

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.1.1.2 CHANGES IN ENERGY (PACK 1)

SCORE

/92

PERCENTAGE

%

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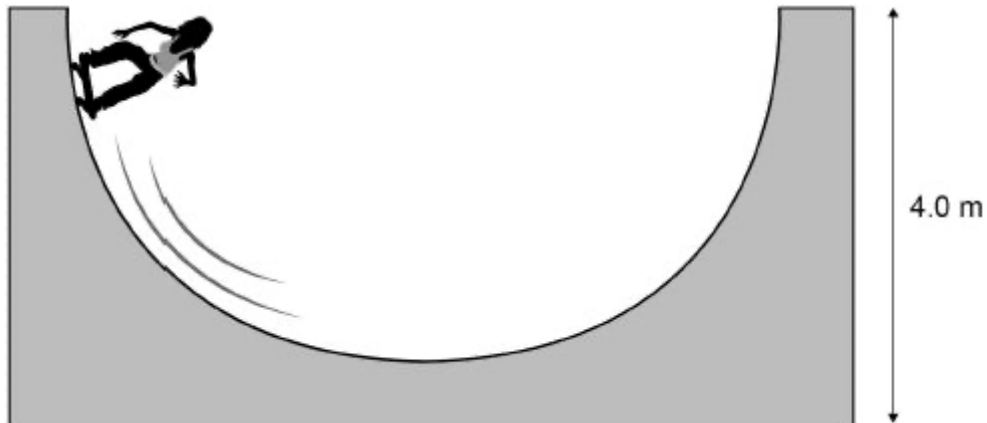
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Q1.

The diagram below shows a girl skateboarding on a semi-circular ramp.



The girl has a mass of 50 kg

- (a) Calculate the gravitational potential energy (g.p.e.) of the girl at the top of the ramp.

Use the equation:

$$\text{g.p.e.} = \text{mass} \times \text{gravitational field strength} \times \text{height}$$

$$\text{gravitational field strength} = 9.8 \text{ N/kg}$$

$$\text{g.p.e.} = \text{_____} \text{ J}$$

(2)

- (b) The girl has a speed of 7 m/s at the bottom of the ramp.

Calculate the kinetic energy of the girl at the bottom of the ramp.

Use the equation:

$$\text{kinetic energy} = 0.5 \times \text{mass} \times (\text{speed})^2$$

$$\text{Kinetic energy} = \text{_____} \text{ J}$$

(2)

- (c) Not all of the g.p.e. has been transferred to kinetic energy.

Which **two** statements explain why?

Tick **two** boxes.

Some energy is wasted.

☐

The mass of the girl is too low.

☐

The ramp is not high enough.

☐

The g.p.e. of the girl is not zero.

☐

The speed of the girl is too great.

☐

(2)

- (d) Explain how lubricating the wheels of the skateboard can increase the speed of the girl.

Use ideas about energy in your explanation.

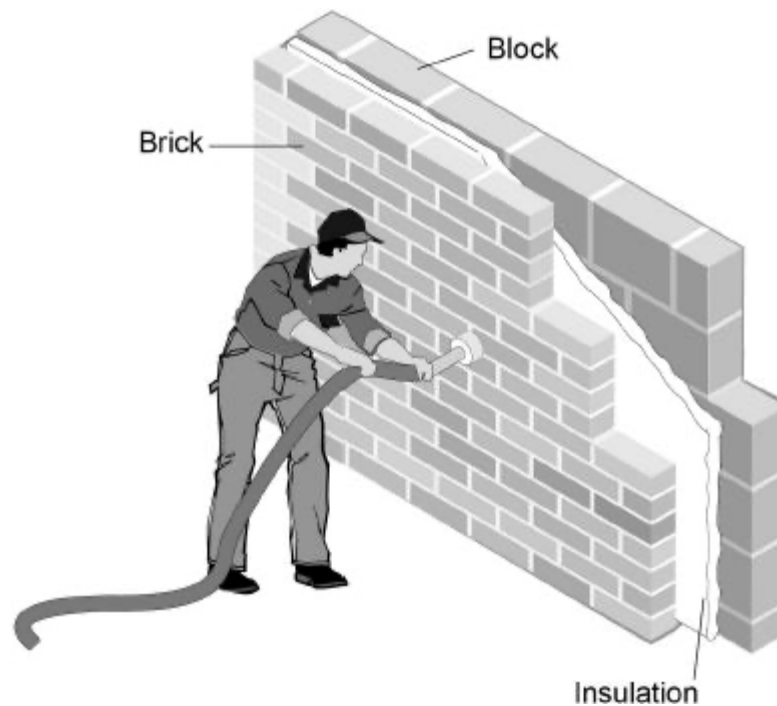
(3)

(Total 9 marks)

Q2.

Figure 1 shows cavity wall insulation being installed in the wall of a house.

Figure 1



(a) Explain how the wall reduces unwanted energy transfers.

(3)

(b) The cavity insulation was tested.

- The heating inside the house was switched off.
- The temperature inside the house was measured every 20 minutes for 2 hours.

The table below shows the results.

