LESSON 5 FRICTION : HOMEWORK ANSWERS

1. Nelson: p103 #3

(a) In order to move the suitcase you need 59N of force. Since there is no acceleration, this means that the force of friction is also 59N.
We can easily calculate μ if we know the mass:

m = 22kg;
Fg = mg = 9.8N/kg * 22 kg = 215.6N
Since there are no other vertical forces, F_N = Fg = 215.6N

$\mu = Ff / F_N$
$= 59 / 215.6$
$= 0.27$

(b) It looks like the friction that we were considering in (a) was static friction, the amount of friction that's needed to overcome the initial movement. Now the object is moving at a constant speed, and we have kinetic friction which is less.

Ff = 54N.

Repeat all of the calculations above, but with 54 instead of 59.

2. Nelson p103 #6

(a) m = 252N.
Fpull = 425 N.
a = 0 , so $\Sigma Fx = 0$, .: Ff = Fpull . F_N = Fg as in the previous question

$\mu = Ff / F_N$
$= 425 / (252)(9.8)$
$= 0.172$

(b) Now there is more weight, more mass pushing down and so a greater normal force.
The coefficient of friction, however, is not affected by this at all.

(c) Fpull = Ff
$Ff = \mu F_N$
All we have to do is recalculate F_N using the combined mass.

Ff = 0.172(252+56)(9.8) N
= 519 N

3. What is the coefficient of friction if you slide a brick on a surface and it comes to a stop in 0.7 seconds over a distance of 1.0 m ?

This problem makes it seem that we don't have enough information. In particular, we don't have the mass. Let's just work through the problem as much as we can and hope that maybe it will work out, that the mass won't matter.

Using the distance and time we need to calculate the acceleration.

$$\Delta d = \frac{1}{2}at^2 + v_i t$$

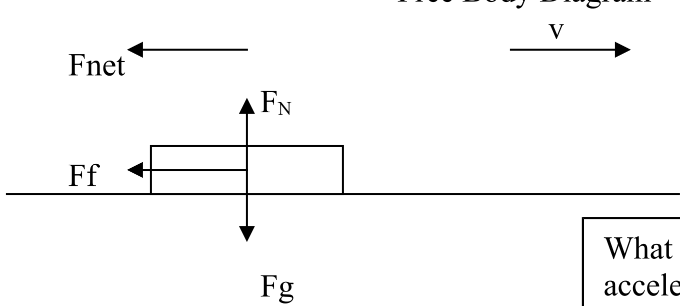
$\Delta d = +1$m.
$t = 0.7$ s
$a = ?$
$v1 = ?$
$v2 = 0$

Okay, we need a form of this equation with v2 in it instead of v1.
We know that v2 = at + v1, so let's put this in for v1 (ie. v1 = v2 – at)

$\Delta d = \frac{1}{2} at^2 + v2 - at$
$\Delta d = - \frac{1}{2} at^2 + v_2$ ← Bingo!

$+1 = -\frac{1}{2} a (0.7)^2 + 0$
$-2 = 0.49 a$
$a = - 4.1$ m/s^2 . This is negative as it should be because the object is slowing down.

Free Body Diagram



Fnet = Ff
.: ma = Ff   Oh dear. We don't know what m is.

$ma = \mu$ FN
$ma = \mu mg$ Aha! The mass cancels out

$a = \mu g$ so $\mu = a/g = 4.1 / 9.8 = 0.42$

Q.E.D

What happened to the negative sign from the acceleration?

Well, the formula for friction is

$|F_f| = \mu |F_N|$ so any negative signs there disappear.
But the negative sign is in front of 'a' and thus F_{net}.

Looking at the FBD, Fnet and Ff are in the same direction, so they have the same sign and it will cancel out.