

AQA GCSE PHYSICS (HIGHER) • 8463

PHYSICS



EXAM QUESTION PACK

4.1.2.2 EFFICIENCY (PACK 1)

SCORE

/75

PERCENTAGE

%

STEMUP

These questions belong to AQA, not to us.

The examination questions, mark schemes and examiner comments in this pack were written and published by AQA. They are past assessment materials, reproduced here so that students can revise from them.

What we do not own

STEMUP is not affiliated with AQA and does not own, and makes no claim to own, any of the question, mark scheme or examiner report material in this pack. AQA has not endorsed, approved or been involved in the production of it. AQA and the qualification titles used here belong to their respective owners and appear for identification only.

Where to find the originals

AQA publishes its past papers, mark schemes and examiner reports. Always check the current specification at aqa.org.uk before you revise, because content and wording can change between series.

If you hold the rights to any material in this pack and would like it amended or removed, contact admin@stemup.co.uk and we will act on it.

Q1.

Astronauts have landed on the Moon on six separate occasions.

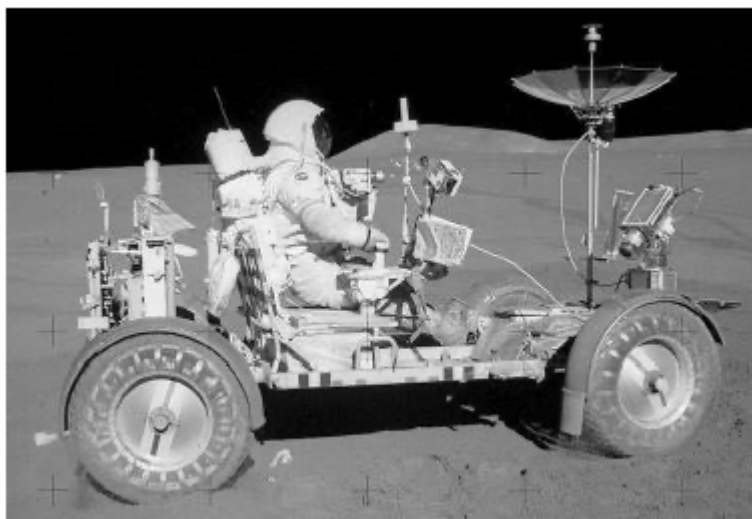
- (a) The Moon is in a circular orbit around the Earth. The speed of the Moon is constant.

Explain why the Moon is accelerating.

(3)

The astronauts moved around the surface of the Moon in a lunar rover.

The photograph below shows a lunar rover.



- (b) At one point, the lunar rover accelerated from 1.4 m/s to 2.6 m/s

The acceleration of the lunar rover was 0.31 m/s²

Which calculation could be used to calculate the distance travelled s during this acceleration?

Tick **one** box.

$$s = \sqrt{2.6^2 - 1.4^2 - 2 \times 0.31}$$

☐

$$s = \frac{1.4^2 - 2.6^2}{2 \times 0.31}$$

☐

[illegible]

(2)
(Total 12 marks)

Q2.

Figure 1 shows a student making potato soup.

Figure 1



- (a) The student places 0.5 kg of potato into a pan of water.

During cooking, the temperature of the potato increases from 20 °C to 100 °C

The specific heat capacity of the potato is 3400 J/kg °C

Calculate the change in thermal energy of the potato.

Use the equation:

change in thermal energy = mass × specific heat capacity × temperature change

Change in thermal energy = _____ J

(3)

- (b) Why is the energy supplied by the cooker greater than that calculated in part (a)?

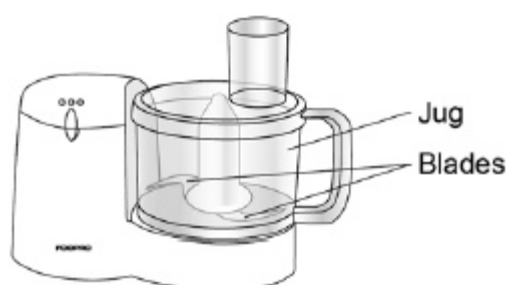
(1)

- (c) Suggest **one** way that the student could reduce the time to heat the potato to 100 °C

(1)

Figure 2 shows a food processor.

