Mr Baker's Science-Stuff

Energy Stores

Name: _____

Class: _____

Date: _____

Time: **161 minutes**

Marks: **158 marks**

Comments:

Q1.

The image shows a man using a leaf blower to move some leaves.

The leaf blower is powered by an electric motor connected to a battery.

(a) Energy transfers take place when the leaf blower is being used.

Use the correct answer from the box to complete each sentence.

chemical	electrical	kinetic	nuclear	sound

The battery stores _____ energy which is transferred into electrical energy.

The electric motor transfers electrical energy usefully into _____ energy.

The motor wastes energy as _____ energy and as energy that heats the surroundings.

(3)

(b) The total power input to the leaf blower is 750 W.
The useful power output of the leaf blower is 360 W.

Calculate the efficiency of the leaf blower.

_____

_____

_____

_____

Efficiency = _____

(2)

(Total 5 marks)

Q2.

The diagram below shows a cyclist riding along a flat road.

(a) Complete the sentence.

Choose answers from the box.

chemical	**elastic potential**	**gravitational potential**	**kinetic**

As the cyclist accelerates, the _____ energy store in the cyclist's body decreases and the _____ energy of the cyclist increases.

(2)

(b) The mass of the cyclist is 80 kg. The speed of the cyclist is 12 m/s.

Calculate the kinetic energy of the cyclist.

Use the equation:

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

_____

_____

_____

_____

Kinetic energy = _____ J

(2)

(c) When the cyclist uses the brakes, the bicycle slows down.

This causes the temperature of the brake pads to increase by 50 °C.
The mass of the brake pads is 0.040 kg.
The specific heat capacity of the material of the brake pads is 480 J/kg °C.

Calculate the change in thermal energy of the brake pads.

Use the equation:

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

_____

_____

_____

Change in thermal energy = _____ J

(2)

(d) How is the internal energy of the particles in the brake pads affected by the increase in temperature?

Tick **one** box.

Decreased ☐

Increased ☐

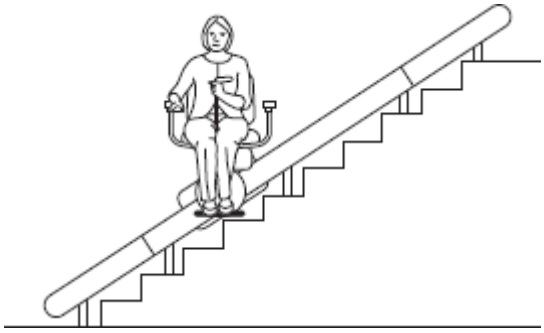
Not affected ☐

(1)

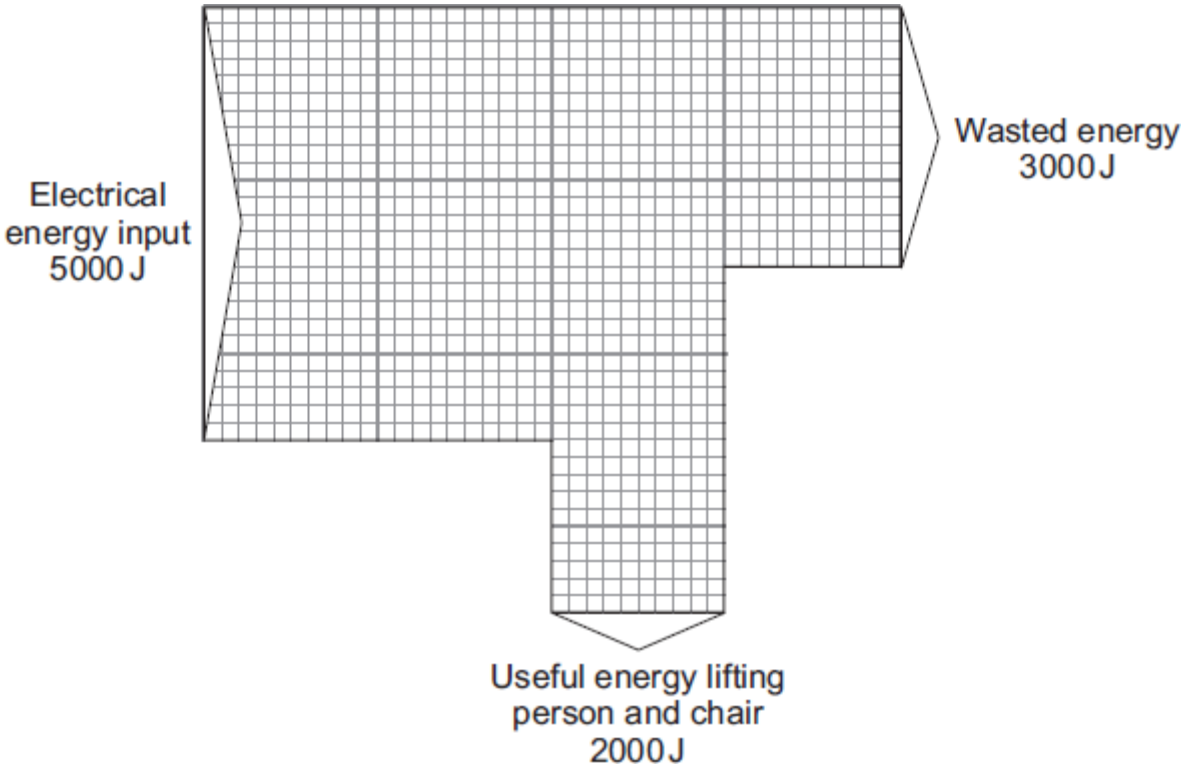
(Total 7 marks)

Q3.

A person uses a stairlift to go upstairs. The stairlift is powered by an electric motor.



The Sankey diagram shows the energy transfers for the electric motor.



(a) Complete the following sentence.

The electric motor wastes energy as _____ energy.

(1)

(b) Use the equation in the box to calculate the efficiency of the electric motor.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

_____

_____

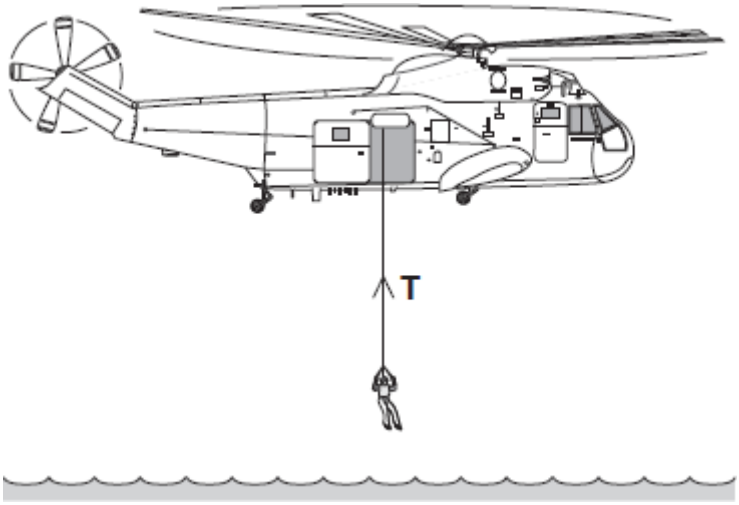
Efficiency = _____

(2)

(Total 3 marks)

Q4.

The diagram shows a helicopter being used to rescue a person from the sea.



(a) (i) The mass of the rescued person is 72 kg.

Use the equation in the box to calculate the weight of the rescued person.

$$\text{weight} = \text{mass} \times \text{gravitational field strength}$$

gravitational field strength = 10 N/kg

Show clearly how you work out your answer.

_____

_____

Weight = _____ N

(2)

(ii) An electric motor is used to lift the person up to the helicopter.
The motor lifts the person at a constant speed.

State the size of the force, **T**, in the cable.

Force **T** = _____ N

(1)

(b) To lift the person up to the helicopter, the electric motor transformed 21 600 joules of energy usefully.

(i) Use a form of energy from the box to complete the following sentence.

gravitational potential	heat	sound

The electric motor transforms electrical energy to kinetic energy. The kinetic energy is then transformed into useful _____ energy.

(1)

(ii) It takes 50 seconds for the electric motor to lift the person up to the helicopter.

Use the equation in the box to calculate the power of the electric motor.

$$\text{power} = \frac{\text{energy transformed}}{\text{time}}$$

Show clearly how you work out your answer and give the unit.

Choose the unit from the list below.

coulomb (C) **hertz (Hz)** **watt (W)**

_____

_____

Power = _____

(3)

(Total 7 marks)

Q5.

Figure 1 shows a lift inside a building.

Figure 1

(a) The motor in the lift does 120 000 J of work in 8.0 seconds.

Calculate the power output of the motor in the lift.

Use the equation:

$$\text{Power output} = \frac{\text{work done}}{\text{time}}$$

Power output = _____ W

(2)

(b) The power input to the motor is greater than the power output.

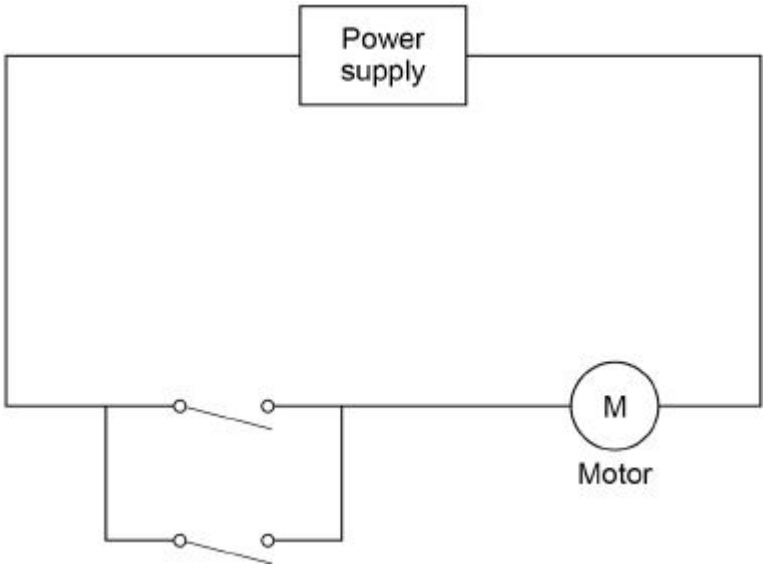
Tick **two** reasons why.

