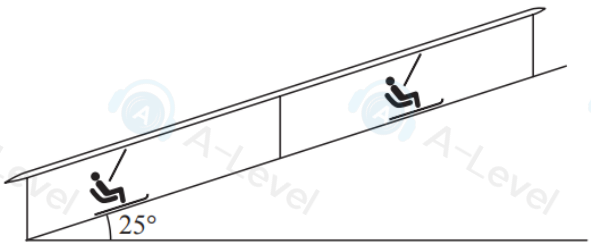
9 A ski lift carries skiers along a 450 m slope that is at an incline of 25° to the horizontal.



It can be assumed that the motor has to lift an average additional mass of 80 kg for each skier using the ski lift.

Which of the following expressions represents the work done against gravity when lifting an individual skier up the slope?

☒ **A** $\frac{80 \times g \times 450}{\cos 25°}$

☒ **B** $\frac{80 \times g \times 450}{\sin 25°}$

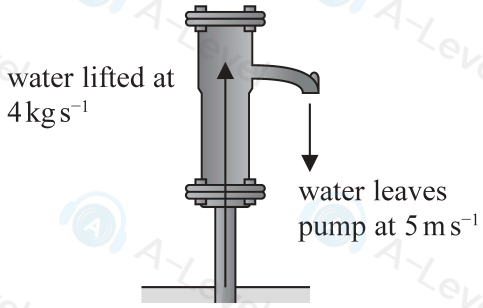
☒ **C** $80 \times g \times 450 \times \cos 25°$

☒ **D** $80 \times g \times 450 \times \sin 25°$

(Total for Question 9 = 1 mark)

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8 An electric pump lifts water from a well through a height of 10 m at a rate of $4\,kg\,s^{-1}$. The water leaves the pump with a velocity of $5\,m\,s^{-1}$ as shown.



Which of the following expressions could be used to determine the minimum power output of the pump in watts?

☒ **A** $\frac{1}{2}(4 \times 5^2)$

☒ **B** $(4 \times 9.81 \times 10)$

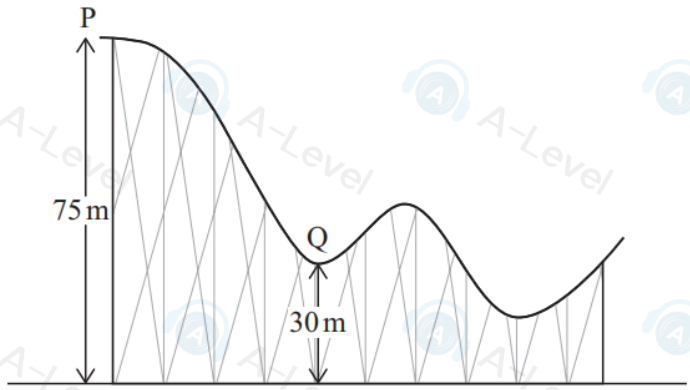
☒ **C** $(4 \times 9.81 \times 10) + \frac{1}{2}(4 \times 5^2)$

☒ **D** $(4 \times 9.81 \times 10) - \frac{1}{2}(4 \times 5^2)$

(Total for Question 8 = 1 mark)

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10 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 $\sqrt{79g} - \sqrt{30g}$

B $\sqrt{150g} - \sqrt{60g}$

C $\sqrt{45g}$

D $\sqrt{90g}$

(Total for Question 10 = 1 mark)

5 Two students, P and Q, of equal mass climb to the top of a mountain. They both start their climb from the same vertical height.



Student P takes two hours to climb a shorter, steeper route. Student Q takes three hours to climb a longer, less steep route.

