Energy & Power

Question Paper 1

Level	International A Level
Subject	Physics
Exam Board	Edexcel
Topic	Mechanics
Sub Topic	Energy & Power
Booklet	Question Paper 1

Time Allowed: **82 minutes**

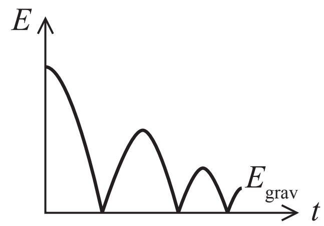
Score: **/68**

Percentage: **/100**

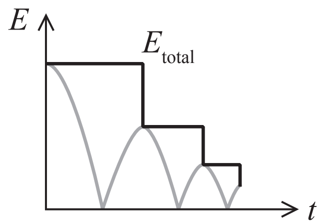
Grade Boundaries:

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

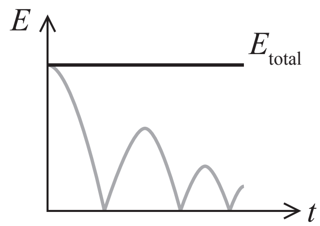
1 A ball is dropped and bounces three times before being caught. The following graph shows how the gravitational potential energy E_{grav} of the ball varies with time t.



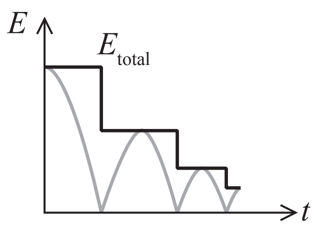
Ignore the effects of air resistance. Select the graph that correctly shows how the total kinetic and potential energy E_{total} of the ball varies with time.



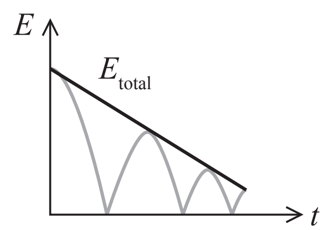
A



B



C



D

☒ **A**

☒ **B**

☒ **C**

☒ **D**

(Total for Question 1 = 1 mark)

2 A motor takes 10 minutes to lift a mass of 40 000 kg through a height of 5 m.

The minimum power of the motor in watts can be found using

☐ **A** $\dfrac{40\,000 \times 9.81 \times 5 \times 60}{10}$

☐ **B** $\dfrac{40\,000 \times 9.81 \times 5}{10 \times 60}$

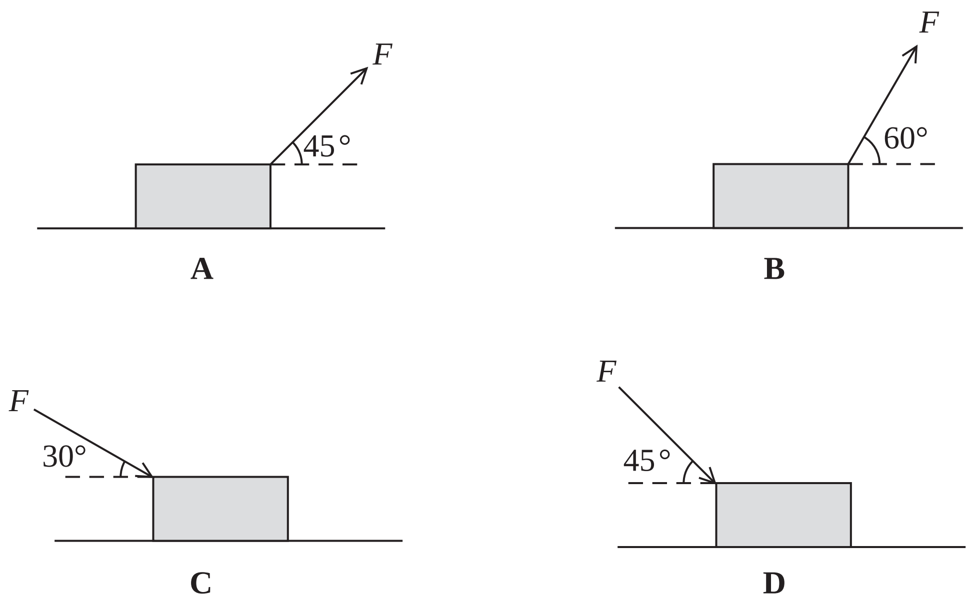
☐ **C** $\dfrac{40\,000 \times 5 \times 60}{10}$

☐ **D** $\dfrac{40\,000 \times 5}{10 \times 60}$

(Total for Question 2 = 1 mark)

3 A force *F* is applied to a box causing the box to move along a horizontal surface.

Which of the following would produce the most work done by *F* on the box for a given horizontal displacement?



