PHYSICS

LONG ANSWER QUESTION PRACTICE

How to use this booklet

A selection of longer written questions have been selected from past GCSE papers for you to practice answering. You should revise the content first to ensure you have a good knowledge and then have a go at answering the questions. A model full mark answer has been provided at the end of the booklet for every question so you can compare you answer to see if there are any other details you could have included.

All the questions are challenging and are the equivalent of either the end of the foundation paper (level 2) or the end of the higher paper (level 3). They are however a good representation of what to expect in your exams.

The questions that are printed in bold font are from the triple science curriculum only.

Contents

6 Mark Questions

Energy

Energy Stores and Systems – Level 2 Question.

A student investigated the specific heat capacity of metals.

Describe an experiment the student could do to measure the specific heat capacity of a metal.

(6 marks)

HINTS and TIPS:

If a question asks you to "describe an experiment", they are asking you to write a method.

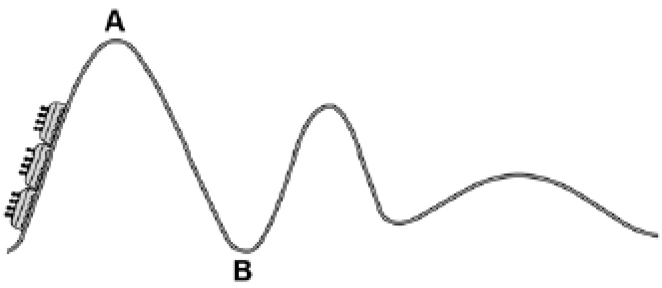
Think back to the required practical that you have done in your lessons and be specific about what you are measuring, are you measuring the mass or the volume? You cannot say the amount. You have to think about keywords and terms, is the energy transferred or is it conducted? What determines the speed at which the energy is transferred.

Remember to consider all aspects of the practical and think about the independent, dependent and controlled variables to get a valid result as well as how you are going to keep yourself safe.

You should always think about how you can make your results more accurate and how to improve the resolution.

Energy Stores and Systems – Level 3 Question.

The figure below shows a rollercoaster.



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

The mass of the rollercoaster is 600 kg.

Gravitational field strength = 9.8 N / kg.

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

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

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

(6 marks)

HINTS and TIPS:

Remember that as soon as you see a maths question that is worth 6 marks you are going to need to use at least two equations and maybe even convert units.

Circle any of the numbers that are in the question (using a different colour pen is a good idea) and use the units to work out what they are representing, such as distance, mass or time.

Think of an equation (or look one up on your equation sheet) that can link some of the numbers you are given in the question and the answer you are trying to calculate. Then think of a second equation that uses the other numbers you are given in the question to calculate the missing number that you need in your previous equation.

Conservation and Dissipation of Energy – Level 2 Question.

A householder wants to reduce her energy bills. She collected information about a number of ways of reducing energy used. The information is shown in the table.

Ways of reducing energy used	Cost to buy and install in £	Money saved per year in £
Install an energy-efficient boiler	2 000	320
Insulate the loft	400	200
Install double-glazed windows	12 000	120
Install cavity wall insulation	415	145

Use the information in the table to compare the different ways of reducing the energy used. Your answer should include some calculations.

(6 marks)

HINTS and TIPS:

Command word – Compare: This requires the student to describe the similarities and/or differences between things, not just write about one.

The question asks you to use the information in the table and to include some of your calculations. This means that writing down any calculations you make as part of your answer will score you marks.

Think about how long it will take you to payback the money spent on installing the home improvements and use this in your answer as well. Your answer may include the cost of the improvement and the saving in a year but the most important figure to include will be the payback time for each.

You should also think about stating which is the most cost-effective or gives the greatest energy saving per year, or even better, rank the four options based on your calculations.

Conservation and Dissipation of Energy – Level 3 Question.

The lunar rover used four electric motors connected in parallel to a 36 V battery.

The maximum output power of one motor was 190 W

The efficiency of each motor was 72%

Calculate the current drawn from the battery when all four motors were operating at maximum power.

(6 marks)

HINTS and TIPS:

Remember that as soon as you see a maths question that is worth 6 marks you are going to need to use at least two equations and maybe even convert units.

Circle any of the numbers that are in the question (using a different colour pen is a good idea) and use the units to work out what they are representing, such as distance, mass or time.

Think of an equation (or look one up on your equation sheet) that can link some of the numbers you are given in the question and the answer you are trying to calculate. Then think of a second equation that uses the other numbers you are given in the question to calculate the missing number that you need in your previous equation. The trickiest part of this question is realising that the power supplied by the battery is not given in the question and also to consider the fact that there are four motors connected to the battery.

National and Global Energy Resources – Level 2 Question.

A farmer plans to generate all the electricity needed on her farm, using either a biogas generator or a small wind turbine.

The biogas generator would burn methane gas. The methane gas would come from rotting the animal waste produced on the farm. When burnt, methane produces carbon dioxide.

The biogas generator would cost £18 000 to buy and install. The wind turbine would cost £25 000 to buy and install.

The average power output from the wind turbine would be the same as the continuous output from the biogas generator.

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

Conclude, with a reason, which system would be better for the farmer to buy and install.

(6 marks)

HINTS and TIPS:

Command word – Evaluate: Students should use the information supplied, as well as their knowledge and understanding, to consider evidence for and against when making a judgement.

To gain marks on this question you are going to need to discuss both the advantages and disadvantages of both methods of generating electricity. Think about whether or not they are renewable and whether or not they contribute gases which in turn contribute to global warming or are they carbon neutral? Be specific in terms of what is being produced or used and the effects that this can have.

Once you have compared the two methods you need to make a conclusion, say which you think is the best method for generating electricity, with reasons that are compared to the other method.

National and Global Energy Resources – Level 3 Question.

Describe, in as much detail as you can, how the energy stored in coal is transferred into electrical energy in a power station.

(5 marks)

HINTS and TIPS:

Command word – Describe: Students may be asked to recall some facts, events or process in an accurate way.

