

GCSE Physics (9 – 1)

Gravitational Potential Energy

Name:

Group:



Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.

For markers use	
Question	Mark
1	/6
2	/8
3	/6
4	/9
5	/11
6	/6
Total	/46
%	
Grade	

Information

- The maximum mark for this paper is 46 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. Gravitational potential energy is simply the energy an object has due to its height above the ground.

For each of the following questions **circle** the letter of the correct answer.

a) An object has a mass of 5 kg and a gravitational potential energy of 500 J.

If the gravitational field strength is 10 N/kg, at what height is the object located?

A

B

C

D

10 m

50 m

25 m

250 m

(1 mark)

b) If the height of an object is doubled while its mass remains constant, what happens to its gravitational potential energy?

A

B

C

D

It remains the same

It halves

It doubles

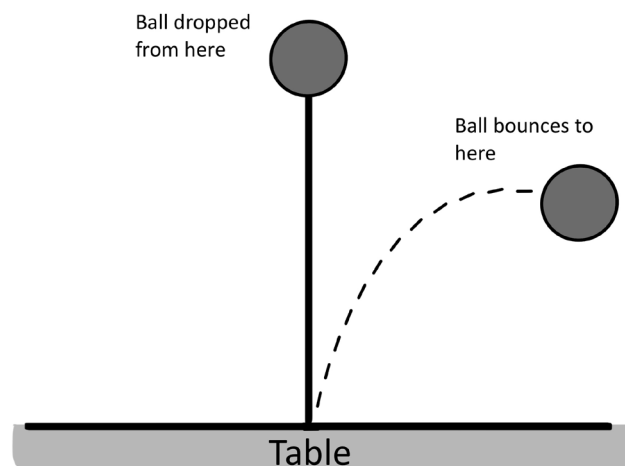
It quadruples

(1 mark)

c) A tennis ball is dropped from a height.

It hits the ground and bounces back up, but the maximum height of the bounce is lower than the starting height.

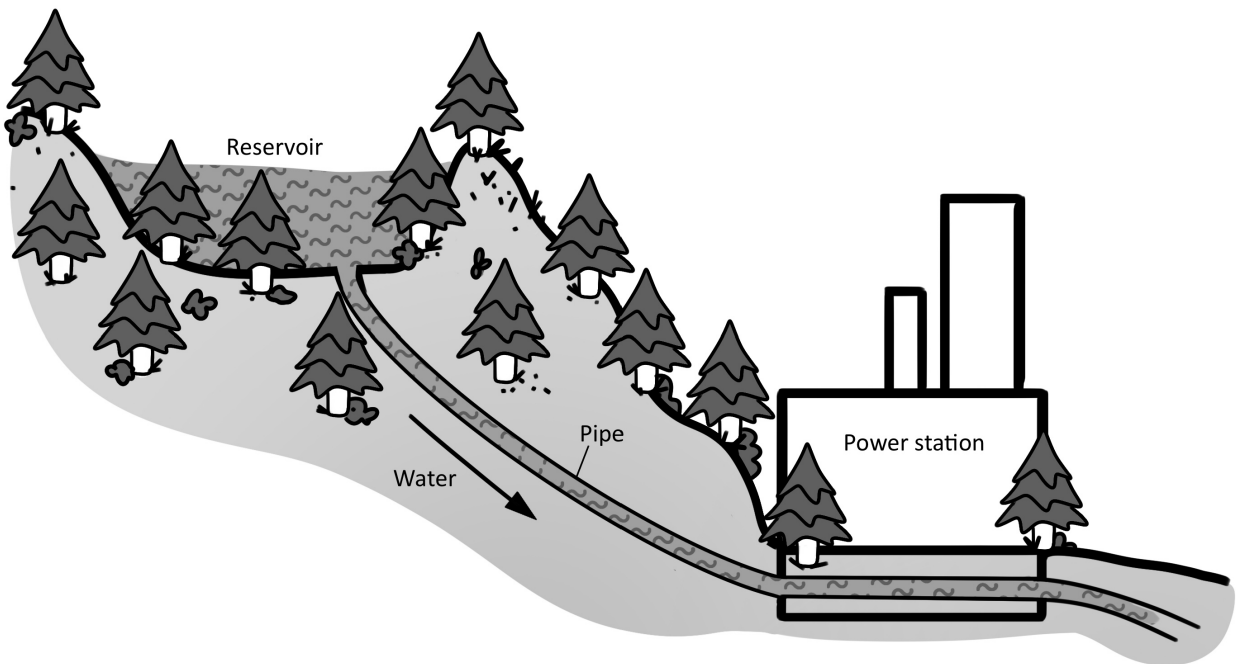
This means the ball has less gravitational potential energy at the top of the first bounce than it did at the start.