☒ **A**

☒ **B**

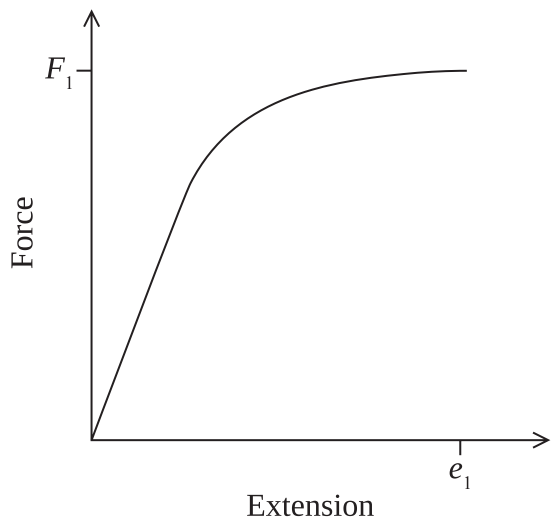
☒ **C**

☒ **D**

(Total for Question 3 = 1 mark)

Use the graph below to answer question 4.

The force-extension graph for a wire is shown.
When a force F_1 is applied across the ends of the wire, an extension e_1 is produced.

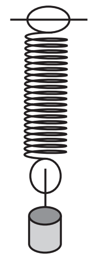


4 Which of the following correctly describes the work done W to extend the wire?

- ☒ **A** $W = 0.5\, F_1 e_1$
- ☒ **B** $W > 0.5\, F_1 e_1$
- ☒ **C** $W = \dfrac{F_1}{e_1}$
- ☒ **D** $W < \dfrac{F_1}{e_1}$

(Total for Question 4 = 1 mark)

5 A spring of length 5.0 cm is suspended from a retort stand. When a mass of 0.030 kg is added the length of the spring doubles.



0.030 kg

The energy stored in the stretched spring can be calculated using

☒ **A** $\frac{1}{2} \times 0.030 \times 9.81 \times 0.10^2$

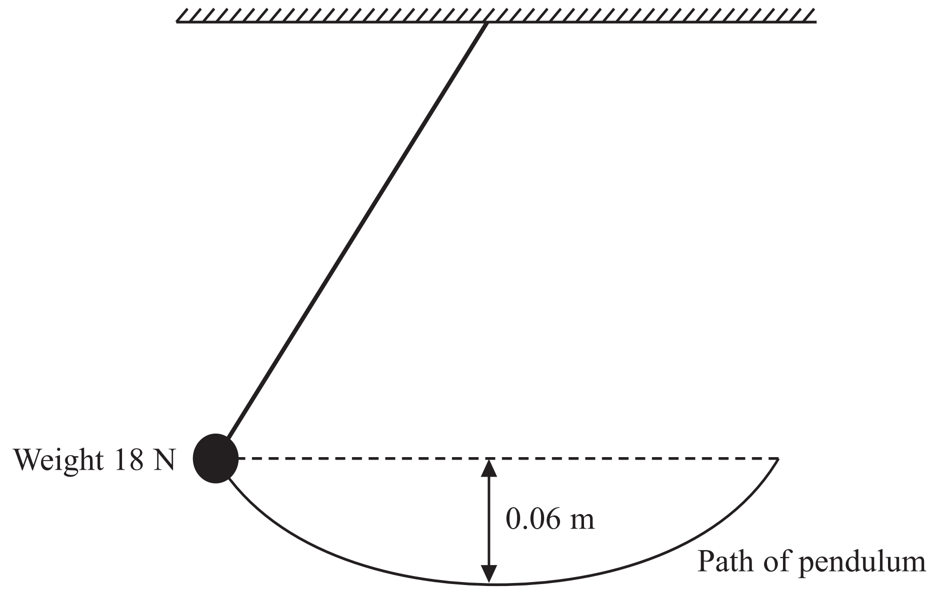
☒ **B** $\frac{1}{2} \times 0.030 \times 9.81 \times 0.10$

