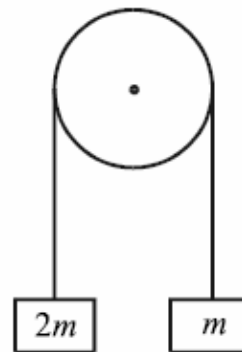


2004 – FORCES QUESTION

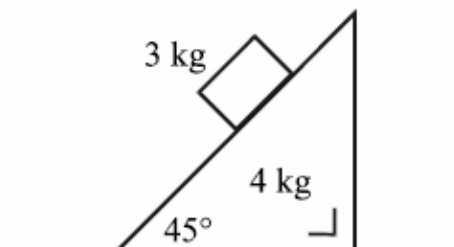
4. (a) Two particles, of masses $2m$ and m , are attached to the ends of a light inextensible string which passes over a fixed smooth light pulley.



The system is released from rest with both particles at the same horizontal level.

- (i) Find the acceleration of the system, in terms of g .
- (ii) The string breaks when the speed of each particle is v . Find, in terms of v , the vertical distance between the particles when the string breaks.

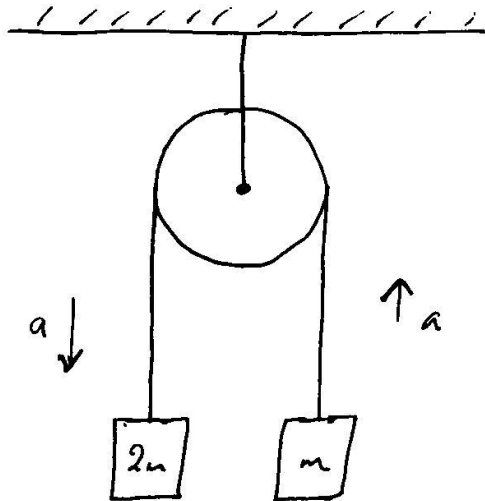
- (b) A smooth wedge of mass 4 kg and slope 45° rests on a smooth horizontal surface. A particle of mass 3 kg is placed on the smooth inclined face of the wedge. The system is released from rest.



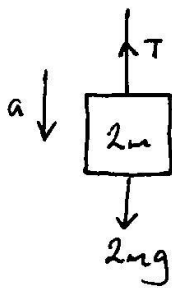
- (i) Show, on separate diagrams, the forces acting on the wedge and on the particle.
- (ii) Find the acceleration of the particle relative to the wedge.
- (iii) Find how far the wedge has travelled when the particle has moved a distance of 1 m down the inclined face of the wedge.

2004

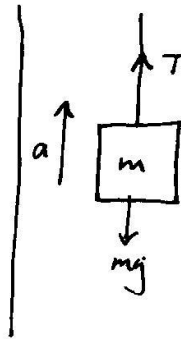
Q4
(9)



G)



$$2mg - T = 2ma$$



$$T - mg = ma$$

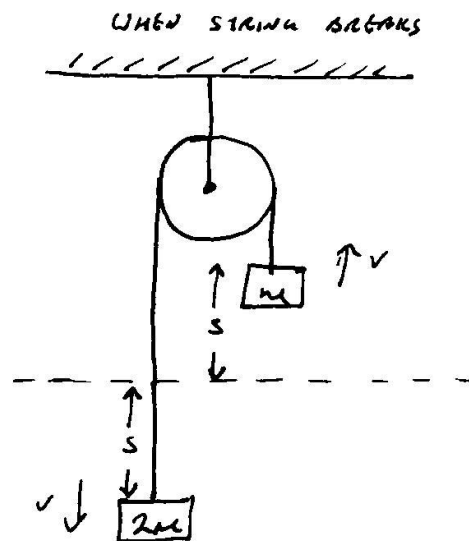
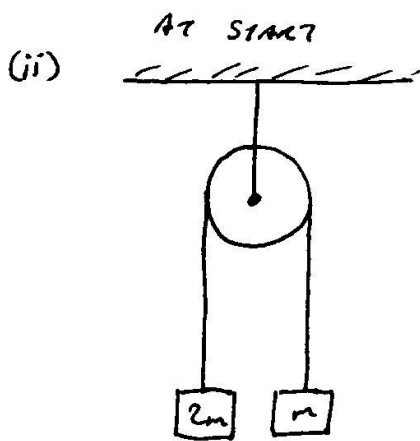
Simultaneous Equations:

$$2mg - T = 2ma$$

$$-mg + T = ma$$

$$mg = 3ma$$

$$\underline{\underline{\frac{g}{3} = a}}}$$



* FIND DISTANCE TRAVELLED BY $2m$ BLOCK IN REACHING SPEED V .

$$\begin{aligned}
 u &= 0 \\
 v &= V \\
 a &= \frac{g}{3} \\
 s &=? \\
 t &=?
 \end{aligned}$$