Time in minutes	Temperature in °C
0	25.0
20	20.8
40	17.4
60	14.5
80	12.1

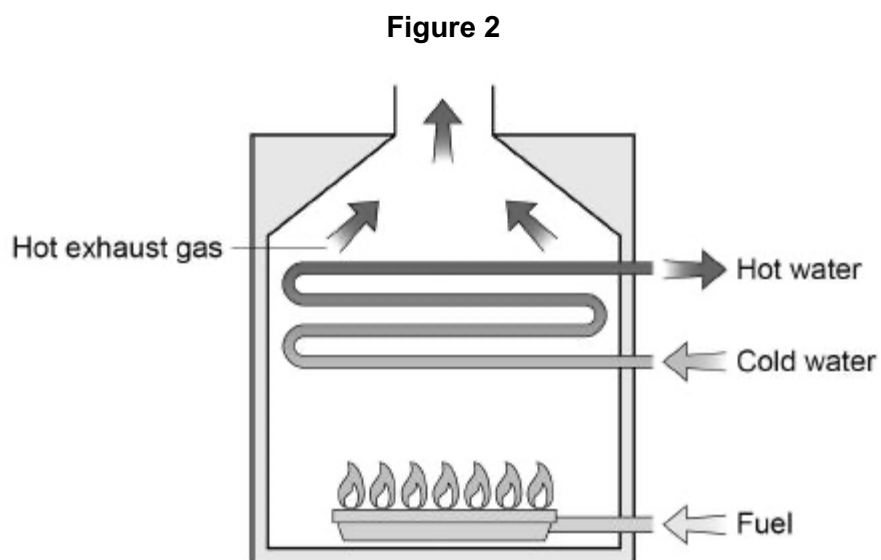
100	10.0
120	8.4

Determine the temperature inside the house after 30 minutes.

Temperature = _____ °C

(2)

- (c) **Figure 2** shows the gas boiler used to heat the house.



Describe how different energy stores are changed by the boiler.

(3)

- (d) To heat the house, the boiler transfers 15 MJ of energy in 10 minutes.

Calculate the power of the boiler.

Write any equation that you use.

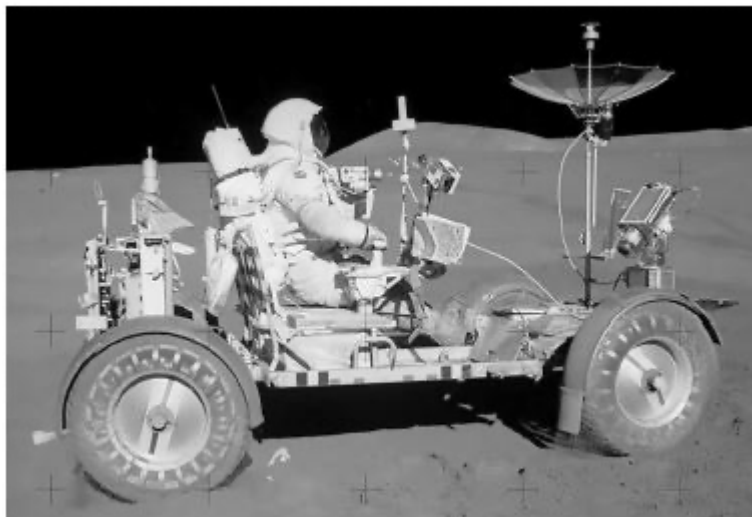
Power = _____ W
(4)
(Total 12 marks)

Q3.

Astronauts have been to the Moon.

- (a) Astronauts moved around the surface of the Moon in a lunar rover.

The photograph below shows a lunar rover.



The batteries on the lunar rover provided a potential difference of 36 V

The total charge stored in the batteries was 870 000 C

Calculate the maximum energy that could have been transferred from the batteries.

Use the equation:

$$\text{energy transferred} = \text{charge flow} \times \text{potential difference}$$

Maximum energy transferred = _____ J

(2)

- (b) Not all of the energy from the batteries was usefully transferred to the kinetic energy of the lunar rover.

Explain why.

(2)

The astronauts collected rock samples from the Moon.

Scientists analysed the percentages of elements in Moon rock and Earth rock.

The table below shows the results.

Element	Percentage in Moon rock	Percentage in Earth rock
Aluminium	8	8
Iron	13	5
Oxygen	42	47
Silicon	X	28
Other elements	10	12

(c) Calculate value **X** in the table above.

X = _____ %

(1)

(d) Give **one** similarity and **one** difference between Moon rock and Earth rock.

Use the table above.

Similarity _____

Difference _____

(2)

(e) Scientists used to think the Earth and Moon formed separately.

Scientists now believe that the Moon formed after a collision between the Earth and a small planet.

This new idea came from the study of Moon rocks.

Why do scientific theories sometimes change?

Tick **one** box.

Scientists agree that the existing theory is old-fashioned

☐

Scientists change their theories to make the theories more popular

☐

Scientists decide that the new theory is more exciting

☐

Scientists discover new evidence which the existing theory cannot explain

☐

(1)

- (f) Write down the equation which links gravitational field strength, gravitational potential energy, height and mass.

(1)

- (g) When the astronauts left the Moon, they used a spacecraft with a mass of 2150 kg

Calculate the height reached by the spacecraft at the point where it had a gravitational potential energy of 86 000 000 J

The gravitational field strength of the Moon is 1.6 N/kg

Height = _____ m

(3)

(Total 12 marks)

Q4.

The image shows a girl riding a self-balancing scooter.



- (a) The scooter has an electric motor powered by a battery.

