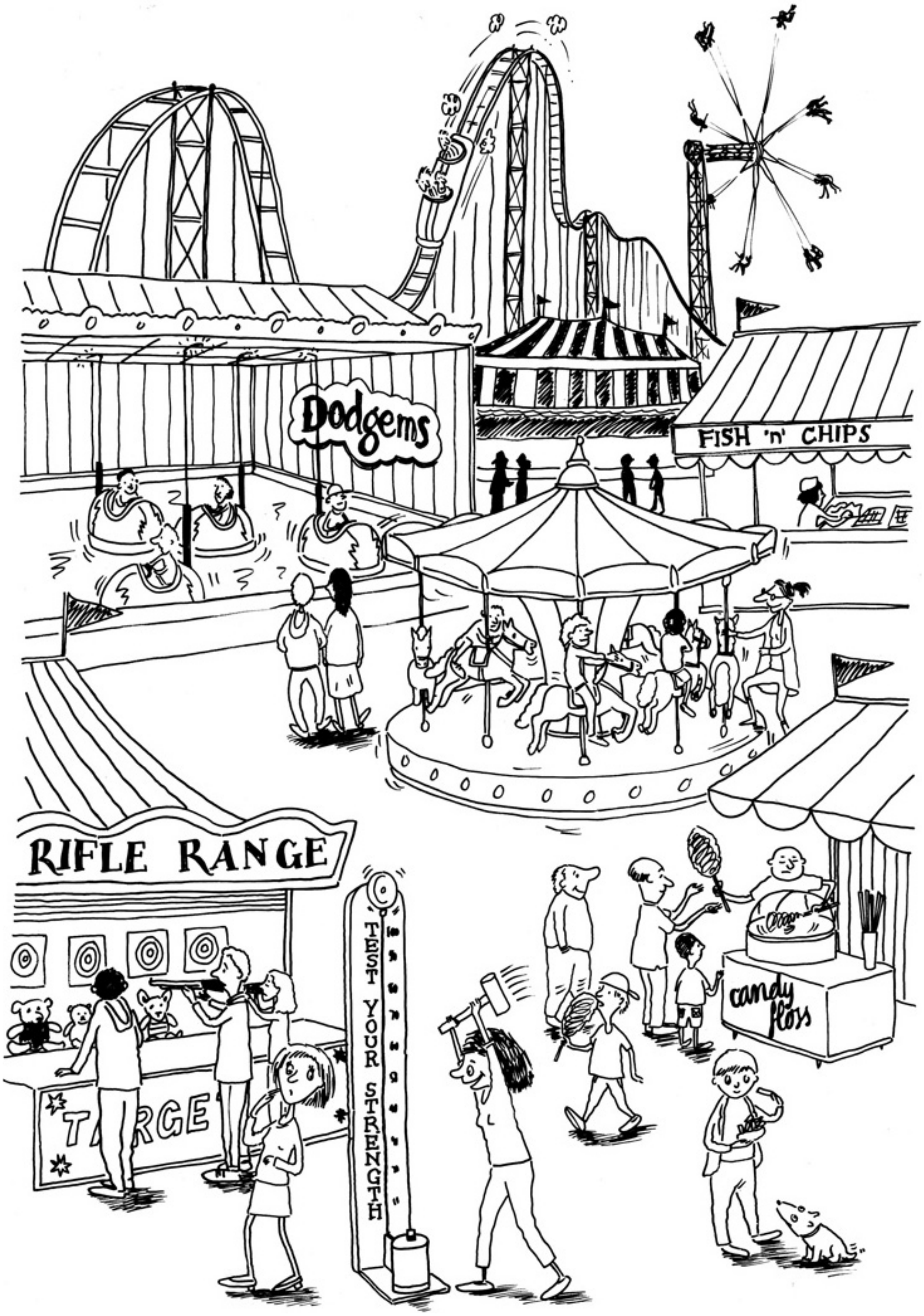
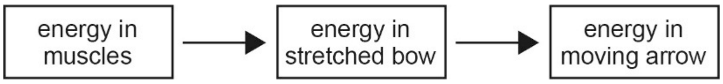
1 Look at this picture of a fairground.

a Identify as many different energy stores and transfers as you can.

b List three energy transfers that are useful and three that are not useful.



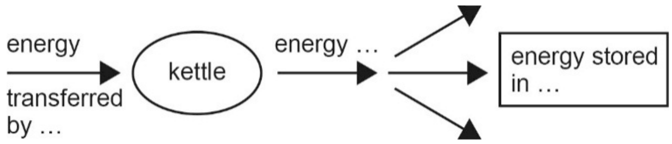
We can represent energy stores and transfers using flow diagrams. The diagram below shows some of the energy stores and transfers when someone shoots an arrow.



1 The boxes show energy stores. What name do we give to each of these energy stores?

2 The arrows show energy transfers. What label should be on the arrows? (*Hint*: it is the same label for both arrows.)

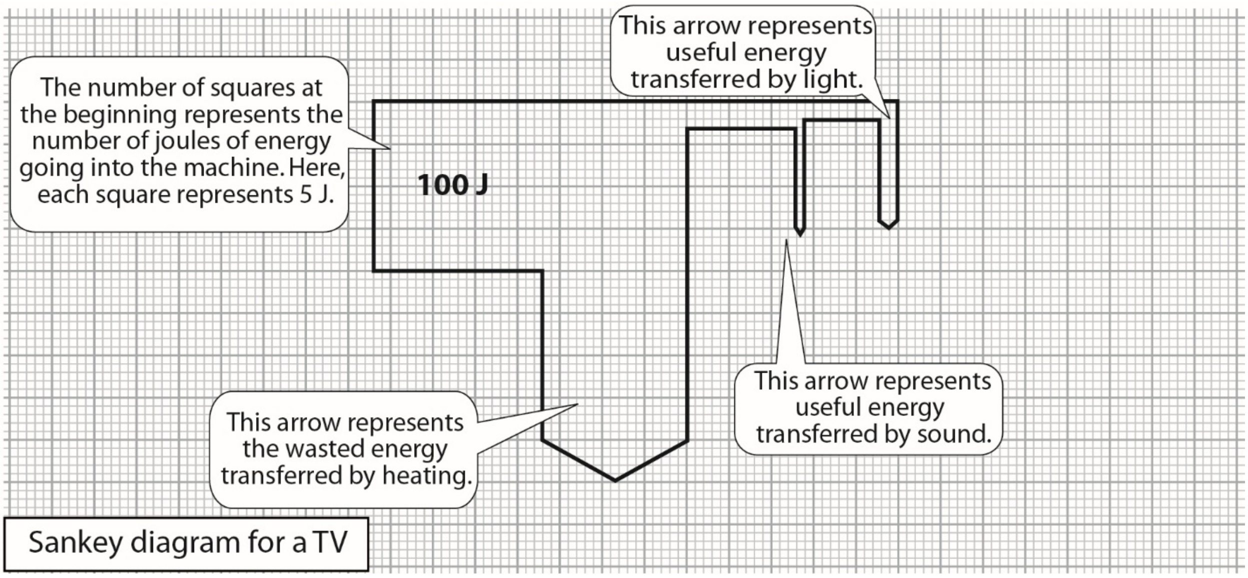
3 When we boil a kettle, energy is transferred to it by electricity. The energy ends up stored as **thermal energy** in the hot water, in the kettle and in the surroundings.



a Copy and complete the diagram on the right to show the different energy stores and transfers.

b Explain which of the final energy stores is useful energy.

A **Sankey diagram** shows energy transfers. The widths of the arrows on the diagram are proportional to the amount of energy they represent. It is easier to draw a Sankey diagram if you use graph paper.



4 Look at the Sankey diagram for a TV. For every 100 J of energy transferred to the TV, how much is transferred to the surroundings by:

a heating
b light
c sound?

5 A light bulb transfers 60 J of energy every second. It transfers 33 J of useful light energy and the rest is transferred to the surroundings by heating.

a How is energy transferred to the light bulb?

b How much energy is transferred from the light bulb by heating?

c Draw a Sankey diagram to represent the energy transfers in the light bulb.

Name ______________________________ **Class** _____________ **Date** ______________

1 Fill in the gaps using words from the box. You can use each word once, more than once or not at all.

Energy is stored in our bodies. Energy stored in this way is sometimes called ________________ energy. As you climb up to a diving board, some of the energy stored in your body is transferred to ________________ potential energy. When you jump from a diving board, the gravitational _______________ energy is transferred to ______________ energy as you accelerate downwards.

Not all the energy is transferred as useful energy – your body gets warmer as you climb, and this ______________ energy is transferred to your surroundings _________________.

by heating	by light	by sound	chemical	elastic	gravitational	kinetic	potential	thermal

S1 Describe the energy stores and transfers when you climb up to a high diving board and then jump into a swimming pool.

2 Give an example of something that transfers energy by:

a heating __________________________

b light ___________________________

c sound ___________________________

d forces ___________________________

3 Give an example of an object that stores:

a **kinetic energy**

____

b **chemical energy**

____

c gravitational potential energy

____

d **elastic potential energy**

____

4 When a ball bounces, energy is transferred between different stores. The sentences below go into the energy flow diagram. Write one letter from the diagram next to each sentence to show where it goes.

A → B → C → D → E

___________ energy stored in the moving ball (kinetic energy)

___________ energy stored in the moving ball (kinetic energy)

___________ energy stored in the squashed ball as it hits the floor (elastic potential energy)

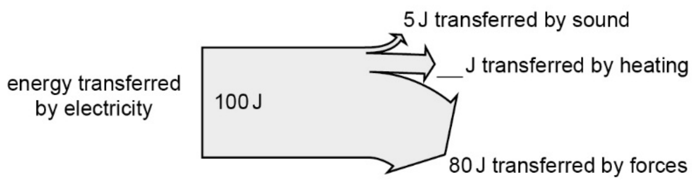
___________ energy stored in the ball before it drops (**gravitational potential energy**)

___________ energy stored in ball as it rises (gravitational potential energy)

5 The diagram shows the energy transfers in an electric motor.

a Fill in the missing number.

b Explain how you worked out the answer to part **a**.



____

Edexcel GCSE (9–1)
Sciences

SP3a.4 Energy stores and transfers
Homework 1

Name ______________________________ **Class** _____________ **Date** ______________

1 Most cars use energy stored in petrol or diesel.

a What name do we give for the way energy is stored in petrol? ________________________________

b What is the name for the energy stored in the moving car?________________________________

c What forms of wasted energy does a car's engine transfer? ________________________________

d Explain what happens to the energy stored in the moving car when the driver applies the brakes to stop the car. Use all the words in the box in your answer.

brakes	by heating	forces	friction
surroundings	temperature	transferred	

____

____

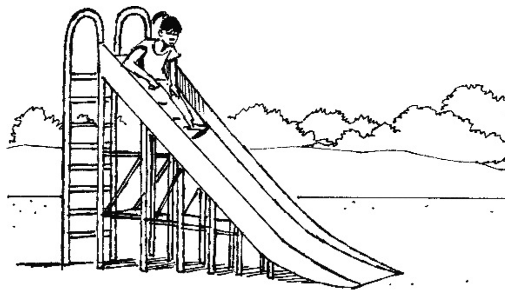
____

2 What is the name for the way energy is stored in Jenny when:

a she is at the top of the slide _______________

b she reaches the bottom of the slide?

____



3 A ball bounces when it hits the ground.

a Complete the diagram to show the energy stores and transfers as the ball falls to the ground.

energy stored in ball before it is dropped (_______________ _______________ energy)	energy → transferred by forces	energy stored in moving ball just before it hits the ground (_______________ energy)	energy → transferred by forces	energy stored in squashed ball as it hits the ground (_______________ _______________ energy)

b Describe the energy transfers and stores as the ball moves upwards to the top of the next bounce.

____

4 The diagram shows energy transfers in a television. The TV transfers 10 J of energy by light each second.

a Explain how you can work this out from the information given on the diagram.

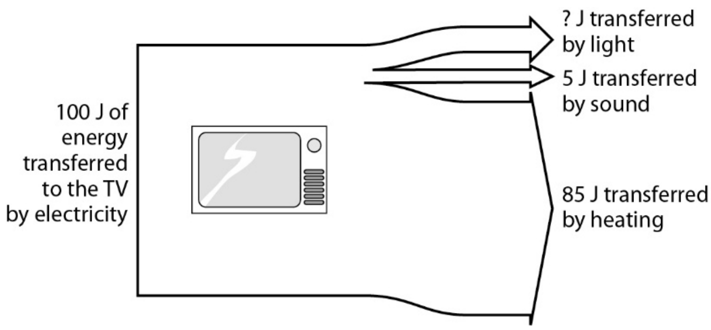
____

____

b How much of the energy transferred each second is useful?

____

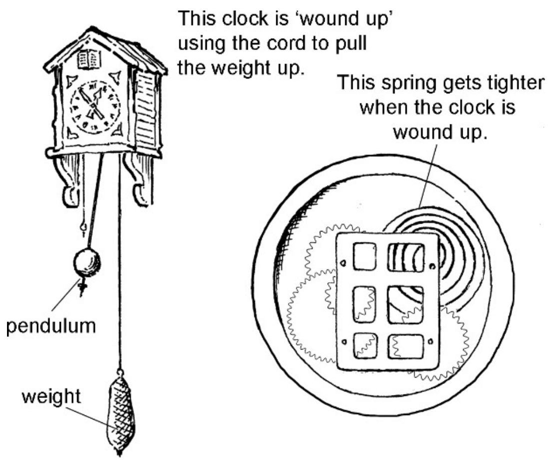
____



Ways of storing energy			**Ways of transferring energy**		
chemical	elastic potential (strain)	gravitational potential	forces	heating	light
kinetic	nuclear (atomic)	thermal	sound		

1 Most clocks today use electricity, either from the mains supply or from cells. The drawings show two different kinds of clock that do not use electricity.

Draw flow diagrams to describe the energy stores and transfers in the clocks shown here.



2 10 000 J of energy is transferred to a kettle, but only 7500 J of the energy is transferred to the water in the kettle.

a What happens to the energy not used to heat the water?

b Draw a flow diagram to represent the energy transfers. Label all the arrows on your diagram.

3 A light bulb transfers 100 J of energy every second. 5 J of energy is transferred to the surroundings by light.

a In what way is the wasted energy transferred?

b Draw a **Sankey diagram** on graph paper to represent the energy transfers in the light bulb.

4 A plasma TV uses 300 J of energy every second, and transfers 5 J by light and 5 J by sound.

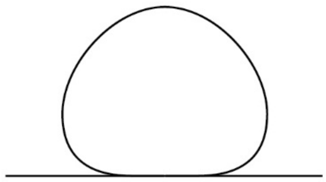
a In what way is the wasted energy transferred?

b How much energy is wasted each second? Explain how you worked out your answer.

c Draw a Sankey diagram on graph paper to represent these energy transfers.

d Energy cannot be created or destroyed. Explain what we mean when we refer to 'wasted' energy.

Fred drops a ball and it bounces several times. The drawing shows the ball at the instant it hits the ground.