☒ **C** $\frac{1}{2} \times 0.030 \times 9.81 \times 0.050^2$

☒ **D** $\frac{1}{2} \times 0.030 \times 9.81 \times 0.050$

(Total for Question 5 = 1 mark)

6



A pendulum consists of an 18 N weight attached to a piece of string. The weight is released from the position shown in the diagram. The speed in m s^{-1} at the bottom of the swing is given by

☒ **A** $\sqrt{\dfrac{2 \times 9.81 \times 0.06}{18}}$

☒ **B** $\sqrt{9.81 \times 0.06}$

☒ **C** $\sqrt{2 \times 9.81 \times 0.06}$

☒ **D** $\sqrt{2 \times 9.81 \times 18 \times 0.06}$

(Total for Question 6 = 1 mark)

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7 A pump is positioned at the bottom of a well and it pumps 15 kg of water 25 m to the surface each minute.

The power of the pump is

☒ **A** 6.3 W

☒ **B** 61 W

☒ **C** 3700 W

☒ **D** 22 000 W

(Total for Question 7 = 1 mark)

8 A passenger in an airport pulls a suitcase at a constant speed with a force of 80 N at an angle of 65° to the horizontal.

(a) (i) Show that the horizontal component of the applied force is about 30 N.

(2)

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(ii) Hence calculate the work done on the suitcase in pulling it a distance of 320 m.

(2)

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Work done = ...

(iii) Show that the vertical component of the applied force is about 70 N.

(2)

(iv) State why no work is done in a vertical direction even though there is a component of the applied force in the vertical direction.

(1)

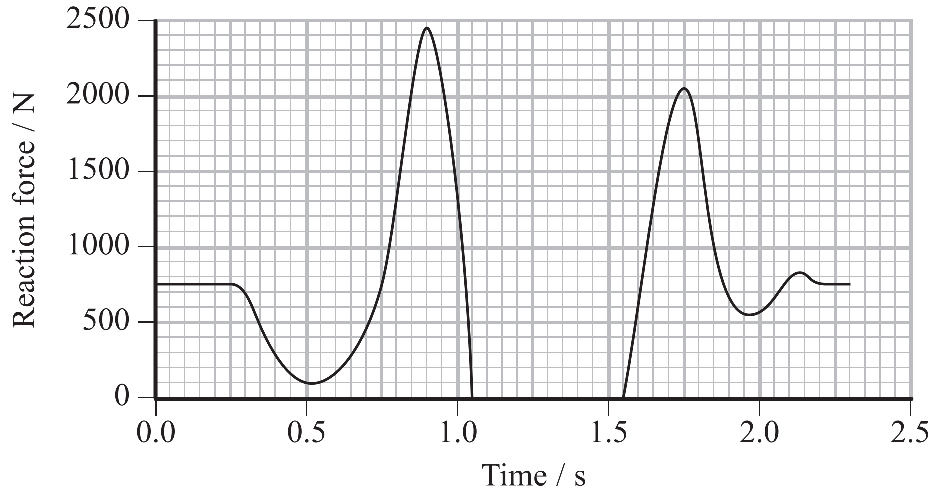
*(b) Explain how the magnitude and angle of the applied force must change in order to make the suitcase accelerate horizontally.

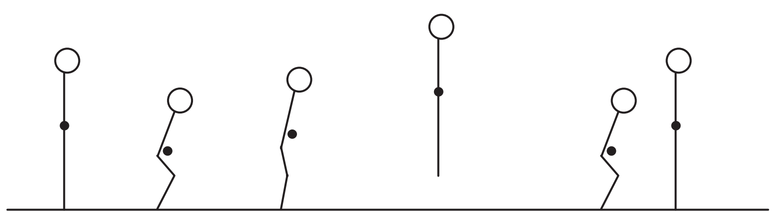
(4)

(Total for Question 8 = 11 marks)

9 An athlete bends his knees and then springs up into a vertical jump. The graph below shows how the reaction force from the ground on the athlete varies with time.