During the ride the battery transfers 15 000 C of charge.

The potential difference across the battery is 36 V

Calculate the energy transferred by the battery.

Use the equation:

$$\text{energy transferred} = \text{charge flow} \times \text{potential difference}$$

Give your answer in kJ

Energy transferred = _____ kJ

(3)

The table gives data for two scooters with different motors.

Both motors have the same efficiency.

	Power of motor in W	Mass in kg
Scooter A	500	10.5
Scooter B	700	14.0

- (b) Explain why scooter **B** has a higher maximum speed.

(2)

- (c) Both scooters can be ridden for 20 minutes before the battery needs recharging.
Compare the amount of chemical energy stored in the batteries of each scooter.

(1)

- (d) Write the equation that links energy transferred, power and time.

(1)

- (e) Calculate the energy transferred by the motor in scooter **B** in 20 minutes.

Energy transferred = _____ J

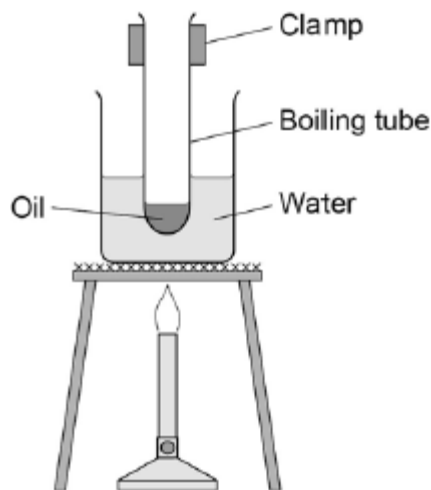
(3)

(Total 10 marks)

Q5.

A student investigated the change in temperature when oils of different specific heat capacities were heated.

She set up the apparatus shown in the figure below.



This is the method used.

1. Put 25 g of oil into a boiling tube.
2. Pour 100 ml of water into a beaker and heat it with a Bunsen burner.
3. When the water is boiling, put the boiling tube into the beaker.
4. When the temperature of the oil reaches 30 °C, heat for a further 30 seconds and record the rise in temperature.
5. Repeat with different oils.
6. Repeat the whole investigation.

- (a) Name **two** pieces of apparatus the student used that are **not** shown in the figure above.

1. _____
2. _____

(2)

- (b) What are the independent and dependent variables in the student's investigation?

Independent _____

Dependent _____

(2)

- (c) Give **two** safety precautions the student should have taken.

1. _____
2. _____

(2)

- (d) Suggest **one** improvement to the student's method.

(2)

(e) The table below shows the student's results.

Type of oil	Temperature rise in °C			
	1	2	3	Mean
Castor oil	20	19	21	20
Linseed oil	19	18	19	19
Mineral oil	21	21	21	21
Olive oil	17	17	18	
Sesame oil	23	23	20	22

Calculate the mean temperature rise for olive oil.

Give your answer to two significant figures.

Mean temperature rise = _____ °C

(2)

(f) The mean change in temperature of the castor oil is 20 °C

The specific heat capacity of castor oil is 1 800 J / kg °C

The mass of oil used is 0.025 kg

Calculate the change in thermal energy of the castor oil the student used.

Use the correct equation from the Physics Equations Sheet.

Select the correct unit from the box.

joule	newton	volt
-------	--------	------

Change in thermal energy = _____

Unit = _____

(3)
(Total 13 marks)

Q6.

Figure 1 shows a battery operated remote control car.

Figure 1



© Brandon Bolin/iStock/Thinkstock

- (a) The car's battery contains a store of energy.
- As the car moves, energy from one store is transferred to another store.
- Describe how different stores of energy change as the car moves.

(2)

- (b) The car has a top speed of 12 m / s and a mass of 800 g.
- Write down the equation that links kinetic energy, mass and speed.

Equation _____

(1)

- (c) Calculate the maximum kinetic energy of the car.

Maximum kinetic energy = _____ J

(2)

- (d) Explain why having a more efficient motor increases the top speed of the car.

(2)

- (e) **Figure 2** shows an electric car being charged.

Figure 2



By Alan Trotter Electric Car Charging [CC-BY-2.0]via Flickr

A driver wishes to buy a new car.

The table below gives some data about an electric car and one with a petrol engine.

	Electric car	Petrol engine car
Cost (£)	27 000	15 000
Running cost per year (£)	250	2 000
Average lifetime (years)	12	12

Which car would be the most economic over its 12 year lifetime?

Use data from the table above to support your answer.

You should include the difference in cost in your answer.

(4)
(Total 11 marks)

Q15.

(a) A washing machine washes dirty clothes and then spins the clothes to remove some of the water.

(i) Use the correct words from the box to complete the sentence.

chemical	electrical	kinetic	sound
----------	------------	---------	-------

When the washing machine spins the clothes, _____
energy is transferred into useful _____ energy.

(2)

(ii) Name **one** type of energy the washing machine wastes when spinning the clothes.

(1)

(iii) What eventually happens to all the wasted energy?

Tick **one** box.

The wasted energy is transferred to the clothes.

☐

The wasted energy is transferred to the surroundings.

☐

The wasted energy is trapped and is re-used.

☐

(1)

(b) The table shows information about two different washing machines, **A** and **B**.

