Solution to Worksheet - 8

A.1: u = 40 km/hr = 100/9 m/s, S = 40 m

$v^2 - u^2 = 2as$

$0 - \left(\frac{100}{9}\right)^2 = 2a\,(4.0)$

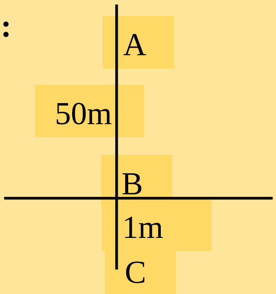
$\Rightarrow a = \frac{-10000}{81 \times 8} m/s^2$

F = m × a

$= 2000 \times \frac{-100 \times 100}{81 \times 8}$

$= -3 \times 10^4$ N

A.2:



$A \to B$

$v_B{}^2 - u^2 = 2gs$

$v_B{}^2 = 2 \times 9.8 \times 50 = 980$

Now, $B \to C$

$v_C{}^2 - v_B{}^2 = 2a \times 1$

$0 - 980 = 2a \times 1$

$\Rightarrow$ a = –490 m/s²

F = ma

= 5 × (– 490) = – 2450 N

$v_C = v_B + at$

$0 = \sqrt{980} + (-490)t$

t = .064s

A.3: 0.5g – T = 0.5a

T = 5 –.5 × 2 = 4N

A.4: mass = 50 g = 50 × 10^{-3}

(a) T = m (g + a)

= (50 × 10^{-3}) [9.8 + 1.2] = .55 N

(b) T = mg + m(- a)

= (50 × 10^{-3}) [9.8 - 1.2] = .43 N

(c) Uniform velocity, a = 0

T = mg = 50 × 10^{-1} × 9.8 = .49 N

(d) T = m (g - a)

= (50 × 10^{-3}) [9.8 - 1.2] = .43 N

(e) T = m (g – (–a))

= (50 × 10^{-3}) [9.8 + 1.2] = .55N

(f) Uniformly velocity, a = 0

T = mg = .49N

A.5: R_{max} = M (g + a)

72g = Mg + Ma ....(1)

R_{min} = M (g – a)

60 = Mg – Ma ....(2)

Adding equ.(1) & (2),

132 g = 2 Mg

$\Rightarrow$ M = 66 Kg

Magnitude of acceleration,

60 g = 66 (g – a)

$\Rightarrow a = \frac{g}{11} = .9 m/s^2$

A.6: 2as = v² – u²

$2a \times .05 = 0 - 2^2$

$\Rightarrow$ a = – 40m/s²

F = ma $= .025 \times (-40) = 1N$

A.7:

$F_{net} = \sqrt{1^2 + 1^2 + 2.1.1\cos 60^0} = \sqrt{3}N$

F = ma or $\sqrt{3} = 2a_{net}$

Or $a_{net} = \sqrt{3}/2$ m/s²

A.8: Given, breaking load $T = \frac{3}{4}Mg$

$Mg - T = Ma$

$Mg - \frac{3}{4}Mg = Ma \Rightarrow a = \frac{g}{4}$

A.9: Given mass of bullet = 0.01Kg

$F = \frac{change\ in\ momentum}{time}$

$M\ a = \frac{mv - 0}{t}$

Where M is mass of machine gun

$(2 \times 100)\ a = \{(.01)\times 500\times(10\ \text{bullets/sec})\}$

$a = 25\ cm/s^2$

A.10: $F = \frac{\Delta P}{\Delta t} = \frac{P_i - P_t}{\Delta t} = \frac{mv - O}{\Delta t}$

$= \frac{V\rho v}{\Delta t} = \frac{A\Delta\ell\rho v}{\Delta t} = A\rho v^2$

$= \pi r^2 \rho v^2$

A.11: $F = \frac{\Delta P}{\Delta t} = \frac{P_i - P_t}{\Delta t}$

$= \frac{mv\cos\theta - m(-v\cos\theta)}{\Delta t}$

$= \frac{2V\rho v\cos\theta}{\Delta t} = \frac{2a\Delta l\rho v\cos\theta}{\Delta t}$

$F = 2a\rho v^2 \cos\theta$

A.12: $F = A\rho v^2$ (see A. 10)

$5\times 10^{-2}\times 1000\times(20)^2$

= 200N

A.13: $F = \frac{change\ in\ momentum}{time}$

$= \frac{mv - m\times 0}{t}$

$= \{50\times 10^{-3}\times 400\}\times\frac{30}{60}$ = 10 N

A.14: mass of rope = m

P = (M + m) a

$a = \frac{P}{M+m}$

Force on block by rope $F = Ma = \frac{MP}{M+m}$

A.15: F = – kx = ma

Or $15 \times .2 = .3a$

Or $a = -10\ m/s^2$

A.16: $a = \frac{net\ putting\ force}{Total\ mass} = \frac{6g - 3g}{6+3}$

$= g/3\ m/s^2$

(a) $s = \frac{1}{2}at^2 = \frac{1}{2}\times\frac{9.8}{3}\times 4 = 6.5m$

(b) 0.6g – T = 0.6a

.6 (g – a) = T

$\Rightarrow T = .6\ (g - g/3) = 3.92N$

(c) Force exerted by clamp = 2T

= 2×3.92 = 7.84N

A.17: Let v be velocity for .3kg when we stop .6kg mass (using a = g/3 from A.16)

