Lagan College Mathematics Department

GCSE
FURTHER MATHS

Connected Bodies
& Pulleys

PP Questions

11 A van of mass 1250 kg is towing a trailer of mass 550 kg by means of a light horizontal tow bar. The tractive force produced by the van's engine is 3840 N. The van and trailer are travelling along a straight horizontal road as shown in **Fig. 7**.

Fig. 7

The van and trailer accelerate uniformly from rest to 21 m/s in 15 seconds.

(i) Calculate this acceleration of the van and trailer, [1]

(ii) Show that the **total** resistance to the motion of the van and trailer is 1320 N. [4]

The resistance to the motion of the van is 0.704 N per kg of mass.

Calculate, in Newtons,

(iii) the resistance to the motion of the van, [1]

(iv) the resistance to the motion of the trailer, [1]

(v) the magnitude of the tension in the towbar. [2]

The van and trailer then travel at a constant speed of 21 m/s and after some time the towbar breaks.

(vi) Assuming that the resistance to the motion of the trailer remains the same calculate the **additional** distance travelled by the trailer before it comes to rest. [4]

12 A car of mass 1050 kg pulls a trailer of mass 750 kg along a straight horizontal road by means of a light inextensible horizontal towbar as shown in **Fig. 8**.

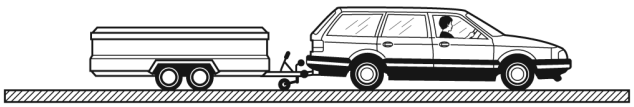


Fig. 8

The car and trailer accelerate uniformly from rest with an acceleration of 1.2 m/s^2.

The car's engine exerts a tractive force of 3450 N and the resistance to the motion of the car is 0.8 N/kg.

(i) Calculate the resistance to the motion of the car. [1]

(ii) Show that the total resistance to the motion of the car and trailer is 1290 N. [3]

Calculate

(iii) the resistance to the motion of the trailer, [2]

(iv) the tension in the towbar. [2]

At the instant when the speed of the car and trailer is 12 m/s the coupling in the towbar snaps.

Assume that the resistance to the motion of the trailer remains the same.

Find

(v) the time taken by the trailer in coming to rest after the towbar snaps, [3]

(vi) the distance the trailer travels in this time. [2]

THIS IS THE END OF THE QUESTION PAPER

10 Two packages A and B of masses 5 kg and m kg respectively, where $m < 5$, are connected by a light inextensible string which passes over a smooth pulley fixed to the ceiling of a store, as shown in **Fig. 7**.

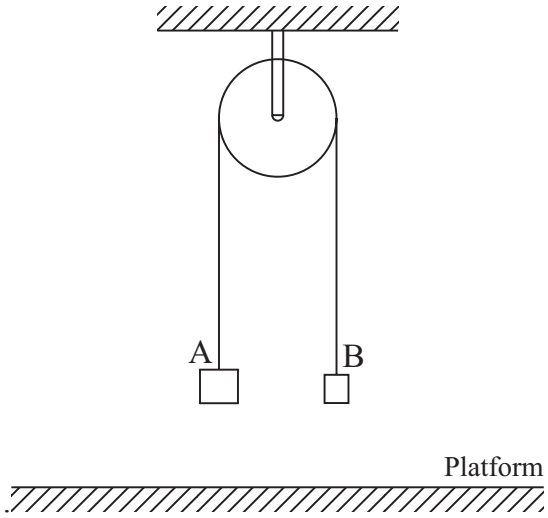


Fig. 7

The packages are held so that both parts of the string are hanging vertically with the string taut. The system is released from rest and the magnitude of the acceleration of each package during the subsequent motion is 2.5 m/s^2.

(i) Copy **Fig. 7** and mark on your diagram the forces acting on the packages. [1]

By forming an equation of motion for each package, find

(ii) the tension in the string, [2]

(iii) the value of m, [2]

(iv) the force exerted by the string on the pulley when the packages are in motion. [1]

When the packages have been in motion for 1.5 seconds, A strikes a fixed platform. The string becomes slack and B initially continues to rise.

