Pearson Edexcel

Additional Assessment Materials Summer 2021

Pearson Edexcel GCSE in Physics (1PH0) Foundation

Resource Set Topic B – Test 2: Energy and Forces doing work, Forces and their effects

Questions

(Public release version)

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Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

4 (a) (i) Which of these forces keeps the Moon moving around the Earth?

(1)

☒ **A** contact

☒ **B** electrostatic

☒ **C** gravitational

☒ **D** magnetic

(ii) Which of these is a scalar quantity?

(1)

☒ **A** velocity

☒ **B** momentum

☒ **C** energy

☒ **D** acceleration

(b) Figure 7 shows a box at rest on a floor.

The force that the floor exerts on the box is shown by the vector in Figure 7.

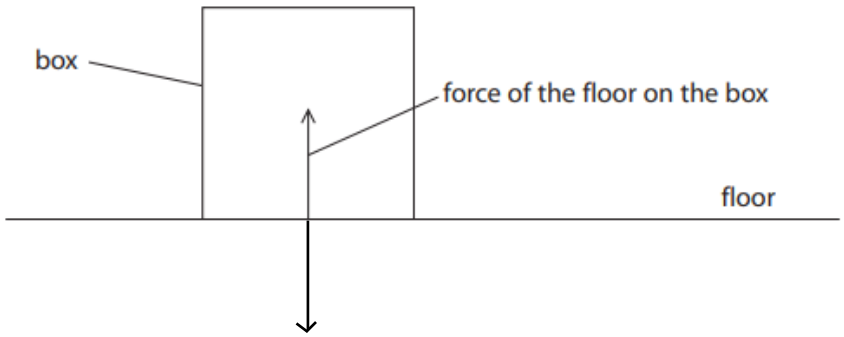


Figure 7

Add another vector to the diagram in Figure 7 to show the weight of the box.

(2)

(c) Figure 8 shows part of a cart.

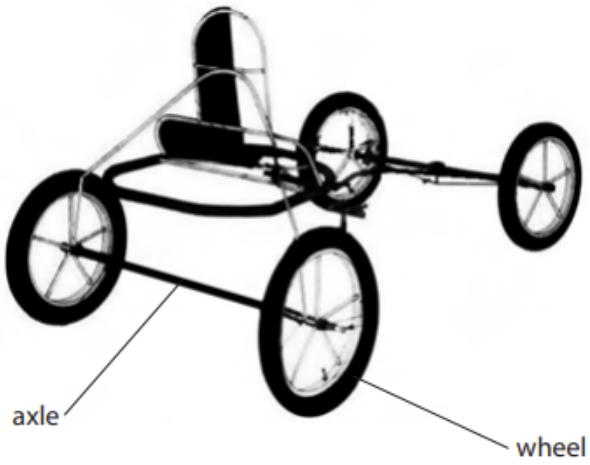


Figure 8

When the wheels turn the axles become warm.

(i) Explain why the axles become warm when the wheels turn.

(2)

As the wheels rotate, there is friction between the axle and the wheels causing a transfer of heat.

(ii) Give **one** way of reducing the heating of the axles when the wheels turn.

(1)

Lubricate the bearings

(d) (i) Complete the equation that relates efficiency, useful energy transferred by a device and total energy supplied to the device.

(1)

$$\text{efficiency} = \frac{\text{Useful energy transferred}}{\text{Total energy supplied}}$$

(ii) In one second an engine has a total energy input of 7500 J.

In one second 3200 J is transferred to the surroundings as wasted energy.

Calculate the useful energy transferred by the engine.

(1)

7500 - 3200

useful energy transferred = 4300 J

(iii) Calculate the efficiency of this engine.

(2)

$$\frac{4300}{7500} \times 100$$

efficiency of the engine = 57.3%

5 (a) (i) Figure 9 shows two gears.

Gear Q moves clockwise as shown by the arrow.

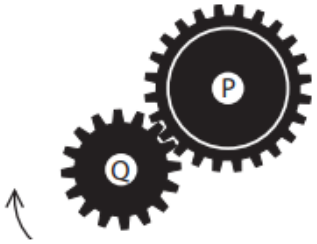


Figure 9

Which of these describes how gear P moves?

