22 A student has two radiators in her home. They are filled with different liquids and have different power ratings.

Fig. 1.1 shows information about the two heaters.

Oil radiator	Water radiator
 Heater contains 10 kg of **oil**	 Heater contains 10 kg of **water**
1000 W heater	**1500 W heater**

Fig. 1.1

Table 1.1 shows information about oil and water.

Material	Specific heat capacity (J / kg ºC)	Freezing point (ºC)	Boiling point (ºC)
Oil	1 700	–24	250
Water	4 200	0	100

Table 1.1

(a) The student's conservatory can be very cold. Sometimes the temperature can get as low as –6 °C.

She thinks that it may be better to use the oil radiator in the conservatory than the water radiator.

Suggest why.

Use the information in **Table 1.1** to help you answer.

At -6°c, water is a solid yet oil is a liquid, liquids dissipate heat better than solids.

[1]

(b) Both radiators have a 'cut-out' which prevents them getting hotter than 60 °C.

Suggest why.

If the temperature were to increase beyond 60°c, there is a risk to the students. Nearly boiling oil or water can cause burn if accidently contacted by the students.

or

there is a risk of water or oil volume expanding as 60°C is close to their boiling points.

[1]

(c) The student knows that the oil heater produces 800 J of energy each second.

Calculate the energy produced by the oil heater in 10 minutes.

10 mins = 10 × 60 seconds = 600 seconds

800 J : 1 second

×600 ↓ 480,000 J : 600 seconds

Answer = ...480,000...... J

[2]

(d) The student wants the oil heater to heat up by 40°C

(i) How much energy is needed?

Use the information in **Fig. 22.1** and **Table 22.1** to help you answer.

Show your working.

$E = mc\Delta\theta$

$\Delta\theta = 40°C$

$m = 10$ kg

$c = 1700$

$E = 10 \times 1700 \times 40 = 680000$ J

Answer = ...680 000...... J

[2]

(ii) She supplies enough energy to heat up the oil radiator by 40 °C but it only heats up to 32 °C.

Suggest **two** reasons why. **[2]**

Because a portion of the energy will be lost to the environment, reducing the temperature increase. (less energy available)

Another portion of the energy will be used for heating the radiator itself, thus less energy is available for the oil to be 40°C.

Total Marks for Question Set 22: 8

Equations in physics

$(\text{final velocity})^2 - (\text{initial velocity})^2 = 2 \times \text{acceleration} \times \text{distance}$

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

thermal energy for a change in state = mass × specific latent heat

$\text{energy transferred in stretching} = 0.5 \times \text{spring constant} \times (\text{extension})^2$

potential difference across primary coil × current in primary coil = potential difference across secondary coil × current in secondary coil