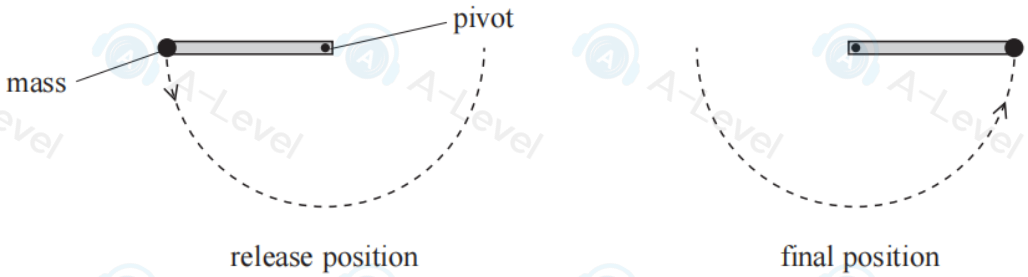
Which row of the table correctly describes the gain in gravitational potential energy and power developed by student P compared to student Q?

	Gain in gravitational potential energy	Power developed
☒ **A**	greater for P than Q	greater for P than Q
☒ **B**	greater for P than Q	less for P than Q
☒ **C**	same for P and Q	greater for P than Q
☒ **D**	same for P and Q	less for P than Q

(Total for Question 5 = 1 mark)

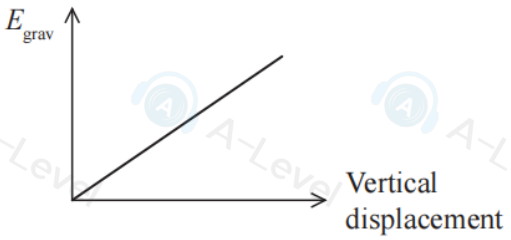
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10 A mass is fixed to one end of a metre rule, which is pivoted at the other end. The mass and metre rule are held horizontally and released, as shown in the first diagram. The mass moves to its final position, as shown in the second diagram.

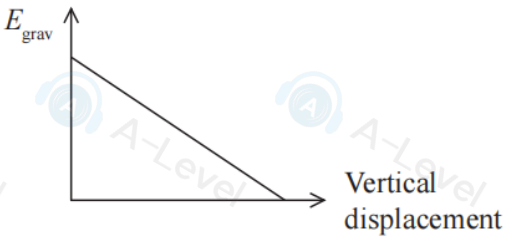


release position　　final position

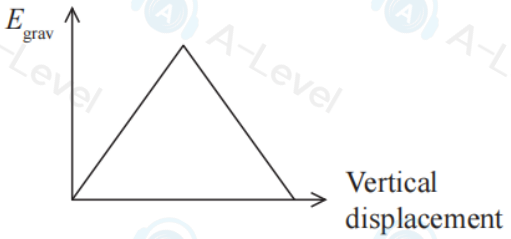
Which of the following is the graph of gravitational potential energy E_{grav} of the mass against vertical displacement for the motion of the mass?



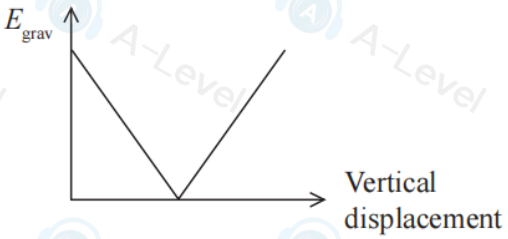
A



B



C



D

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 10 = 1 mark)

3 A block of mass m is placed on a bench and a horizontal force F is applied to the block. The block accelerates along the bench, travels a distance d in time t and reaches a velocity v.

The work done by the force F on the block is

☒ **A** Fd

☒ **B** Ft

☒ **C** Fv

☒ **D** mgd

(Total for Question 3 = 1 mark)

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2 An object of mass 8.2 kg, initially at rest, falls a vertical distance of 25 m through the air and has a final velocity of 20 m s^{-1}.

Which of the following gives the energy in joules dissipated by air resistance?

