3.3 Energy: Test Pack

Calculator allowed · about 55 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

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

(a) A stretched trampoline spring, just before a gymnast is released upwards. **(1)**

(b) A skydiver falling at a constant, high speed. **(1)**

(c) A full can of petrol, before it is burned in an engine. **(1)**

(d) A cup of tea, just after it has been made with boiling water. **(1)**

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

(a) Solar **(1)**

(b) Wind **(1)**

(c) Natural gas **(1)**

(d) Coal **(1)**

(e) Biomass **(1)**

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

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3 Equation you may need: E = P x t. A 60 W lamp is left switched on for 5 hours. A 2 kW kettle is switched on for 6 minutes. Show that the lamp transfers more total energy than the kettle.

(5)

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4 State the main method of thermal energy transfer (conduction, convection or radiation) taking place in each example.

(a) A bird warms its eggs by sitting on them. **(1)**

(b) On a hot day, a cool breeze blows in from the sea toward the land as warm air over the land rises. **(1)**

(c) You feel warmth from a toaster's glowing element without touching it. **(1)**

(d) On a frosty morning, a metal fence post feels much colder to touch than a wooden fence post right next to it. **(1)**

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5 Practical investigation: a student investigates how different wrapping materials affect the time taken for an ice cube to completely melt at room temperature. She wraps identical ice cubes (each starting at 0°C) in different materials and records the time for each to fully melt. Her results are shown in the table. Material: none (control), wool fabric, bubble wrap, aluminium foil. Time to melt (minutes): 18, 34, 40, 12.

Material	Time to melt (minutes)
none (control)	18
wool fabric	34
bubble wrap	40
aluminium foil	12

(a) Identify the independent variable and the dependent variable in this investigation. **(2)**

(b) State two variables that should be kept the same to make this a fair test. **(2)**

(c) Explain why the ice cube wrapped in aluminium foil melted faster than the unwrapped control. **(2)**

6 Give two pieces of evidence you could collect in a classroom experiment to show that thermal energy is produced when a wire carrying current is heated (for example a nichrome wire).

(2)

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7 A student compares two kettles. Kettle A boils 1.0 kg of water in 3 minutes using 210 kJ energy. Kettle B boils 1.0 kg of water in 4 minutes using 240 kJ energy. Which kettle is more efficient at heating the water? Show reasoning and state the better kettle.

(2)

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8 A student investigates insulating different cups. They measure the temperature of 250 g of hot water (initially 80°C) in three cups after 30 minutes. Results: cup A: 48°C, cup B: 54°C, cup C: 60°C. Which cup is best at reducing energy transfer to the surroundings? Explain your answer and name two variables that should be controlled in the experiment.

(4)

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9 A simple electric motor does 1500 J of useful work in 5 minutes. Calculate the average power output of the motor in watts. Then state two reasons why the input electrical power will be higher than this output.

(a) Calculate the average power output in watts. (1 minute = 60 seconds) **(3)**

(b) State two reasons why the input electrical power is higher than the useful output power. **(2)**

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10 A 2 kg textbook is lifted slowly 1.5 m above a desk. Use g = 10 N/kg. Calculate the increase in gravitational potential energy.

(2)

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11 Explain why insulating a saucepan with a lid reduces energy transfer to the surroundings when cooking soup. Include two reasons.

(3)

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12 Complete the sentence. 'Energy cannot be created or destroyed; it can only be ...' Finish the sentence.