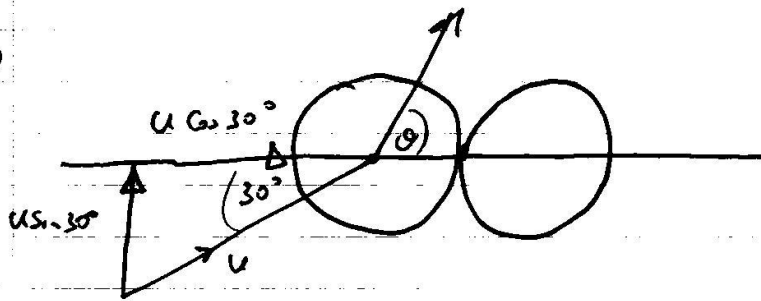
$$\begin{aligned}
 v^2 &= u^2 + 2as \\
 v^2 &= (0)^2 + 2\left(\frac{g}{3}\right)s \\
 v^2 &= \frac{2g}{3}s
 \end{aligned}$$

$$\frac{3v^2}{2g} = s$$

SINCE THE PARTICLES WERE ATTACHED BY THE SAME STRING, THE m BLOCK WILL HAVE MOVED UPWARD BY THE SAME DISTANCE.

SO THE VERTICAL DISTANCE BETWEEN THE BODIES IS:

$$\frac{3v^2}{2g} + \frac{3v^2}{2g} = \frac{6v^2}{2g} = \underline{\underline{\frac{3v^2}{g}}}$$

Q5
(b)

	<u>BEFORE</u>	<u>MASS</u>	<u>AFTER</u>
①	$u \cos 30^\circ \vec{i} + u \sin 30^\circ \vec{j}$	m	$p \vec{i} + u \sin 30^\circ \vec{j}$
	$\Rightarrow \frac{u\sqrt{3}}{2} \vec{i} + \frac{u}{2} \vec{j}$		$p \vec{i} + \frac{u}{2} \vec{j}$
②	$0 \vec{i} + 0 \vec{j}$	m	$q \vec{i} + 0 \vec{j}$

Con. of Mom:

$$\left(\frac{u\sqrt{3}}{2}\right)(m) + (0)(m) = p(m) + q(m)$$

$$\frac{u\sqrt{3}}{2} = p + q$$

$$\boxed{u\sqrt{3} = 2p + 2q}$$

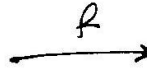
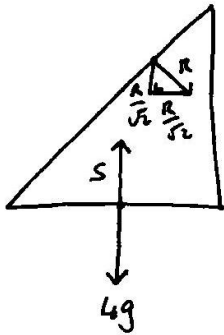
Coeff. of Res.:

$$\frac{p - q}{\frac{u\sqrt{3}}{2} - 0} = -e$$

$$p - q = -\frac{eu\sqrt{3}}{2}$$

$$\boxed{2p - 2q = -eu\sqrt{3}}$$

Wedge:



• DISCOUNT \perp FORCES

11 FORCES:

$$\frac{R}{\sqrt{2}} = 4f$$

$$\boxed{R = 4\sqrt{2}f} \quad (3)$$

(ii) SOLVING: (1) $3g - R\sqrt{2} = 3f$ (2) $3g = 3\sqrt{2}a - 3f$

(3) $R = 4\sqrt{2}f$

(1) $3g - (4\sqrt{2}f)(\sqrt{2}) = 3f$

$$3g - 8f = 3f$$

$$3g = 11f$$

$$\boxed{\frac{3g}{11} = f}$$

(2) $3g = 3\sqrt{2}a - 3f$

$$3g = 3\sqrt{2}a - 3\left(\frac{3g}{11}\right)$$

$$3g = 3\sqrt{2}a - \frac{9g}{11}$$

$$\frac{42g}{11} = 3\sqrt{2}a$$

$$\boxed{\frac{14g}{11\sqrt{2}} = a}$$

(iii) FIND TIME TAKEN FOR PARTICLE TO TRAVEL 1m:

$$u = 0$$

$$v = -$$

$$a = \frac{14g}{11\sqrt{2}}$$

$$s = 1$$

$$t = ?$$

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

$$1 = (0)t + \frac{1}{2}\left(\frac{14g}{11\sqrt{2}}\right)t^2$$

$$1 = \frac{7g}{11\sqrt{2}}t^2$$

$$\frac{11\sqrt{2}}{7g} = t^2$$

FIND DISTANCE BY WEDGE IN THIS TIME:

$$u = 0$$

$$v = -$$

$$a = \frac{3g}{11}$$

$$s = ?$$

$$t^2 = \frac{11\sqrt{2}}{7g}$$

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

$$s = (0)t + \frac{1}{2}\left(\frac{3g}{11}\right)\left(\frac{11\sqrt{2}}{7g}\right)$$

$$s = \frac{3\sqrt{2}}{14}$$