It is important to plan what you are going to write in response to this question as it looks very simple yet is worth 5 marks. Write your answer chronologically, starting with the energy that is stored in the coal and then work through each process stating the desired transfers of energy at each stage, until you are left with the electrical energy that is fed into the national grid.

Electricity

Level 2 Question.

Iceland is a country that generates nearly all of its electricity from renewable sources.

In 2013, about 80% of Iceland's electricity was generated using hydroelectric power stations (HEP).

Describe how electricity is generated in a hydroelectric power station. Include the useful energy transfers taking place.

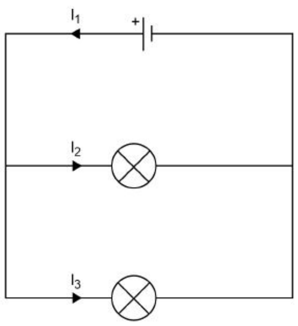
(4 marks)

HINTS and TIPS:

Command word – Describe: Students may be asked to recall some facts, events or process in an accurate way.

It is important to plan what you are going to write in response to this question as it looks very simple yet is worth 4 marks. Write your answer chronologically, starting with the energy that is stored in the water at a height and then work through each process stating the desired transfers of energy at each stage, until you are left with the electrical energy that is fed into the national grid.

Level 3 Questions.



1. Calculate the charge that flows through the cell in 1 minute.

   Each filament lamp has a power of 3 W and a resistance of 12 Ω

   Write any equations that you use.

   Give the unit.

(5 marks)

HINTS and TIPS:

Remember that as soon as you see a maths question that is worth 5 marks you are going to need to use at least two equations and maybe even convert units.

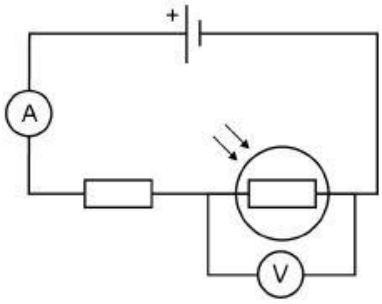
Circle any of the numbers that are in the question (using a different colour pen is a good idea) and use the units to work out what they are representing, such as distance, mass or time, remember you may need to convert some into the correct units, such as grams into kilograms.

Think of an equation (or look one up on your equation sheet) that can link some of the numbers you are given in the question and the answer you are trying to calculate. Then think of a second equation that uses the other numbers you are given in the question to calculate the missing number that you need in your previous equation. The trickiest part of this question is understanding how to rearrange the equation correctly so that you can calculate the first part of the answer.

2. The student builds a different circuit.

   Figure 3 shows the circuit.

Figure 3



Explain how the readings on both meters change when the environmental conditions change.

(6 marks)

HINTS and TIPS:

Command word – Explain: Students should make something clear, or state the reasons for something happening.

This is a difficult question to answer fully. Start by ensuring you know what each of the symbols are (you can even annotate them if you want). Once you are confident you know what each symbol is start with the LDR and then describe what can affect its resistance, and how the resistance and therefore the current are affected. You can then talk about how this affects the current in the circuit as a whole and thus what you would expect to see on the ammeter.

As the resistance of the resistor is fixed, this change in current will lead to a change in potential difference across the resistor which will then lead to a change in resistance across the LDR, which will b seen on the voltmeter.

Particle Model of Matter

Level 2 Question.

The information in the box is about the properties of solids and gases.

Solids:
- have a fixed shape
- are difficult to compress (to squash).

Gases:
- will spread and fill the entire container
- are easy to compress (to squash).

Use your knowledge of kinetic theory to explain the information given in the box.

You should consider:
- the spacing between the particles
- the movement of individual particles
- the forces between the particles.

(6 marks)

HINTS and TIPS:

This question requires you to link the knowledge that you have gained in year 10 to the understanding of properties of solids and liquids you covered in year 7. The question tells you the properties of solids and gases, what you need to do is explain, using your knowledge of kinetic (particle) theory, how these properties are caused. Make sure you consider each of the three bullet points you are given.

Level 3 Question.

An athlete runs in a marathon race. As he runs, his body gets hotter.

His body produces sweat to help him cool down.

Explain in terms of particles, how sweating helps the athlete to cool down.

(4 marks)

HINTS and TIPS:

Command word – Explain: Students should make something clear, or state the reasons for something happening.

The question asks you to answer in terms of particles and you must ensure that you answer this as a physics question rather than a biology question. Think about the transfers of energy between the body and the particles in the sweat and what this causes the particles to do. Once you have thought about this think about what will happen to the liquid and the body as a whole.

Atomic Structure and Radiation

Level 2 Question.

Ionising radiation can be used to treat patients in hospital.

People working in hospitals must limit their exposure to ionising radiation.

Explain how the use of ionising radiation in hospitals can be both useful **and** harmful.

(6 marks)

HINTS and TIPS:

Command word – Explain: Students should make something clear, or state the reasons for something happening.

To answer this question fully you need to ensure that you understand which types of radiation in a hospital and what it is used for and why it is used in these cases. Write a suitable answer including where the radiation is used and why it is used for this. You also need to make sure that you include any dangers of the radiation.

Level 3 Question.

Explain how ionising radiation can have hazardous effects on the human body.

(5 marks)

HINTS and TIPS:

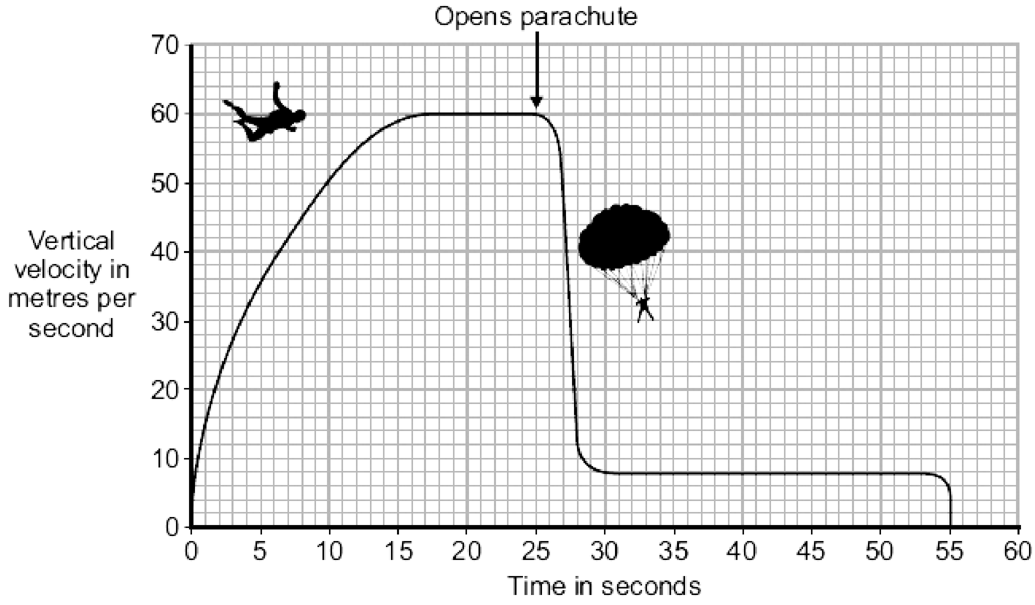
Command word – Explain: Students should make something clear, or state the reasons for something happening.

As with many of these questions it is worth working through the series of events chronologically starting with the fact that ionising radiation turns atoms into ions and ending with the fact that it causes cancer. Unusually for a long answer question in science this is not marked in levels, it is simply one mark for each correct point that you include.

Forces

Forces and their Interactions – Level 2 Question.

The graph shows how the vertical velocity of a parachutist changes from the moment the parachutist jumps from the aircraft until landing on the ground.



Using the idea of forces, explain why the parachutist reaches a terminal velocity and why opening the parachute reduces the terminal velocity.

(6marks)

HINTS and TIPS:

To get full marks you need to split your answer into two parts, the first explaining why and how the parachutist reaches terminal velocity for a first time, the second explaining why and how the parachutist reaches terminal velocity for a second time.

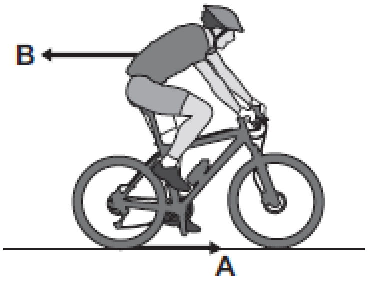
Think about forces that are acting on the vertical, which is larger, in which direction the resultant force acts and therefore the effect that this will have on the parachutist. Make sure that you think about how these forces change as the speed of the parachutist alters and the effects that this can have on them.

Re-cover all of this information, this time after the parachute has been opened to ensure that you get all of the possible available marks.

Forces and Motion – Level 2 Question.

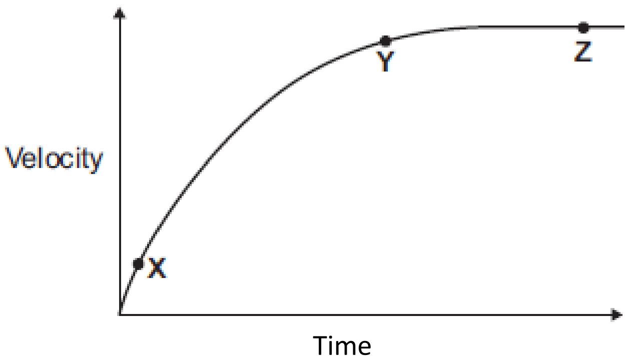
Figure 1 shows the horizontal forces acting on a moving bicycle and cyclist.

Figure 1



2 shows how the velocity of the cyclist changes during the first part of a journey along a straight and level road. During this part of the journey the force applied by the cyclist to the bicycle pedals is constant.

Figure 2



Describe how **and** explain, in terms of the forces **A** and **B**, why the velocity of the cyclist changes:

- between the points **X** and **Y**
- and between the points **Y** and **Z**, marked on the graph in **Figure 2**.

(6 marks)

HINTS and TIPS:

To get full marks you need to split your answer into two parts, the first explaining what and why is happening between X and Y and then the same again between Y and Z. Think carefully about what is being represented by the graph by checking the axis and then interpreting how, or if, the cyclist's motion is altering.

Think about the horizontal forces that are acting on the cyclist, which is larger, in which direction the resultant force acts and therefore the effect that this will have on the cyclist. Make sure that you think about how these forces change as the speed of the cyclist alters and the effects that this can have on them.

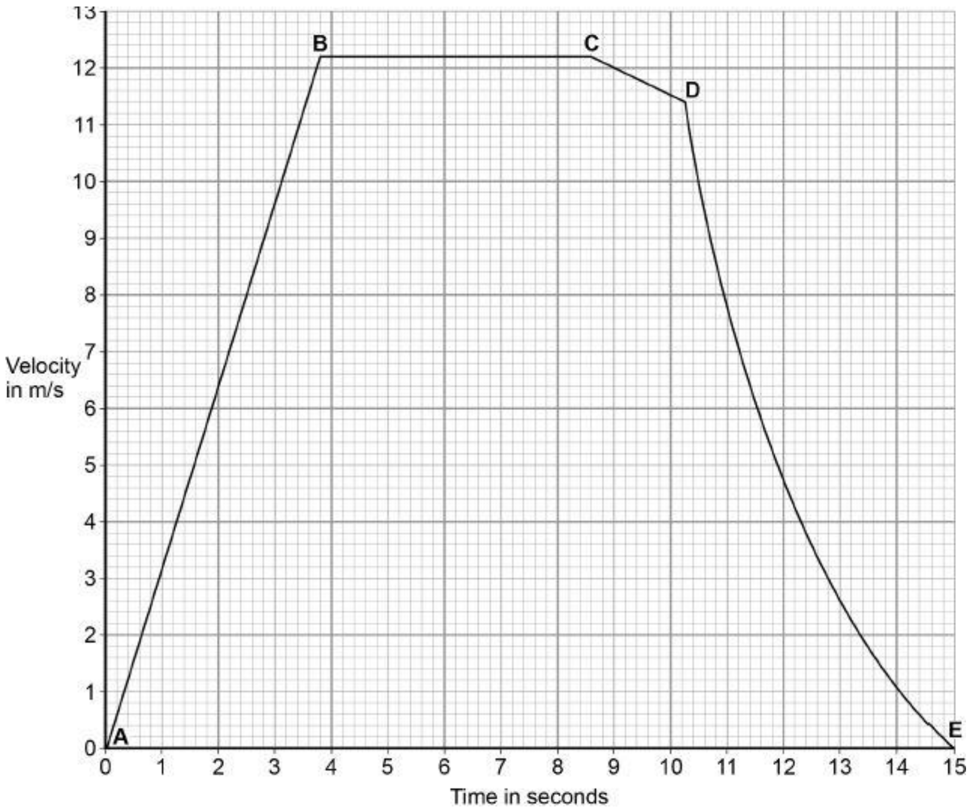
Re-cover all of this information, this time for between Y and Z to ensure that you get all of the possible available marks.

