3.3 Energy: 30-minute Pack

Calculator allowed · about 30 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Equation you may need: change in thermal energy = mass x specific heat capacity x change in temperature (E = m x c x change in T). The specific heat capacity of water is 4200 J/(kg °C).

(a) Calculate the energy needed to heat 2 kg of water by 20°C. **(2)**

.....

(b) Write your answer to part (a) in kilojoules (kJ). **(1)**

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2 Which of these is a non-renewable fossil fuel?

(a) Choose the correct answer. **(1)**

- ☐ A) Solar
- ☐ B) Wind
- ☐ C) Natural gas
- ☐ D) Hydroelectric

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3 An electric kettle heats water until it boils.

(a) State the useful energy transfer pathway that occurs when the kettle heats the water. **(2)**

(b) State one way that energy is wasted from the kettle to the surroundings. **(1)**

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4 For each situation, name the main energy store involved. Choose from: kinetic, gravitational potential, elastic potential, chemical, thermal.

(a) A clockwork toy car has its spring wound up tightly, ready to be released. **(1)**

(b) A cyclist pedals along a flat road at a fast, constant speed. **(1)**

(c) A clothes iron has just been switched on for several minutes and is now very hot. **(1)**

(d) A phone battery has just been fully charged. **(1)**

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5 Classify each energy resource as 'renewable' or 'non-renewable'.

(a) Geothermal **(1)**

(b) Tidal **(1)**

(c) Oil **(1)**

(d) Peat **(1)**

(e) Hydroelectric **(1)**

(f) Nuclear fuel (uranium) **(1)**

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6 Equation you may need: E = P x t. A washing machine has a power rating of 1500 W and runs for 45 minutes on a wash cycle. A games console has a power rating of 100 W and is left on for 5 hours. Show that the washing machine transfers more total energy than the games console.

(4)

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7 A typical UK house loses energy through its roof and walls. Evaluate the use of loft insulation compared with cavity wall insulation for reducing a house's energy losses. In your answer, consider installation cost, ongoing energy and money savings, and how each method reduces energy transfer.

(6)

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Mark scheme · 3.3 Energy: 30-minute Pack

Question 1

(a) correct substitution: 2 x 4200 x 20 **M1**

(a) 168000 J cao **A1**

(a) Answer: **168000 J**

(b) 168 kJ ft from (a) **B1**

(b) Answer: **168 kJ**

Question 2

(a) C cao **B1**

(a) Answer: **C) Natural gas**

Question 3

(a) energy is transferred electrically (from the mains/electrical energy store) **B1**

(a) to the thermal energy store of the water oe **B1**

(a) Answer: **Electrical energy is transferred to the thermal energy store of the water.**

(b) thermal energy transferred (by heating) to the surroundings through the kettle body/lid oe **B1**

(b) Answer: **Energy is transferred by heating to the surrounding air through the body of the kettle.**

Question 4

(a) elastic potential (energy store) cao **B1**

(a) Answer: **Elastic potential energy store**

(b) kinetic (energy store) cao **B1**

(b) Answer: **Kinetic energy store**

(c) thermal (energy store) cao **B1**

(c) Answer: **Thermal energy store**

(d) chemical (energy store) cao **B1**

(d) Answer: **Chemical energy store**

Question 5

(a) renewable cao **B1**

(a) Answer: **Renewable**

(b) renewable cao **B1**

(b) Answer: **Renewable**

(c) non-renewable cao **B1**

(c) Answer: **Non-renewable**

(d) non-renewable cao **B1**

(d) Answer: **Non-renewable**

(e) renewable cao **B1**

(e) Answer: **Renewable**

(f) non-renewable cao **B1**

(f) Answer: **Non-renewable**

Question 6

convert washing machine time to hours: 45 / 60 = 0.75 h (or work consistently in another unit) **M1**

washing machine energy = 1500 x 0.75 = 1125 Wh (1.125 kWh) **A1**

console energy = 100 x 5 = 500 Wh (0.5 kWh) **M1**

correct comparison and conclusion: 1125 Wh > 500 Wh, so the washing machine transfers more total energy cso **A1**

Answer: **Washing machine = 1125 Wh (1.125 kWh); games console = 500 Wh (0.5 kWh); the washing machine transfers more energy overall.**

Question 7

Level 1 Basic, isolated statements about insulation are made, with little or no reference to cost, savings, or how the method reduces energy transfer. **1-2**

Level 2 A description of at least one type of insulation is given, with some reference to cost and/or savings, but the comparison between loft insulation and cavity wall insulation is limited or one-sided. **3-4**

Level 3 A clear, balanced evaluation is given, comparing loft insulation and cavity wall insulation across installation cost, ongoing energy/money savings (and payback time), and how each reduces energy transfer, leading to a justified overall conclusion. **5-6**

Indicative content:

- Loft insulation reduces energy loss through the roof, a major route for heat loss since warm air rises and can transfer energy by convection and conduction through the ceiling and roof.
- Cavity wall insulation fills the gap between a house's inner and outer walls with an insulating material, reducing energy loss by conduction and convection through the walls.
- Loft insulation is usually cheaper to install and quicker to fit than cavity wall insulation.
- Cavity wall insulation often costs more to install but can save more money per year, because walls typically make up a larger total surface area for heat loss than the roof.
- The payback time (how long the money saved on energy bills takes to cover the installation cost) can be estimated by dividing the installation cost by the annual saving; comparing payback times helps judge which is the better investment.
- Both methods work mainly by trapping pockets of air (or another insulating material), which is a poor conductor of thermal energy, reducing the rate of energy transfer out of the house.
- A balanced conclusion should weigh the higher installation cost of cavity wall insulation against its potentially larger annual savings, and consider practicality (for example, some older houses do not have cavity walls and cannot use this method).

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