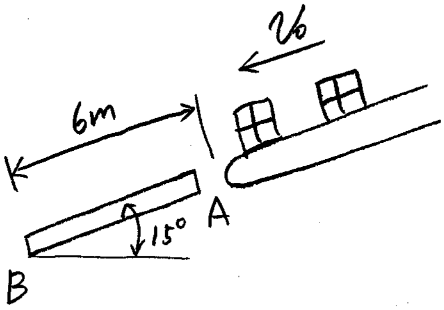
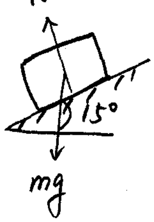
13.12(14)



$\mu_k = 0.40$

$$T_1 + U_1 = T_2 + U_2$$

At A $\quad T_A = \frac{1}{2} m V_0^2$



$N = mg\cos 15°$

$$U_{A\to B} = F_{net} \times \text{distance}$$

$$= (mg\sin 15° - \mu_k mg\cos 15°) \times 6$$

At B $\quad T_B = 0$

$$\therefore \quad T_A + U_{A\to B} = T_B$$

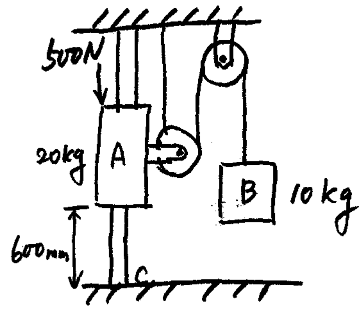
$$\frac{1}{2} \cancel{m} V_0^2 + 6\cancel{m}g(\sin 15° - \mu_k \cos 15°) = 0$$

$$V_0^2 = -12g(\sin 15° - \mu_k \cos 15°)$$

$$\therefore V_0^2 = 15.0$$

$$V_0 = 3.87 \text{ m/s}$$ 15°

13.19(21)

