Energy Revision materials

Checklist

Key points:	☺	☹
Chemical analysis		
Know the ways energy is stored		
Know how energy can be transferred		
Know what conservation of energy is		
What is work done		
How is work done calculated		
What happens to work done to overcome friction		
Explain what happens to the gravitational potential energy stores of an object when it moves up or down		
Know how to calculate the change in gravitational potential energy of an object		
Know how to calculate the amount of energy in a kinetic energy store		
Know how to calculate the amount of energy in an elastic potential energy store		
Explain what useful and wasted energy is		
Know what is meant by efficiency		
Know how to calculate efficiency		
What is meant by power		
Know how to calculate the power of an appliance		
Know how to calculate the efficient of appliance in terms of power		
Know what re-newable and non-renewable sources are		
Explain how electricity is generate from the following; nuclear power, coal, oil, gas, wind power, wave power, tidal power, solar power and geothermal energy		
Give an advantage and disadvantage of the following; nuclear power, coal, oil, gas, wind power, wave power, tidal power, solar power and geothermal energy		
Know what materials make the best conductors and insulators		
Explain how thermal conductivity of the material affects the rate of energy transfer through it by conduction		
Know what is meant by specific heat capacity		

How to calculate the energy change that occurs when an object changes temperature		
Explain how you can reduce the rate of energy transfer from your home		

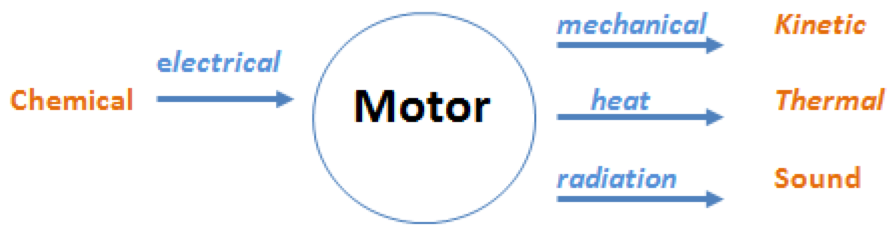
Energy stores and systems

An energy system is a group of objects that have the ability to do work.

Remember: energy can not be created or destroyed so when work is done, energy from one store is carried along a pathway to another energy store.

Consider the energy flow diagram for an electric shaver.

The battery has a store of chemical energy. The current flows through an electrical pathway to the motor. Energy from the motor follows a mechanical pathway to a kinetic store of the moving blades, a heat pathway to a thermal store and a radiation pathway to a sound store.



Types of energy stores

Energy stores	Examples
Chemical	In food, fuel and electric batteries
Kinetic	In moving objects
Gravitational potential	In objects raised above a planets surface
Elastic potential	In a stretched, compressed or twisted object
Internal (thermal)	In any heated object
Magnetic	In any object with a magnetic field
Electrostatic	In electrostatic forces between charges
Nuclear	The forces acting between atomic nuclei

Force pathways include:

- **Mechanically** – when a force acts and an object moves
- **Electrically** – when an electric current flows
- **Heating** – a temperature difference between objects
- **Radiation** – electromagnetic waves or sound

Examples

Examples of energy changes in a system:

An object thrown (projected) upwards e.g. You throw a tennis ball upwards.

- As the **ball leaves** your **hand** it has a **store** of **kinetic energy**.
- At its **highest point** it has a **store** of **gravitational potential energy (G.P.E)**.
- As you are about to catch it just **before it hits your hand** it has a **store** of **kinetic energy.**

A moving object hitting an obstacle e.g. A bowling ball hitting a pins.

- As you move the muscles of your arm to throw the ball the **chemical energy store** in your muscles **decreases** and the **kinetic energy store** of the bowling ball **increases**.
- At the ball hits a pin some of the **kinetic energy** has been transferred to a **store** of **internal (thermal) energy** this causes the ball and its surroundings to warm up a little.
- You will hear a **sound** when the ball hits the pin, the **energy of the sound** is also transferred to the **internal energy store** of the **surroundings**.

A vehicle slowing down e.g. When you apply the brakes in a lorry

- The **moving** lorry has a **store** of **kinetic energy**.
- At the **brakes** are applied the **kinetic energy store decreases** the energy is transferred to the **internal (thermal) energy store** in the brakes and the brakes get hot.
- You will hear a **sound** when the brakes of the lorry are applied, the **energy of the sound** is also transferred to the **internal energy store** of the **surroundings**.
- When the lorry **stops** its **kinetic energy store** is **zero**.

Energy is measured in Joules (J)

1 kilojoule (kJ) = 1000 J (10^3J) **1 megajoule = 1000 000 J (10^6J)**

Exam practice 1

Work done

When an object is moved by a force, work is done on the object by the force. So the force transfers energy to the object. The amount of energy transferred to the object is equal to the work done.

Work done by a force depends on the size of the force and the distance moved.

Energy transferred = work done

Work (J) = Force (N) x Distance (along the line of the force) (m)

W = F s

Example

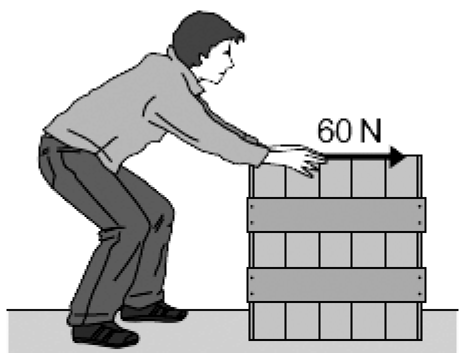
Calculate the work done if the aircraft is moved a distance of 20m and the pushback truck exerts a force of 11,800 N on the aircraft.

Work = 11, 800 x 20 = 236,000 J

Work done to overcome friction is transferred as energy to the thermal energy stores of an object that rub together and the surroundings.

Exam practice 2

Q1. The diagram shows a worker using a constant force of 60 N to push a crate across the floor.



My Revision Notes AQA GCSE Physics for A* – C, Steve Witney, © Philip Allan UK

(a) The crate moves at a constant speed in a straight line

(i) Draw an arrow on the diagram to show the direction of the friction force acting on the moving crate.

(1)

(ii) State the size of the friction force acting on the moving crate.

.... N

Give the reason for your answer.

....

....

(2)

(b) Calculate the work done by the worker to push the crate 28 metres.

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

Choose the unit from the list below.

joule **newton** **watt**

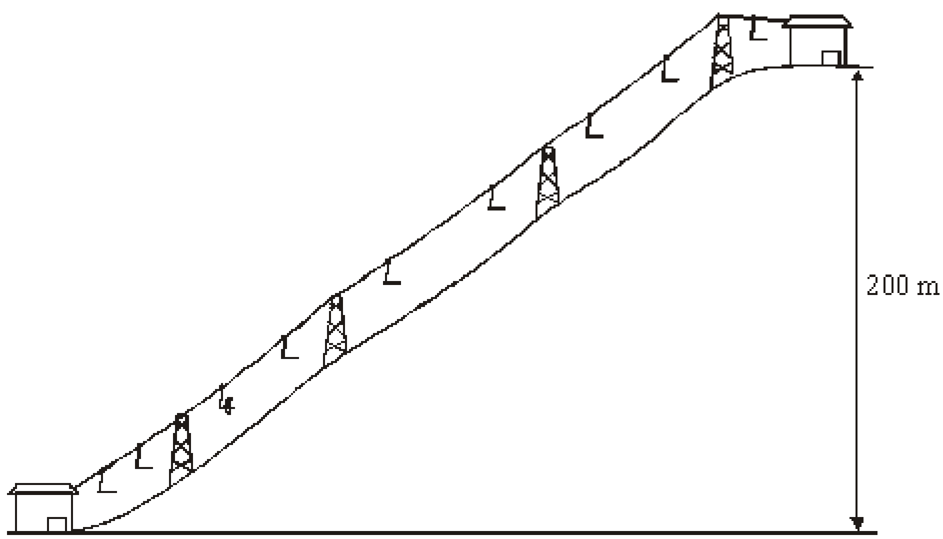
....

....

Work done = ...

(3)
(Total 6 marks)

Q2. (a) A chair lift carries two skiers, Greg and Jill, to the top of a ski slope. Greg weighs 700 N and Jill weighs 500 N.



(i) Write down the equation that links distance moved, force applied and work done.

....

(1)

(ii) Calculate the work done to lift Greg and Jill through a vertical height of 200 m. Show clearly how you work out your answer and give the unit.

....

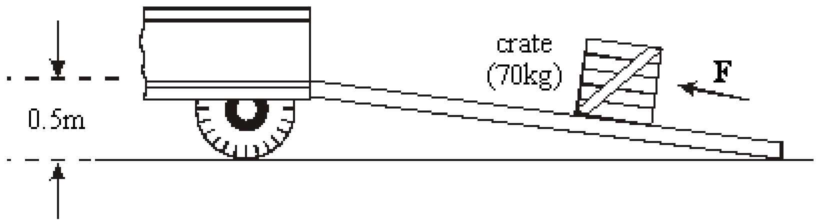
....

....

work done = ...

(3)

3. The diagram below shows a plank being used as a simple machine.
The crate is slid up the plank into the back of the lorry.



(i) The mass of the crate is 70kg. Calculate the weight of the crate.

....

.... Weight .... N

(2)

(ii) Calculate the work done when the crate is lifted a vertical distance of 0.5m.

....

....

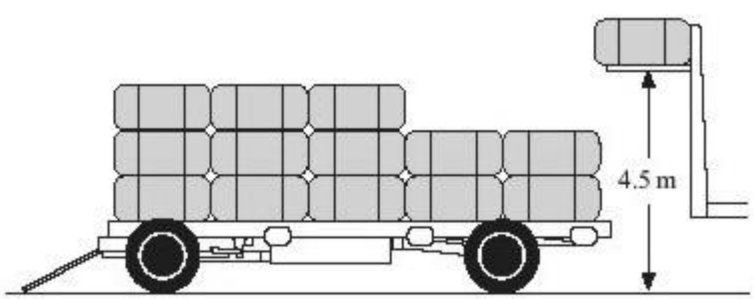
....

.... Work done ....

(4)
(Total 6 marks)

Q4. A forklift truck was used to stack boxes on to a trailer.

It lifted a box weighing 1900 N through 4.5 m.



Calculate the work done on the box. Show your working.

....

....

....

....

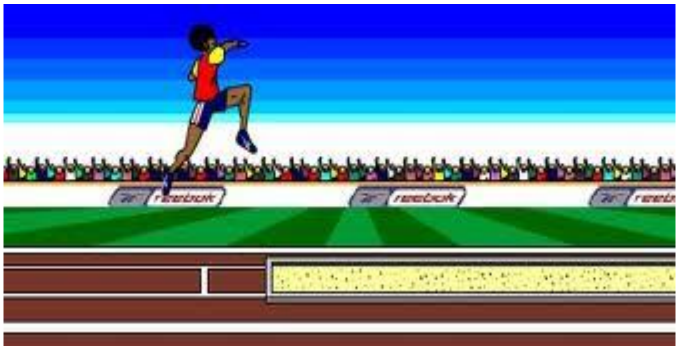
Work done = ... J

(Total 3 marks)

Kinetic energy

The energy in kinetic energy store of a moving object depends in its mass and speed.

The long-jumper is using her **kinetic energy** to carry her body as far as possible. The more kinetic energy she has, the longer her jump will be. Her kinetic energy depends on her mass (which she can not change) and her velocity (she can run faster!).



The kinetic energy of a moving object can be calculated using the equation:

Kinetic energy (J) = 0.5 × Mass (kg)× Speed^2 (m/s)

$E_k = ½\ m\ v^2$

If her mass is 46 kg and she is travelling at 8 m/s, her kinetic energy during her jump will be:

$E_k = ½\ m\ v^2$

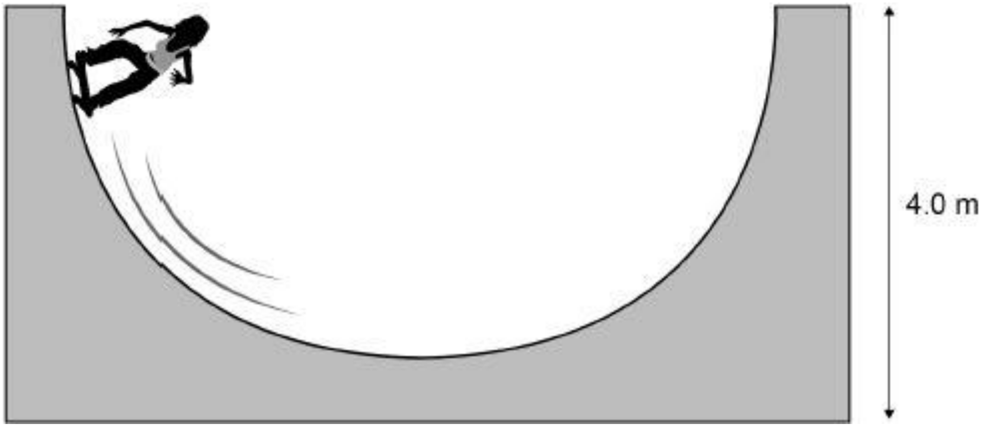
$E_k = ½ \times 46 \times 8^2$

The energy transferred in the jump is: E_k = 1472 J

Exam practice 3

Q1.

