Energy 1

Name: _____

Class: _____

Date: _____

Time: **85 minutes**

Marks: **79 marks**

Comments:

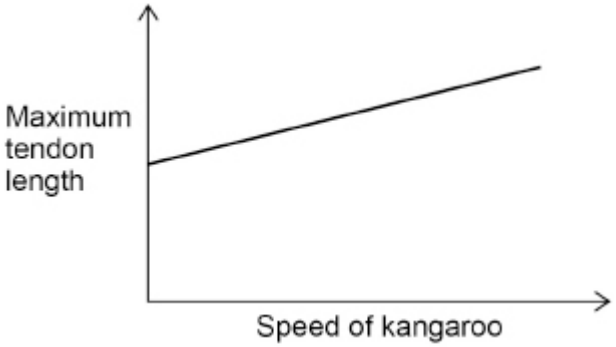
1. Kangaroos are large animals that travel by jumping.

The photograph below shows a kangaroo.

Each leg of a kangaroo has a tendon connected to a muscle. Each tendon can be modelled as a spring.

When a jumping kangaroo lands on the ground, the tendons stretch.

(a) The diagram below shows a sketch graph of how the maximum tendon length during a jump changes with the speed of the kangaroo.



Explain why a kangaroo can jump higher as its speed increases.

(3)

(b) A kangaroo has a maximum gravitational potential energy during one jump of 770 J

When the kangaroo lands on the ground 14% of the maximum gravitational potential energy is transferred to elastic potential energy in one tendon.

The tendon has an unstretched length of 35.0 cm

When the kangaroo lands on the ground the tendon stretches to a length of 42.0 cm

Calculate the spring constant of the tendon.

Spring constant = _____ N/m

(5)

(Total 8 marks)

2. A student investigated how the area of a solar panel affected the output potential difference of the solar panel.

The student placed different sized solar panels under a lamp.

The photograph shows a solar panel under a lamp.

(a) Which variable should be controlled?

Tick (✓) **one** box.

The area of the solar panels ☐

The brightness of the lamp ☐

The output potential difference of the solar panels ☐

(1)

(b) The student measured the output potential difference using a voltmeter.

When the voltmeter was **not** connected, the reading on the voltmeter was 0.7 V

What name is given to this type of error?

Tick (✓) **one** box.

Zero error ☐

Random error ☐

Measurement error ☐

(1)

The table shows the results of the investigation.

Solar panel	**Area of solar panel in cm^2**	**Output potential difference in volts**			
		Test 1	Test 2	Test 3	Mean
A	10	2.5	2.4	2.6	2.5
B	20	5.0	5.0	4.9	5.0
C	30	7.5	11.9	7.5	7.5
D	50	12.4	12.6	12.5	12.5

(c) The readings for which solar panel show an anomalous result?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(d) The student did **not** have a solar panel with an area of 40 cm^2

Determine the most likely value for the mean output potential difference of a 40 cm^2 solar cell.

_____

_____

Mean output potential difference = _____ V

(1)

(e) The total input energy transfer to one of the solar panels was 8.0 joules.

The useful output energy transfer was 0.96 joules.

Calculate the efficiency of the solar panel.

Use the equation:

$$\text{efficiency} = \frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$$

_____

_____

_____

_____

Efficiency = _____

(2)

(f) Solar power is a renewable energy resource.

Complete the sentence.

Choose the answer from the box.

burned	**replenished**	**consumed**

A renewable energy resource is one that is _____ as it is used.

(1)

(g) Some homes have solar panels which generate electricity.

On a sunny day the potential difference across a solar panel is 31 volts.

A charge of 490 coulombs flows through the solar panel.

Calculate the energy transferred by the solar panel.

Use the equation:

energy transferred = charge flow × potential difference

Give your answer to 2 significant figures.

_____

_____

_____

_____

Energy transferred = _____ J

(3)

(h) Why do solar panels on homes help reduce the environmental impact of using electrical devices?

Tick (✓) **one** box.