☒ **A** $8.2 \times 9.81 \times 25$

☒ **B** $0.5 \times 8.2 \times 20^2 + 8.2 \times 9.81 \times 25$

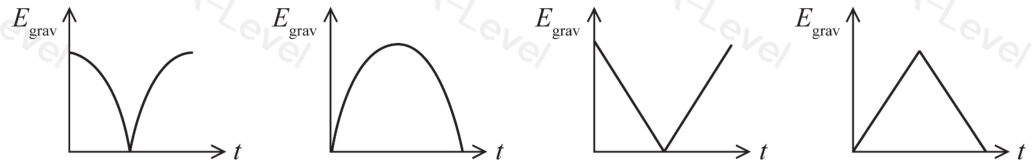
☒ **C** $8.2 \times 9.81 \times 25 - 0.5 \times 8.2 \times 20^2$

☒ **D** $0.5 \times 8.2 \times 20^2 - 8.2 \times 9.81 \times 25$

(Total for Question 2 = 1 mark)

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?

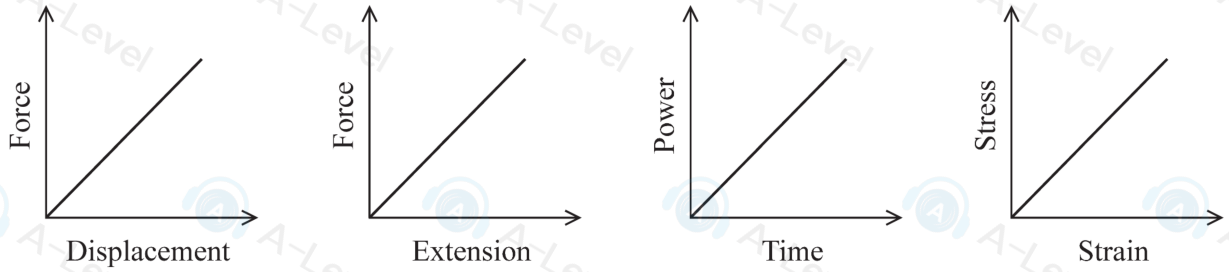


☒ **A** ☒ **B** ☒ **C** ☒ **D**

(Total for Question 8 = 1 mark)

4 The area under each of the following graphs represents a physical quantity.

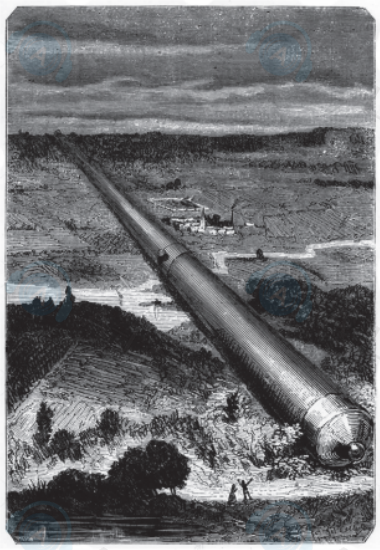
For which graph is the area under the graph **not** equal to work done?



☒ **A** ☒ **B** ☒ **C** ☒ **D**

(Total for Question 4 = 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 = ...

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(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)

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14 The photograph shows a fireboat used to put out fires on ships at sea. A pump, fixed to the boat, pumps water from the sea. The seawater is projected at high speed out of a pipe connected to the pump.



(Source: © Konrad Zelazowski/age fotostock/Superstock)

(a) The mass of seawater pumped each second is 300 kg. The pipe has a diameter of 10.0 cm.

density of seawater = 1030 kg m^{-3}

(i) Show that the speed at which the seawater is projected from the pipe is about 37 m s^{-1}.

(4)

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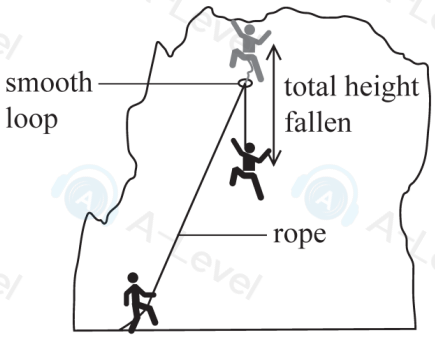
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(ii) Determine the rate at which the momentum of the seawater is changed by the

17 The diagram shows a climber on a rock face. A rope is kept firmly anchored by a person on the ground and passes through a smooth loop to the climber. The climber slips and falls a short distance as shown.