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



The girl has a mass of 50 kg

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

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

Use the equation:

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

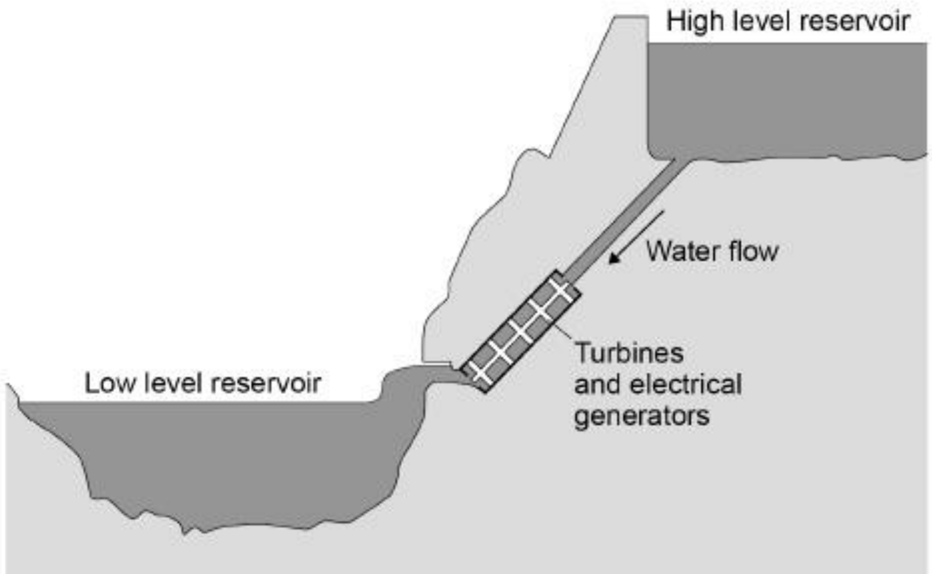
____

____

Kinetic energy = ___________________________ J

(2)

Q2.
The diagram shows the flow of water through a hydroelectric power station.



The falling water turns the turbines.

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

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

____

(1)

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

The speed of the water is 30 m/s

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

Give your answer in kilojoules (kJ).

____

____

____

____

Kinetic energy = ______________________ kJ

Q3. (b) The car has a top speed of 12 m / s and a mass of 800 g.

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

Equation ____

(1)

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

____

____

____

Maximum kinetic energy = ___________________ J

(2)

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

____

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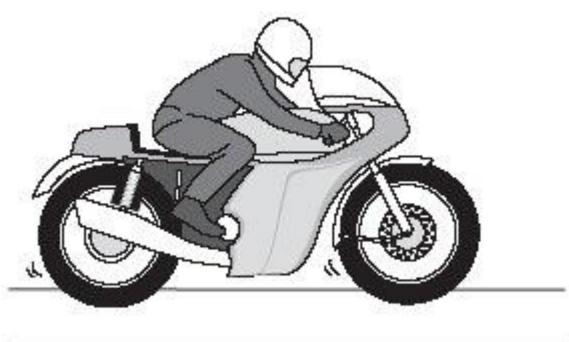
____

____

(2)

Q4. The diagram shows a motorbike of mass 300 kg being ridden along a straight road.



The rider sees a traffic queue ahead. He applies the brakes and reduces the speed of the motorbike from 18 m/s to 3 m/s.

(a) Calculate the kinetic energy lost by the motorbike.

Show clearly how you work out your answer.

....

....

....

....

Kinetic energy lost = ... J

(2)

(b) (i) How much work is done on the motorbike by the braking force?

....

(1)

(ii) What happens to the kinetic energy lost by the motorbike?

....

(1)
(Total 4 marks)

<u>**Elastic potential energy**</u>

Elastic potential energy is the energy stored in an elastic object when work is done on an object.

Stretched or bent objects have **elastic energy (E_e)** if they have the ability to **recover** to their original shape and dimensions.

When a weight (force) is added to a spring it extends (gets longer).

The spring now has a store of elastic potential energy which will be released if the weight is removed.

The amount of stored elastic energy (E_e) can be calculated using the following equation:

Elastic potential energy (J) = 0.5 × Spring constant (N/m) × Extension^2 (m)

$E_e = \frac{1}{2} k e^2$

In the above example the spring has a spring constant of 670 N/m. The elastic potential energy of the spring when a 50 N load is hung from it is:

$E_e = ½\ k\ e^2$

$E_e = 0.5 \times 670 \times 0.075^2$

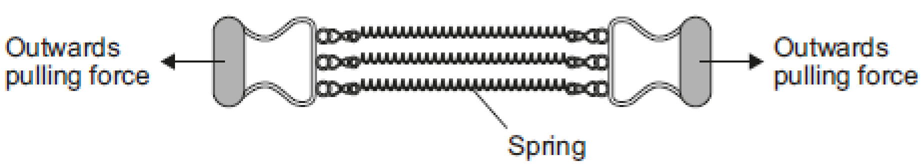
The elastic energy stored in the spring is: E_e = <u>1.88 J</u>

<u>Exam practice 4</u>

Q1.

Figure 1 shows an exercise device called a chest expander. The three springs are identical.

Figure 1



A person pulls outwards on the handles and does work to stretch the springs.

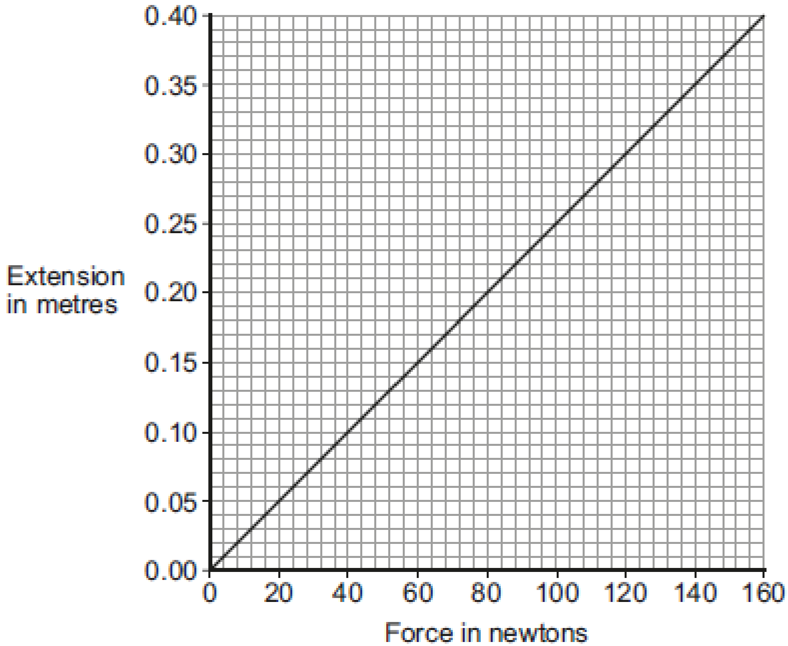
(a) Complete the following sentence.

When the springs are stretched ___________ ___________ energy is stored in the springs.

(1)

(b) **Figure 2** shows how the extension of a single spring from the chest expander depends on the force acting on the spring.

Figure 2



(i) How can you tell, from **Figure 2**, that the limit of proportionality of the spring has not been exceeded?

____

____

(1)

(ii) Use data from **Figure 2** to calculate the spring constant of the spring. Give the unit.

____

____

____

Spring constant = ____________ Unit ____________

(3)

(iii) Three identical resistors joined in parallel in an electrical circuit share the total current in the circuit.

In a similar way, the three springs in the chest expander share the total force exerted.

By considering this similarity, use **Figure 2** to determine the total force exerted on the chest expander when each spring is stretched by 0.25 m.

____

____

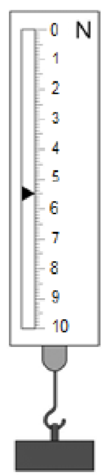
Total force = ___________ N

(2)

Q2 .A newtonmeter measures the weight of objects.

Look at **Figure 1**.

Figure 1



(a) What is the weight of the object in **Figure 1**?

Weight = ... N

(1)

(b) The spring inside the newtonmeter behaves elastically.

What happens to the length of the spring when the object is removed from the newtonmeter?

Tick **one** box.

The spring gets longer ☐

The spring gets shorter ☐

The spring stays the same length ☐

(1)

(c) A student carried out a practical to investigate the extension of a spring.

Write a method the student could have used.

....

....

....

....

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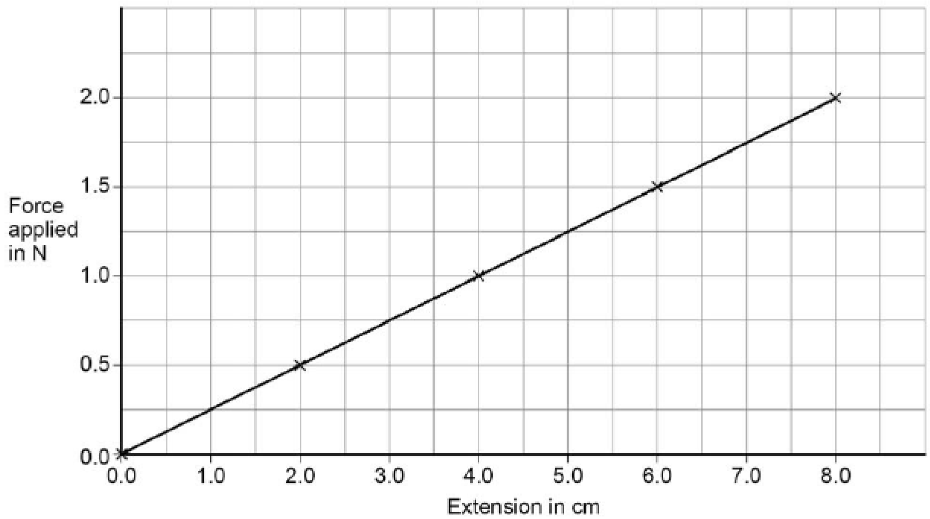
....

(4)

(e) The student added weights to a spring and measured the extension of the spring.

Figure 2 shows his results.

Figure 2



What is the relationship between force applied and extension?

Tick **one** box.

Extension is inversely proportional to force ☐

Extension increases by smaller values as force increases ☐

Extension is directly proportional to force ☐

(1)

(f) Use **Figure 2** to determine the additional force needed to increase the extension in the spring from 5.0 cm to 7.0 cm.

Force needed = ... N

Gravitational potential energy stores

Changes in gravitational potential energy stores

The gravitational potential energy store of an object increases when it moves up and decreases when it moves down.

The work done when an object moves up or down depends on:

- How far it moved vertically (change in height)
- The weight

Using work done = force applied x distance moved in the direction of the force:

Change in object's gravitational potential energy (J) = Weight (N) × change of height (m)

Gravitational potential energy stores and mass

The gravitational field strength at the surface of the Moon is less than on the Earth.

The amount of gravitational potential energy (G.P.E) gained by an object raised above ground level can be calculated using the equation:

G.P.E (J) = Mass (kg) × Gravitational field strength (N/kg) × Height (m)

$$E_p = m\ g\ h$$

The pile driver hammer has a mass of 120 kg and it is raised to a height of 4 m above the ground. How much G.P.E will it have?

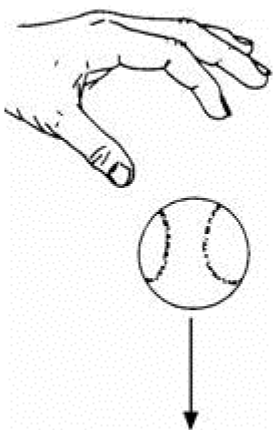
$E_p = m\ g\ h$

$E_p = 120 \times 10 \times 4$

The G.P.E gained is: $E_p = 4800$ J

Exam practice 5

Q1. Complete the following sentences.



