Energy 3

Name: ______________________

Class: ______________________

Date: ______________________

Time: **55 minutes**

Marks: **50 marks**

Comments:

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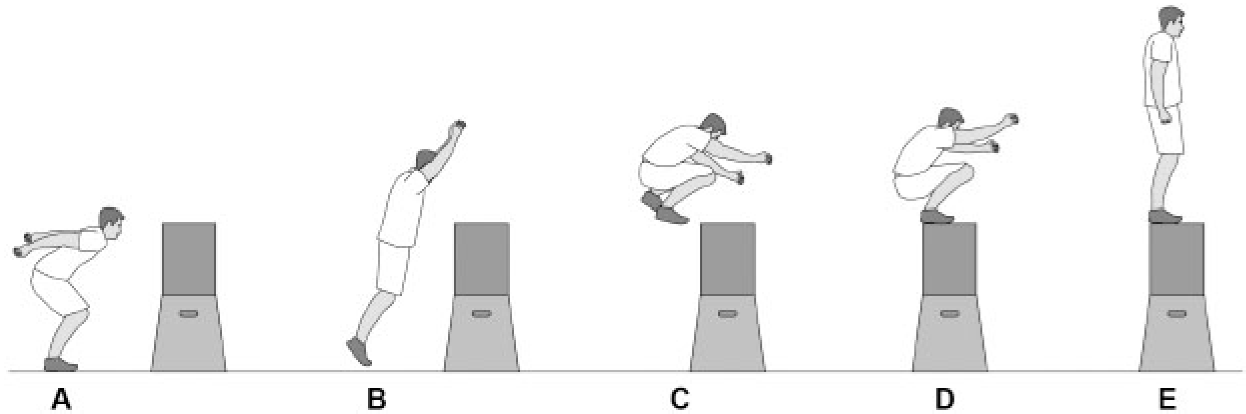
1. A person performs a 'vertical box jump'.

The figure below shows five different stages, **A**, **B**, **C**, **D** and **E**, of the jump.



(a) Complete the sentences.

Choose answers from the box.

A	**B**	**C**	**D**	**E**

The person has the least gravitational potential energy at stage __________.

The person has the greatest kinetic energy at stage __________.

(2)

(b) The person in the figure above has a mass of 60 kg.

The person leaves the ground with a speed of 5.5 m/s.

Calculate the kinetic energy of the person.

Use the equation:

$$\text{kinetic energy} = 0.5 \times \text{mass} \times (\text{speed})^2$$

____

____

____

Kinetic energy = ____________________ J

(2)

(c) The person has a mass of 60 kg.

The height of the jump is 1.5 m.

gravitational field strength = 9.8 N/kg

Calculate the gravitational potential energy of the person at a height of 1.5 m.

Use the equation:

gravitational potential energy = mass × gravitational field strength × height

____

____

____

Gravitational potential energy = ____________________ J

(2)

(d) The person jumps onto a box higher than the one in the figure above.

To jump onto a higher box, the person’s speed when leaving the ground is different.

Explain how the speed is different when jumping onto a higher box.

You should answer in terms of gravitational potential energy and kinetic energy.

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(3)

(e) Suggest **one** reason why a person is more likely to be injured when falling off a higher box.

____

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(1)

(Total 10 marks)

2. Fossil fuels are burned in car engines and in power stations.

(a) Describe how different energy stores change in a car engine when a fossil fuel is burned.

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____

(2)

(b) Some car engines burn a fuel that is produced using plants.

Name a fuel produced using plants.

____

(1)

(c) Some cars do **not** contain an engine that burns a fuel.

Suggest how cars that do **not** burn a fuel are powered.