Less electricity is used in the home. ☐

Less fossil fuel is burned. ☐

The electricity from the solar panels is cheaper. ☐

(1)

(Total 11 marks)

3. The photograph shows a toaster.

The toaster is connected to the mains supply using a three-core cable.

(a) What is the function of the earth wire inside the cable?

Tick (✓) **one** box.

To carry the current from the supply to the toaster ☐

To complete the circuit in the toaster ☐

To melt if a fault occurs inside the toaster ☐

To stop the metal case of the toaster becoming live if a fault occurs ☐

(1)

(b) Complete the sentences.

Choose answers from the box.

blue	**brown**	**orange**	**white**	**yellow**

The insulation around the earth wire is green and _____ .

The insulation around the live wire is _____ .

The insulation around the neutral wire is _____ .

(3)

(c) The toaster is switched on for 120 seconds.

The power of the toaster is 850 watts.

Calculate the energy transferred by the toaster.

Use the equation:

energy transferred = power × time

_____

_____

_____

Energy transferred = _____ J

(2)

(d) Complete the sentences.

Choose answers from the box.

chemical	**elastic potential**	**kinetic**	**thermal**

When bread is lowered into the toaster, a spring is stretched. The stretched spring stores _____ energy.

After the bread is toasted, the spring makes the toast move upwards. As the speed of the toast increases, the _____ energy of the toast increases.

(2)

(e) Write the equation which links gravitational field strength, gravitational potential energy, height and mass.

_____

_____

(1)

(f) The toast was moved upwards by the spring.

The change in gravitational potential energy of the toast was 0.049 J

The mass of the toast was 0.050 kg

gravitational field strength = 9.8 N/kg

Calculate the change in height of the toast.

_____

_____

_____

_____

_____

_____

Change in height = _____ m

(3)

(Total 12 marks)

4. There are many different energy resources.

(a) Which **two** energy resources are renewable?

Tick **two** boxes.

Biofuel	☐
Coal	☐
Gas	☐
Geothermal	☐
Nuclear fuel	☐

(2)

(b) Some non-renewable energy resources are more reliable than others.

Which statement correctly describes a reliable resource?

Tick **one** box.

It does not burn fuel. ☐

It is predictable. ☐

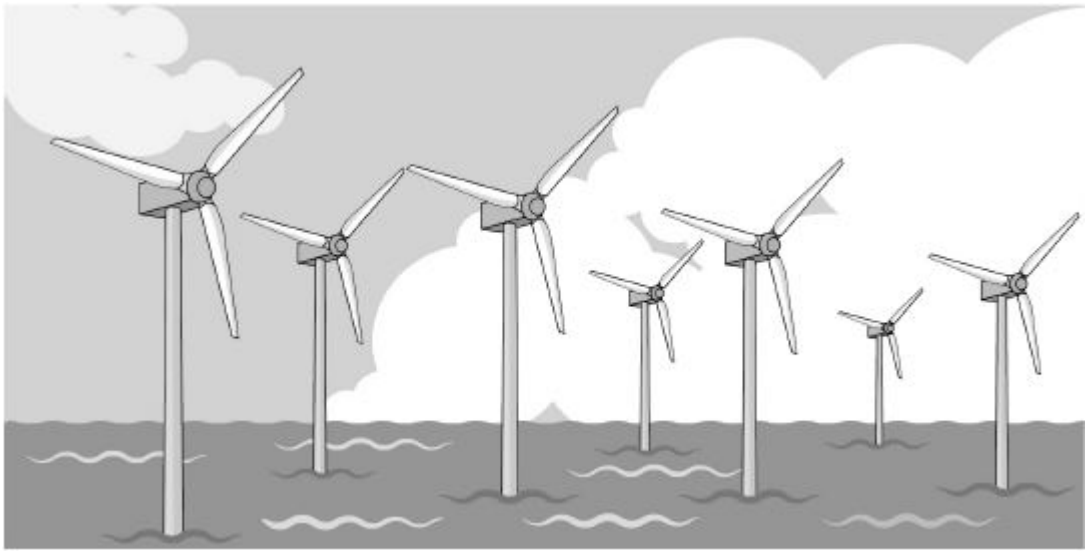
It will never run out. ☐

It is cheap to use. ☐

(1)

(c) **Figure 1** shows a wind farm.