Energy is transferred in heating the surroundings.	☐
Friction causes energy to be transferred in non-useful ways.	☐
The motor is connected to the mains electricity supply.	☐
The motor is more than 100% efficient.	☐
There are only four people in the lift.	☐

(2)

(c) **Figure 2** shows part of the circuit that operates the lift motor.

Figure 2



The lift can be operated using either of the two switches.

Explain why.

_____

_____

_____

_____

_____

(2)

(d) Write down the equation that links gravitational field strength, gravitational potential energy, height and mass.

_____

_____

(1)

(e) The lift goes up 14 m. The total mass of the people in the lift is 280 kg.

gravitational field strength = 9.8 N/kg

Calculate the increase in gravitational potential energy of the people in the lift.

Give your answer to 2 significant figures.

_____

_____

_____

_____

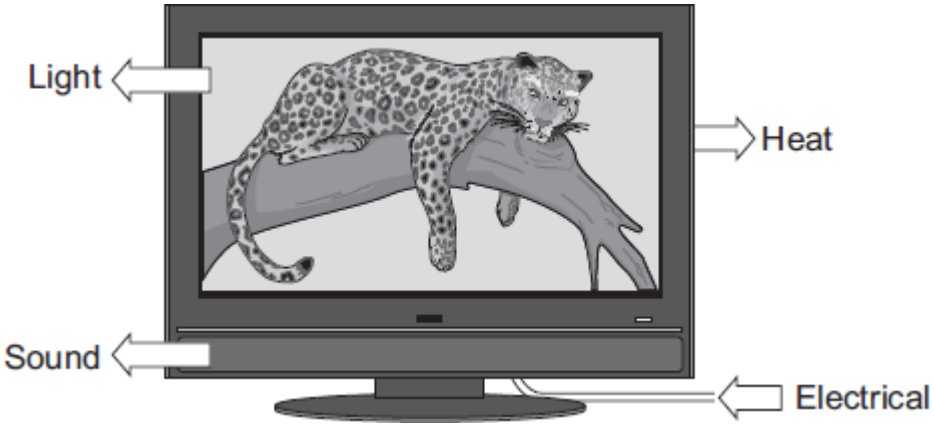
Increase in gravitational potential energy = _____ J

(3)

(Total 10 marks)

Q6.

(a) The diagram shows the energy transformations produced by a television.



When the television is working, 1200 joules of energy are supplied to the television every second. The useful energy transferred by the television is 720 joules every second.

(i) Use the equation in the box to calculate the efficiency of the television.

$$\text{efficiency} = \frac{\text{useful energy transferred by the device}}{\text{total energy supplied to the device}}$$

Show clearly how you work out your answer.

_____

_____

Efficiency = _____

(2)

(ii) Use **one** word from the diagram to complete the following sentence.

The electrical energy that is **not** usefully transformed by the television is wasted as _____ .

(1)

(b) A homeowner is sent an electricity bill every 3 months. The total amount of electrical energy used during one 3-month period was 800 kilowatt-hours.
Electrical energy costs 15p per kilowatt-hour.

Use the equation in the box to calculate the cost of the energy transferred from the mains electricity supply.

total cost = number of kilowatt-hours × cost per kilowatt-hour

Show clearly how you work out your answer and give the unit.

_____

_____

Cost = _____

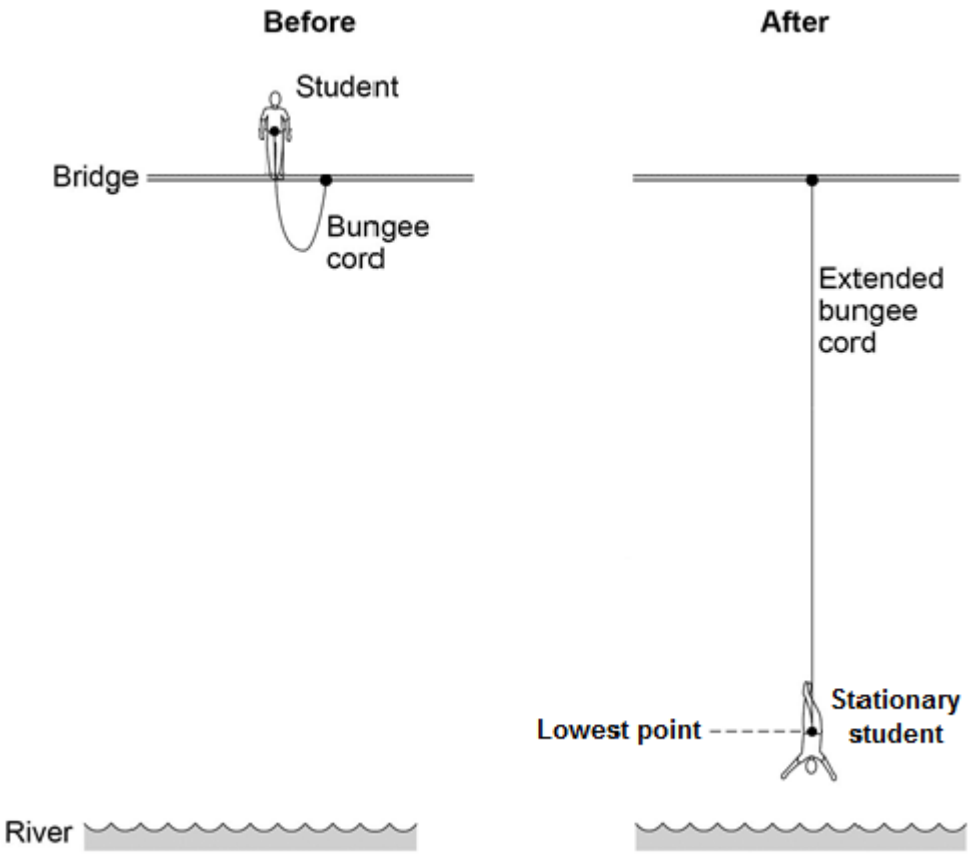
(2)

(Total 5 marks)

Q7.

The image below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20 m.



(a) For safety reasons, it is important that the bungee cord used is appropriate for the student's weight.

Give **two** reasons why.

1. _____

_____

2. _____

_____

(2)

(b) The student jumps off the bridge.

Complete the sentences to describe the energy transfers.

Use answers from the box.

elastic potential	**gravitational potential**	**kinetic**	**sound**	**thermal**

Before the student jumps from the bridge he has a store of

_____ energy.

When he is falling, the student's store of _____

energy increases.

When the bungee cord is stretched, the cord stores energy as

_____ energy.

(3)

(c) At the lowest point in the jump when the student is stationary, the extension of the bungee cord is 35 metres.

The bungee cord behaves like a spring with a spring constant of 40 N / m.

Calculate the energy stored in the stretched bungee cord.

Use the correct equation from the Physics Equations Sheet.

_____

_____

_____

Energy = _____ J

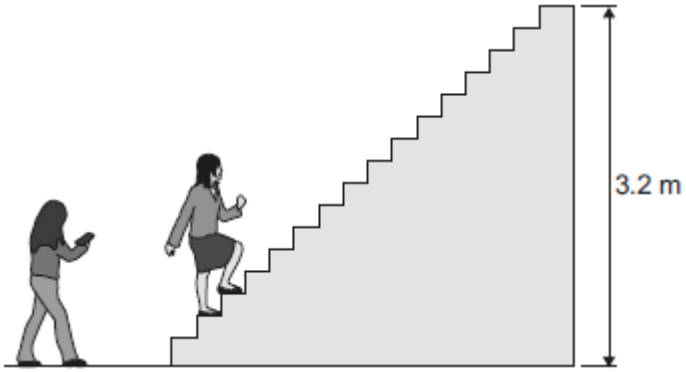
(2)

(Total 7 marks)

Q8.

A student did an experiment to calculate her power.
The diagram below shows how she obtained the measurements needed.

The student first weighed herself and then ran up a flight of stairs. A second student timed how long it took her to go from the bottom to the top of the stairs. The height of the stairs was also measured.



(a) Complete the following sentence.

To run up the stairs the student must do work against

the force of _____ .

(1)

(b) The student did 2240 J of work going from the bottom of the stairs to the top of the stairs.

The student took 2.8 seconds to run up the stairs.

(i) Calculate the power the student developed when running up the stairs.

_____

_____

Power = _____ W

(2)

(ii) How much gravitational potential energy did the student gain in going from the bottom to the top of the stairs?

Tick (✓) **one** box.

much more than 2240 J ☐

2240 J ☐

much less than 2240 J ☐

(1)

(c) Another four students did the same experiment.

The measurements taken and the calculated values for power are given in the table.

Student	Weight in newtons	Time taken in seconds	Power in watts
A	285	3.8	240
B	360	2.4	480
C	600	3.4	560
D	725	4.0	580

(i) To make a fair comparison of their powers the students kept **one** variable in the experiment constant.

What variable did the students keep constant?

_____

(1)

(ii) From the data in the table a student wrote the following conclusion.

'The greater the weight of the student the greater the power developed.'

Suggest why this conclusion may **not** be true for a larger group of students.

_____

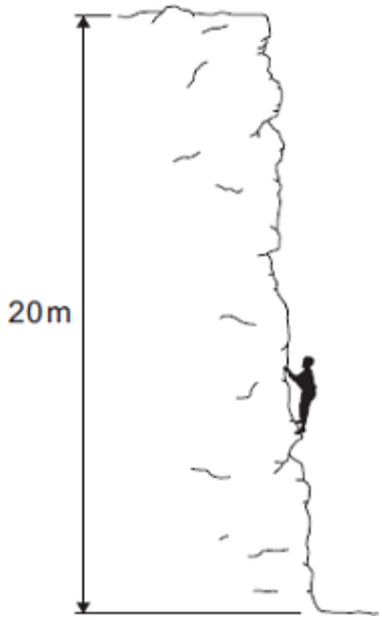
_____

(1)

(Total 6 marks)

Q9.

The diagram shows a climber part way up a cliff.



(a) Complete the sentence.

When the climber moves up the cliff, the climber

gains gravitational _____ energy.

(1)

(b) The climber weighs 660 N.

(i) Calculate the work the climber must do against gravity, to climb to the top of the cliff.

_____

_____

Work done = _____ J

(2)

(ii) It takes the climber 800 seconds to climb to the top of the cliff.
During this time the energy transferred to the climber equals the work done by the climber.

Calculate the power of the climber during the climb.