When you drop a ball, it falls to the ground.

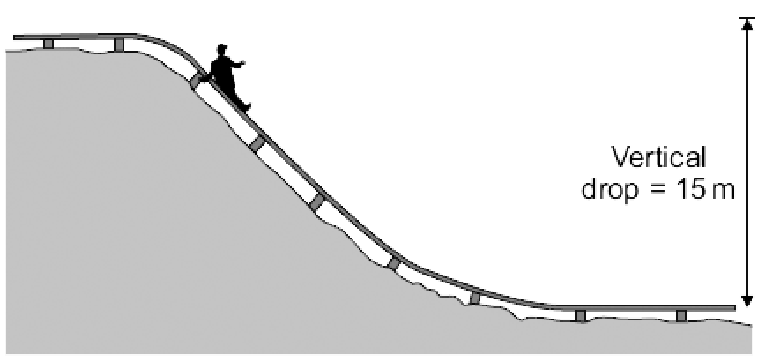
This happens because the .... pulls the ball

towards it with a force called ....

Forces are measured in units called ....

(Total 3 marks)

Q2. The miners working in a salt mine use smooth wooden slides to move quickly from one level to another.



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

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

gravitational field strength = 10 N/kg

Show clearly how you work out your answer.

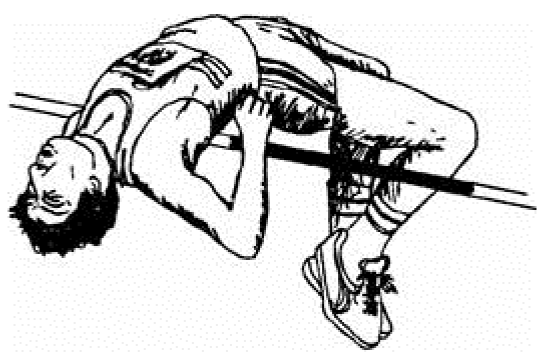
....

....

Change in gravitational potential energy = ... J

(2)

Q3. The diagram shows a high jumper.



In order to jump over the bar, the high jumper must raise his mass by 1.25 m.
The high jumper has a mass of 65 kg. The gravitational field strength is 10 N/kg.

(a) The high jumper just clears the bar.

Calculate the gain in his gravitational potential energy.

....

....

....

....

....

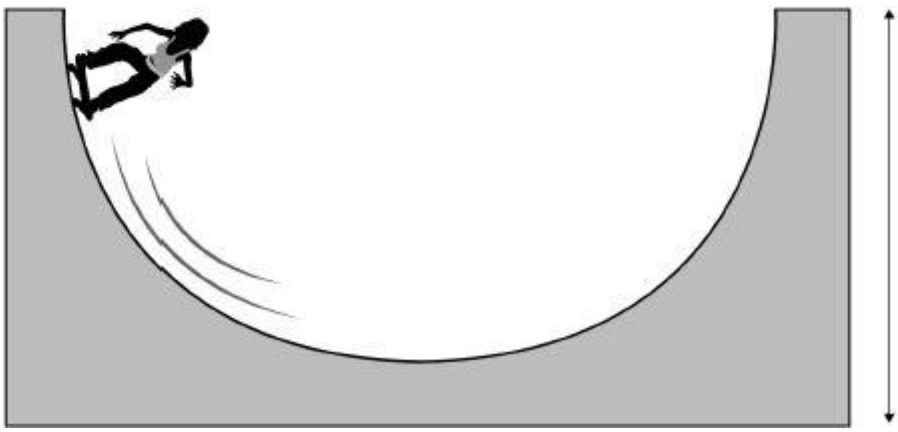
....

Gain in gravitational potential energy .... J

(4)

Q4.

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



The girl has a mass of 50 kg

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

Use the equation:

g.p.e. = mass × gravitational field strength × height

gravitational field strength = 9.8 N/kg

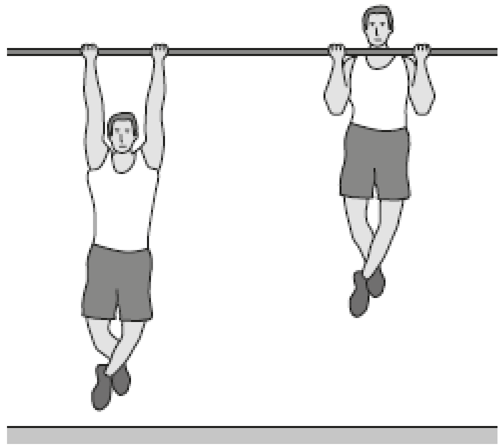
____

____

g.p.e. = ___________________ J

(c) The student in **Figure 3** is doing an exercise called a chin-up.

Figure 3



Each time the student does one chin-up he lifts his body 0.40 m vertically upwards.
The mass of the student is 65 kg.
The student is able to do 12 chin-ups in 60 seconds.

Calculate the power developed by the student.

Gravitational field strength = 10 N/kg

____

____

____

____

____

Power = ____________ W

(3)

<u>Power</u>

Power is the rate at which energy is transferred

The rate at which work is done (rate means "how quickly")

Power is measured in Joules / second 1 J/s = 1 Watt

Power can be calculated using the following equation:

Power (W) = <u>Energy transferred (J)</u>

Time (s)

Example

An object which transfers energy does so at a certain rate.

The metal filament in this light bulb transfers then electrical energy store into heat and light.

This bulb transfers 2400 joules of energy in 60 seconds.

P= 2400 / 60 = 40 J/s

So this is a **40 Watt** light bulb.

Another type of power

Power = work done / time

The crane lifts the 2000 kg container through a height of 5.4m in 30s.

The power of the crane is:

Power = Work / time **But: Work = force x distance**

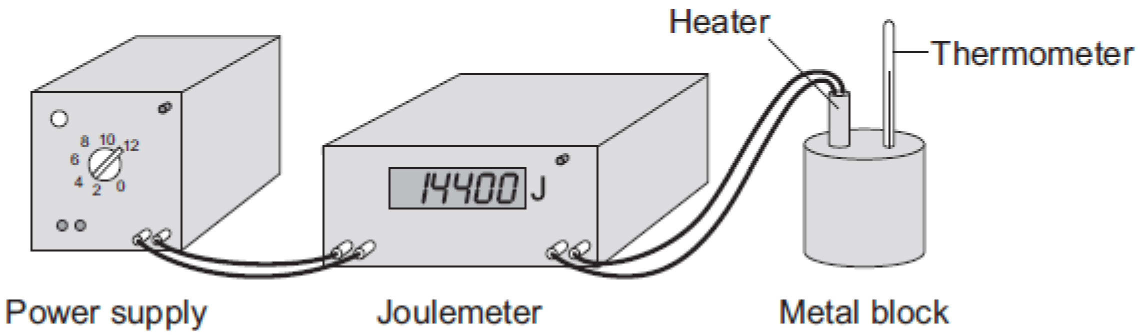
= 20 000 N x 5.4 m = 108 000 J

Power = 108 000 J / 30 s

The Power of the crane is 3600 J/s or 3600 Watts

Exam practice

Q1. A student used an electric heater to heat a metal block. The student measured the energy input to the heater with a joulemeter.



Before starting the experiment, the student reset the joulemeter to zero. The student switched the power supply on for exactly 10 minutes. During this time, the reading on the joulemeter increased to 14 400.

(a) (i) Calculate the energy transferred each second from the power supply to the heater.

Show clearly how you work out your answer.

....

....

Energy transferred each second = ... J/s

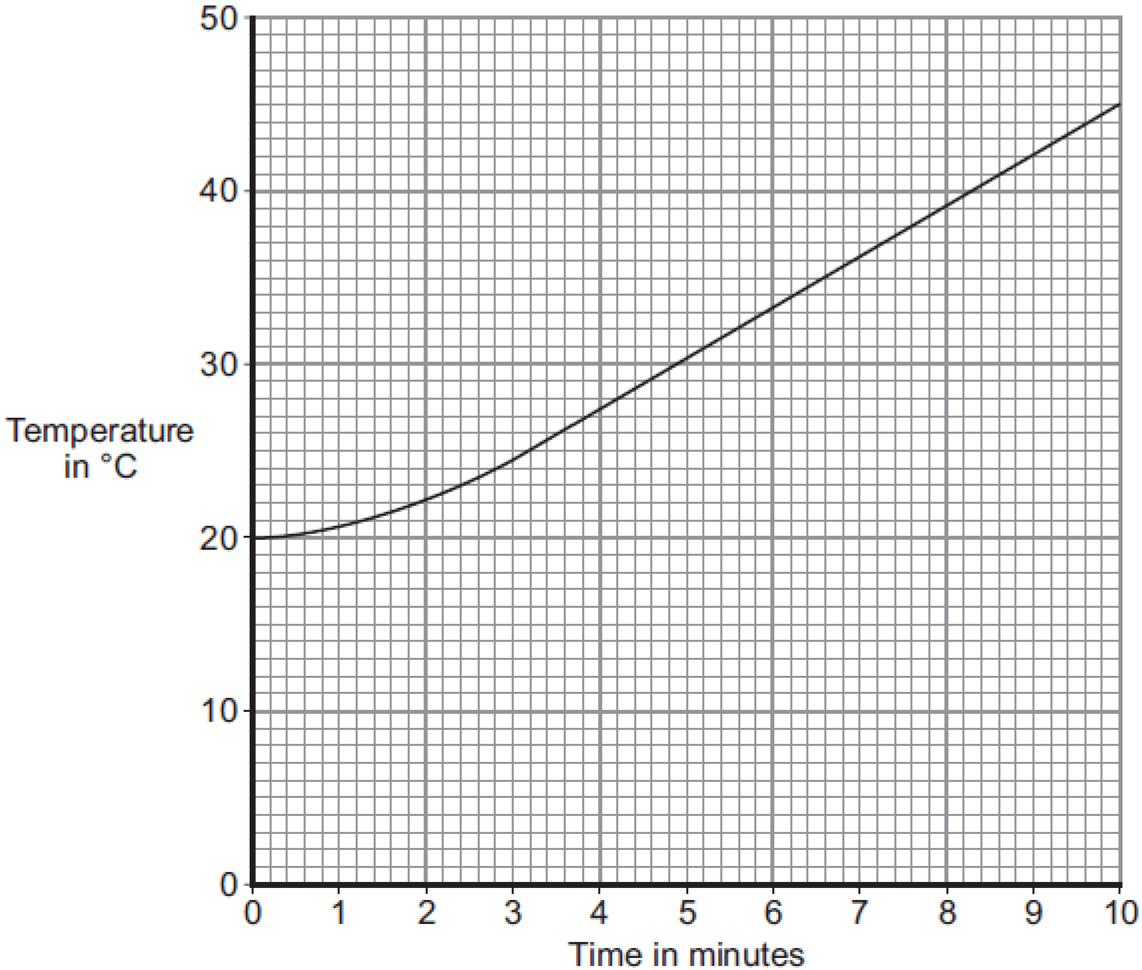
(2)

(ii) What is the power of the heater?

....

(1)

(b) The student measured the temperature of the metal block every minute. The data obtained by the student is displayed in the graph.



(i) What range of temperatures did the student measure?

From .... °C to .... °C

(1)

(ii) Before starting the experiment, the student had calculated that the temperature of the block would go up by 36 °C.

The student's data shows a smaller increase.

Which **one** of the following statements gives the most likely reason for this?

Put a tick (✓) in the box next to your answer.

The student does not read the thermometer accurately. ☐

The block transfers energy to the surroundings. ☐

The power supply is not connected correctly to the joulemeter. ☐

(1)

Q2. (a) The weightlifter in the picture has lifted a weight of 2250 newtons above his head. The weight is held still.

(i) In the box are the names of three forms of energy.

gravitational potential	kinetic	sound

Which **one** of these forms of energy does the weight have?

....

(1)

(b) To lift the weight, the weightlifter does 4500 joules of work in 3.0 seconds.

Use the following equation to calculate the power developed by the weightlifter. Show clearly how you work out your answer.

$$\text{power} = \frac{\text{work done}}{\text{time taken}}$$

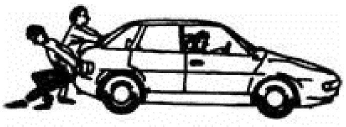
....