Figure 1



The total power output of the wind farm is 19.6 MW

All of the wind turbines have the same power output.

What is the power output of **one** wind turbine?

Tick **one** box.

2.7 MW ☐

2.8 MW ☐

2.9 MW ☐

3.2 MW ☐

3.3 MW ☐

(1)

(d) Give **two** reasons why people might **not** like having wind turbines near their homes.

1. _____

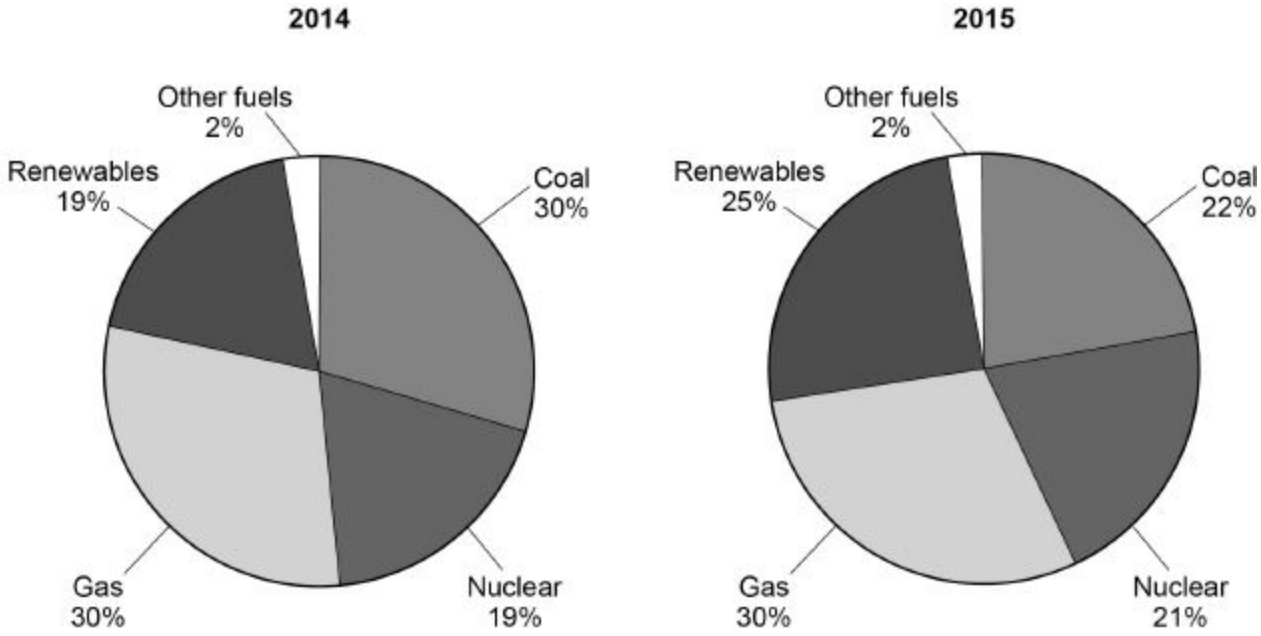
2. _____

(2)

(e) **Figure 2** shows the electricity generated by different energy resources in the UK.

The total amount of electricity generated was the same in 2014 and in 2015

Figure 2



There are changes in the amounts of different energy resources used between 2014 and 2015