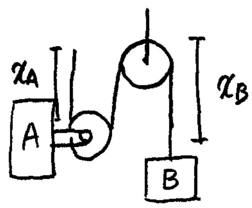


$V_A = ?$

V_A counter weight B is replaced by a 98.1 N ↓

---

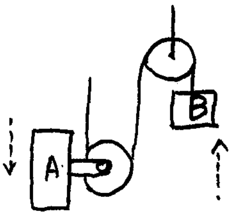
①



$$2x_A + x_B = 0 \qquad |x_B| = 2|x_A|$$

$$2V_A + V_B = 0 \qquad |V_B| = 2|V_A|$$

②



$$T_1 + U_{1\to2} = T_2$$

(a) $T_1 = 0$

$$U_{1\to2} = F\cdot x_A + m_A g\, x_A - m_B g\, x_B$$

$$= 500 \times 0.6 + 20 \times 9.81 \times 0.6 - 10 \times 9.81 \times 1.2$$

$$= 300\ \text{J}$$

$$T_2 = \frac{1}{2} m_A V_A^2 + \frac{1}{2} m_B V_B^2$$

$$= \frac{1}{2} \times 20\, V_A^2 + \frac{1}{2} \times 10 \times 4 V_A^2$$

$$= 30\, V_A^2$$

$$0 + 300 = 30\, V_A^2$$

$$\therefore V_A = 3.16\ \text{m/s} \ \downarrow$$

(b) $T_1 = 0 \qquad U_{1\to2} = 300\,J$

$$T_2 = \frac{1}{2} m_A v_A^2$$

$$= 10\ v_A^2$$

$$(\because\ U_{1\to2} = F\cdot x_A + m_A g\, x_A - F_B\, x_B)$$

$$= 300\,J$$

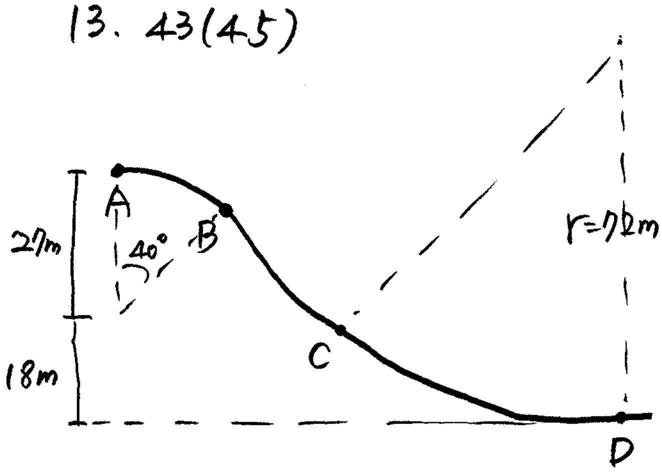
$$F_B = 98.1\ N$$

$$m_B g = 10 \times 9.81\ [N]$$

$$\therefore\ v_A^2 = 30$$

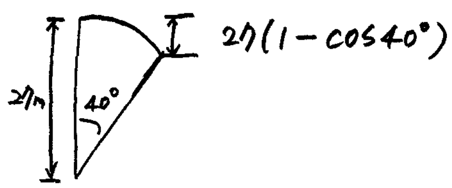
$$v_A = 5.48\ m/s \downarrow$$

13. 43(45)



Total mass 250 kg

At A $\quad v_A = 0 \quad$ then $\quad T_A = 0$

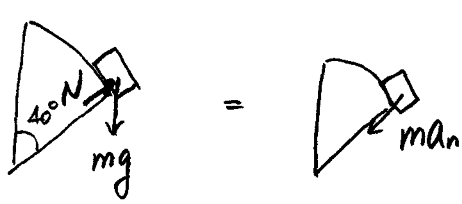


$$U_{A\to B} = mgh$$
$$= 250 \times 9.81 \times 27(1-\cos 40^\circ)$$
$$= 15492 \text{ J}$$

$$T_B = \frac{1}{2} m v_B^2$$
$$= 125 v_B^2$$

$$T_A + U_{A\to B} = T_B$$

$$\therefore v_B^2 = 123.9 \ m^2/s^2$$

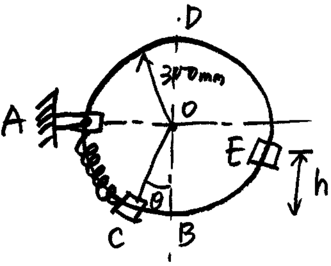


$$N - mg\cos 40^\circ = -\frac{m v_B^2}{r}$$

$$N = mg\cos 40^\circ - \frac{m v_B^2}{r}$$
$$= 250 \times 9.81 \times \cos 40^\circ - \frac{250 \times 123.9}{27}$$

$$\underline{N = 732 \text{ N}}$$

13.61(63)



$k = 40\,N/m$

200g collar C

$\theta = 30°$

(a) Max height

(b) Max velocity

$T_1 + V_1 = T_2 + V_2$

(a) $V_c = 0 \quad T_c = 0$

Let, maximum height is point E

$V_E = 0 \quad T_E = 0.$

Consider Potential Energy (Spring & Gravity)

$(V_c)_{spring} = \frac{1}{2} k (\Delta L_{BC})^2$

$= 0.493\ J$

The arc length is $r\theta$ (θ: radian)

$\therefore \Delta L_{BC} = 0.3 \times \frac{\pi}{6}$

$= \frac{\pi}{20}\ m$

$(V_c)_g = mg(1-\cos\theta)r$

$= 0.2 \times 9.81 (1 - \cos 30°)\, 0.3$

$= 0.079\ J$

$(V_E)_{spring} = 0$

$(V_E)_g = mgh$

$= 0.2 \times 9.81 h = 1.962 h\ [J]$

$\therefore \quad T_c + V_c = T_E + V_E$

$0 + 0.493 + 0.079 = 0 + 0 + 1.962 h$

$\therefore h = 0.292\ m$

(b) You can get the maximum velocity at B,

where the potential energy is zero.

$$T_B = \frac{1}{2} m v_B^2$$

$$= 0.1\, v_B^2$$

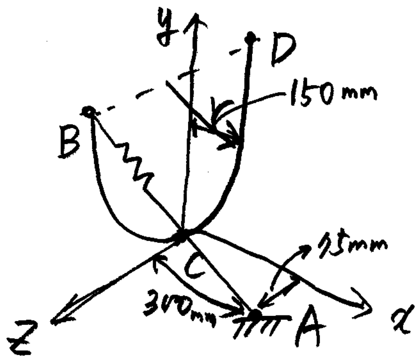
$$V_B = 0$$

$$T_c + V_c = T_B + V_B$$

$$0.572 = 0.1\, v_B^2$$

$$v_B = 2.39 \text{ m/s} = v_{max}$$

13.69(70)



