Topic 1 Energy H

Name: _____

Class: _____

Date: _____

Time: **41 minutes**

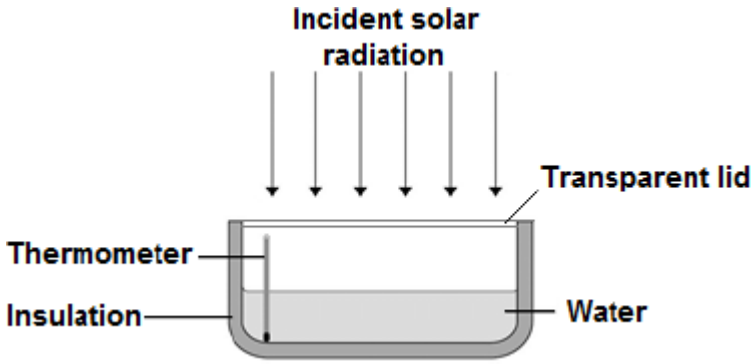
Marks: **40 marks**

Comments:

Q1.A student investigated how much energy from the Sun was incident on the Earth's surface at her location.

She put an insulated pan of water in direct sunlight and measured the time it took for the temperature of the water to increase by 0.6 °C.

The apparatus she used is shown in the figure below.



(a) Choose the most appropriate resolution for the thermometer used by the student.

Tick **one** box.

0.1 °C ☐

0.5 °C ☐

1.0 °C ☐

(1)

(b) The energy transferred to the water was 1050 J.

The time taken for the water temperature to increase by 0.6 °C was 5 minutes.

The specific heat capacity of water is 4200 J / kg °C.

Write down the equation which links energy transferred, power and time.

.....

(1)

(c) Calculate the mean power supplied by the Sun to the water in the pan.

.....

.....

.....

Average power = ... W

(2)

(d) Calculate the mass of water the student used in her investigation.

Use the correct equation from the Physics Equation Sheet.

.....

.....

.....

Mass = ... kg

(3)

(e) The student's results can only be used as an estimate of the mean power at her location.

Give **one** reason why.

.....

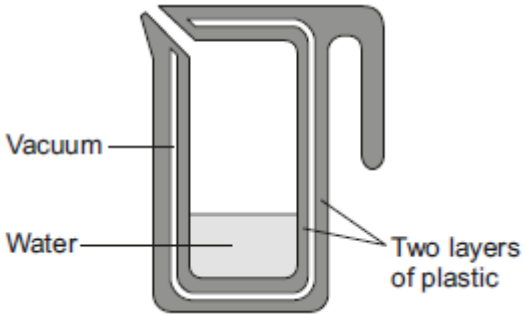
.....

(1)

(Total 8 marks)

Q2. A new design for a kettle is made from two layers of plastic separated by a vacuum. After the water in the kettle has boiled, the water stays hot for at least 2 hours.

The new kettle is shown below.



(a) The energy transferred from the water in the kettle to the surroundings in 2 hours is 46 200 J.

The mass of water in the kettle is 0.50 kg.

The specific heat capacity of water is 4200 J/kg °C.

The initial temperature of the water is 100 °C.

Calculate the temperature of the water in the kettle after 2 hours.

.....

.....

.....

.....

Temperature after 2 hours = ... °C

(3)

(b) Calculate the average power output from the water in the kettle to the surroundings in 2 hours.

.....

.....

.....

