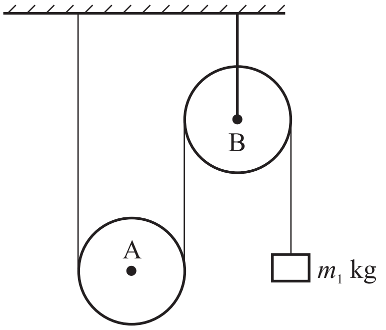
Leaving Cert Questions

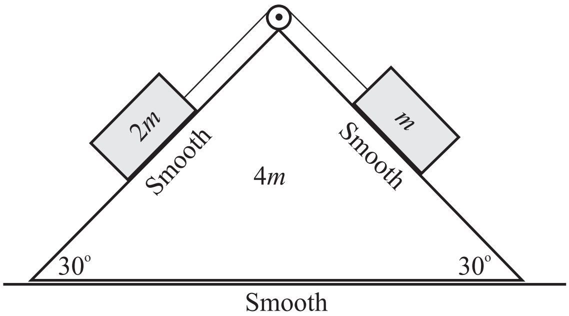
2008

4. (a) The diagram shows a light inextensible string having one end fixed, passing under a smooth movable pulley A of mass m kg and then over a fixed smooth light pulley B.
The other end of the string is attached to a particle of mass m_1 kg.
The system is released from rest.
Show that the upward acceleration of A is

$$\frac{(2m_1 - m)g}{4m_1 + m}.$$



(b) Particles of mass $2m$ and m are connected by a light inextensible string which passes over a smooth pulley at the vertex of a wedge-shaped block, one particle resting on each of the smooth faces.
The mass of the wedge is $4m$ and the inclination of each face to the horizontal is 30°.
The wedge rests on a smooth horizontal surface and the system is released from rest.



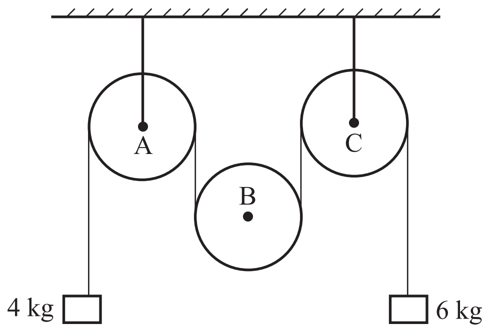
(i) Show, on separate diagrams, the forces acting on the wedge and on the particles.

(ii) Find the acceleration of the wedge.

2007

4. (a) A particle slides down a rough plane inclined at 45° to the horizontal. The coefficient of friction between the particle and the plane is $\frac{3}{4}$.
Find the time of descending a distance 4 metres from rest.

(b) A light inextensible string passes over a small fixed pulley A, under a small moveable pulley B, of mass m kg, and then over a second small fixed pulley C.
A particle of mass 4 kg is attached to one end of the string and a particle of mass 6 kg is attached to the other end.
The system is released from rest.



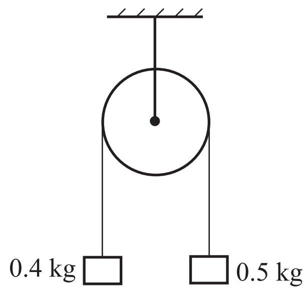
(i) On separate diagrams show the forces acting on each particle and on the moveable pulley B.

(ii) Find, in terms of m, the tension in the string.

(iii) If m = 9.6 kg prove that pulley B will remain at rest while the two particles are in motion.

2006

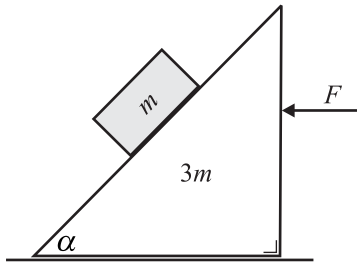
4. (a) Two particles of mass 0.4 kg and 0.5 kg are attached to the ends of a light inextensible string which passes over a fixed smooth light pulley.
The system is released from rest.



(i) Find the acceleration of the system, in terms of *g*.

