AQA
Realising potential

TOPIC TEST

AS and A-level MATHS

Forces 2

Specification content coverage: R4

In this test you will be assessed on using Newton's 3rd Law, including pulleys and connected particles.

The test comprises two sections. The questions in section A will test you on the basics of the topic. Those in section B require a bit more thinking.

Section A: The basics

1 Three forces $\mathbf{A} = 2\mathbf{i} + 4\mathbf{j}$, $\mathbf{B} = 6\mathbf{i} - 14\mathbf{j}$ and $\mathbf{C} = 3\mathbf{i} + 2\mathbf{j}$ act on a particle.

1 (a) Calculate the resultant of these three forces, giving your answer in terms of **i** and **j**.

[1 mark]

1 (b) A fourth force, **D**, acts on the particle so it remains in equilibrium.

Find **D**, giving your answer in terms of **i** and **j**.

[1 mark]

2 (a) **In this question use $g = 10$ m s^{-2}.**

A box of mass 5 kg is placed on top of another box of mass 7 kg on horizontal ground, as shown in the diagram.

Draw a diagram to show the directions and magnitudes of the forces that are acting on the box of mass 5 kg.

[1 mark]

2 (b) Draw a diagram to show the directions and magnitudes of the forces that are acting on the box of mass 7 kg.

[2 marks]

3 (a) **In this question use $g = 9.8$ m s^{-2}.**

A person of mass 70 kg stands on the floor of a lift.

Calculate the force exerted on the person by the floor of the lift when the lift is accelerating upwards at 4 m s^{-1}.

[2 marks]

3 (b) Calculate the force exerted on the person by the floor of the lift when the lift is accelerating downwards at 6 m s^{-1}.

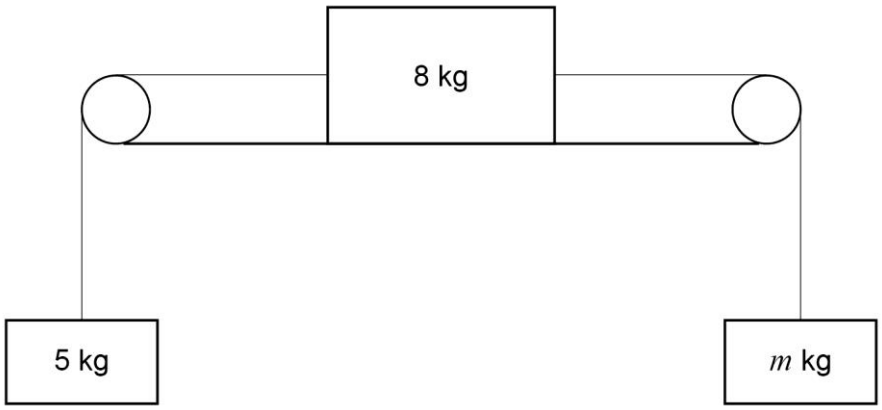
[2 marks]

4 (a) **In this question use g = 9.8 m s^{-2}.**

A box of mass 8 kg rests on a smooth horizontal table.

Two strings of equal length are attached to each end of the box, and these pass over a smooth pulley at each end of the table.

The other ends of the strings are attached to other boxes, one of mass 5 kg, the other of mass m kg as shown in the diagram.



The system is released from rest and the 8 kg box moves to the left with acceleration 1.96 m s^{-2}.

By resolving vertically on the 5 kg box, find the value of the tension in the string on the left.

[2 marks]

4 (b) By resolving horizontally on the 8 kg box, find the value of the tension in the string on the right.

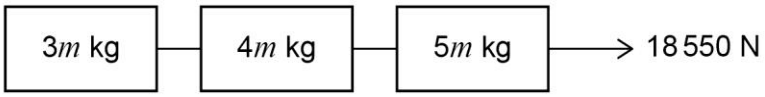
[2 marks]

4 (c) By resolving vertically on the m kg box, find the value of m.

[2 marks]

Section B: A bit more thinking

5 Two trucks of masses $3m$ kg and $4m$ kg are pulled along a straight horizontal track by an engine of mass $5m$ kg with a driving force of 18 550 N, as shown in the diagram.



The $3m$ kg mass experiences a resistance of 100 N, the $4m$ kg mass experiences a resistance of 150 N and the $5m$ kg mass experiences a resistance of 300 N.

The system accelerates at 2.5 m s^{-2}.

Calculate the value of m, find the tension in the horizontal coupling between the trucks, and find the tension in the horizontal coupling between the $4m$ kg truck and the engine.

5 (a) Calculate the value of m.

[2 marks]

5 (b) Find the tension in the horizontal coupling between the trucks and between the $4m$ kg truck and the engine.

[3 marks]

6 **In this question use g = 9.8 m s^{-2}.**

A box of mass 9 kg rests on a smooth horizontal table.

A string attached to the box passes over a smooth pulley at the edge of the table. The other end of the string is attached to box of mass 3 kg, which hangs vertically. The system is released from rest.

Calculate the acceleration of the system, the tension in the string and the time it takes the boxes to move 3 m.

[6 marks]

7 **In this question use g = 9.81 m s^{-2}.**

Two small particles of masses 6 kg and 3 kg are attached to the ends of a light inextensible string. The string passes over a smooth pulley at a height of 5 m above the ground.

The system is released from rest with both particles hanging vertically at a height of 2 m above the ground.

Explain whether the 3 kg particle will reach the pulley before it begins to move.

Fully justify your answer.

[6 marks]