(1)

☒ **A** anticlockwise, slower than gear Q

☐ **B** anticlockwise, faster than gear Q

☐ **C** clockwise, slower than gear Q

☐ **D** clockwise, faster than gear Q

(ii) Figure 10 shows the number of teeth on the gears.

Gear P has 24 teeth, gear Q has 16 teeth.

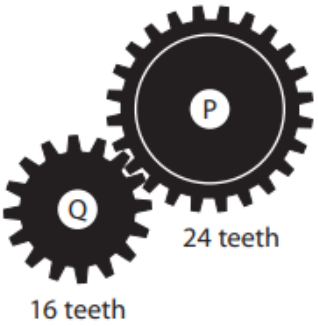


Figure 10

Which of these gives the ratio of the number of teeth on gear P to the number of teeth on gear Q?

(1)

☐ **A** 24 – 16

☐ **B** 16 + 24

☒ **C** 3 : 2

☐ **D** 2 : 3

(b) Figure 11 shows a lever used to lift a heavy load.

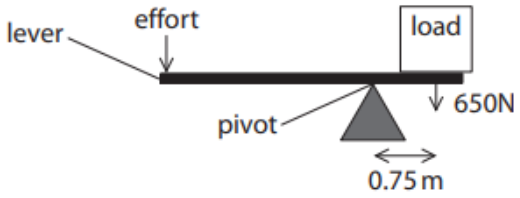


Figure 11

(i) The weight of the load is 650 N.
The centre of the load is 0.75 m from the pivot.

Calculate the moment of the load about the pivot.
State the unit.

Use the equation

moment = force × distance from the pivot

(3)

$= 650 \times 0.75$
$= 487.5 \approx 490$

moment = 490 unit Nm

(ii) State the principle of moments.

(1)

For an object to be in equillibrium, total clockwise moment and anti-clockwise moments should be equal.

(iii) An effort of 160 N is applied to the end of the lever to balance the load in Figure 11.

Calculate the distance between the effort and the pivot.

(3)

$490 = 160 \times d$

$d = \frac{490}{160}$

$= 3.0625$
≈ 3.1

distance = 3.1 m

9 A cyclist is riding a bicycle at a steady velocity of 12 m/s.

The cyclist and bicycle have a total mass of 68 kg.

(a) Calculate the kinetic energy of the cyclist and bicycle.

Use the equation

$$KE = \frac{1}{2} \times m \times v^2$$

(2)

$= \frac{1}{2} \times 68 \times (12)^2$

$= 4896 \approx 4900$

kinetic energy = 4900 J

(b) Describe the energy transfers that happen when the cyclist uses the brakes to stop.

(2)

The kinetic energy in the cycle is converted to thermal energy.

(c) The cyclist starts to cycle again.

The cyclist does 1600 J of useful work to travel 28 m.

Calculate the average force the cyclist exerts.

(3)

work done = force x distance

$1600 = F \times 28$

$F = \frac{1600}{28}$

$= 57.14$

≈ 57

average force = 57 N

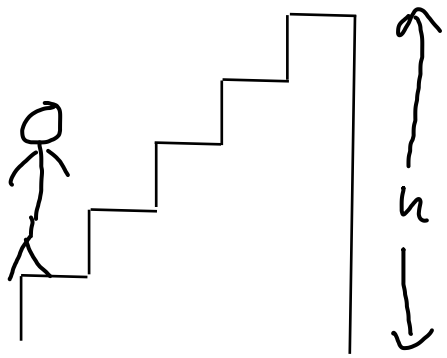
*(d) A class of students investigate the power output of each student in the class.

The class must decide whether they use a method using steps or a method using weights. The whole class must use the same method.

Plan what measurements the students should take and how these can be used to calculate and compare the power output of each student.

You may draw a diagram to help with your plan.

(6)



The time taken for students to run up a stair is used to calculate the power of the student. The vertical height of the stairs (h), mass of the student (m) and the time taken (t) for the student to run up the stairs is taken. The measurements are taken from a measuring tape, weighing scale and a stopwatch respectively. The work done by the student is taken as the gain in potential energy of the student and calculated by work done= m x g x h, where g is the gravitational acceleration constant (value=10). Power is calculated by taking the ratio of work done and the time taken by the student. The vertical distance travelled by each student should be kept the same to obtain a fair reading. A method using steps is used here.