Figure 2



- (d) The student places the cooked potato into the jug of the food processor.
The food processor contains a motor that spins blades to chop the potato.
The total power input to the motor is 500 W
The useful power output from the motor is 300 W
Calculate the efficiency of the motor in the food processor.
Use the equation:

$$\text{efficiency} = \frac{\text{useful power output}}{\text{total power input}}$$

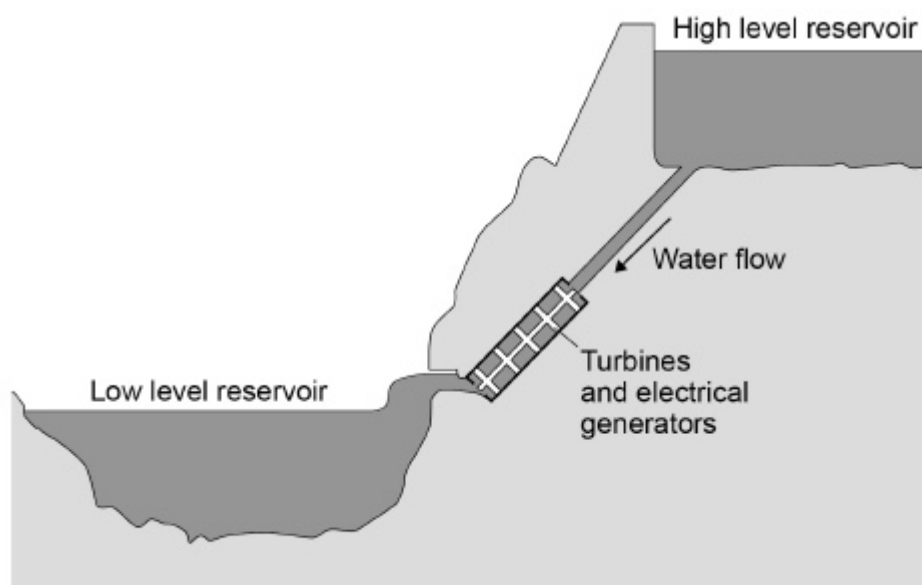
Efficiency = _____

(2)

- (e) The jug is made of plastic with a low thermal conductivity.
Explain why this is an advantage.

Q3.

The diagram shows the flow of water through a hydroelectric power station.



The falling water turns the turbines.

The movement of the turbines causes the electrical generators to generate electricity.

- (a) Write the equation which links kinetic energy, mass and speed.

_____ (1)

- (b) In 1 minute, a mass of 9 000 kg of water flows through the turbines.

The speed of the water is 30 m/s

Calculate the total kinetic energy of the water passing through the turbines in 1 minute.

Give your answer in kilojoules (kJ).

Kinetic energy = _____ kJ

(3)

- (c) Write the equation which links efficiency, total input energy transfer and useful output energy transfer.

(1)

- (d) The efficiency of the turbines and generators is 80%

Calculate the useful output energy transfer from the hydroelectric power station in 1 minute.

Use your answer to part (b).

Useful output energy transfer = _____ kJ

(3)

- (e) A small group of people live in an area in the mountains.

The people plan to buy an electricity generating system that uses either the wind or the flowing water in a nearby river.

- The wind turbine costs £50 000 to buy and install.
- The hydroelectric generator costs £20 000 to buy and install.
- The average power output from the wind turbine is 10 kW
- The hydroelectric generator will produce a constant power output of 8 kW

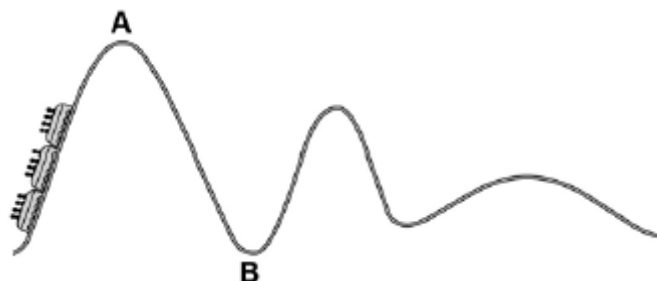
Compare the advantages and disadvantages of the two methods of generating electricity.

Use your knowledge of energy resources and information given.

(4)
(Total 12 marks)

Q4.

The figure below shows a rollercoaster.



The rollercoaster car is raised a vertical distance of 35 m to point **A** by a motor in 45 seconds.

The mass of the rollercoaster is 600 kg.

The motor has a power rating of 8 000 W.

- (a) Calculate the percentage efficiency of the motor.

Gravitational field strength = 9.8 N / kg.

Efficiency = _____ %

(5)

- (b) The rollercoaster rolls from point **A** to point **B**, a drop of 35 m.

Calculate the speed of the roller coaster at point **B**.

Assume that the decrease in potential energy store is equal to the increase in kinetic energy store.

Speed at point **B** = _____ m / s

(6)
(Total 11 marks)

Q19.

Laptop computers can get very hot when they are left on for a long time. This decreases the energy efficiency of a laptop computer.

(a) Which statement best describes what **decreased efficiency** means?

Tick (✓) **one** box.

