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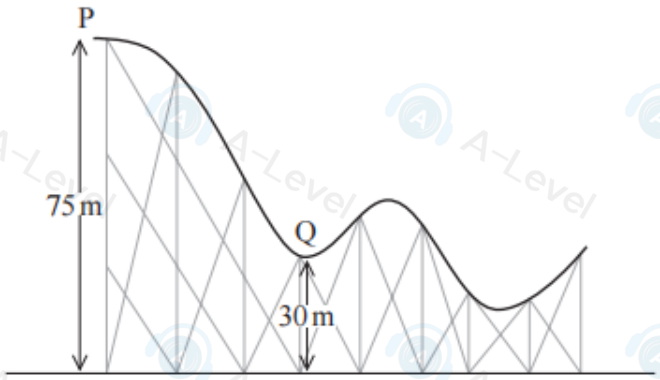
3 The diagram shows a roller coaster. A roller coaster car stops momentarily at P before descending towards Q.



Which of the following expressions could be used to determine the velocity of the roller coaster car at Q?

☐ **A** $\sqrt{75g} - \sqrt{30g}$

☐ **B** $\sqrt{150g} - \sqrt{60g}$

☐ **C** $\sqrt{45g}$

☐ **D** $\sqrt{90g}$

(Total for Question 3 = 1 mark)

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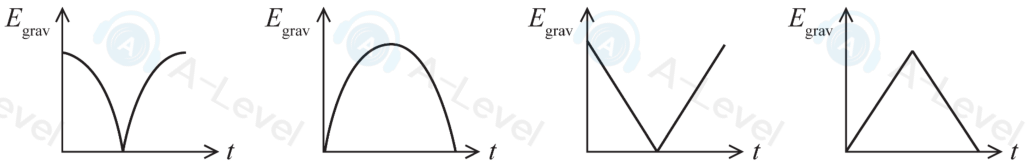
8 A ball is dropped, bounces once and is then caught.

Which of the following graphs of gravitational potential energy E_{grav} against time t could represent the motion of the ball?



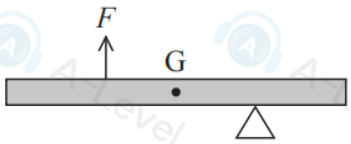
☒ **A** ☐ **B** ☐ **C** ☐ **D**

(Total for Question 8 = 1 mark)

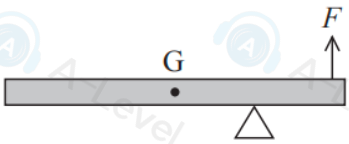
5 A beam is supported by a pivot as shown in the diagrams. The centre of gravity of the beam is at G. The beam is acted on by a force *F*.

Which diagram shows an arrangement where the beam could **not** be in equilibrium?

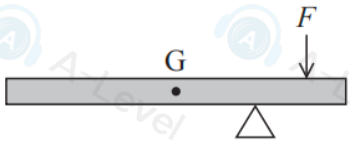
A



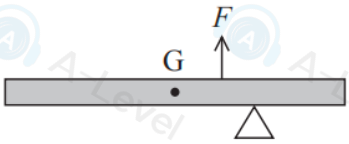
B



C



D



☒ **A**

☒ **B**

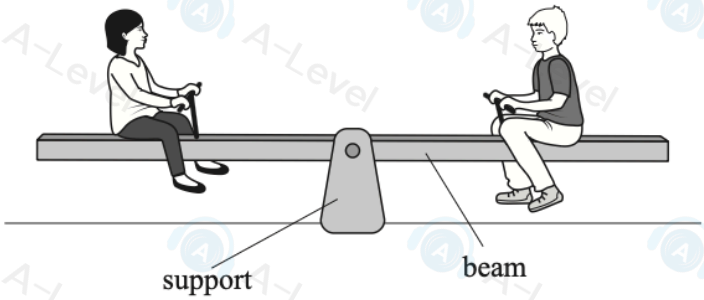
☒ **C**

☒ **D**

(Total for Question 5 = 1 mark)

2: A see-saw is a uniform beam that balances on a support. The beam can rotate around the top of the support.