	Washing machine A	Washing machine B
Cost to buy	£269	£249
Maximum wash load	8 kg	7 kg
Energy transferred in one wash cycle	0.7 kWh	1.2 kWh
Water used in one wash cycle	48 litres	50 litres

Use the information in the table to give **one** advantage and **one** disadvantage of washing machine **A** compared with washing machine **B**.

Advantage _____

Disadvantage _____

(2)

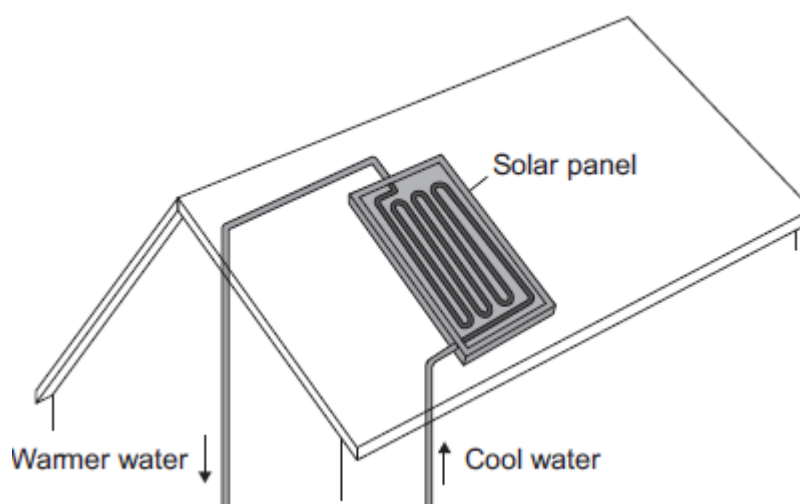
(Total 6 marks)

Q16.

Solar panels can heat water for use in a home.

Figure 1 shows a solar panel on the roof of a house.

Figure 1



(a) The solar panel is designed to transfer as much energy to the water as possible.

(i) Draw a ring around the correct answer to complete the sentence.

The solar panel is black to increase energy transferred to the water by

conduction. **infrared radiation.**

(1)

(ii) Draw a ring around the correct answer to complete the sentence.

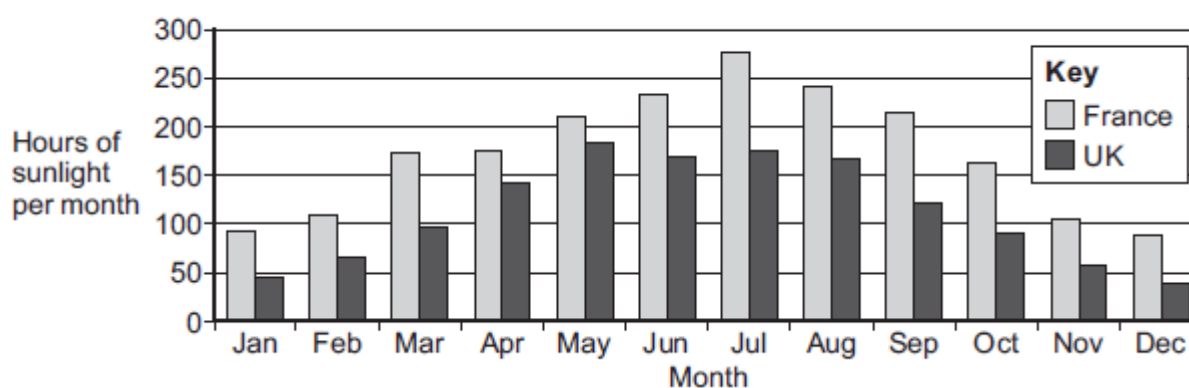
Solar panels usually have a large surface area so that more energy can be

absorbed. **emitted.** **reflected.**

(1)

(b) **Figure 2** shows the hours of sunlight each month for one year in France and in the UK.

Figure 2



Solar panels are used more in France than in the UK.

Use **Figure 2** to explain why.

(2)

- (c) The solar panel heats 200 kg of water each day. On one day it increases the temperature of the water by 50 °C.

The specific heat capacity of water is 4200 J / kg °C.

Calculate the energy needed to increase the temperature of 200 kg of water by 50 °C.

Use the correct equation from the Physics Equations Sheet.

Tick (✓) the correct unit.

Energy = _____

	Tick (✓)
joules	
seconds	
watts	

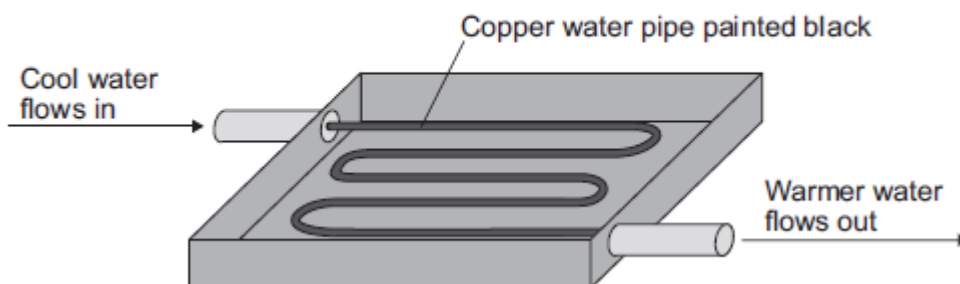
(3)

(Total 7 marks)

Q17.