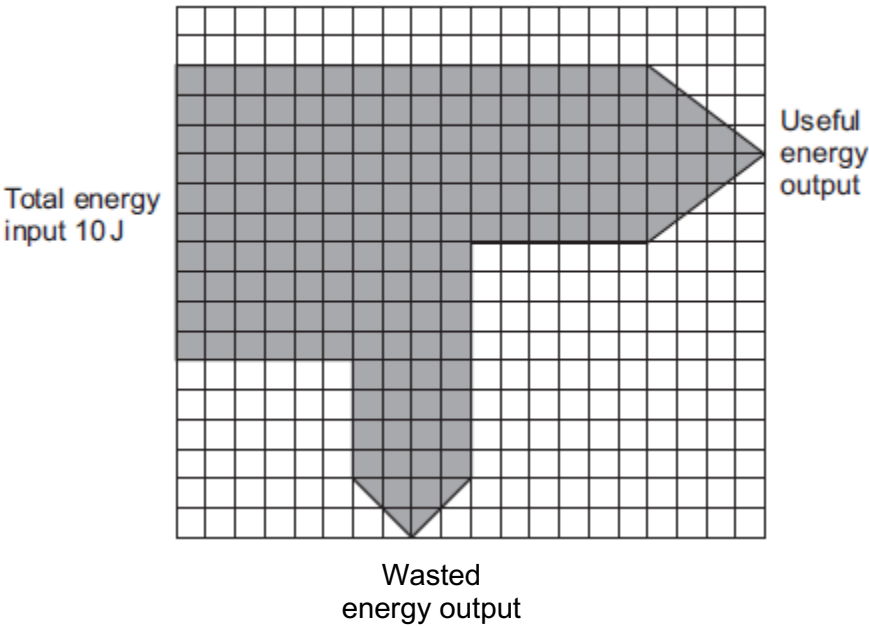
Statement	Tick (✓)
The energy output is increased.	
A greater proportion of the energy is wasted.	
The energy input is decreased.	

(1)

(b) The total energy input to a laptop computer is 10 J each second.

Figure 2 shows the energy transfers in a laptop computer each second.

Figure 2



- (i) Use **Figure 2** to calculate the useful energy output each second for the laptop computer.

Useful energy output each second = _____ J

(1)

- (ii) Calculate the efficiency of the laptop computer.

Use the correct equation from the Physics Equations Sheet.

Efficiency = _____

(2)

- (iii) What effect does the wasted energy have on the surroundings?

(1)

(Total 5 marks)

Q20.

Laptop computers can get very hot when they are left on for a long time. This decreases the energy efficiency of a laptop computer.

- (a) What does **decreased efficiency** mean?

Tick (✓) **one** box.

Statement	Tick (✓)
The energy output is increased.	
A greater proportion of the energy is wasted.	
The energy input is decreased.	
A greater proportion of the energy is usefully transferred.	

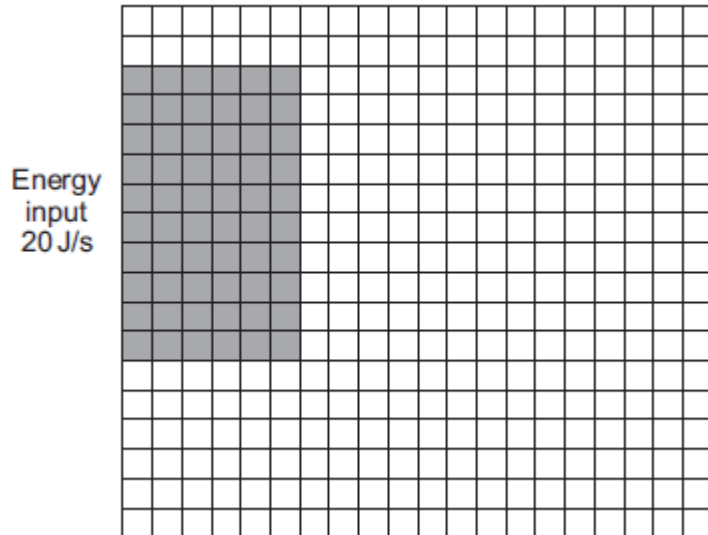
(1)

- (b) The input energy to a laptop computer is 20 J each second. When the laptop is being used, 12 J of energy is transferred usefully each second and 8 J of energy is wasted each second.

Use the grid in **Figure 2** to complete the Sankey diagram for the laptop computer when it is being used.

Label your diagram.

Figure 2



(2)
(Total 3 marks)

Q21.

The cost of electricity is increasing. People want to use devices that are more energy efficient.

- (a) What does *energy efficient* mean?

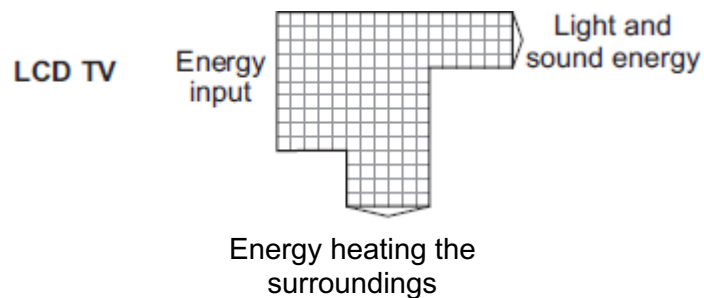
Tick (✓) **one** box.

