

## Y2M5 XMQs and MS

(Total: 8 marks)

1. P3\_2018 Q7 . 8 marks - Y2M5 Forces and friction

Mathsvault.io Solutions

7.

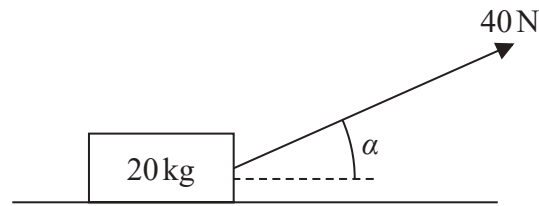


Figure 1

A wooden crate of mass 20 kg is pulled in a straight line along a rough horizontal floor using a handle attached to the crate.

The handle is inclined at an angle  $\alpha$  to the floor, as shown in Figure 1, where  $\tan \alpha = \frac{3}{4}$

The tension in the handle is 40 N.

The coefficient of friction between the crate and the floor is 0.14

The crate is modelled as a particle and the handle is modelled as a light rod.

Using the model,

(a) find the acceleration of the crate.

(6)

The crate is now pushed along the same floor using the handle. The handle is again inclined at the same angle  $\alpha$  to the floor, and the thrust in the handle is 40 N as shown in Figure 2 below.



Figure 2

(b) Explain briefly why the acceleration of the crate would now be less than the acceleration of the crate found in part (a).

(2)



Question	Scheme	Marks	AOs
7(a)	Resolve vertically	M1	3.1b
	$R + 40\sin \alpha = 20g$	A1	1.1b
	Resolve horizontally	M1	3.1b
	$40\cos \alpha - F = 20a$	A1	1.1b
	$F = 0.14R$	B1	1.2
	$a = 0.396$ or $0.40$ ( $\text{m s}^{-2}$ )	A1	2.2a
		(6)	
(b)	Pushing will increase $R$ which will increase available $F$	B1	2.4
	Increasing $F$ will <u>decrease</u> $a$ * GIVEN ANSWER	B1*	2.4
		(2)	
<b>(8 marks)</b>			
<b>Notes:</b>			
<p><b>(a)</b>  <b>M1:</b> Resolve vertically with usual rules applying  <b>A1:</b> Correct equation. Neither <math>g</math> nor <math>\sin \alpha</math> need to be substituted  <b>M1:</b> Apply <math>F = ma</math> horizontally, with usual rules  <b>A1:</b> Neither <math>F</math> nor <math>\cos \alpha</math> need to be substituted  <b>B1:</b> <math>F = 0.14R</math> seen (e.g. on a diagram)  <b>A1:</b> Either answer</p>			
<p><b>(b)</b>  <b>B1:</b> Pushing increases <math>R</math> which produces an increase in available (limiting) friction  <b>B1:</b> <math>F</math> increase produces an <u><math>a</math> decrease</u> (need to see this)  <b>N.B.</b> It is possible to score B0 B1 but for the B1, some “explanation” is needed to say why friction is increased e.g. by pushing into the ground.</p>			