8 (a) Which of these is the equation for work done?

(1)

- ☐ **A** work done = force ÷ distance moved in direction of force
- ☒ **B** work done = force × distance moved in direction of force
- ☐ **C** work done = force ÷ distance moved at right angles to direction of force
- ☐ **D** work done = force × distance moved at right angles to direction of force

(b) A ball has a mass of 0.046 kg.

(i) Calculate the change in gravitational potential energy when the ball is lifted through a vertical height of 2.05 m.

Use the equation

$$\Delta GPE = m \times g \times \Delta h$$

(2)

$= 0.046 \times 10 \times 2.05$

$= 0.943$

change in gravitational potential energy = 0.943 J

(ii) The ball is released.

Calculate the kinetic energy of the ball when the speed of the ball is 3.5 m/s.

(3)

$KE = \frac{1}{2} m v^2$

$= \frac{1}{2} \times 0.046 \times (3.5)^2$

$= 0.28175 \approx 0.282$

kinetic energy of the ball = 0.282 J

(iii) The ball bounces several times.

Figure 15 shows how the height of the ball above the floor changes with time.

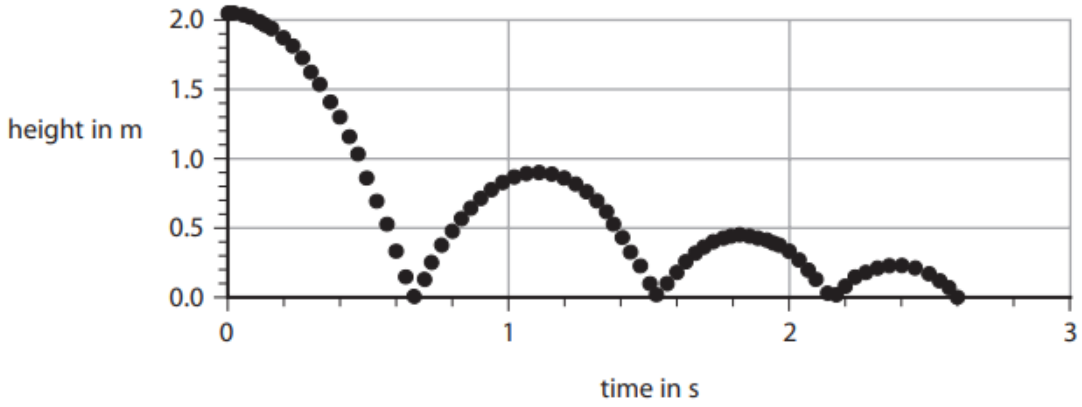


Figure 15

Use Figure 15 to estimate the maximum height that the ball reaches after the first bounce.

(1)

height after first bounce = 0.9 m

(iv) Explain why the ball does not bounce back to its starting height of 2.05 m.

(2)

Some of the energy is converted to heat and sound and lost from the total energy of the system.

10 (a) Figure 19 shows four forces, P, Q, R and S, acting on a rod.

The rod can rotate around an axle.

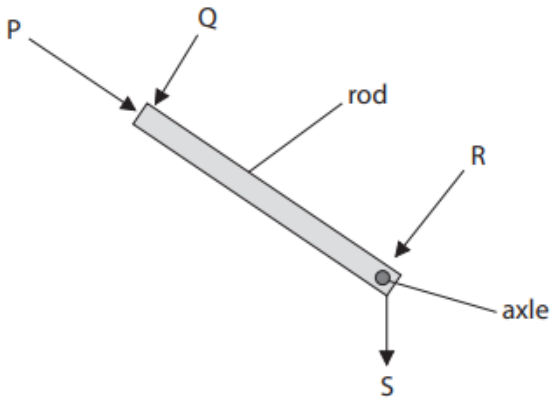


Figure 19

Which force will make the rod rotate about the axle?

(1)

☐ **A** P

☒ **B** Q

☐ **C** R

☐ **D** S

(b) Figure 20 shows a person trying to lift a large rock using a metal bar.

