K13E Energy: Depth and Practice

AQA AQA KS3 Science - Energy · Calculator allowed · about 75 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 State the energy store that increases when a battery powers a torch bulb.

(1)

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2 A kettle transfers energy from the electrical store to the thermal store of the water. Write down the correct energy transfer using an arrow: electrical -> thermal.

(a) Complete the energy transfer using words and an arrow. **(1)**

(b) State one useful form of energy produced by the kettle when it boils water. **(1)**

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3 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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4 Explain why insulating a saucepan with a lid reduces energy transfer to the surroundings when cooking soup. Include two reasons.

(3)

5 A 60 W lamp is switched on for 30 minutes. Calculate the energy transferred by the lamp in that time. Give your answer in joules. (1 minute = 60 seconds)

(4)

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6 A cyclist brakes and slows down. Describe two energy transfers that happen when the brakes are applied.

(3)

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

(2)

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8 A compressed spring stores 12 J of elastic potential energy. If all this energy is used to lift a small mass vertically, how high could a 0.5 kg mass be lifted? Use g = 10 N/kg. Show working.

(2)

9 An experiment measures the temperature rise of 500 g of water when 2000 J of energy are added. The temperature of the water rises by 1.0 degrees C. Calculate the specific heat capacity found by this experiment using c = energy / (mass x temperature change). Give mass in kg.

(4)

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10 A shop installs LED lamps that use 12 W each instead of old bulbs that used 60 W. Using the idea of efficiency, explain why this is a good change for reducing energy use. Give a short calculation comparing energy used in one hour for one lamp.

(3)

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11 Give one piece 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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12 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)

13 A car of mass 800 kg starts from rest and accelerates, so that its kinetic energy increases by 1.6×10^5 J. Calculate the change in speed of the car. Use KE = 1/2 m v^2 and show working. Give your answer in m/s.

(4)

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14 A student draws an energy flow diagram for a burning candle showing chemical store -> heat and light stores. Suggest one improvement to this diagram that shows wasted energy and explain why it is an improvement.

(3)

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15 State the unit of power and give one device with a power rating labelled in that unit.

(2)

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16 A student investigates insulating different cups. They measure the temperature of 250 g of hot water (initially 80 degrees C) in three cups after 30 minutes. Results: cup A: 48 degrees C, cup B: 54 degrees C, cup C: 60 degrees 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)

17 Extended response (6 marks). A community centre wants to reduce its energy bills. They can install better insulation in the roof, replace old boilers with newer ones, or fit solar panels. Discuss which option or combination of options you would recommend. In your answer: consider energy transfers, cost versus benefit, and possible wasted energy. Use evidence and reasoning.

(6)

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18 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 one reason why the input electrical power will be higher than this output.

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

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

Mark scheme · K13E Energy: Depth and Practice

Question 1

- **B1** electrical energy to thermal and light (accept light or heat or electrical -> light)
- Answer: **Light energy (from electrical energy).**

Question 2

- (a) **B1** electrical -> thermal cao
- (a) Answer: **electrical -> thermal**
- (b) **B1** thermal or heat energy cao
- (b) Answer: **Thermal energy.**

Question 3

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

Question 4

- **M1** 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
- **A1** linked explanation that less energy leaves so soup stays hotter for longer (oe)
- 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 5

- **M1** convert time to seconds 30 x 60 = 1800 s and multiply energy = power x time
- **M1** substitution 60 x 1800
- **A1** 108000 J cao
- **B1** answer includes correct unit J
- Answer: **108000 J**

Question 6

- **M1** kinetic energy -> thermal energy in the brake pads/wheels
- **M1** some energy transferred to the surroundings as thermal radiation or sound energy
- **A1** description linking slowing to decrease in kinetic energy and increase in heat (oe)
- Answer: **Kinetic energy of the bike and rider is transferred into thermal energy in the brake pads and tyres, and some energy is given to the surroundings as sound and thermal radiation.**

Question 7

- **B1** 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)
- Answer: **transferred or changed from one form to another (between stores)**