Forces and Motion – Level 3 Question.

An athlete takes part in a race on a straight, horizontal running track.

Figure 1 shows the velocity-time graph for the athlete during the race.

Figure 1



The acceleration is **not** constant from **D** to **E**.

Determine the acceleration at a time of 12.0 s

Use **Figure 1**.

Give the unit.

(5 marks)

HINTS and TIPS:

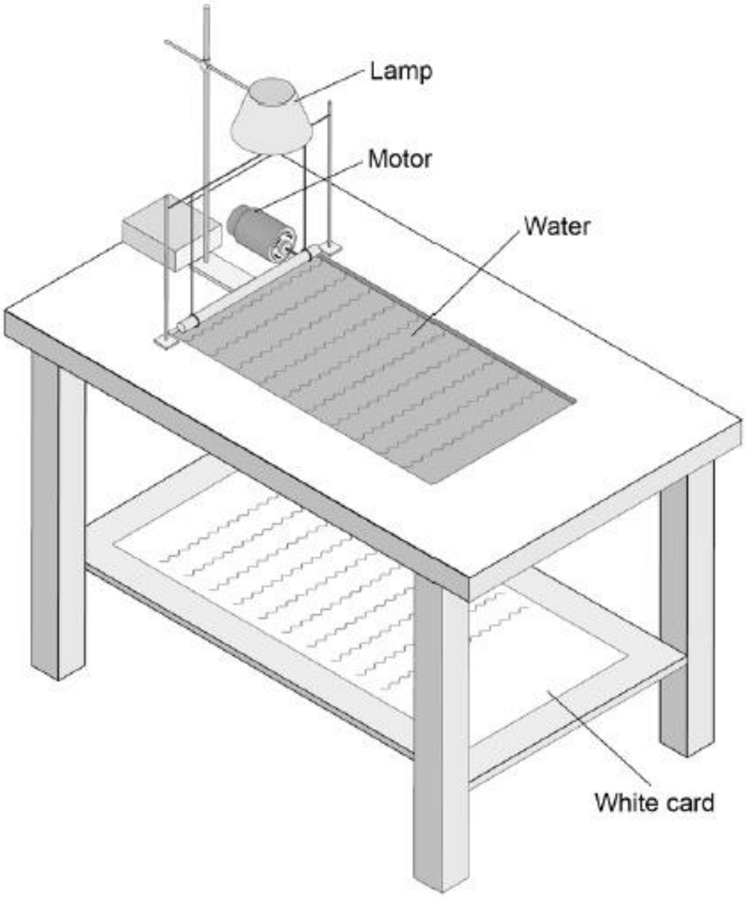
Command word – Determine: Use given data or information to obtain and answer.

You know that the acceleration is not constant between D and E for two reasons; it tells you in the question, and, the line on the graph is not straight. To determine the acceleration at a certain point you are going to need to use your maths skills, this will include drawing a tangent and using this to gain representative figures of the change in velocity and the change in time. Once you have these figures you can use basic maths and the equation linking acceleration, changing velocity and time to calculate the acceleration of the object.

Wave Properties

Level 2 Question.

The diagram shows a ripple tank.



Explain how a student could make appropriate measurements and use them to determine the wavelength of the waves in the ripple tank.

(6 marks)

HINTS and TIPS:

Command word – Explain: Students should make something clear, or state the reasons for something happening.

In this question you are being asked how to fine out the wavelength of the wave from the equipment above. The first thing you need to do is remember how to calculate the wavelength of a wave and therefore what variables you need to find. As you know that $v=\lambda f$, you therefore need to find out what the frequency of the wave is and the speed of the wave.

You should then include a description of how to find out the frequency and speed of the wave, stating any extra equipment and calculations needed, before describing, with calculations, how to calculate the speed at which the wave is travelling.

Level 3 Question.

Another student uses a ripple tank where all the water is the same depth.

She measures the wavelength of each wave as 0.34 m.

The period of each wave is 0.42 s.

Calculate the speed of the wave.

Use the correct equation from the Physics Equation Sheet.

Give the unit.

Give your answer to three significant figures.

(5 marks)

HINTS and TIPS:

Command word – Calculate: Students should use numbers given in the question to work out the answer.

This question is worth five marks but the answer is only worth three! You are told in the questions that you get a mark for giving the unit and for giving your answer correctly rounded to three significant figures.

Circle any of the numbers that are in the question (using a different colour pen is a good idea) and use the units to work out what they are representing, such as distance, mass or time.