5 How is energy stored in the ball:

a just before it is dropped

b just before it hits the ground

c as it is on the ground, as shown in the drawing?

6 Draw a flow diagram to show the energy stores and transfers as the ball falls, bounces, and then comes to a stop at the top of the first bounce.

The amount of **gravitational potential energy** stored in an object depends on its height above the ground. When a ball bounces, it never reaches the height from which it was dropped.

7 A ball is dropped from 1 metre above the ground. At the top of the first bounce it is 50 cm above the ground.

a How much energy is stored in the ball at the top of the first bounce, compared with the energy stored in it just before it was dropped? Explain your answer.

b Explain what happens to the rest of the energy.

Extra challenge

8 A bouncy ball is thrown downwards. At the top of its first bounce it is higher than the point from which it was thrown. Explain why this does not break the **law of conservation of energy**.

Name ______________________ **Class** __________ **Date** ____________

Progression questions

Answer these questions.

1 How is energy transferred between different stores?

____

____

2 How can we represent energy transfers in diagrams?

____

____

3 What happens to the total amount of energy when energy is transferred?

____

____

Now circle the faces in the 'Start' row in the table showing how confident you are of your answers.

Question	**1**	**2**	**3**
Start	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Assessment

Using a different colour, correct or add to your answers above. You may need to use the back of this sheet or another piece of paper. Then circle the faces in the 'Check' row in the table.

Question	**1**	**2**	**3**
Check	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Feedback

What will you do next? Tick one box.

☐ strengthen my learning ☐ strengthen then extend ☐ extend

Note down any specific areas you need to improve.

____

Action

You may now be given another activity. After this, note down any remaining areas you need to improve and how you will try to improve in these areas.

____

____

Edexcel GCSE (9–1) Sciences

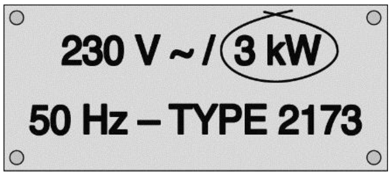
SP3b.1 Efficiency of a kettle

Your teacher may watch to see if you can…

- carry out calculations to interpret your results, showing your working.

Introduction

The power rating of an electric kettle tells us how many joules of energy are transferred in the heating element every second. So an electric kettle with a power rating of 3 kW transfers 3000 joules (3 kJ) of energy every second.



Aim

In theory, it takes 336 000 J of energy to heat 1 litre of water from 20 °C (roughly room temperature) to boiling point. You are going to test a kettle to see how much electrical energy it actually uses to do this.

Planning

You need to measure the following things:

- 1 litre (1 kg) of water into the kettle
- the time to reach boiling point in seconds after the kettle is turned on.

1 Write a step-by-step plan for your investigation. Think about how to measure the amount of water accurately, how to measure the time to boil the water and how to tell when the water is boiling.

Recording your results

2 How many seconds did the kettle take to boil 1 litre of water?

3 What was the power of your kettle in watts? (Convert kW to W by multiplying by 1000.)

4 Use this equation to calculate the energy transferred by the kettle.

energy (in J) = power (in W) × time (in seconds)

Considering your results/conclusions

5 **a** What do you notice about the amount of energy actually needed to boil the water compared with the theoretical value?

b Why is there a difference?

6 Calculate the **efficiency** of the kettle.

Further work

If you have a kettle with a different power rating available, repeat the test.

7 **a** How do the results with this kettle compare with the results from the first one?

b Is the difference between theoretical and actual energy used the same? If not, why not?

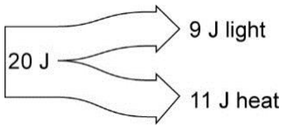
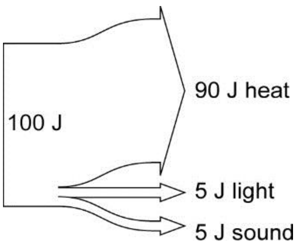
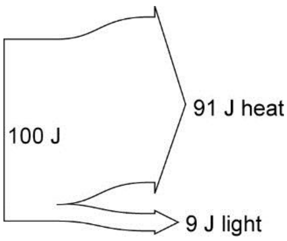
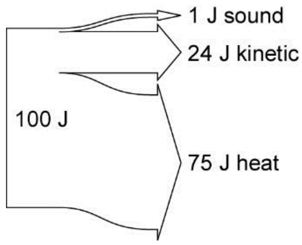
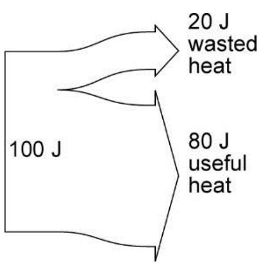
Evaluation

8 How could you increase the quality of the data you have collected to be more sure of your calculated result? Think about the variables that were difficult to control.

9 Why would comparing your results with others allow you to be more certain of your calculated result?

The cards show different energy transfers and stores.

Cut out all the cards and match each picture card with three other cards.

1 useful: light wasted: heat	2 	3 useful: light, sound wasted: heat	4 **efficiency** = 0.8
5 efficiency = 0.24	6 useful: kinetic wasted: heat, sound	7 old-style light bulb	8 television
9 	10 	11 useful: light wasted: heat	12 moving car
13 efficiency = 0.09	14 efficiency = 0.1	15 	16 boiling water in a kettle
17 efficiency = 0.45	18 	19 energy-efficient light bulb	20 useful: heat wasted: heat

Edexcel GCSE (9–1) Sciences

SP3b.3 Energy efficiency equation practice

1 The table gives information about some different machines. Copy the table and fill in the missing values.

	Total energy supplied per second (J)	**Useful energy transferred per second (J)**	**Wasted energy transferred per second (J)**	**Efficiency**
a	100	80	20	
b	25	6.25	18.75	
c	30	12	18	
d	80	68	12	
e	1200		120	0.9
f	5000		250	0.95
g	750		525	0.3
h		350	150	0.7
i		260	140	0.65
j		10	40	0.2

2 An incandescent bulb is supplied with 100 J of energy every second and transfers 5 J of energy by light. Calculate the **efficiency** of the bulb.

3 A plasma TV transfers 300 J of energy every second. It transfers 5 J by light and 5 J by sound. What is the efficiency of the TV?

4 An ordinary light bulb has an efficiency of 0.05. If 400 J is supplied by electricity, how much energy is transferred from the bulb by light?

5 A low energy light bulb is supplied with 20 J of energy each second and transfers 9 J by light.

a What is its efficiency?

b How much energy must be transferred to a normal incandescent bulb (efficiency 0.05) for it to transfer 9 J of energy by light?

6 It takes 300 kJ of energy to bring a full kettle of water to the boil. How much energy must be supplied to the kettle by electricity if the efficiency of the kettle is:

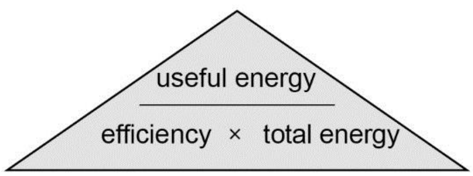
a 0.95 **b** 0.9?

7 An electric crane lifts a load of bricks up 5 metres and transfers 90 kJ of gravitational potential energy to them. The crane has an efficiency of 0.8. Calculate the amount of energy transferred to the crane by electricity.

8 A TV is supplied with 50 J of energy each second. It transfers 8 J of this by light and also transfers energy by sound and by heating. Its efficiency is 0.24. Calculate the amount of energy transferred by sound each second.

9 A power station has an efficiency of 0.5, the transmission lines that get the electricity to homes have an efficiency of 0.9, and a light bulb has an efficiency of 0.05. How much energy must be input as fuel to the power station for the light bulb to transfer 1 J of energy? (*Hint*: start by working out how much energy must be supplied to the bulb, then how much must be sent down the transmission lines for this amount to arrive)

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



Name ______________________________ **Class** _____________ **Date** ______________

EASIER

1 Complete these sentences using words from the box. You can use each word once, more than once or not at all.

When you open a door there is ________________ between the two parts of the hinge. Friction causes moving objects to ____________ and can also cause ________________. Oil is a _______________ and ________________ the amount of ________________ between moving objects. Oiling a hinge means ________________ of the energy transferred by ________________ is wasted by heating and by ________________ so it takes ________________ energy to open the door.

cool down	forces	friction	heat up	heating	increases	less
lubricant	more	noise	reduces	sound		

S1 Explain why adding oil to door hinges makes the door easier and quieter to open.

2 **a** How is most wasted energy transferred? Circle one phrase.

by electricity   by forces   by heating   by light   by sound

b How is the useful energy transferred from a radio? Circle one phrase.

by electricity   by forces   by heating   by light   by sound

3 Complete this sentence by crossing out the incorrect words.

Efficiency is a measure of the amount of (useful/wasted) energy transferred by an appliance, compared with the (wasted/total) energy transferred.

4 Calculate the efficiency of the radio in question S2 below: efficiency = $\frac{\_\_\_\_\ \text{J}}{\_\_\_\_\ \text{J}}$ = ________

S2 A radio is supplied with 50 J of energy and transfers 5 J of this by sound. Explain what happens to the rest of the energy and calculate the efficiency of the radio.

5 Explain why oiling a bicycle chain makes it easier to pedal the bike. Use all the words from the box in your answer.

by heating	energy	forces	friction	lubricate/lubricant	oil
reduces	surroundings	transfers/transferred	wasted		

When you pedal a bike, the links in the chain move as the chain moves around. When two objects move past each other, ____

____

____

____

____

____

HARDER

Edexcel GCSE (9–1)
Sciences

SP3b.5 Energy efficiency Homework 1

Name ______________________________ **Class** _____________ **Date** ______________

1 Which equation is the correct equation for calculating the **efficiency** of a machine? Tick one box.

efficiency = ☐ $\frac{\text{total energy transferred}}{\text{useful energy transferred}}$ ☐ $\frac{\text{wasted energy transferred}}{\text{useful energy transferred}}$ ☐ $\frac{\text{useful energy transferred}}{\text{total energy transferred}}$

2 Some of these statements are true and some are false. Tick the boxes to show which ones are which.

		True	False
a	An old-style light bulb uses 60 J of energy to transfer 6 J of useful energy by heating.	☐	☐
b	The efficiency of an old-style light bulb is usually around 0.05 to 0.1.	☐	☐
c	A low energy bulb uses 15 J of energy to give 6 J of useful energy transferred by light and only wastes 9 J of energy by heating.	☐	☐
d	The efficiency of the low energy bulb = $\frac{6}{9}$ = 0.67	☐	☐
e	An efficient appliance wastes more energy than an inefficient one.	☐	☐
f	You always get the same amount of energy out of a machine as you put into it.	☐	☐

3 For each statement that you have ticked as false, explain why it is wrong.

Statement ___ is wrong because ____

____

Statement ___ is wrong because ____

____

Statement ___ is wrong because ____

____

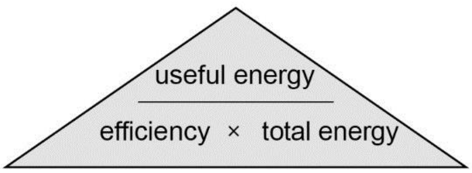
4 In which way is most wasted energy transferred? Tick one box.

☐ by light ☐ by heating ☐ by sound ☐ by forces

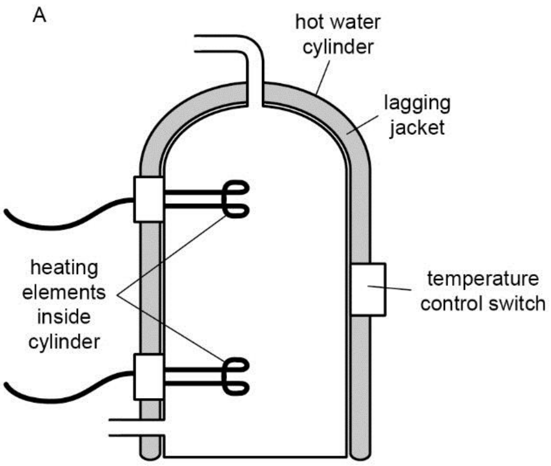
5 Complete these sentences using words in the box. You can use each word once, more than once or not at all.

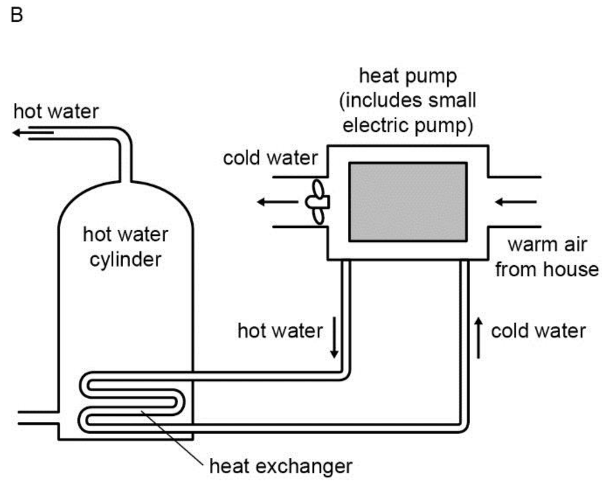
There is ________________ between the moving parts of machines. Friction causes the ________________ of the machine to rise so energy is being wasted by ________________. This ________________ energy is stored in the machine or the surroundings as ________________ energy. The amount of ________________ between moving parts can be reduced by ________________ the machine.

by heating	by light	friction	kinetic	lubricating	temperature	thermal	useful	wasted



Hot water in homes is normally provided by a gas boiler. However, many houses have immersion heaters in their hot water tanks that use electricity to heat the water. Immersion heaters are used if the home has no gas supply, or if the central heating is switched off for the summer. A more efficient way of heating water is to use a heat pump. This acts a little bit like a fridge in reverse – it takes warm air from the house and 'concentrates' the energy to heat water. This works even in the winter, although then the water sometimes needs a bit of extra heating from an immersion heater.





It takes 1.2 kilowatt hours (kWh) of electrical energy to heat a tank full of water using a heat pump. It takes 5.5 kWh if the same amount of water is heated using an immersion heater. A kilowatt hour is a unit of energy used by energy suppliers. (1 kWh = 3 600 000J)

1 The immersion heater and hot water cylinder together (diagram A) have an **efficiency** of 0.73.

a How much energy is transferred to the water in the cylinder?

b How is the wasted energy transferred?

c How could the efficiency of the immersion heater and its cylinder be increased?

2 **a** How is wasted energy transferred by the heat pump (diagram B)? (*Hint*: there is more than one way.)

b The heat pump transfers the same amount of useful energy to the water in the tank as the immersion heater. Calculate its efficiency based on the energy used by the motor. (*Hint*: your answer may look wrong to you!)

3 Your answer to question **2b** is not the true efficiency of the heat pump.

a Why is this not the true efficiency? (*Hint*: think about all the sources of energy that go into the system.)

b Would the true efficiency be greater or smaller than the value you calculated?

c Which value for the efficiency of a heat pump is most useful for a home owner deciding how to heat water?

d Suggest what else you would need to know before deciding whether to buy and install a heat pump or an immersion heater.