- (a) **Figure 1** shows a solar panel. Solar panels can be fitted to house roofs and used to heat water for domestic hot water systems.

Figure 1



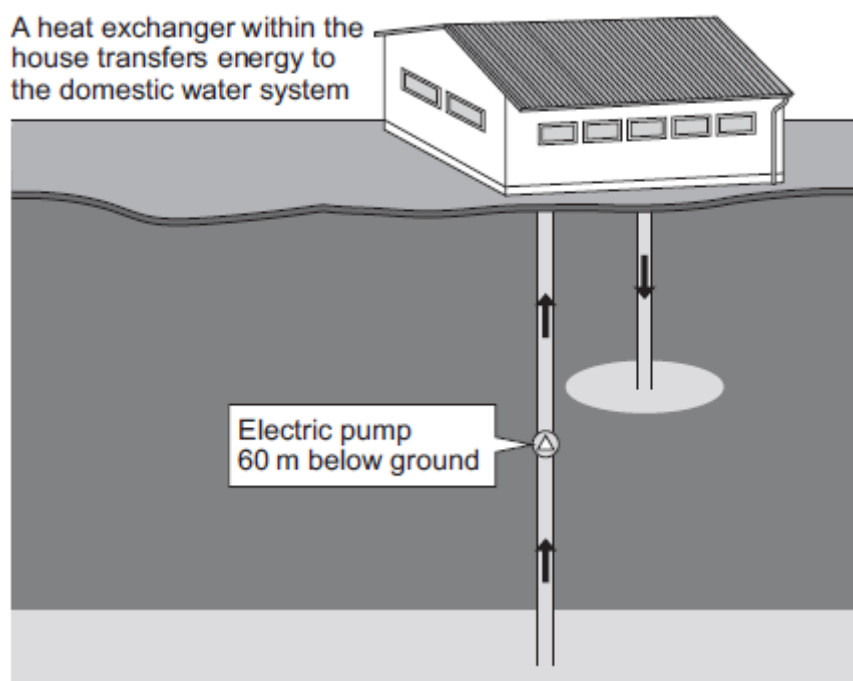
Use **Figure 1** to explain how the design of the water pipe increases the rate of

energy transfer from the Sun to the water.

(3)

- (b) **Figure 2** shows a different method of heating water called a ground source heat pump. Two holes are drilled into the ground and fitted with pipes. Warm water is pumped up one pipe and waste water is returned to the ground through the other pipe. In the house, energy is transferred from the warm water by a heat exchanger.

Figure 2



- (i) Suggest **one** advantage of using this method of heating water rather than using solar panels.

(1)

- (ii) A leaflet about a ground source heat pump states:

‘Ground source heat pumps are 300 – 400% efficient. For each joule of mains electrical energy the pumps use, they transfer three to four times more energy from the water’.

Two students read the leaflet.

Student **A** says, 'It is incorrect to say that a device is 300 – 400% efficient'.

Student **B** says, 'The statement is correct'.

Both conclusions could be considered to be correct.

Explain why.

Student **A**'s conclusion _____

Student **B**'s conclusion _____

(4)

- (iii) Domestic water enters the heat exchanger at a temperature of 7.0 °C and leaves the heat exchanger at a temperature of 55 °C.

Each day 19 000 000 joules of energy are supplied to the water passing through the heat exchanger.

Calculate the mass of water that can be heated each day.

Choose the correct equation from the Physics Equations Sheet.

Specific heat capacity of water = 4200 J / kg °C.

Give your answer to 2 significant figures.

Mass of water = _____ kg
(4)
(Total 12 marks)

Mark schemes

Q1.

- (a) $E_p = 50 \times 9.8 \times 4.0$ 1
- $E_p = 1960 \text{ (J)}$
allow an answer rounded to 2000 (J) 1
allow a maximum of 1 mark if $g = 10 \text{ N/kg}$ is used
an answer of 1960 scores 2 marks
- (b) $E_k = 0.5 \times 50 \times 7^2$ 1
- $E_k = 1225 \text{ (J)}$
allow 1200 or 1230 (J) 1
an answer of 1225 scores 2 marks
- (c) some energy is wasted 1
- the g.p.e of the girl is not zero 1
- (d) reduces the amount of friction
*do **not** accept reference to friction between the wheels and the ramp* 1
- so more energy is usefully transferred
*allow less energy is wasted **or** less heating* 1
- greater kinetic energy 1
- [9]

Q2.

- (a) the wall has two / three layers
allow the wall is thick 1
- cavity wall insulation / brick / block has a low thermal conductivity 1
- so less energy is transferred by conduction
allow rate of energy transfer is lower
ignore any reference to convection and / or radiation 1
- (b)

$$T = 17.4 + \left(\frac{(20.8 - 17.4)}{2} \right)$$

or

$$T = 20.8 + \left(\frac{(20.8 - 17.4)}{2} \right)$$

1

$$T = 19.1 (^{\circ}\text{C})$$

1

an answer in the range 18.5–19.1 scores **2** marks

- (c) chemical energy store of the fuel decreases

1

thermal energy store of the water increases

allow kinetic energy store of the water particles increases

1

thermal energy store of the air / atmosphere increases

allow kinetic energy store of the air particles increases

1

- (d) $E = 15\,000\,000 \text{ (J)}$

1

$$t = 600 \text{ (s)}$$

1

$$P = \frac{15\,000\,000}{600}$$

allow a correct substitution of incorrectly / not converted values of E and / or t

1

$$P = 25\,000 \text{ (W)}$$

allow a correct calculation using incorrectly / not converted values of E and / or t

1

[12]

Q3.