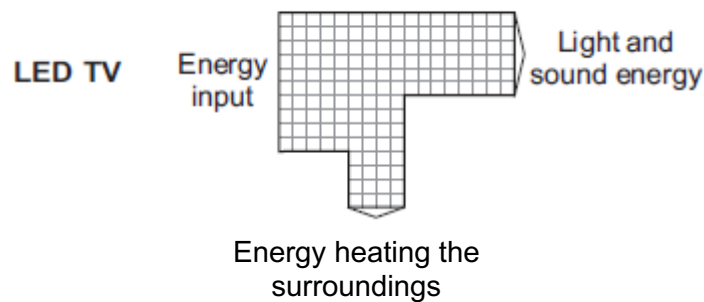
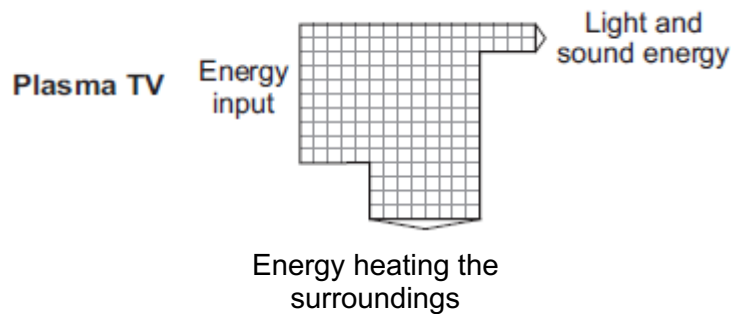
Statements	Tick (✓)
Energy efficient means a low energy input.	
Energy efficient means a small proportion of wasted energy.	
Energy efficient means a small proportion of useful energy.	

(1)

- (b) A householder is trying to decide which TV to buy. The choice is between an LCD TV, a Plasma TV and an LED TV. The TVs had the same sized screens.

The Sankey diagrams show the proportion of the input energy that is transferred to different energy forms by the three TVs.





Which TV wastes the largest proportion of the input energy?

(1)

- (c) The power rating of a TV when in use is 0.3 kW.

Calculate the energy used by the TV when in use for 6 hours.

Use the correct equation from the Physics Equations Sheet.

Draw a ring around the correct unit.

Energy used = _____

kW

kWh

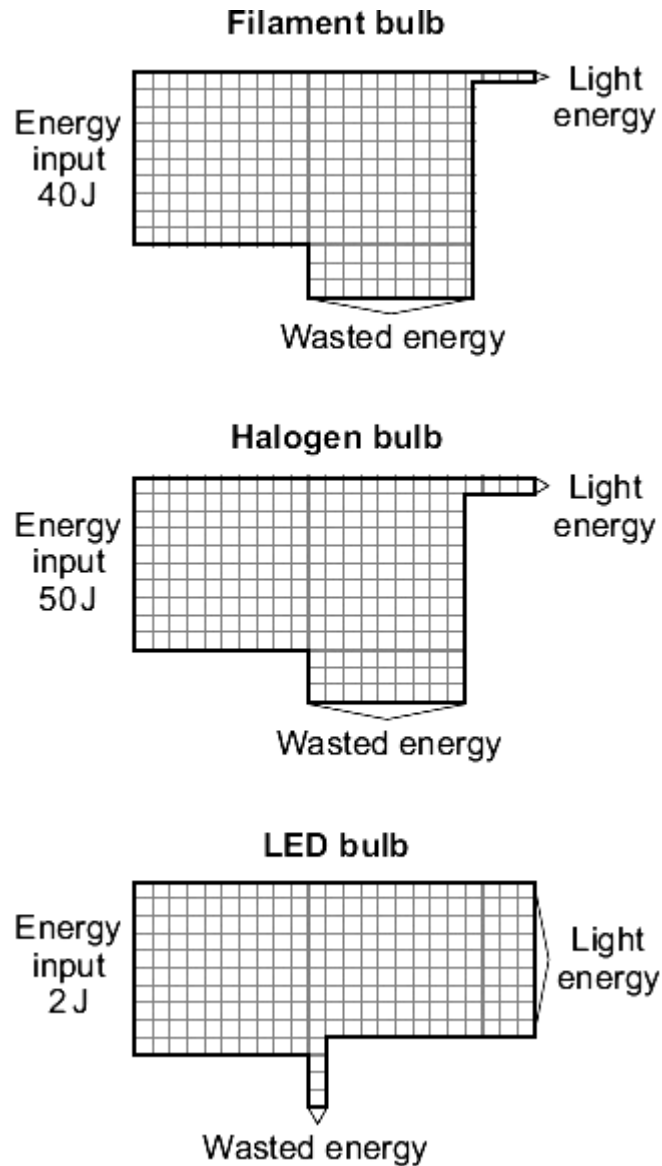
W

(3)

(Total 5 marks)

Q22.

