3.3 Energy: 1-hour Pack

Calculator allowed · about 60 minutes

Name: _____ Date: ____ / ____ / _____

Answer ALL questions. Show all your working.

1 Equation you may need: P = E / t. A student transfers 3000 J of energy in their kinetic and gravitational potential energy stores when climbing a flight of stairs. Running up the stairs takes 5 s. Walking up the same flight of stairs takes 15 s.

(a) Calculate the student's power output when running up the stairs. **(2)**

.....

(b) Calculate the student's power output when walking up the stairs. **(2)**

.....

(c) The same amount of energy, 3000 J, is transferred in both cases. Explain why the student's power output is greater when running. **(2)**

.....

.....

2 In a particular year, the UK's electricity was generated from these sources: natural gas 40%, wind 25%, nuclear 15%, solar 5%, biomass 5%, coal 5%, other sources 5%.

(a) Calculate the total percentage of the UK's electricity that came from renewable sources (wind, solar and biomass only). **(2)**

.....

(b) Suggest one advantage and one disadvantage of increasing the percentage of UK electricity generated from wind power. **(2)**

.....

.....

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3 Equation you may need: KE = 1/2 x m x v^2. A car of mass 800 kg is travelling at a speed of 20 m/s.

(a) Calculate the kinetic energy store of the car. Give your answer in joules. **(2)**

.....

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

.....

4 Equation you may need: efficiency = (useful output energy transferred / total input energy transferred) x 100. A filament lamp is supplied with 100 J of electrical energy. Only 20 J is usefully transferred as light; the rest is wasted, mostly as heat.

(a) Calculate the efficiency of the lamp. **(2)**

.....

(b) State one reason why the efficiency of the lamp is less than 100%. **(1)**

.....

5 Equation you may need: P = E / t. An electric motor transfers 1200 J of energy in 30 s.

(a) Calculate the power of the motor. **(2)**

.....

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6 A mobile phone charger has a total power input of 12 W. Of this, 9 W is usefully transferred to the phone battery's chemical energy store. The rest is wasted, mostly heating the charger casing.

(a) Calculate the wasted power output of the charger. **(1)**

.....

(b) Equation you may need: efficiency = (useful output energy transferred / total input energy transferred) x 100. Calculate the efficiency of the charger. **(2)**

.....

(c) Suggest one change to the charger's design that would reduce the amount of wasted energy. **(1)**

.....

7 Equation you may need: energy transferred (kWh) = power (kW) x time (hours). An electric heater has a power rating of 2 kW and is switched on for 3 hours. Electricity costs 28p per kWh.

(a) Calculate the number of kWh of energy transferred by the heater. **(2)**

.....

(b) Calculate the total cost of running the heater for the 3 hours. **(2)**

.....

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8 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 aluminium is 900 J/(kg °C).

(a) Calculate the energy needed to heat 0.5 kg of aluminium by 40°C. **(2)**

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

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9 For each statement, identify whether it is True or False. If a statement is false, give the correct version.

(a) Energy can be created within a system, as long as an equal amount is later destroyed. **(1)**

(b) The efficiency of a device can never be greater than 100%. **(1)**

(c) Power is measured in joules (J). **(1)**

(d) A renewable energy resource can be replenished (replaced) at least as quickly as it is used. **(1)**

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10 A toaster heats and browns a slice of bread.

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

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

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11 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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12 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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13 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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14 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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15 A cyclist brakes and slows down. Describe two energy transfers that happen when the brakes are applied.