_____

_____

Power = _____ W

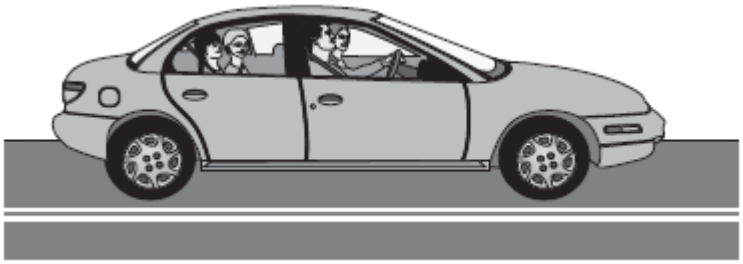
(2)

(Total 5 marks)

Q10.

The figure below shows a car with an electric motor.

The car is moving along a flat road.



(a) (i) Use the correct answers from the box to complete each sentence.

light	electrical	kinetic	potential	sound

The car's motor transfers _____ energy

into useful _____ energy as the car moves.

Some energy is wasted as _____ energy.

(3)

(ii) What happens to the wasted energy?

_____

_____

(1)

(b) The electric motor has an input energy of 50 000 joules each second.

The motor transfers 35 000 joules of useful energy each second.

Calculate the efficiency of the electric motor.

_____

_____

_____

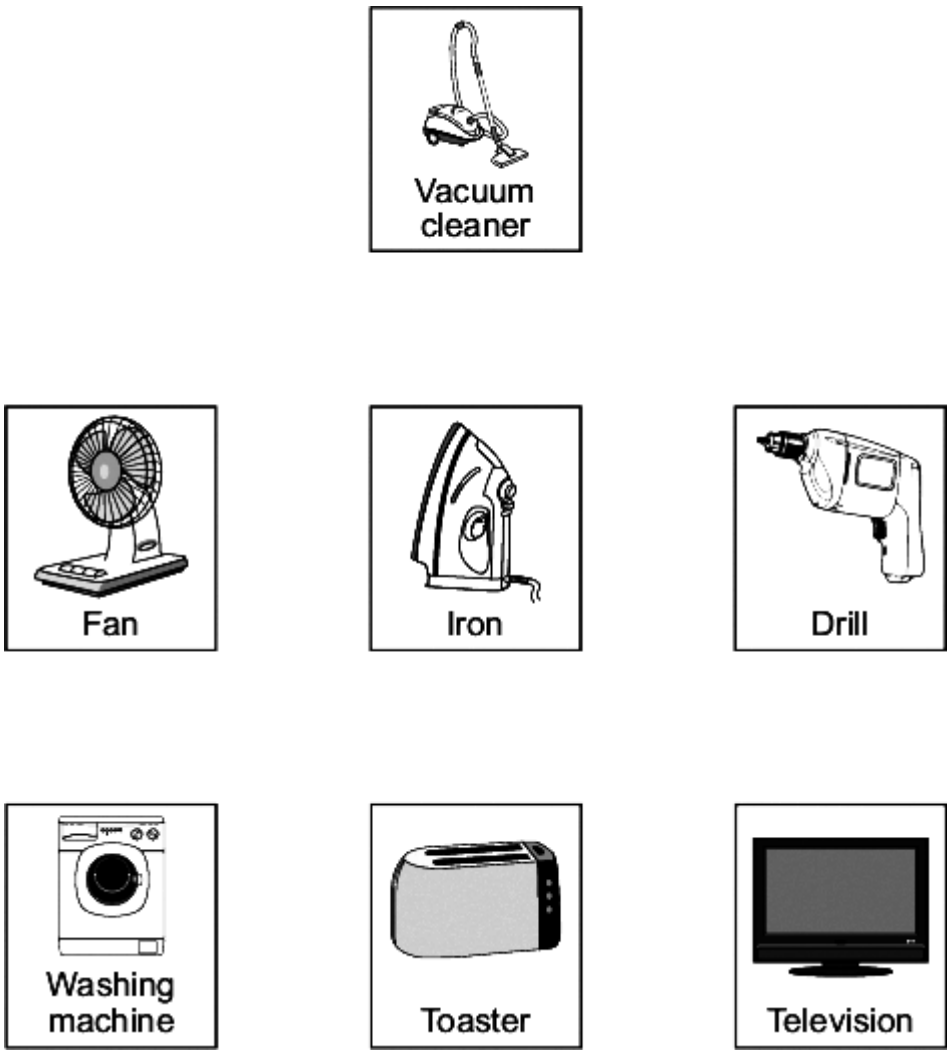
Efficiency = _____

(2)

(Total 6 marks)

Q11.

The appliances shown below transfer electrical energy to other types of energy.



(a) The vacuum cleaner is designed to transfer electrical energy to kinetic energy.

Three more of the appliances are also designed to transfer electrical energy to kinetic energy. Which **three**?

Draw a ring around each correct appliance.

3

(b) Which **two** of the following statements are true?

Tick (✓) **two** boxes.

Appliances only transfer part of the energy usefully. ☐

The energy transferred by appliances will be destroyed. ☐

The energy transferred by appliances makes the surroundings warmer. ☐

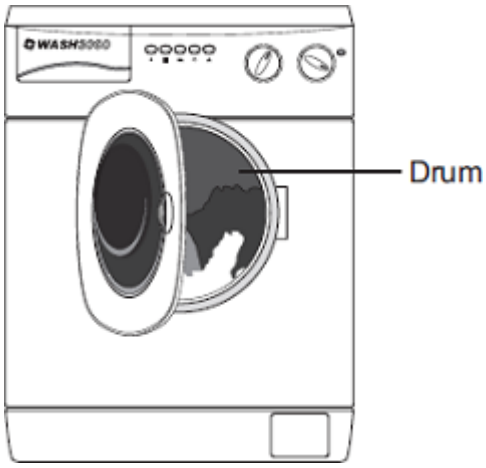
The energy output from an appliance is bigger than the energy input. ☐

(2)

(Total 5 marks)

Q12.

The picture shows a washing machine. When the door is closed and the machine switched on, an electric motor rotates the drum and washing.



(a) Complete the following sentences.

(i) An electric motor is designed to transform electrical energy into

_____ energy.

(1)

(ii) Some of the electrical energy supplied to the motor is wasted as

_____ energy and _____ energy.

(1)

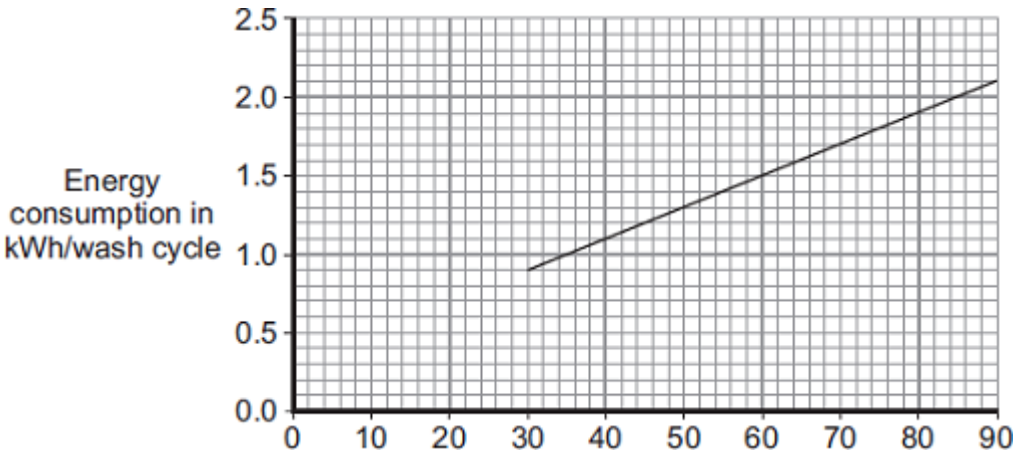
(b) What happens to the energy wasted by the electric motor?

_____

_____

(1)

(c) The graph shows that washing clothes at a lower temperature uses less energy than washing them at a higher temperature. Using less energy will save money.



(i) Electricity costs 15p per kilowatt-hour (kWh).

The temperature setting is turned down from 40 °C to 30 °C.

Use the graph and equation in the box to calculate the money saved each wash cycle.

total cost = number of kilowatt-hours x cost per kilowatt-hour

Show clearly how you work out your answer.

_____

_____

Money saved = _____

(2)

(ii) Reducing the amount of energy used by washing machines could reduce the amount of carbon dioxide emitted into the atmosphere.

Explain why.

_____

_____

_____

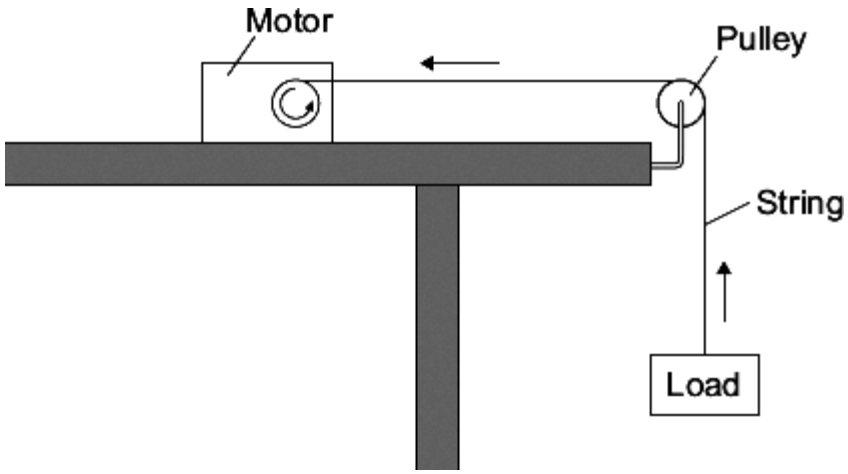
_____

(2)

(Total 7 marks)

Q13.

A student uses an electric motor to lift a load.



In the motor, the electrical energy is transferred into other types of energy. Some of this energy is useful and the rest of the energy is wasted.

(a) (i) Name the useful energy output from the electric motor.