Two children of equal weight sit on a see-saw at equal distances from the support, as shown.

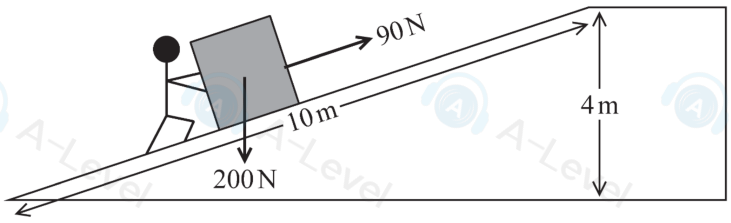


Which row of the table describes the resultant force and resultant moment on the beam?

	Resultant force	Resultant moment
☒ **A**	zero	zero
☒ **B**	zero	anticlockwise
☒ **C**	downwards	zero
☒ **D**	downwards	anticlockwise

(Total for Question 2 = 1 mark)

4 A force of 90 N is used to push a box along a ramp of length 10 m, up to a platform. The platform is 4 m above the ground. The weight of the box is 200 N.



Which of the following expressions could be used to determine the efficiency of the ramp?

☒ **A** $\frac{90 \times 10}{200 \times 4}$

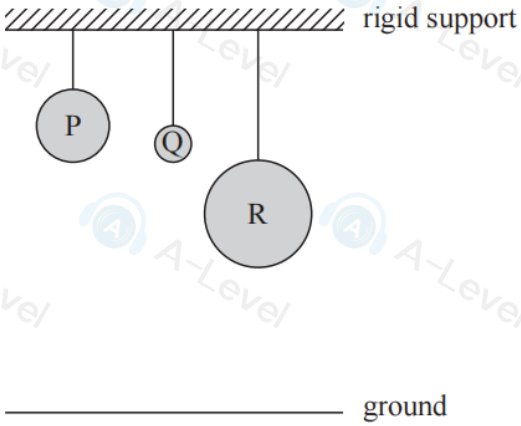
☒ **B** $\frac{200 \times 4}{(90 \times 10) + (200 \times 4)}$

☒ **C** $\frac{200 \times 4}{90 \times 10}$

☒ **D** $\frac{90 \times 10}{(90 \times 10) + (200 \times 4)}$

(Total for Question 4 = 1 mark)

5 Three spheres P, Q and R of the same mass are lifted from the ground and suspended from a rigid support as shown.



The greatest change in gravitational potential energy is seen in sphere(s)

☒ **A** P.

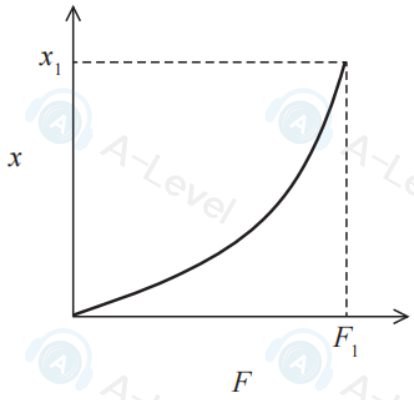
☒ **B** P and Q.

☒ **C** P and R.

☒ **D** R.

(Total for Question 5 = 1 mark)

6 The graph shows how the extension x of a spring varies with the applied force F.

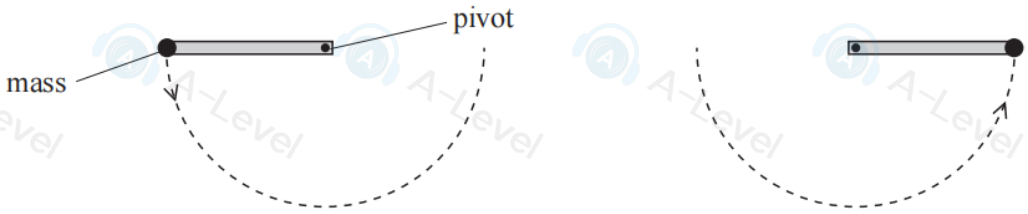


Select the expression that best describes the work done W in extending the spring.