- A** The energy was destroyed by the impact with the ground.
- B** The energy is still there, but it is stored as kinetic energy at the top of the bounce.
- C** The energy was transferred to the thermal store of the ball and the surroundings.
- D** The energy was converted into chemical energy inside the tennis ball.

(1 mark)

d) The figure below shows a hydroelectric system in a hilly region.



As water moves through the system what are the main energy changes taking place?

- A electrical energy $\rightarrow$ gravitational energy $\rightarrow$ kinetic energy
- B chemical energy $\rightarrow$ kinetic energy $\rightarrow$ electrical energy
- C kinetic energy $\rightarrow$ electrical energy $\rightarrow$ gravitational energy
- D gravitational energy $\rightarrow$ kinetic energy $\rightarrow$ electrical energy

(1 mark)

e) A drone with a gravitational potential energy of 120 J is hovering at a height of 6 m. Assuming the gravitational field strength is 10 N/kg, what is the mass of the drone?



- | | | | |
|----------|----------|----------|----------|
| A | B | C | D |
| 0.5 kg | 2.0 kg | 20 kg | 7200 kg |

(1 mark)

f) A crane lifts a 500 kg steel beam from the ground to a height of 20 m. If the gravitational field strength is 10 N/kg, how much gravitational potential energy does the beam gain?

- | | | | |
|----------|----------|----------|------------|
| A | B | C | D |
| 10 kJ | 25 kJ | 100 kJ | 100,000 kJ |

(1 mark)

(Total for Question 1 is 6 marks)

2. Calculate the gravitational potential energy for each of the following questions.
Assume gravitational field strength (g) = 9.8 N/kg unless stated otherwise.

- a) A cat with a mass of 4 kg climbs a tree to a height of 3 m.
Calculate the gravitational potential energy gained by the cat.

Gravitational energy = ... J
(2 marks)

- b) A box of mass 0.5 kg is lifted 1.2 m onto a table.
Calculate the gravitational potential energy stored in the box.

Gravitational energy = ... J
(2 marks)

- c) An elevator lifts a person with a mass of 70 kg through a vertical height of 20 m.
Calculate the increase in gravitational potential energy.

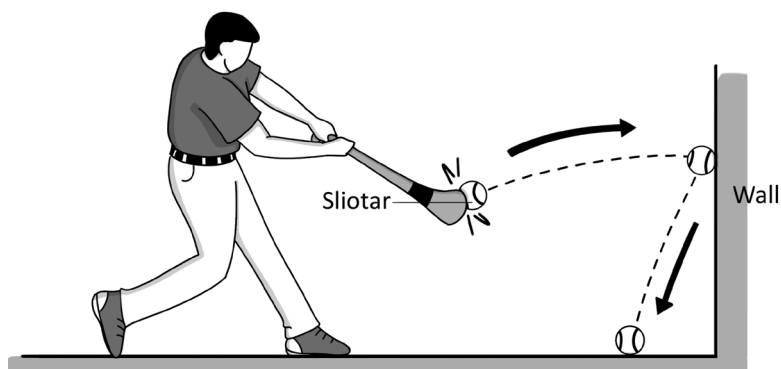
Gravitational energy = ... J
(2 marks)

- d) A 2500 kg roller coaster carriage is raised 40 m to the top of the first drop.
Calculate the gravitational potential energy gained.

Gravitational energy = ... J
(2 marks)

(Total for Question 2 is 8 marks)

3. The figure below shows a sliotar (ball) being hit against a wall.



- a) The ball gains 5.5 J of gravitational potential energy as it rises from the fielder's hand to its maximum height. The sliotar has a mass of 110 grams. Calculate the maximum height reached by the ball.

Gravitational field strength = 10 m/s^2

Use the equation:

$$\text{GPE} = m \times g \times \Delta h$$

Height = ... m
(3 marks)

- b) Calculate the kinetic energy of the sliotar when it is travelling at a velocity of 20 m/s.