- (a) $870\,000 \times 36$

1

$$31\,320\,000 \text{ (J)}$$

or

$$3.1 \times 10^7 \text{ (J)}$$

allow 31 000 000 (J)

or 31 300 000(J)

1

*an answer 31 320 000 (J) scores **2** marks*

- (b) some energy was wasted / dissipated
allow efficiency is always less than 100% 1
- (and) transferred to thermal energy 1
- (c) 27 (%) 1
- (d) **similarity**
 any **one** from:
- contain same amount of aluminium
 - contain (very) similar amounts of silicon
ignore same amount of silicon unless their answer to part (c) was 28%
 - oxygen makes up the highest percentage
allow both contain aluminium, iron, oxygen and silicon 1
- difference**
 any **one** from:
- Moon rock contains more iron (than Earth rock)
 - Moon rock contains less oxygen (than Earth rock)
 - Moon rock contains less silicon (than Earth rock)
allow ecf from part (c) 1
- do **not** allow 2 marks for silicon as both similarity and difference*
- (e) scientists discover new evidence which the existing theory cannot explain 1
- (f) gravitational potential energy = mass × gravitational field strength × height
allow $E_p = mgh$ 1
- (g) $86\,000\,000 = 2150 \times 1.6 \times h$ 1
- $(h =) \frac{86\,000\,000}{2150 \times 1.6}$ 1
- $(h =) 25\,000 \text{ (m)}$ 1
- an answer 25 000 (m) scores 3 marks*
- [12]

Q4.

- (a) $E = 15\,000 \times 36$ 1
- $E = 540\,000$

		1
	$E = 540 \text{ (kJ)}$	
	<i>an answer of 540 (kJ) scores 3 marks</i>	
		1
(b)	(the motor in) scooter B has a higher power	1
	therefore	
	(because both motors have the same efficiency) scooter B will have a greater kinetic energy	
		1
(c)	the battery in scooter B has a greater store of chemical energy	1
(d)	energy transferred = power $\times$ time <i>allow $E = P \times t$</i>	1
(e)	20×60	1
	$E = 1\,200 \times 700$	1
	$E = 840\,000 \text{ (J)}$	
	<i>an answer of 840 000 (J) scores 3 marks</i>	
		1
		[10]

Q5.

(a)	thermometer	1
	stopclock / stopwatch	
	<i>accept measuring cylinder</i>	
	<i>accept top pan balance</i>	1
(b)	independent: type of oil	1
	dependent: temperature rise in $^{\circ}\text{C}$	1
(c)	wear safety goggles	1
	oil not heated directly	
	<i>accept any reasonable comment about not handling hot apparatus.</i>	1
(d)	repeat the experiment	1

and calculate the mean temperature rise

OR

heat the oil for a longer period of time (1)

to get a wider range of temperatures (1)

1

(e) $(17 + 17 + 18) / 3 (= 17.33)$

1

temperature rise = 17 (°C)

1

accept 17 (°C) with no working shown for 2 marks

allow 17.33 with no working shown for 1 mark

(f) $E = 0.025 \times 1800 \times 20$ (J)

1

$E = 900$ (J)

1

allow 900 without working shown for the 2 calculation marks

Joule

1

[13]

Q6.

(a) the store of chemical energy (in the battery) decreases

1

the internal energy of the surrounding air increases.

1

accept description of energy becoming less usefully stored for 2 marks

(b) kinetic energy = $\frac{1}{2}$ mass $\times$ velocity²

1

(c) $E_k = \frac{1}{2} \times 0.8 \times 12^2$

1

$E_k = 57.6$ (J)

1

allow 57.6 (J) without working shown for 2 marks

(d) lower proportion of wasted energy
accept less energy is wasted

1

higher proportion of energy is converted into kinetic energy
accept more kinetic energy

1

(e) **Level 2 (3–4 marks):**

A relevant and coherent argument which demonstrates processing and numerical

analysis of the information presented and draw a conclusion which is logically consistent with the reasoning and refers to payback time for the vehicles.

Level 1 (1–2 marks):

Simple comparisons are made which demonstrate a basic ability to numerically analyse the information presented. The conclusion, if present, may not be consistent with the calculations.

0 marks:

No relevant content

Indicative content

- The electric car costs £12 000 more to buy
- Running cost of electric car = £3 000
- Running cost of petrol engine car = £24 000
- Total cost of electric car = £30 000
- Total cost of petrol engine car = £39 000
- The electric car cost £1 750 less to run each year
- The electric car will save £9 000
- Additional cost is covered in 6.9 years
- So the electric car will be cheaper over the 12 year lifetime

or

Electric

$$27000 / 12 = 2250$$

$$\text{Annual cost} = 2250 + 250 = 2500$$

Petrol

$$15000 / 12 = 1250$$

$$\text{Annual cost} = 1250 + 2000 = 3250$$

So electric is £750 cheaper per year

4

[11]

Q15.