Assuming that B does not reach the pulley, calculate

(v) the speed of the packages at the moment when A strikes the platform, [1]

(vi) the **additional** distance through which B rises after A strikes the platform, [2]

(vii) the time which elapses between A striking the platform and the string becoming taut again. [2]

11 A car and a motorcycle are travelling in the same direction along a dual carriageway. **At the same instant** they pass a sign warning them of a checkpoint ahead.

The car passes the warning sign at a speed of 20 m/s, continues at this speed for 1 minute and then decelerates uniformly to rest at the checkpoint.

The motorcyclist passes the warning sign at a speed of 26 m/s and continues at this speed for T seconds. He then decelerates uniformly to rest at the checkpoint.

They both arrive at the checkpoint at the same instant.

(i) Using **Fig. 8** in your Supplementary Answer Booklet, sketch the speed/time graphs for both vehicles as they travel from the warning sign to the checkpoint. [2]

The distance from the warning sign to the checkpoint is 1.3 km.

Calculate

(ii) the distance travelled by the car in the first minute, [1]

(iii) the deceleration of the car, [2]

(iv) the time for which the car was decelerating, [1]

(v) the total time for the journey between the warning sign and the checkpoint, [1]

(vi) the value of T. [4]

11 A van of mass M kg tows a trailer of mass 480 kg by means of a light horizontal tow bar along a straight horizontal road.

The tractive force produced by the engine in the van is 3450 N, as shown in **Fig. 7**.

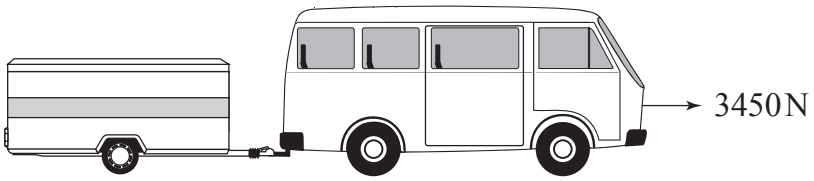


Fig. 7

The van and trailer accelerate uniformly from rest to a speed of 10 m/s while travelling a distance of 125 m.

(i) Find the acceleration of the van and trailer. [1]

The resistance to motion of the van is 1180 N.

The tension in the tow bar is 1806 N.

(ii) Find the value of M. [3]

(iii) Find the resistance to motion of the trailer. [2]

The tractive force is increased so that the van and trailer travel the next 125 m in 10 seconds with uniform acceleration.

(iv) Calculate the acceleration of the van and trailer while travelling the second 125 m. [1]

Assuming the resistances to motion remain the same, calculate

(v) the new tension in the tow bar; [2]

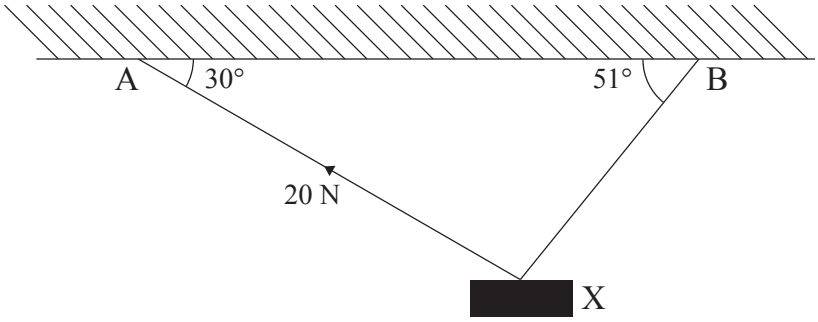
(vi) the amount by which the tractive force was increased. [2]

Examiner Only	
Marks	Remark

2 A block X, of mass m kg, is held in equilibrium by two light inextensible strings XA and XB, attached to a horizontal ceiling. The strings are inclined to the ceiling at angles of 30° and 51°, as shown in the diagram below.