Extra challenge

4 A fridge is standing in the middle of an empty room with all the doors and windows closed. The fridge is switched on and its door is opened.

a Will the temperature in the room go down, stay the same or go up?

b Explain your answer to part **a**.

Name ______________________ Class ___________ Date ____________

Progression questions

Answer these questions.

1 What does **efficiency** mean?

2 How do we calculate the efficiency of an energy transfer?

3 How can we reduce unwanted energy transfers in machines?

Now circle the faces in the 'Start' row in the table showing how confident you are of your answers.

Question	**1**	**2**	**3**
Start	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Assessment

Using a different colour, correct or add to your answers above. You may need to use the back of this sheet or another piece of paper. Then circle the faces in the 'Check' row in the table.

Question	**1**	**2**	**3**
Check	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Feedback

What will you do next? Tick one box.

☐ strengthen my learning ☐ strengthen then extend ☐ extend

Note down any specific areas you need to improve.

Action

You may now be given another activity. After this, note down any remaining areas you need to improve and how you will try to improve in these areas.

Your teacher may watch to see if you can…

- take accurate measurements.

Aim

To compare the thermal conductivities of different materials. You will need to work in a team to carry out this investigation.

Planning

1 You are going to test different materials to see how they affect the rate of cooling of hot water. List the variables you need to keep the same to make sure your test is fair.

Method

Apparatus

- kettle
- 3 beakers
- lids for beakers with hole
- 3 thermometers
- stop clock
- different insulating materials
- sticky tape

⚠ Safety

Take care with hot water. Mop up any spills straight away.

A Cover two of the beakers with insulating material, and fasten it in place with sticky tape. Use a different material for each beaker. The insulating material should be the same thickness on each beaker.

B Pour the same volume of hot water from a kettle into all three beakers and put the lids on. Put a thermometer through the hole in each lid.

C When the liquid in the thermometers has stopped rising, start the stop clock and record the temperature of the water in each beaker. Try to record all of the temperatures at the same time.

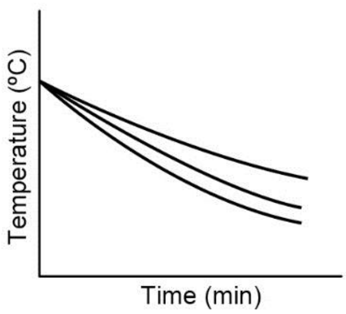
D Record the temperature in each beaker every 30 seconds. Do not stop the stop clock when you are reading the temperatures, and keep trying to read all the temperatures at the same time. Continue taking the temperature until the water in one beaker has cooled by 30 ºC.

Recording your results

2 Draw a table like this to record your results.

Time (minutes)	Temperature (ºC)		
	Beaker 1	Beaker 2	Beaker 3
0			
0.5			
1			

3 Draw a graph to show your results. Plot the temperatures for all three beakers on the same graph. Draw a smooth curve through the points for each beaker. Your graph should look similar to the one on the right.



4 Calculate the overall temperature change for the water in each beaker. Label each line on the graph to show what kind of **insulation** was on the beaker.

Considering your results/conclusions

5 Which material was the better insulating material? Explain your answer.

6 Which material had the lowest **thermal conductivity**? Explain your answer.

Evaluation

7 Was your investigation a fair test? Explain your answer.

8 Explain why you need to use the results from the beaker with no **insulation** when drawing your conclusion.

9 Did you use your graph or the calculated temperature differences to decide which insulating material was better? Explain why you used the information you did.

10 **a** Explain why scientists often repeat tests when they are carrying out an investigation.

b Suggest why drawing a graph of the results from this investigation can serve a similar purpose to taking repeat measurements.

Choose one of the following research tasks. Look up the information you need to answer the question and present your findings on a poster or as a computer presentation.

A: Insulating properties of materials

Snow is a cold material – it melts if it gets too warm. But snow is also a surprisingly good insulating material because of pockets of air trapped between the crystals.

Living in cold climates

Blocks of snow are used to build igloos, which are winter shelters built by the Inuit people who live in Greenland and northern Canada. Some Inuit people use houses partly built into the ground and with walls constructed of wood and sod (turf). Turf is also used to cover the roof.

Surviving on a mountain

Mountaineers often take several days or even weeks to climb high mountains. They carry sleeping bags with them, and usually tents made of nylon or polyester. However they may also dig snow-holes to sleep in.

1 Compare the thermal conductivities of the materials used to make:

- igloos
- tents
- sod houses
- modern houses.

2 Explain what other information you need to know to work out which of the building types in question 1 has the best **insulation**.

3 Suggest why an igloo provides better insulation than a tent.

4 Compare the thermal insulation properties of snow and ice, and explain the difference.

B: Building design

Homes in different parts of the world often have quite different designs. Sometimes this is due to the limited building materials available or the way of life of the inhabitants. But the design of buildings also depends on the climate – whether the structure needs to help keep the inhabitants warm or to keep them cool.

5 Choose one of these pairs of houses and find out how each was built. Summarise the key features of the two house designs.

- Celtic ‘roundhouse’ and Scottish ‘blackhouse’
- alpine chalet and Greek or Spanish villa or house.

6 Find out about the typical weather conditions in the places where your two houses were built.

7 Explain how the design and materials of each house helps to protect the inhabitants against the weather.

Name ____________ **Class** ____________ **Date** ____________

EASIER

1 Draw lines to match up the sentence halves below.

Walls can be built of materials …	… reduces the rate at which energy is transferred.
The **thermal conductivity** of a material …	… is a good **thermal insulator**.
A material with a low thermal conductivity …	… with better insulating properties.
Using thicker materials …	… is a measure of how well it transfers energy by heating.

S1 Explain two ways in which walls can be built to keep a house warmer.

2 Complete these sentences using words from the box. You can use each word once, more than once or not at all.

We have duvets or ______________ on our beds to keep us______________ at night. They ______________ the energy transfer from our bodies to the rest of the room.

These materials contain ______________. Air is a ______________ **thermal conductor** (it has ______________ thermal conductivity) and it cannot transfer energy by ______________ when it cannot move.

Fridges and freezers keep food ______________. They are built with walls and doors made from ______________ materials. This ______________ reduces the transfer of energy from the ______________ surroundings into the ______________ food.

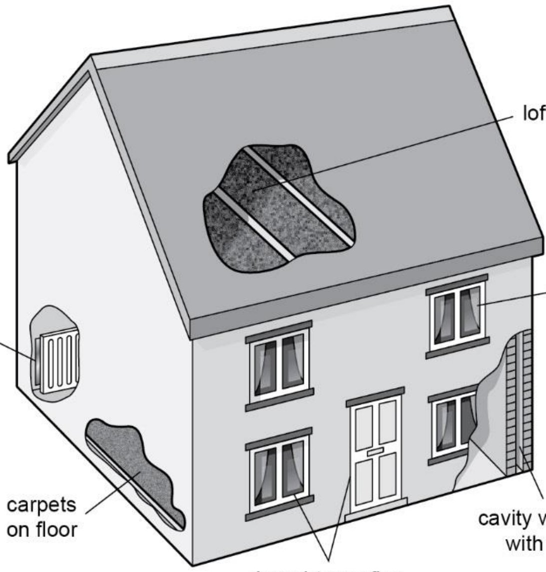
HARDER

blankets	cold	conducting	**conduction**	**convection**	cool	cooler	good
high	increase	increases	insulating	low	poor	**radiation**	reduce
		reduces	trapped air	warm	warmer		

S2 Explain two ways in which **insulation** is used at home to reduce energy transfers.

Name ______________________ Class __________ Date __________

The diagram shows different ways of making a house more energy efficient.



1 Which of these things describes a more energy efficient house compared to a less energy efficient one? Tick two boxes.

- ☐ Less energy is transferred through the walls by heating.
- ☐ The house is always warm inside.
- ☐ Fuel bills are lower.
- ☐ It has gas central heating.
- ☐ Less energy is needed to heat it if both houses are kept at the same temperature.

2 Name one feature of the house that reduces the energy transferred by the following:

a **radiation** ______________________________

b **conduction** ______________________________

c **convection** ______________________________

3 Tick the boxes to show which statements are true and which are false.

		True	False
a	A material with a high **thermal conductivity** is a good insulator.	☐	☐
b	Energy can be transferred faster through thin walls than through thick walls.	☐	☐
c	Materials that contain trapped air are good **thermal conductors**.	☐	☐
d	**Insulation** can keep cold things cold.	☐	☐

4 Write corrected versions of the statements that are false.

____

____

5 Explain statement **c** in question 3, or your corrected version if you thought statement **c** was false.

____

____

6 Explain statement **d** in question 3, or your corrected version if you thought statement **d** was false.

____

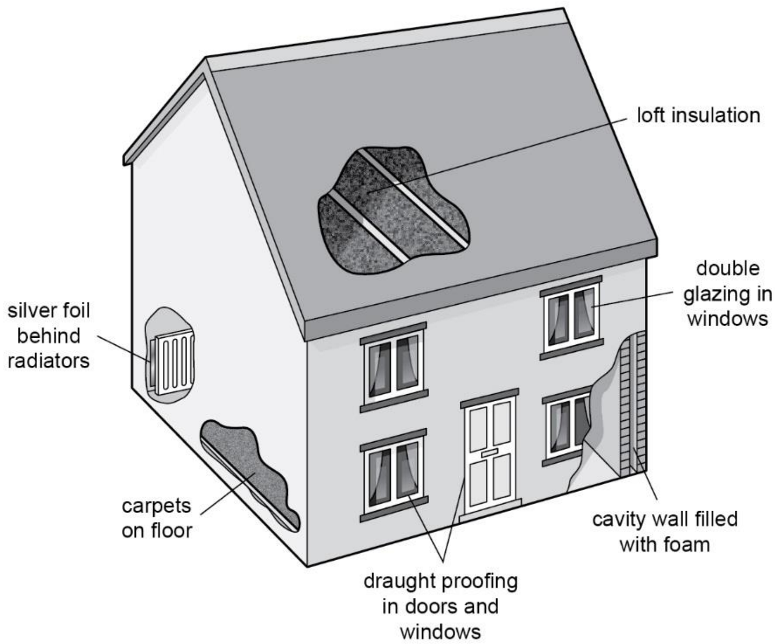
____

1 Small birds often look bigger when the weather is cold because they fluff their feathers up. Suggest why they do this.

2 Many houses have double-glazed windows. These have two sheets of glass with an air gap between them. Why does double glazing provide better **insulation** than single glazing?

3 First aiders will often cover someone who has been injured outdoors with a very thin blanket made from shiny metal foil. Suggest some of the advantages and disadvantages of using foil instead of a normal blanket.

The diagram shows different ways of making a house more energy efficient.



4 Explain what energy efficient means when we are talking about a house.

5 Explain how each of the labelled features helps to make the house on the right more energy efficient. Use the phrase '**thermal conductivity**' in at least two of your explanations.

6 Explain why having thick loft insulation is better than having only a thin layer.

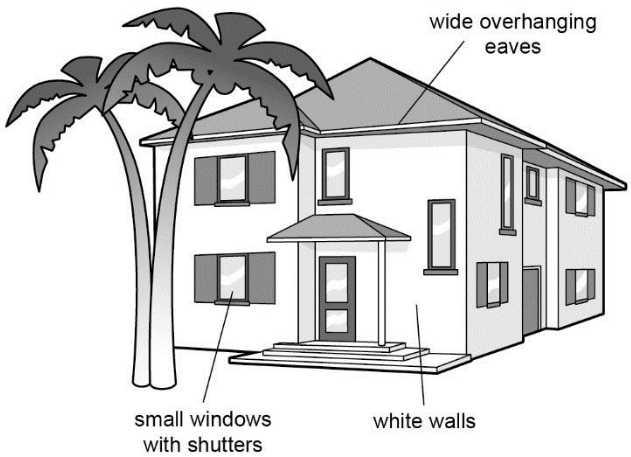
7 In snowy weather, you can sometimes see a row of houses where the snow has melted on some roof tops but not on others.

- **a** What does this tell you about the temperatures inside the lofts of houses with snow on the roof compared to houses with no snow?
- **b** Suggest two different reasons for the different temperatures.

Extra challenge

In some hot countries, the largest contribution to a household electricity bill is the cost of running air conditioning. The amount that needs to be spent on air conditioning can be reduced by designing the house to be cool.

8 Explain how each of the labelled features helps the house on the right to stay cool.



Name ____________ **Class** ____________ **Date** ____________

Progression questions

Answer these questions.

1 What does **thermal conductivity** mean?

2 What affects the rate at which buildings cool?

3 How can **insulation** reduce unwanted energy transfers?

Now circle the faces in the ‘Start’ row in the table showing how confident you are of your answers.

Question	**1**	**2**	**3**
Start	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Assessment

Using a different colour, correct or add to your answers above. You may need to use the back of this sheet or another piece of paper. Then circle the faces in the ‘Check’ row in the table.

Question	**1**	**2**	**3**
Check	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Feedback

What will you do next? Tick one box.

☐ strengthen my learning ☐ strengthen then extend ☐ extend

Note down any specific areas you need to improve.

Action

You may now be given another activity. After this, note down any remaining areas you need to improve and how you will try to improve in these areas.

Name ____________________ **Class** __________ **Date** __________

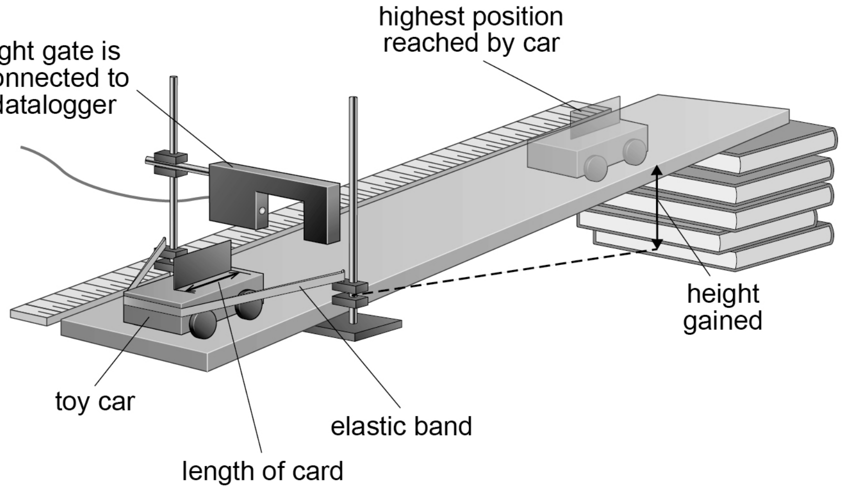
Your teacher may watch to see if you can:
- carry out instructions carefully and safely.

Introduction

You can give a toy car a store of kinetic energy (KE) by using elastic bands to fire it up a ramp. As the toy car moves up the ramp it will gain a store of gravitational potential energy (GPE).

Aim

To find out how the initial speed of the car affects how far up the ramp it moves.