- (a) (i) electrical
answers must be in the correct order

1

kinetic

1

- (ii) any **one** from:
- thermal (energy)
 - sound (energy).
 - allow "heat" (energy)*

1

- (iii) The wasted energy is transferred to the surroundings

1

- (b) *advantage of A:*
answers must be comparative

1

any **one** from:

- bigger wash load
- uses less energy
allow uses less electricity
- uses less water.

disadvantage of A:

higher cost (to buy)

1

[6]

Q16.

- (a) (i) infrared radiation

1

- (ii) absorbed

1

- (b) France has more hours of sunlight (all year round)

or

France has more hours of sunlight in every month of the year

accept the converse

allow France is sunnier

1

(so) there will be more energy to heat the water

or

(so) more energy can be absorbed / transferred

allow (so) more water can be heated

allow 'heat' for energy

1

- (c) 42 000 000

allow 4.2×10^7

allow for 1 mark correct substitution

200 × 4200 × 50 provided no subsequent step shown

or

42 000

2

joules

42 000 kJ = **3 marks**

1

[7]

Q17.

- (a) black (paint) is a good absorber of (infrared) radiation

allow 'heat' for radiation

ignore light / sunlight / energy

allow black (paint) is a good emitter of (infrared) radiation to the water

1

copper pipes are
good conductors (of energy)

1

the pipes have a large surface area to absorb (a lot of) energy

allow 'heat' for energy

ignore light / sunlight for energy

1

(b) (i) any **one** from:

- energy is available 24 hours a day
- constant supply of energy all year around
- works at night.

ignore no visual pollution

1

(ii) *Student A:*

max 3 marks if conclusions for student A and Student B are written in the wrong places.

nothing can be more than 100% efficient

1

(because the law of conservation of energy states that) energy cannot be created (or destroyed)

or

(because) some energy is always wasted to the surroundings

1

Student B:

the output heat energy is 3 to 4 times greater than the (electrical) energy input

1

so the efficiency is 3 or 4 which is 300 – 400 %

or

because additional energy is provided by the warm water from the ground

*allow a correct calculation of efficiency using either 3 or 4
joules for useful energy output*

1

(iii) 94 (kg)

*allow 3 marks for an answer with more than 2 significant
figures that rounds to 94 kg*

allow 2 marks for

$$19\,000\,000 = m \times 4200 \times 48$$

or

$$m = 19\,000\,000 / (4200 \times 48)$$

or

$$m = 19\,000\,000 / 201\,600$$

or

*correctly calculated mass using an incorrect temperature
change.*

allow 1 mark for a temperature rise of 48 °C

*allow 1 mark for a correct substitution using an incorrect
temperature change provided some evidence of working out
the temperature change is shown*

allow 1 mark for an incorrect answer correctly rounded to two significant figures, provided some evidence of working is shown

4

[12]

Examiner reports

Q1.

- (a) A straightforward calculation with a given equation. Students needed to use the height from the diagram and some did not do this and so only managed to calculate the weight but 83% of students scored both marks.
- (b) A slightly more difficult calculation but with a given equation, this question caused a few more problems with the squaring of the speed tripping up a few students but 76% were able to score both marks. A significant number made no attempt.
- (c) This multiple choice question about energy transfer proved difficult. A third of students gained both marks and just over a half scored one mark.
- (d) This question required an explanation in terms of the forces and the energy transferred. 57% of students scored zero and only a tenth scored more than 1 mark. The concept of energy was not well understood. There were frequent references to generating more energy or increasing gravitational potential energy. Even when the students recognised that the lubrication would reduce friction, they failed to understand what effect this would have.

Q2.

- (a) Very few students gained more than one mark on this question. This is a new specification point this year but the answer to the question is straight recall from the specification. Most students wrote vague answers about heat being contained inside and the cold not being allowed to enter. The starting point about the thickness of the wall was rarely mentioned and nor was the low thermal conductivity of the material.
- (b) 72% of students calculated this correctly, either using the method in the mark scheme, or by calculating the midpoint using $(20.8 + 17.4) / 2$. Of the incorrect responses, some students attempted to adjust the result to take into account the decreasing rate at which the temperature decreased, but were not always successful. Some students calculated the differences between the given temperatures, then the differences between the differences in order to determine the trend and then estimated the temperature at 30 minutes. Some students attempted to find an average temperature over a range of time, using various ranges.
- (c) 49% of students scored no marks. Only 17% of students scored more than one mark and fewer than 2% scored three marks. Many students appeared confused by the reference to energy stores, rather than being asked to simply identify a chain of energy changes. Most commonly, one mark was scored for referring to thermal energy being added to the water. There were very few who considered the thermal store of the air.

A fairly common misconception was that, despite clearly shown exiting the boiler as hot water, the water would be heated enough to boil and leave the boiler as steam – the implication being that the hot exhaust gas was formed in this way.

- (d) 75% of students gained at least one mark. Just over a tenth of students correctly carried out both conversions and achieved four marks. The most common mistake was in the conversion of 15 MJ into J but most students knew the equation and could substitute their sometimes incorrect conversions into the equation and calculate it correctly. A very simple answer saw $15 / 10 = 1.5$ often written down and this gave the student two marks. Unfortunately a few students calculated energy $\times$

time and could only obtain the conversion marks if done correctly.

Q3.

- (a) Around three quarters of students gained the two marks for this calculation.

10% did not attempt it, and a small number of students divided the two given numbers.

Some students worked out the correct answer, then divided by 1000, possibly because the answer of 31 320 000 J looked very large.