....

Power = ... watts

(2)
(Total 5 marks)

Q3. A man's car will not start, so two friends help him by pushing it.



Mass of car = 800 kg

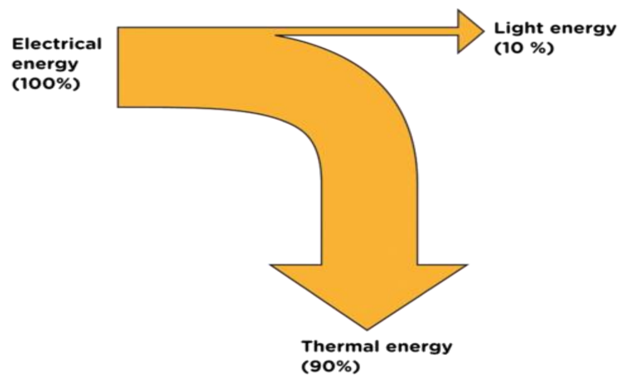
By pushing as hard as they can for 12 seconds they make the car reach a speed of
3 metres per second

(b) Whilst pushing the car the two friends together do a total of 2400 joules of work. Calculate their total power.

....

....

.... Answer .... watts



Energy Transfer

Energy can be stored, transferred or dissipated - but can not be created or destroyed.

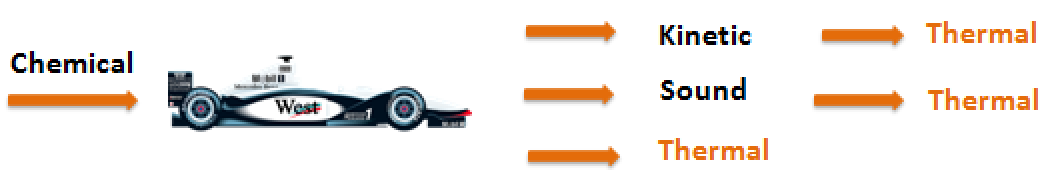
The diagram shows the energy transfer for a light

bulb. All the electrical energy store can be accounted for as light energy and thermal energy.

The thermal energy is not useful in this case and can be considered to be dissipated or "waste" energy.

<u>Unwanted energy</u> transfers result in energy stores that are not useful.

The F1 car below shows that eventually all the chemical energy (fuel) put in the car ends up as <u>unwanted</u> thermal energy which is dissipated to the surroundings. Unwanted energy is often described as being 'wasted'



Kinetic energy is dissipated by the tyres, brakes and air resistance to become unwanted thermal energy stores.

Sound energy is absorbed by materials and becomes thermal energy.

Thermal energy is produced by the engine as fuel is burnt.

Oil is used in the engine, gearbox and other moving parts as a lubricant to reduce friction and reduce unwanted thermal energy in these parts.

Efficiency

The amount of useful energy you get from an energy transfer, compared to the energy put in, is called the **EFFICIENCY**

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

This calculation will result in a decimal value which can be multiplied by 100 to give a percentage efficiency.

Example

The wind turbine produces 120 MW of electrical energy for every 500 MW of kinetic energy provided by the wind.

$$\text{Efficiency} = \frac{\text{Useful output energy transfer}}{\text{total input energy transfer}}$$

$= \frac{120}{500} = 0.24$ efficient

or 0.24 x 100 = 24 % efficient

Efficiency can also be calculated from the power transferred.

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

Remember that power is the time it takes to do work.

Work = Force x distance

The 300 W water pump raises 200 kg of water to a height of 2 m in one minute.

The efficiency of the pump is:

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

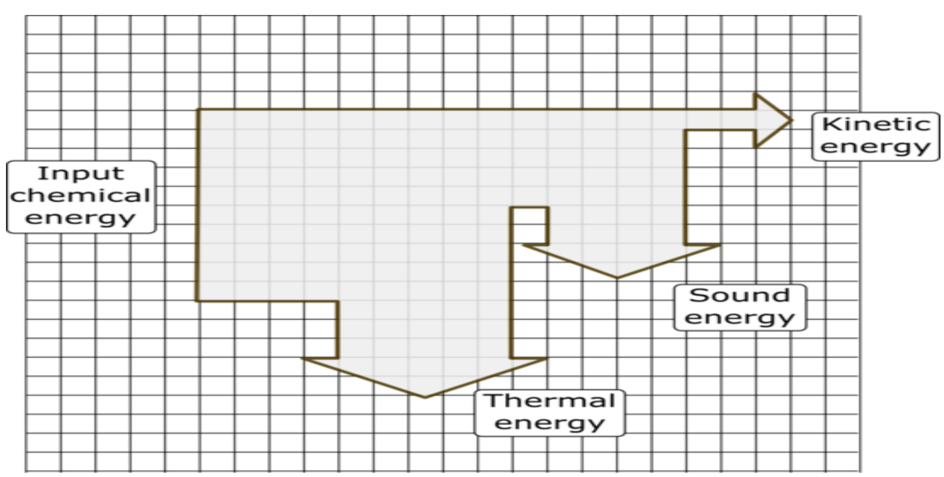
Power in = 300 W

$$\text{Power out} = \frac{2000\text{ N} \times 2\text{ m}}{60} = 66.7\text{ W}$$

$$\text{Efficiency} = \frac{66.7 \times 100}{300} = 22.2\ \%$$

Sankey diagrams

Sankey diagrams show how energy is changed by a device. The wider the arrow, the more energy is flowing in that direction. Arrows that continue to travel to the right show useful forms of energy. Arrows that diverge downwards show the forms of wasted energy.



This Sankey Diagram shows the energy input and output for an old diesel car engine.

Question 1

In the above Sankey diagram every grid represent 10KJ (Joules). Use the grid to calculate the following:

<u>Input Energy</u>	**<u>Output Energy</u>**
Chemical energy	Thermal energy
	Sound energy
	Kinetic energy
Total input energy = KJ	**Total output energy = KJ**

Calculate the efficiency of the diesel car engine**?**

....

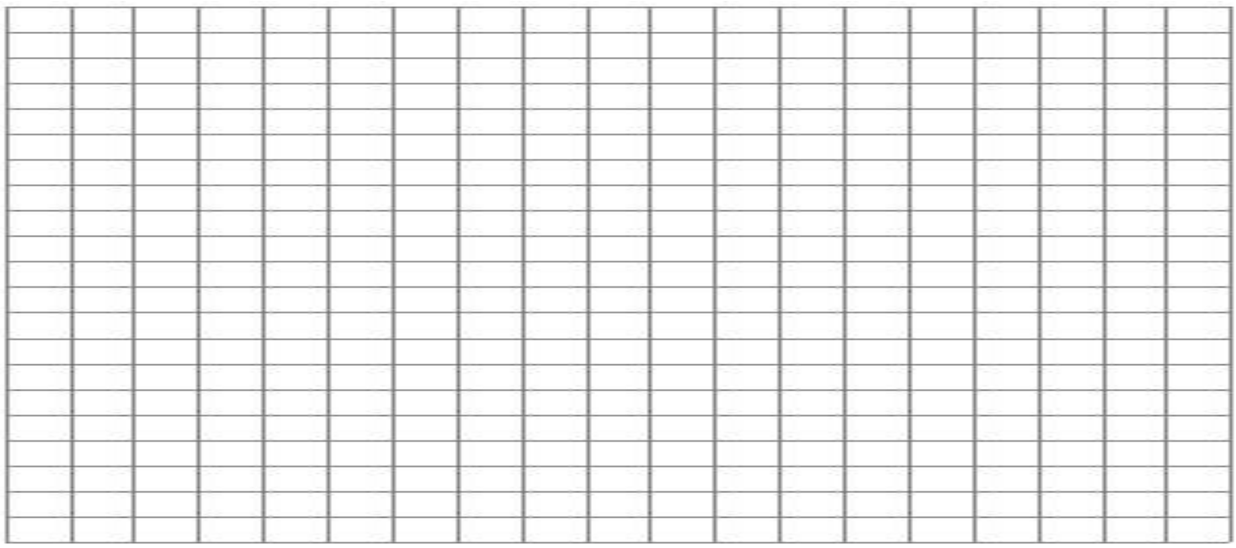
....

....

Efficiency = ...

To complete this sheet successfully you will need to use a pencil and a rubber as you might make errors in drawing the energy Sankey diagrams correctly in the first attempt.

Question 2



An electrical torch uses 100 Joules (J) of electrical energy to change it to 10 J of light energy and 90 J of heat energy. Use the grids below to sketch a sankey diagram for the torch. You need to decide each grid how many Joules it represents.

Calculate the efficiency of the electric torch?

....

....

....

Efficiency = ...

Question 3

A mobile phone transforms 110J of input chemical energy into 30J of sound energy, 30J of light energy, and 40 Joules of heat energy. Draw a Sankey diagram to present your data (you need to decide each grid how much Joules it represents).

Calculate the efficiency of the mobile phone**?**

....

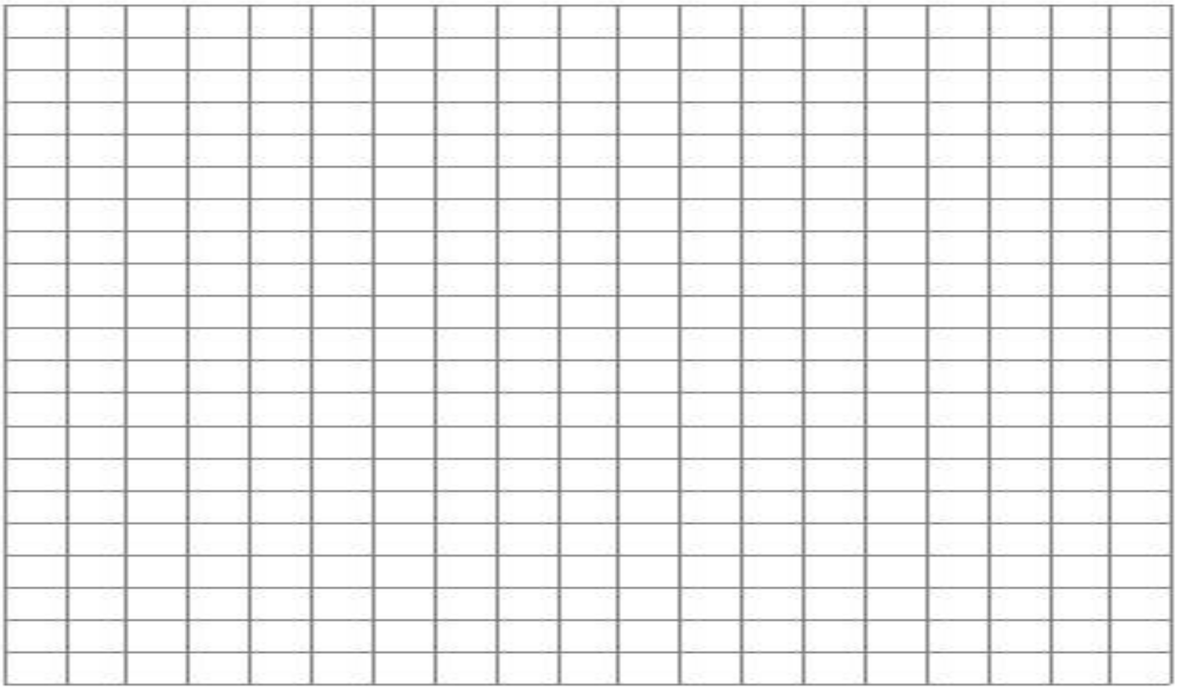
....

....

Efficiency = ...

Question 4

An energy saving light bulb uses 12J of electrical input energy to give out 6J of light energy. How much watsed heat energy would a florscent bulb give out? Draw a Sankey diagram to show that.



Calculate the efficiency of the energy saving light bulb**?**

....

....

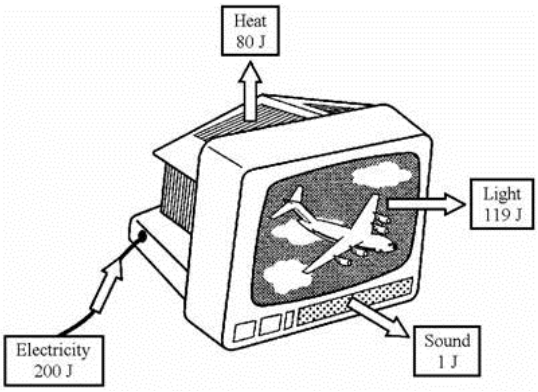
....

