M1 – February Half-Term Homework (M/52)

M1 – Jan 10

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1. A particle A of mass 2 kg is moving along a straight horizontal line with speed $12\,\text{m s}^{-1}$. Another particle B of mass m kg is moving along the same straight line, in the opposite direction to A, with speed $8\,\text{m s}^{-1}$. The particles collide. The direction of motion of A is unchanged by the collision. Immediately after the collision, A is moving with speed $3\,\text{m s}^{-1}$ and B is moving with speed $4\,\text{m s}^{-1}$. Find

(a) the magnitude of the impulse exerted by B on A in the collision,

(2)

(b) the value of m.

(4)

M1 – Jun 08

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1. Two particles P and Q have mass 0.4 kg and 0.6 kg respectively. The particles are initially at rest on a smooth horizontal table. Particle P is given an impulse of magnitude 3 N s in the direction PQ.

(a) Find the speed of P immediately before it collides with Q.

(3)

Immediately after the collision between P and Q, the speed of Q is 5 m s^{-1}.

(b) Show that immediately after the collision P is at rest.

(3)

M1 – Jun 09

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3. Two particles A and B are moving on a smooth horizontal plane. The mass of A is $2m$ and the mass of B is m. The particles are moving along the same straight line but in opposite directions and they collide directly. Immediately before they collide the speed of A is $2u$ and the speed of B is $3u$. The magnitude of the impulse received by each particle in the collision is $\dfrac{7mu}{2}$.

Find

(a) the speed of A immediately after the collision,

(3)

(b) the speed of B immediately after the collision.

(3)

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3.

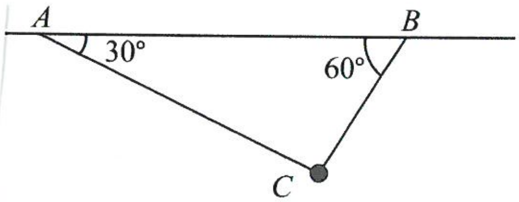


Figure 1

A particle of mass g is attached at C to two light inextensible strings AC and BC. The other ends of the sgs are attached to fixed points A and B on a horizontal ceiling. The particle hangs in dibrium with AC and BC inclined to the horizontal at 30° and 60° respectively, as sh in Figure 1.

Given that the tens in AC is 20 N, find

(a) the tension in

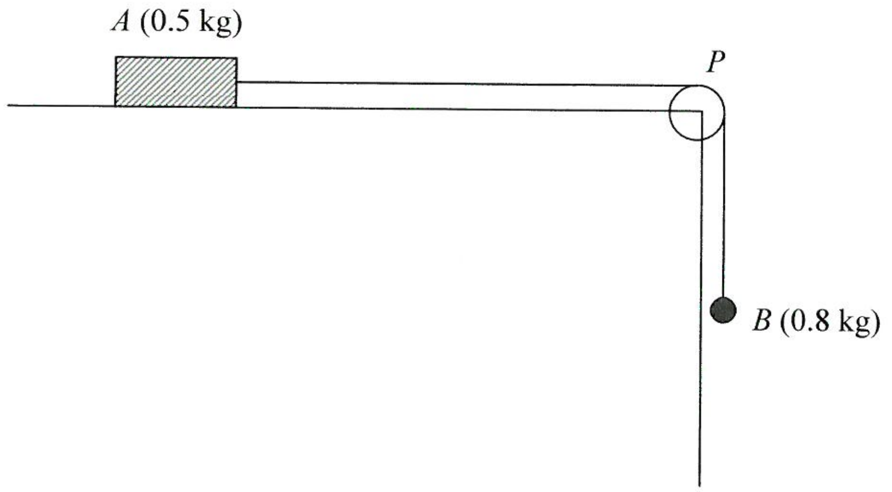
(4)

(b) the value of m.

(4)

5.