Method

A Stick a piece of card to the top of the car as shown in the diagram. Measure the length of the card. You will need to enter this length into the datalogger.

B Find the mass of the toy car in kilograms and write it down.

Apparatus

- ramp
- books
- toy car
- rubber bands
- clamps and stands
- metre rule
- card
- sticky tape or reusable putty
- light gate
- datalogger
- balance

C Set up the apparatus as shown in the diagram. Make sure the card on the car will pass through the light gate when you release the car.

D Pull the toy car back so that it stretches the rubber band a short distance, and then release it. Note how far up the ramp the car goes and how far you stretched the rubber bands.

E Measure the vertical distance from the ramp just under the light gate to the highest point the car reached. Record the speed of the car (from the datalogger) and the height it gained.

F Repeat steps D and E for different amounts of stretch in the elastic bands (to give the car different speeds as it goes through the light gate).

Name ______________________ **Class** __________ **Date** ____________

Recording your results

1 Enter your results in this table.

Rubber band stretch, d (cm)	Start speed of car (m/s)	KE at start (J)	Change in vertical height (m)	Change in GPE (J)

2 Calculate the KE of the car at the start and the GPE of the car at its highest point using the equations in the box.

> KE = ½ × mass × $(\text{speed})^2$
> change in GPE = mass × 10 N/kg × change in vertical height

3 Plot a scatter diagram to show your results. Put the starting KE on the horizontal axis and the change in GPE on the vertical axis. Join the points on your graph with a line of best fit.

Considering your results/conclusion

4 What does your graph show you? ______________________________

____

____

5 State the energy changes that happen when:

a the rubber band is released and moves the car ______________________________

____

b the car slows down to a stop at its highest point. ______________________________

____

6 Why is the gravitational potential energy gained always less than the initial kinetic energy?

____

____

____

Your teacher may watch to see if you can:

- make accurate measurements.

Introduction

If you drop a ball it may bounce several times before eventually coming to a stop. As the ball moves through the air, and each time it bounces, the ball transfers some energy to its surroundings. A more efficient ball will transfer less energy to its surroundings each time it bounces, and so will continue to bounce for longer.

Aim

To measure the efficiency of two different bouncy balls.

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

Method

A Find the mass of one ball and write it down. Call this ball X.

B Hold the metre rule with the zero end on the floor.

C Drop the ball from the top of the ruler. Note the height the ball reaches at the top of its first bounce.

D Repeat steps B and C until you have 10 measurements.

E Repeat steps A to D for the other ball (ball Y).

Apparatus

- two balls
- metre rule
- balance

Recording your results

1 Draw a table to record your results.

Considering your results/conclusions

2 Calculate the change in gravitational potential energy (GPE) stored in ball X as you raised it to its starting position.

3 Calculate the mean height of the first bounce for ball X, ignoring any anomalous measurements. Use this mean height to calculate the change in GPE as it rises to the top of its first bounce.

4 How much kinetic energy is stored in the ball just before it hits the floor for the first time, assuming that the ball transfers no energy to its surroundings as it falls?

5 Calculate the speed of the ball just before it hits the floor. You will need to rearrange the equation for kinetic energy.

6 Calculate the speed of the ball just after its bounce. (*Hint*: you will need to use the value of GPE at the top of the first bounce.)

7 Calculate the efficiency of the ball. You need to use the two values for GPE you have calculated. The GPE at the starting position is the ‘total energy supplied’.

8 Repeat questions 2 to 7 for the other ball.

9 Predict which ball will bounce for the longest if you drop them from the same height, and explain your prediction. Use the word ‘efficiency’ in your answer.

Evaluation

10 Explain why you needed to obtain 10 measurements of the height of the bounce.

11 Suggest a way of making more accurate measurements of the height of a bounce.

Name ______________________ **Class** __________ **Date** ____________

You will be expected to recall the equations for change in gravitational potential energy (GPE) and kinetic energy (KE) in your examination. You will need to choose the correct formula to answer the question and you should also be able to change the subject of the equations and to use the correct units.

Use a value of 10 N/kg for the Earth's gravitational field strength for all questions on this sheet.

When we talk about the gravitational potential energy (GPE) stored in an object, we are referring to the change in GPE as the object is raised to that position from the floor or from the ground.

1 Goods in a warehouse are stored on shelves. Table **A** shows the changes in gravitational potential energy as different items are put onto their shelves.

Calculate the missing values in the table.

	Change in GPE	**Mass**	**Change in height**
a		4 kg	2 m
b		2.5 kg	3 m
c		500 g	2.5 m
d	800 J		2 m
e	1125 J	75 kg	
f	1.5 kJ	50 kg	
g	50 J		50 cm

A

2 **a** Calculate the change in GPE when an astronaut lifts a 2 kg hammer onto a shelf 1.5 m above the floor in a base on the Moon. The gravitational field strength on the Moon is 1.6 N/kg.

b The same hammer is lifted onto a shelf of the same height on Mars. It gains 11.1 J of GPE.

Calculate the gravitational field strength on Mars.

c A space probe with a mass of 400 kg lands on Titan (one of the moons of Saturn). When it is 500 m above the surface it stores 280 kJ of GPE.

Calculate the gravitational field strength on Titan.

3 Table **B** shows the kinetic energy (KE) stored in moving balls of different kinds. The speeds in the table are the fastest speeds for those balls.

Calculate the missing values in the table.

	Ball	**KE**	**Mass**	**Speed (m/s)**
a	cricket ball		0.16 kg	44
b	football		0.4 kg	30
d	hockey ball		150 g	30
e	ice hockey puck	185 J		48
f	tennis ball	142 J		70
g	table tennis ball		2.7 g	40
h	golf ball	186.3 J		90

B

4 A car has a mass of 1500 kg. Calculate the KE stored in the car when it is travelling at the following speeds.

a 10 m/s (about 20 mph)

b 20 m/s (about 45 mph)

c 30 m/s (about 70 mph)

5 A student drops a bouncy ball from a height of 2 m. The mass of the ball is 0.02 kg. She measures the maximum height it reaches on each bounce and calculates the GPE at the top of each bounce. Table **C** shows her results.

Calculate the missing values in the table below.

Bounce	**0**	**1**	**2**	**3**	**4**	**5**
Height (m)	2.0	1.4	1.0			
GPE (J)	0.4			0.14	0.10	0.07

C

6 In the investigation in question **5**, the GPE stored in the ball at the top of each bounce is converted to kinetic energy by the time the ball reaches the ground again. When the ball is first dropped, it has 0.4 J of kinetic energy just before it reaches the ground. Its speed is 6.32 m/s.

Calculate the speed of the ball just before it reaches the ground after bounces 3, 4 and 5. (*Hint*: remember to take the square root once you have calculated v^2).

7 The bob of a large pendulum has mass of 30 kg. The change in height of the pendulum as it swings is 0.5 m.

a Calculate the change in GPE as the bob moves from its highest to its lowest point.

b All the GPE stored in the bob at its highest point is transferred to kinetic energy as the bob reaches its lowest point. Calculate the maximum speed of the bob.

8 A wrecking ball has a mass of 5000 kg. The ball is pulled sideways and rises by 6 m. When it is released it swings and hits the building to be demolished when it is at the lowest point of its swing.

a Calculate the speed of the ball when it hits the building.

b Calculate the maximum speed of the ball if it is only pulled upwards by 3 m before being released.

---

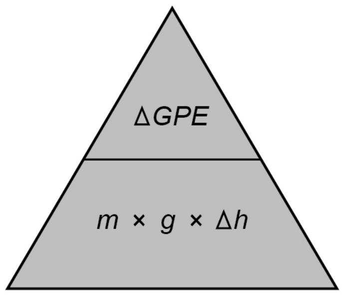
change in gravitational potential energy = mass × gravitational field strength × change in vertical height

ΔGPE represents the change in gravitational potential energy in J

m represents mass in kg

g represents gravitational field strength in N/kg

Δh represents change in vertical height in m

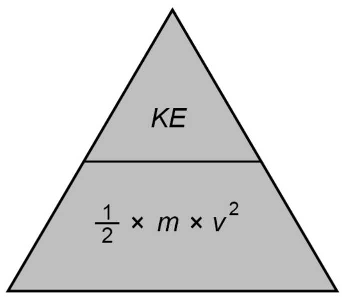


kinetic energy = ½ × mass × (speed)^2

KE represents kinetic energy in J

m represents mass in kg

v represents speed in m/s



Name ____________________ **Class** __________ **Date** ____________

EASIER

1 An aeroplane is flying at 50 m/s at 500 m above the ground. Its mass is 900 kg.

Gravitational field strength on the Earth is 10 N/kg.

a Write down the equation for calculating a change in gravitational potential energy (GPE).

ΔGPE (J) = ____________ (kg) × ____________ (N/kg) × ____________ (___)

b Write in the correct numbers from the question.

ΔGPE = ____________ × ____________ × ______________

c Work out the answer.

ΔGPE = ____________ units __________

d Write down the equation for calculating kinetic energy (KE).

KE (J) = _____ × ____________ (kg) × (___________)^2 (m/s)^2

e Write in the correct numbers from the question.

KE = _____ × ____________ × (___________)^2

f Work out the answer.

KE = __________ units __________

S1 A missile is flying at 220 m/s at 100 m above the sea. Its mass is 1000 kg. Calculate its:

a gravitational potential energy

b kinetic energy.

2 The mass of an eagle is 4 kg. Calculate how high above the ground it has climbed when it is storing 20 000 J of GPE.

Write the numbers from this question into the equation with height on the left:

change in vertical height (m) = $\dfrac{\text{\_\_\_\_\_\_\_\_\_\_ J}}{\text{\_\_\_\_\_\_\_\_\_\_ kg} \times \text{\_\_\_\_\_\_\_\_\_\_ N/kg}}$

Work out the answer: change in vertical height = ______________ m

3 A falcon is flying at 20 m/s. It is storing 240 J of kinetic energy. Calculate its mass.

Write the numbers from this question into the equation with mass on the left:

mass (kg) = $\dfrac{\text{\_\_\_\_\_\_\_\_\_\_ J}}{\frac{1}{2} \times (\text{\_\_\_\_\_\_\_\_\_\_ m/s})^2}$

Work out the answer: mass = ______________ kg

HARDER

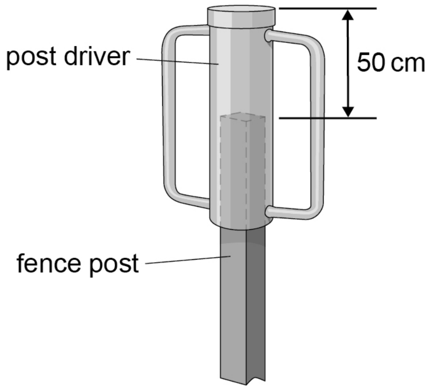
---

change in gravitational potential energy (J) = mass (kg) × gravitational field strength (N/kg) × change in vertical height (m)

kinetic energy (J) = ½ × mass (kg) × (speed)^2 (m/s)^2

Name ______________________ **Class** __________ **Date** __________

A post driver is a tool used to drive fence posts into the ground. It is a hollow tube with a closed top. It has handles on the side. The person using the tool fits it over the fence post then lifts it up and allows it to drop onto the post.



1 A post driver has a mass of 10 kg. Calculate the change in gravitational potential energy (GPE) stored when the post driver is lifted by 50 cm above the post, as shown in the diagram. The gravitational field strength on Earth is 10 N/kg.

50 cm = ________ m

ΔGPE = ________ kg × ________ N/kg × ________ m

ΔGPE = ________ J

2 Calculate the change in GPE stored when a 15 kg post driver is lifted by 70 cm.

ΔGPE = ________ J

3 A 10 kg post driver is moving at 2 m/s just before it hits the fence post.

a Calculate the kinetic energy (KE) stored in the moving post driver.

KE = ½ × ________ kg × (_______ m/s)^2

KE = ________ m/s

b How much GPE was the post driver storing just before it was dropped? Explain your answer.

____

____

c Calculate the height from which this post driver was dropped onto the post.

change in vertical height (m) = $\dfrac{\text{\_\_\_\_\_\_\_\_\_\_ J}}{\text{\_\_\_\_\_\_\_\_ kg} \times \text{\_\_\_\_\_\_\_\_\_\_\_\_ N/kg}}$

height = __________ m

4 A post driver is storing 22.5 J of KE when it is moving at 3 m/s. Calculate the mass of the post driver.

mass = $\dfrac{\text{\_\_\_\_\_\_\_\_\_\_ J}}{\frac{1}{2} \times (\text{\_\_\_\_\_\_\_\_\_\_ m/s})^2}$

mass = _______ kg

ΔGPE = change in gravitational potential energy (J)

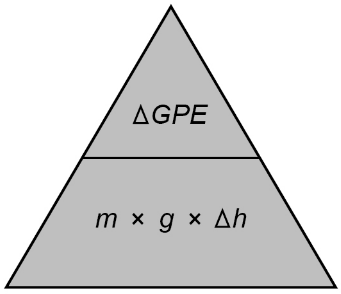
m = mass (kg)

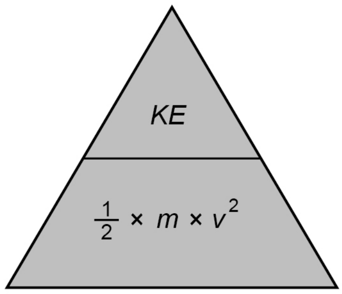
g = gravitational field strength (N/kg)

Δh = change in vertical height (m)

KE = kinetic energy (J)

v = speed (m/s)





Name ______________________ **Class** __________ **Date** ____________

For all questions on this sheet, use g = 10 N/kg

1 A grandfather clock uses energy stored in raised weights. The weights transfer energy to the clock mechanism as they fall. One clock has a 4.5 kg weight that supplies energy to the chimes (which play a few notes every 15 minutes), and two 3.5 kg weights that power the clock and the mechanism that strikes the hours.

a Calculate how much energy is stored when all three of these weights are raised by 70 cm.

b How far does the 4.5 kg weight have to be lifted to store 45 J of energy?

2 The water tank in a house can hold 200 litres of water. The mass of 1 litre of water is 1 kg. The tank is 2 m above the bathroom taps and 5 m above the kitchen taps. The kitchen taps are 1 m above the floor.

a Calculate the gravitational potential energy (GPE) stored in the water in the tank when it is full. State any assumptions made in your answer.

b Calculate the speed at which the water would come out of the bathroom taps and kitchen taps. You may assume that no energy is transferred due to friction in the pipes.

3 The Victoria Falls in Africa is one of the world's largest waterfalls. Just over 1000 m^3 of water pass over the falls every second and fall approximately 100 m. 1 m^3 of water has a mass of 1000 kg.

a What mass of water goes over the falls every second? Give your answer in standard form.

b Calculate the GPE of 1 kg of water at the top of the falls.