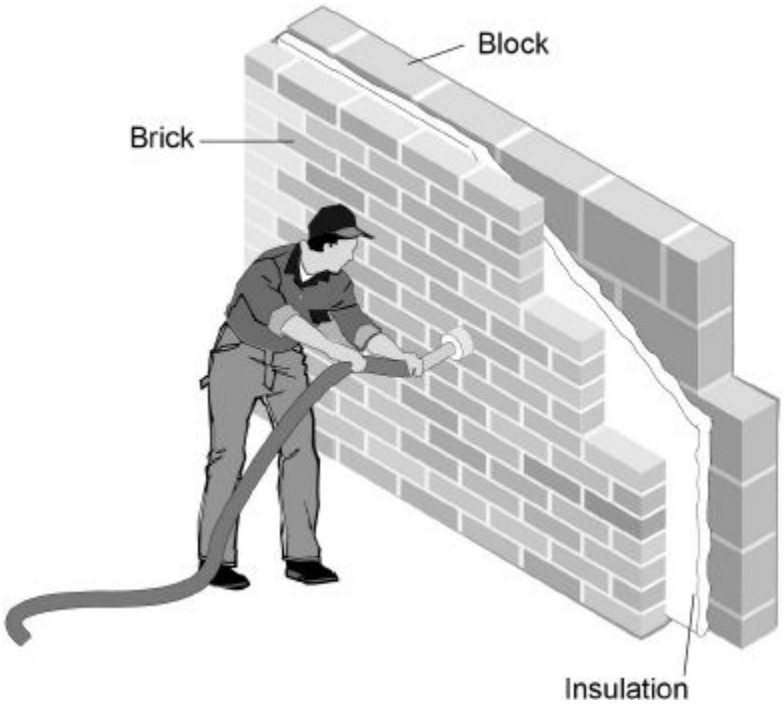
Explain the environmental impacts of the changes.

(4)

(Total 10 marks)

5. **Figure 1** shows cavity wall insulation being installed in the wall of a house.

Figure 1



(a) Explain how the wall reduces unwanted energy transfers.

_____

_____

_____

_____

_____

_____

(3)

(b) The cavity insulation was tested.

- The heating inside the house was switched off.
- The temperature inside the house was measured every 20 minutes for 2 hours.

The table below shows the results.

Time in minutes	Temperature in °C
0	25.0
20	20.8
40	17.4
60	14.5
80	12.1
100	10.0
120	8.4

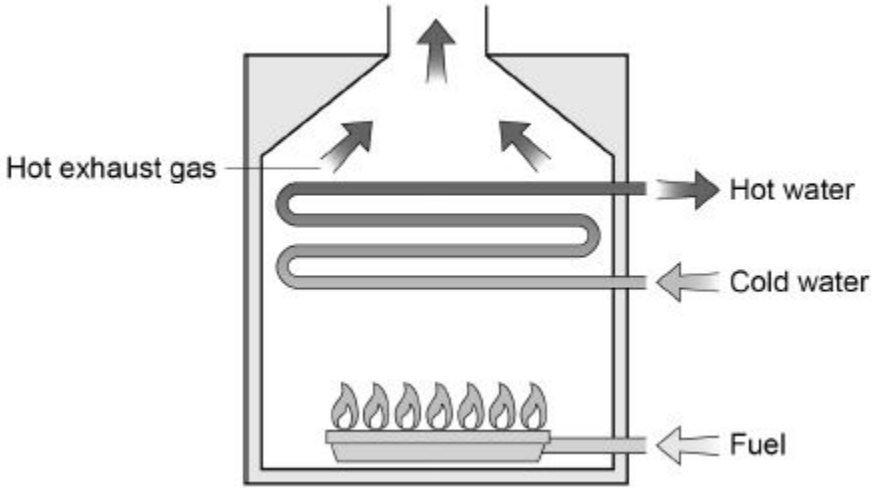
Determine the temperature inside the house after 30 minutes.

Temperature = _____ °C

(2)

(c) **Figure 2** shows the gas boiler used to heat the house.

Figure 2



Describe how different energy stores are changed by the boiler.

_____

_____

_____

_____

(3)

(d) To heat the house, the boiler transfers 15 MJ of energy in 10 minutes.

Calculate the power of the boiler.

Write any equation that you use.

_____

_____

_____

Power = _____ W

(4)

(Total 12 marks)

6. **Figure 1** shows a student making potato soup.

Figure 1

(a) The student places 0.5 kg of potato into a pan of water.

