

Energy 5

Name: _____

Class: _____

Date: _____

Time: **54 minutes**

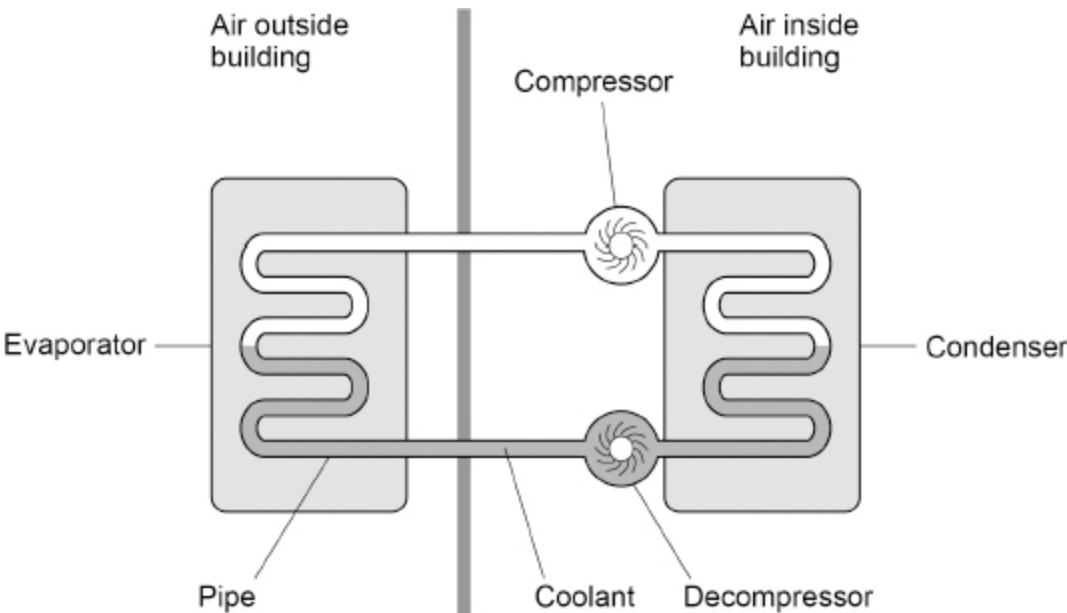
Marks: **50 marks**

Comments:

1.

An air source heat pump transfers energy from the air outside a building to increase the temperature of the air inside the building.

The figure below shows an air source heat pump.



The compressor is connected to the mains electricity supply.

The pipe in the heat pump contains a substance called coolant.

In the evaporator, energy is transferred from the air outside the building to the liquid coolant.

The temperature of the coolant increases and it evaporates.

(a) Explain what happens to the internal energy of the coolant as its temperature increases.

(2)

(b) What name is given to the energy needed to change the state of the liquid coolant?

(1)

(c) What happens to the mass of the coolant as it evaporates and becomes a vapour?

Tick (✓) **one** box.

Decreases

Stays the same

Increases

(1)

(d) The compressor increases the density and temperature of the coolant vapour inside the pipe.

Explain why the pressure in the pipe increases.

(2)

- (f) The air in the building gains 400 J for every 100 J of energy transferred from the mains electricity supply to the compressor.

An advertisement claims that the heat pump system has an efficiency of 400%.

Explain why the advertisement is **not** correct.

(3)
(Total 15 marks)

2.

The photograph below shows a sailing boat crossing an ocean.



There is a wind turbine on the boat.

- (a) The wind turbine generates electricity to charge a battery on the boat.

Name one **other** renewable energy resource that could be used on the boat to generate electricity.

(1)

(b) The boat also has a generator that burns a fossil fuel.

The battery can be charged by either the wind turbine **or** the generator.

Give **two** reasons why this is useful.

1 _____

2 _____

(2)

(c) Explain **one** environmental impact of using fossil fuels to generate electricity.

(2)

(d) The kinetic energy of the boat is 81 kJ.

mass of boat = 8000 kg

Calculate the speed of the boat.

Speed = _____ m/s

(4)

- (e) As the boat passes over a wave, the gravitational potential energy of the boat increases by 19 600 J.

mass of boat = 8000 kg

gravitational field strength = 9.8 N/kg

Calculate the change in height of the centre of mass of the boat as it passes over the wave.