The Sankey diagrams show the energy transferred to the surroundings each second by three different bulbs.



- (a) The filament bulb is the least efficient of the three bulbs.

Explain what *least efficient* means.

(2)

- (b) Calculate the percentage efficiency of the halogen bulb.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

Efficiency = _____ %

(2)

- (c) What effect does the wasted energy from a bulb have on the surroundings?

(1)

- (d) Use the Sankey diagrams to give a reason why the overall cost of using an LED bulb is the lowest of the three bulbs.

(1)

- (e) The table gives further information about each type of bulb.

Bulb	Cost to buy in £	Average lifespan in hours
Filament	0.50	1000
Halogen	2.00	2500
LED	15.00	25000

Use **only** the information in the table to answer the following questions.

- (i) Which type of bulb is the most cost-effective?

Give a reason for your answer.

Bulb _____

Reason _____

(2)

- (ii) Sales of LED bulbs are increasing.

Suggest **one** reason why.

(1)

(Total 9 marks)

Q23.

A battery powered electric fan is used to move air around a room.



Photograph supplied by Comstock/Thinkstock

- (a) Use words from the box to complete each sentence.

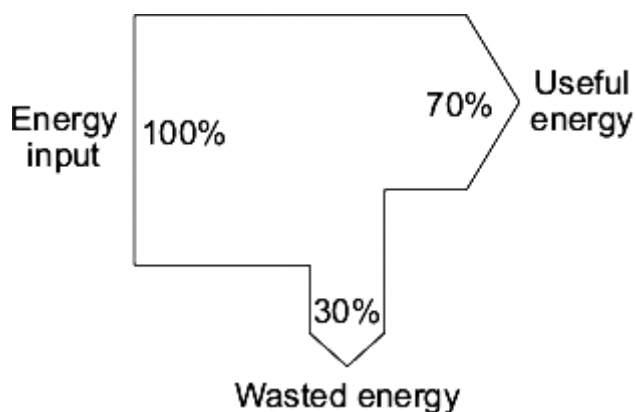
chemical	light	kinetic	electrical	sound
-----------------	--------------	----------------	-------------------	--------------

In the batteries, _____ energy is transferred to
_____ energy in the wires.

The fan has _____ energy as it rotates.

(3)

- (b) The Sankey diagram shows how much energy is usefully transferred when the fan is being used.



- (i) What is the efficiency of the fan?

(1)

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

All of the energy from the fan is eventually transferred to the surroundings.

This makes the temperature of the surroundings

increase.
decrease.
stay the same.

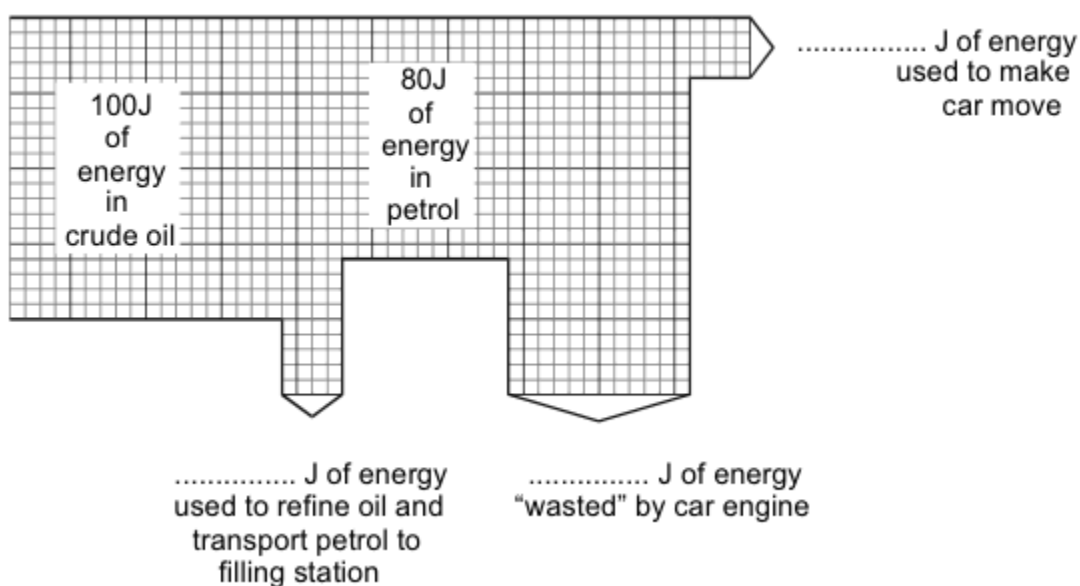
(1)

(Total 5 marks)

Q24.