_____

(1)

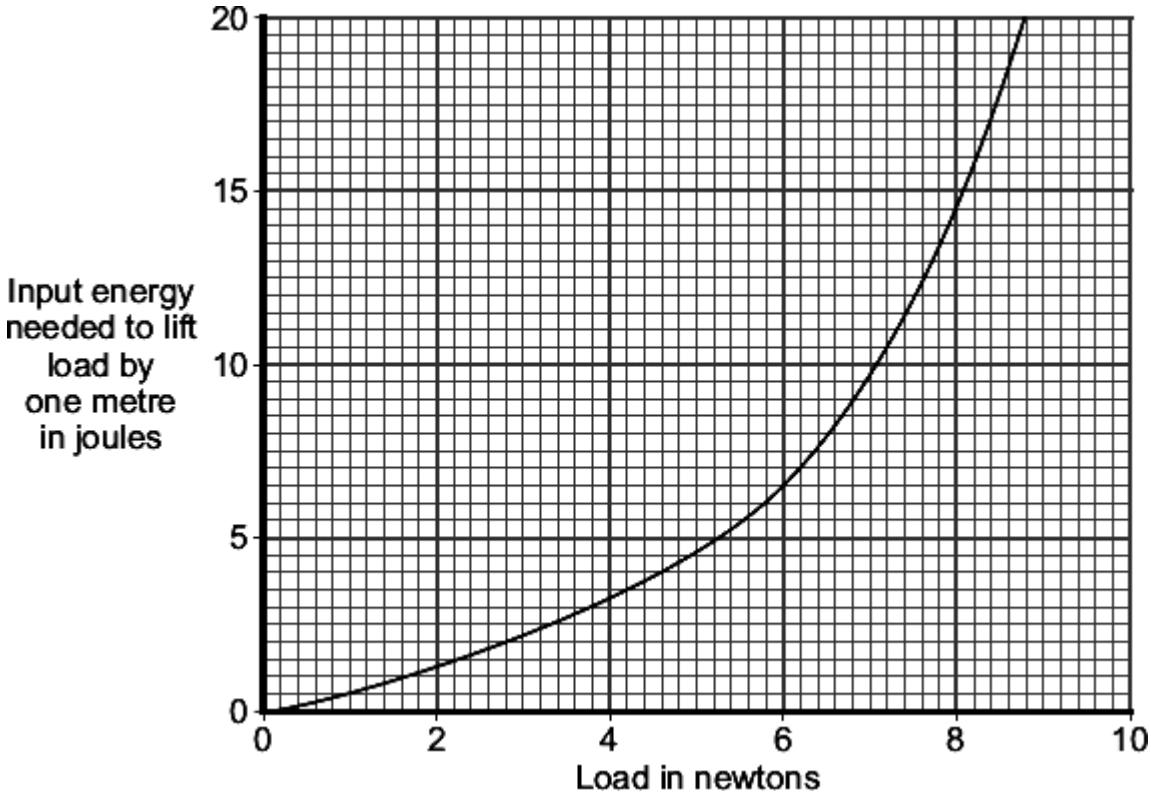
(ii) What eventually happens to the wasted energy?

_____

_____

(1)

(b) The graph shows the input energy the motor needs to lift different loads by one metre.



What can you conclude from the graph about the relationship between the load lifted and the input energy needed?

_____

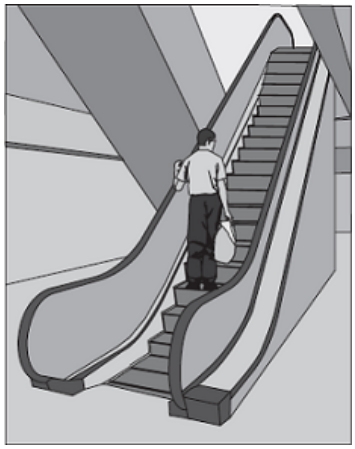
_____

_____

_____

(2)

(c) A shop uses escalators to lift customers to different floor levels. The escalators use electric motors. When the shop is not busy some escalators are turned off. A sign tells the customers that the escalators are turned off to save energy.



(i) Each escalator has one motor with an average power of 4000 W. The motor is turned on for an average of 8 hours each day, 6 days each week. Electricity costs 15 pence per kilowatt-hour.

Calculate the cost of the electricity used in an average week to run **one** escalator.

Show clearly how you work out your answer.

_____

_____

_____

Cost = _____ pence

(3)

(ii) Give **one** environmental advantage to turning off electrical appliances when they are not being used.

_____

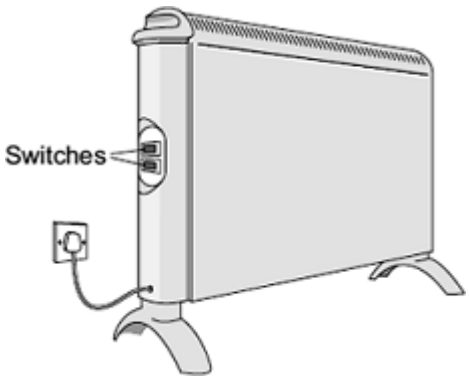
_____

(1)

(Total 8 marks)

Q14.

(a) The diagram shows two switches on a room heater. The heater has three power settings. The power produced by two of the settings is given in the table.



Setting	Power in watts
Low	700
Medium	1400
High	

(i) When both switches are on, the heater works at the high power setting.

What is the power of the heater, in kilowatts, when it is switched to the **high** power setting?

_____

Power = _____ kilowatts

(1)

(ii) The heater is used on the **high** power setting. It is switched on for 1½ hours.

Calculate the energy transferred from the mains to the heater in 1½ hours.

Show clearly how you work out your answer and give the unit.

_____

_____

_____

Energy transferred = _____

(3)

(iii) This type of heater is a very efficient device.

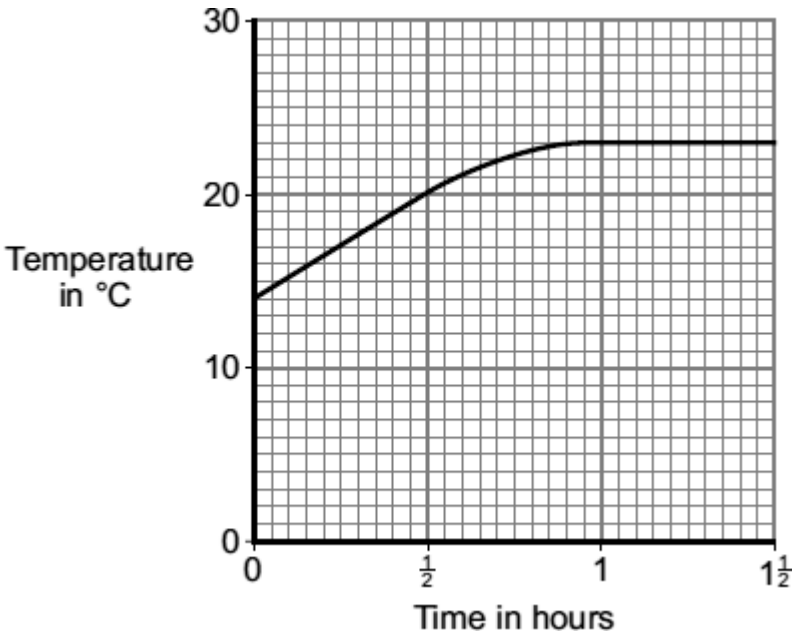
What is meant by a device being very efficient?

_____

_____

(1)

(b) The graph shows how the temperature of a room changes during the 1½ hours that the heater is used.



After 1 hour, the temperature of the room has become constant, even though the heater is still switched on.

Explain why.

_____

_____

_____

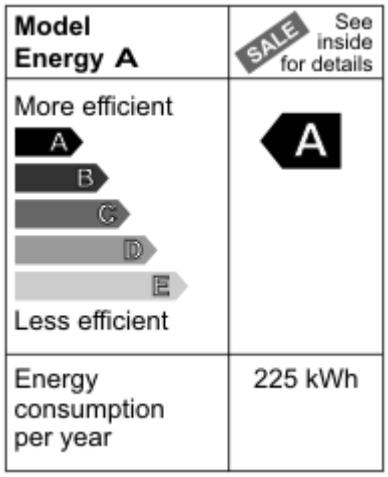
_____

(2)

(Total 7 marks)

Q15.

The diagram shows the label from a new freezer.



(a) An old freezer has an energy consumption per year of 350 kWh.

Use the equation in the box to calculate the extra cost of using the old freezer for one year compared with using a new 'A' rated freezer.

total cost = number of kilowatt-hours × cost per kilowatt-hour

Assume 1 kilowatt-hour (kWh) of energy costs 12 p.

Show clearly how you work out your answer.

Extra cost per year = £ _____

(2)

(b) The price of the new freezer was reduced in a sale.

Reducing the price reduces the payback time for replacing the old freezer from 12 years to 9 years.

Calculate, in pounds, how much the new freezer was reduced in the sale.

Show clearly how you work out your answer.

Price reduced by = £ _____

(2)

(c) An advertisement in a shop claims that:

'Replacing an old freezer with a new 'A' rated freezer will benefit the environment.'

Do you agree that replacing the freezer will benefit the environment?

Answer yes or no. _____

Explain the reasons for your answer.

_____

_____

_____

_____

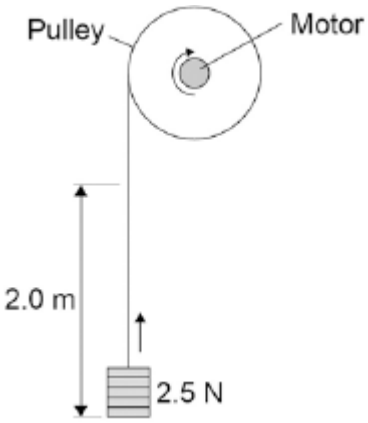
(2)

(Total 6 marks)

Q16.

A student investigated the efficiency of a motor using the equipment in **Figure 1**.

Figure 1



He used the motor to lift a weight of 2.5 N a height of 2.0 m.

He measured the speed at which the weight was lifted and calculated the efficiency of the energy transfer.

He repeated the experiment to gain two sets of data.

(a) Give **one** variable that the student controlled in his investigation.

_____

(1)

(b) Give **two** reasons for taking repeat readings in an investigation.

