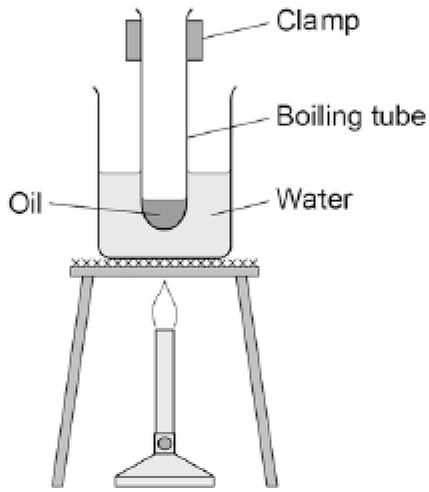
1 A student investigated the change in temperature when oils of different specific heat capacities were heated.

She set up the apparatus shown in the figure below.



This is the method used.

1. Put 25 g of oil into a boiling tube.
2. Pour 100 ml of water into a beaker and heat it with a Bunsen burner.
3. When the water is boiling, put the boiling tube into the beaker.
4. When the temperature of the oil reaches 30 °C, heat for a further 30 seconds and record the rise in temperature.
5. Repeat with different oils.
6. Repeat the whole investigation.

(a) Name **two** pieces of apparatus the student used that are **not** shown in the figure above.

1. Thermometer

2. Clock, balance

(2)

(b) What are the independent and dependent variables in the student's investigation?

Independent type of oil

Dependent change in temp

(2)

(c) Give **two** safety precautions the student should have taken.

1. goggles

2. don't heat oil directly

(2)

(d) Suggest **one** improvement to the student's method.

heat oil for longer time period to get a bigger temp rise

(repeat)

(2)

(e) The table below shows the student's results.

	Temperature rise in °C			
Type of oil	**1**	**2**	**3**	**Mean**
Castor oil	20	19	21	20
Linseed oil	19	18	19	19
Mineral oil	21	21	21	21
Olive oil	17	17	18	17
Sesame oil	23	23	20	22

Calculate the mean temperature rise for olive oil.

Give your answer to two significant figures.

17+17+18 = 17.3̇

Mean temperature rise = 17 (2sf) °C

(2)

(f) The mean change in temperature of the castor oil is 20 °C

The specific heat capacity of castor oil is 1 800 J / kg °C

The mass of oil used is 0.025 kg

Calculate the change in thermal energy of the castor oil the student used.

Use the correct equation from the Physics Equations Sheet.

Select the correct unit from the box.

joule	newton	volt

$\Delta E = m \times c \times \Delta\theta$

$= 0.025 \times 1800 \times 20$

Change in thermal energy = 900

Unit = Joule

(3)

(Total 13 marks)

2 **Figure 1** shows a kettle a student used to determine the specific heat capacity of water.

Figure 1

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The student placed different masses of water into the kettle and timed how long it took for the water to reach boiling point.

The student carried out the experiment three times.

The student's results are shown in the table below.

	Time for water to boil in seconds					
Mass of water in kg	**1**	**2**	**3**	**Mean**	**Mass × change in temperature in kg°C**	**Energy supplied in kJ**
0.25	55	60	63	59	20	131
0.50	105	110	116	110	40	243
0.75	140	148	141	143	60	314
1.00	184	190	183	182	80	401
1.25	216	215	211	214	100	471
1.50	272	263	266	267	120	587
1.75	298	300	302		140	

(a) Suggest how the student was able to ensure that the change in temperature was the same for each mass of water.

• Ensure water is at same temperature at the start

• Water boils at the same temp (100°C)

(2)

(b) Calculate the uncertainty in the student's measurements of time to boil when the mass of water was 1.75 kg.

range = 302 - 298 = 4

uncertainty = range / 2

Uncertainty = ±2 s

(2)

(c) The power rating of the kettle is 2.20 kW.

Calculate the average electrical energy used by the kettle, in kJ, for 1.75 kg of water to reach boiling point.