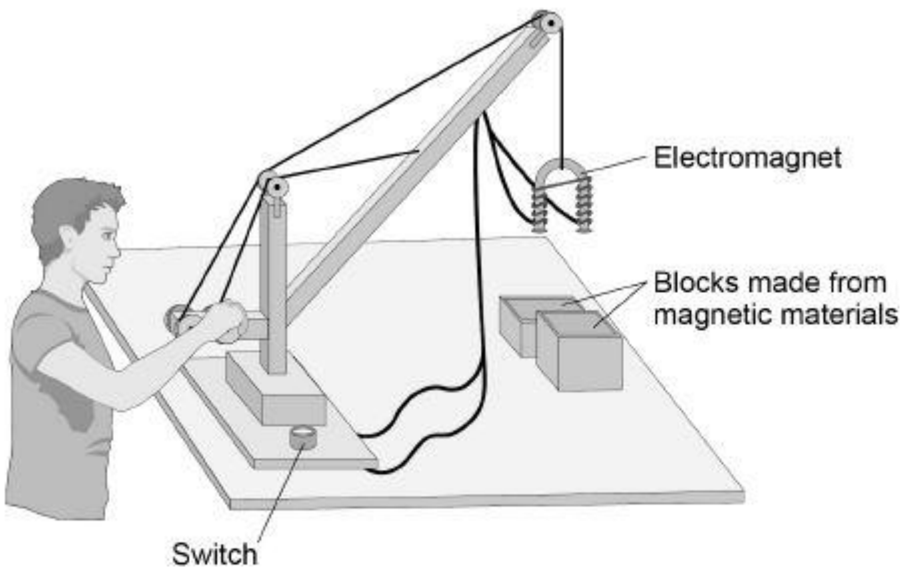
Think of an equation (or look one up on your equation sheet) that can link some of the numbers you are given in the question and the answer you are trying to calculate, so what equations do you know that have wave speed in them as well as either wavelength or time period? Then think of a second equation that uses the other numbers you are given in the question to calculate the missing number that you need in your previous equation. From this point it is simply a matter of substituting the numbers into the equation and then carrying out any rearrangements necessary.

Magnetism

Level 2 Question.

Figure 2 shows a toy crane.

Figure 2



The toy crane uses an electromagnet to pick up and move the blocks.

Explain how this electromagnet is able to pick up and move the blocks.

(6 marks)

HINTS and TIPS:

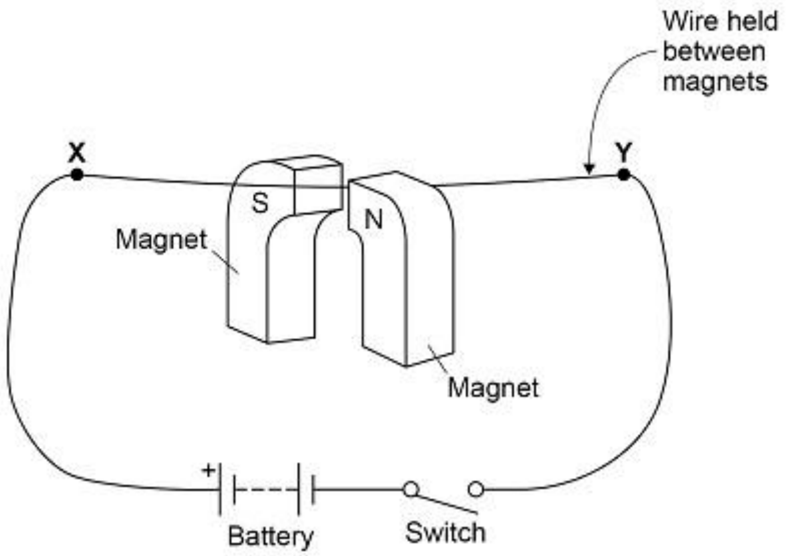
Command word – Explain: Students should make something clear, or state the reasons for something happening.

This is quite a tricky question as the examiners are asking for more detail than you might expect. You are expected to include how the electromagnet works in your answer so it is easiest to work chronologically. Start from the switch being turned on and then link this to the idea that the circuit is completed and then include what happens to result in the electromagnet being turned on. At this point you can start to discuss how the crane can move the blocks and finally reverse the process that you have just described to release the blocks from the electromagnet.

It is really important that you understand what it means by the phrase “magnetic materials” and the difference between these and magnets as obviously these will behave in different ways under and electromagnet.

Level 3 Question.

The figure below shows the apparatus used.



Electric motors use the motor effect.

Energy is supplied to the electric motor by a battery.

The battery is charged using a charger.

When the charger is connected to the battery, the potential difference across the battery is 15.0 V

The total energy stored when the battery is fully charged is 0.81 MJ

The average current used to charge the battery is 3.00 A

Calculate the time taken to fully charge the battery.

(6 marks)

HINTS and TIPS:

Command word – Calculate: Students should use numbers given in the question to work out the answer.

Circle any of the numbers that are in the question (using a different colour pen is a good idea) and use the units to work out what they are representing, such as distance, mass or time. Remember to convert any units into the standard units if required.

Think of an equation (or look one up on your equation sheet) that can link some of the numbers you are given in the question and the answer you are trying to calculate, so what equations do you know that have time in them as well as either current, energy or potential difference? Then think of a second equation that uses the other numbers you are given in the question to calculate the missing number that you need in your previous equation. From this point it is simply a matter of substituting the numbers into the equation and then carrying out any rearrangements necessary.

MODEL ANSWERS

Energy

Energy Stores and Systems – Level 2 Question.

The student should measure the mass of the piece of metal using a balance and record this in a table. They should then use an immersion heater attached to a joulemeter to heat the metal block. The student would then record the starting temperature of the metal and record this in a table before turning on the heater for a set amount of time. Once the time is up the energy transferred can be recorded and the final temperature also added to the table. Using the final and initial temperatures the student can calculate the temperature change. Now the student can calculate the specific heat capacity by using this equation:

$$Specific\ heat\ capacity = \frac{Energy\ Transferred\ (J)}{Mass\ (kg) \times Temperature\ change\ (\ ^oC)}$$

To improve the accuracy of the results the student should insulate the metal block to reduce energy transfers to the surroundings.

(6 marks)

Energy Stores and Systems – Level 3 Question.

As

$$E_G = E_k$$

$$mgh = \frac{1}{2}mv^2$$

$$600 \times 9.8 \times 35 = \frac{1}{2} \times 600 \times v^2$$

$$205{,}800 = 300v^2$$

$$\frac{205{,}800}{300} = v^2$$

$$686 = v^2$$

$$\sqrt{686} = v$$

$$v = 26.2 m/s$$

(6 marks)

Conservation and Dissipation of Energy – Level 2 Question.

Payback times

Energy efficient boiler	=	$\frac{2000}{320}$	= 6¼ years
Loft insulation	=	$\frac{400}{200}$	= 2 years
Install double-glazing	=	$\frac{12000}{120}$	= 100 years
Cavity wall insulation	=	$\frac{415}{145}$	= 2.86 years.