(ii) After falling 1 m the 0.5 kg mass strikes a horizontal surface and is brought to rest. The string again becomes taut after *t* seconds.
Find the value of *t* correct to two places of decimals.

(b) A smooth wedge of mass 3*m* and slope α rests on a smooth horizontal surface.
A particle of mass *m* is placed on the smooth inclined face of the wedge and is released from rest.
A horizontal force *F* is applied to the wedge to keep it from moving.



(i) Show, on separate diagrams, the forces acting on the wedge and on the particle.

(ii) Prove that the reaction between the wedge and the horizontal surface is

$$mg(3+\cos^2\alpha).$$

(iii) If the speed of the particle after 1 s is 4.9 m/s find the value of α.

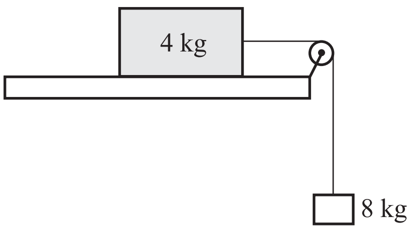
2005

1. (b) A mass of 8 kg falls freely from rest. After 5 s the mass penetrates sand. The sand offers a constant resistance and brings the mass to rest in 0.01 s.
Find

(i) the constant resistance of the sand

(ii) the distance the mass penetrates into the sand.

4. (a) A particle of mass 4 kg rests on a rough horizontal table. It is connected by a light inextensible string which passes over a smooth, light, fixed pulley at the edge of the table to a particle of mass 8 kg which hangs freely under gravity.



The coefficient of friction between the 4 kg mass and the table is $\frac{1}{4}$.

The system starts from rest and the 8 kg mass moves vertically downwards.
Find

(i) the tension in the string

(ii) the force exerted by the string on the pulley.

(b) Two particles of masses 3 kg and 5 kg are connected by a light inextensible string, of length 4 m, passing over a light smooth peg of **negligible radius**.
The 5 kg mass rests on a smooth horizontal table. The peg is 2.5 m directly above the 5 kg mass.
The 3 kg mass is held next to the peg and is allowed to fall vertically a distance 1.5 m before the string becomes taut.

(i) Show that when the string becomes taut the speed of each particle is

$$\frac{3\sqrt{3g}}{8} \text{ m/s.}$$

(ii) Show that the 3 kg mass will not reach the table.

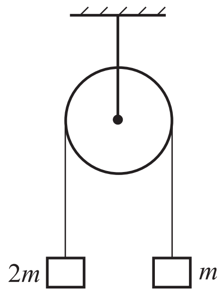
2004

1. (b) A car of mass 1200 kg tows a caravan of mass 900 kg first along a horizontal road with acceleration f and then up an incline α to the horizontal road at uniform speed.
The force exerted by the engine is 2700 N. Friction and air resistance amount to 150 N on the car and 240 N on the caravan.
Calculate

(i) the acceleration, f, of the car along the horizontal road

(ii) the value of α, to the nearest degree.

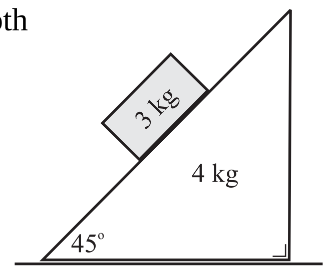
4. (a) Two particles, of masses $2m$ and m, are attached to the ends of a light inextensible string which passes over a fixed smooth light pulley.
The system is released from rest with both particles at the same horizontal level.



(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.



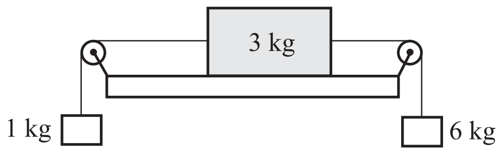
(i) Show, on separate diagrams, the forces acting on the wedge and on the particle.

(ii) Find the acceleration of the particle relative to the wedge.

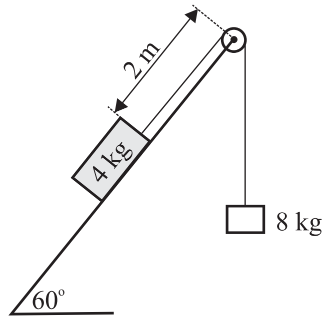
(iii) Find how far the wedge has travelled when the particle has moved a distance of 1 m down the inclined face of the wedge.