Efficiency = ...

Exam practice 7

Q1.

(a) The drawing shows the energy transferred each second by a television set.



(i) What form of energy is transferred as waste energy by the television set?

.... **(1)**

(ii) What effect will the waste energy have on the air around the television set?

.... **(1)**

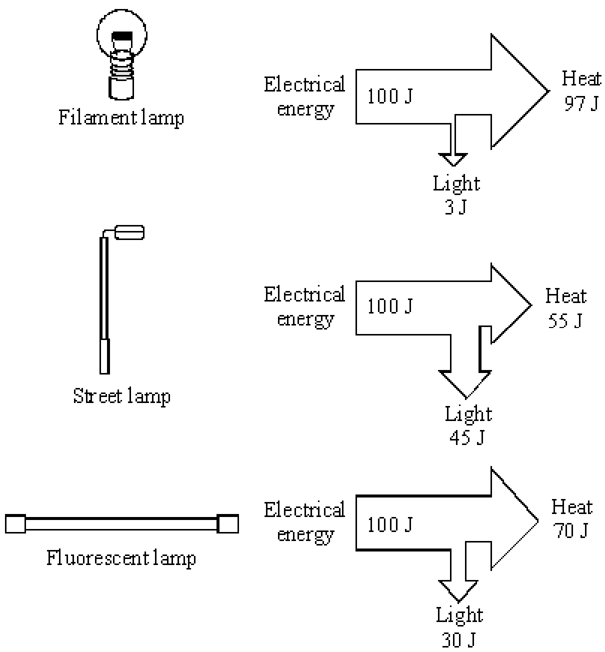
(iii) Calculate the efficiency of the television set.

....

....

Efficiency = ... **(2)**

(b) The diagrams show the energy transferred each second for three different types of lamp. For each lamp the electrical energy input each second is 100 joules.



Which type of lamp is the most efficient?

....

Give a reason for your choice.

....

....

(2)

(Total 6 marks)

Q2.

The table gives data about two types of low energy bulb.

Type of bulb	**Power input in watts**	**Efficiency**	**Lifetime in hours**	**Cost of one bulb**
Compact Fluorescent Lamp (CFL)	8	20%	10 000	£3.10
Light Emitting Diode (LED)	5		50 000	£29.85

(a) Both types of bulb produce the same useful power output.

(i) Calculate the useful power output of the CFL.

Show clearly how you work out your answer.

....

....

....

Useful power output = ... W

(2)

(ii) Calculate the efficiency of the LED bulb.

Show clearly how you work out your answer.

....

....

....

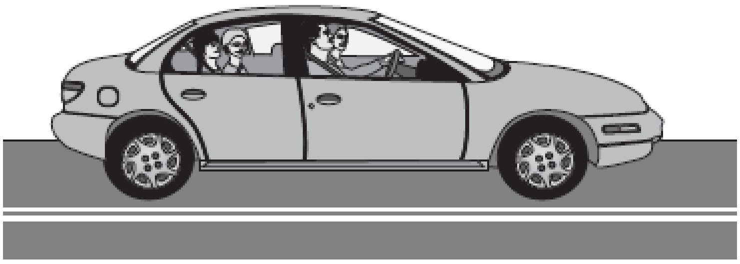
Efficiency = ...

(1)

Question 1

The figure below shows a car with an electric motor.

The car is moving along a flat road.



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

light	**electrical**	**kinetic**	**potential**	**sound**

The car's motor transfers .... energy

into useful .... energy as the car moves.

Some energy is wasted as .... energy.

(3)

(ii) What happens to the wasted energy?

....

....

(1)

(b) The electric motor has an input energy of 50 000 joules each second. The motor transfers 35 000 joules of useful energy each second. Calculate the efficiency of the electric motor.

Use the correct equation from the Physics Equations Sheet.

....

....

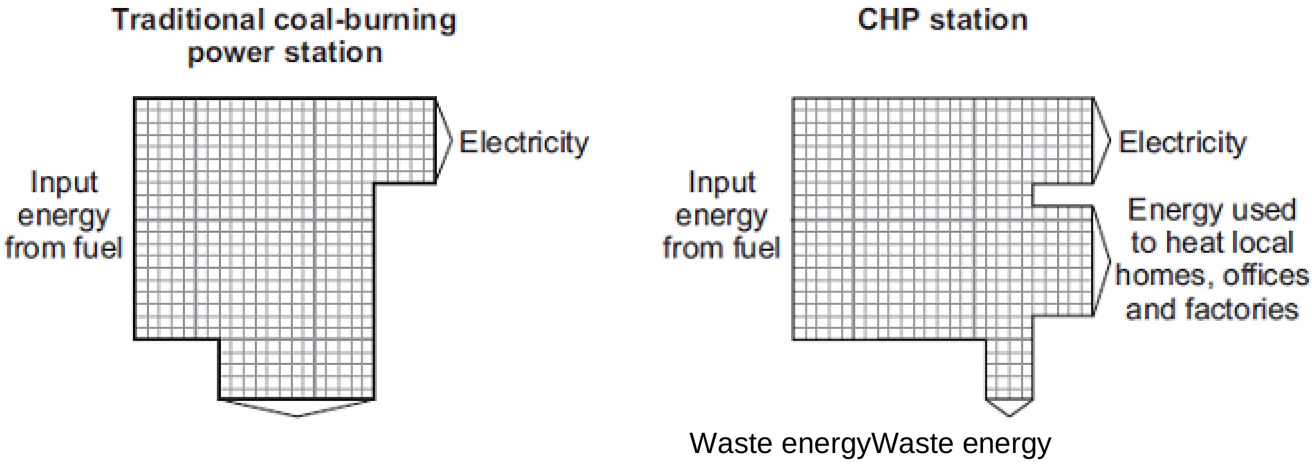
Efficiency = ...

(2)

(Total 6 marks)

Question 2

The Sankey diagrams show the energy transfers in a traditional coal-burning power station and a combined heat and power (CHP) station.



(a) What effect does the waste energy from a power station have on the surroundings?

....

....

(1)

(b) Calculate the efficiency of the CHP station.

Use the correct equation from the Physics Equations Sheet.

....

....

....

Efficiency = ...

(2)

(Total 3 marks)

Energy resources

Non-renewable energy sources are those which will **eventually run out** – there is a finite supply. New supplies are more difficult to find and extract.

Renewable energy sources are those which can **replenish themselves in the short term,** and so will never run out.

Nuclear energy resources are technically non-renewable but they can be produced on an almost indefinite basis.

How energy resources are used.

Transport – cars, trains, buses, planes etc.

Electricity generation – industry, homes, commerce, lighting etc.

Heating – homes, industrial processes, schools and hospitals etc.

Energy use is usually divided between the four economic sectors - **residential, commercial, transportation**, and **industrial.**

ENERGY RESOURCES	
Non-renewable	
Coal	Fossil fuels They are becoming more difficult to find and extract
Oil	
Gas	
Nuclear	Plentiful but difficult to extract / purify
Renewable	
Bio-fuel	Plant matter usually used as a fuel
Wind	Turbines spin a generator to produce electricity
Hydro-electric	Falling water spins a turbine to produce electricity
Geothermal	Hot rocks underground produce steam
Tides	Rise and fall of the tide can be used to turn a turbine
Sun	To directly heat things or produce electricity
Waves	Up and down movement can turn turbines

Non-renewable sources

Coal	Coal is mined then burnt to provide heat or used to generate electricity.	Large reserves of coal which are relatively inexpensive to mine. All major coal mines have now closed in the UK.	Coal mining is dangerous and burning coal contributes to global warming.
Oil	Frequently burnt to produce electricity. Large quantities of oil are refined to provide fuels for transport.	Large reserves becoming more difficult to find and extract. Transport and refinement are relatively easy.	Oil reserves becoming more difficult to find and extract. The need for oil in developed countries means supplies are politically sensitive. Releases greenhouse gases when burnt.
Gas	Extracted from underground gas fields sometimes alongside oil extraction. Mainly used for electricity production, domestic heating and industrial processes that require heat.	Cleaner than burning oil or coal. Relatively easy to transport and store.	UK has good gas reserves but extraction is expensive (often under the sea) and becoming more difficult to reach.
Nuclear	Nuclear supplies (Uranium) are mined and purified. The nuclear fission releases heat which is used to produce steam. This spins a turbine and generator to make electricity	Potentially in-exhaustable energy supply even though it is extracted form resources in the ground.Very efficient process which produces lots of electricity from little nuclear fuel.	Danger of nuclear accidents releasing radioactive materials into the air or water. Security of nuclear sites can be a problem.Start-up costs and decommissioning are very expensive and no real solution to managing radioactive waste has been found.

Renewable energy sources

Solar	Energy from sunlight is captured in photovoltaic cells and converted into electricity. Hot water from solar panels	Renewable energy resource. Individual houses can have their own electricity/hot water supply.	Manufacture and installation of solar panels/cells can be costly.
Wind	Wind turbines turn wind energy into electricity by turning a generator.	Renewable energy resource and can be used as individual units.	Manufacture and installation of wind farms can be costly. Some consider an eyesore.
Tidal	The movement of tides drives turbines. A tidal barrage is built across estuaries to trap water.	Ideal for an island such as the UK to potentially generate a lot of energy. Tidal barrage can help prevent flooding.	Construction of barrage is very costly and can impact on wildlife. Only a few estuaries are suitable.
Biomass	An organic material, which can be burned to provide energy, eg heat or electricity. After treatment with chemicals it can be used as a fuel in vehicle engines.	It is a cheap and readily available source of energy. If replaced, biomass can be a long-term, sustainable energy source.	When burned, it gives off greenhouse gases. Growing takes up large amounts of arable land..
Wave	The movement of water in and out of a cavity on the shore compresses trapped air, driving a turbine.	More likely to be small local operations, rather than done on a national scale.	Construction can be costly. Only produces small amounts of electricity.

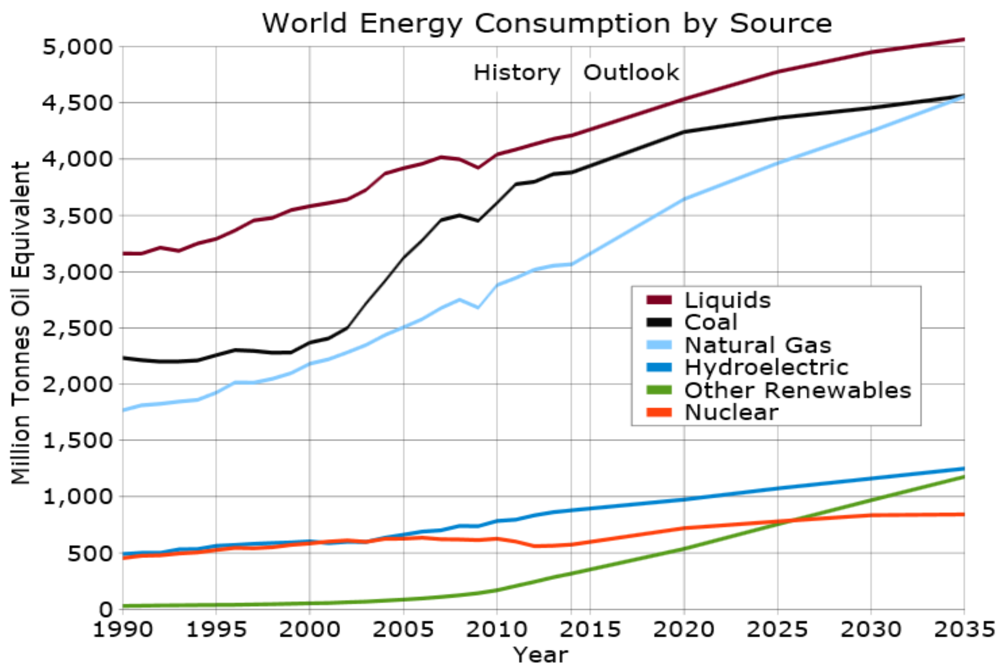
Geothermal	In volcanic regions, cold water is pumped underground and comes out as steam. Steam can be used for heating or to power turbines creating electricity.	Renewable energy resource. Used successfully in some countries, such as New Zealand and Iceland.	Can be expensive to set up and only works in areas of volcanic activity.
Hydroelectric Power (HEP)	Energy harnessed from the movement of water through rivers, lakes and dams. Used to turn turbines for electricity production.	Creates water reserves as well as energy supplies.	Costly to build. Can cause the flooding of surrounding communities and landscapes.