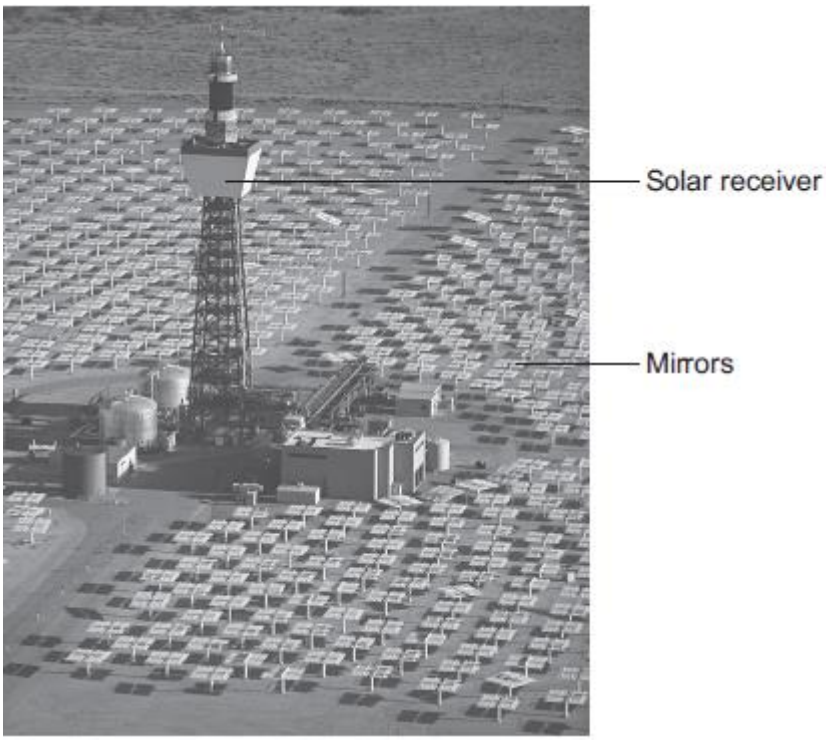
.....

Average power output = ... W

(2)

(Total 5 marks)

Q3. The image shows a solar thermal power station.



Energy from the Sun is directed at the solar receiver by many mirrors.

(a) (i) Suggest **one** reason why a solar thermal power station is built in a hot desert.

.....

.....

(1)

(ii) Complete the following sentence to describe how the mirrors direct energy from the Sun towards the solar receiver.

Energy from the Sun is ..... by the mirrors

towards the solar receiver.

(1)

(iii) Heated water is used to generate electricity in the solar thermal power station. Choose the correct answer from the box to complete each sentence.

boiler	**motor**	**transformer**	**turbine**

At the solar receiver, water is heated in a .....

which turns the water into steam. The steam turns a

.....which is connected to a water into steam. The

steam turns a ..... which is connected to a generator.

The generator produces electricity. A ..... is used

to change the voltage for transmission along power lines.

(3)

(b) A solar storage power station is a new type of solar power station.
It is able to store energy from the Sun to generate electricity at night.

The solar storage power station can supply a town with a maximum electrical power of 140 000 kW for 15 hours.

Calculate the maximum energy, in kWh, stored by the solar storage power station.

.....

.....

.....

Energy = ... kWh

(2)

(c) A different method of generating electricity uses wind turbines.
A student researching a wind farm wrote the following.

> Top Hill Wind Farm has 25 wind turbines.
> Last week, one of the wind turbines generated electricity for only 42 hours out of a possible 168 hours.
> My conclusion is that all wind turbines operate for only
> 25% of the time.

(i) Give **two** reasons why the student is **not** correct in reaching his conclusion.

1.....

.....

2.....

.....

(2)

(ii) Give **one** reason why wind turbines do not generate electricity all the time.

.....

.....

(1)

(iii) Give **one** advantage of using wind turbines to generate electricity compared with using fossil fuel power stations.

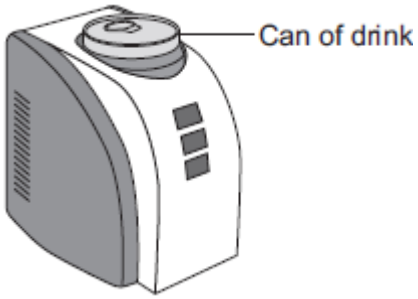
.....

.....

(1)
(Total 11 marks)

Q4.A 'can-chiller' is used to make a can of drink colder.

The image below shows a can-chiller.



(a) The initial temperature of the liquid in the can was 25.0 °C.
The can-chiller decreased the temperature of the liquid to 20.0 °C.
The amount of energy transferred from the liquid was 6930 J.
The mass of liquid in the can was 0.330 kg.

Calculate the specific heat capacity of the liquid.

Give the unit.

.....

.....

.....

.....

Specific heat capacity = ... unit .....