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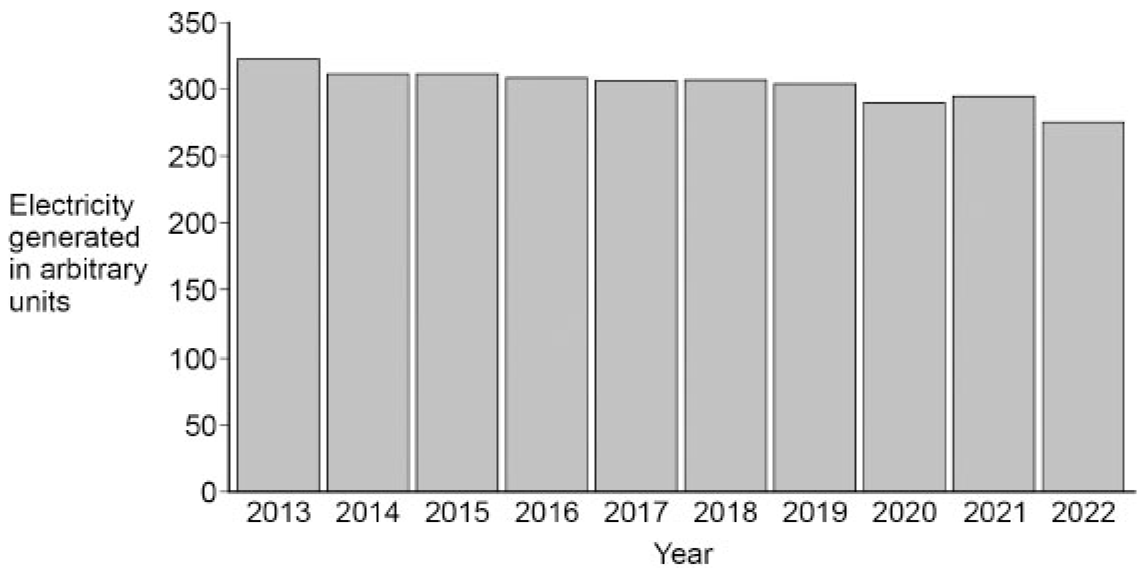
(1)

The figure below shows how the total amount of electricity generated in the UK has changed with time.



(d) The proportion of electricity that is generated using renewable energy resources has increased since the year 2013.

Which conclusion is correct?

Use the figure above.

Tick (✓) **one** box.

The amount of fossil fuel that is burned to generate electricity each year has decreased.	☐
The concentration of carbon dioxide in the atmosphere has decreased.	☐
The rate of increase of the mean temperature of the atmosphere has decreased.	☐

(1)

(e) The UK plans to stop burning fossil fuels to generate electricity.

Explain **one** reason why it will take many years before all electricity is generated using renewable resources.

____

____

____

____

(2)

(f) Renewable energy resources can have a negative impact on the environment.

Give **one** negative environmental impact of hydro-electric power and of wind power.

Hydro-electric power ____

____

Wind power ____

____

(2)

(Total 9 marks)

3. A student investigated the specific heat capacity of aluminium.

The student used an electric heater to increase the temperature of an aluminium block.

The student measured the:

- mass of the block
- energy transferred to the block
- temperature change of the block.

The table below shows the results.

Mass in kilograms	0.75
Energy transferred in joules	13 800
Temperature change in °C	20

(a) Calculate the specific heat capacity of aluminium.

Use the Physics Equations Sheet.

____

____

____

____

____

Specific heat capacity = ____________________ J/kg °C

(3)

(b) Describe a method the student could have used to obtain the results in the table above.

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(6)

(c) Wrapping the aluminium block in insulation makes the value for the specific heat capacity of aluminium more accurate.

Which are **two** reasons why?

Tick (✓) **two** boxes.

The amount of wasted energy is less.	☐
The energy transferred to the aluminium block is greater.	☐
The insulation heats the aluminium block.	☐
The power of the electric heater increases.	☐
The temperature increase of the aluminium block is greater.	☐

(2)

(Total 11 marks)

4. The figure below shows an outdoor swimming pool.

The water in the swimming pool comes from the sea.

The water in the pool is heated using a geothermal energy resource.

(a) Which of the following describes a geothermal energy resource?

Tick (✓) **one** box.