$k = 320 N/m$ (undeformed length 200mm)

the collar of mass : 500g

$$L_{AB} = \sqrt{0.3^2 + 0.15^2 + 0.075^2}$$

$$= 0.344 \ m$$

at B $\quad v_B = 0 \quad T_B = 0$

$$V_B = (V_B)_s + (V_B)_g$$

$$(V_B)_s = \frac{1}{2} k \Delta L_B^2 = \frac{1}{2} \times 320 (0.344 - 0.200)^2$$

$$= 3.31 \ J$$

$$(V_B)_g = mgr$$

$$= 0.5 \times 9.81 \times 0.15$$

$$= 0.736 \ J$$

at C $\quad T_C = \frac{1}{2} m v_C^2 = 0.25 v_C^2$

$$(V_C)_s = \frac{1}{2} k \Delta L_C^2 \qquad \left(\begin{array}{l} \Delta L_C = L_{AC} - 0.2 \\ L_{AC} = \sqrt{0.3^2 + 0.075^2} = 0.309 m \end{array} \right)$$

$$= \frac{1}{2} \times 320 \times (0.309 - 0.200)^2$$

$$= 1.90 \ J$$

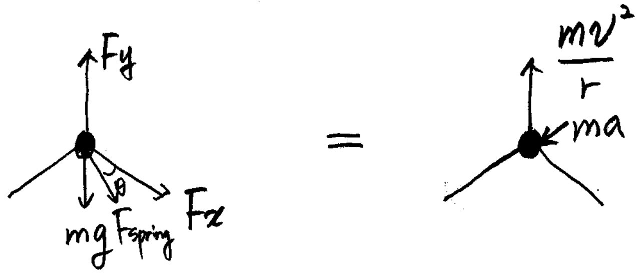
$$T_B + V_B = T_c + V_c$$

$$0 + 3.31 + 0.736 = 0.25\, v_c^2 + 1.90$$

$$v_c^2 = 8.58$$

$$v_c = 2.93 \text{ m/s}$$

(b)



$$F = F_x i + F_y j \qquad \theta = \tan^{-1}\frac{75}{300} = 14.04°$$

$$F_s = k\,\Delta L_{AC}\,(\cos\theta\, i + \sin\theta\, k)$$

$$= 320 \times 0.109 \times (\cos 14.04°\, i + \sin 14.04°\, k)$$

$$= 33.84\, i + 8.46\, k$$

$$\Sigma F = (F_x + 33.84)\, i + (F_y - 4.905)\, j + 8.46\, k$$

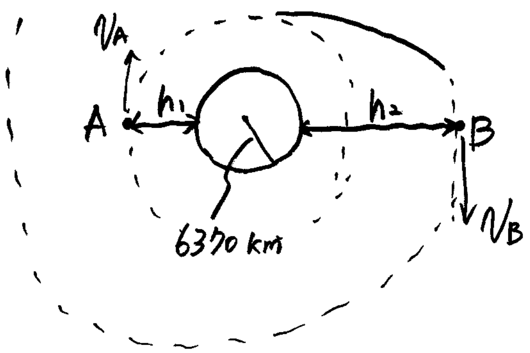
$$= \frac{mv^2}{r}\, j + ma\, k.$$

$$F_x + 33.84 = 0 \qquad F_y - 4.905 = \frac{0.5 \times 2.93^2}{0.15}$$

$$F_x = -33.84\ N \qquad F_y = 33.52\ N$$

$$F = -33.8\ N\, i + 33.5\ N\, j$$

13.105(104)



$h_1 = 320$ km

$h_2 = 800$ km

Conservation of angular momentum

$$m r_A v_A = m r_B v_B$$

$r_A = 6690$ km

$r_B = 7170$ km

$\therefore \; v_A = 1.072\, v_B$

Conservation of energy

$$T_A + V_A = T_B + V_B$$

$$GM = gR^2 = 9.81 \times 6370^2 \times 10^6 = 3.98 \times 10^{14} \ m^3/s^2$$

at A

$$T_A = \frac{1}{2} m v_A^2, \quad V_A = -\frac{GMm}{r_A} = -\frac{3.98 \times 10^{14}}{6690 \times 10^3} = -5.95 \times 10^7 \times m$$