During cooking, the temperature of the potato increases from 20 °C to 100 °C

The specific heat capacity of the potato is 3400 J/kg °C

Calculate the change in thermal energy of the potato.

Use the equation:

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

Change in thermal energy = _____ J

(3)

(b) Why is the energy supplied by the cooker greater than that calculated in part (a)?

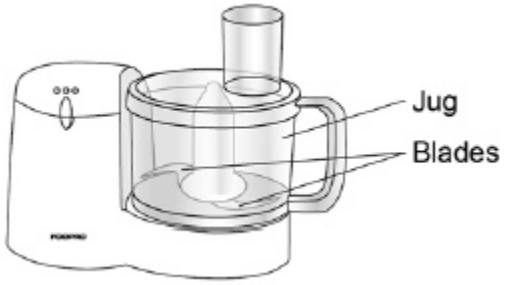
(1)

(c) Suggest **one** way that the student could reduce the time to heat the potato to 100 °C

(1)

Figure 2 shows a food processor.

Figure 2



(d) The student places the cooked potato into the jug of the food processor.

The food processor contains a motor that spins blades to chop the potato.

The total power input to the motor is 500 W

The useful power output from the motor is 300 W

Calculate the efficiency of the motor in the food processor.

Use the equation:

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

Efficiency = _____

(2)

(e) The jug is made of plastic with a low thermal conductivity.

Explain why this is an advantage.

(2)

(Total 9 marks)

7. On 7th June 2017 more than 50% of the electricity generated in the UK was from renewable sources.

(a) Suggest **two** environmental conditions in the UK on 7th June 2017.

1. _____

_____

2. _____

_____

(2)

(b) At midday 35.4 GW of electricity was generated.

20.8% of this was provided by gas-fired power plants.

Calculate the energy per second that was provided by gas-fired power stations.

_____

_____

_____

Energy per second = _____ J

(3)

(c) Some of the electricity generated was from low-carbon sources.

Low-carbon sources emit very little carbon dioxide.

Name **one** non-renewable resource that is a low-carbon source.

_____

(1)

(d) In the UK, electricity is delivered to consumers by the National Grid.

Explain the main features of the National Grid.

(6)

(e) The National Grid supplied a house with 18 000 000 J of energy in 1 hour.

What was the average current supplied to the house during that hour?

Write any equations that you use.

Current = _____ A

(5)

(Total 17 marks)

1.

(a) the (maximum tendon) extension increases (as speed increases)

allow the tendons stretch more (as speed increases)

1

so the elastic potential energy increases

allow so the (elastic) force increases

1

which is transferred to gravitational potential energy

1

(b) $E = 770 \times 0.14$

allow E = 107.8 (J)

1

extension = 0.070m

1

$107.8 = 0.5 \times k \times 0.070^2$

this mark may be awarded if extension is incorrectly/not converted and/or if the efficiency equation has not been applied

1

$k = 2 \times \frac{107.8}{0.070^2}$

this mark may be awarded if extension is incorrectly/not converted and/or if the efficiency equation has not been applied

1

k = 44 000 (N/m)

this mark may be awarded if extension is incorrectly/not converted

this mark may not be awarded if the efficiency equation has not been applied

1

[8]

2.

(a) the brightness of the lamp

1

(b) zero error

1

(c) C

1

(d) 10.0

allow 10

1

(e) $\frac{0.96}{8.0}$

1

= 0.12

allow 12%

1

*an answer of 0.12 or 12% scores **2** marks*

(f) replenished

1

(g)

*an answer of 15 000 (J) scores **3** marks*

E = 490 × 31

1

E = 15 190

allow 15 200 if correct substitution is seen

1

E = 15 000 (J)

allow an answer to 2 s.f. consistent with their calculated value of E using E=QV

1

(h) less fossil fuel is burned

1

[11]

3. (a) to stop the metal case of the toaster becoming live if a fault occurs

1

(b) yellow

1

brown

1

blue

1

(c) E = 850 × 120

1

E = 102 000 (J)