- (b) Around one quarter of students did not attempt this question. Few realised that this was a question about useful and wasted energy and only 6% gained both marks. Those who scored one mark tended to get it for the mention of thermal / heat energy.

A common incorrect response was to refer to the energy being 'lost' rather than 'wasted'. Many seemed to think that the Moon's gravity affected how the energy from the batteries was transferred to kinetic energy.

- (c) Around 6% of students did not attempt this question. Around one third gave the correct value of 27%.

A fairly common incorrect answer was 73%, where the given values had been added, but not subtracted from 100.

There were a large number of answers in the region of 27, indicating that students knew what to do but either added the values together incorrectly or subtracted from 100 incorrectly. In some cases, working was shown which confirmed this.

- (d) 12% of students did not attempt this question. Around one third of students were able to correctly identify both a similarity and a difference from the table, the majority choosing the aluminium and iron percentages respectively.

Despite the instruction to use the table of data, many students stated similarities and differences in texture, hardness, gravity, colour, density, etc. Such answers gained no marks.

Some students, although using the table, did not score marks because they did not 'add value' to the data. This was relevant for the 'difference' mark, where a qualitative description of the difference was required. For instance, an answer or 'iron' or 'iron is different' did not gain a mark, whereas 'Moon rock contains a higher percentage of iron' did.

- (e) Around 85% of student responses were correct. Responses for the incorrect options were fairly evenly spread, with 'scientists change their theories to make the theories more popular' being chosen more than the other two.

- (f) This was the first occasion in this paper where an equation had to be recalled. Nearly one third of students left this blank.

Of those who wrote something, some wrote an equation which was totally unconnected to the quantities listed. Some wrote expressions which were not equations, i.e. did not have an equals sign. Some wrote equations in the form of chemical equations, e.g. gravitational potential energy + mass → gravitational field strength + height.

Of those who wrote a mathematical equation connecting the given quantities, less than 20% gave a correct form of the equation to gain the mark.

- (g) More than one quarter of students left this blank, which tied in with the fact that many had left the previous question blank because they did not know the gravitational potential energy equation.

Of the students who attempted this calculation, many had difficulty manipulating an equation linking four quantities. Many combinations of the given values were seen, the most popular being to multiply the energy value by one of the other two quantities and then divide by the third. Some students took all three numbers, or just two of them and multiplied them together.

Q15.

- (a) (i) Some students gave the correct answers, but in the wrong order. Chemical energy was sometimes given for the starting energy and sound for the useful energy.
- (ii) Sound was the most common correct answer given for the energy wasted by the washing machine. Thermal energy was rarely mentioned. Quite a lot of students thought that electrical energy was wasted.
- (iii) Three quarters of students identified that the wasted energy is transferred to the surroundings.
- (b) Comparative statements were needed, so simply quoting figures did not gain a mark. Some students misunderstood the energy transferred per cycle and thought it was either energy wasted, or that using less energy meant that the machine was not as good.

Q16.

- (a) (i) Less than half the students correctly said that the solar panel is black to increase energy transfer to the water by infrared radiation. Almost as many thought it was to reduce energy transfer by conduction.
- (ii) The majority of students correctly said that the solar panels have a large surface area to absorb more energy.
- (b) Most students gained the first marking point for saying that there are more hours of sunlight in France. This was phrased in a variety of ways. Few students gained the second marking point due to poor use of language. Some reference to more energy being absorbed was required. 'More sun' or 'more light' were ignored.
- (c) Most students gained at least 1 mark for either substituting correctly into the equation, or for selecting the correct unit. There were quite a lot who did not attempt the question, and did not select a unit, which might have been worth a guess. Those who gained two marks were able to correctly calculate the energy needed but then gave an incorrect unit, or they gave the correct unit and substituted into the equation correctly, but then made a mistake in the calculation. This was often by omitting a 0 from a correctly calculated value on the answer line.

Q17.

- (a) Students had to make clear that black paint is a good absorber of radiation, not just say 'it absorbs radiation'. Similarly, they had to say that the copper is a good

conductor of energy or heat, not just that it is a conductor. Few students gained the last marking point as they needed to link the large surface area to absorbing a lot of energy or 'heat'. Many just said that the water would be in the pipe for a longer time. Credit could not be gained from using poor terminology such as black paint 'attracts' or 'collects' heat. The word 'absorb' was required. It was possible to gain a mark for saying 'black paint is a good emitter of radiation', but only if students made clear where the radiation was being emitted to, i.e. to the water in the pipe.

- (b)
 - (i) Most correct responses included reference to the ground source heat pump being more reliable than solar panels or working all day and night. There were quite a lot of references to the cost of solar panels or them being an eyesore, both of which were ignored. Some said that the ground source heat pump recycled water, which was also ignored.
 - (ii) A lot of confused responses were seen. Students did not appear to understand that the water would be warmed by energy underground. Some students gained a mark for saying that efficiency could not be greater than 100% or that energy cannot be created, but they were not usually linked together.
 - (iii) Many students do not understand the difference between significant figures and decimal places, so could not gain full marks. Some students attempted to give a reorganised equation without first showing the substitution into the equation. This often meant that errors were made and only 1 mark could be awarded for a temperature rise of 48 °C. Students should be encouraged to write down the initial substitution which would have gained an extra mark.