In the UK a **mix** of energy supplies are used so should one supply become **unavailable**, others can be used without **disruption** to supplies.

Some energy sources are more **reliable** than others. Coal, oil, gas and nuclear are reliable sources as they can supply a **continuous** flow of electricity.

Electricity from wind turbines relies on the wind blowing, solar power does not work at night and hydro-electric requires a continuous supply of water. These are considered **unreliable** sources.

World energy use trends and predictions



The total amount of energy used in the world is increasing as the population increases and each person is using more energy.

Renewable energies only make up around 20% of total energy consumption and this trend is unlikely to change until after 2035.

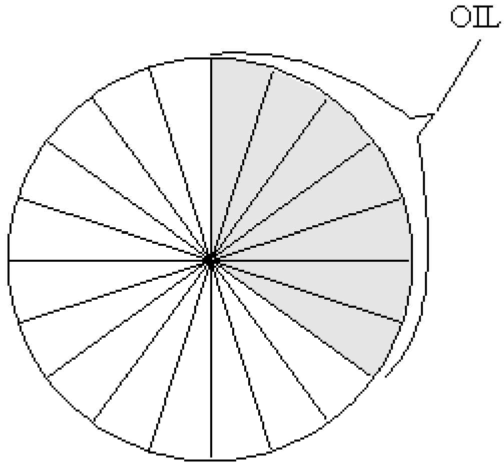
Exam practice 8

Q1.

The table shows the main sources of energy used in Britain in 1990.

coal	35%
oil	35%
gas	24%
nuclear	5%
moving water (hydro)	1%

(a) Finish the pie-chart, using the figures in the table.



(4)

(b) Complete the following sentences.

To release energy from coal, gas and oil they must be burned.

Coal, gas and oil are all ______________________________

(1)

(c) Which **one** of the energy sources in the table is renewable? ____________________

Write down the name of **one** other renewable energy source. ____________________

(2)

(d) How does the amount of energy obtained from nuclear sources in 1990 compare with the amount obtained from moving water?

____

____

(2)

(Total 9 marks)

Q2.

The world's biggest offshore wind farm, built off the Kent coast, started generating electricity in September 2010.

(a) One advantage of using the wind to generate electricity is that it is a renewable energy source.

(i) Give **one** other advantage of using the wind to generate electricity.

____

____

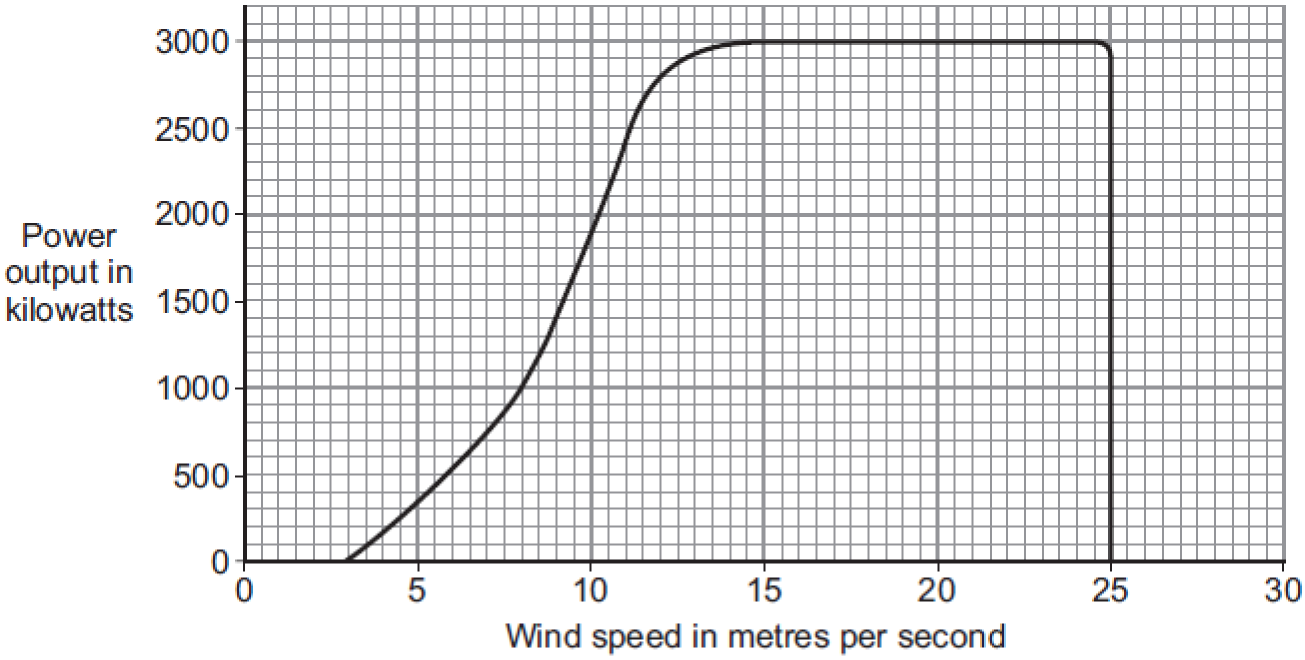
(1)

(ii) Name **one** other renewable energy source used to generate electricity.

____

(1)

(b) The graph shows how wind speed affects the power output from a large wind turbine.



(i) What is the maximum possible power output from this wind turbine?

____

(1)

(ii) Read this part of a newspaper article.

Cold weather stops wind turbines

For the past two weeks, most of the UK's wind turbines have been generating less than one sixth of their maximum power output. To avoid major power cuts in the future, some experts have said that more nuclear power stations need to be built to provide a reliable source of energy.

Use the graph to explain why the power output from the wind turbines was less than one sixth of the maximum.

(2)

(iii) Having more nuclear power stations will help to avoid power cuts in the future.

Which **two** of these reasons explain why?

Put a tick (✓) in the boxes next to your answers.

A small amount of nuclear fuel generates a large amount of electricity.	☐
The radioactive waste produced must be stored for many years.	☐
Nuclear power stations do not depend on the weather to generate electricity.	☐

(1)
(Total 6 marks)

Q3.

Iceland is a country that generates most of its electricity using geothermal power stations and hydroelectric power stations.

(a) (i) Complete the following sentences to describe how some geothermal power stations work.

In regions where volcanoes are active, the ground is hot.

Cold ______________________ is pumped down into the ground

and is ______________________ by hot rocks.

It returns to the surface as steam. The steam is used to turn a turbine.

The turbine drives a ______________________ to produce electricity.

(3)

(ii) Which **one** of the following statements about geothermal power stations is true?

Tick (✓) **one** box.

Geothermal power stations use fossil fuels. ☐

Geothermal power stations produce carbon dioxide. ☐

Geothermal power stations provide a reliable source of electricity. ☐

(1)

(b) What is needed for a hydroelectric power station to be able to generate electricity?

Tick (✓) **one** box.

Falling water ☐

A long coastline ☐

Lots of sunny days ☐

(1)
(Total 5 marks)

Q4.

(a) Coal, gas, oil and wood are all examples of fuels.

(i) What are fuels?

____

(1)

(ii) Write the names of these fuels in the table below to show which are renewable and which are non-renewable.

RENEWABLE FUELS	NON-RENEWABLE FUELS

(2)

(b) The list below shows energy resources which are not fuels.

geothermal nuclear solar tides wind

Write the names of the energy resources in the table below to show which are renewable and which are non-renewable.

RENEWABLE FUELS	NON-RENEWABLE FUELS

(2)

(c) Why is it better to use more renewable energy resources rather than non-renewable resources?

___

___

___

___

(2)

(Total 7 marks)

Q5.

(a) Water waves are a renewable energy source.

The government wants more electricity to be generated from renewable energy sources. Some people do not think this is a good idea.

What reasons could a government scientist give to show people that using more renewable energy sources is a good idea.

___

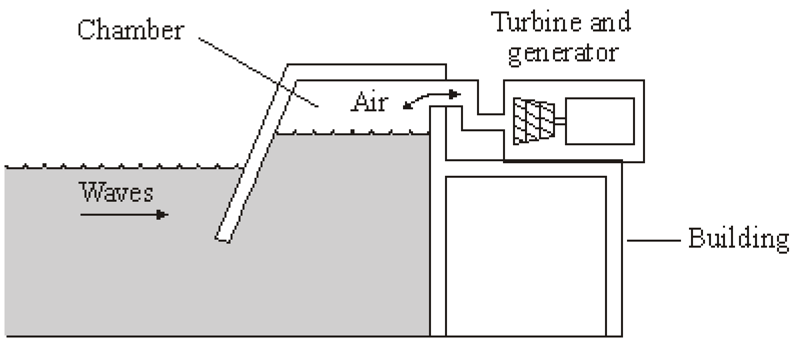
___

___

___

(2)

(b) The diagram shows a wave-powered generator. The generator transforms kinetic energy from the waves to electrical energy.



AQA GCSE SCIENCE CORE FOUNDATION STUDENT'S BOOK by Graham Hill, Nigel Heslop, Christine Woodward,Steve Witney and Toby Houghton. Published by Hodder and Stoughton 2006 © Reproduced by permission of John Murray (Publishers) Ltd

The following sentences describe how the wave generator works. The sentences are in the wrong order.

R Waves push air up and down a chamber inside the building.
S The turbine turns the generator.
T The generator transforms kinetic energy to electrical energy.
U The air rushes through a turbine making it spin.
V Strong waves move towards the wave-powered generator.

Arrange these sentences in the correct order. Start with letter **V**.

V → [ ] → [ ] → [ ] → [ ]

(3)
(Total 5 marks)

Q6.

A small community of people live in an area in the mountains.
The houses are not connected to the National Grid.

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

Figure 1 shows where these people live.

Figure 1

(b) **In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.**

Information about the two electricity generation systems is given in **Figure 2**.

Figure 2

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

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

Use your knowledge of energy sources as well as information from **Figure 2**.

(6)
(Total 7 marks)

___

___

Q7.

Electricity can be generated using various energy sources.

(a) Give **one** advantage and **one** disadvantage of using nuclear power stations rather than gas-fired power stations to generate electricity.

Advantage ___

___

Disadvantage ___

___

(2)

Energy transfer by heating

Energy transfer by conduction

Metals are the best conductors of metals.

Non –metals materials such as wool and fibre glass are the best insulators.

The energy transfer by conduction through a material depends on its thermal conductivity.

Materials that are good insulators are necessary to keep you warm in winter. Good insulators need to be materials that has low conductivity, so energy transfer as low as possible.

The energy transfer per second through a layer of insulating material depends on;

- The temperature difference across the material.
- The thickness of the material
- The thermal conductivity of the materials.

To reduce the energy transfer;

- The thermal conductivity of the insulating material should be as low as possible.
- The thickness of insulating layer should be a thick as it practically possible.

Conduction in metals

The electrons in a piece of metal can leave their atoms and move around in the metal as free electrons. The parts of the metal atoms left behind are positively charged metal ions.

The ions are packed closely together and they vibreate continually. The hotter the metal, the more kinetic energy these vibrations have. This kinetic energy is transferred from hot parts of the metal to cooler parts by the free electrons.

These move through thestructure of the metal, colliding with ions as they go.

Exam practice 9

1. The jug is made of plastic with a low thermal conductivity.

   Explain why this is an advantage.

   ____

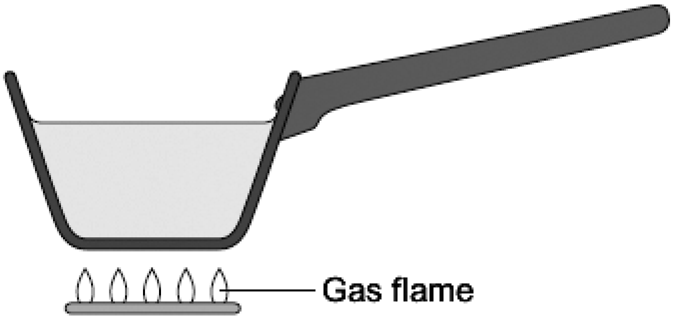
   ____

   ____

   ____

(2)

2. The diagram shows a metal pan being used to heat water.



Energy from the gas flame is transferred through the metal pan by conduction.

Explain the process of conduction through metals.

....

....