Question 8

- **M1** use Ep = m g h rearranged to h = Ep / (m g) with substitution 12 / (0.5 x 10)
- **A1** 2.4 m cao
- Answer: **2.4 m**

Question 9

- **M1** convert mass to kg 500 g = 0.5 kg and substitute c = 2000 / (0.5 x 1.0)
- **M1** calculate 2000 / 0.5
- **A1** 4000 J/kg degrees C cao
- **B1** unit J/kg degrees C given
- Answer: **4000 J/kg degrees C**

Question 10

- **M1** compute energy old bulb = 60 x 3600 = 216000 J or state 60 W uses more energy per second
- **M1** compute energy LED = 12 x 3600 = 43200 J
- **A1** comparison that LED uses 172800 J less per hour or is 1/5 the energy (oe)
- Answer: **Old bulb: 60 x 3600 = 216000 J in one hour. LED: 12 x 3600 = 43200 J. The LED uses 172800 J less, so it is more efficient and saves energy.**

Question 11

- **B1** 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
- Answer: **Measure a temperature rise of the wire with a thermometer or temperature probe; or observe melting wax near the hot wire (safe example).**

Question 12

- **M1** compare energy used for same mass: 210 kJ versus 240 kJ
- **A1** state kettle A is more efficient because it uses less energy to boil the same amount of water
- 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 13

- **M1** use delta KE = 0.5 m (v^2 - u^2) and rearrange to v^2 - u^2 = 2 x delta KE / m
- **M1** substitute v^2 - u^2 = 2 x 160000 / 800 = 400
- **M1** take square root to get change in speed of 20 m/s
- **A1** 20 m/s cao
- Answer: **20 m/s**

Question 14

- **M1** suggest adding a label for waste thermal energy to surroundings or sound
- **M1** explain that not all energy becomes useful light; most becomes heat that warms air
- **A1** link to energy dissipation or wasted energy leaving the system (oe)
- Answer: **Add an arrow from chemical store to thermal energy of surroundings labelled 'waste heat' and explain that most energy becomes heat not light, so this shows energy being dissipated.**

Question 15

- **B1** watt or W
- **B1** example such as kettle 2000 W or hairdryer 1500 W or phone charger 5 W
- Answer: **Unit: watt (W). Example: kettle 2000 W.**

Question 16

- **M1** 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
- **B1** 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
- Answer: **Cup C is best because its temperature fell least (80 to 60 degrees C) so it lost the least thermal energy. Control variables: same mass of water and same initial temperature (or same room conditions).**

Question 17

- **Level 3** (5-6): Detailed discussion with clear judgement and reasons. Explains how each option affects energy transfers, evaluates cost and energy savings, considers wasted energy and suggests a justified combination or single recommendation with evidence.
- **Level 2** (3-4): Some evaluation and reasoning. Describes how options reduce energy loss or produce energy, gives basic cost-benefit comments and a simple recommendation with limited justification.
- **Level 1** (0-2): Simple statements about one or more options with little or no reasoning or comparison. No clear recommendation.
- **Indicative content:**
  - Insulation reduces energy transfer from thermal store of building to surroundings, low running cost, good return over time; limits wasted heat.
  - New boilers are more efficient so less fuel energy is wasted as heat to surroundings; initial cost medium, quick effect on heating bills.
  - Solar panels convert light energy to electrical energy, reduce electricity bought from grid, initial cost high, depends on sunlight, may not cover heating needs.
  - Combine insulation with a more efficient boiler for best practical saving; solar panels add benefit for electrical loads but may have slow payback.
  - Consider maintenance, lifespan, and that insulation reduces all heating needs so reduces wasted energy overall; state a justified recommendation and consider budget.

Question 18

- (a) **M1** convert time to seconds 5 x 60 = 300 s and use P = E / t substitution 1500 / 300
- (a) **M1** calculate 1500 / 300 = 5
- (a) **A1** 5 W cao
- (a) Answer: **5 W**
- (b) **B1** energy lost as thermal energy due to friction or resistance in the motor
- (b) **B1** or energy lost as sound, or inefficiencies in the motor (any one reason required)
- (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.**