K13D Energy: Exam Drill

AQA AQA KS3 Science - Physics · Calculator allowed · about 70 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 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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2 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)**

3 Use the Physics Equations Sheet: KE = 1/2 x m x v^2. A cyclist and bicycle together have a mass of 70 kg and are travelling at a speed of 8 m/s.

(a) Calculate the kinetic energy store of the cyclist and bicycle together. Give your answer in joules. **(2)**

....

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

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4 Use the Physics Equations Sheet: GPE = m x g x h, where g = 10 N/kg. A diver of mass 55 kg stands on a diving board 3 m above the water.

(a) Calculate the gravitational potential energy store of the diver, relative to the water. **(2)**

....

(b) The diver falls freely from the board into the water (ignore air resistance). State what happens to this gravitational potential energy store as the diver falls. **(1)**

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5 The diver in Question 4 falls freely from rest and air resistance can be ignored. Use the Physics Equations Sheet: KE = 1/2 x m x v^2. Show that the diver's speed just before hitting the water is about 7.7 m/s.

(4)

6 Use the Physics Equations Sheet: efficiency = (useful output energy transferred / total input energy transferred) x 100. An electric motor is supplied with 150 J of electrical energy. Only 90 J is usefully transferred to lift a load; the rest is wasted, mostly as heat and sound from the motor.

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

....

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

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7 Use the Physics Equations Sheet: P = E / t. A hairdryer transfers 3000 J of energy in 25 s. Calculate the power of the hairdryer.

(2)

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8 An electric desk fan has a total power input of 45 W. Of this, 36 W is usefully transferred to the kinetic energy store of the moving air. The rest is wasted, mostly heating the motor.

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

....

(b) Use the Physics Equations Sheet: efficiency = (useful output power / total input power) x 100. Calculate the efficiency of the fan. **(2)**

....

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

9 Use the Physics Equations Sheet: energy transferred (kWh) = power (kW) x time (hours). An electric oven has a power rating of 3 kW and is used for 1.5 hours. Electricity costs 30p per kWh.

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

....

(b) Calculate the total cost of running the oven for the 1.5 hours. **(2)**

....

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10 Complete the table by classifying 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)**

11 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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12 Use the Physics Equations Sheet: 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 degrees C).

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

....

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

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13 Use the Physics Equations Sheet: 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)

14 Use the Physics Equations Sheet: work done = force x distance and P = E / t, where g = 10 N/kg. A weightlifter raises a 120 kg barbell (weight = 1200 N) through a height of 2.1 m.

(a) Calculate the work done raising the barbell. **(2)**

....

(b) In competition, the lift takes 1.5 s. Calculate the weightlifter's power output during the lift. **(2)**

....

(c) A fitness enthusiast performs the same lift slowly, taking 6 s instead of 1.5 s. State and explain how their power output compares with the competition lift, even though the same work is done. **(1)**

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15 Required practical: 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 degrees 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.

(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)**

16 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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17 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)**

18 In a particular year, the UK generated electricity from these sources: natural gas 35%, nuclear 20%, wind 28%, solar 4%, hydroelectric 2%, biomass 6%, coal 5%.

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

....

(b) Suggest one advantage and one disadvantage of relying on nuclear power for a fifth of the UK's electricity. **(2)**

Mark scheme · K13D Energy: Exam Drill

Question 1

- (a) **B1** elastic potential (energy store) cao
- (a) Answer: **Elastic potential energy store**
- (b) **B1** kinetic (energy store) cao
- (b) Answer: **Kinetic energy store**
- (c) **B1** thermal (energy store) cao
- (c) Answer: **Thermal energy store**
- (d) **B1** chemical (energy store) cao
- (d) Answer: **Chemical energy store**

Question 2

- (a) **B1** energy is transferred electrically (from the mains/electrical energy store)
- (a) **B1** to the thermal energy store of the bread (and the toaster's heating elements) oe
- (a) Answer: **Electrical energy is transferred to the thermal energy store of the bread.**
- (b) **B1** thermal energy transferred (by heating) to the surrounding air through the toaster's casing/vents oe
- (b) Answer: **Energy is transferred by heating to the surrounding air through the toaster's casing.**

Question 3

- (a) **M1** correct substitution: $KE = 0.5 \times 70 \times 8^2$
- (a) **A1** 2240 J cao
- (a) Answer: **2240 J**
- (b) **B1** 2.24 kJ ft from (a)
- (b) Answer: **2.24 kJ**

Question 4

- (a) **M1** correct substitution: $GPE = 55 \times 10 \times 3$
- (a) **A1** 1650 J cao
- (a) Answer: **1650 J**
- (b) **B1** transferred to the kinetic energy store (of the diver) oe
- (b) Answer: **It is transferred to the diver's kinetic energy store.**

Question 5

- **M1** recognise energy conservation: KE at the bottom = GPE at the top (= 1650 J, ft from Q4a)
- **M1** rearrange $KE = 1/2 \times m \times v^2$ to make v the subject: $v = \sqrt{2 \times KE / m}$
- **A1** correct substitution and evaluation: $v = \sqrt{2 \times 1650 / 55} = \sqrt{60}$
- **A1** v = 7.7 m/s (2 s.f.), consistent with the given value of about 7.7 m/s cso
- Answer: **v = 7.7 m/s (7.75 m/s to 3 s.f.)**