A non-renewable energy resource with high carbon emissions. ☐

A non-renewable energy resource with low running costs. ☐

A renewable energy resource that uses hot rocks underground. ☐

A renewable energy resource that uses the tides. ☐

(1)

(b) 15 kg of seawater is heated before it is added to the pool.

specific heat capacity of seawater = 3800 J/kg °C

Calculate the change in thermal energy of 15 kg of seawater when its temperature is increased by 9.0 °C.

Use the equation:

change in thermal energy = mass × specific heat capacity × temperature change

____

____

____

Change in thermal energy = ____________________ J

(2)

(c) The energy transferred from 1.0 m^2 of the surface of the pool to the air is 80 J each second.

The surface area of the pool is 120 m^2.

Calculate the energy transferred from the whole surface of the pool to the air each second.

____

____

Energy transferred each second = ____________________ J

(1)

(d) Which of the following units is the same as 1 J/s?

Tick (✓) **one** box.

1 N ☐

1 Pa ☐

1 W ☐

(1)

(e) The pool is above sea level.

5.0 kg of water is pumped from sea level into the pool.

The water gains 196 J of gravitational potential energy.

gravitational field strength = 9.8 N/kg

Calculate the height of the pool above sea level.

Use the equation:

$$\text{height} = \frac{\text{gravitational potential energy}}{\text{mass} \times \text{gravitational field strength}}$$

___

___

___

Height = ____________________ m

(2)

(f) The water in some swimming pools is heated by burning fossil fuels.

Explain **one** environmental **disadvantage** of burning fossil fuels.

___

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___

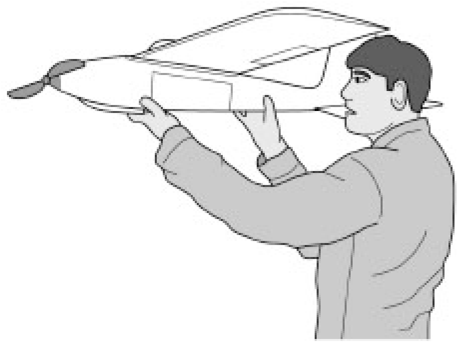
(2)
(Total 9 marks)

5. A drone is a miniature aircraft that has a remote control.

An inventor designed a battery powered drone.

The inventor tested what would happen if the battery runs out of charge during a flight.

Figure 5 shows the inventor about to launch the drone.



(a) After the drone was launched, it moved at a constant speed and gained height.

The thermal stores of energy of the drone increased.

Describe **two** other changes to the energy stores of the drone as it moved at a constant speed and gained height.

1 ____

____

2 ____

____

(2)

When the drone reached a height of 840 m the motor was switched off.

The motor was switched back on after a short time, when the drone had fallen to a lower height above the ground.

The change in gravitational potential energy of the drone during the fall to this lower height was 3920 J.

The mass of the drone is 2.5 kg.

gravitational field strength = 9.8 N/kg

(b) Calculate the height above the ground of the drone when the motor was switched back on.

Use the Physics Equations Sheet.

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____

____

____

Height above ground = ____________________ m

(4)

(c) When the motor was switched off, the kinetic energy of the drone was 150 J.

Calculate the maximum possible speed of the drone when the motor was switched back on.

Use the Physics Equations Sheet.

Give your answer in km/s.

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____

____

____

____

____

____

Maximum possible speed of drone = ____________________ km/s

(5)

(Total 11 marks)

Mark schemes

1. (a) **A**

must be in this order

1

B

1

(b) $E_k = 0.5 \times 60 \times 5.5^2$

1

$E_k = 907.5$ (J)

allow 908 (J) or 910 (J)

1

(c) $E_p = 60 \times 9.8 \times 1.5$

1

$E_p = 882$ (J)

allow 880 (J)

1

(d) gravitational potential energy (on the box) is greater

1

so the kinetic energy (leaving the ground) is greater

1

(so must leave the ground at a) greater speed

1

(e) greater velocity / speed (when hitting the ground)
or
greater force (exerted by the ground)

1

[10]