Diagram not to scale



(a) The 'fall factor' is used by climbers to estimate the severity of a climbing fall and is given by

$$\text{'fall factor'} = \frac{\text{height fallen before the rope begins to stretch}}{\text{total unstretched length of rope}}$$

A climber slips and falls with a 'fall factor' of 0.80 before coming to rest.
The energy from the fall is absorbed by the climbing rope.
The maximum strain in the rope is 9.0%.

(i) Show that the maximum force acting on the climber due to the rope is about 10 kN.
Assume the extension of the rope is proportional to its tension.

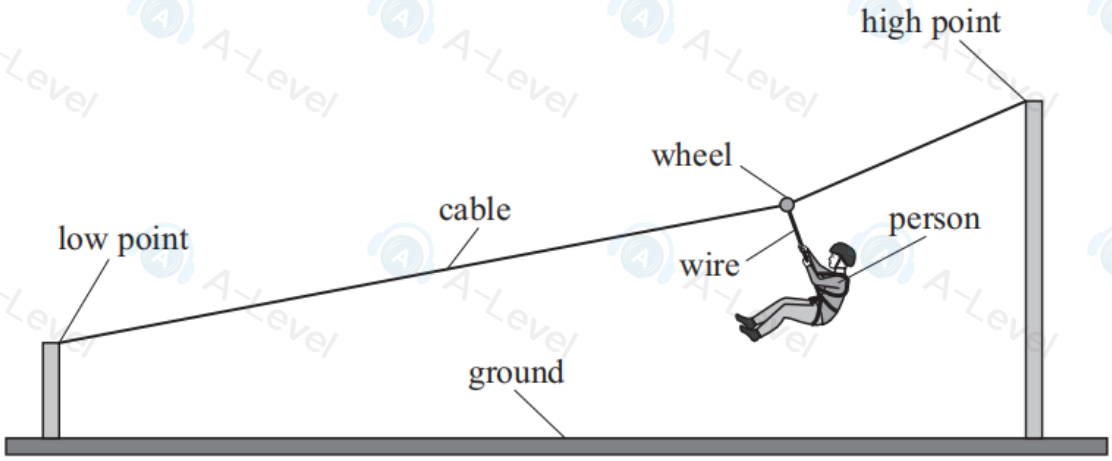
total unstretched length of rope = 15.0 m
mass of climber = 71 kg

(5)

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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.

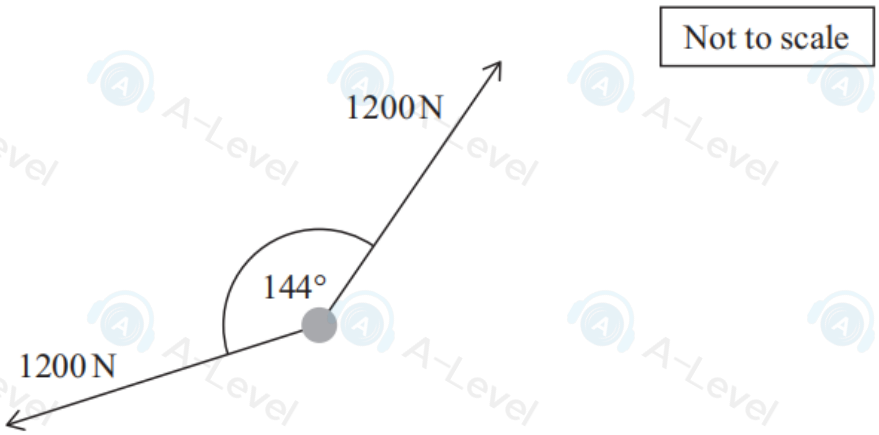


(a) In the position shown, the person is accelerating.

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)