

## Dynamics Worksheet #1

①  $m = 3.0 \text{ kg}$        $F = ma$        $v_f = v_i + at$   
 $F = 24 \text{ N}$        $24 = 3a$        $v_f = 0 + 8(5)$   
 $v_i = 0$        $a = 8.0 \text{ m/s}^2$        $v_f = 40 \text{ m/s}$   
 $t = 5 \text{ s}$   
 $d = ?$

$$d = \left( \frac{v_f + v_i}{2} \right) t$$

$$= \left( \frac{40 + 0}{2} \right) 5 = \underline{100 \text{ m}}$$

②  $m = 40 \text{ kg}$        $v_f = v_i + at$   
 $v_i = 0$        $8 = 0 + a(2)$   
 $v_f = 8 \text{ m/s}$        $a = 4 \text{ m/s}^2$   
 $t = 2 \text{ s}$

(a)  $F = ma = (40)(4) = \underline{160 \text{ N}}$  (b) The friction between her feet and the ground exerts the force.

③  $m = 8 \text{ g} = 0.008 \text{ kg}$        $v_f = v_i + at$   
 $v_i = 400 \text{ m/s}$        $100 = 400 + a(4 \times 10^{-4})$   
 $v_f = 100 \text{ m/s}$        $-300 = a(4 \times 10^{-4})$   
 $t = 4 \times 10^{-4} \text{ s}$        $a = 750\,000 \text{ m/s}^2$

(a)  $F = ma = (0.008)(750\,000) = \underline{6000 \text{ N}}$

(b)  $d = \left( \frac{v_f + v_i}{2} \right) t = \left( \frac{100 + 400}{2} \right) (4 \times 10^{-4}) = \underline{0.1 \text{ m}}$

④  $m = 1.8g = 0.0018 \text{ kg}$   
 $v_f = 500 \text{ m/s}$   
 $v_i = 0$   
 $d = 25 \text{ cm} = 0.25 \text{ m}$

$$d = \left( \frac{v_f + v_i}{2} \right) t$$

$$0.25 = \left( \frac{500 + 0}{2} \right) t$$

$$0.25 = 250t$$

$$t = 0.001 \text{ s}$$

$$v_f = v_i + at$$

$$500 = 0 + a(0.001)$$

$$a = 500\,000 \text{ m/s}^2$$

$$F = ma = (0.0018)(500\,000) = \underline{900 \text{ N}}$$

⑤  $v_i = 72 \text{ km/h} = 20 \text{ m/s}$   
 $v_f = 0$   
 $m = 1000 \text{ kg}$   
 $F = 8000 \text{ N}$

Stopping time:

$$F = ma$$

$$8000 = 1000a$$

$$a = 8 \text{ m/s}^2$$

(we are stopping so a must be negative)

$$v_f = v_i + at$$

$$0 = 20 - 8t$$

$$t = 2.5 \text{ s}$$

$$d = \left( \frac{v_f + v_i}{2} \right) t$$

$$= \left( \frac{0 + 20}{2} \right) (2.5)$$

$$d = 25 \text{ m}$$

Reaction time: (during the reaction time the car is still moving forwards at its initial velocity)

$$v = 20 \text{ m/s}$$

$$t = 0.6 \text{ s}$$

$$d = ?$$

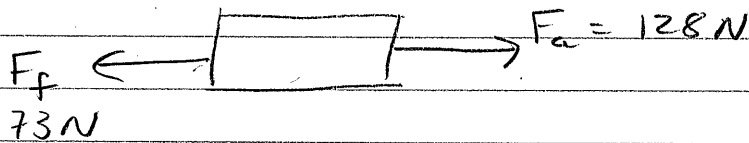
$$v = \frac{d}{t}$$

$$20 = \frac{d}{0.6} \quad d = 12 \text{ m}$$

∴ The total distance is  $12 + 25 = \underline{37 \text{ m}}$ .

You miss the child by 3 m.

(6)



$$F_{\text{net}} = 128 - 73 = 55 \text{ N forwards}$$

Empty Wagon

$$F_{\text{net}} = 55 \text{ N}$$

$$a = 5 \text{ m/s}^2$$

$$F = ma$$

$$55 = m(5)$$

$$m = 11 \text{ kg}$$

Wagon and Child

$$F_{\text{net}} = 55 \text{ N}$$

$$a = 1.0 \text{ m/s}^2$$

$$F = ma$$

$$55 = m(1)$$

$$m = 55 \text{ kg}$$

$$\text{Mass of child} = 55 - 11 = \underline{44 \text{ kg}}$$

(7)