(4)

(b) Energy is transferred through the metal walls of the can of drink by conduction.
Explain how.

.....

.....

.....

.....

.....

.....

.....

.....

(4)

(c) The energy from the can of drink is transferred to the air around the can-chiller. A convection current is set up around the can-chiller. Explain how.

.....

.....

.....

.....

.....

.....

(3)

(d) The can-chiller has metal cooling fins that are designed to transfer energy quickly to the surroundings.

Give **two** features that would help the metal cooling fins to transfer energy quickly to the surroundings.

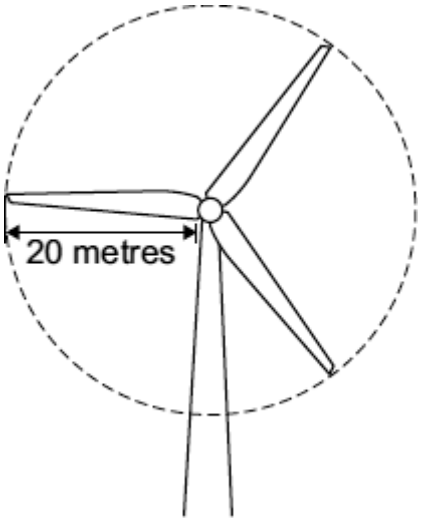
1.....

2.....

(2)

(Total 13 marks)

Q5. The diagram shows a wind turbine.



(a) The blades of the turbine are 20 metres long. On average, 15 000 kg of air, moving at a speed of 12 m/s, hit the blades every second.

Calculate the kinetic energy of the air hitting the blades every second.

Show clearly how you work out your answer.

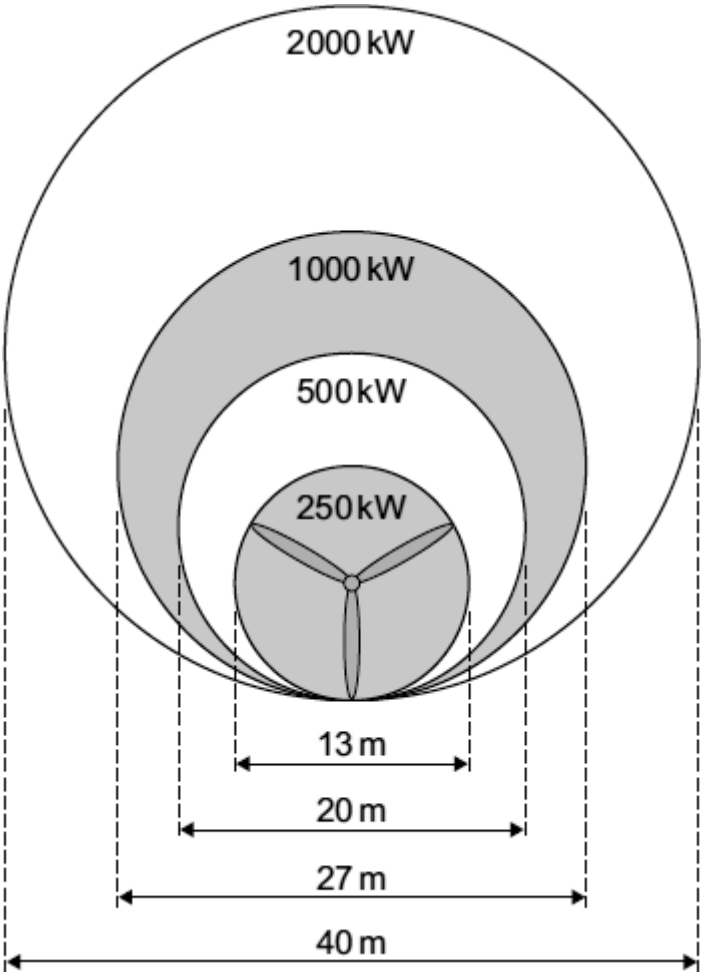
.....

.....

Kinetic energy = ... J

(2)

(b) Part of the kinetic energy of the wind is transformed into electrical energy.
The diagram shows that, for the same wind speed, the power output of a turbine, in kilowatts, depends on the length of the turbine blades.