Figure 4



A block of wood A of mass 0.5 kg rests on a rough horizontal table and is attached to one end of a light inextensible string. The string passes over a small smooth pulley P fixed at the edge of the table. The other end of the string is attached to a ball B of mass 0.8 kg which hangs freely below the pulley, as shown in Figure 4. The coefficient of friction between A and the table is μ. The system is released from rest with the string taut. After release, B descends a distance of 0.4 m in 0.5 s. Modelling A and B as particles, calculate

(*a*) the acceleration of B,

(3)

(*b*) the tension in the string,

(4)

(*c*) the value of μ.

(5)

(*d*) State how in your calculations you have used the information that the string is inextensible.

(1)

6. A stone S is sliding on ice. The stone is moving along a straight line ABC, where $AB = 24$ m and $AC = 30$ m. The stone is subject to a constant resistance to motion of magnitude 0.3 N. At A the speed of S is 20 m s^{-1}, and at B the speed of S is 16 m s^{-1}. Calculate

(*a*) the deceleration of S,

(2)

(*b*) the speed of S at C.

(3)

(*c*) Show that the mass of S is 0.1 kg.

(2)

At C, the stone S hits a vertical wall, rebounds from the wall and then slides back along the line CA. The magnitude of the impulse of the wall on S is 2.4 N s and the stone continues to move against a constant resistance of 0.3 N.

(*d*) Calculate the time between the instant that S rebounds from the wall and the instant that S comes to rest.

(6)

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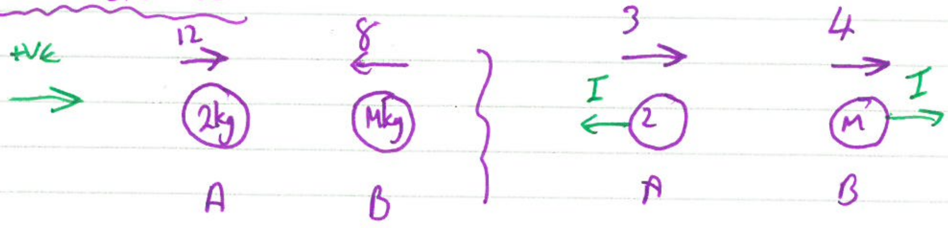
Q1



(a) Impulse = change in momentum

on particle A: $-I = 2(3-12)$ M1

$I = 18Ns$ A1

(b) Momentum is conserved $\therefore$ $(12 \times 2) + (-8 \times M) = (3 \times 2) + (4 \times M)$ M1 A1

$24 - 8M = 6 + 4M$ M1

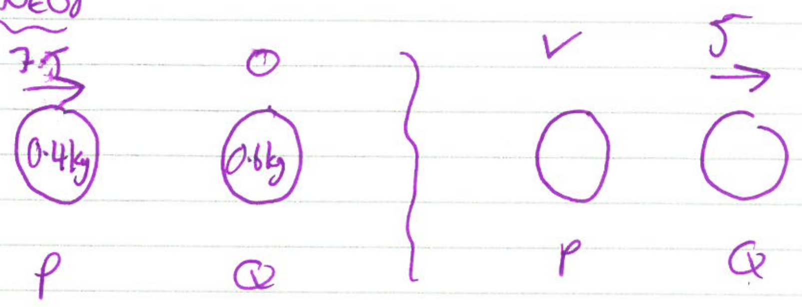
$18 = 12M$

$M = 1.5kg$ A1

M/6

M1 – JUNE 08

Q1.



(a) $I = 0.4(v - 0)$ M1 A1

$\frac{3}{0.4} = v = 7.5 ms^{-1}$ A1

(b) Momentum is conserved ∴ $(0.4 \times 7.5) + (0.6 \times 0) = 0.4v + (5 \times 0.6)$ M1 A1