The diagram shows what happens to each 100 joules of energy from crude oil when it is used as petrol in a car.

The widths of the arrows show exactly how much energy is transferred in each particular way.



- (a) Complete the diagram by adding the correct energy value alongside each arrow.

(2)

- (b) Calculate how efficient the car engine is at transferring the energy **from petrol** into useful movement.

Show clearly how you work out your answer.

(2)
(Total 4 marks)

Mark schemes

Q1.

- (a) (in circular motion) the direction is (constantly) changing

1

(so) velocity is (constantly) changing

1

(and) acceleration is rate of change of velocity

allow

$$acceleration = \frac{\text{change in velocity}}{\text{time}}$$

1

(b) $s = \frac{2.6^2 - 1.4^2}{2 \times 0.31}$

1

(c) $0.72 = \frac{190}{P_{\text{input}}}$

allow $\frac{72}{100} = \frac{190}{P_{\text{input}}}$

1

$$P_{\text{input}} = \frac{190}{0.72}$$

1

$$P_{\text{input}} = 264 \text{ (W)}$$

allow an answer that rounds to 264 (W)

1

$$264 = 36 \times I$$

allow their calculated

$$P_{\text{input}} = 36 \times I$$

1

$$I = 7.33 \text{ (A)}$$

1

$$I = 29 \text{ (A)}$$

allow an answer that rounds to 29 (A)

allow their value for $I \times 4$ correctly calculated

1

an answer of 29 (A) scores 6 marks

- (d) old theory suggests Moon rocks would be different from Earth rocks

1

(but) new evidence shows they are similar

this mark is dependent on scoring the first mark

allow **1** mark for new evidence (from studying Moon rocks) could not be explained by the old theory

1

[12]

Q2.

- (a) 80 °C

1

$$\Delta E = 0.5 \times 3400 \times 80$$

1

$$\Delta E = 136\,000 \text{ (J)}$$

an answer of 136 000 (J) scores **3** marks

1

- (b) energy is dissipated into the surroundings
allow any correct description of wasted energy

1

- (c) put a lid on the pan
allow any sensible practical suggestion
eg add salt to the water

1

- (d) efficiency = 300/500

1

$$\text{efficiency} = 0.6$$

an answer of 0.6 or 60% scores **2** marks

allow efficiency = 60%

an answer of 0.6 with a unit scores **1** mark

an answer of 60 without a unit scores **1** mark

1

- (e) lower rate of energy transfer

1

(so) potato soup will remain at a higher temperature

1

[9]

Q3.

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

allow $E = \frac{1}{2}mv^2$

1

- (b) $0.5 \times 9000 \times 30^2$

1

$$4\,050\,000$$

1

4050 (kJ)

an answer of 4050 (kJ) scores 3 marks
an answer of 4 050 000 scores 2 marks

1

(c) efficiency =

$$\frac{\text{useful output energy transfer}}{\text{total input energy transfer}}$$

1

(d) $0.80 = \frac{\text{useful output energy transfer}}{4050}$

allow ecf from (b)

1

(useful output energy transfer =) $0.80 \times 4\,050$

1

= 3240 (kJ)

an answer of 3240 (kJ) scores 3 marks

1

(e)

Level 2: Scientifically relevant features are identified; the way(s) in which they are similar/different is made clear and (where appropriate) the magnitude of the similarity/difference is noted.	3-4
Level 1: Relevant features are identified and differences noted.	1-2
No relevant content	0
Indicative content advantages of both methods: • both renewable sources of energy • both have no fuel (cost) • no carbon dioxide produced advantages of wind • higher average power output advantages of hydroelectric • constant / reliable power (output) • lower (installation) cost disadvantages of wind • higher (installation) cost • variable / unreliable power output	

disadvantages of hydroelectric • lower power output	
disadvantages of both methods • (may be) noisy • visual pollution	

4
[12]

Q4.

(a) $600 \text{ kg} = 5880 \text{ N}$

1

$$\text{power} = \frac{5880 \times 35}{45}$$

1

$$= 4573.3 \text{ (W)}$$

this step without the previous steps stated gains 3 marks

1

$$\% \text{ Eff.} = \frac{4573.3 \times 100}{8000}$$

1

$$= 57.17 \text{ (\%)}$$

allow 57.17 with no working shown for 5 marks

1

(b) $\text{gpe} = 600 \times 9.8 \times 35$

1

$$= 205\,800$$

1

$$\text{gpe} = \text{KE} = \frac{1}{2} m v^2$$

1

$$v = \sqrt{\frac{2 \times \text{KE}}{m}}$$

1

$$= \sqrt{\frac{411\,600}{600}}$$

1

$$= 26.2 \text{ (m / s)}$$

allow 26.2 with no working shown for 6 marks

1

[11]

Q19.