- ☒ **A** $W = F_1 x_1$
- ☒ **B** $W = \frac{1}{2} F_1 x_1$
- ☒ **C** $W < \frac{1}{2} F_1 x_1$
- ☒ **D** $W > \frac{1}{2} F_1 x_1$

(Total for Question 6 = 1 mark)

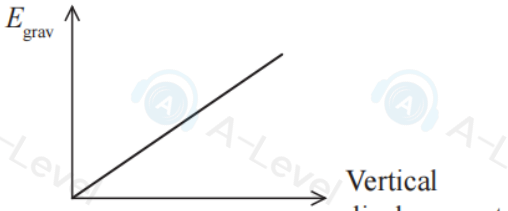
10 A mass is fixed to one end of a metre rule, which is pivoted at the other end. The mass and metre rule are held horizontally and released, as shown in the first diagram. The mass moves to its final position, as shown in the second diagram.



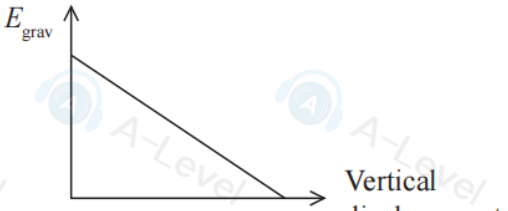
release position

final position

Which of the following is the graph of gravitational potential energy E_{grav} of the mass against vertical displacement for the motion of the mass?

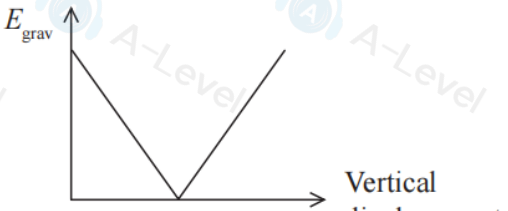


A



B

C



D

☒ **A**

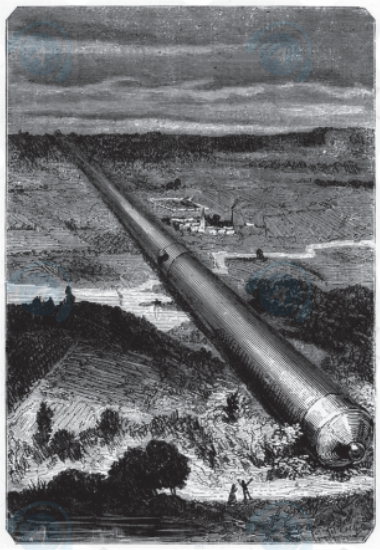
☒ **B**

☒ **C**

☒ **D**

(Total for Question 10 = 1 mark)

15 In 1865, in his book 'From the Earth to the Moon', the writer Jules Verne wrote about sending men to the Moon. In order to escape the Earth's gravitational field, Verne proposed firing a capsule from a cannon of length 220 m, as shown in this illustration from the book.



(a) The velocity of the capsule at the end of the cannon was estimated to be 11 km s^{-1}.

(i) Calculate the acceleration of the capsule through the cannon.

(3)

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Acceleration = ...

(ii) It can be assumed that only 50% of the energy supplied by the gunpowder in the cannon would have been transferred to the capsule.

Determine the mass of gunpowder that would have been required to obtain a maximum speed of 11 km s^{-1}.