Kinetic energy = ... J
(2 marks)

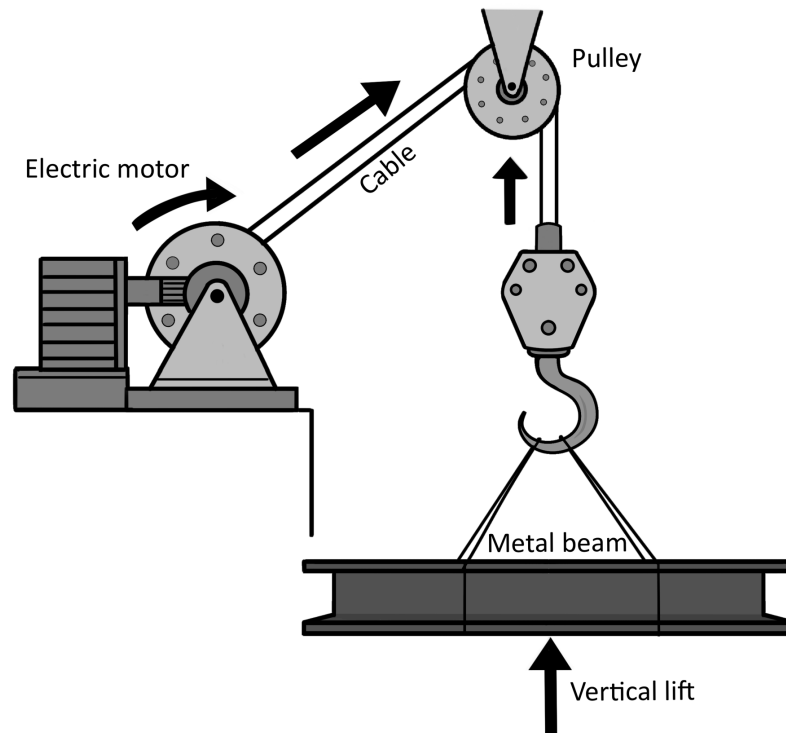
- c) The actual height reached by the ball is slightly less than the height calculated in part (a).
Suggest **one** reason why.

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(1 mark)

(Total for Question 3 is 6 marks)

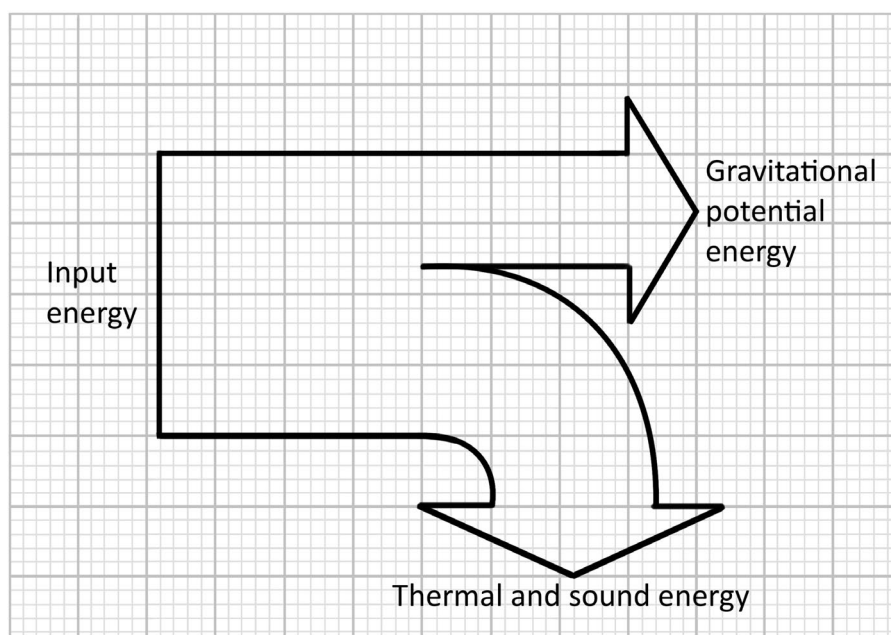
4. An electric motor is used to lift a metal beam vertically. The figure below shows the motor in action.



- a) The motor has a power rating of 2.5 kW. The motor runs for 4 seconds.
Calculate the total energy supplied to the motor in this time.

Energy Input = ... J
(2 marks)

- b) The figure shows a Sankey diagram representing the energy transfer of the motor.
The useful energy output is gravitational potential energy (GPE).
The wasted energy is transferred as sound and thermal energy.



Using your answer from part (a) and the Sankey diagram, calculate the value of the gravitational potential energy.