(a) A greater proportion of the energy is wasted

(b) (i) 6(J)

1

1

(ii) 60 % **or** 0.6

allow ecf from (c)(i) for 2 marks

allow 1 mark for correct substitution,

i.e. $\frac{6}{10} (\times 100)$

allow for 1 mark:

$\frac{ecf(c)(i)}{10} (\times 100)$

allow for 1 mark an answer of 60 or 0.6 with unit

2

(iii) heats them / increases the temperature

1

[5]

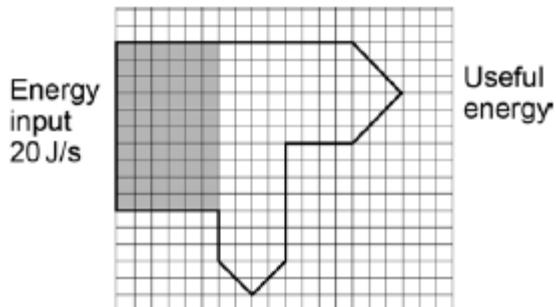
Q20.

(a) A greater proportion of the energy is wasted

1

(b) arrow 4 squares wide labelled 'wasted (energy)' and arrow 6 squares wide labelled 'useful (energy)'

i.e.



Wasted energy

allow for 1 mark:

correct width arrows with no labels

or

correct width arrows with numerical labels only

or

arrows plotted correctly but wasted energy arrow in incorrect position

or

a correctly labelled diagram showing useful energy is greater than wasted energy

2

[3]

Q21.

- (a) energy efficient means a small proportion of wasted energy 1
- (b) plasma (TV) 1
- (c) 1.8
allow 1 mark for correct substitution eg 0.3×6 2
- kWh
box takes precedent 1
- [5]

Q22.

- (a) highest proportion / percentage of (input) energy wasted
NB this answer gains 2 marks
allow higher / greater
allow ratio
accept for 1 mark lots of energy wasted
or
allow for 1 mark wastes most energy 2
- $$\text{efficiency} = \frac{\text{useful energy out} (\times 100\%)}{\text{total energy in}}$$
- (b) 10 % (or 0.1 if % sign crossed out)
allow 1 mark for the correct substitution into the correct equation
eg $(5/50) \times 100$
or $(1/10) \times 100$
allow 1 mark if 0.1 is given as the answer, but % sign is still present 2
- (c) heats it (the surroundings)
allow given off as heat
or
increases the temperature
ignore global warming 1
- (d) lowest energy input / needed / used
allow input only 2 J 1
- (e) (i) filament (bulb)
allow 1 mark for filament bulb being chosen provided a reason is given (reason may be incorrect, but sensible eg

cheapest)

1

lifespan is longest for the purchase cost

accept cost per hour is least / hours per £ is most

accept relevant calculation

1

(ii) longest lifespan

allow lasts 25 000 hours

*do **not** accept most cost-effective*

1

[9]

Q23.

(a) chemical

1

electrical

1

kinetic

1

must be in correct order

(b) (i) 70(%)

allow 0.7

allow $\frac{7}{10}$ or $\frac{70}{100}$

ignore units

1

(ii) increase

1

[5]

Q24.

(a) energy used to refine oil... = 20J

energy 'wasted' = 60J

energy used to make car move = 20J

*all three correct = **2** marks*

*two correct = **1** mark*

*one / none correct = **0** marks*

2

(b) 25% / 0.25

for correct answer

allow error carried forward correctly from part (a)

if answer is incorrect accept evidence of $\frac{\text{useful energy out}}{\text{total energy in}}$

or 20% / 0.2 for 1 mark

2

[4]

Examiner reports

Q1.

- (a) Over 11% of students made no attempt to answer this question and more than three quarters scored no marks.

Few students realised that this question was linked to the vector nature of velocity and acceleration. Indeed, several students stated that the question was incorrect because the moon could not be accelerating because it was moving at constant speed.

Students who attempted an incorrect explanation attributed the acceleration to a variety of causes – global warming, astronauts landing on the moon and the earth's changing magnetic field were fairly common answers.

Students who scored marks for this question usually cited the constant change in direction of the moon, linking this to a change in velocity, but omitting the link between velocity and acceleration.

- (b) Around half of students chose the correct response to the calculation. The next most popular choice was the final box, which was similar to the correct one, but with '2' as a multiplier. The other two responses were equally chosen.
- (c) Around 3% of students performed this complex calculation correctly to gain all six marks. Some students attempted calculations, but it was often difficult to follow the line of reasoning. Strings of figures, apparently randomly multiplied or divided, were often seen, with no attempt to explain what was being worked out. It would benefit students to explain, just with a word or two, what they think they are working out. Some students attempted to deal with all stages of this multi-stage calculation in one equation – such answers seldom scored any marks.