(4)

mass of capsule = 1500 kg
energy released from gunpowder = 3 MJ kg^{-1}

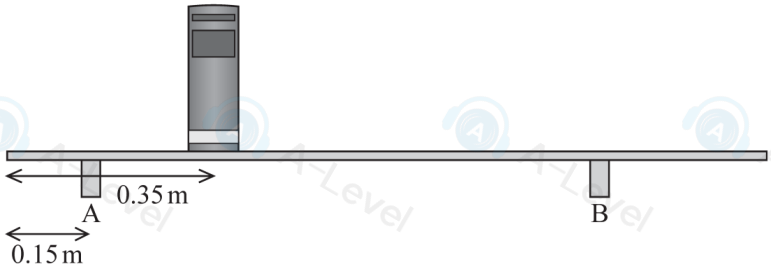
Mass of gunpowder = ...

*(b) In order to land safely on the surface of the Moon, Verne suggested that gases could be ejected from the capsule to reduce its speed.

Explain how ejecting gases from the capsule could reduce its speed. Your answer should include reference to Newton's laws of motion.

(5)

13 Two brackets, A and B, support a shelf of length 1.2 m. Bracket A is positioned 0.15 m from the left-hand end of the shelf. A book is placed 0.35 m from the left-hand end of the shelf as shown.



(a) The normal contact forces of each bracket on the shelf are equal.

Determine the distance of bracket B from the left-hand end of the shelf.

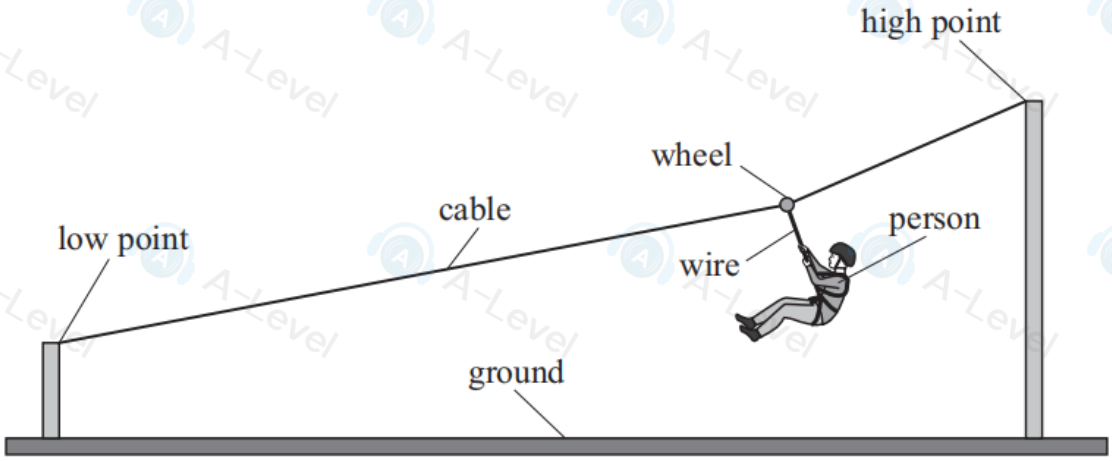
weight of book = 8.5 N
weight of shelf = 14 N

(5)

Distance = ...

19 A 'zip-line' consists of a cable fixed at two points, one higher than the other.

A person hangs from a wire attached to a wheel, as shown. The wheel can move along the cable. The wheel moves the person along the cable.