1. _____

_____

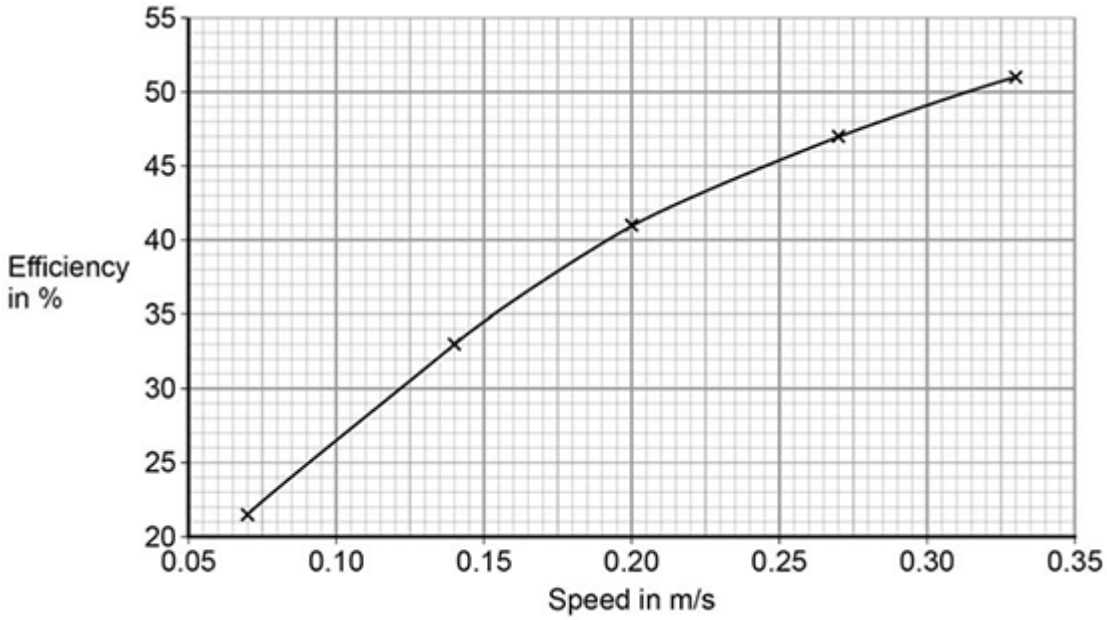
2. _____

_____

(2)

(c) **Figure 2** shows a graph of the student's results.

Figure 2



Give **two** conclusions that could be made from the data in **Figure 2**.

_____

_____

_____

_____

(2)

(d) Give the main way that the motor is likely to waste energy.

_____

_____

(1)

(e) When the total power input to the motor was 5 W the motor could not lift the 2.5 N weight.

State the efficiency of the motor.

Efficiency = _____ %

(1)

(Total 7 marks)

Q17.

The image shows a battery-powered drone.

(a) Complete the sentences.

Choose the answers from the box.

chemical	**elastic potential**	
gravitational potential	**kinetic**	**nuclear**

As the drone accelerates upwards

its _____ energy increases

and its _____ energy increases.

The _____ energy store

of the battery decreases.

(3)

(b) In the USA, drones are not allowed to be flown too high above the ground.

Suggest **one** possible risk of flying a drone too high above the ground.

_____

_____

_____

(2)

(c) Write down the equation that links energy transferred, power and time.

_____

(1)

(d) The drone can fly for 25 minutes before the battery needs recharging.

The power output of the battery is 65.0 W

Calculate the maximum energy stored by the battery.

_____

_____

_____

_____

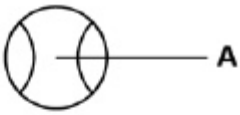
Maximum energy = _____ joules

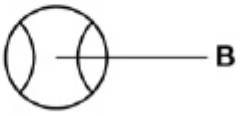
(3)

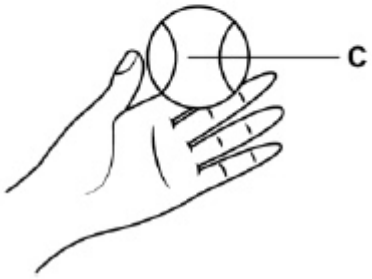
(Total 8 marks)

Q18.

The diagram shows a tennis ball thrown vertically into the air.







At position **C**, the ball has just left the tennis player's hand at a speed of 5.0 m/s

The tennis ball has a mass of 0.058 kg

(a) Write down the equation that links kinetic energy, mass and speed.

_____

(1)

(b) Calculate the kinetic energy of the tennis ball at position **C**.

_____

_____

Kinetic energy = _____ J

(2)

(c) At position **A** the tennis ball is at maximum height.

What is the gravitational potential energy of the tennis ball at position **A**?

Ignore the effect of air resistance.

_____

(1)

At position **B** the tennis ball has 0.38 J of gravitational potential energy.

(d) Write down the equation that links gravitational field strength, gravitational potential energy, height and mass.

_____

(1)

(e) Calculate the height of the tennis ball above the tennis player's hand when at position **B**.

gravitational field strength = 9.8 N/kg

_____

_____

_____

_____

_____

Height = _____ m

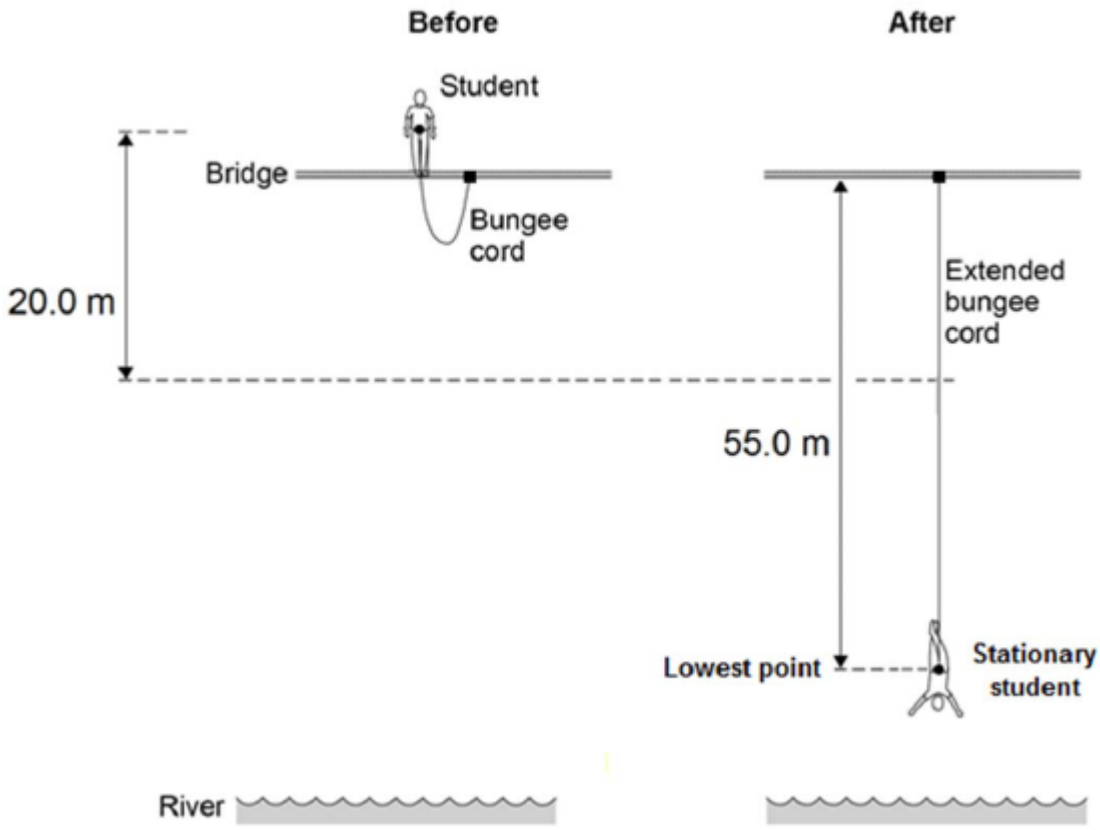
(3)

(Total 8 marks)

Q19.

The figure below shows a student before and after a bungee jump.

The bungee cord has an unstretched length of 20.0 m.



The mass of the student is 50.0 kg.

The gravitational field strength is 9.8 N / kg.

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

_____

(1)

(b) Calculate the change in gravitational potential energy from the position where the student jumps to the point 20.0 m below.

_____

_____

_____

Change in gravitational potential energy = _____ J

(2)

(c) 80% of this change in gravitational potential energy has been transferred to the student's kinetic energy store.

How much has the student's kinetic energy store increased after falling 20.0 m?

Kinetic energy gained = _____ J

(1)

(d) Calculate the speed of the student after falling 20.0 m.

Give your answer to two significant figures.

_____

_____

_____

_____

Speed = _____ m / s

(4)

(e) At the lowest point in the jump, the energy stored by the stretched bungee cord is 24.5 kJ.

The bungee cord behaves like a spring.

Calculate the spring constant of the bungee cord.

Use the correct equation from the Physics Equation Sheet.

_____

_____

_____

_____

_____

_____

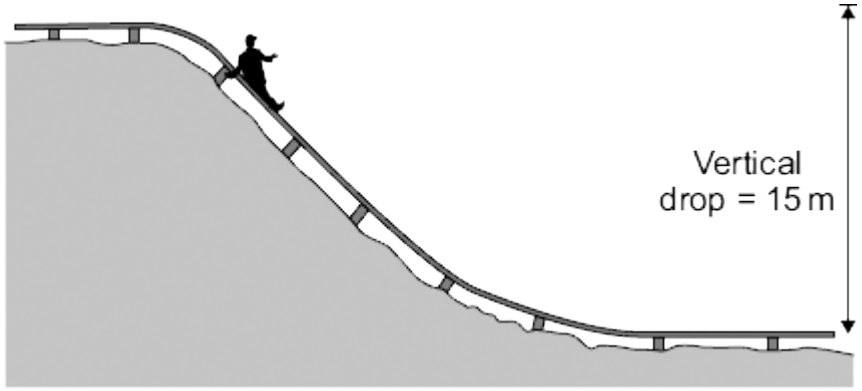
Spring constant = _____ N / m

(3)

(Total 11 marks)

Q20.

The miners working in a salt mine use smooth wooden slides to move quickly from one level to another.



(a) A miner of mass 90 kg travels down the slide.

Calculate the change in gravitational potential energy of the miner when he moves 15 m vertically downwards.

gravitational field strength = 10 N/kg

Show clearly how you work out your answer.

_____

_____

Change in gravitational potential energy = _____ J

(2)

(b) Calculate the **maximum** possible speed that the miner could reach at the bottom of the slide.

Show clearly how you work out your answer.

Give your answer to an appropriate number of significant figures.

_____

_____

_____

_____

Maximum possible speed = _____ m/s

(3)

(c) The speed of the miner at the bottom of the slide is much less than the calculated maximum possible speed.