Change in height = _____ m

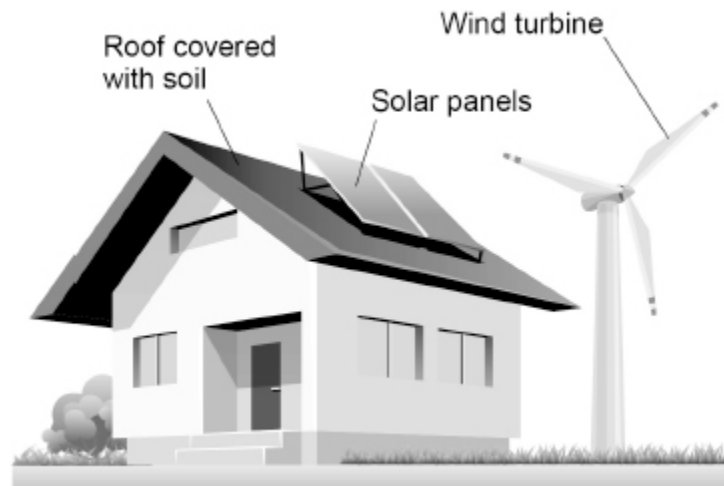
(3)

(Total 12 marks)

3.

An eco-house is designed to be environmentally friendly.

The diagram below shows a picture of an eco-house.



(a) The solar panels and a wind turbine are used to generate electricity for the eco-house.

Solar and wind are both renewable energy resources.

What does renewable energy resource mean?

Tick (✓) **one** box.

It can be replenished as it is used.

It is unreliable.

It has no fuel costs.

It produces no greenhouse gases.

(1)

(b) Biomass, nuclear and natural gas are three other energy resources.

Complete the table to show whether each energy resource is renewable or non-renewable.

Tick (✓) **one** box for **each** energy resource.

| Energy resource | Renewable | Non-renewable |
|-----------------|-----------|---------------|
| Biomass | | |
| Nuclear | | |
| Natural gas | | |

(2)

(c) Moving air makes the wind turbine spin.

The wind turbine generates electricity which is used to charge a battery.

Complete the sentences.

Choose answers from the box.

| | | | |
|-----------------|-------------------|----------------------|----------------|
| chemical | electrical | gravitational | kinetic |
|-----------------|-------------------|----------------------|----------------|

When the wind turbine spins faster there is an increase in its _____ energy.

Charging the battery increases the _____ store of energy of the battery.

(2)

(d) The roof of the eco-house is covered with soil.

Covering the roof with soil decreases the thermal conductivity of the roof.

What are the advantages of having a roof with a lower thermal conductivity?

Tick (✓) **two** boxes.

Less energy is needed to heat the house.

The rate of energy transfer by conduction is greater.

The roof is a better insulator.

The roof is less likely to leak.

Weather will have a greater effect on the temperature of the house.

(2)

- (e) The average power transferred to the solar panels by sunlight is 26 000 W
Calculate the average energy transferred to the solar panels in 30 seconds.

Use the equation:

$$\text{energy transferred} = \text{power} \times \text{time}$$

$$\text{Average energy transferred to solar panels} = \text{_____ J}$$

(2)

- (f) Write down the equation that links efficiency, total power input and useful power output.

(1)

- (g) The solar panels on the roof of the eco-house have an efficiency of 0.15

The average power input to the solar panels is 26 000 W

Calculate the average useful power output from the solar panels.

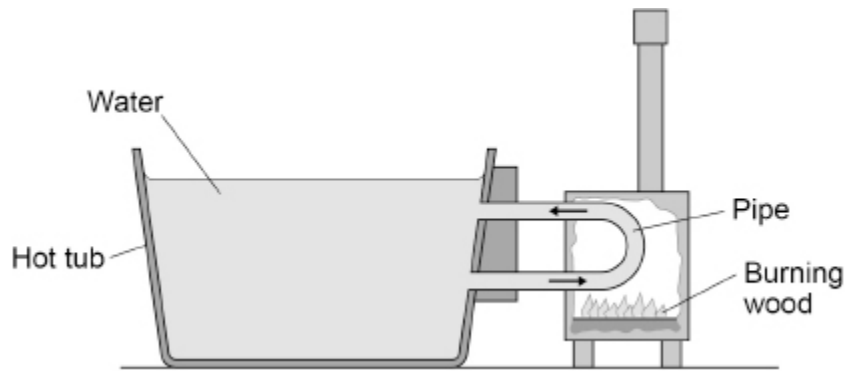
$$\text{Average useful power output} = \text{_____ W}$$

(3)

(h) Explain why it is a good idea for the eco-house to have both a wind turbine and solar panels.

(2)
(Total 15 marks)

4. The diagram below shows a wood-fired hot tub.



(a) What type of fuel is wood?

Tick (✓) **one** box.

- A non-renewable biofuel
- A non-renewable fossil fuel
- A renewable biofuel
- A renewable fossil fuel

(1)

(b) Give **two** environmental effects of using wood as an energy resource.