$$m = 6 \text{ kg}$$

$$v_f = v_0$$

$$F = 36 \text{ N}$$

$$v_f = 2v_0$$

$$d = 10 \text{ m}$$

$$F = ma$$

$$36 = 6a$$

$$a = 6 \text{ m/s}^2$$

$$v_f = v_i + at$$

$$2v_0 = v_0 + 6t$$

$$v_0 = 6t$$

$$t = \frac{v_0}{6}$$

$$(a) \quad d = \left( \frac{v_f + v_i}{2} \right) t$$

$$10 = \left( \frac{2v_0 + v_0}{2} \right) \frac{v_0}{6}$$

$$10 = \left( \frac{3v_0}{2} \right) \frac{v_0}{6} = \frac{3v_0^2}{12}$$

$$120 = 3v_0^2$$

$$v_0^2 = 40$$

$$v_0 = \underline{6.32 \text{ m/s}}$$

$$(b) \quad t = \frac{v_0}{6}$$

$$= \frac{6.32}{6}$$

$$= \underline{1.05 \text{ s}}$$

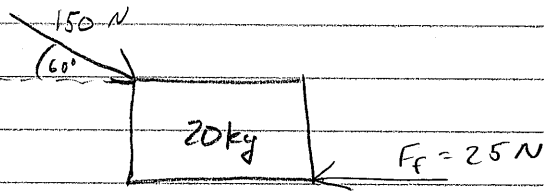
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$$\begin{aligned}
 & m_1 \\
 & F = 8 \text{ N} \\
 & a = 2 \text{ m/s}^2 \\
 & F = ma \\
 & 8 = m_1 \cdot 2 \\
 & m_1 = 4 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 & m_2 \\
 & F = 8 \text{ N} \\
 & a = 4 \text{ m/s}^2 \\
 & F = ma \\
 & 8 = m_2 \cdot 4 \\
 & m_2 = 2 \text{ kg}
 \end{aligned}$$

$$\begin{aligned}
 & m_1 + m_2 \\
 & m = 4 + 2 = 6 \text{ kg} \\
 & F = 8 \text{ N} \\
 & F = ma \\
 & 8 = 6a \\
 & \underline{a = 1.33 \text{ m/s}^2}
 \end{aligned}$$

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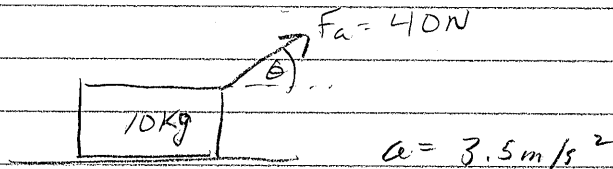


Net horizontal force

$$\begin{aligned}
 F_a &= 150 \cos 60^\circ = 75 \text{ N} \\
 F_{\text{net}} &= 75 - 25 = 50 \text{ N}
 \end{aligned}$$

$$\begin{aligned}
 F_{\text{net}} &= ma \\
 50 &= 20a \\
 a &= 2.5 \text{ m/s}^2
 \end{aligned}$$

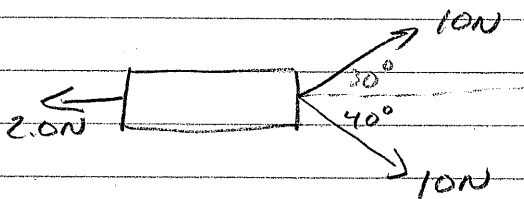
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Horizontal force  
 $40 \cos \theta$

$$\begin{aligned}
 F_{\text{net}} &= ma \\
 40 \cos \theta &= 10(3.5) \\
 \cos \theta &= 0.875 \\
 \underline{\theta = 29^\circ}
 \end{aligned}$$

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Net Horizontal Force:

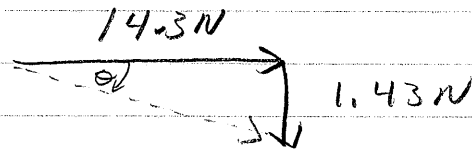
$$-2.0 + 10 \cos 30 + 10 \cos 40 = 14.3 \text{ N}$$

Net Vertical Force:

$$10 \sin 30 - 10 \sin 40 = -1.43 \text{ N}$$

11 cont'd

Total Net Force:



$$c^2 = (14.3)^2 + (1.43)^2 = 206.53$$

$$\tan \theta = \frac{1.43}{14.3}$$

$$F_{\text{net}} = 14.4 \text{ N } 5.7^\circ \text{ S of E}$$

$$\theta = 5.7^\circ$$

$$F_{\text{net}} = ma$$

$$14.4 = 10 a$$

$$a = \underline{1.44 \text{ m/s}^2 \text{ } 5.7^\circ \text{ S of E}}$$

(12) (a)  $F = ma$   
 $= 100(2)$   
 $F = \underline{200 \text{ N}}$

(b) His feet must push with an equal force (Newton's Third Law)  
200 N

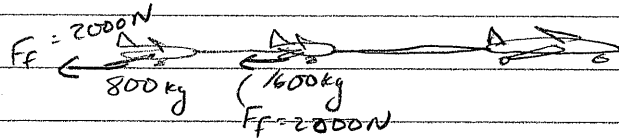
(c) If there is no friction, then the boy's acceleration is:

$$F = ma$$

$$200 = 30 a$$

$$a = \underline{6.67 \text{ m/s}^2}$$

(13)



(a)  $v_i = 0$

$v_f = 40 \text{ m/s}$

$F_{\text{net}} = 10000 - 2000 - 2000 = 6000 \text{ N}$

$m = 1600 + 800 = 2400 \text{ kg}$

$F = ma$

$6000 = (2400)a$

$a = 2.5 \text{ m/s}^2$

$v_f = v_i + at$

$40 = 0 + 2.5t$

$t = 16 \text{ s}$

$d = \left( \frac{v_f + v_i}{2} \right) t$

$= \left( \frac{40 + 0}{2} \right) 16$

$d = 320 \text{ m}$

(b)  $F = ma$

$F_{\text{net}} = (800)(2.5) = 2000 \text{ N}$

The applied force is then  $2000 + 2000 = \underline{4000 \text{ N}}$   
friction

(14)

(a) mass is the slope of the line

$\text{mass} = \left( \frac{5 - 1}{.85 - .05} \right) = 5 \text{ kg}$

(b) There is a frictional force acting on the cart. The magnitude of this force is where the graph crosses the y-axis.

In this case, the force of friction is approximately 0.6 N.