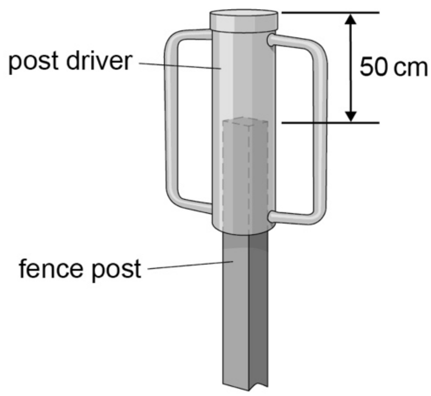
c If all the GPE stored in 1 kg of water is transferred to kinetic energy, calculate the speed of the water as it reaches the bottom.

d Suggest why the water will not be falling as fast as your answer to part **c** suggests.

e What is the total energy transferred per second as the GPE stored in the water falling in one second is transferred to other energy stores.

f Suggest the ways in which this energy is finally stored.

4 A post driver is used to drive fence posts into the ground. It is a hollow tube with a closed top, and handles on the side. A person fits the driver over a fence post, then lifts it up and lets it drop.



a A post driver has a mass of 10 kg. Calculate the change in GPE stored when the post driver is lifted by 50 cm above the post, as shown in the diagram.

b Calculate the speed of the driver when the end hits the post.

c Explain how much extra energy is stored if the post driver is lifted by 1 metre instead of only 50 cm.

d Calculate the speed of the post driver after it falls for 1 m.

e A new design of post driver has a mass of 15 kg. Suggest one advantage and one disadvantage of this new design.

Extra challenge

5 **H** The post driver in question **4a** stops in 0.5 seconds when it hits the fence post.

a Calculate the force needed to bring the post driver to a stop. (*Hint*: use your answer to **4b**.)

b What provides this force?

c Explain how your answer might be different if the post were being sunk into very soft ground.

The momentum of a moving object is the product of its mass and its velocity. The force needed to stop a moving object depends on how fast its momentum changes.

$$\textit{force} = \frac{\textit{change in momentum}}{\textit{time}} = \frac{mv - mu}{t}$$

F = force (N) m = mass (kg)

u = initial velocity (m/s) v = final velocity (m/s)

t = time (s)

Name ______________________ **Class** __________ **Date** ____________

Progression questions

Answer these questions.

1 What factors affect the gravitational potential energy stored in an object?

____

____

2 How do you calculate gravitational potential energy?

____

____

3 How do you calculate the amount of kinetic energy stored in a moving object?

____

____

Now circle the faces in the 'Start' row in the table showing how confident you are of your answers.

Question	1	2	3
Start	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Assessment

Using a different colour, correct or add to your answers above. You may need to use the back of this sheet or another piece of paper. Then circle the faces in the 'Check' row in the table.

Question	1	2	3
Check	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Feedback

What will you do next? Tick one box.

☐ strengthen my learning ☐ strengthen then extend ☐ extend

Note down any specific areas you need to improve.

____

Action

You may now be given another activity. After this, note down any remaining areas you need to improve and how you will try to improve in these areas.

____

____

____

____

Your teacher may watch to see if you can…
- follow instructions carefully
- follow all safety rules.

Introduction

Power stations produce electricity by using a turbine to make generators spin. You can build a model turbine.

Aim

To build a model of part of the electricity generation process in a power station.

Method

Apparatus

- two aluminium pie dishes
- wooden dowel
- Bunsen burner
- tripod
- gauze
- scissors
- drawing pin
- stand and two clamps
- 250 cm^3 beaker of water
- funnel
- eye protection

⚠ Safety

Wear eye protection.

Take care with sharp edges when the pie dishes have been cut.

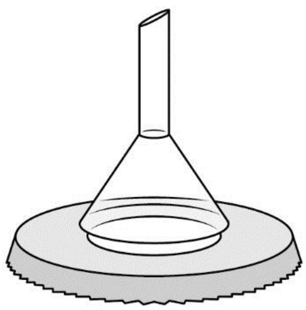
Do not put your hands near the steam. Move the turbine away from the steam and let it cool before adjusting it

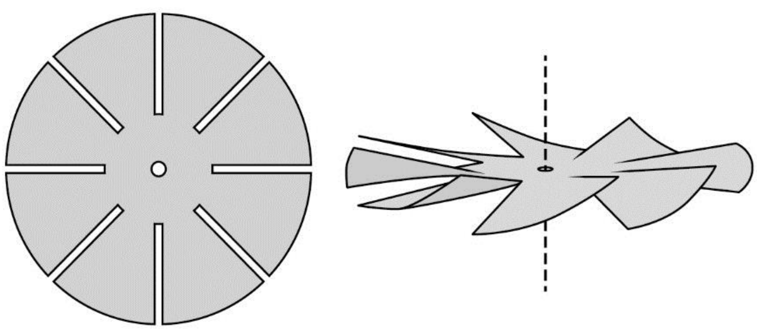
If you do get a scald from the steam, cool the burn under cold running water for at least ten minutes.

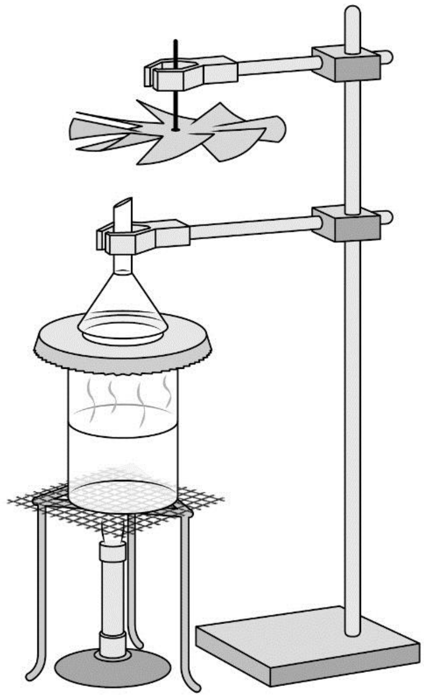
A Put one of the pie dishes on the table and draw a circle in the middle of it that is just smaller than the top of the funnel. Carefully cut around the line you drew.

B Take the second pie dish and flatten down the edges. Draw lines across the dish until you have divided it into eight parts. Cut along the lines you have drawn, but do not go all the way to the middle.

C Bend one edge of each cut. Bend them all in the same direction. This pie dish will be your model turbine. Fasten the centre of your turbine to the end of the wooden dowel using a drawing pin.







D Wear eye protection. Set up the Bunsen burner and tripod so that you can use the Bunsen burner to heat the beaker of water. Do not light the Bunsen yet.

E Put the pie dish with the hole in it on top of the beaker, and use a clamp and stand to hold the funnel just above it, as shown in the diagram. Use the other clamp to hold your turbine just above the end of the funnel.

F Light the Bunsen burner and record what happens.

Evaluation

1 How long did it take before your turbine started to spin?

2 Does it matter which way up you mount the turbine? (Try it!)

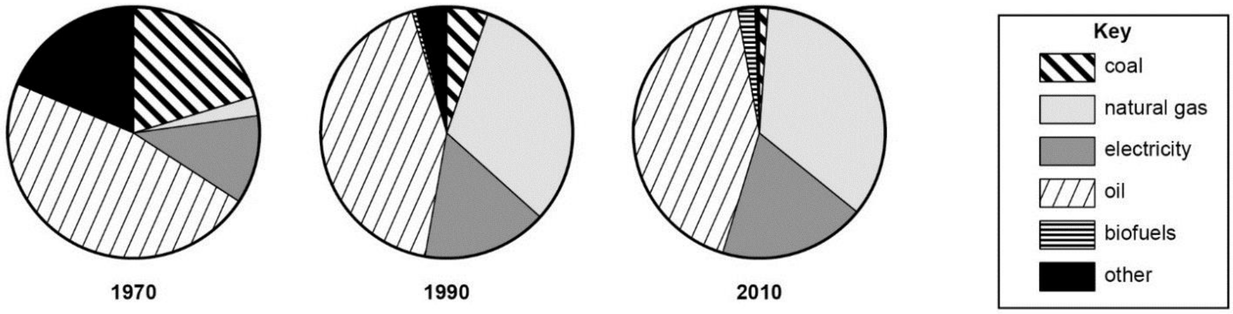
3 Can you adjust the turbine to make it spin at different speeds?

4 You have made a model of part of a power station.

a How would you have to adapt your apparatus to make a model of a complete power station?

b List the fuels that could be used in a real power station.

These pie charts show how the type of energy used in the UK has changed since 1970. ‘Other’ includes gas made from coal, and other sources of energy, and ‘oil’ includes petrol and diesel. Biofuels are fuels made from waste wood or from crops grown to be used as fuel. The charts show the *final* use of the energy so (for example) coal that is burnt to generate electricity is included here under electricity.



Data from Energy consumption in the UK*, Department of Energy and Climate Change*

1 Describe how the proportion of the following fuels used has changed since 1970.

a coal **b** natural gas **c** oil.

2 The table shows the information used to plot the pie charts. Use these data to draw a bar chart with all the bars for each year grouped together. You do not need to draw bars for the ‘Total’ column.

Year	Energy used (millions of tonnes of oil equivalent)						
	Coal	**Natural gas**	**Electricity**	**Oil**	**Biofuels and waste**	**Other**	**Total**
1970	29 822	3662	16 542	68 511	–	27 044	145 581
1990	8122	46 052	23 601	63 302	451	5739	147 266
2010	1889	51 886	28 274	63 223	3314	681	149 266

3 The pie charts, your bar chart and the table all show similar information. What information do the table and bar chart give that the pie charts do not?

4 Explain why the amount of coal, oil and natural gas used in the UK for the years shown is actually much greater than the total amounts shown in the table.

5 Suggest reasons for:

a the changes in the amount of coal and natural gas used

b the increase in electricity consumption

c the relatively constant amount of oil used

d the increase in biofuels.

Homes with central heating: 25% in 1970, 90% in 2010	Vehicles on UK roads: 13 548 in 1970, 34 120 in 2010
The proportion of power stations that use oil has decreased a lot in the last 30 years.	Compared to 1970, in 2010 many more people had computers, several TVs per house and other electrical equipment.

Name ______________________________ **Class** _____________ **Date** ______________

EASIER

1 Cut out the cards at the bottom of this sheet. Using the white cards, match up the names and uses. Write the name and uses of each fuel in your book, leaving three lines of space under each one.

2 The grey cards describe advantages and disadvantages. Take a fuel from question 1 and decide which grey cards go with it. Which of these cards are advantages and disadvantages? Write the advantages and disadvantages for that fuel in your book, then use the same cards again to help you to decide what to write for the next fuel.

S1 Name four different **non-renewable** fuels and describe how they are used.

3 Complete these sentences using words from the box. You can use each word once, more than once or not at all.

__________________ resources will run out one day. __________________ the use of non-renewable resources now will make supplies last longer. Fossil __________________ are non-renewable resources. Burning **fossil fuels** releases __________________, which contributes to __________________ change. Burning __________________ fossil fuel will help to reduce this effect. Accidents with oil rigs or __________________ can pollute the sea with oil and kill __________________.

Nuclear fuel is non-renewable. It is used in __________________ power stations. These are very __________________ to build and to __________________. Accidents in nuclear power stations can release __________________ materials into the atmosphere.

all | break up | carbon dioxide | cheap | climate | decommission | expensive | fuels | increasing | less | more | non-renewable | nuclear | oxygen | people | radioactive | reducing | remains | **renewable** | tankers | temperature | water | wildlife

HARDER

S2 Suggest why the use of renewable energy resources has been increasing in the UK in recent years.

Coal	**Oil**	**Natural gas**	**Nuclear fuel**
used in power stations	used in nuclear power stations	used in power stations	used in power stations
used in homes for central heating and hot water		used to make petrol and diesel for use in vehicles	
releases polluting gases when it is burned	spills can pollute the seas and kill wildlife	stores a lot of energy	easy to store in vehicles and to supply to engines
carbon dioxide contributes to **climate change**	accidents can spread radioactive materials over a wide area	causes less pollution than other fossil fuels for the same amount of electricity generated	produces dangerous waste that is difficult to store
expensive to build power stations	does not release carbon dioxide when it is used	releases carbon dioxide when it burns	will run out one day

Name ______________________ **Class** __________ **Date** __________

Pollution-free motoring!

The new *Zap!* car has batteries instead of a fuel tank. Just plug in for a couple of hours and you are set for miles of pollution-free motoring! No carbon-dioxide emissions!

Our electric car has an efficiency of 0.75 compared to only around 0.15 for a petrol-driven car.

1 Electric cars use energy stored in a battery.

a Is electricity a fuel? Explain your answer. ______________________

____

b What fuel do most cars use? ______________________

c Give one advantage of this fuel when used in cars. ______________________

d Give one disadvantage of using this fuel. ______________________

2 Electricity is generated in power stations and can also be generated using **renewable** resources.

a Name two **fossil fuels** that are used in fossil fuel power stations. ______________________

b Give another use for one of these fuels. ______________________

c What gas do these fuels emit when they burn? ______________________

d What problem is this gas partly responsible for? ______________________

e Name a type of fuel used in power stations that does not emit this gas. ______________________

3 Is it true to say that the *Zap!* car does not cause any pollution when it is used? Explain your answer.

____

____

____

4 The efficiency of the *Zap!* car is given as 0.75. What does this mean? Tick one box.

- ☐ It wastes 75 J of energy for every 100 J stored in the battery.
- ☐ It transfers 75 J of useful energy for every 100 J stored in the battery.
- ☐ It transfers 75 J of energy altogether for every 100 J stored in the battery.

5 An electric car is charged using electricity from a fossil-fuel power station with an efficiency of 0.5. Some energy is also transferred by heating in the wires that carry the electricity from the power station to the place where the car is charged.

a Which do you think is the true efficiency of the electric car when you think about the energy stored in the fossil fuel:

☐ $0.5 \times 0.75 = 0.375$ ☐ $0.5 + 0.75 = 1.25$ ☐ less than 0.375?

b Is the electric car really more efficient than a petrol-driven car? Explain your answer.

____

____

____

Pollution-free motoring!

The new *Zap!* car has batteries instead of a fuel tank. Just plug in for a couple of hours and you are set for miles of pollution-free motoring! No carbon-dioxide emissions!

Our electric car has an efficiency of 0.75 compared to only around 0.15 for a petrol-driven car.

1 Electric cars used energy stored in a battery.

a Explain why electricity is not considered to be an energy resource.

b Explain why the statement that the electric car provides ‘pollution-free motoring’ is misleading.

2 Most cars use petrol or diesel as energy stores.

a Describe two advantages of these fuels when used in cars.

b Describe one disadvantage shared by all uses of **fossil fuels**.

3 An electric car *can* be run without causing the emission of polluting gases. Explain how this can be done.

4 The efficiency of the *Zap!* car is given as 0.75. What does this mean?

5 Power stations can be fitted with scrubbers that remove waste gases. Carbon dioxide captured in this way can be stored underground instead of being released into the atmosphere.

If an electric car has the same overall efficiency as a petrol car, explain how using the electric car instead of the petrol car *could* help to reduce the amount of carbon dioxide being put into the atmosphere.