1. _____

2. _____

(2)

(c) Describe the change to the stores of energy of the wood, pipe and water as the water is heated.

Wood _____

Pipe _____

Water _____

(3)

(d) The temperature of the water reaches 42 °C

The temperature then stays constant even though the fire continues to burn.

Explain why the temperature of the water stays constant.

(2)

(Total 8 marks)

Mark schemes

1.

(a) the kinetic energy (and the potential energy) of the particles increases

allow the speed of the particles increases

1

so the internal energy increases because it is the sum of kinetic and potential energy
(of the particles)

1

(b) latent heat (of vaporisation)

allow specific latent heat (of vaporisation)

1

(c) stays the same

1

(d) more collisions per second

1

a greater force per collision

1

(e) $0.875 = \frac{\text{useful output energy transfer}}{1\,560\,000}$
allow a correct substitution using incorrectly/not converted values of efficiency and/or energy

1

useful output energy transfer = 1 365 000(J)

this answer only

the equation

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

must have been used to score subsequent marks

1

$1\,365\,000 = 125 \times c \times (22.1 - 11.6)$

allow a correct substitution using their calculated value of useful output energy

1

$c = \frac{1\,365\,000}{125 \times 10.5}$

allow a correct re-arrangement using their value of useful output energy

1

$c = 1040 \text{ (J/kg } ^\circ\text{C)}$

allow a correct calculation using with their value of useful output energy

1

$c = 1.04 \times 10^3 \text{ (J/kg } ^\circ\text{C)}$

this mark can only be awarded for a calculation using the correct equations

1

(f) the advertisement has ignored the energy input from the surrounding air

1

so the total energy input is greater than the energy supplied from the electricity

an answer that the total energy input comes from the electricity supply and the air outside the building gains the first two marking points

1

the efficiency must be less than 100%

1

[15]

2.

(a) solar

allow biofuel / biodiesel allow wave power

1

(b) sometimes there is no wind (but the battery can still be charged using the generator)

allow if the generator breaks then the turbine can still generate electricity

1

when there is wind less fuel is burned

allow a disadvantage of burning fossil fuel

1

(c) carbon dioxide

1

increases global warming

OR

sulfur dioxide or NO_x emissions (1)

increases acid rain (1)

OR

particulates or NO_x emissions (1)

can harm living organisms (1)

allow increases the greenhouse effect

1

(d) 81 kJ = 81 000 J

1

$$81000 = 0.5 \times 8000 \times v^2$$

allow a correct substitution using an incorrectly/not converted value of energy

1

$$v = \sqrt{\frac{81000}{0.5 \times 8000}}$$

allow a correct re-arrangement using an incorrectly/not converted value of energy

1

$$v = 4.5 \text{ (m/s)}$$

allow a correct calculation using an incorrectly/not converted value of energy

1

(e) $19600 = 8000 \times 9.8 \times \Delta h$

1

$$\Delta h = \frac{19\,600}{8000 \times 9.8}$$

1

$\Delta h = 0.25 \text{ m}$

1

[12]

3.

(a) it can be replenished as it is used

1

- (b) biomass – renewable
nuclear – Non-renewable
natural gas – Non-renewable

all 3 correct

| Energy resource | Renewable | Non-renewable |
|-----------------|-----------|---------------|
| Biomass | ✓ | |
| Nuclear | | ✓ |
| Natural gas | | ✓ |

allow 1 mark for two correct answers

2

(c) kinetic

answers must be in the correct order

1

chemical

1

(d) less energy is needed to heat the house

1

the roof is a better insulator

1

(e) $E = 26\,000 \times 30$

1

780 000 (J)

1

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

1

(g) $0.15 = \frac{\text{useful power output}}{26000}$

1

useful power output = 26000×0.15

1

useful power output = 3900 (W)

1

(h) sometimes it is not sunny/windy

1

so there's more chance of electricity being generated at any time

OR

more electricity is generated (1)

which reduces the running costs (of the eco-home) (1)

if no other mark scored, allow a reference to reduced greenhouse gas emissions or reduced global warming for 1 mark

1

[15]

4.

(a) a renewable biofuel

1

(b) any two from

- burning wood causes air pollution

allow creates smoke

- burning wood may lead to deforestation

ignore cutting down trees

- destruction of habitats

- burning wood is carbon-neutral

allow does not contribute to global warming or the greenhouse effect or climate change

2

(c) the chemical store of energy of the wood decreases

both the store of energy and what happens to the store are required

1

the internal/thermal store of energy of the pipe increases

1

the internal/thermal store of energy of the water increases

1

(d) energy is dissipated (to the surroundings)

allow energy is transferred/lost to the surroundings

1

at the same rate that energy is transferred to the water

1

[8]