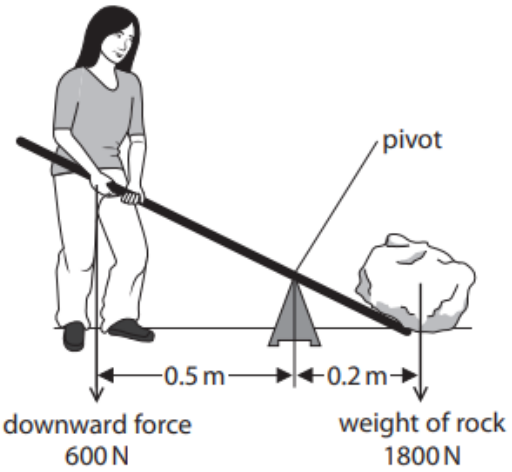


Figure 20

The rock weighs 1800 N.

The person can only produce a downwards force of 600 N.

The person cannot lift the rock.

(i) Explain, using calculations, why the person cannot lift the rock.

(3)

a) By rock

Moment Produced: $1800 \times 0.2 = 360\,Nm$

Force required: $F \times 0.5 = 360$ $F = 720\,N$

The rock produces a moment of 360Nm clockwise. In order for the person to lift the rock she has to produce a moment of 360Nm or more counter clockwise which requires a force of 720N. However, the person can only produce a force of 600N which is not sufficient to lift the rock.

(ii) Explain **one** change to the arrangement that will make it possible for this person to lift the rock.

(2)

Increase the distance between the person and the pivot keeping the distance between the rock and the pivot the same. Hence a lower force is enough to produce the required moment anticlockwise.

(c) Figure 21 shows a bicycle.

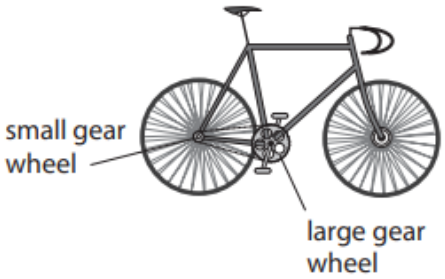


Figure 21

(i) The rider uses the pedals to make the large gear wheel turn.

The large gear wheel moves the chain.
The chain turns the small gear wheel.

The large gear wheel has 48 teeth.

The small gear wheel has 12 teeth.

The large gear wheel turns 2 times each second.

Calculate the number of times that the small gear wheel turns each second.

(2)

Teeth moved per second: $48 \times 2 = 96$

Small gear turns: $12x = 96$

$x = \frac{96}{12}$

8 turns each second

(ii) Oil is applied to the wheel of a bicycle at the point shown in Figure 22.

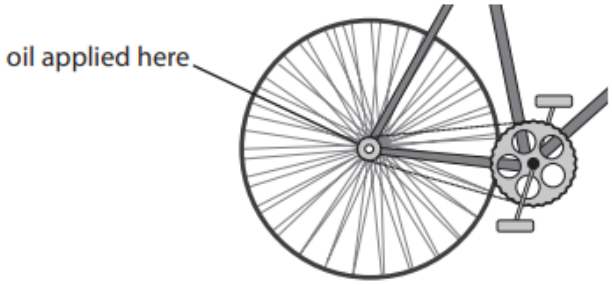


Figure 22

Explain how the oil improves the efficiency of the bicycle.

(3)

The oil acts as a lubricant and reduces the friction between the axle and the wheel. This reduces the energy loss as heat which allows more energy to be converted to kinetic energy. Thus, increases the efficiency of the bicycle.

3 (a) (i) Figure 6 shows two gears.

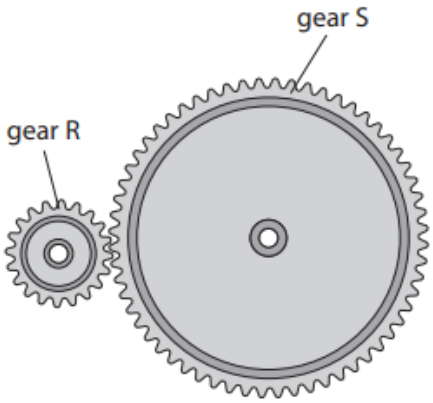


Figure 6

Gear R and gear S can rotate.