Extra challenge

6 A *Zap!* electric car is charged using electricity from a fossil-fuel power station with an efficiency of 0.5.

a Calculate the efficiency of the electric car when you compare its useful energy transfer to the energy stored in the fossil fuel used in the power station. Ignore any energy wasted in transmission lines.

b Explain whether this electric car really is more efficient than a petrol-driven car.

Name ______________________ **Class** __________ **Date** __________

Progression questions

Answer these questions.

1 What **non-renewable** energy resources can we use?

____

____

2 How are the different non-renewable resources used?

____

____

3 How is the use of non-renewable energy resources changing?

____

____

Now circle the faces in the ‘Start’ row in the table showing how confident you are of your answers.

Question	**1**	**2**	**3**
Start	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Assessment

Using a different colour, correct or add to your answers above. You may need to use the back of this sheet or another piece of paper. Then circle the faces in the ‘Check’ row in the table.

Question	**1**	**2**	**3**
Check	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Feedback

What will you do next? Tick one box.

☐ strengthen my learning ☐ strengthen then extend ☐ extend

Note down any specific areas you need to improve.

____

Action

You may now be given another activity. After this, note down any remaining areas you need to improve and how you will try to improve in these areas.

____

____

Your teacher may watch to see if you can:
- follow instructions carefully
- take careful measurements.

Introduction

Solar cells can produce electricity using light. The output can be measured using a voltmeter; the higher the voltage, the more power the cell can provide.

Aim

To investigate how the output of a solar panel changes when the distance from the light source changes.

Prediction

1 How do you think the voltage from the solar cell will change as you move the lamp further away from it? Explain your prediction if you can.

Method

A Set the solar cell on the bench and prop it up with books or blocks so that it is standing vertically. Connect it to the voltmeter.

B Place the lamp in front of the solar panel so that light will shine on the panel when the lamp is switched on. Measure the distance from the bulb to the solar panel.

C Write down the reading on the voltmeter. Then switch the lamp on and write down the reading again.

D Move the lamp further away from the solar panel and measure the distance.

E Repeat steps C and D until you have at least three readings at different distances.

Apparatus

- solar cell
- books or blocks
- voltmeter
- connecting wires
- lamp
- ruler

Optional
- cardboard
- protractor
- coloured filters

Recording your results

2 Draw a table like this to record your results.

Distance from lamp (cm)	Voltage with lamp off (V)	Voltage with lamp on (V)	Difference (voltage on – voltage off) (V)

3 Draw a scatter graph to show your results. Plot the distance from the lamp on the horizontal axis and the voltage difference on the vertical axis. Draw a curve of best fit through the points.

Considering your results/conclusions

4 What conclusion can you draw from your results?

Evaluation

5 Explain why you recorded the voltage with the lamp switched off each time, and subtracted this from the voltage with the lamp switched on.

Further investigations

6 A hypothesis is an idea that can be tested. Scientists use a hypothesis to write a prediction.

Choose one of these hypotheses and write a prediction that can be tested:

- The voltage of the cell depends on the area of the **solar cell**.
- The voltage depends on the angle of the cell relative to the light source.
- The voltage depends on the type of light source.

7 Write a plan for an investigation to test your prediction. Your plan should:

a State which variable you are going to change (the independent variable) and which variable you are going to measure (the dependent variable).

b Explain which variables you are going to control (the control variables) and how you are going to do this.

c Explain the range of measurements you will take and the intervals; state whether you need to carry out some preliminary tests to determine this.

d Describe how you will measure the output of the solar cell.

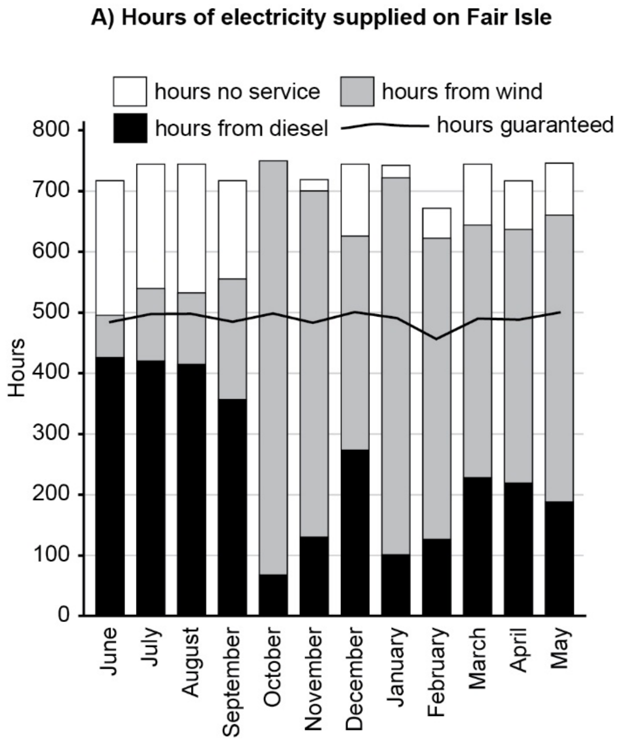
e Explain how you will attempt to make your results precise and reliable.

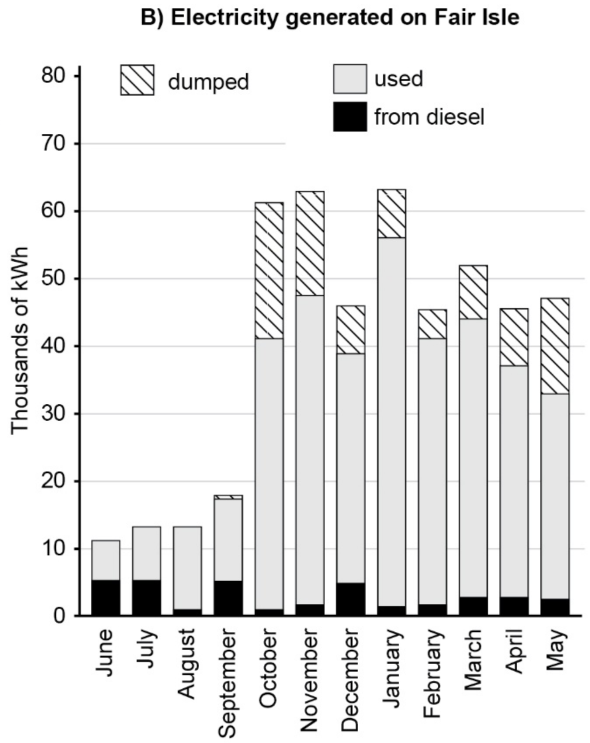
8 Predict the relationship you expect to find between the independent variable and the output. Explain why you think this.

9 Show your plan to your teacher before you start.

Fair Isle is a small island, about 5 km long and 2 km wide, off the coast of Scotland between the Shetland and Orkney islands. The UK is one of the windiest countries in Europe, and the Scottish islands are the windiest parts of the UK. The island is not connected to the National Grid, so there is no mains electricity.

Until 1982 the inhabitants of the islands got all their electricity from small diesel generators. In 1982 the first **wind turbine** was erected on Fair Isle with the approval of the local residents. Another wind turbine was added later, again with the approval of the island's residents.





1 At the start of the period shown in the graphs, there was only one wind turbine on Fair Isle. When did the second wind turbine start to contribute to the power supply? Explain your answer.

2 The electricity company on Fair Isle only guarantees an electricity supply for a certain number of hours per month.

a For approximately how many hours a day is there a guaranteed supply?

b Why does the number of guaranteed hours per month drop in February?

3 What do the two graphs tell you about:

a the total amount of energy available from the wind each month

b the number of hours each day when there was enough wind to use it to supply electricity?

4 a What further information would you need to give more accurate answers to question 3?

b The wind turbines on Fair Isle produce electricity for around 60 per cent of the time. Explain whether you would expect a wind turbine on the mainland to provide electricity for this proportion of the time.

5 Use graph A to estimate what percentage of electrical energy on Fair Isle is supplied by the wind turbines.

6 Many people would like to see the UK generating a lot more of its electricity from wind power. Describe two of the difficulties that would have to be overcome to make this happen.

EASIER

Name ______________________________ **Class** _____________ **Date** _____________

1 Complete these sentences using words from the box. Each word can be used once, more than once or not at all.

Solar energy comes from the _____________. It can be used to produce electricity directly in __________. It can also be used to generate ____________ in solar power stations by heating ____________________ or air. Solar energy can also be used to heat water for use in __________.

Hydroelectricity and **tidal power** use energy stored in _________ to generate electricity. _____________ power stations use _____________ in rivers or flowing down from reservoirs in high places. Tidal power can be generated by underwater ___________. These can be placed in underwater currents or in _________ that trap water at high tide and let it flow out later.

Wind turbines use energy stored in ___________ to generate electricity.

Biofuels are made from _____________ or from animal wastes. They can be _____________ in the same way as fossil fuels.

barrages	burnt	electricity	fossil	homes	hot water	hydroelectric	moving air
moving water	plants	solar batteries	**solar cells**	Sun	turbines	water	windmills

S1 Describe five renewable energy resources and how they are used.

2 The clouds show some advantages and disadvantages of different renewable energy resources. For each one put a tick (✓) if it is an advantage or a cross (×) if it is a disadvantage. Then write down which renewable resources it refers to. You can use the letters in the key for this if you wish.

One has been done for you.

a does not produce carbon dioxide ✓ H, S, T, W

b available at any time _______________

c only available during the day ________________

d only available in certain weather conditions ________________

e requires a dam to be built, which is expensive __________________

f requires a barrage to be built across an estuary, which is very expensive _________________

g needs a lot of land to produce the same amount of electricity as a fossil-fuelled power station __________________

h produces the same amount of carbon dioxide as the plants absorbed when they grew ________________

i available at predictable times __________________

Key
B = biofuels
H = hydroelectricity
S = solar
T = tidal
W = wind

S2 State two advantages of a hydroelectric power station compared to a natural gas power station.

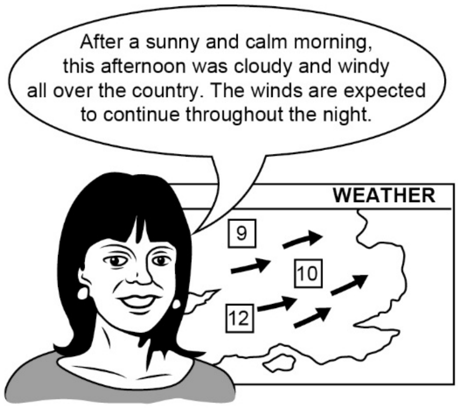
HARDER

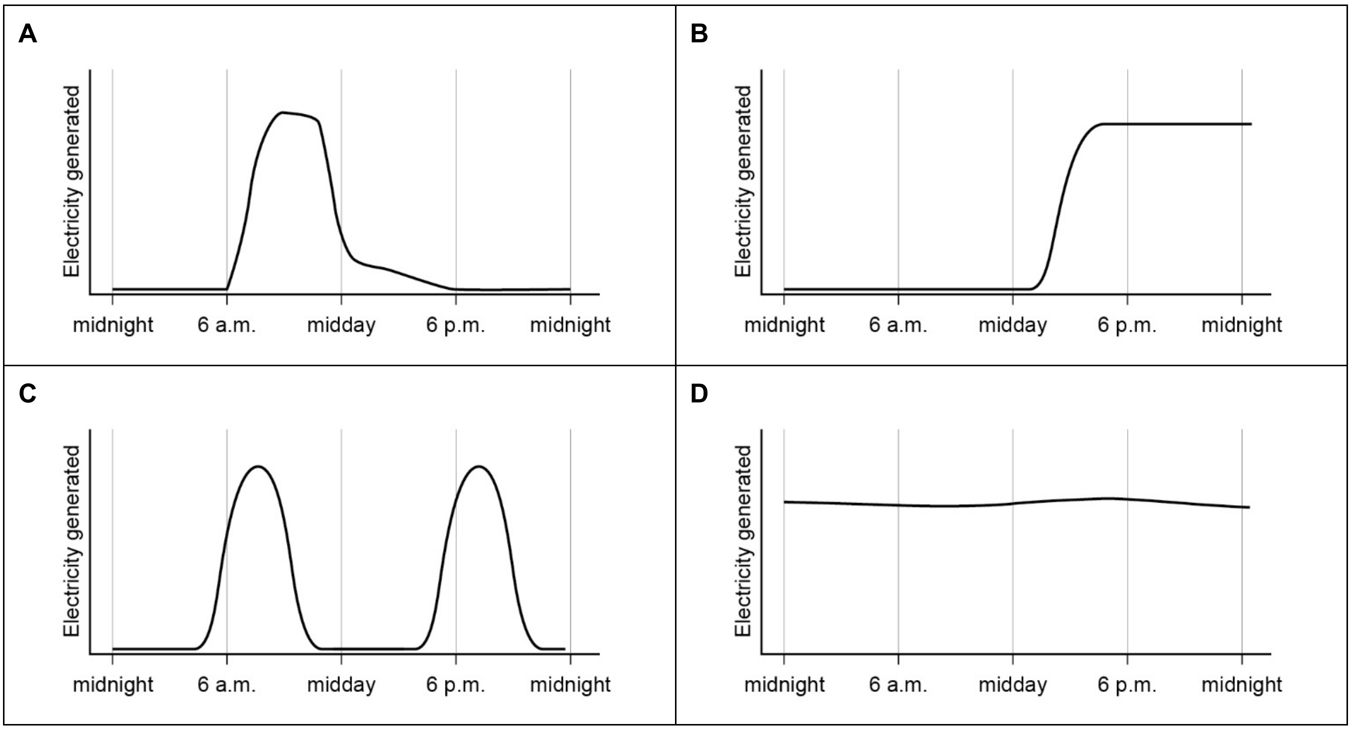
Name ______________________________ **Class** _____________ **Date** ______________

A fossil-fuel power station can generate electricity at any time of the day or night. This is not the case with all renewable energy resources.

The weather forecast for a particular day is shown on the right. Each graph below represents the electricity produced during the day by power stations using the different renewable energy resources shown in the box.

hydroelectricity	solar	tides	wind





1 Decide which resource each graph represents. Explain how you worked out your answers.

Graph A: ____________________

Graph B: ____________________

Graph C: ____________________

Graph D: ____________________

2 Which of the renewable energy resources on this sheet is:

a always available at any time ____________________

b not available all the time but is available at predictable times ____________________

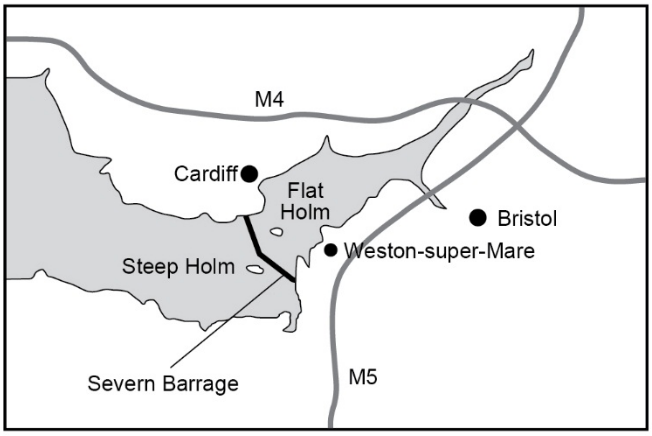
c is never available at night ____________________

d possibly available during the day or at night, but depends on the weather. ____________________

3 Give two reasons why the UK is trying to increase the amount of electricity generated using renewable resources.

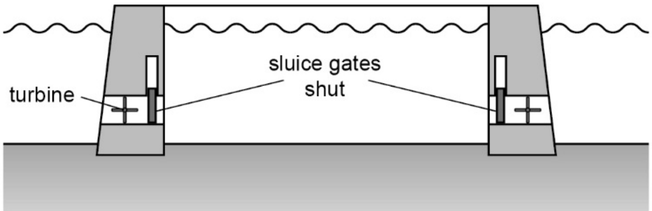
____

There have been various studies carried out since 1974 on the possibility of building a barrage across the River Severn to generate electricity from the tides. The Severn Estuary is particularly suitable as its tidal range (the difference between the heights of high tide and low tide) averages 13 metres. The map on the right shows one such proposal.