The <u>data</u> from the table indicates that the <u>most cost-effective</u> home improvement would be the loft insulation followed by the cavity wall insulation, an energy efficient boiler and then double glazing. The best for <u>reducing energy</u> use is the boiler, followed by the loft insulation, cavity wall insulation and then double glazing. <u>Overall</u>, I would definitely <u>not choose</u> the double glazing as this has the least impact on energy usage and it is not possible to pay it back in a life time. I <u>would choose</u> the loft insulation as it is the quickest to payback and the second best in terms of energy reduction.

(6 marks)

Conservation and Dissipation of Energy – Level 3 Question.

$$\% \text{ efficiency} = \frac{\text{useful power output}}{\text{total power input}} \times 100$$

$$72 = \frac{190}{P_{input}} \times 100$$

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

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

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

$$P_{input} = 263.89\,W$$

$$\text{Power} = \text{Current} \times \text{Potential difference}$$

$$263.89 = I \times 36$$

$$\frac{263.89}{36} = I$$

$$I = 7.33 \text{ (for 1 motor)}$$

$$I = 7.33 \times 4$$

$$I = 29.3A \text{ (for 4 motors)}$$

(6 marks)

National and Global Energy Resources – Level 2 Question.

Both wind turbines and biogas generators are a renewable energy resource that are free. Unlike wind turbines, biogas is a reliable energy resource that does not depend on the weather and is a concentrated source of energy, meaning there will always be enough energy for the farm. Wind turbines expensive to install with a long payback time but they do not produce any carbon dioxide and therefore don't contribute to global warming.

I would choose to install the biogas generator as not only is the resource free, it is also using a waste product from the farm. It is a reliable resource meaning that there will always be energy on the farm and it is carbon neutral as the carbon dioxide emitted comes from the plant material that had previously locked the carbon from the atmosphere.

(6 marks)

National and Global Energy Resources – Level 3 Question.

Coal is a store of chemical energy which when burnt is transferred into thermal energy, this is used to heat the water which in turn boils and turns into steam. The steam then turns the turbines, increasing their kinetic energy store. These turbines then turn the generator which converts the kinetic energy into electrical energy. This is then transferred using the national grid.

(5 marks)

Electricity

Level 2 Question.

Water is stored in a reservoir at a higher level meaning it has a greater store of gravitational potential energy. This water is released and the gravitational potential energy is transferred to kinetic energy as it started to move. This turns the turbine, meaning that the turbine now has kinetic energy, which in turn turns the generator that can then transfer the kinetic energy to electrical energy.

(4 marks)

Level 3 Questions.

1.

$P = I^2 R$

$3 = I^2 \times 12$

$\frac{3}{12} = I^2$

$I^2 = 0.25$

$I = \sqrt{0.25}$

$I = 0.5A$

$Q = It \qquad t = 1min = 60s.$

$Q = 0.5 \times 60$

$Q = 30C$ (per bulb)

$Q = 30 \times 2$

$Q = 60C$ (total).

(5 marks)

2. The symbol shows an LDR, which has varying resistance depending upon the light levels. As the light level increases the resistance decreases, so on a brighter day the current in the circuit will increase, this would be shown on the ammeter.

As the resistance in the resistor is fixed, and because we know V=IR, when the current increases, the potential difference across it will also increase. The potential difference in a series circuit is shared across the components and therefore as the potential difference across the fixed resistor increases, the potential difference across the LDR will decrease, this will be seen on the voltmeter.

As the daylight is more intense, the resistance of the LDR will be reduced further meaning it has a smaller share of the potential difference.

(6 marks)

Particle Model of Matter

Level 2 Question.

The particles in a solid are close together with little room between them, meaning they are hard to compress. There are strong forces of attraction holding the particles together meaning that their shape is fixed. Although this is the case, the particles of a solid do vibrate around a fixed position.

The particles in a gas are far apart and randomly arranged. This space between the particles means they are easy to compress. The lack of attractive forces between the particles means they are freely moving and spread out. A gas will therefore fill the container it is in.

(6 marks)

Level 3 Question.

The sweat is secreted onto the athlete's skin. Thermal energy from the skin is then transferred into the particles of the liquid sweat where it is transferred to the kinetic store meaning the particles of the liquid move more due to their gain in energy. Those particles which has the greatest energy will evaporate and leave the surface of the body. This means that the particles of sweat that are left behind with have a lower average amount of energy meaning that the temperature of the body will reduce.

(4 marks)

Atomic Structure and Radiation

Level 2 Question.

Ionising radiation can cause the mutation in the DNA of cells causing them to grow uncontrollably, leading to cancer. The people working in hospitals will be subjected to an increased dose due to their regular exposure.

Although this is true, ionising radiation may be used for diagnosis in hospitals in CT scans or X-rays. It may also be used to treat cancer in radiotherapy and for the low temperature sterilization of theatre instruments.

(6 marks)

Level 3 Question.

As the name suggests, ionising radiation can cause the atoms within our bodies to turn into ions, these ions can then break up molecules in our cells, including DNA. This causes damage to the DNA which can lead to cells growing uncontrollably and eventually on to cancer.

(5 marks)

Forces

Forces and their Interactions – Level 2 Question.

As the parachutist jumps out of the plane, the two forces acting on them are gravity and air resistance. At this time, gravity is much the large force, meaning that the forces are unbalanced and the parachutist will accelerate towards the ground.

As the parachutist's speed increases, they collide with more particles in the air, meaning their air resistance increases. Eventually the forces due to air resistance equals the force due to gravity. At this point the two forces are balanced the parachutist continues as they were, they have reached terminal velocity.

When the parachute is opened, the parachutists surface area is increased, meaning they collide with more particles and so air resistance increases. At this point, the air resistance is larger than the force due to gravity meaning that the forces are unbalanced and therefore the parachutist begins to decelerate.

As the parachutist slows down, they collide with few particles in the air, meaning that air resistance reduces. This continues until the air resistance and the gravity equal out again, meaning the forces are once again balanced. At this point the parachutist will continue at a new, lower terminal velocity.