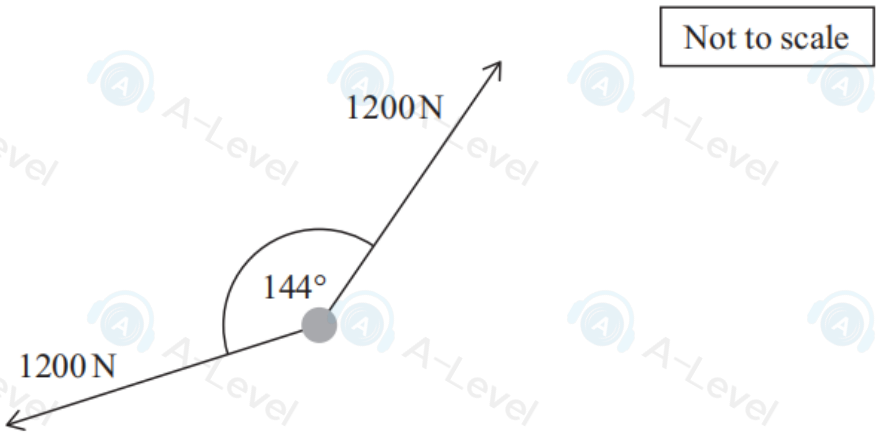


(a) In the position shown, the person is accelerating.

Complete the free-body force diagram below to show the three forces acting on the person in this position.

(3)

(b) At a particular instant, the tension in the cable is 1200 N and the angle formed by the cable at the wheel is 144°, as shown.



(i) Show, by calculation, that the force on the wheel from the cable is about 740 N.

(2)

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(ii) There is a force on the wheel from the wire of 800 N.

The angle between the force from the cable and the 800 N force from the wire is 150°.

Determine the magnitude of the resultant force on the wheel using a scaled vector diagram.

You should ignore the weight of the wheel.

(4)

Resultant force on the wheel = ...

(c) People take turns at moving along the zip-line from the high point to the low point. The people are initially at rest at the high point.

Explain why the speeds of people with different masses are always about the same when they reach the low point.

(3)

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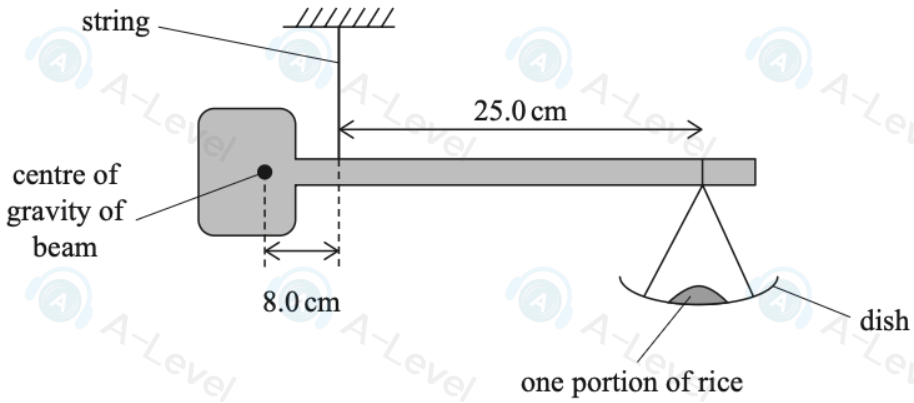
(Total for Question 19 = 12 marks)

16 A balance is formed by a beam suspended from a string. A dish is hung from the beam and the balance is used to measure a fixed portion of rice.

When the dish contains one portion of rice, the balance is in equilibrium, as shown.



(a) State the conditions needed for an object to be in equilibrium.

(2)

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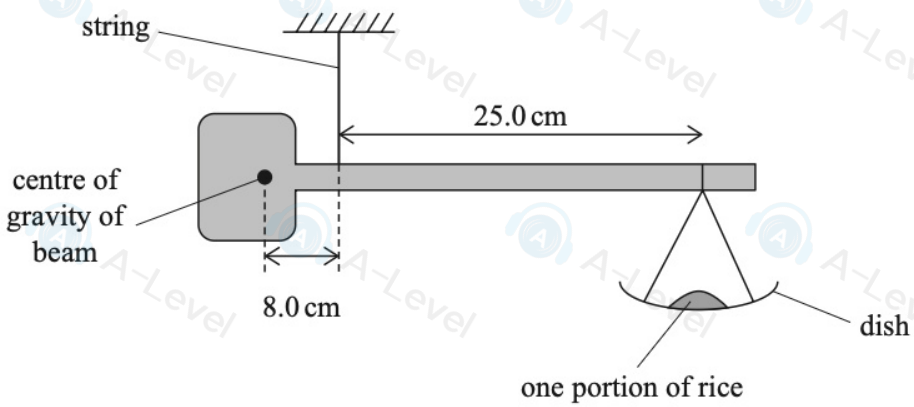
16 A balance is formed by a beam suspended from a string. A dish is hung from the beam and the balance is used to measure a fixed portion of rice.

