FA – April 2018

**Part 2 – Problems (Value – 42)**

Solve the problems on loose leaf. Show your work.

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#3 1. A force of 165 N is applied to a box to drag it across a rough wooden floor. If the box accelerates at a rate of 3.45 m/s$^2$ and the coefficient of friction between the box and floor is 0.49, what is the mass of the box? Include a labeled FBD for the box. (12)

#1 2. A motorcycle and its rider are moving at 12.0 m/s [W]. A force of 1.55 x $10^3$ N [W] accelerates the motorcycle and rider uniformly for 2.98 s. In this time, they travel a distance of 63.0 m. What is the combined mass of the rider and her motorcycle? (8)

#4 3. You are traveling in your car at a velocity of 24.0 m/s east when you slam on your brakes. You skid 38.0 m before stopping. What is the coefficient of friction between your car tires and the road? Include an FBD for your car while it's skidding. (14)

#2 4. You want to move a 38 kg steel crate across a steel floor. What is the magnitude and direction of the force with which you must push to start the crate moving if the crate is to be moved to the left? Include an FBD for the crate just before it starts to move. (8)

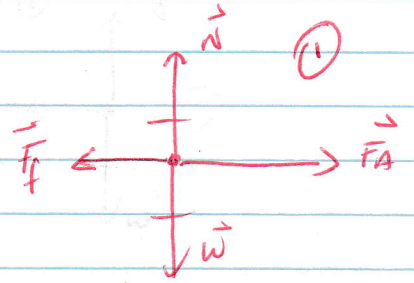
Note:

| Surfaces | $\mu_s$ | $\mu_k$ |
|---|---|---|
| Steel on steel | 0.15 | 0.060 |

## Part 2

1. $F_A = 165\ N$
$a = 3.45\ m/s^2$
$\mu = 0.49$
$m = ?$

#3




①

$\vec{F}_{net} = m\vec{a}$ ①

$+F_A - F_f = m(+a)$ ③

$F_A - \mu N = ma$ ①

$F_A - \mu w = ma$ ①

$F_A - \mu mg = ma$ ①

$F_A = \mu mg + ma$ ①

$F_A = m(\mu g + a)$ ①

$m = \dfrac{F_A}{\mu g + a}$ ①

$m = \dfrac{165}{(0.49)(9.80) + 3.45}$

$m = 20\ kg$ ①

[12]

The mass of the box is 20 kg.

[8]

2. $\vec{v}_i = -12.0\ m/s$
$\vec{F} = -1.55 \times 10^3\ N$ ①
$t = 2.98\ s$
$\vec{d} = -63.0\ m$
$m = ?$

#1

←

$\vec{d} = \vec{v}_i t + \frac{1}{2}\vec{a}t^2$ ①

$2(\vec{d} - \vec{v}_i t) = \vec{a}t^2$ ①

$\vec{a} = \dfrac{2(\vec{d} - \vec{v}_i t)}{t^2}$ ①

$\vec{a} = \dfrac{2(-63.0 - (-12.0)(2.98))}{(2.98)^2}$

$\vec{a} = -6.135\ m/s^2$ ①

$\vec{F}_{net} = m\vec{a}$ ①

$m = \dfrac{\vec{F}_{net}}{\vec{a}}$ ①

$m = \dfrac{-1.55 \times 10^3}{-6.135}$

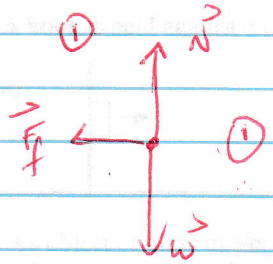
$m = 253\ kg$ ①

The combined mass 253 kg.

$\Rightarrow E$

3. $\vec{v}_i = +24.0 \text{ m/s}$
$\vec{d} = +38.0 \text{ m}$
$\vec{v}_f = 0 \text{ m/s}$
$\mu = ?$

#4




$\vec{v}_f^2 = \vec{v}_i^2 + 2\vec{a}\vec{d}$ ①

$\vec{a} = -\vec{v}_i^2$ ①
$2\vec{d}$

$\vec{a} = -(24.0)^2$
$2(38.0)$

$\vec{a} = -7.579 \text{ m/s}^2$ ①

$\vec{F}_{net} = m\vec{a}$ ①
$-F_f = m(-a)$ ②
$\mu N = ma$ ①
$\mu w = ma$ ①
$\mu mg = ma$ ①

$\mu = \frac{a}{g}$ ①

$\mu = \frac{7.579}{9.80}$

$\mu = 0.773$ ①

14

The coefficient of friction is 0.773. ①

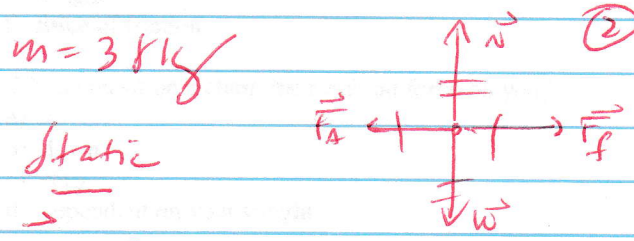
4. $m = 38 \text{ kg}$

Static

$\vec{F}_A = ?$

$\mu_s = 0.15$

#2




$F_A = F_f$ | $F_f = \mu N$
$N = w$ | $w = mg$

$F_A = F_f$ ①
$F_A = \mu N$ ①
$F_A = \mu w$ ①
$F_A = \mu mg$ ①

$F_A = (0.15)(38)(9.80)$
$F_A = 56 \text{ N}$ ①

18

The applied force is 56 N, left ①