2003

4. (a) A particle of mass 3 kg rests on a smooth horizontal table and is attached by two light inelastic strings to particles of masses 6 kg and 1 kg which hang over smooth light pulleys at opposite edges of the table.
The system is released from rest.
Find the acceleration of the system, in terms of g.



(b) A block of mass 4 kg rests on a rough plane inclined at 60° to the horizontal. It is connected by a light inextensible string which passes over a smooth, light, fixed pulley to a particle of mass 8 kg which hangs freely under gravity.
The coefficient of friction between the block and the plane is $\frac{1}{4}$. The system starts from rest with the block at a distance of 2 m from the pulley.
The 8 kg mass moves vertically downwards.



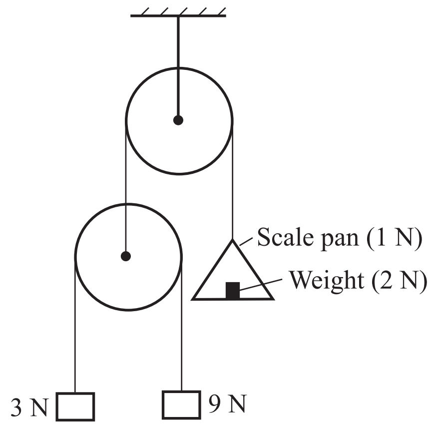
(i) Show that the tension in the string is 52 N, correct to the nearest whole number.

(ii) How far has the block moved up the plane after 1 second?

(iii) After 1 second the string is cut. Determine whether or not the block will reach the pulley.

2002

4. (b) A smooth light pulley is connected by a light inextensible string passing over a smooth light fixed pulley to a scale pan of weight 1 N.
A particle of weight 2 N is placed symmetrically on the centre of the scale pan.
Two particles of weight 3 N and 9 N are connected by a light inextensible string passing over the smooth light pulley.
The system is released from rest.
The acceleration of the scale pan is $\frac{g}{2}$ m s^{-2} vertically upwards.

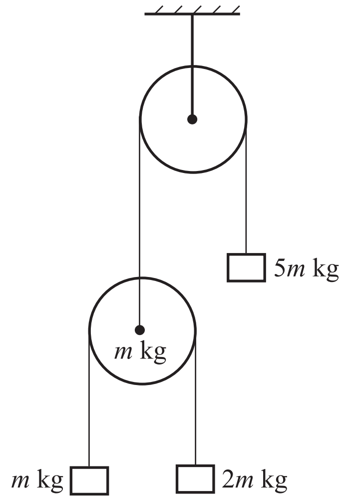


(i) Find the acceleration, in terms of g, of the particle of weight 9 N.

(ii) Find the normal reaction (force) between the particle of weight 2 N and the scale pan.

2001

4. A smooth pulley, of mass m kg, is connected by a light inextensible string passing over a smooth light fixed pulley to a particle of mass $5m$ kg.
Two particles of masses m kg and $2m$ kg are connected by a light inextensible string passing over the smooth pulley of mass m kg.
The system is released from rest.



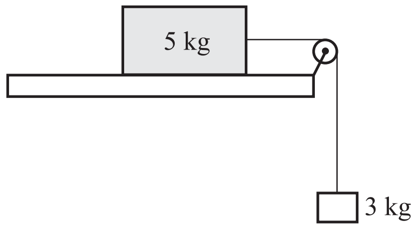
(i) Draw a diagram showing all the forces acting on each particle and on the smooth pulley of mass m kg.

(ii) Find the acceleration of each particle, in terms of g.

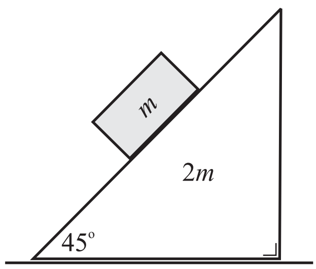
(iii) When the particle of mass $2m$ kg has moved down 1 metre relative to the fixed pulley, find how far the particle of mass $5m$ kg has moved relative to the fixed pulley.