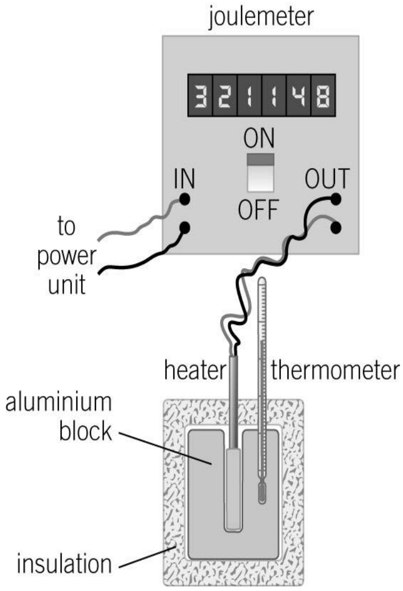
....

....

....

....

(4)
(Total 4 marks)



<u>**Specific heat capacity – Required practical**</u>

The **thermal (internal) energy store** in a system changes if its **temperature changes.**

When metal is heated in a furnace the **thermal energy store** increases. The amount of energy gained depends on the **mass** of the metal, how much the **temperature increases** and the **specific heat capacity** of the metal.

Specific Heat Capacity (*c*) – the amount of energy required to raise the temperature of 1 kg of a substance by one degree Celsius.

<u>Example Apparatus</u>

Joulemeter – measures energy

going into the heater in joules

Heater – heats the block

Insulation – stops heat escaping

into the atmosphere

Thermometer – measures the

temperature rise

The amount of energy stored in or released from a system as its temperature changes can be calculated using the equation:

Change in thermal energy (J) = Mass (kg) x Specific Heat Capacity J/kg°C x Temperature Change (°C)

$$\Delta E = m \times c \times \Delta\theta \qquad \text{rearrange to give} \qquad c = \Delta E / m \times \Delta\theta$$

Example

Example: When the heater was left on for 5 mins, the heater supplied 10 800 J of thermal energy to the aluminium block.

The temperature of the 2 kg block of aluminium rose by 6 °C.

c = 10 800 / 2 x 6   Specific heat capacity of aluminium = 900 J/kg °C

What you could be asked in the exam?

Why do you need to insulate the block (*to stop heat loss to the atmosphere*)

Why is your answer not the true value (*because not all the heat was transferred into the block and through to the thermometer*)

Why is the temperature increase slower at first? *(because it takes some time for the block to heat up and for the heat to reach the thermometer.)*

It may not be a block of metal. You could use a kettle to heat an amount of water or any other way of heating something.

What's the **resolution** of temperature measurements? This experiment could be repeated and you'd get slightly different readings. They could ask about **repeatability** and ask you to calculate the **mean** or the **uncertainty**.

Exam practice 10

Q1.

(e) Geothermal power stations pump water through heated rocks.

The temperature of the water increases from 20 °C to its boiling point of 100 °C

Calculate the change in thermal energy when the mass of water heated is 150 kg

Specific heat capacity = 4 200 J/kg °C

Use the Physics Equations Sheet.

____

____

____

Change in thermal energy = ______________________ J

(3)

(Total 8 marks)

Q2.

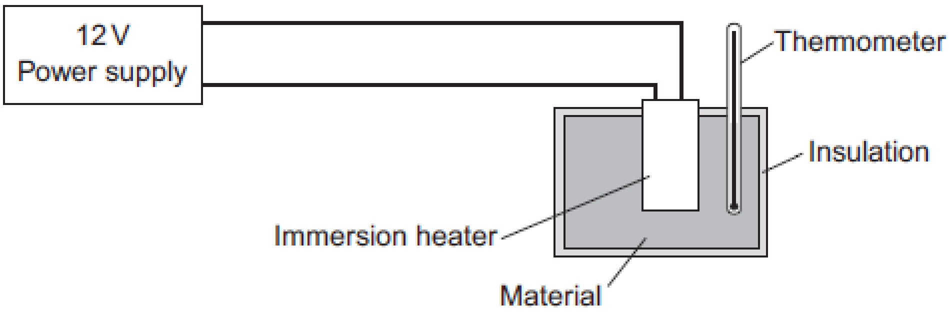
A student used the apparatus in **Figure 1** to compare the energy needed to heat blocks of different materials.

Each block had the same mass.

Each block had holes for the thermometer and the immersion heater.

Each block had a starting temperature of 20 °C.

Figure 1



The student measured the time taken to increase the temperature of each material by 5 °C.

(a) (i) State **two** variables the student controlled.

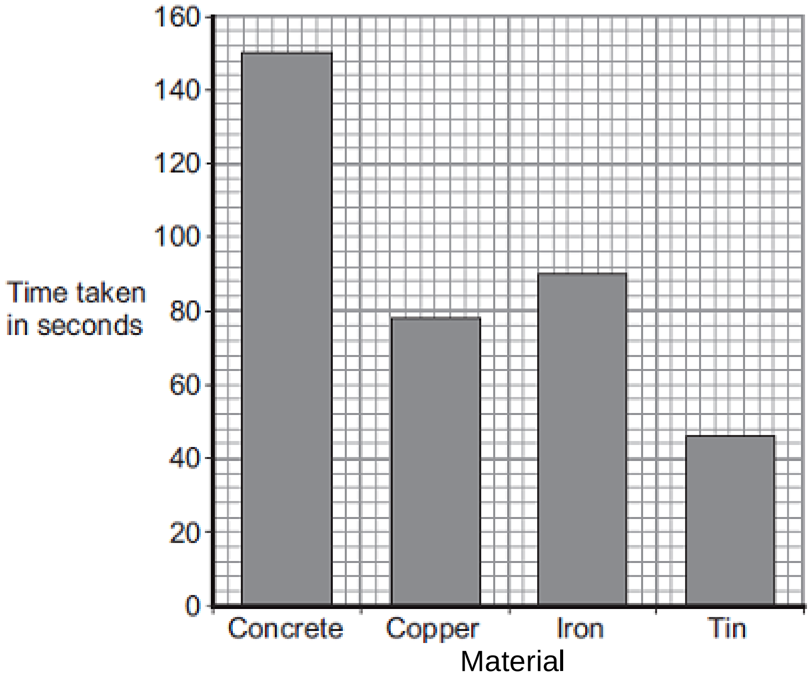
1. ____________________

2. ____________________

(2)

Figure 2 shows the student's results.

Figure 2



(ii) Why was a bar chart drawn rather than a line graph?

____

____

(1)

(iii) Which material was supplied with the most energy?

____

Give the reason for your answer.

(2)

(iv) The iron block had a mass of 2 kg.

Calculate the energy transferred by the heater to increase the temperature of the iron block by 5 °C.

The specific heat capacity of iron is 450 J / kg °C.

___

___

___

Energy transferred = ___ J

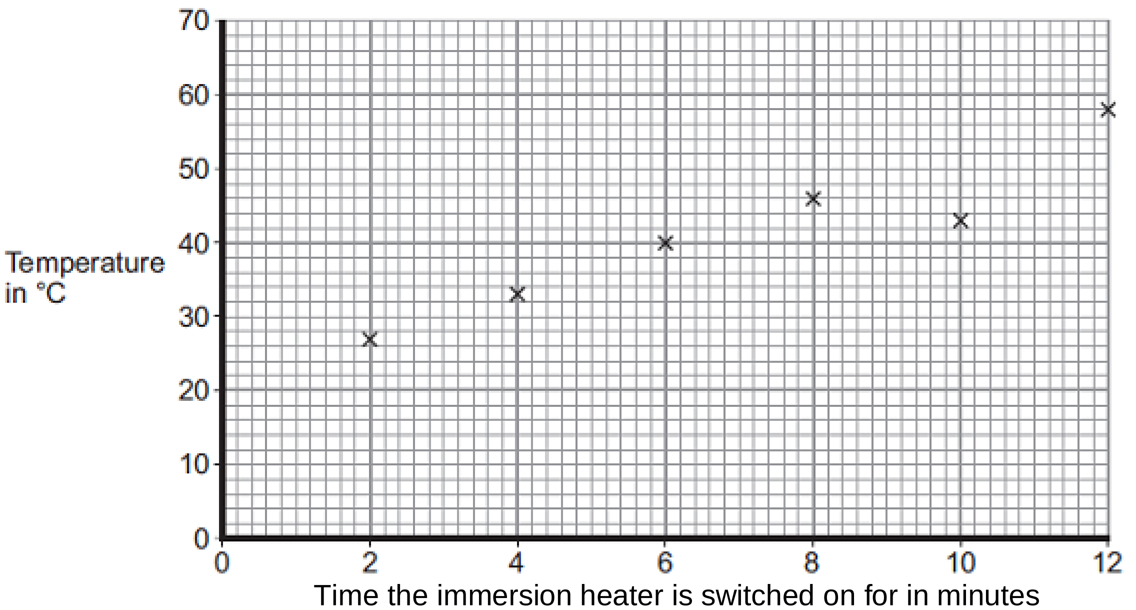
(2)

(b) The student used the same apparatus to heat a 1 kg block of aluminium.

He recorded the temperature of the block as it was heated from room temperature.

The results are shown in **Figure 3**.

Figure 3



(i) One of the student's results is anomalous.

Draw a ring around the anomalous result.

(1)

(ii) Draw the line of best fit for the points plotted in **Figure 3**.

(1)

(iii) What was the temperature of the room?

Temperature = _______________ °C

(1)

(iv) What was the interval of the time values used by the student?

Interval = _______________ minutes

(1)

(Total 11 marks)

Q3.

Figure 1 shows a student making potato soup.

Figure 1

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

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

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

Calculate the change in thermal energy of the potato.

Use the equation:

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

____

____

____

____

____

____

Change in thermal energy = ____________________ J

(3)

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

(1)

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

(1)

Figure 2 shows a food processor.

Figure 2

)

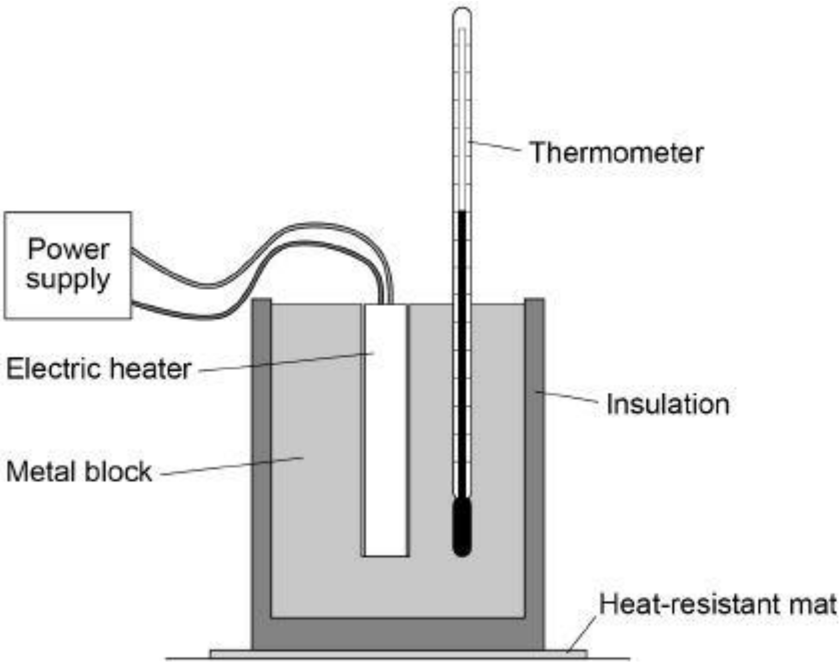
Q4.

A student investigated how the temperature of a metal block changed with time.

An electric heater was used to increase the temperature of the block.

The heater was placed in a hole drilled in the block as shown in **Figure 1**.