1

*an answer of 102 000 (J) scores **2** marks*

(d) elastic potential

1

kinetic

1

(e) gravitational potential energy = mass × gravitational field strength × height

or

$E_p = m\ g\ h$

allow gpe

1

allow any correct re-arrangement

(f) $0.049 = 0.050 \times 9.8 \times h$

1

$$h = \frac{0.049}{0.050 \times 9.8}$$

1

$h = 0.10$ (m)

1

*an answer of 0.10 (m) scores **3** marks*

[12]

4. (a) biofuel

1

geothermal

1

(b) it is predictable

1

(c) 2.8 MW

1

(d) any **two** from:

- visual pollution
- noise pollution
- dangerous to birds
- may lower house prices

2

(e) **Level 2:** Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- less fossil fuel burnt
- more nuclear fuel used
- more renewables used
- gas remained the same
- less carbon dioxide released
- less greenhouse gases
- less global warming
- less acid rain
- less environmental pollution
- more hazardous waste produced (nuclear)
- the percentage generated by coal has decreased 8%
- the percentage generated by renewables has increased by 6%
- the percentage generated by nuclear has increased by 2%

[10]

5. (a) the wall has two / three layers

allow the wall is thick

1

cavity wall insulation / brick / block has a low thermal conductivity

1

so less energy is transferred by conduction

allow rate of energy transfer is lower

ignore any reference to convection and / or radiation

1

(b)

$$T = 17.4 + \left(\frac{(20.8 - 17.4)}{2}\right)$$

or

$$T = 20.8 + \left(\frac{(20.8 - 17.4)}{2}\right)$$

1

T = 19.1 (°C)

1

an answer in the range 18.5−19.1 scores **2** marks

(c) chemical energy store of the fuel decreases

1

thermal energy store of the water increases

allow kinetic energy store of the water particles increases

1

thermal energy store of the air / atmosphere increases

allow kinetic energy store of the air particles increases

1

(d) E = 15 000 000 (J)

1

t = 600 (s)

1

$$p = \frac{15\,000\,000}{600}$$

allow a correct substitution of incorrectly / not converted values of E and / or t

1

P = 25 000 (W)

allow a correct calculation using incorrectly / not converted values of E and / or t

1

[12]

6. (a) 80 °C

1

ΔE = 0.5 × 3400 × 80

1

ΔE = 136 000 (J)

*an answer of 136 000 (J) scores **3** marks*

1

(b) energy is dissipated into the surroundings

allow any correct description of wasted energy

1

(c) put a lid on the pan

allow any sensible practical suggestion

eg add salt to the water

1

(d) efficiency = 300/500

1

efficiency = 0.6

*an answer of 0.6 or 60% scores **2** marks*

allow efficiency = 60%

*an answer of 0.6 with a unit scores **1** mark*

*an answer of 60 without a unit scores **1** mark*

1

(e) lower rate of energy transfer

1

(so) potato soup will remain at a higher temperature

1

[9]

7. (a) very little cloud cover

allow high intensity sunlight

1

favourable wind speed

allow high wind speed

1

(b) 35.4×10^9

allow 35 400 000 000

1

$E = 35.4 \times 10^9 \times (20.8 / 100)$

1

$E = 7.4 \times 10^9$(J)

*an answer of 7.4×10^9(J) or 7 400 000 000 scores **3** marks*

allow 7 400 000 000

1

(c) nuclear

1

(d)

Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	4-6
Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear	3-4
Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1-2
No relevant content	0
Indicative content **step up transformer** • increases the potential difference • decreases the current • reduces heating of transmission cables • less wasted energy • more efficient energy transfer **transmission cables** • low resistance • reduces heating • reduces wasted energy **step down transformer** • increases the current • decreases the potential difference • to a safe level • the level is suitable for domestic appliances	

6

(e) P = E / t

P = 18 000 000 / 3 600

1

P = 5 000

1

P =I V

I = P / V

1

I = 5 000 / 230

1

I = 22 (A)

allow an answer that rounds to 22 (A)

*an answer of 22 (A) scores **5** marks*

1

[17]