2000

4. (a) A mass of 5 kg on a rough horizontal table is connected by a light inextensible string passing over a smooth light pulley, at the edge of the table, to a 3 kg mass hanging freely. The coefficient of friction between the 5 kg mass and the table is $\frac{1}{5}$.
The system is released from rest.
Find the distance fallen by the 3 kg mass in the first 2 seconds after the system is released from rest.



(b) A smooth wedge of mass $2m$ and slope 45° is placed on a smooth horizontal surface. A particle of mass m is placed on the inclined face of the wedge.
The system is released from rest.



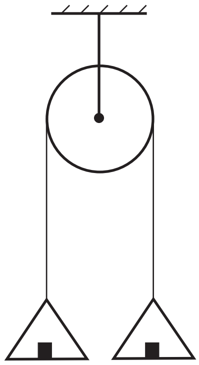
(i) Show on separate diagrams the forces acting on the wedge and the particle.

(ii) Show that the acceleration of the wedge is $\frac{1}{5}g$ m s^{-2}.

(iii) Find the speed of the mass relative to the wedge, when the speed of the wedge is 1 m/s.

1999

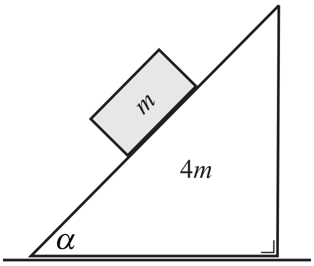
4. (a) Two scale-pans each of mass 0.5 kg are connected by a light inelastic string which passes over a smooth light fixed pulley. A mass of 0.2 kg is placed on one pan and a mass of 0.4 kg is placed on the other pan. The system is released from rest. Calculate



(i) the acceleration of the system,

(ii) the forces between the masses and the pans.

(b) A smooth wedge of mass $4m$ and slope α, is placed on a smooth horizontal surface.
A particle of mass m moves down the inclined face of the wedge.



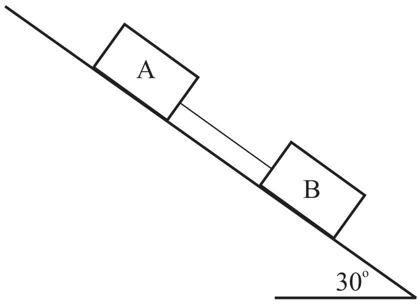
(i) Show on separate diagrams, the forces acting on the wedge and on the particle.

(ii) Prove that the acceleration of the wedge is $\dfrac{g\cos\alpha\sin\alpha}{4+\sin^2\alpha}$.

(iii) If $\alpha = 30^\circ$ find the acceleration of the mass relative to the wedge.

1998

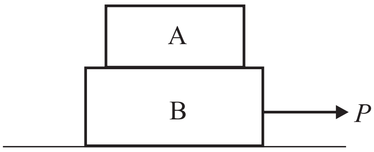
4. (a) Blocks A and B, of mass 15 kg and 25 kg, respectively, are connected by a light, inextensible string as shown in the diagram. The coefficients of friction are 0.4 for block A and 0.2 for block B. The blocks move down the plane which is inclined at 30° to the horizontal. Find



(i) the acceleration of block B

(ii) the tension in the string.

(b) The two blocks shown in the diagram are at rest on a horizontal surface when a force P is applied to block B. Blocks A and B have masses 20 kg and 35 kg, repectively. The coefficient of friction between the two blocks is 0.35 and the coefficient of friction between the horizontal surface and block B is 0.3.



Determine the maximum force, P, before A slips on B.

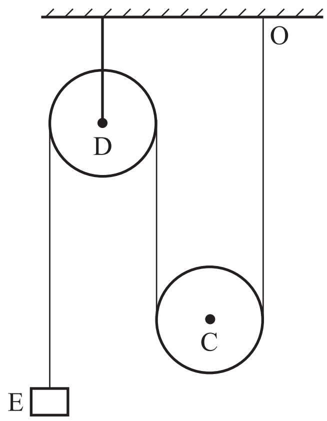
1997

4. (a) A particle A, of mass *m* kg, rests on a smooth horizontal table. It is connected by a light inextensible string which passes over a light, smooth, fixed pulley to a second particle B, of mass 2 kg, which hangs freely under gravity. The system starts from rest with A at a distance of 1 metre from the pulley.