The tension in the string XA is 20 N.

(i) Mark on the diagram the other forces acting on the block.



[1]

(ii) Calculate the tension in the string XB.

Answer _____ N [2]

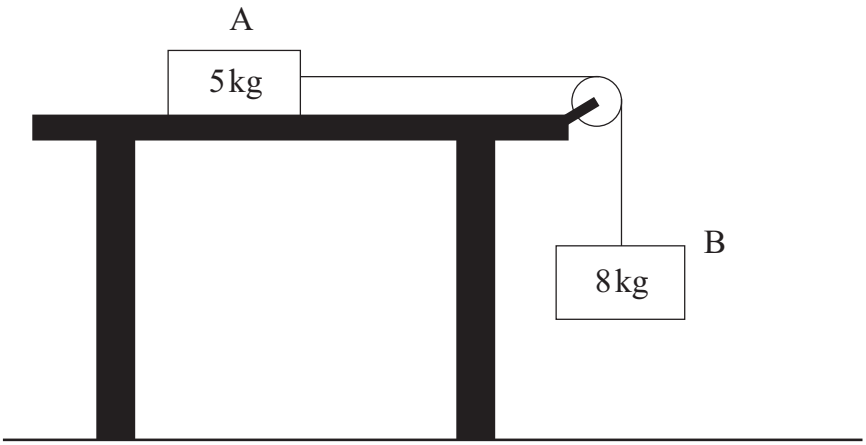
(iii) Calculate the value of m.

Examiner Only	
Marks	Remark

Answer _____ [3]

Examiner Only	
Marks	Remark

4 Two blocks A and B, of masses 5 kg and 8 kg, are attached by a light inextensible string which passes over a smooth pulley. Block A is held at rest on a rough horizontal table and block B hangs in the air above horizontal ground, as shown in the diagram below.



The system is released from rest. After 0.8 seconds block B has moved 1.6 m downwards. It is still above the ground and block A has not reached the pulley.

(i) On the diagram above, mark all the forces acting on each of the blocks. [3]

(ii) Show that the acceleration of the blocks is $5\,\text{m/s}^2$.

[2]

Examiner Only	
Marks	Remark

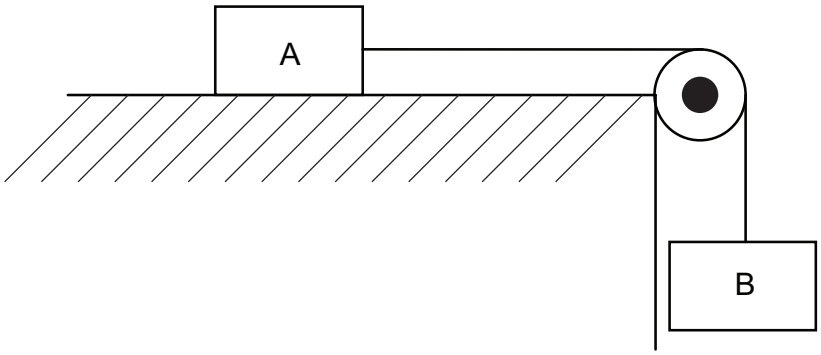
(iii) Hence calculate the tension in the string.

Answer _____ N [2]

(iv) Calculate the coefficient of friction between the table and block A.

Answer _____ [3]

4 Two boxes A and B, with masses 1.1 kg and 1.4 kg respectively, are attached to the ends of a light inextensible string. The box A lies on a smooth horizontal table. The string passes over a smooth fixed pulley at the edge of the table.



This system is released from rest with the box B hanging vertically.

Calculate

(i) the acceleration of the system, [3]

(ii) the tension in the string, [1]

(iii) the force exerted by the string on the pulley when the boxes are in motion, [2]

(iv) the distance travelled by box B after 0.5 seconds, assuming that it does not reach the ground. [2]