Explain why.

(3)

(Total 8 marks)

Q21.

(a) The table gives information about some ways of reducing the energy consumption in a house.

Method of reducing energy consumption	Installation cost in £	Annual saving on energy bills in £
Fit a new hot water boiler	1800	200
Fit a solar water heater	2400	100
Fit under floor heating	600	50
Fit thermostatic radiator valves	75	20

Which way of reducing energy consumption is most cost effective over a 10-year period?

To obtain full marks you must support your answer with calculations.

(3)

(b) Explain why using an energy-efficient light bulb instead of an ordinary light bulb reduces the amount of carbon dioxide emitted into the atmosphere.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q22.

A homeowner had a new gas boiler installed.

(a) The following information is an extract from the information booklet supplied with the boiler.

Fuel	Natural Gas
Water temperature	60 °C
Energy supplied to gas boiler	8.0 kJ/s (8.0 kW)
Efficiency	0.95

(i) Calculate the energy transferred each second by the gas boiler to the water inside the boiler.

Show clearly how you work out your answer.

_____

_____

Energy transferred by the gas boiler each second = _____ kJ

(2)

(ii) The energy value of the gas used in a home is measured in kilowatt-hours (kWh).

The homeowner has a pre-payment meter and pays £30 into his account. With a pre-payment meter, gas costs 15p per kilowatt-hour.

Calculate the total number of hours that the gas boiler would operate for £30.

Show clearly how you work out your answer.

_____

_____

_____

_____

Number of hours = _____

(2)

(b) Although the gas boiler is very efficient, some energy is wasted.

Explain what happens to the waste energy.

_____

_____

_____

_____

(2)

(Total 6 marks)

Q23.

Figure 1 shows a cyclist riding along a straight, level road at a constant speed.

Figure 1

(a) Complete the sentences.

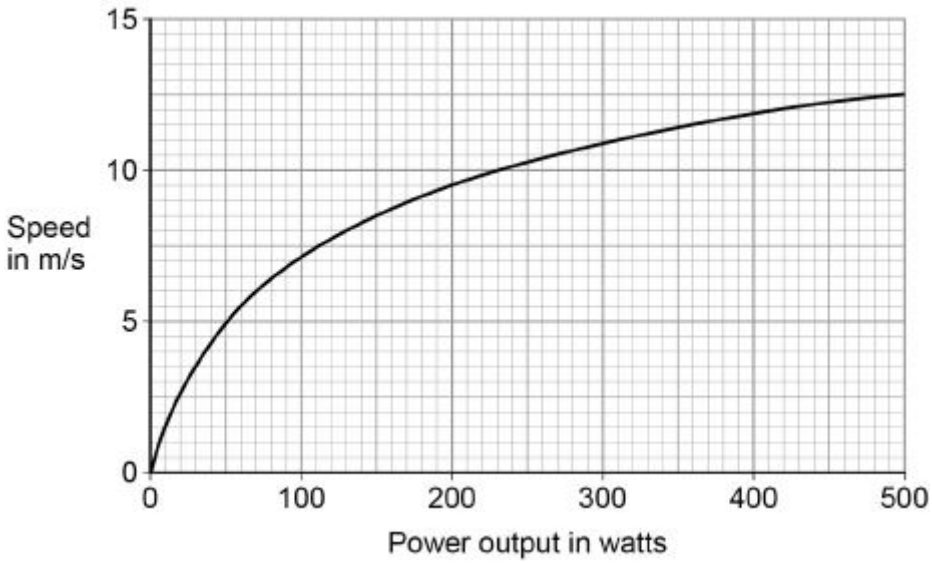
As the cyclist rides along the road, the _____ energy store in the cyclist's body decreases.

The speed of the cyclist is constant when the work done by the cyclist is _____ the work done against air resistance.

(2)

Figure 2 shows how the speed changes as the power output of the cyclist changes.

Figure 2



(b) Write down the equation that links power, time and work done.

_____

(1)

(c) Calculate the work done by the cyclist when his power output is 200 W for 1800 seconds.

Work done = _____ J

(3)

(d) Calculate the percentage increase in speed of the cyclist when the power output changes from 200 W to 300 W.

Percentage increase in speed = _____

(2)

(e) The maximum speed this cyclist can travel on a level road is 14 m/s.

How does cycling uphill affect the maximum speed of this cyclist?

Explain your answer.

(3)

(Total 11 marks)

Q1.

(a) chemical

correct order only

1

kinetic

1

sound

1

(b) 48% or 0.48

*an answer of 0.48 with a unit gains **1** mark*
*an answer of 0.48% gains **1** mark*
*an answer of 48 with or without a unit gains **1** mark*

2

[5]

Q2.

(a) chemical

1

kinetic

1

in this order only

(b) $E_k = 0.5 \times 80 \times 12^2$

1

$E_k = 5760$ (J)

1

*an answer of 5760 (J) scores **2** marks*

(c) $E = 0.040 \times 480 \times 50$

1

$E = 960$ (J)

1

*an answer of 960 (J) scores **2** marks*

(d) increased

1

[7]

Q3.

(a) heat / thermal
or / and
sound

*do **not** accept noise*
other forms of energy eg light negates answer

1

(b) 0.4
or
40 %

*allow **1** mark for* $\frac{2000}{5000}$
or
equivalent fraction
*an answer 0.4 % gains **1** mark*
*answers 0.4 or 40 given with any unit gains **1** mark*
*40 without % gains **1** mark*

2

[3]

Q4.

(a) (i) 720

*allow **1** mark for correct substitution,*
ie 72 × 10 provided no subsequent step shown

2

(ii) 720
or
their (a)(i)

1

(b) (i) gravitational potential

allow gravitational
allow potential

1

(ii) 432

*allow **1** mark for correct substitution, ie* $\frac{21600}{50}$ *provided no subsequent step shown*

2

watt / W

1

[7]

Q5.

(a) $P = \frac{120\,000}{8.0}$

1

P = 15 000 (W)

1

*an answer of 15 000 (W) scores **2** marks*

(b) energy is transferred in heating the surroundings

1

friction causes energy to be transferred in non-useful ways

1

(c) the switches are in parallel

1

(so) closing either switch completes the circuit

1

(d) gravitational potential energy = mass × gravitational field strength × height

allow $E_p = m\ g\ h$

1

(e) $E_p = 280 \times 9.8 \times 14$

1

$E_p = 38\ 416$ (J)

1

$E_p = 38\ 000$ (J)

*an answer that rounds to 38 000 scores **2** marks*

1

*an answer of 38 000 scores **3** marks*

[10]

Q6.

(a) (i) 0.6
or
60%

*allow **1** mark for correct substitution ie* $\frac{720}{1200}$ *provided no subsequent step shown*

*an answer of 0.6 / 60 with a unit gains **1** mark only*

*an answer of 60 gains **1** mark only*

2

(ii) heat

allow thermal

1

(b) 12 000 p
or
£120

to score both marks the unit must be consistent with the numerical answer

*answers 12 000 and 120 gain **1** mark only*

*allow **1** mark for correct substitution ie 800 × 15 **or** 800 × 0.15*

provided no subsequent step shown

2

[5]

Q7.

(a) any **two** from:

- bungee rope may snap
- rope may extend too much
- student may land in the river

2

(b) gravitational potential

correct order only

1

kinetic

1

elastic potential

1

(c) ½ × 40 × 35^2

1

24 500 (J)

accept 25 000 (J) (2 significant figures)

1

*allow 24 500 (J) with no working shown for **2** marks*

[7]

Q8.

(a) gravity

accept weight for gravity
air resistance is insufficient

1

(b) (i) 800

*allow **1** mark for correct substitution ie*

$$P = \frac{2240}{2.8}$$

provided no subsequent step

2

(ii) 2240 J

1

(c) (i) (vertical) height

accept (height of) stairs

1

(ii) a fast / short time (for a lighter student) may give the greatest power

accept time is a factor

or

a slow / long time (for a heavy student) may give the least power

fitness is insufficient

1

[6]

Q9.

(a) potential

1

(b) (i) 13 200

*allow **1** mark for correct substitution, ie 660 × 20 provided no subsequent step shown*

2

(ii) 16.5

allow 1 mark for correct

or

$\frac{\text{their (b)(i)}}{800}$ correctly calculated

substitution, ie $\frac{13\,200}{800}$ ***or*** $\frac{\text{their (b)(i)}}{800}$

provided no subsequent step shown

2

[5]

Q10.

(a) (i) electrical

correct order only

1

kinetic

1

sound

1

(ii) transferred into surroundings / atmosphere

accept warms the surroundings

allow released into the environment

becomes heat or sound is insufficient

1

(b) 0.7 / 70 %

*an answer of 70 without % or with the wrong unit **or** 0.7 with a unit gains **1** mark*

2

[6]

Q11.

(a) fan

1

drill

1

washing machine

*four circled including correct three scores **1** mark*

five circled scores zero

1

(b) Appliances only transfer part of the energy usefully

1

The energy transferred by appliances makes the surroundings warmer

1

[5]

Q12.

(a) (i) kinetic

*do **not** accept movement*

1

(ii) thermal sound

accept heat for thermal
*do **not** accept noise for sound*
***both** answers required in either order*

1

(b) transferred to surroundings / surrounding molecules / atmosphere

'it escapes' is insufficient

or
becomes dissipated / spread out

accept warms the surroundings
accept degraded / diluted
accept a correct description for surroundings eg to the washing machine
*do **not** accept transformed into heat on its own*

1

(c) (i) 3 (.0 p)

*allow **1** mark for correct substitution of correct values ie 0.2 x 15*
*allow **1** mark for calculating cost at 40°C (16.5p)*
or
cost at 30°C (13.5p)

2

(ii) any **two** from:

- less electricity needed

ignore answers in terms of the washing machine releasing less energy
an answer in terms of the washing machine releasing CO_2 negates mark
*do **not** accept less energy is produced*

- fewer power stations needed

- less fuel is <u>burned</u>

accept a correctly named fuel
*do **not** accept less fuel is needed*

2

[7]

Q13.