Give a reason why doubling the diameter of the blades more than doubles the power output of a turbine.

.....

.....

(1)

(Total 3 marks)

M1.(a) 0.1 (°C)

1

(b) power = energy transferred / time

allow P = E / t

1

allow E = P × t

(c) 1050 / 300

1

3.5 (W)

1

*accept 3.5 (W) with no working shown for **2** marks*

(d) 1050 = m × 4200 × 0.6

1

m = 1050 / (4200 × 0.6)

1

m = 0.417 (kg)

1

*accept 0.417 (kg) with no working shown for **3** marks*

(e) any **one** from:

- energy used to heat metal pan (as well as the water)
- energy transfer to the surroundings (through the insulation)
- angle of solar radiation will have changed during investigation
- intensity of solar radiation may have varied during investigation

1

[8]

M2.(a) 78 (°C)

*allow **2** marks for correct temperature change ie 22 °C*
*allow **1** mark for correct substitution*
ie 46 200 = 0.5 × 4200 x θ
or
$\frac{46200}{0.5 \times 4200} = \theta$

3

(b) 6.4 (W)

*allow **2** marks for an answer that rounds to 6.4*
*allow **1** mark for correct substitution*
ie 46 200 = P × 7200
an answer of 23 000 or 23 100 or 385 gains 1 mark

2

[5]

M3.(a) (i) high levels of infrared radiation (from the Sun)

allow lots of (solar) energy (available)
*do **not** accept 'heat' for infrared*
'it is hot' is insufficient
'lots of sunlight' is insufficient

1

(ii) reflected

1

(iii) boiler

correct order only

1

turbine

1

transformer

1

(b) 2 100 000 (kWh)

*allow **1** mark for correct substitution i.e. 140 000 × 15*
provided no subsequent step

2

(c) (i) only 1 wind turbine was considered

accept only one location is considered

1

or

other wind turbines may have generated more electricity

accept insufficient sample size

only 1 week's weather was reported on
or
wind speed varies from one week to another

'wind speed varies' is insufficient

1

(ii) any **one** from:

- wind speed is too high / low

  allow no wind
  allow too windy
- wind is unreliable.

  allow wind is variable

1

(iii) any **one** from:

- wind is a renewable energy source
- do not use fuel
- energy source is free
- do not release carbon dioxide
- do not release greenhouse gases
- do not release sulfur dioxide
- do not cause acid rain
- do not cause climate change
- do not cause global warming
- do not cause global dimming.

answer must be an advantage of wind, converse answers in terms of fossil fuels are insufficient

accept do not release pollutant gases

'no pollution' is insufficient

1

[11]

M4.(a) 4200

*allow **2** marks for correct substitution*
ie 6930 = 0.330 × c × 5.0

*answers of 1050 **or** 840*

or

correctly calculated answer from correct substitution of incorrect temperature change

or

identification of temperature change ie 5 °C
*gain **1** mark*

3

J / kg°C

accept J / kg K

1

(b) (in a metal) free electrons

to gain full credit the answer must be in terms of free electrons

1

gain kinetic energy

accept move faster

1

(free electrons) transfer energy to other electrons / ions / atoms

*do **not** accept particles*

1

by collision

*allow a maximum of **2** marks for answers in terms of atoms / ions / particles*

- *gaining kinetic energy or vibrating faster / more*
- *transferring energy by collisions*

1

(c) (air) particles spread out

1

(which causes the) air to become less dense / expand

*do **not** accept particles become less dense*

1

(so the) warm air rises

*do **not** accept heat rises*
particles rise is insufficient

1

(d) large surface area

ignore references to type of metal or external conditions

1

black / dark (colour)

1

[13]

M5. (a) 1 080 000

*allow **1** mark for correct substitution*

ie ½ × 15 000 × 12 × 12

2

(b) any **one** from:

- KE (of wind) more than doubles
- mass of air (hitting blades) more than doubles
- area swept out by blades more than doubles
  *do **not** accept blades are larger / have a bigger area*
- area swept out by blades increases × 4

1

[3]