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M1 JAN 05

1) ①

Momentum before =  $1.5 \times 3 + 2.5 \times (-4) = -5.5 \text{ N s}$   
 Momentum after =  $1.5 \times v + 2.5 \times (-2) = 2.5v - 3.75$   
 $2.5v - 3.75 = -5.5 \Rightarrow 2.5v = -1.75 \Rightarrow v = -0.7 \text{ ms}^{-1}$

b) Unchanged c) Mom P before =  $4.5 \text{ N s}$   
 Mom P after =  $-3.75 \text{ N s}$   
 Impulse =  $8.25 \text{ N s}$

2) RF↑=0 4T=60g ⇒ T=15g N

$4.5g \times x + 1.5g \times 3 = 40g \times 1.5$   
 $4.5g x + 4.5g = 60g$   
 $4.5g x = 15g$   
 $x = \frac{1}{3} \text{ m}$

3) Area =  $\frac{(20+16) \times 9}{2} = 162 \text{ m}^2$

b) Area =  $\frac{(9+u) \times 5}{2} = 200 - 162 = 38$   
 $(9+u) \times 5 = 76 \Rightarrow 9+u = 15.2 \Rightarrow u = 6.2 \text{ ms}^{-1}$

c) gradient =  $-\frac{2.8}{5} = -0.56$  dec =  $0.56 \text{ ms}^{-2}$

4) a) RF↑=0 NR=2.5g cos 20 = 2.3

b) RF↑=0  $x = 2.5g \sin 20 + f_{\text{max}}$   
 $f_{\text{max}} = \mu NR = 0.4 \times 2.3 = 0.92$   
 $x = 8.38 + 0.92 = 17.59 \text{ N}$

c) fmax = 9.21

$\leftarrow 2.5g \sin 20 = 8.38$   
 $\Rightarrow$  friction = 8.38 as this is less than 9.21 N (f)

5) U=0 S=0.4 t=0.5

$S = ut + \frac{1}{2}at^2 \Rightarrow 0.4 = \frac{1}{2}a(0.5)^2$   
 $a = 3.2 \text{ ms}^{-2}$

ⓑ RF↓=ma ⇒  $0.8g - T = 0.8 \times 3.2 \Rightarrow T = 5.28 \text{ N}$

Ⓐ RF↑=ma ⇒  $T - f_{\text{max}} = 0.5 \times 3.2 \Rightarrow f_{\text{max}} = 5.28 - 1 = 4.28 \text{ N}$   
 RF↑=0 ⇒ NR = 4.9 N  $f_{\text{max}} = \mu NR \Rightarrow \mu = \frac{4.28}{4.9} = 0.87$

d) Inextensible ⇒ same acceleration for A and B.

6)  $U=20 \quad V=16 \quad S=24$   
 $V^2 = U^2 + 2aS \Rightarrow 16^2 = 20^2 + 2a(24) \Rightarrow 48a = -144$   
 $a = -3$   
 dec =  $3 \text{ ms}^{-2}$

b)  $u=20 \quad s=30 \quad a=-3$  ③  
 $V^2 = u^2 + 2as \Rightarrow V^2 = 400 + 2(-3)(30) \Rightarrow V = 14.8 \text{ ms}^{-1}$

c)  $0.3 \leftarrow \text{m} \rightarrow 0$   $\vec{RF} = ma \Rightarrow 0 - 0.3 = mx - 3$   
 $-0.3 = 3m \Rightarrow m = 0.1 \text{ kg}$

d) momentum before =  $0.1 \times 14.8 = 1.48$   
 Impulse = change in momentum =  $2.4$   
 momentum after =  $1.48 - 2.4 = -0.92$

$-0.92 = mv \Rightarrow v = \frac{-0.92}{0.1} = -9.2$   $\leftarrow 9.2 \text{ ms}^{-1}$

$0 \leftarrow \text{m} \rightarrow 0.3$   $\vec{RF} = 0 - 0.3 = 0.1a \quad a = \frac{-0.3}{0.1} = -3 \text{ ms}^{-1}$  as expected

$\vec{u} = 9.2 \quad \vec{a} = -3 \quad \vec{v} = 0$   
 $V = u + at \Rightarrow 0 = 9.2 - 3t \quad t = \frac{9.2}{3} = 3.06 \text{ sec}$

7)  $Vel = \frac{\text{change in pos}}{\text{time}} = \frac{9i + 24j}{3} = 3i + 8j \text{ kmh}^{-1}$

b)  $p = (20i + 10j) + t(3i + 8j) = (20 + 3t)i + (10 + 8t)j$   
 $q = (14i - 6j) + t(0i + 12j) = 14i + (-6 + 12t)j$

c)  $d = (14 - (20 + 3t))i + ((-6 + 12t) - (10 + 8t))j$   
 $d = (-6 - 3t)i + (-16 + 4t)j$

$d^2 = (-6 - 3t)^2 + (-16 + 4t)^2 = (36 + 36t + 9t^2) + (256 - 128t + 16t^2)$   
 $d^2 = 292 - 92t + 25t^2$

d)  $225 = 292 - 92t + 25t^2 \Rightarrow (t-1)(25t-67) = 0 \quad t = 2.68$