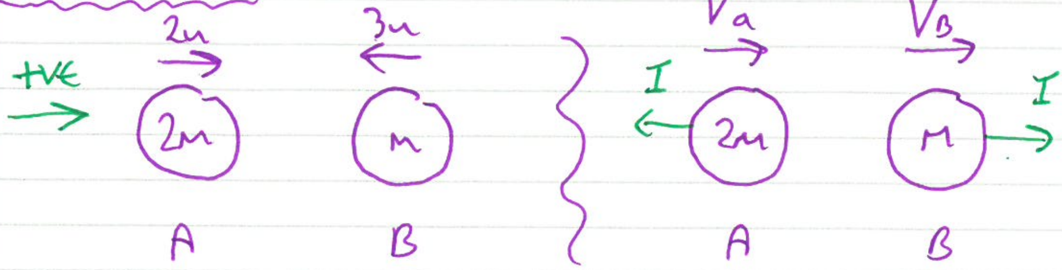
$3 + 0 = 0.4v + 3$

$v = 0$ As required A1

M/6

M1 – June09

Q3



(a) Impulse on A: $-I = 2m(V_a - 2u)$

$-\frac{7mu}{2} = 2m(V_a - 2u)$ M1A1

$-7mu = 4mV_a - 8mu$

$4mV_a = mu$

$V_a = \frac{[illegible]}{4}$ A1

(b) Momentum is conserved ∴ $(2m \times 2u) + (m \times {}^{-}3u) = (2mV_a) + (mV_B)$ M1 A1