The diagram below the graph shows the position of the athlete at the corresponding times as he completes his jump.





(a) Show that the mass of the athlete is about 80 kg.

(2)

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(b) The small dot on each diagram of the athlete represents his centre of gravity.

(i) State what is meant by centre of gravity.

(1)

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(ii) Between 0.25 s and 0.75 s the athlete bends his knees. As a result of this, his centre of gravity moves lower.

Explain how the graph shows that an acceleration is produced as the athlete bends his knees.

(2)

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*(c) In order to jump, the athlete pushes down on the ground between 0.75 s and 1.05 s.

With reference to Newton's laws, explain why the athlete must push down on the ground.

(3)

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(d) The maximum reaction force was reached at $t = 0.9$ s. Calculate the acceleration of the athlete at this point.

(3)

Acceleration = ...

(e) The athlete was in the air for 0.50 s.

(i) Calculate the height jumped by the athlete.

(2)

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Height = ...

(ii) Calculate the speed of the athlete on leaving the ground.

(2)

....

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Speed = ...

(Total for Question 9 = 15 marks)

10 A water fountain in a lake is operated by an electric pump. The pump pushes water to a height of 5.5 m.

The manufacturers of the pump claim that the pump can move a mass of 22 000 kg of water per hour.

(a) Calculate the minimum power output of the pump.

(3)

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Minimum power output = ...

(b) Explain why the power output calculated in (a) is a minimum value.

(2)

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(Total for Question 10 = 5 marks)

11 The aim of a high jump event is to jump over a horizontal bar at the greatest possible height without knocking the bar off. The Fosbury flop and Straddle jump are two styles of jump that can be used by athletes in high jump events.

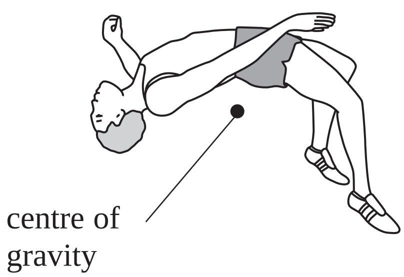
Fosbury flop

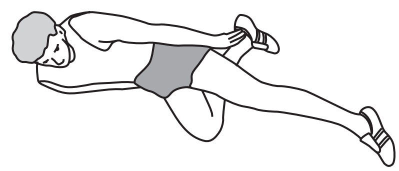
Straddle jump

(a) The diagrams below show the positions of the athletes as they pass over the bar. The approximate position of the centre of gravity of the athlete using the Fosbury flop has been drawn.

Mark the approximate position of the centre of gravity of the athlete using the Straddle jump.

(1)





*(b) Suggest, with an explanation, why most athletes prefer to use the Fosbury flop.

(3)

(Total for Question 11 = 4 marks)

12 An escape lane is an emergency area placed next to a steep, downhill section of a road. It allows vehicles with brake failure to slow down and stop away from the other traffic.

One type of escape lane uses a gravity ramp. These are built with an upwards gradient to slow the vehicle.

(a) Explain how using the ramp enables a vehicle to stop.

(2)

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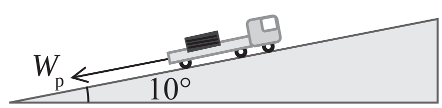
(b) An escape lane consists of a ramp at an angle of 10° to the horizontal and is 180 m in length. A lorry of mass 2.8×10^3 kg enters the escape lane due to brake failure.



(i) Show that the component of the weight of the lorry parallel to the ramp is about 5×10^3 N.

(3)

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(ii) The lorry uses the full length of the ramp while stopping and the frictional force of the road surface can be assumed to be negligible.

Calculate the maximum work done on the lorry bringing it to rest.

(2)

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Maximum work done on the lorry = ...