There is an alternative to building a barrage which many people think will be more environmentally friendly. The proposal is to build as many as six enclosures in the Severn Estuary, each one about 8 kilometres in diameter, up to a mile offshore. Each 'lagoon' will operate in a similar way to a tidal barrage.

The diagram shows the state of a lagoon at high tide.



1 Describe how the turbines in the lagoons will be used to generate electricity. You can do this by drawing a sequence of diagrams similar to the one on the right, or you can describe the operation of the lagoons in words.

2 Suggest differences between the barrage and the lagoons in terms of:

a the likely effect on wildlife

b the effects on shipping

c the amount of aggregate (rock and stone) needed to construct them

d the visual impact.

	Barrage	Lagoons
Electricity generated*	about 18 TWh/year	about 24 TWh/year
Enclosed area	500 km^2	300 km^2
Overall wall length	16 km	150 km

** 1 TWh is 1 terrawatt hour – a measure of the amount of energy provided.*

3 Suggest one reason why the barrage will cost a lot more money to build than the lagoons. (*Hint*: there are shipping docks at Bristol.)

4 Compare the barrage and the lagoons in terms of:

a the electricity generated

b the likely cost of the electricity.

5 There are two high tides each day in the Severn Estuary, and scientists can accurately predict the times of the tides many years ahead. Electricity can be generated by the turbines for a period during each rising tide and each falling tide.

Compare the production of electricity from a tidal barrage or tidal lagoon to the electricity produced by a wind farm, in terms of when electricity can be produced.

6 The water level in a lagoon is 6 m above the water level outside. The lagoon is storing 3×10^9 kg of water.

a Calculate the GPE stored when 3×10^9 kg of water is raised by 6 m. (Use g = 10 N/kg.)

b Explain why the GPE stored by the water in the lagoon is less than the value you have calculated.

Extra challenge

7 A recent proposal for building tidal lagoons involves building four lagoons in the Severn Estuary and two in the Irish Sea, off the west coast of northern England. Find out and explain how this will improve the supply of electricity available from the lagoons.

Name ______ **Class** ______ **Date** ______

Progression questions

Answer these questions.

1 What renewable energy resources can we use?

2 How are the different renewable resources used?

3 How is the use of renewable energy resources changing?

Now circle the faces in the 'Start' row in the table showing how confident you are of your answers.

Question	**1**	**2**	**3**
Start	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Assessment

Using a different colour, correct or add to your answers above. You may need to use the back of this sheet or another piece of paper. Then circle the faces in the 'Check' row in the table.

Question	**1**	**2**	**3**
Check	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺	☹ ☹ 😐 ☺ ☺

Feedback

What will you do next? Tick one box.

☐ strengthen my learning ☐ strengthen then extend ☐ extend

Note down any specific areas you need to improve.

Action

You may now be given another activity. After this, note down any remaining areas you need to improve and how you will try to improve in these areas.

SP3a Energy stores and transfers

Word	Pronunciation	Meaning
atomic energy		A name used to describe energy when it is stored inside atoms. Another name for 'nuclear energy'.
chemical energy		A name used to describe energy when it is stored in chemical substances. Food, fuel and batteries all store chemical energy.
elastic potential energy	*po-**ten**-shall*	A name used to describe energy when it is stored in stretched or squashed things that can change back to their original shapes. Another name for 'strain energy'.
gravitational potential energy	*grav-it-**ay**-shon-al* *po-**ten**-shall*	A name used to describe energy when it is stored in objects in high places that can fall down.
joule (J)	*jool*	A unit for measuring energy.
kinetic energy	*kin-**et**-ick*	A name used to describe energy when it is stored in moving things.
law of conservation of energy		The idea that energy can never be created or destroyed, only transferred from one store to another.
nuclear energy		A name used to describe energy when it is stored inside atoms. Another name for 'atomic energy'.
Sankey diagram		A diagram showing energy transfers, where the width of each arrow is proportional to the amount of energy it represents.
strain energy		A name used to describe energy when it is stored in stretched or squashed things that can change back to their original shapes. Another name for 'elastic potential energy'.
system		A set of things being studied – for example a kettle, the water in it and its surroundings form a simple system.
thermal energy		A name used to describe energy when it is stored in hot objects. The hotter something is the more thermal energy it has.

SP3b Energy efficiency

Word	Pronunciation	Meaning
dissipated		Spread out.
efficiency	*e-**fish**-en-see*	A way of saying how much energy something wastes. A more efficient machine wastes less energy.
lubrication		To reduce friction by putting a substance (usually a liquid) between two surfaces.

SP3c Keeping warm

Word	Pronunciation	Meaning
absorb		To soak up or take in.
conduction	*con-**duck**-shun*	The way energy is transferred through solids by heating. Vibrations are passed on from particle to particle.
convection	*con-**veck**-shun*	The movement of particles in a fluid (gas or liquid) depending on their temperature. Hotter, less dense regions rise, and cooler, denser regions sink.
emit		To give out.
fluid		A liquid or a gas.
infrared radiation	*ray-dee-**ay**-shun*	Another name for energy that travels by radiation. It can travel through transparent things and a vacuum or empty space.
insulation		A material that does not allow something, e.g. heat or electricity, to pass through it.
radiation	*ray-dee-**ay**-shun*	A way of transferring energy by heating. Also known as infrared radiation.
thermal conductivity		A measure of how easily energy can pass through a material by heating. A material with a low thermal conductivity is a good insulating material.
thermal conductor		A material that allows energy to be transferred through it easily by heating.
thermal insulator		A material that does not allow energy to be transferred through it easily by heating.

SP3e Non-renewable resources

Word	Pronunciation	Meaning
climate change		Changes that will happen to the weather as a result of global warming, which is caused by the increase in the amount of carbon dioxide in the atmosphere.
fossil fuel		A fuel formed from the dead remains of organisms over millions of years (e.g. coal, oil or natural gas).
non-renewable		Any energy resource that will run out because we cannot renew our supplies of it (e.g. oil).
nuclear fuel		A radioactive metal such as uranium. Nuclear fuels are used in nuclear power stations to generate electricity.
renewable		An energy resource that will never run out (e.g. solar power).
uranium	*you-**rain**-ee-um*	A radioactive metal that can be used as a nuclear fuel.

SP3f Renewable resources

Word	Pronunciation	Meaning
biofuel		A fuel made from plants or animal wastes.
hydroelectricity		Electricity generated by moving water (usually falling from a reservoir) turning turbines and generators.
solar cell	*s**O**-lah sell*	A flat plate that uses energy transferred by the light to produce electricity.
solar energy	*s**O**-lah*	Energy from the Sun.
tidal power		Generating electricity using the movement of the tides.
wind turbine		A kind of windmill that generates electricity using energy transferred by the wind.

Name ______________________ **Class** __________ **Date** ____________

1 The energy needed to heat our homes or to make cars and lorries work comes from various energy resources.

Energy resources can be renewable or non-renewable.

a State **two** renewable resources.

1 ____

2 ____

(2)

b State **two** non-renewable energy resources.

1 ____

2 ____

(2)

c Describe **one** advantage and **one** disadvantage of generating electricity using a hydroelectric power station rather than wind turbines.

Advantage: ____

____

Disadvantage: ____

____

(2)

(Total for Question 1 = 6 marks)

2 **Figure 1** shows a wind-up torch. Turning the handle generates an electric current that charges a battery inside the torch.

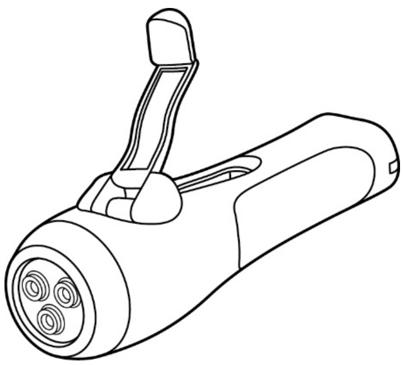


Figure 1

a Deduce the type of energy stored in the battery.

Tick **one** box.

☐ **A** chemical

☐ **B** kinetic

☐ **C** nuclear

☐ **D** sound

(1)

b The torch is switched on. The bulb transfers energy to its surroundings.

A student says:

'Some of the energy is not transferred in a useful way: it is wasted'.

Deduce how this wasted energy is transferred.

Tick **one** box.

☐ **A** by forces

☐ **B** by light

☐ **C** by sound

☐ **D** by heating

(1)

c Describe what happens to the wasted energy.

____

(1)

(Total for Question 2 = 3 marks)

3 **a** A bowling ball has a mass of 17 kg.

The ball leaves a bowler's hand at a speed of 7.0 m/s.

Calculate the kinetic energy of the bowling ball.

kinetic energy = _______________ J

(3)

b A block of concrete has a mass of 48 kg.

A crane lifts the block to a height of 12 m above the ground.

Calculate the gravitational potential energy stored by the block.

(gravitational field strength *g* = 10 N/kg)

gravitational potential energy = _______________ J

(3)

(Total for Question 3 = 6 marks)

4 **Figure 2** lists the thermal conductivities of four materials.

Material	Thermal conductivity (W/m °C)
air	0.024
fibre glass	0.040
foam	0.020
polystyrene	0.033

Figure 2

a Which material in **Figure 2** is the best thermal conductor?

Tick **one** box.

☐ **A** air

☐ **B** fibre glass

☐ **C** foam

☐ **D** polystyrene

(1)

b Which material in **Figure 2** is the best thermal insulator?

Tick **one** box.

☐ **A** air

☐ **B** fibre glass

☐ **C** foam

☐ **D** polystyrene

(1)

c **Figure 3** shows foam insulation around a copper cylinder.

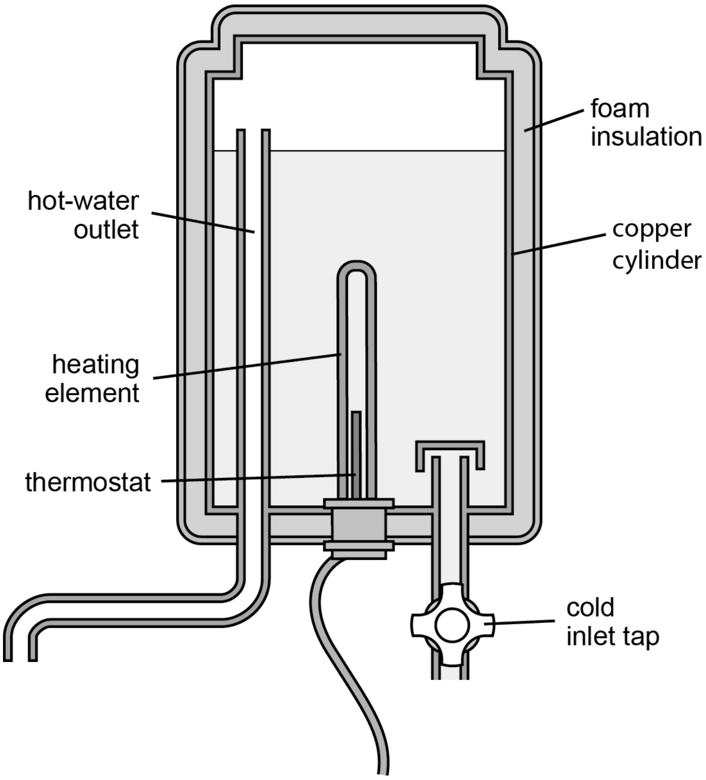


Figure 3

Hot water is stored in the copper cylinder until it is needed.

Explain how the foam insulation keeps the water hot.

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(2)

(Total for Question 4 = 4 marks)

5 A student carries out an investigation with a tennis ball.

The student drops the tennis ball from different heights.

The student then measures the heights of the ball's first bounce after it has hit the floor.

The student records the results in **Figure 4**.

Height from which ball is dropped (cm)	Height of the ball's first bounce (cm)
120	70
100	60
90	55
80	50

Figure 4

a State the **dependent** variable in this investigation.

____

(1)

b Describe the energy transfers that the tennis ball goes through.

____

____

(2)

c Give **two** ways that the student could obtain more reliable results.

1 ____

2 ____

(2)

(Total for Question 5 = 5 marks)

6 A student writes:

'*When I rub my dry hands together on a cold morning, they warm up. However, when I repeat this with soapy water, my hands don't warm up as much.'*

Explain these observations by considering the energy transfers involved.

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(3)

(Total for Question 6 = 3 marks)

7 An electric light bulb has an efficiency of 18%.

400 J of energy are supplied to the light bulb by electricity.

a Calculate the amount of energy transferred by light.

energy = ______________ J

(3)

b Draw a labelled Sankey diagram to represent these energy changes.

(4)

(Total for Question 7 = 7 marks)

8 **Figure 5** shows a pendulum in an old clock.

The pendulum is a metal rod with a large mass on the end that swings from side to side.

There is a small wind-up spring that keeps the pendulum swinging.

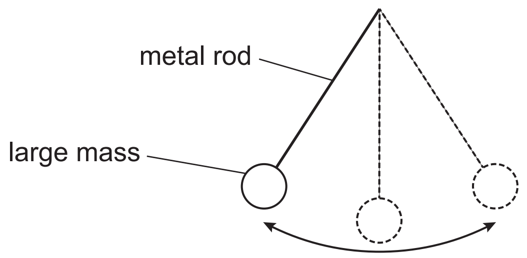

Figure 5

Describe the energy changes that happen as the pendulum swings from side to side.

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(6)

(Total for Question 8 = 6 marks)

TOTAL FOR PAPER = 40 MARKS

Name ______________________ **Class** __________ **Date** ____________

1 A student carries out an investigation with a tennis ball.

The student drops a tennis ball from different heights.

The student then measures the heights of the ball's first bounce after it has hit the floor.

The student records the results in **Figure 1**.

Height from which ball is dropped (cm)	Height of the ball's first bounce (cm)
120	70
100	60
90	55
80	50

Figure 1

a State the **dependent** variable in this investigation.

____

(1)

b Describe the energy transfers that the tennis ball goes through.