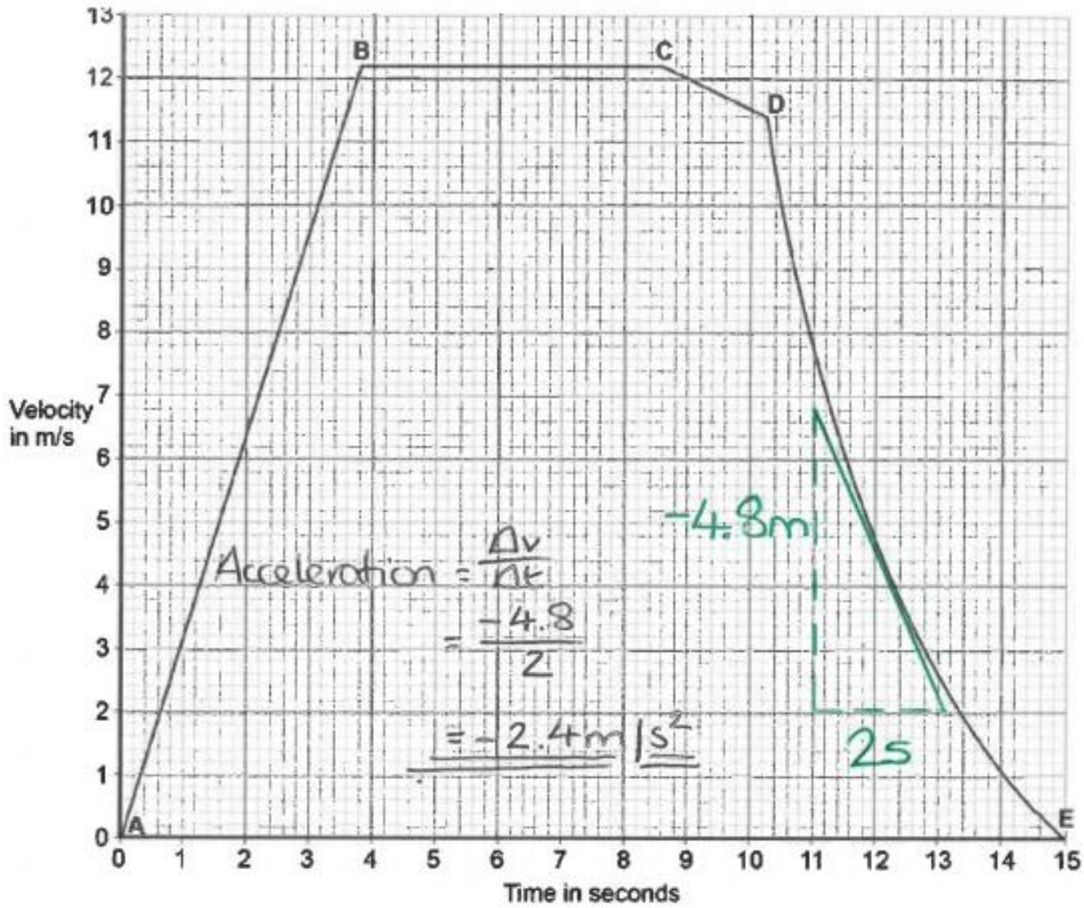
(6marks)

Forces and Motion – Level 2 Question.

When the cyclist first sets out at X, the forward force, A, is much larger than the resistive force, B. This means that the forces are unbalanced, the cyclist will accelerate and so their velocity increases. At Y the cyclist's speed has increased, meaning they collide with more particles in the air and thus their air resistance increases. This means that the resultant force forward is smaller, and so although the cyclist continues to accelerate to the right, they do so at a smaller rate. By the time the cyclist gets to point Y the forces due to air resistance, B equals force A. At this point the two forces are balanced the cyclist continues as they were, they have reached terminal velocity, or full speed.

(6 marks)

Forces and Motion – Level 3 Question.



(5 marks)

Wave Properties

Level 2 Question.

In order to calculate the properties of a wave the student would need a stop clock and a metre ruler as well as the ripple tank.

To find the frequency the student could count the number of waves that pass a point in set amount of time. The frequency can then be calculated using the equation;

$$frequency = \frac{no. of\ waves}{total\ time\ for\ waves\ to\ pass}$$

To find the wavelength of the wave the student should use the meter rule to measure the length of 10 waves. You can then find the average length on one wave by using the equation;

$$wavelength = \frac{length\ of\ 10\ waves}{10}$$

To calculate the wavelength the student should use the frequency and the wavelength values previously calculate and use the equation;

$$v = f\lambda$$

(6 marks)

Level 3 Question.

Time period = $\frac{1}{\text{frequency}}$

$0.42 = \frac{1}{f}$

$f = \frac{1}{0.42}$

$f = 2.38\text{Hz}$

wavespeed = frequency × wavelength

$v = 2.38 \times 0.34$

$v = 0.809\text{m/s}$

(5 marks)

Magnetism

Level 2 Question.

When the child turns on the switch, the circuit is completed meaning that the current flows, inducing a magnetic field around the solenoid leading to an magnetic field being induced in the iron core and thus the electromagnet is turned on.

As the electromagnet is lowered towards the iron blocks, they are attracted to the magnet meaning that as the crane moves the blocks are also moved. Switching off the current reverses the above process meaning that the electromagnet is turned off and thus the blocks are released.

(6 marks)

Level 3 Question.

$P = IV$

$P = 3 \times 15$

$P = 45W$

$0.81MJ = 810{,}000J$

$E = Pt$

$810{,}000 = 45 \times t$

$\frac{810{,}000}{45} = t$

$t = 18{,}000s$

(6 marks)

MARK SCHEMES

Energy

Energy Stores and Systems – Level 2 Question.

Level 3 (5–6 marks):

A full, detailed and coherent plan covering all the major steps is provided, which outlines what needs to be measured to calculate specific heat capacity. The steps are set out in a logical manner that could be followed by another person to calculate the specific heat capacity.