(iii) Calculate the maximum speed of the lorry so that it could be stopped by the ramp.

(2)

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Maximum speed of the lorry = ...

(c) Another type of escape lane uses a mechanical-arrestor system. This uses a series of steel nets set up along an escape lane to stop a vehicle. The nets are connected to the barriers at the sides of the escape lane using long steel strips that extend beyond their elastic limit as the vehicle slows down.

(i) State one advantage of building a mechanical-arrestor escape ramp compared to a gravity ramp.

(1)

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(ii) Suggest why it is necessary for the steel strips to extend beyond their elastic limit.

(2)

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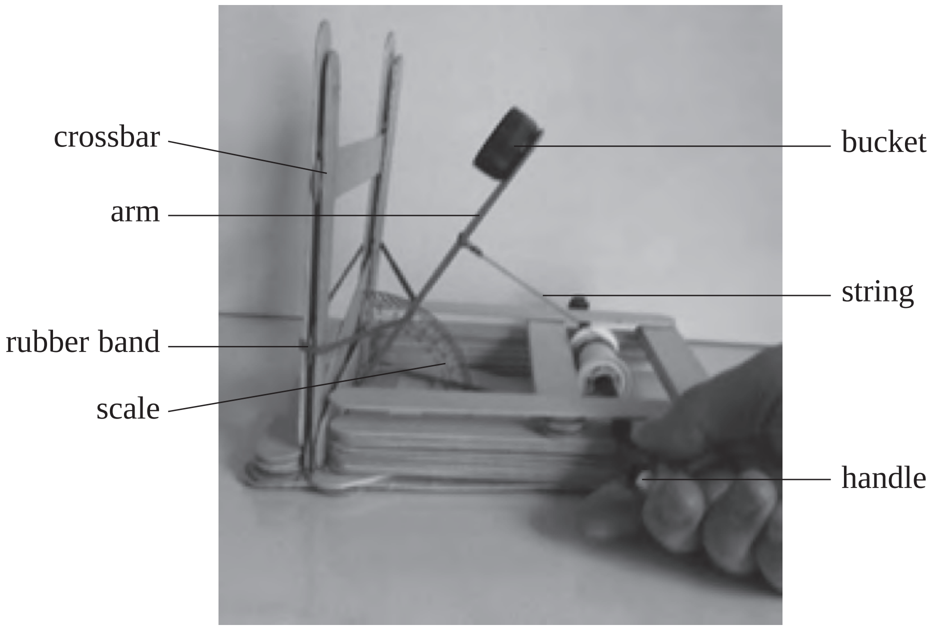
(Total for Question 12 = 12 marks)

13 A Mangonel is a type of catapult used to launch projectiles such as rocks. A student made a working model of a Mangonel.



As the handle is turned, the arm is pulled back by the string. This increases the tension in the rubber band. When the string is released, the rubber band causes the arm to move upwards, launching a projectile from the bucket when the arm hits the crossbar.

(a) (i) Suggest why a rubber band is used to support the arm.

(1)

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(ii) State the energy transfers that occur when the string is released.

(1)

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(b) The student varied the angle to the vertical at which the arm was released.
The range of the projectile was measured for each angle.

Release angle to the vertical / °	15	30	45	60
Mean range / m	0.14	0.58	0.95	1.70

*(i) Explain why the range increases as the angle increases.

(4)

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(ii) The student replaces the projectile with one of a smaller mass.

State why this increases the range of the projectile.

(1)

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(iii) Suggest one modification to the model that would also increase the range of the projectile. Give a reason for your answer.

(2)

Modification ....

....

Reason ....

....

(c) The student wishes to place a target in the path of the projectile. The height of the target is 5.0 cm. The projectile is released horizontally from a height of 13.0 cm.

(i) Show that the time taken for the projectile to fall to a height of 5.0 cm is about 0.1 s.

(2)

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(ii) When the arm was pulled back through an angle of 60°, the time taken for the projectile to travel 1.7 m horizontally was 0.16 s.

Calculate the minimum horizontal distance that the target should be placed from the model for the projectile to hit it.

(3)

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Minimum horizontal distance = ...

(Total for Question 13 = 14 marks)