2. (a) any **two** from

- chemical store (of the fuel) decreases
- thermal store (of engine / gases / surroundings) increases
- kinetic energy (of the engine / car) increases

2

(b) biofuel

allow a named biofuel

allow biogas

allow wood

ignore fossil fuels

1

(c) (by a) battery
or
(by) electricity

allow (by an) electric motor

1

(d) the amount of fossil fuel that is burned to generate electricity each year has decreased

1

(e) many generators are required
or
lots of resources are required

allow named device such as wind turbines for generators

ignore unreliable

1

so it is expensive

*if no other mark awarded allow **1** mark for lack of political will*

1

(f) *hydro-electric power*

loss of habitat

1

wind power

negative visual impact

allow dangerous for birds

allow noise pollution

1

[9]

3. (a) $13\,800 = 0.75 \times c \times 20$

1

$c = \frac{13\,800}{0.75 \times 20}$

1

$c = 920$ (J/kg °C)

1

(b) **Level 3:** The method would lead to the production of a valid outcome. The key steps are identified and logically sequenced.

5-6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3-4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1-2

No relevant content

0

Indicative content

Mass

- use a top pan balance to measure mass of block

Energy transfer

- use a joulemeter to measure energy transferred to block
- connect heater to a joulemeter
- measure initial energy and switch on
- switch off and measure final energy
- calculate the difference between initial and final energy

- use an ammeter, voltmeter and stopwatch
- calculate energy transferred

Temperature change

- use a thermometer to measure temperature of block
- measure the initial temperature
- measure the final temperature
- calculate the difference between initial and final temperature

for **Level 3** answers must describe all three measurements

(c) the amount of wasted energy is less

1

the temperature increase of the aluminium block is greater

1

[11]

4. (a) a renewable energy resource that uses hot rocks underground

1

(b) $\Delta E = 15 \times 3800 \times 9.0$

1

513 000 (J)

1

(c) 9600 (J)

1

(d) 1 W

1

(e)

$$\text{height} = \frac{196}{5.0 \times 9.8}$$

1

4 (m)

allow 4.0 (m)

1

(f) **EITHER**

releases carbon dioxide

ignore references to pollution

1

which contributes to global warming

allow climate change for global warming
allow which is a greenhouse gas
allow which contributes to the greenhouse effect

OR

releases sulfur / nitrogen dioxide (1)

allow other oxides of nitrogen

which causes acid rain (1)

OR

releases soot (1)

allow carbon for soot
allow particulates

which can cause global dimming (1)

allow reduces air quality
allow causes smog

1

[9]

5. (a) chemical store of energy decreases

1

gravitational potential energy of the drone increases

1

(b) $3920 = 2.5 \times 9.8 \times \Delta h$

1

$$\Delta h = \frac{3920}{2.5 \times 9.8}$$

1

$\Delta h = 160$ (m)

1

(840 - 160) = 680 (m)

allow an answer consistent with their calculated value of Δh using the correct equation

OR

Initial $E_p = 2.5 \times 9.8 \times 840$ (1)

allow initial $E_p = 20580$

Final E_p(= 20580 - 3920)
= 16660 (1)

allow correct use of an incorrectly calculated value of E_p using the gravitational potential energy equation

$$h = \frac{16660}{2.5 \times 9.8} \text{ (1)}$$

allow a correct substitution and rearrangement using their calculated value of E_p using the gravitational potential energy equation

= 680 (m) (1)

allow an answer consistent with their calculated value of E_p using the gravitational potential energy equation

1

(c) max E_k = 3920 + 150 (= 4070 J)

allow max E_k = 4070 J

1

4070 = 0.5 × 2.5 × v^2

allow a substitution using their value for kinetic energy

1

$$v = \sqrt{\frac{4070}{0.5 \times 2.5}}$$

allow a correct re-arrangement using their value for kinetic energy

allow $v^2 = \frac{4070}{0.5 \times 2.5}$

1

v = 57.06... (m/s)

allow v = 57 (m/s)

1

v = 0.057... (km/s)

allow an answer consistent with their calculated value for v using the kinetic energy equation

1

[11]