Of those whose working was clear enough to follow, the most frequent mistake was working out the input power as 72% of the output power, ending up with a smaller value for the input power than the output. However, such answers could go on to gain up to three of the marks by using the $P = IV$ equation and/or multiplying by four.

- (d) In order to gain marks, students needed to refer to the old theory and what it would suggest about the composition of Moon rocks compared to Earth rocks. Very few answers made reference to the old theory, so very few students gained marks.

Many answers stated that if the Moon rocks had a similar composition to Earth rocks, it was likely that they originated from the same place – this is what was stated in the question so there was no credit for repeating it.

There was evidence that a number of students had mis-read or failed to understand the question, as they referred to the Giant Impact Hypothesis as being incorrect because the Earth would have been destroyed in a collision.

Q19.

- (a) Decreased efficiency was understood by most students.
- (b) (i) Just over half of the students were able to interpret the Sankey diagram to give the correct useful energy output.

- (ii) Most students calculated the percentage efficiency, but many forgot to give the % symbol, so only gained 1 mark for an answer of 60. A few students made an error in part (i), but if they used this value to calculate the efficiency they could still gain 2 marks, although very few did this. Students should be reminded to always show their working, as this may gain them a mark even if their final answer is incorrect.
- (iii) Just under half of the students could describe the effect of the wasted energy on the surroundings. Others had not read the question carefully and gave a description of wasted energy. Global warming, noise and pollution were all ignored.

Q20.

- (a) The majority of students knew that decreased efficiency means a greater proportion of the energy is wasted. The most common distractor was that the energy input is decreased.
- (b) A wide range of styles of Sankey diagrams were drawn. Most students managed to plot the width of the bars correctly, but often the wasted energy was drawn incorrectly and shown to come off the useful energy arrow. Often the labels were incomplete or not attempted. Useful energy was sometimes labelled as used or transferred energy, which was insufficient, or the arrows were just labelled with the figures. The question confused some students who had not seen a Sankey diagram before.

Q21.

- (a) Most students knew that energy efficient means a small proportion of energy is wasted.
- (b) Around 80 per cent of the students correctly identified from the Sankey diagrams that the plasma TV wastes the largest proportion of input energy.
- (c) Students could generally substitute correctly into the equation, but then often carried out an incorrect calculation, obtaining 0.18 or 18 instead of 1.8. A common mistake was to change hours into minutes. An incorrect unit was often given.

Q22.

- (a) There was widespread confusion about what efficiency is, exemplified by statements such as 'appliance that's the least useful'. The lowest level of acceptable response 'the bulb with lots of energy wasted' gained one mark. To gain two marks, students should have made it clear that efficiency is about proportion or percentage, rather than simple comparative statements about the amount of energy lost. Many students stated that it was 'the bulb that loses the most energy', which is incorrect because out of the three bulbs, the halogen bulb wastes the most energy as it has the highest energy input. Some students said it was not good for the environment or it caused pollution.
- (b) A quarter of students were able to gain at least one mark and it was clear that many students are unfamiliar with the use of Sankey diagrams to calculate efficiency and used incorrect values in their calculations. Many answers were more than 100% because they had not used the equation from the sheet correctly. Students would benefit from being taught how to organise calculations logically.

- (c) Few students read the question properly and did not answer in terms of the effect on the surroundings. Only a third of students gained credit for this question.
- (d) Most incorrect answers focussed on the efficiency of the LED bulb rather than the fact that the energy input was only 2 J compared with 40 J and 50 J for the other two bulbs. As three bulbs were being compared an absolute comparator was needed - lowest energy input, rather than less or low.
- (e)
 - (i) Many students ignored the instruction, 'Use **only** the information in the table to answer the following questions', leading to the incorrect answer of LED, or a statement about efficiency. Only a few students followed the instruction and gained one mark for filament bulb, but the correct reason was rarely given. Once again an absolute comparator was needed to compare three bulbs.
 - (ii) Again, many students ignored the instruction, leading to the use of the Sankey diagrams to answer the question. Many incorrectly stated that, 'the LED bulbs last a long time', which makes no comparison with the other two bulbs. The filament bulb lasting 1000 hours may also be considered a long time, but an absolute comparator was needed for the mark to be awarded.

Q23.

- (a) Almost two-thirds of students gained three marks. Of the incorrect responses, many students named electrical energy in the batteries, rather than chemical, and chemical energy in the wires instead of electrical.
- (b)
 - (i) Many students carried out a calculation to work out the efficiency of the fan, even though this was not necessary given the figures on the diagram. Quite a few added all three numbers up to give an answer of 200, or described the efficiency as being 'good' rather than giving a figure. Some quoted that 30% of the energy was wasted, which did not answer the question.
 - (ii) By far the most common answer was that the energy transferred from the fan decreases the temperature of the surroundings. Less than a third of students selected 'increase'.