$P = \frac{E}{t}$ ⇒ $2200 \times 300 = 660 \text{ kJ}$

Average energy = ______________________ kJ

(2)

(d) Use information from the table above to calculate the change in temperature of the water during the investigation.

use any row: m = 0·75

$m \times \Delta\theta = 60$ ∴ $\Delta\theta = \frac{60}{0.75}$

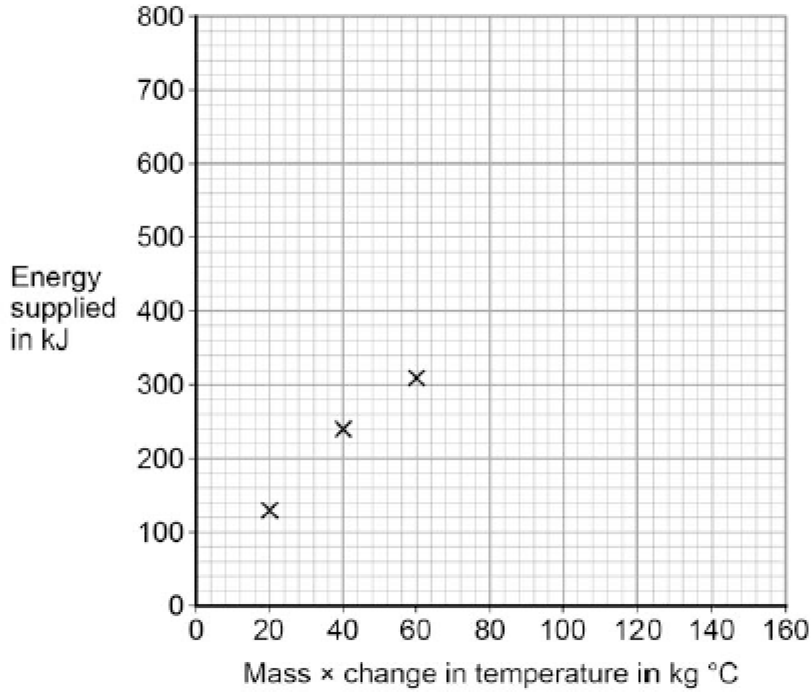
Change in temperature = 80 °C

(2)

(e) The student plotted a graph of energy supplied in kJ against mass × change in temperature in kg °C.

Figure 2 shows the graph the student plotted.

Figure 2



Use data from the table above to plot the four missing points.

Draw a line of best fit on the graph.

(3)

(f) Use the graph to determine the mean value of the specific heat capacity of water, for the student's investigation.

this will be the gradient $\frac{\Delta y}{\Delta x}$

$= \frac{\text{Energy supplied}}{m\Delta\theta}$

Specific heat capacity of water = ______________ J / kg °C

(4)

4200 → 4800

(g) The student's value for the specific heat capacity of water was greater than the accepted value.

Suggest why.

heat lost to surrounds so more energy supplied

(1)

(h) The kettle used in the experiment had a label stating that the power rating of the kettle was 2.2 kW.

The student did not measure the power of the kettle.

Suggest why measuring the power of the kettle may improve the student's investigation.

might not be using 2.2kW – inaccurate label.

(1)
(Total 17 marks)

3 During the day, the Sun transfers energy to an outdoor swimming pool.

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(a) By which method of energy transfer does the pool receive energy from the Sun?

radiation

(1)

(b) (i) The mass of water in the pool is 5000 kg. The specific heat capacity of water is 4200 J/kg°C.

Calculate how much energy needs to be supplied to increase the water temperature by 5°C and state the correct unit.

Use the correct equation from the Physics Equations Sheet.

Give the unit.

$\Delta E = m c \Delta\theta = 5000 \times 4200 \times 5$

Energy = 1.05×10^8 J

(3)

(ii) The Sun supplies energy to the water in the pool at a rate of 16 kJ every second.

Calculate how much time it would take for energy from the Sun to raise the water temperature by 5 °C.

You will need to use your answer to **(b)(i)** and the correct equation from the Physics Equations Sheet.