(i) Calculate the acceleration of A.

(ii) If A reaches the pulley in $\frac{5}{7}$ seconds, find *m*.

(b) The diagrams shows a light inextensible string having one end fixed at O, passing under a smooth movable pulley C of mass *km* kg and then over a fixed smooth light pulley D. The other end of the string is attached to a particle E of mass *m* kg.



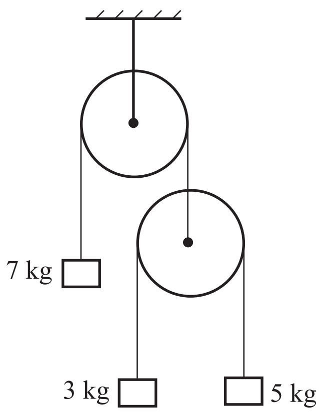
(i) Show on separate diagrams the forces acting on each mass when the system is released from rest.

(ii) Show that the upward acceleration of C is $\frac{(2-k)g}{4+k}$.

(iii) If $k = 0.5$, find the tension in the string.

1996

4. A light inextensible string passes over a smooth fixed pulley. It carries at one end a particle of mass 7 kg and at the other end a light, smooth pulley over which passes a light string with particles of mass 3 kg and 5 kg at its ends.



(i) On separate diagrams show the forces acting on each particle and on the movable pulley.

(ii) Find the accelerations of the three particles when the system is released from rest.

(iii) If the 3 kg mass is replaced by a mass of *m* kg, find the value of *m* if this particle does not move when the system is released from rest.

ANSWERS
LEAVING CERT. QUESTIONS

2008. 4 (b) (ii) $\dfrac{g\sqrt{3}}{19}$ m s^{-2}

2007. 4 (a) 2.15 s (b) (ii) $\dfrac{48mg}{5m+48}$

2006. 4 (a) (i) $\frac{1}{9}g$ m s^{-2} (ii) 0.3 s (b) (iii) 30°

2005. 1 (b) (i) 39,278.4 N (ii) 0.245 m
4 (a) (i) $\frac{10}{3}g$ N (ii) $\frac{10\sqrt{2}}{3}g$ N

2004. 1 (b) (i) 1.1 m s^{-2} (ii) 6°
4 (a) (i) $\frac{1}{3}g$ m s^{-2} (ii) $\dfrac{3v^2}{g}$ m (b) (ii) $\dfrac{14g}{11\sqrt{2}}$ m s^{-2} (iii) $\dfrac{3\sqrt{2}}{14}$ m

2003. 4 (a) $\frac{1}{2}g$ m s^{-2} (b) (ii) 1.65 m (iii) It reaches the top.

2002. 4 (b) (i) $\frac{3}{4}g$ m s^{-2} (ii) 3 N

2001. 4 (ii) 5m mass: $\frac{2}{13}g$ m s^{-2}; 2m mass: $\frac{3}{13}g$ m s^{-2}; 1m mass: $\frac{7}{13}g$ m s^{-2}; (iii) $\frac{2}{3}$ m

2000. 4 (a) $\frac{1}{2}g$ m (b) (ii) $3\sqrt{2}$ m s^{-1}

1999. 4 (a) (i) $\frac{1}{8}g$ m s^{-2} (ii) 0.225g N, 0.35g N (b) (iii) $\frac{10}{17}g$ m s^{-2}

1998. 4 (a) (i) 2.57 m s^{-2} (ii) 15.9 N (b) 35.75g N

1997. 4 (a) (i) $\dfrac{2g}{m+2}$ (ii) 3 kg (b) (iii) $\frac{1}{3}mg$ N

1996. 4 (ii) 7 kg : $\frac{1}{29}g$ m s^{-2}; 5 kg : $\frac{8}{29}g$ m s^{-2}; 3 kg : $\frac{6}{29}g$ m s^{-2} (iii) $\frac{35}{9}$ kg