(a) (i) kinetic (energy)

allow gravitational potential (energy) / gpe

movement is insufficient

1

(ii) dissipates into the surroundings

allow warms up the surroundings / air / motor

accept lost to the surroundings

accept lost as heat

ignore reference to sound

it is lost is insufficient

1

(b) energy (required) increases with load

accept positive correlation

*do **not** accept (directly) proportional*

1

further amplification eg increases slowly at first (or up to 4 / 5 N), then increases rapidly

simply quoting figures is insufficient

an answer that only describes the shape of the line gains no marks

1

(c) (i) $E = P \times t$

2880

*accept £28.80 for all **3** marks*

*an answer £2880 gains **2** marks*

*allow **1** mark for obtaining 48 h **or** converting to kW*

*allow **2** marks for correct substitution*

ie 4 × 48 × 15

note: this substitution may be shown as two steps

*an answer 2 880 000 gains **2** marks*

*an answer £4.80 / 480 gains **2** marks*

*an answer of 192 (ie calculation of energy without subsequent calculation of cost) gains **1** mark)*

3

(ii) any sensible suggestion eg

conserves fossil fuels

less (fossil) fuels burned

less pollutant gas (produced)

accept a named pollutant gas

less greenhouse gas (produced)

saves energy is insufficient

1

[8]

Q14.

(a) (i) 2.1

correct answer only

1

(ii) 3.15

or

their (a)(i) × 1.5 correctly calculated

*allow **1** mark for correct substitution*

ie 2.1 × 1.5

or

their (a)(i) × 1.5

2

kilowatt-hour

accept kWh

or

*a substitution 2100 × 5400 scores **1** mark*

*2100 × 5400 incorrectly calculated with answer in joules scores **2** marks*

*an answer of 11 340 000 scores **2** marks*

*an answer of 11 340 000 J scores **3** marks*

1

(iii) most (input) energy is usefully transformed

accept does not waste a lot of energy

accept most of the output / energy is useful

*do **not** accept it does not waste energy*

1

(b) the room is losing energy / heat

1

at the same rate as the heater supplies it

this mark only scores if the first is scored

*do **not** accept heater reaches same temperature as room / surroundings*

rate of heat gain = rate of heat loss scores both marks

1

[7]

Q15.

(a) £15

*allow **1** mark for use of 125 (kWh)*

*allow **1** mark for an answer 1500*

*allow **both** marks for 1500 pence / p*

*allow **1** mark for correct calculation of annual cost for either freezer (£27 and £42)*

2

(b) £45

or their (a) × 3

*allow **1** mark for correct use of 3*
*allow **1** mark for 12 – 9 = 3*

2

(c) any **two** from:

the marks are for the explanation

yes **plus** explanation

- less electricity / energy needed / used
  accept less energy wasted
- less (fossil) fuels burned
  accept a named fossil fuel
  *do **not** accept conserving (fossil) fuels*
- less polluting gases emitted
  accept a named polluting gas / greenhouse gases / carbon emissions / reduce global warming
  accept an answer in terms of nuclear fuel
  eg less nuclear fuel required (1)
  less nuclear waste (1)

2

or no **plus** explanation

- old freezer must be disposed of
- hazardous chemicals inside freezer
  accept CFC gases
- *(*lot of*)* energy used in producing new freezer

[6]

Q16.

(a) weight (lifted)

or

height (lifted)

1

(b) any **two** from:

- calculate a mean
- spot anomalies
- reduce the effect of random errors

2

(c) as speed increases, the efficiency increases

1

(but) graph tends towards a constant value

or

appears to reach a limit

accept efficiency cannot be greater than 100%

1

(d) heating the surroundings

1

(e) 0 (%)

1

[7]

Q17.

(a) gravitational potential

1

kinetic

1

chemical

1

(b) flying drones may damage aircraft
or
falling drones may injure people
or
damage buildings / vehicles

allow any sensible suggestion of a hazard caused by a flying / falling drone

1

(c) energy transferred = power × time

allow E = Pt

1

(d) t = 25 × 60 = 1500 (s)

1

E = 65 × 1500

1

E = 97 500 (J)

an answer of 97 500 (J) scores 3 marks
allow 2 marks for an answer of 1625 (J)

1

[8]

Q18.

(a) kinetic energy = 0.5 × mass × speed^2

allow $E_k = 1/2\ mv^2$

1

(b) $E_k = 0.5 \times 0.058 \times 5^2$

1

$E_k = 0.725$ (J)

*an answer of 0.725 (J) scores **2** marks*

1

(c) 0.725 (J)

allow ecf from (b)

allow the same amount of E_k as at A

1

(d) gravitational potential energy = mass × gravitational field strength × height

allow Ep = mgh

1

(e) $0.38 = 0.058 \times 9.8 \times h$

1

$$h = \frac{0.38}{(0.058 \times 9.8)}$$

1

h = 0.67 (m)

*an answer that rounds to 0.67 scores **3** marks*

1

[8]

Q19.

(a) g.p.e. = mass × gravitational field strength × height

accept $E_p = mgh$

1

(b) $E_p = 50 \times 9.8 \times 20$

1

9800 (J)

*allow 9800 (J) with no working shown for **2** marks*

answer may also be correctly calculated using W = Fs

*ie allow W = 490 × 20 for **1** mark*

*or answer of 9800 (J) using this method for **2** marks*

1

(c) 7840 (J)

allow ecf from '11.2'

1

(d) $7840 = ½ \times 50 \times v^2$

1

$$v = \sqrt{\frac{7840}{1/2 \times 50}}$$

allow $v^2 = \frac{7840}{(1/2 \times 50)}$ *for this point*

1

17.7(0875) (m / s)

1

18 (m / s)

*allow ecf from '11.3' correctly calculated for **3** marks*
*allow 18 (m / s) with no working for **2** marks*
answer may also be correctly calculated using $v^2 - u^2 = 2as$

1

(e) extension = 35 (m) and conversion of 24.5 kJ to 24500 J

1

24 500 = ½ × k × 35^2

1

40

1

*allow 40 with no working shown for **3** marks*
*an answer of '16.2' gains **2** marks*

[11]

Q20.

(a) 13 500 (J)

*allow **1** mark for correct substitution, ie 90 x 10 x 15 provided no subsequent step shown*

2

(b) 17

or

$\sqrt{\frac{\text{their (a)}}{45}}$

correctly calculated and answer given to 2 or 3 significant figures

accept 17.3
*allow **2** marks for an answer with 4 or more significant figures, ie 17.32*
or
*allow **2** marks for correct substitution, ie 13 500/ their (a) = ½ x 90 x v^2*
or
*allow **1** mark for a statement or figures showing KE = GPE*

3

(c) work is done

1

(against) friction (between the miner and slide)

*accept 'air resistance' **or** 'drag' for friction*

1

(due to the) slide not (being perfectly) smooth

accept miners clothing is rough

or

causing (kinetic) energy to be transferred as heat/internal energy of surroundings

accept lost/transformed for transferred

accept air for internal energy of surroundings

1

[8]

Q21.

(a) four calculations correctly shown

200 × 10 – 1800 = £200
100 × 10 – 2400 = –£1400
50 × 10 – 600 = –£100
20 × 10 – 75 = 125

*accept four final answers only **or** obvious rejection of solar water heater and underfloor heating, with other two calculations completed any 1 complete calculation correctly shown **or** showing each saving × 10 of all four calculations = 1 mark answers in terms of savings as a percentage of installation cost **may** score savings mark only*

2

hot water boiler

correct answers only

1

(b) less electricity / energy to be generated / needed from power stations

accept less demand

1

reduction in (fossil) fuels being burnt

accept correctly named fuel

accept answer in terms of:
fewer light bulbs required because they last longer (1 mark)
less energy used / fuels burnt in production / transport etc. (1 mark)

ignore reference to CO_2 or global warming

ignore reference to conservation of energy

1

[5]

Q22.

(a) (i) 7.6

*allow **1** mark for correct substitution and / or transformation*

ie $0.95 = \frac{x}{8}$

95 × 8.0

2

(ii) 25 (hours)

*allow **1** mark for obtaining number of kWh = 200*

an answer of 26(.3) gains both marks

2

(b) any **two** from

- transferred to the surroundings / air / atmosphere
- becomes spread out
- shared between (many) molecules
- (wasted as) heat / sound

2

[6]

Q23.

(a) chemical

1

equal to

allow the same as

1

in this order only

(b) $\text{power} = \frac{\text{work done}}{\text{time}}$

allow $P = \frac{W}{t}$

1

(c) $200 = \frac{W}{1800}$

1

W = 200 × 1800

1

W = 360 000 (J)

1

*an answer of 360 000 (J) scores **3** marks*

(d) 11 − 9.5 = 1.5 (m/s)

allow a change in speed between 1.2 and 1.5 (m/s)

1

$\left(\frac{1.5}{9.5}\right) \times 100 = 15.8\,(\%)$

allow an answer consistent with their change in speed

*an answer of 16 (%) scores **2** marks*

1

*an answer that rounds to 15.8 (%) scores **2** marks*

(e) maximum speed is lower

1

because maximum power output of cyclist is constant

allow maximum force on pedals is constant

1

(but) additional work is done (against gravity)

*do **not** accept additional work done against friction or air resistance*

or

gravitational potential energy (of cyclist) is increased

1

[11]

Q1.

(a) This question was well answered, with more than half of students scoring all 3 marks. A surprising number of students thought that the battery stores nuclear energy.

(b) This question was generally well answered numerically but many failed to gain the second mark by omitting the % sign or adding some unit to the answer, usually watts. Over a quarter of students scored 2 marks, whereas two fifths scored only 1 mark. Many incorrect answers showed an incorrect substitution (750 / 360). Some students multiplied the 750 and 360.

Q2.

(a) Approximately half the students scored both marks for correctly identifying that the cyclist's chemical energy store decreases and the kinetic energy increases. A further 30% scored one mark, usually for identifying the kinetic energy. A common mistake was to say that the gravitational potential energy store decreases.

(b) Almost 90% of students scored the two marks for this question by substituting the given values into the given equation and correctly working it out. Many students showed the substitution of numbers into the equation before working out the answer. Some students were able to gain one mark by doing this, even though their subsequent calculation was incorrect.
The most common error was not realising that the speed value should be squared. Kinetic energy = ½ × 80 × 12 was therefore an incorrect substitution into the equation and no marks could be awarded.

(c) As in the previous question, most students scored two marks. A few students were able to score one mark for showing the correct substitution of numbers into the equation even though their subsequent calculation was incorrect. A common error amongst those who scored no marks was to convert the given mass into grams.

(d) More than three quarters of students correctly identified that the internal energy of the particles in the brake pads would increase.

Q3.