Figure 1



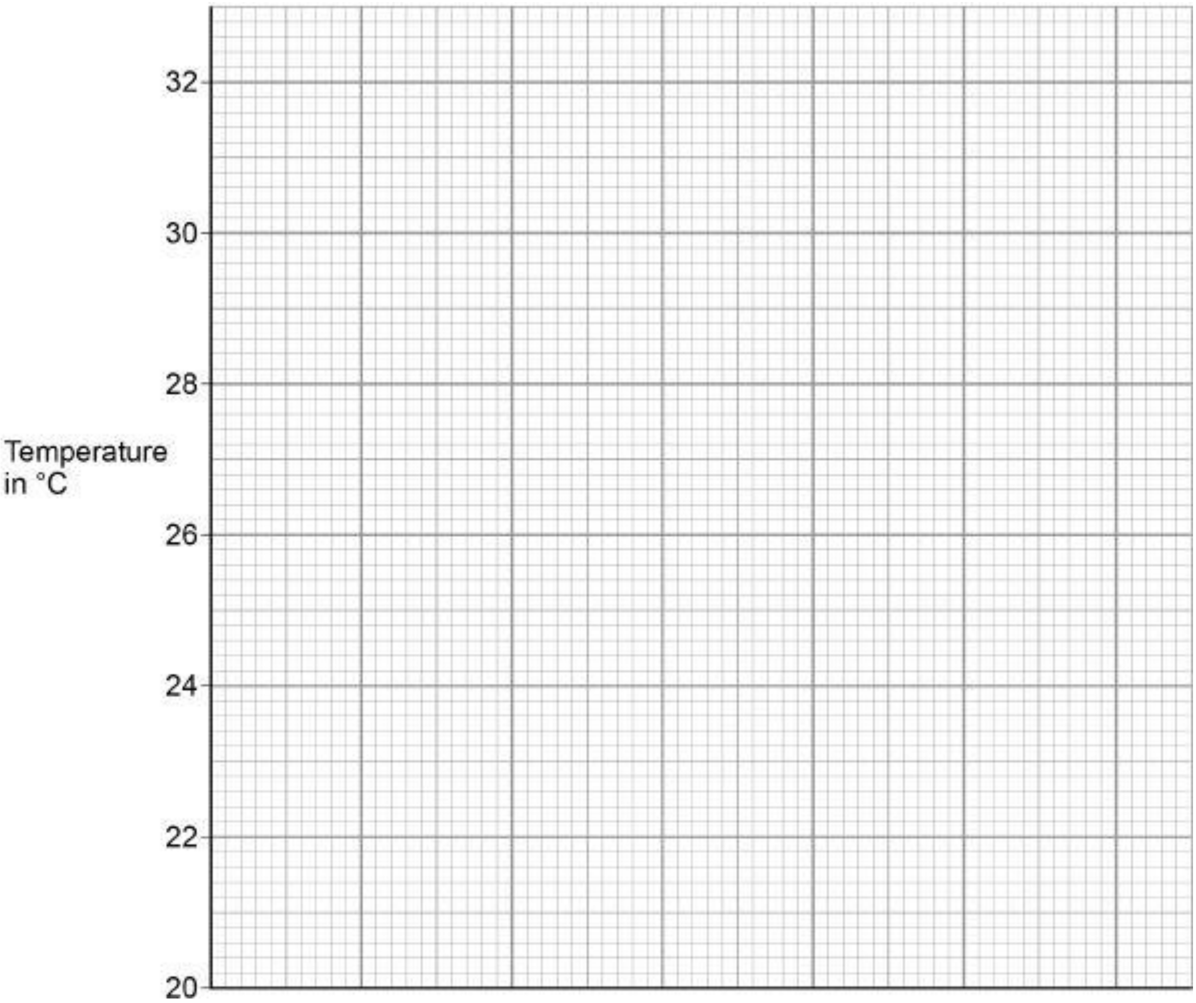
The student measured the temperature of the metal block every 60 seconds.
The table below shows the student's results.

Time in s	Temperature in °C
0	20.0
60	24.5
120	29.0
180	31.0
240	31.5

(a) Complete the graph of the data from the table above on the graph below.

- Choose a suitable scale for the x-axis.
- Label the x-axis.
- Plot the student's results.
- Draw a line of best fit.

Figure 2



(4)

(b) The rate of change of temperature of the block is given by the gradient of the graph.

Determine the gradient of the graph over the first 60 seconds.

___

___

___

___

Gradient = ____________

(2)

(c) The metal block had a mass of 1.50 kg

The specific heat capacity of the metal was 900 J/kg °C

Calculate the change in thermal energy of the metal during 240 seconds.

Use the Physics Equations Sheet.

Give your answer in kilojoules.

___

___

___

___

___

___

___

___

Change in thermal energy = ____________________ kJ

(4)

(d) Another student repeated the investigation.

Give **two** variables this student would need to control to be able to compare their results with the results in the table above.

1. ___

2. ___

(2)

(Total 12 marks)

Q5.

(b) The air in a room is at a temperature of 12 °C.

The house owner switches the heating on until the temperature reaches 22 °C. The amount of energy needed to raise the temperature of the air to 22 °C is 580 000 J.

The mass of air in the room is 58 kg.

Calculate the specific heat capacity of air and give the unit.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

___

___

Specific heat capacity = ____________

(3)

(Total 5 marks)

Heating and insulating

Thermal insulation is often used to reduce unwanted energy transfers.

All the **energy** used to **heat a home** is eventually **transferred** as **thermal energy** to the **surroundings**.

The diagram, shows the percentage energy lost through different parts of the building.

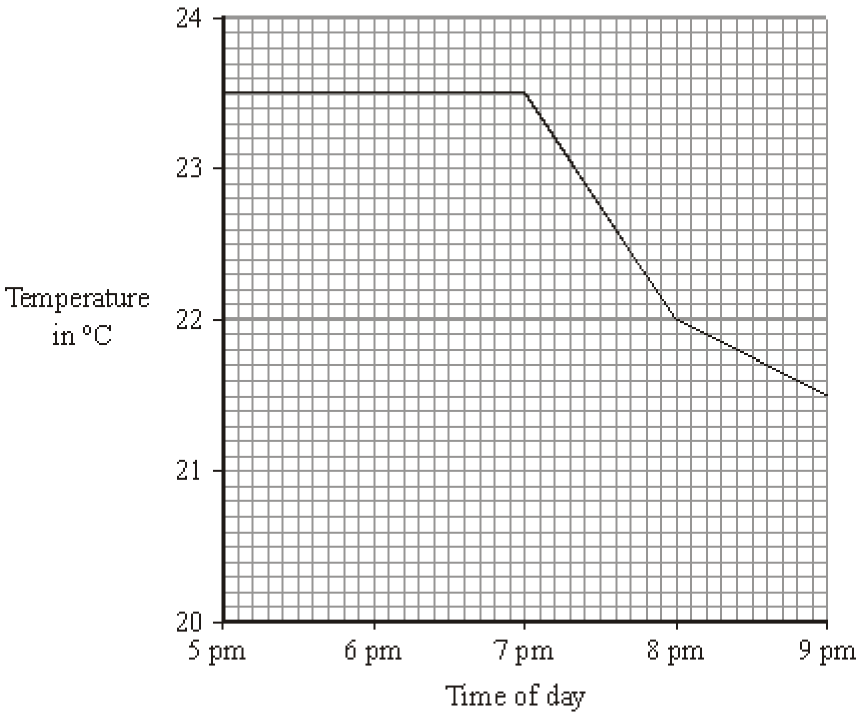
The higher the thermal conductivity, the quicker heat is transferred through the material.

Houses are often built from brick, concrete, wood and glass. All have quite **high thermal conductivity** values. **Insulation** uses materials with low thermal conductivity, such as fibreglass in the loft, foam in wall cavities and trapped gases in double glazing.

Exam practice 11

Q1.

(a) The graph shows the temperature inside a flat between 5 pm and 9 pm. The central heating was on at 5 pm.



(i) What time did the central heating switch off?

____

(1)

(ii) Closing the curtains reduces heat loss from the flat.

What time do you think the curtains were closed?

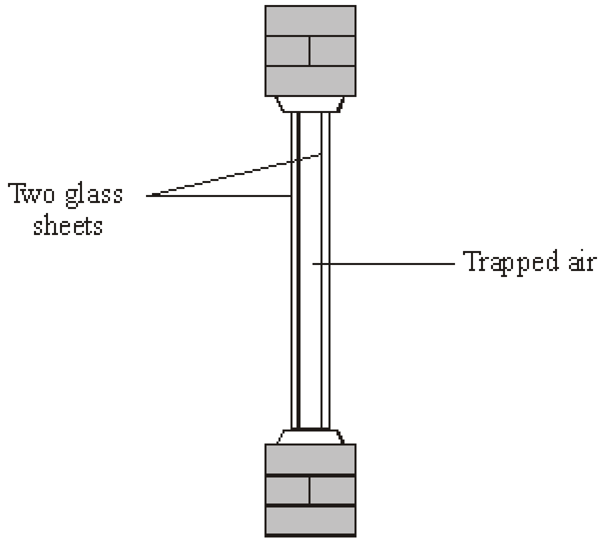
____

Give a reason for your answer.

____

(2)

(b) Less heat is lost through double-glazed windows than through single-glazed windows.



A double-glazed window

Complete the following sentences by choosing the correct words from the box. Each word may be used once or not at all.

conduction	**conductor**	**convection**	**evaporation**	**insulator**	**radiation**

Air is a good ____________________ . When trapped between two sheets of

glass it reduces heat loss by __________________ and ____________________

(3)

(c) The table gives information about three types of house insulation.

Type of insulation	Cost to install	Money save each year on heating bills	Payback time
Double glazing	£4000	£200	20 years
Loft insulation	£300	£100	3 years
Cavity wallinsulation	£600	£150	

(i) Use the information in the table to calculate the payback time for cavity wall insulation.

____

(1)

(ii) Explain why people often install loft insulation before installing double glazing or cavity wall insulation.

____

____

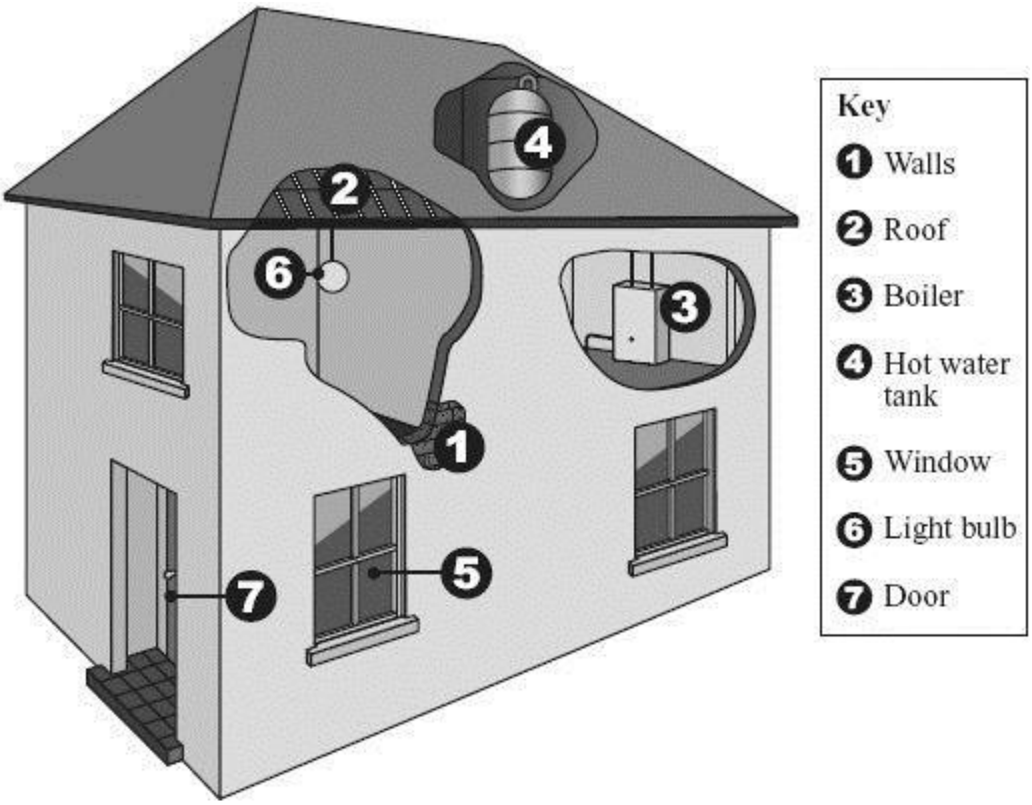
____

(2)

(Total 9 marks)

Q2.

The drawing shows parts of a house where it is possible to reduce the amount of energy lost.



(a) Give **one** way in which the amount of energy lost can be reduced from each of the following parts of the house.

1, **2** and **4** ______________________________

5 ______________________________

7 ______________________________

(3)

(b) Energy consumption can be reduced by using a more efficient boiler or more efficient light bulbs.

What is meant by a *more efficient* light bulb?

____

____

(1)

(Total 4 marks)

Q3.

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

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

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

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

____

____

____

____

____

____

(3)

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

____

____

____

____

(2)

(Total 5 marks)