Gravitational potential energy = ... J
(2 marks)

- c) The metal beam has a mass of 85 kg.
Using the gravitational potential energy calculated in part (b), determine the height the beam was lifted. Gravitational field strength = 9.8 N/kg

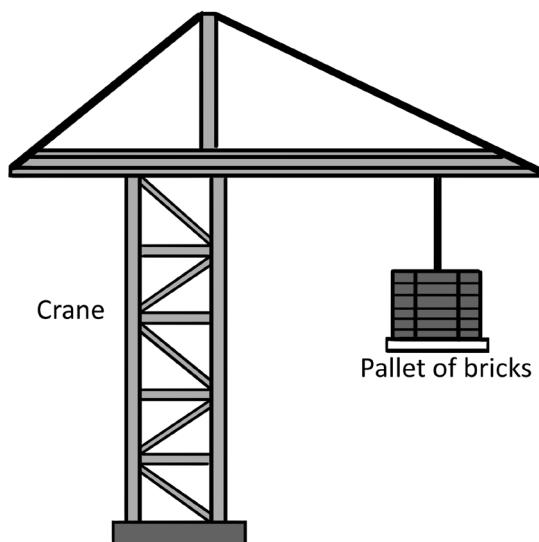
Height = ... m
(3 marks)

- d) The motor is very noisy when it lifts the beam.
Explain how the Sankey diagram above would change if the motor were lubricated and replaced with a quieter model.

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(2 marks)

(Total for Question 4 is 9 marks)

5. An electric crane is used on a building site to lift a pallet of bricks from the ground to the top of a wall. The figure below shows the crane lifting the pallet of bricks.



- a) State the **equation** linking gravitational potential energy, mass, gravitational field strength and height.

.....
(1 mark)

- b) The pallet of bricks has a mass of 150 kg.

Calculate the increase in gravitational potential energy when the crane lifts the pallet to a vertical height of 12 m. Assume gravitational field strength (g) = 9.8 N/kg.

Increase in gravitational potential energy = ...
(2 marks)

- c) It takes 24 seconds for the crane to lift the bricks to the top of the wall.

Calculate the useful power output of the motor during this lift.

Power = ... W
(2 marks)

- d) The electric motor is supplied with more power than you calculated in part (c).

Explain why the input power must be higher than the useful output power.

In your answer, refer to the law of conservation of energy.

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(2 marks)

e) Suggest **one** way the efficiency of the crane motor could be increased.

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(1 mark)

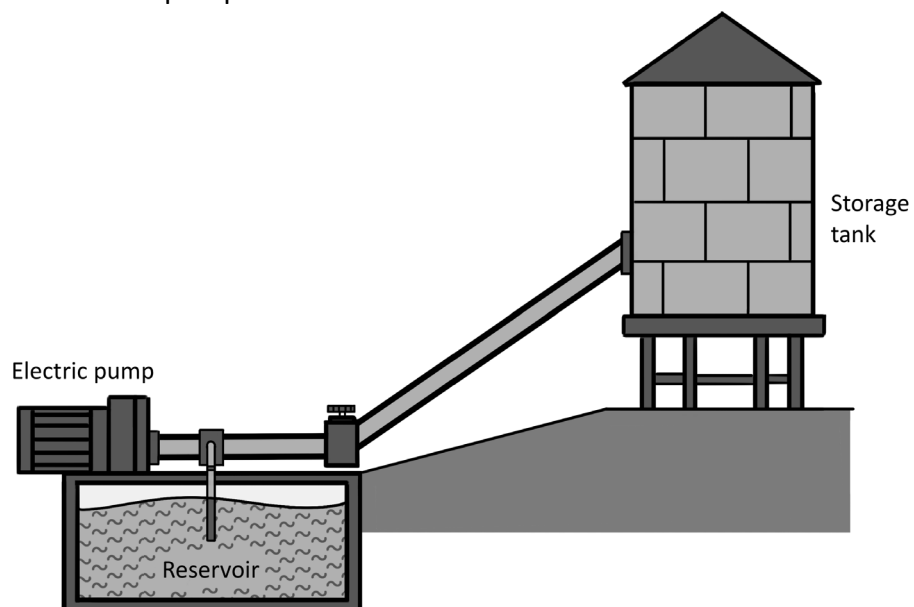
f) The crane motor operates at a constant power output.
Later in the day, the crane lifts a heavier load of 300 kg to the same height.
Explain how this increase in mass affects the time taken to lift the load.

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(3 marks)

(Total for Question 5 is 11 marks)

6. An electric water pump is used to raise water from a reservoir into a high storage tank. The figure below shows the pump and reservoir.



The pump is connected to a 230 V mains supply and draws a current of 8.0 A.
The pump runs for 2.5 minutes.

In this time, it pumps a volume of 1.8 m^3 of water. The pump has an efficiency of 72%.
Calculate the vertical height the water is lifted.

Gravitational field strength = 9.8 N/kg . Density of water = 1000 kg/m^3

Height = ... m
(6 marks)

(Total for Question 6 is 6 marks)