$4mu - 3mu = 2m \times \frac{u}{4} + mV_B$

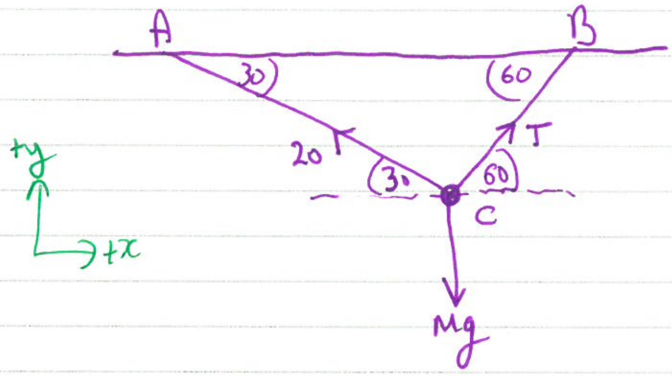
$u = \frac{u}{2} + V_B$

$V_B = \frac{u}{2}$ A1

M/6

M1 – JAN 10

Q3



(a) System in equilibrium $\therefore$ $\Sigma F_x = 0$
$\Sigma F_y = 0$

ΣF_x: $T\cos 60 - 20\cos 30 = 0$ M1 A1 A1

$$T.\frac{1}{2} - 20.\frac{\sqrt{3}}{2} = 0$$

$$\frac{T}{2} = 10\sqrt{3}$$

$$T = 20\sqrt{3}\ N$$ A1

(b) ΣF_y: $T\sin 60 + 20\sin 30 - Mg = 0$ M1 A1 A1

$$T.\frac{\sqrt{3}}{2} + 20.\frac{1}{2} = Mg$$

$$20\sqrt{3}.\frac{\sqrt{3}}{2} + 10 = Mg$$

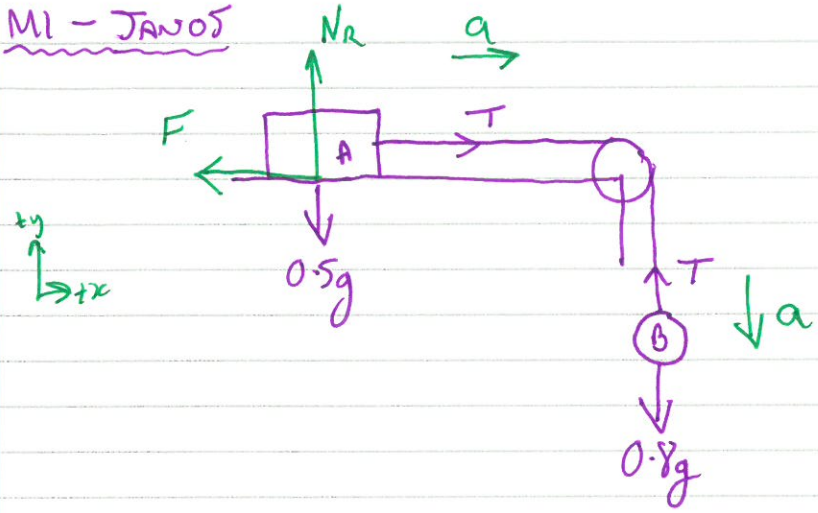
$$40 = Mg$$

$$M = \frac{40}{g} =$$ A1

M/8

M1 – JAN 05

Q5



(a) Particle B: $u=0$ $a=?$ $s=0.4$ $t=0.5$

Using $s = ut + \frac{1}{2}at^2$

$0.4 = \frac{1}{2}a \times 0.5^2$ M1 A1

$0.4 = 0.125a$

$a = 3.2\,ms^{-2}$ A1

(b) N2L on particle B: $0.8g - T = 0.8a$ M1 A1

$0.8g - 0.8 \times 3.2 = T$ M1

$T = 5.28\,N$ A1

(c) Forces on particle A: $T - F = 0.5a$ M1 A1

$5.28 - 0.5 \times 3.2 = F$

$F = 3.68\,N$

$N_R - 0.5g = 0$

$N_R = 0.5g$

$F = \mu N_R$

$3.68 = \mu \times 0.5g$ B1

$\mu = \frac{3.68}{0.5g} = 0.75$ (2dp) M1 A1

(d) acceleration is the same throughout system. B1

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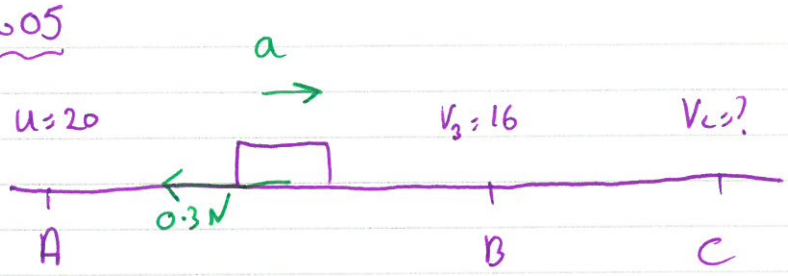
M1 – JAN 05

Q6.



(a) $u = 20 \quad V_3 = 16 \quad a = ? \quad s = 24$

Using $v^2 = u^2 + 2as$

$16^2 = 20^2 + 2 \times 24 \times a$ M1

$48a = -144$

$a = -3\,ms^{-2}$ ie deceleration of $3\,ms^{-2}$ A1

(b) $u = 16 \quad a = -3 \quad V_c = ? \quad s = 6$

Using $v^2 = u^2 + 2as$

$V_c^2 = 16^2 + 2 \times -3 \times 6$ M1 A1

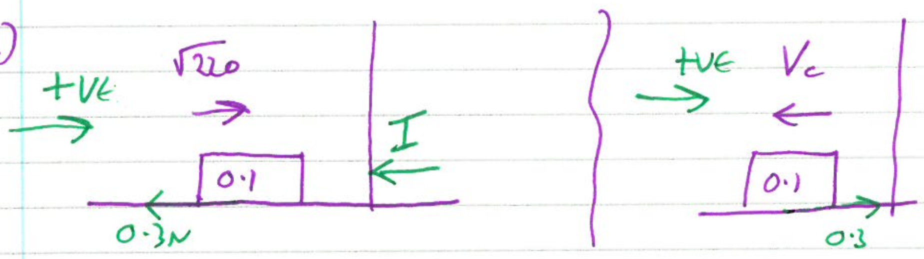
$V_c^2 = 256 - 36$

$V_c = \sqrt{220}\ ms^{-1}$ A1

(c) N2L $\quad -0.3 = m \times -3$ M1

$m = 0.1\ kg$ A1

(d)



$-I = 0.1(-V_c - \sqrt{220})$ M1 A1

$-2.4 = 0.1(-V_c - \sqrt{220})$

$-24 = -V_c - \sqrt{220}$

$V_c = 24 - \sqrt{220} = 9.17\,ms^{-2}$ A1

Now $u = 9.17 \quad V = 0 \quad a = -3 \quad t = ?$

Using $v = u + at$

$0 = 9.17 - 3t$ M1 A1

$t = 3.06$ sec (2dp) A1

M/13.