Gear R has 20 teeth.

Gear S has 60 teeth.

Gear S rotates through 2 complete revolutions.

Calculate how many complete revolutions gear R rotates by.

(2)

Teeth covered = $60 \times 2 = 120$

$120 = 20 \times x$

$x = \frac{120}{20}$

gear R has rotated through ..... 6 ..... revolutions

(ii) Figure 7 shows two gears, S and T.

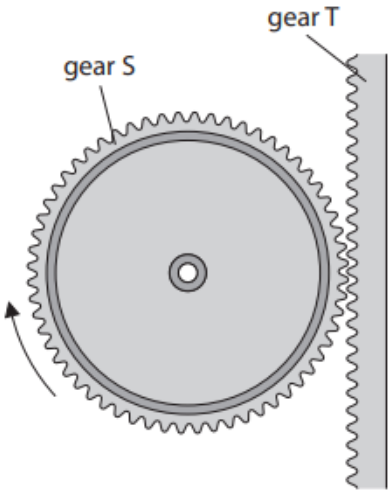


Figure 7

Gear S can rotate on a fixed axle.

Gear T can move up and down.

Gear S has 60 teeth.

The distance between each of the teeth on gear S and on gear T is 2 mm.

Gear S moves through one complete revolution in the direction shown.

Which of these describes the motion of gear T?

(1)

- ☐ **A** 60 mm up
- ☐ **B** 60 mm down
- ☐ **C** 120 mm up
- ☒ **D** 120 mm down

Teeth covered : 60

(b) (i) Figure 8 shows a force of 70 N turning a lever about point P.

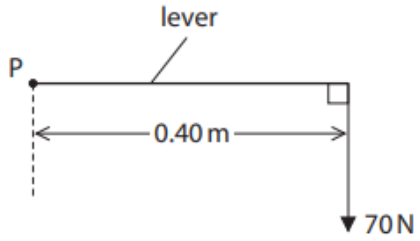


Figure 8

Calculate the moment of the 70 N force about point P.

State the unit.

Use the equation

moment = force × distance normal to the direction of the force

(3)

$= 70 \times 0.40$

moment = 28 unit Nm

(ii) Figure 9 shows a worker using a wheelbarrow to move some sand.

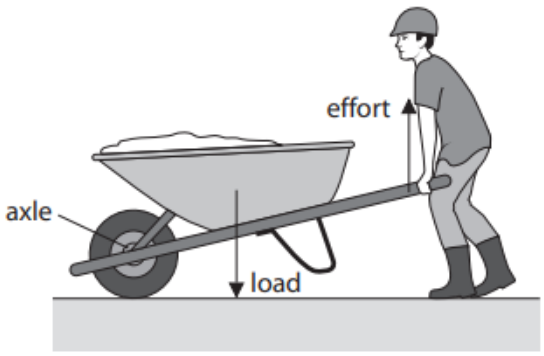


Figure 9

The load is equal to the total weight of the sand and the wheelbarrow.

The effort is the force that the worker applies to the wheelbarrow handles.

The worker applies just enough effort to lift the load.

Explain why the effort is smaller than the load.

(2)

The upward forces and the downward forces should be equal to just lift the load. The downward force is the weight of the load and upward forces are the effort and the normal contact force in the wheel by the ground. Hence, the effort required is less than the load.

(iii) Some sand falls down and sticks between the wheel and the axle.

State why it might be harder to push the wheelbarrow along when there is some sand between the wheel and the axle.

(1)

The friction at the point increases and causes more of the energy to be converted to heat and sound.

9 (a) Figure 23 shows a drone.

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Figure 23

The drone has four spinning blades.

The upward force produced enables the drone to rise in the air.

The speed at which the blades spin is measured in turns per minute.

Figure 24 shows how the upward force produced by the four blades depends on the speed at which the blades spin.