$\frac{1.05 \times 10^8}{16,000} =$

Time = 6562.5 seconds

(3)

(iii) On one day, the temperature of the pool is 7 °C lower than the air temperature.

The time it takes for the pool temperature to rise by 5 °C is less than the answer to part **(b)(ii)**.

Suggest a reason why.

it is also getting energy from the air

(1)

(Total 8 marks)

Mark schemes

1 (a) thermometer **1**

stopclock / stopwatch

accept measuring cylinder

accept top pan balance **1**

(b) independent: type of oil **1**

dependent: temperature rise in °C **1**

(c) wear safety goggles **1**

oil not heated directly

accept any reasonable comment about not handling hot apparatus. **1**

(d) repeat the experiment **1**

and calculate the mean temperature rise

OR

heat the oil for a longer period of time (1)

to get a wider range of temperatures (1) **1**

(e) (17 + 17 + 18) / 3 (= 17.33) **1**

temperature rise = 17 (°C) **1**

*accept 17 (°C) with no working shown for **2** marks*

*allow 17.33 with no working shown for **1** mark*

(f) $E = 0.025 \times 1800 \times 20$ (J) **1**

$E = 900$ (J) **1**

*allow 900 without working shown for the **2** calculation marks*

Joule **1**

[13]

2 (a) water boils at the same temperature each time **1**

control starting temp by allowing enough time for water and kettle to reach room temperature

1

(b) uncertainty = (302 – 298) / 2

1

uncertainty = ± 2 (s)

ignore missing ±

1

(c) (Energy transferred = Power × time)

E = 2.20 × 300

1

E = 660 (kJ)

1

*allow 660 (kJ) without working shown for **2** marks*

*allow answer calculated using incorrect value for t (298 or 302) for **1** mark*

(d) (mass × change in temperature) / mass

*allow **1** mark for any correct pair of values from the table*

1

eg 20 / 0.25

80 (°C)

1

*allow 80 (°C) without working shown for **2** marks*

(e) four points plotted correctly

*allow **1** mark for three correctly plotted points*

2

ecf their 5.3

allow ± 1mm

accurate line drawn

line should be straight and drawn with a ruler

1

line must not go through the origin

(f) values read correctly from graph

1

correct conversion into J

1

correct use of $\Delta y / \Delta x$

1

value in range 4200 – 4800

1

*allow value in range 4200 – 4800 without working shown for **4** marks*

(g) some of the energy supplied does not raise the temperature of the water

some of the energy is wasted is insufficient

1

(h) (the power of the kettle may not be 2.2kW)

(by measuring the power) the student can accurately calculate the amount of energy supplied to each mass of water

1

[17]

3 (a) radiation

ignore infra red, IR, or heat

1

(b) (i) 105 000 000

($E = mc\theta$)

accept answers in standard form eg. 1.05×10^8

*$E = 5000 \times 4200 \times 5$ gains **1** mark*

Unit mark is independent, but must match value given for full marks

if no other marks gained 1 mark for any correct unit of energy

2

J / joules

not lower case j

allow Joules

allow units in words eg kilojules

*allow 105 000 kJ or 105 MJ for **3** marks. These figures must have units.*

allow units written as words Eg. kilojoules

not KJ, kj, mJ, Mj

1

(ii) 6600(s) / 6560(s) / 6563(s) / 6562.5(s)

(E = Pt)

allow ecf from (b)(ii)

allow answers in minutes and hours provided correct and unit changed on answer line

eg. 109 / 110 minutes or 1.8 hours

if correct answer given with incorrect unit, maximum mark of ***2*** *eg 6600 minutes*

105 000 000 = 16 000 × t gains ***1*** *mark*

t = 105 000 000 / 16 000 gains ***2*** *marks*

t = 105 000 000 / 16 gains ***1*** *mark*

or

6 562 500(s) gains 2 marks

3

(iii) energy gained from surroundings / air

allow heat

ignore air is warmer or pool is colder

1

[8]