____

____

(2)

c Give **two** ways that the student could obtain more reliable results.

1 ____

2 ____

(2)

(Total for Question 1 = 5 marks)

2 A student writes:

'When I rub my dry hands together on a cold morning, they warm up. However, when I repeat this with soapy water, my hands don't warm up as much.'

Explain these observations by considering the energy transfers involved.

____

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____

(3)

(Total for Question 2 = 3 marks)

3 An electric light bulb has an efficiency of 18%.

400 J of energy are supplied to the light bulb by electricity.

a Calculate the amount of energy transferred by light.

Energy = ______________ J

(3)

b Draw a labelled Sankey diagram to represent these energy changes.

(4)

(Total for Question 3 = 7 marks)

4 In order to compare the thermal conductivities of two different insulators, a scientist pours hot water into two beakers.

The different insulators are wrapped around the beakers.

The scientist records the initial temperatures of the hot water.

a State **two** factors that should be kept constant in order to make the experiment fair.

1 ____

2 ____

(2)

b State **two** further measurements that the scientist should make.

1 ______________________________

2 ______________________________

(2)

c Explain how the scientist will determine which is the better insulator.

____

____

(1)

(Total for Question 4 = 5 marks)

5 **a** A car has a kinetic energy of 41.6 kJ.

The speed of the car is 8.0 m/s.

Calculate the mass of the car.

Mass of car = ______________ kg

(4)

b A spacecraft is in a circular orbit around the planet Mars at a height of 140 km.

A small part of the spacecraft falls off and eventually lands on the surface of the Mars.

The small part has a mass of 1.8 kg.

During its fall, the small part loses 0.932 MJ of gravitational potential energy.

Calculate the gravitational field strength of Mars.

g = ______________ N/kg

(4)

(Total for Question 5 = 8 marks)

6 a Which of the following is a **renewable** source of energy?

Tick **one** box.

☐ **A** bio-fuel

☐ **B** coal

☐ **C** natural gas

☐ **D** oil

(1)

b Which of the following energy resources use a store of gravitational potential energy?

Tick **one** box.

☐ **A** hydroelectric

☐ **B** nuclear

☐ **C** solar

☐ **D** wind

(1)

c The use of non-renewable energy resources in the UK has changed in the last 30 years.

Explain how the use of energy resources has changed in the last 30 years.

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(4)

(Total for Question 6 = 6 marks)

7 A child is stationary on a swing.

The child is given a push by a parent and the child starts swinging.

The parent stops pushing the child.

Figure 2 shows how the kinetic energy stored in the child varies over the first few swings.

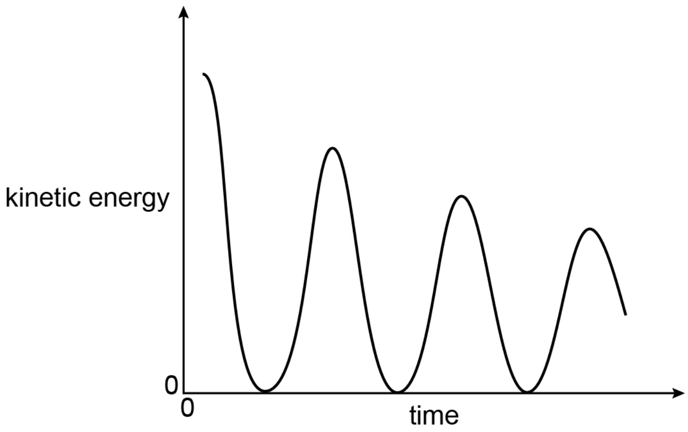

Figure 2

Explain the energy changes during the first few swings.

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(6)

(Total for Question 7 = 6 marks)

TOTAL FOR PAPER = 40 MARKS

Question number	Part	Step	Answer	Additional guidance	Marks
1	a	5	Any **two** of: ● geothermal (1) ● bio-fuel/biomass (1) ● wind (1) ● tidal (1) ● waves (1) ● hydroelectric (1) ● solar/the Sun (1)	Do not accept unclarified 'water'	**2 marks**
	b	5	Any **two** of: ● coal/fossil fuel (1) ● oil (1) ● gas (1) ● nuclear (1)		**2 marks**
	c	5	**Advantage** Any **one** of: ● able to be generated all the time/does not rely on the correct wind speed (1) ● able to generate when needed/start-up or shut-down times are small/can generate electricity to cope with peaks in demand (1) **Disadvantage** Any **one** of: ● more expensive to build hydroelectric power stations (1) ● large areas and villages/towns need to be flooded – impact on environment (1)	Do not accept unqualified answers such as 'it generates more energy' or 'it is more efficient' Do not accept reference to spoiling the view	**2 marks**
2	a	5	**A** chemical		**1 mark**
	b	5	**D** by heating		**1 mark**
	c	5	Any **one** of: ● It spreads out/is dissipated/is transferred to the surroundings of the torch. (1) ● It warms the surrounding air. (1)	Do not accept 'it is wasted'	**1 mark**

Question number	Part	Step	Answer	Additional guidance	Marks
3	a	6	Correct equation: KE = ½ mv^2 (1) Substitution: KE = ½ × 17 × 7^2 (1) Evaluation: 416.5 (J) (1)	Incorrect formula scores 0 marks Ignore significant figures Award full marks for correct answer with no working	**3 marks**
	b	6	Correct equation: GPE = *mgh* (1) Substitution: GPE = 48 × 10 × 12 (1) Evaluation: 5760 (J) (1)	Incorrect formula scores 0 marks Ignore significant figures Award full marks for correct answer with no working	**3 marks**
4	a	5	**B** fibre glass		**1 mark**
	b	7	**C** foam		**1 mark**
	c	7	An explanation that makes reference to any **two** of: ● Foam contains pockets of (trapped) air. (1) ● Air/foam is a poor thermal conductor. (1) ● Amount of thermal energy conducted/lost through the cylinder (walls) is reduced /less than without the foam. (1)	Do not accept 'traps heat' Do not accept 'the foam insulates the cylinder'	**2 marks**
5	a	7	height of the ball's first bounce		**1 mark**
	b	8	GPE converts to KE and thermal energy. (1) KE converts to GPE and thermal energy. (1)	Allow GPE converts to KE, then to elastic potential energy (1) Allow elastic potential energy converts to KE to GPE (1)	**2 marks**
	c	8	Repeat (many times) and find the mean. (1) Obtain results with a wider range. (1)	Do not accept simply 'Repeat the experiment'	**2 marks**

Question number	Part	Step	Answer	Additional guidance	Marks
6		8	An explanation that makes reference to the following points: Friction causes energy to be wasted/involves transferring kinetic energy into thermal energy (1) hence hands become warm. (1) With soapy hands there is less friction so less kinetic energy is transferred to thermal energy. (1)		**3 marks**
7	a	8	Use of correct equation: $\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$ (1) Substitution and conversion of 18% to 0.18 (1) Evaluation: 72 (J) (1)	Award full marks for correct answer with no working	**3 marks**
	b	8	correct idea of energy flow in Sankey diagram (1) correct labels: (400 J of) energy supplied by electricity (72 J of) useful energy transferred by light (1) (328 J of) wasted energy transferred by heating (1) widths of ‘arrows’ (representing energy) roughly to scale (1)		**4 marks**

Question number	Part	Step	Answer	Additional guidance	Marks
8		8	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material which is indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** **AO1 (6 marks)** Description should include some of the following: ● Kinetic energy varies during swing. ● Kinetic energy is maximum at bottom of swing. ● Kinetic energy is minimum at top of swing. ● Gravitational potential energy (GPE) varies during swing. ● GPE is maximum at top of swing. ● GPE is minimum at bottom of swing. ● (continuous) interchange of KE and GPE ● Total amount of energy is constant during one swing. ● Over a number of swings max. KE and max. PE decreases. ● Energy is dissipated/'lost'/transferred to surroundings ● because of air resistance/friction. ● Amplitude/size of swings decrease eventually because of air resistance and friction (as energy 'lost' to surroundings).	See below Ignore references to momentum	**6 marks**

Step	Marks	Descriptor
U	0	No awardable content.
4–5	1–2	**Level 1** ● Demonstrates elements of physics understanding, some of which is inaccurate. Understanding of scientific ideas, enquiry, techniques and procedures lacks detail. (AO1) ● Presents a description that is not logically ordered and with significant gaps. (AO1)
6–7	3–4	**Level 2** ● Demonstrates physics undrstanding which is mostly relevant but may include some inaccuracies. Understanding of scientific ideas, enquiry techniques and procedures is not fully detailed and/or developed. (AO1) ● Presents a description of the procedure that has a structure that is mostly clear, coherent and logical, with minor steps missing. (AO1)
8–9	5–6	**Level 3** ● Demonstrates accurate and relevant physics understanding throughout. Understanding of the scientific ideas, enquiry techniques and procedures is detailed and fully developed. (AO1) ● Presents a description that has a well-developed structure which is clear, coherent and logical. (AO1)

Step boundaries

Step	Marks
U	0–1
1	2–3
2	4–7
3	8–10
4	11–13
5	14–15
6	16–17
7	18–21
8	22+

Indicative grade boundaries

Indicative Grade	Marks
U	0–3
1	4–7
2	8–13
3	14–17
4	18–21
5	22+

Question number	Part	Step	Answer	Additional guidance	Marks
1	a	6	height of the ball's first bounce		**1 mark**
	b	8	GPE converts to KE and thermal energy. (1) KE converts to GPE and thermal energy. (1)	Allow GPE converts to KE, then to elastic potential energy (1) Allow elastic potential energy converts to KE to GPE (1)	**2 marks**
	c	8	Repeat (many times) and find the mean. (1) Obtain results with a wider range. (1)	Do not accept simply 'Repeat the experiment'	**2 marks**
2		8	An explanation that makes reference to the following points: Friction causes energy to be wasted/involves transferring kinetic energy into thermal energy (1) hence hands become warm. (1) With soapy hands there is less friction so less kinetic energy is transferred to thermal energy. (1)		**3 marks**
3	a	8	Use of correct equation: $\text{efficiency} = \frac{\text{useful energy output}}{\text{total energy input}}$ (1) Substitution and conversion of 18% to 0.18 (1) Evaluation: 72 (J) (1)	Award full marks for correct answer with no working	**3 marks**
	b	8	correct idea of energy flow in Sankey diagram (1) correct labels: (400 J of) energy supplied by electricity (72 J of) useful energy transferred by light (1) (328 J of) wasted energy transferred by heating (1) widths of 'arrows' (representing energy) roughly to scale (1)		**4 marks**

Question number	Part	Step	Answer	Additional guidance	Marks
4	a	9	Any **two** of: ● same thickness of insulators (1) ● identical beakers (1) ● same volume of hot water (1) ● room temperature (1)		**2 marks**
	b	9	temperature of first beaker (after a given time interval) (1) temperature of second beaker (after the same time interval) (1) OR time taken for temperature to fall by a certain amount/the same amount for each beaker (2)	Accept: temperatures of the two beakers after the same time (2)	**2 marks**
	c	8	Compare temperature drops. The better insulator will correspond to the smaller drop.	Or words to that effect	**1 mark**
5	a	10	Correct equation: KE = ½ mv^2 (1) Rearrangement: $m = 2 \times \frac{\text{KE}}{v^2}$ (1) Conversion into J and substitution (1) Evaluation: m = 1300 kg (1)	Allow 1 mark if conversion of 41.6 kJ into J is seen Award full marks for correct answer with no working	**4 marks**
	b	10	Correct equation: GPE = mgh (1) Rearrangement: $g = \frac{\text{GPE}}{mh}$ (1) Conversion of km into m and MJ into J and correct substitution (1) Evaluation: g = 3.7 N/kg (1)	Allow 1 mark if conversion of MJ into J or km into m is seen Allow full marks for correct answer with no working	**4 marks**

Question number	Part	Step	Answer	Additional guidance	Marks
6	a	10	**A** bio-fuel		**1 mark**
	b	11	**A** hydroelectric		**1 mark**
	c	12	An explanation that makes reference to the following points: General point: there has been an increase in the use of renewable resources. (1) **AND** Any **one** of: ● Burning fossil fuels puts carbon dioxide into the atmosphere/is causing climate change. (1) ● Carbon dioxide is a 'greenhouse gas'. (1) ● Burning fossil fuels releases other polluting gases (1) ● (e.g. sulfur dioxide) that contribute to acid rain. (1) **AND** Any **two** of: ● international agreements/protocols to reduce the use of fossil fuels (1) ● New technologies have improved the efficiencies of many renewables. (1) ● New technologies have improved the cost of many renewables. (1) ● People have become more interested in renewable energy as a result of increasing interest in green issues (or something similar). (1) ● Government incentives have encouraged the use of many renewables (e.g. solar, wind). (1)	Do not accept vague unqualified responses, such as 'they are more efficient' or 'they harm the environment'	**4 marks**

Question number	Part	Step	Answer	Additional guidance	Marks
7		12	Answers will be credited according to candidate's deployment of knowledge and understanding of the material in relation to the qualities and skills outlined in the generic mark scheme. The indicative content below is not prescriptive and candidates are not required to include all the material that is indicated as relevant. Additional content included in the response must be scientific and relevant. **Indicative content** **AO2 (3 marks) and AO3 (3 marks)** Explanation should include some of the following: **Forms of energy:** ● gravitational potential energy ● kinetic energy ● thermal **Location of energy:** ● gravitational potential energy of mass as it rises ● kinetic energy of mass as it moves ● thermal energy dissipated to surroundings **Linked ideas:** ● At the top of the swing, all of the energy is GPE. ● As the child swings, gravitational potential energy ● is transferred to kinetic energy ● and then back to GPE. ● The kinetic energy from the child is transferred to the surroundings as thermal energy ● through the force of air resistance.	See below	**6 marks**

Step	Marks	Descriptor
U	0	No awardable content.
7–8	1–2	**Level 1** ● The explanation attempts to link and apply knowledge and understanding of scientific ideas, flawed or simplistic connections made between elements in the context of the question. (AO2) ● Interpretation and evaluation of the information attempted but will be limited with a focus on mainly just one variable. Demonstrates limited synthesis of understanding. (AO3)
9–10	3–4	**Level 2** ● The explanation is mostly supported through linkage and application of knowledge and understanding of scientific ideas, some logical connections made between elements in the context of the question. (AO2) ● Interpretation and evaluation of the information on both variables, synthesising most relevant understanding. (AO3)
11–12	5–6	**Level 3** ● The explanation is supported throughout linkage and application of knowledge and understanding of scientific ideas, logical connections made between elements in the context of the question. (AO2) ● Interpretation and evaluation of the information, demonstrating throughout the skills of synthesising relevant understanding. (AO3)

Step boundaries

Step	Marks
U	0–6
5	7
6	8–9
7	10–13
8	14–17
9	18–21
10	22–25
11	26–30
12	31+

Indicative grade boundaries

Indicative Grade	Marks
U	0–6
3	7–9
4	10–13
5	14–17
6	18–21
7	22–25
8	26–30
9	31+