at B

$$T_B = \frac{1}{2} m v_B^2 \quad V_B = -\frac{GMm}{r_B} = -\frac{3.98 \times 10^{14}}{7170 \times 10^3} = -5.55 \times 10^7 \times m$$

$$\frac{1}{2}mV_A^2 - 5.95\times10^7\times m = \frac{1}{2}mV_B^2 - 5.55\times10^7\times m$$

$$\frac{1}{2}\cancel{m}(V_B^2\times1.072^2 - V_B^2) = 4.0\times10^6\times\cancel{m}$$

$$0.149\,V_B^2 = 8.0\times10^6$$

$$V_B = 7327 \text{ m/s}$$

$$V_A = 7855 \text{ m/s}$$

Circular orbit at A & B

$$(V_A)_c = \sqrt{\frac{GM}{r_A}} = 7713 \text{ m/s}$$

$$(V_B)_c = \sqrt{\frac{GM}{r_B}} = 7450 \text{ m/s}$$

(a) $$\Delta V_A = |V_A - (V_A)_c| = 142 \text{ m/s}$$

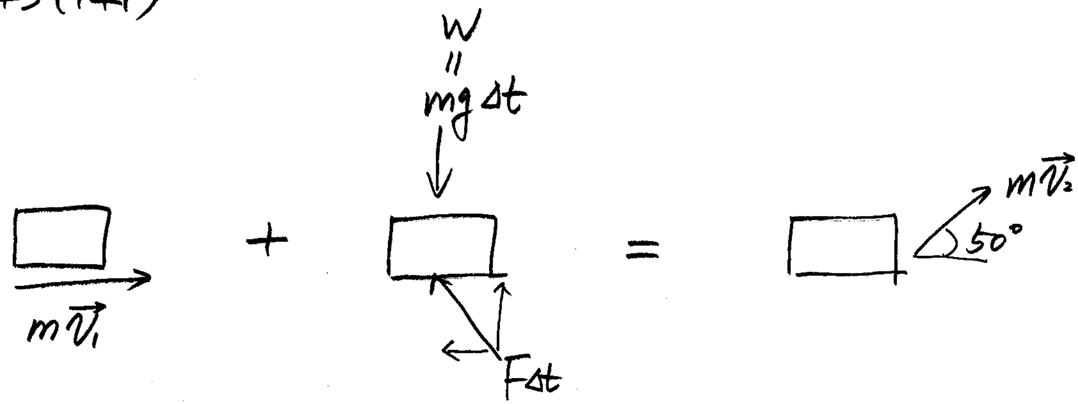
$$\Delta V_B = |V_B - (V_B)_c| = 123 \text{ m/s}$$

(b) $$E = \frac{1}{2}\left[m V_A^2 - m(V_A)_c^2 + (V_B)_c^2 - V_B^2\right]$$

$$E/m = \frac{1}{2}\left[7855^2 - 7713^2 + 7450^2 - 7327^2\right]$$

$$= 2.01\times10^6 \text{ J/kg}$$

13.143 (141)



consider the vertical components.

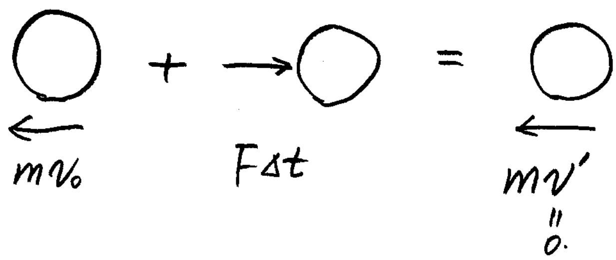
$$0 + (F_v - W)\Delta t = m v_2 \sin 50^\circ$$

$$(F_v - W) \times 0.18 = \frac{W}{9.81} \times 11 \times \sin 50^\circ$$

$$F_v - W = 4.77 W$$

$$F_v = 5.77 W$$

13.154 (153)



$v_0 = 154 \text{ km/h}$

$= 42.8 \text{ m/s}$

$m v_0 - F\Delta t = 0 \quad — ①$

$m = 0.15 \text{ kg}$.

$V_{AVE} = 7.6 \text{ m/s}$

distance 20 cm.

$\Delta t = \frac{0.2}{7.6}$

$= 0.0263 \text{ s}$

Using Eqn ①

$\therefore \quad 0.15 \times 42.8 - F \times 0.0263 = 0$

$\therefore F = 244.1 \text{ N}$