(3)

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Mark scheme · 3.3 Energy: 1-hour Pack

Question 1

(a) correct substitution: 3000 / 5 **M1**

(a) 600 W cao **A1**

(a) Answer: **600 W**

(b) correct substitution: 3000 / 15 **M1**

(b) 200 W cao **A1**

(b) Answer: **200 W**

(c) power is the rate of energy transfer (energy transferred per second) oe **B1**

(c) the same energy is transferred in a shorter time when running, so the rate of energy transfer (power) is greater oe **B1**

(c) Answer: **Power is the rate of energy transfer; since the same energy is transferred in less time when running, the rate (power) is higher.**

Question 2

(a) correct addition: 25 + 5 + 5 **M1**

(a) 35% cao **A1**

(a) Answer: **35%**

(b) advantage: renewable/will not run out, or produces no carbon dioxide during generation oe **B1**

(b) disadvantage: unreliable/depends on wind speed, cannot be increased on demand, or visual/noise impact oe **B1**

(b) Answer: **Advantage: it does not produce carbon dioxide while generating electricity. Disadvantage: it is unreliable because output depends on wind speed.**

Question 3

(a) correct substitution: KE = 0.5 x 800 x 20^2 **M1**

(a) 160000 J cao (allow 1.6 x 10^5 J) **A1**

(a) Answer: **160000 J**

(b) 160 kJ ft from (a) **B1**

(b) Answer: **160 kJ**

Question 4

(a) correct substitution: (20 / 100) x 100 **M1**

(a) 20% cao **A1**

(a) Answer: **20%**

(b) energy is wasted/dissipated (as heat) to the surroundings oe **B1**

(b) Answer: **Energy is wasted as heat to the surroundings.**

Question 5

(a) correct substitution: P = 1200 / 30 **M1**

(a) 40 W cao **A1**

(a) Answer: **40 W**

Question 6

(a) 3 W cao **B1**

(a) Answer: **3 W**

(b) correct substitution: (9 / 12) x 100 **M1**

(b) 75% cao **A1**

(b) Answer: **75%**

(c) any sensible design change, e.g. use more efficient electrical components, improve insulation of the casing, reduce resistance in the circuit oe **B1**

(c) Answer: **Example: use lower-resistance components/wiring so less energy is wasted as heat.**

Question 7

(a) correct substitution: 2 x 3 **M1**

(a) 6 kWh cao **A1**

(a) Answer: **6 kWh**

(b) correct substitution: 6 x 28 (ft from a) **M1**

(b) 168p or £1.68 cao **A1**

(b) Answer: **£1.68**

Question 8

(a) correct substitution: 0.5 x 900 x 40 **M1**

(a) 18000 J cao **A1**

(a) Answer: **18000 J**

(b) 18 kJ ft from (a) **B1**

(b) Answer: **18 kJ**

Question 9

(a) False; energy cannot be created or destroyed, only transferred between stores or dissipated, oe **B1**

(a) Answer: **False - energy cannot be created or destroyed, only transferred between stores.**

(b) True cao **B1**

(b) Answer: **True**

(c) False; power is measured in watts (W); joules (J) is the unit of energy, oe **B1**

(c) Answer: **False - power is measured in watts (W), not joules.**

(d) True cao **B1**

(d) Answer: **True**

Question 10

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

(a) to the thermal energy store of the bread (and the toaster's heating elements) oe **B1**

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

(b) thermal energy transferred (by heating) to the surrounding air through the toaster's casing/vents oe **B1**

(b) Answer: **Energy is transferred by heating to the surrounding air through the toaster's casing.**

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Question 11

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	**M1**
comparison that LED uses 172800 J less per hour or is 1/5 the energy (oe)	**A1**

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 12

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	**M1**
link to energy dissipation or wasted energy leaving the system (oe)	**A1**

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 13

Level 3 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.	**5-6**
Level 2 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.	**3-4**
Level 1 Simple statements about one or more options with little or no reasoning or comparison. No clear recommendation.	**0-2**

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 14

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

Question 15

kinetic energy -> thermal energy in the brake pads/wheels	**M1**
some energy transferred to the surroundings as thermal radiation or sound energy	**M1**
description linking slowing to decrease in kinetic energy and increase in heat (oe)	**A1**

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.**

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