(2)

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Mark scheme · 3.3 Energy: Test Pack

Question 1

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

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

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

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

Question 2

(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 3

convert lamp time to seconds: 5 x 3600 = 18000 s (or work consistently in hours) **M1**

lamp energy = 60 x 18000 = 1080000 J (or 1.08 MJ, or 0.3 kWh) **A1**

convert kettle time to seconds: 6 x 60 = 360 s (or work consistently in hours) **M1**

kettle energy = 2000 x 360 = 720000 J (or 0.72 MJ, or 0.2 kWh) **A1**

correct comparison and conclusion: 1080000 J > 720000 J, so the lamp transfers more total energy cso **A1**

Answer: **Lamp = 1080000 J, kettle = 720000 J; the lamp transfers more energy overall.**

Question 4

(a) conduction cao **B1**

(a) Answer: **Conduction**

(b) convection cao **B1**

(b) Answer: **Convection**

(c) radiation (infrared radiation) cao **B1**

(c) Answer: **Radiation**

(d) conduction cao **B1**

(d) Answer: **Conduction**

Question 5

(a) independent variable = type of wrapping material (oe) **B1**

(a) dependent variable = time taken for the ice cube to melt (oe) **B1**

(a) Answer: **Independent variable: type of wrapping material. Dependent variable: time taken to melt.**

(b) any one of: size/mass of ice cube, starting temperature of the ice, room temperature, thickness of wrapping, position in the room **B1**

(b) a second, different valid control variable from the list above **B1**

(b) Answer: **Any two of: same size/mass of ice cube, same starting temperature, same room temperature, same thickness of wrapping.**

(c) aluminium foil is a metal and a good conductor of thermal energy **M1**

(c) so it transfers energy from the warmer surroundings to the ice cube more quickly than no wrapping or an insulating material, speeding up melting, oe **A1**

(c) Answer: **Aluminium foil is a good conductor, so it transfers thermal energy from the surroundings to the ice more quickly than no wrapping, making it melt faster.**

Question 6

measure temperature increase with a thermometer or temperature probe **B1**

observation such as a hand feeling heat at a safe distance or melting wax from wire (sensible safe example) oe **B1**

Answer: **Measure a temperature rise of the wire with a thermometer or temperature probe; and observe melting wax near the hot wire (safe example).**

Question 7

compare energy used for same mass: 210 kJ versus 240 kJ **M1**

state kettle A is more efficient because it uses less energy to boil the same amount of water **A1**

Answer: **Kettle A is more efficient because it uses 210 kJ to boil 1.0 kg whereas Kettle B uses 240 kJ for the same result.**

Question 8

identify cup C (60 degrees) as best because it lost the least temperature **M1**

state reasoning that smaller drop from 80 to 60 is less energy lost **M1**

control variable 1 such as same mass of water or same initial temperature **B1**

control variable 2 such as same room conditions or same cup material except insulation, or same volume **B1**

Answer: **Cup C is best because its temperature fell least (80 to 60°C) so it lost the least thermal energy. Control variables: same mass of water and same initial temperature (or same room conditions).**

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Question 9

(a) convert time to seconds 5 x 60 = 300 s and use P = E / t substitution 1500 / 300	**M1**
(a) calculate 1500 / 300 = 5	**M1**
(a) 5 W cao	**A1**

(a) Answer: **5 W**

(b) energy lost as thermal energy due to friction or resistance in the motor	**B1**
(b) a second, different valid reason, e.g. energy lost as sound or dissipated to the surroundings (any two different reasons)	**B1**

(b) Answer: **Because some energy is lost as thermal energy due to friction and electrical resistance, and some as sound, so input power must be higher than useful output.**

Question 10

method using E = m g h with substitution 2 x 10 x 1.5	**M1**
30 J cao	**A1**

Answer: **30 J**

Question 11

states that the lid reduces convection (traps hot air/steam)	**M1**
states that insulation or lid reduces heat loss by conduction/radiation or gives an example such as foam or a heavy lid	**M1**
linked explanation that less energy leaves so soup stays hotter for longer (oe)	**A1**

Answer: **The lid stops hot steam escaping so there is less convection; the lid and any insulation reduce heat loss by conduction and radiation, so less energy is transferred to the surroundings.**

Question 12

transferred or changed from one form to another (allow either word or phrase) cao	**B1**
additional clarification phrase such as 'between stores' or 'between objects' (allow oe)	**B1**

Answer: **transferred or changed from one form to another (between stores)**

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