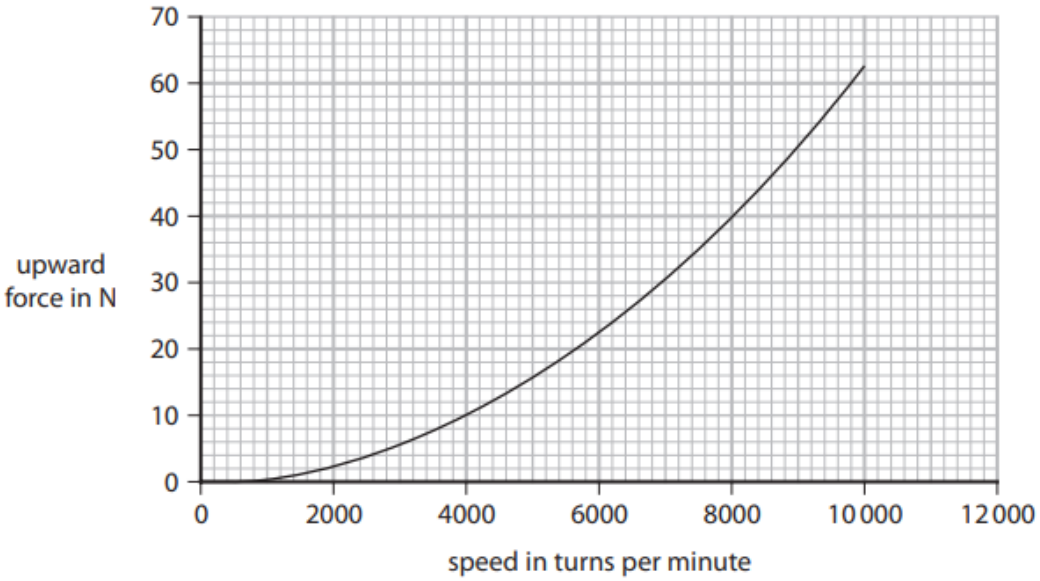

Figure 24

Describe the relationship between upward force and speed shown by this graph.

(2)

As the speed of the blades increases, the upward force increases. The force however, begins to come into effect after a minimum speed of 1000 turns per minute. The force also has an increasing gradient with the speed.

(b) A different drone has a mass of 4.5 kg.

This drone rises from the ground to a height of 20 m.

(i) Calculate the change in gravitational potential energy when the drone rises through a height of 20 m.

The gravitational field strength g = 10 N/kg.

(2)

$\Delta GPE = mgh$

$= 4.5 \times 10 \times 20$

change in gravitational potential energy = 900 J

(ii) State the amount of useful work done by the blades as the drone rises through 20 m.

(1)

useful work done = 900 J

(iii) It takes 4 s for the drone to rise through 20 m.

Calculate the useful power developed by the blades in this time of 4 s.

(2)

$P = \frac{Wd}{t}$

$= \frac{900}{4}$

useful power developed = 225 W

*(c) The blades on the drone are turned by electric motors.

The electric motors are powered by a battery.

Figure 25 represents the energy transfers involved when the drone rises from the ground.

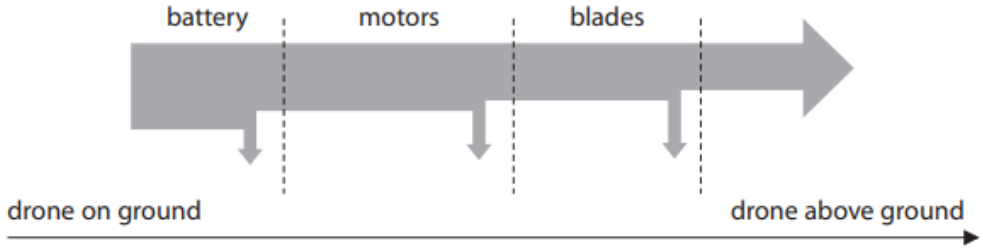

Figure 25

Describe the changes in the way energy is stored when the drone rises from the ground.

Your answer should refer to energy transfers.

(6)

The battery stores the energy as chemical energy. As electricity is provided to motors and the blades, energy is stored as kinetic energy. As the drone rises above the ground the energy is gradually stored as gravitational potential energy. Some energy is converted to sound and heat during the process. The kinetic energy in the blades is converted to kinetic energy in the air that is pushed downward from the blades causing the required lift.

TOTAL FOR PAPER IS 75 MARKS