Question 6

- (a) **M1** correct substitution: $(90 / 150) \times 100$
- (a) **A1** 60% cao
- (a) Answer: **60%**
- (b) **B1** energy is wasted/dissipated (e.g. as heat from friction in the motor's moving parts, or as sound) to the surroundings oe
- (b) Answer: **Energy is wasted as heat (from friction) and sound to the surroundings.**

Question 7

- **M1** correct substitution: $P = 3000 / 25$
- **A1** 120 W cao
- Answer: **120 W**

Question 8

- (a) **B1** 9 W cao
- (a) Answer: **9 W**
- (b) **M1** correct substitution: (36 / 45) x 100
- (b) **A1** 80% cao
- (b) Answer: **80%**
- (c) **B1** any sensible design change, e.g. reduce friction in the bearings/motor, use more efficient motor components, lubricate moving parts, oe
- (c) Answer: **Example: reduce friction in the motor's bearings so less energy is wasted as heat.**

Question 9

- (a) **M1** correct substitution: 3 x 1.5
- (a) **A1** 4.5 kWh cao
- (a) Answer: **4.5 kWh**
- (b) **M1** correct substitution: 4.5 x 30 (ft from a)
- (b) **A1** 135p or GBP 1.35 cao
- (b) Answer: **GBP 1.35**

Question 10

- (a) **B1** renewable cao
- (a) Answer: **Renewable**
- (b) **B1** renewable cao
- (b) Answer: **Renewable**
- (c) **B1** non-renewable cao
- (c) Answer: **Non-renewable**
- (d) **B1** non-renewable cao
- (d) Answer: **Non-renewable**
- (e) **B1** renewable cao
- (e) Answer: **Renewable**
- (f) **B1** non-renewable cao
- (f) Answer: **Non-renewable**

Question 11

- (a) **B1** conduction cao
- (a) Answer: **Conduction**
- (b) **B1** convection cao
- (b) Answer: **Convection**
- (c) **B1** radiation (infrared radiation) cao
- (c) Answer: **Radiation**
- (d) **B1** conduction cao
- (d) Answer: **Conduction**

Question 12

- (a) **M1** correct substitution: 0.5 x 900 x 40
- (a) **A1** 18000 J cao
- (a) Answer: **18000 J**
- (b) **B1** 18 kJ ft from (a)
- (b) Answer: **18 kJ**

Question 13

- **M1** convert washing machine time to hours: 45 / 60 = 0.75 h (or work consistently in another unit)
- **A1** washing machine energy = 1500 x 0.75 = 1125 Wh (1.125 kWh)
- **M1** console energy = 100 x 5 = 500 Wh (0.5 kWh)
- **A1** correct comparison and conclusion: 1125 Wh > 500 Wh, so the washing machine transfers more total energy cso
- Answer: **Washing machine = 1125 Wh (1.125 kWh); games console = 500 Wh (0.5 kWh); the washing machine transfers more energy overall.**

Question 14

- (a) **M1** correct substitution: 1200 x 2.1
- (a) **A1** 2520 J cao
- (a) Answer: **2520 J**
- (b) **M1** correct substitution: P = 2520 / 1.5, ft from (a)
- (b) **A1** 1680 W cao
- (b) Answer: **1680 W**
- (c) **B1** power output is lower, because power = work done / time, and the same energy is transferred over a longer time, oe
- (c) Answer: **Power output is lower, because the same work is done over a longer time, and power is the rate of energy transfer.**

Question 15

- (a) **B1** independent variable = type of wrapping material (oe)
- (a) **B1** dependent variable = time taken for the ice cube to melt (oe)
- (a) Answer: **Independent variable: type of wrapping material. Dependent variable: time taken to melt.**
- (b) **B1** any one of: size/mass of ice cube, starting temperature of the ice, room temperature, thickness of wrapping, position in the room
- (b) **B1** a second, different valid control variable from the list above
- (b) Answer: **Any two of: same size/mass of ice cube, same starting temperature, same room temperature, same thickness of wrapping.**
- (c) **M1** aluminium foil is a metal and a good conductor of thermal energy
- (c) **A1** 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
- (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 16

- **Level 1** (1-2): Basic, isolated statements about insulation are made, with little or no reference to cost, savings, or how the method reduces energy transfer.
- **Level 2** (3-4): 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.
- **Level 3** (5-6): 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.
- **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).

Question 17

- (a) **B1** False; energy cannot be created or destroyed, only transferred between stores or dissipated, oe
- (a) Answer: **False - energy cannot be created or destroyed, only transferred between stores.**
- (b) **B1** True cao
- (b) Answer: **True**
- (c) **B1** False; power is measured in watts (W); joules (J) is the unit of energy, oe
- (c) Answer: **False - power is measured in watts (W), not joules.**
- (d) **B1** True cao
- (d) Answer: **True**

Question 18

- (a) **M1** correct addition: 28 + 4 + 2 + 6
- (a) **A1** 40% cao
- (a) Answer: **40%**
- (b) **B1** advantage: produces electricity reliably regardless of weather, or produces very little carbon dioxide while generating, oe
- (b) **B1** disadvantage: produces radioactive waste that must be safely stored for a long time, or is expensive/slow to build, oe
- (b) Answer: **Advantage: it generates electricity reliably, regardless of the weather. Disadvantage: it produces radioactive waste that needs safe, long-term storage.**