When the dish contains one portion of rice, the balance is in equilibrium, as shown.



(a) State the conditions needed for an object to be in equilibrium.

(2)

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(b) The dish is moved along the beam so that the horizontal distance from the string to the dish is 7.0 cm.

Rice is added to the dish until the balance is in equilibrium.

Deduce whether the dish now contains 3 portions of rice.
You should include a calculation of the weight of 1 portion of rice.

weight of beam = 3.1 N
weight of empty dish = 0.64 N

(6)

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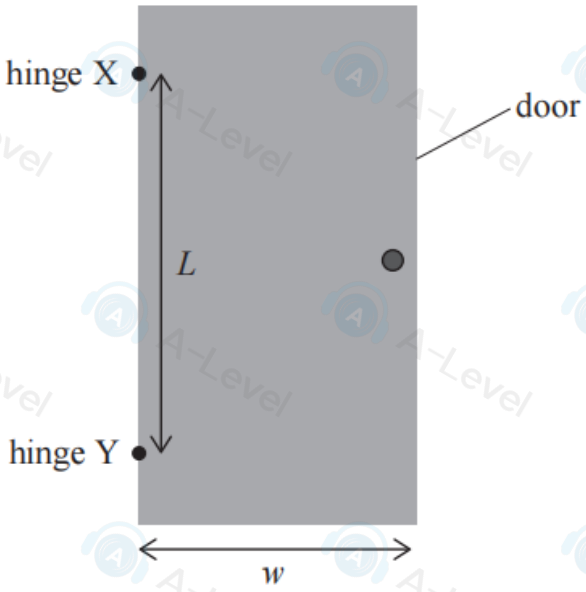
18 A uniform door of width w is supported by two hinges, X and Y.
X and Y are a vertical distance L apart as shown.



(a) State the conditions needed for the door to be in equilibrium.

(2)

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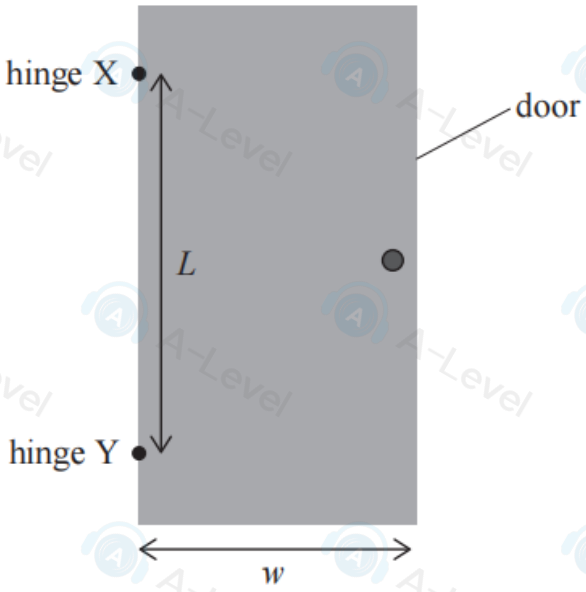
(b) Give the meaning of the term centre of gravity.

(1)

.....

.....

18 A uniform door of width w is supported by two hinges, X and Y.
X and Y are a vertical distance L apart as shown.



(a) State the conditions needed for the door to be in equilibrium.

(2)

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.....

(b) Give the meaning of the term centre of gravity.

(1)

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(iii) An identical door is supported by hinges that are much closer together.

Explain how a smaller value of L affects F and θ.

You should consider moments about point X.

(4)

(Total for Question 18 = 16 marks)