(a) Just under a half of the candidates wrote a correct response of either heat (thermal) or sound energy as the form of wasted energy. However, many candidates opted for kinetic or electrical energy.
A few candidates read the word 'as' to mean 'because' and wrote a sentence in the gap to try to explain why energy is wasted.

(b) There was a pleasing response to this question, with about half of the candidates obtaining the correct answer to the calculation. The most common mistake was to invert the fraction and hence arrive at an answer of 2.5 rather than 0.4.

Q4.

(a) (i) Nearly all students scored both marks. Those students that did not often divided by 10 rather than multiplying.

(ii) Only just over a third of students realised that at constant speed the resultant

force is zero and so the force T must equal the weight of the person. The most common errors were dividing 720 by 10 to get 72, or simply adding 1 to 720 to give 721.

(b) (i) Most students scored this mark.

(ii) Nearly half of students scored all three marks with a further third scoring two marks for the calculation. It seems surprising that a significant number of students failed to choose a unit at all thereby potentially wasting one mark.

Q5.

(a) This was the first of the questions that were common to the Higher tier paper. Although some good clear explanations were seen only 14% of students scored both marks. A common misconception was to think that positive charge, or protons, were being rubbed off the student's socks. A few students seemed to think that friction between the carpet and socks would produce 'heat', which would make the socks negatively charged.

(b) This is a new topic to GCSE Physics, drawing the electric field pattern around a charged sphere. Nearly half of students scored a mark for drawing three additional arrows pointing inwards. From an accuracy point of view, if the three arrows were pointing towards the words in the centre of the sphere, the arrows were considered to be perpendicular to the surface. Some students only drew two arrows. A number of students answered incorrectly in terms of other electric or magnetic field patterns, with lines curving round from the top position to the bottom. 11% of students did not attempt this question.

(c) Approximately 15% of students scored a mark on this question, with very few scoring more than one mark. A common misconception was that the tap was positively charged, so the positive tap and the negatively charged student would attract each other. Then 'electricity' or 'an electric shock' would pass between them. Very few answers referred to the charge or the electrons moving; when this was stated, the direction of transfer was either not mentioned or was thought to be going from the tap to the student. A small minority of answers referred to there being a potential difference, for instance 'the student has a potential difference'. However, they did not state that this was between the student and the tap, so did not gain credit.

(d) Around one quarter of students scored a mark, usually for stating that copper was a good conductor of electricity. Some stated that the copper would absorb the electrons; this did not gain the mark. When students had the correct idea of the copper conducting the charge, few went on to state that therefore there would be less charge on the student.

Q6.

(a) (i) There were many correct answers here. Use of 'J' as a unit for the answer was the most common error.

(ii) Most students correctly identified 'heat' as the wasted energy.

(b) Most students were able to multiply the number of kWh by the cost per kWh to get 120 or 12 000. However less than a half of those students were able to give the appropriate unit to match their numerical answer.

Q8.

(a) The majority of the students scored this mark.

(b) (i) This was well answered by the majority of the students. Those who attempted it and failed to score a mark usually multiplied the numbers rather than dividing.

(ii) The vast majority of the students thought that the g.p.e. gained would be 'much more' or 'much less' than 2240J and so did not score the mark.

(c) (i) About half of the students scored this mark, with most referring to the number, size or height of the stairs.

(ii) Very few of the students scored this mark. Few appreciated that the power developed depends upon both weight and time taken. Some students hinted at this by referring to fitness or muscle development but a clear statement referring to time taken was needed. Those few who referred to the pattern sometimes failed to gain a mark by referring to heavy students running up in a short time. This would have given them a high power output which fits the pattern of the four students in the question.

Q9.

(a) A majority of the students gave the correct answer.

(b) (i) A majority of students scored both marks. However, many incorrect answers showed students multiplying the correct answer by 10 to give a final incorrect answer.

(ii) Over half of the students scored both marks, either using their correct answer to part (b)(i) or by the error carried forward route.

Q10.

(a) (i) Just over a half of all students correctly identified the energy transfers for an electric car.

(ii) Just under two fifths of the students were able to state that waste energy is transferred into the surroundings. Weaker students forgot that the question was about an electric car and confused the wasted energy with exhaust gases. Others thought the waste energy is recycled and used again.

(b) The majority of students were able to substitute the energy values given in the question into a correct equation. Most tried to express the answer as a percentage, but about one third of students failed to gain maximum marks because they either neglected to insert the % sign after the number 70 or they quoted the efficiency as 0.7 but then put either a % sign or a unit after the number.

Q11.

(a) Surprisingly, less than two-thirds of students could identify the fan, the drill and the washing machine as being the devices that were designed to transfer electrical energy to kinetic energy.

(b) Just over half of students scored both marks, and just under half scored one mark.

Q12.

(a) (i) Nearly all students responded correctly with 'kinetic' energy.

(ii) The majority of answers correctly identified the two forms of wasted energy.

(b) Just over half of responses gained credit. Insufficient responses included 'it is wasted' (given in the question) or 'it turns into heat' (answered in the previous part).

(c) (i) Fewer than half of the students gained both marks for this question, although some were able to gain one mark for calculating the cost at 40°C or 30°C.

(ii) More than half of the responses failed to gain credit, many answers indicating that the washing machine itself gave off carbon dioxide. Of those students who had the correct idea, many failed to answer the question as to why reducing the amount of energy used reduces the amount of carbon dioxide.

Q13.

(a) (i) This was well answered with most students scoring the mark.

(ii) almost two-thirds of students answered this question correctly. There were some pleasing answers referring to the dissipation of energy into the surroundings.

(b) The majority of students were able to identify the basic pattern of input energy increasing with increasing load. However, only a tenth of students were able to provide further amplification relating to the shape of the graph.

(c) (i) A large number of students were able to identify the correct equation, but mistakes were often made in not converting (or wrongly converting) watts to kilowatts. Most students scored at least one mark.

(ii) The majority of students scored this mark, however a significant number of students failed to realise that an environmental advantage was required, giving a response of 'to save money'.

Q14.

(a) (i) The majority of candidates indicated that they had correctly added together 1400 and 700 to get 2100. However, a large number of candidates failed to notice that the values given were in watts and that the question asked for the answer in kilowatts.
Of those who made an attempt to convert their answer, a large number of candidates were unable to do this correctly, the most common mistakes being to divide by 100 or to multiply by 1000. Another frequently seen error was an indication of 2100/1000 but then a failure to calculate this correctly.

(ii) It was pleasing to see so many correct answers to this calculation, usually by those candidates who opted to work out the energy in kilowatt-hours.
Of those candidates who opted for joules, a common mistake was to multiply the power by a time of 90 minutes rather than converting to seconds.

(iii) This question was correctly answered by three fifths of the candidates. Most of the candidates who failed to score the mark had either just defined the term efficiency or had not picked up on the question asking for .'very' efficient.

(b) This part question was correctly answered by only a very small minority of

candidates (less than one twentieth). Incorrect responses often stated that the temperature of the room had become the same as the temperature of the heater.

Q15.

(a) Most candidates knew how to answer this, but a significant number failed to realise that their answer of '1500' was pence, not pounds.

(b) This proved to be a difficult question for many candidates, a significant number not attempting it. Of those who made an attempt, quite a few realised that there was a saving of 3 years, but did not link the pay-back time to their previous answer.

(c) Most candidates opted for the 'yes' answer, gaining some credit for stating that less electricity would be used by the new freezer, but often failing to describe how this would benefit the environment. Of those who chose the 'no' option some credit was usually gained for the ideas that the appliance would need to be disposed of.

Q20.

(a) This question was well done with nearly all of the students scoring both marks.

(b) This question was not well answered for a variety of reasons. Some students simply did not know where to start, whilst others tried using momentum. Also, many realised the need to use the equation for kinetic energy, but were then unable to transform it or failed to square root; 300 was a common incorrect answer. Few students stated that GPE = KE although they used their answer from part (a) in the calculation. Only a tenth of students were able to complete the calculation and give an answer with an appropriate number of significant figures.

(c) Most students scored one mark for mentioning friction, but very few students were able to give a complete explanation to score all three marks. The idea that work would be done against friction was hardly ever mentioned. A significant number of students thought that the reduced maximum speed was due to the change in angle of the slide and the slide becoming horizontal.

Q21.

In part (a) those candidates who chose the payback route generally gained no credit, unless they picked the boiler as the best option. Many candidates scored two marks for selecting the boiler and a correct calculation. A significant number of candidates scored all three marks for completing all the calculations correctly and making the correct choice.

Few candidates scored 2 marks in part (b). Most candidates failed to link the less energy back to the power station. The common mark scored was for stating the reduction in fuel burnt. Many considered the efficiency of the bulbs; but did not link it back to the need to generate less electricity. Very few thought about the need for fewer bulbs and the energy saving in their manufacture. There were a significant minority of candidates who thought that conventional light bulbs emit carbon dioxide or that energy loss somehow produces carbon dioxide, often as a result of heat loss.

Q22.

(a) (i) The vast majority of students attempted this calculation, with over three quarters getting the correct answer. The most common errors were in transposing the equation incorrectly, or including the water temperature of 60°C in the calculation.

(ii) Around half of the students were able to use the total cost of £30 and the cost per kWh of 15p to calculate a figure of 200; however that is the point at which most stopped, quoting an answer of 200 hours. A few then attempted to involve the power, with only a minority ending up with the correct answer. A few students did not attempt to answer this question.

(b) Most students gave at least one correct point in answer to this question, with around half being able to give two points correctly.

Q23.

(a) 48% of students scored 2 marks for this question, with 40% scoring 1 mark. Those who scored 1 mark usually did so for the second blank.

(b) 94% of students recalled this equation correctly.

(c) 87% of students scored 3 marks for this question. The first two marks in the question were for the substitution into, and rearrangement of, the equation. The third mark was for a correct final answer.

(d) 31% of students scored 2 marks for this question. Many students read the change in speed correctly from the graph and a range of values, between 1.2 and 1.5 m/s, were accepted. The percentage increase in speed proved more challenging as students were often unsure whether they should have divided by the 9.5 (m/s) or the 11 (m/s). Students who did [((11.5/9.5) − 1) × 100] calculated correctly, scored both marks.

(e) This question differentiated well, with 44% of students scoring 2 or more marks and 49% of students scoring at least 1 mark. Very few students scored 3 marks. The decrease in speed due to additional work done or the increased gravitational potential energy were often seen. Many students thought that the cyclist should increase their power output when cycling uphill, although the question was asking about their maximum speed.