$v = u + at = 0 + \frac{g}{3}\times 2 = \frac{2g}{3}\ m/s^2$

Time taken for string to lighten up,

$v = u + gt \Rightarrow \frac{2g}{3} = 0 + gt \Rightarrow t = \frac{2}{3}sec$

A.18: $a = \frac{net\ pulling\ force}{total\ max}$

$= \frac{5g - 4.8g}{5+4.8} = \frac{.2\times 9.8}{9.8} = 0.2\ m/s^2$

A.19: $T = \frac{2M_1M_2g}{M_1+M_2}$ (Derived)

For non-internal frame

$$T = \frac{2M_1M_2}{M_1+M_2}(g+a)$$

$$T = \frac{2(1.5)(3)}{1.5+3}\left(\frac{11g}{10}\right)$$

$T = 22N$

So, $R = 44N = m(10) \Rightarrow m = 4.4$ kg

A.20: For non-internal frame

$$T = 2\frac{m_1m_2}{m_1+m_2}(g+a)$$

$$T = 2\frac{m_1m_2}{m_1+m_2}(2g) -- (i) \quad [\text{as } g = a]$$

$W_1 = m_1g$ or $m_1 = \frac{W_1}{g}$

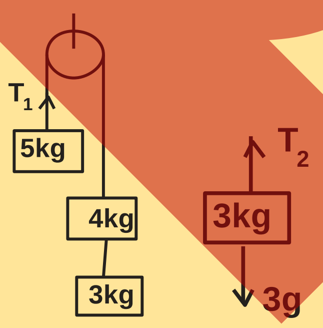
$W_2 = m_2g$ or $m_2 = \frac{W_2}{g}$

Substituting in equation (i)

$$T = 4\frac{W_1W_2}{W_1+M_2}$$

A.21: (a) $a = \frac{(4+3)g - 5g}{5+4+3} = \frac{20}{10} = \frac{5}{3}$

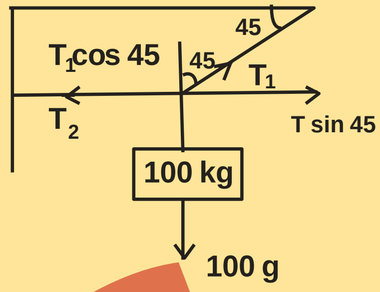
$= 1.67$ m/s^2



$T_1 - 5g = 5a$ or $T_1 = 50 - 5\times\frac{5}{3}$

$T_1 = 58.3$ N

$3g - T_2 = 3a$ or $T_2 = 25N$



(c)

$T_1 \sin 45^o = T_2$ ....(i)

$T_1 \cos 45^o = 100g$........(ii)

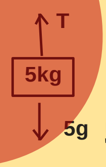
Using (ii)

$T_1 = 1000\sqrt{2}N$

Using (ii)

$T_2 = 1000N$

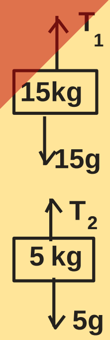
(d) $a = \frac{5g}{10+5} = \frac{50}{15} = 3.27 m/s^2$



$5g - T = 5a$ or $T = 5g - 5a$

$T = 50 - 5\times50/15 = 33.3N$

(e) $a = \frac{15g - 5g}{15+10+5} = \frac{10g}{30} = \frac{g}{3}$



$15g - T_1 = 15a$

$T_1 = 15g - 15a = 15(g - g/3) = 98N$

$T_2 - 5g = 5a$ or $T_2 = 32.7N$

A.22: $\frac{dx}{dt} = 3 + 8t + 15t^2$

$$a = \frac{d^2x}{dt^2} = 8 + 30t$$

At t = 2s, $a = 68 m/s^2$

F = ma = 2 × 68 = 136 N

A.23: $F = ma$ or $-3\hat{i} + 4\hat{j} = 5a$

Or $a = -\frac{3}{5}\hat{i} + \frac{4}{5}\hat{j}$

Given, at t = 0 $v = 6\hat{i} - 12\hat{j}$

For X axis,

v = u + at

0 = 6 + (-3/5)t

Or t = 10s

A.25:

For 5 kg block,

$T_1 - 8g = 8a$

$T_1 = 8g + 8a$

$T_1 = 8 \times 9.8 + 8 \times 2 = 94.4N$

For 3 kg block

$T_2 - 3g = 3a$

$T_2 = 3g + 3a = 3(9.8 + 2)$

$T_2 = 35.4N$