Level 2 (3–4 marks):

The substantive content of a plan is present but may be missing some steps. The plan may not be in a completely logical sequence but leads towards the calculation of the specific heat capacity.

Level 1 (1–2 marks):

Simple statements relating to relevant apparatus or steps are made but they may not be in a logical order. The plan would not allow another person to calculate specific heat capacity.

0 marks:

No relevant content.

Indicative content

- measure the mass of metal
- correct use of balance
- description of how work is done or energy transferred to metal

eg electrical work, mechanical work (eg dropping lead shot)

- how energy transfer or work done is measured

eg electrical using joulemeter, mechanical decrease in potential energy store of falling lead shot

- equate work done / energy transferred = increase in thermal energy store of the metal
- calculate specific heat capacity

6

Energy Stores and Systems – Level 3 Question.

gpe = 600 × 9.8 × 35

1

= 205 800

1

gpe = KE = ½ m v^2

1

$v = \sqrt{\frac{2 \times kE}{m}}$

1

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

1

= 26.2 (m / s)

*allow 26.2 with no working shown for **6** marks*

1

Conservation and Dissipation of Energy – Level 2 Question.

0 marks
No relevant information

Level 1 (1-2 marks)
There is a relevant statement about an energy saving method

Level 2 (3-4 marks)
There is at least one clear comparison of energy saving methods and their cost effectiveness with an appropriate calculation

Level 3 (5-6 marks)
There is a comparison of energy saving methods and their cost effectiveness with appropriate calculations. Comparison to include further detail.

examples of physics points made in the response

examples of relevant statements

- energy efficient boiler saves the most (energy / money) per year
- loft insulation costs the least to install
- double-glazing costs the most to install

examples of statements that include cost effectiveness

- loft insulation is the most cost effective in the long term
- double-glazing is the least cost effective

- loft insulation has the shortest payback time
- double-glazing has the longest payback time
- payback time calculated for any method

payback times:

energy efficient boiler: 6.25 years

loft insulation: 2 years

double glazing: 100 years

cavity wall insulation: 2.86 years

examples of further detail

- for cost effectiveness install in the following order: loft, cavity wall, boiler, double-glazing
- for reducing energy use install in the following order: boiler, loft, cavity wall, double glazing
- don't install double-glazing for insulation purposes
- double-glazing won't pay for itself in your lifetime
- justified choice of best / worst method

6

Examiners comments - A number of students simply quoted the information from the table and included no new relevant information and so gained no credit for their answer. A few actually ignored the numerical data in the table and simply extolled the virtues of loft insulation or explained how double-glazing was able to insulate the house.

Some did go on to identify that loft insulation was the cheapest to install or that fitting an energy-efficient boiler gave the most money saved per year.

Calculations were presented by many students but the main difficulty was explaining the significance of these using clear statements. Few answers went further than calculating the four payback times (often inaccurately).

The least able calculated other sums of money because they misunderstood what was required e.g. multiplying the cost of installation by the annual saving. Some confused the amount saved as being the amount per month that had to be paid. Others thought that a really long pay-back time was a good idea because it gave you a long time to pay back the money.

Many answers failed to make any comparisons between the four options, even though there may have been payback times calculated. Terms such as 'cost effective' were not used by many students and payback time was often inadequately described.

Students needed to complete a calculation to be considered a Level 2 response, payback time or cost effectiveness over a period of time were commonly seen. Students also needed to make a clear comparison to gain 3 or 4 marks, perhaps referring to cost effectiveness or payback time.

For a Level 3 response a minimum of 2 calculations were needed and some further detail (in addition to the Level 2 comparison). Statements referring to the fact that loft insulation would not pay for itself in your lifetime or a ranking of the installation order were needed also. The mark scheme list possible responses but it is not an exhaustive list. Students who discussed the relative insulating properties of the methods gained no credit, but these responses were treated as neutral and ignored. The best answers were those that came to some conclusion about the relative merits of the four methods.

Conservation and Dissipation of Energy – Level 3 Question.

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

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

1

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

1

P_{input} = 264 (W)

allow an answer that rounds to 264 (W)

1

264 = 36 × I

allow their calculated

P_{input} = 36 × I

1

I = 7.33 (A)

1

I = 29 (A)

allow an answer that rounds to 29 (A)

allow their value for I × 4 correctly calculated

1

*an answer of 29 (A) scores **6** marks*

Examiners comments - Around 3% of students performed this complex calculation correctly to gain all six marks. Some students attempted calculations, but it was often difficult to follow the line of reasoning. Strings of figures, apparently randomly multiplied or divided, were often seen, with no attempt to explain what was being worked out. It would benefit students to explain, just with a word or two, what they think they are working out. Some students attempted to deal with all stages of this multi-stage calculation in one equation − such answers seldom scored any marks.

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

National and Global Energy Resources – Level 2 Question.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief description of one advantage **or** disadvantage of using either biogas or wind
or
makes a conclusion with a reason.

Level 2 (3-4 marks)
There is a description of some advantages **and / or** disadvantages for biogas **and / or** wind
or
there is a direct comparison between the two systems **and** at least one advantage / disadvantage
or
a detailed evaluation of one system only with a conclusion.

Level 3 (5-6 marks)
There is a clear and detailed comparison of the two systems.

There must be a clear conclusion of which system would be best with at least one comparative reason given for the choice made.

Examples of the points made in the response

extra information

Biogas

- renewable
- energy resource is free
- reliable energy source

  accept works all of the time
- does not depend on the weather
- uses up (animal) waste products
- concentrated energy source
- cheaper (to buy and install)

  accept once only
- shorter payback-time (than wind)
- adds carbon dioxide to the atmosphere

when waste burns it produces carbon dioxide is insufficient

- contributes to the greenhouse effect

or

contributes to global warming

- no transport cost for fuels

Wind turbine

- renewable
- energy resource is free
- not reliable
- depends on the weather / wind
- will be times when not enough electricity generated for the farm's needs
- dilute energy source
- longer payback-time (than biogas)
- more expensive (to buy and install)

  accept once only

- does not produce any carbon dioxide

  accept does not pollute air

  accept pollutant gases for carbon dioxide

  produces visual or noise pollution is insufficient
  harmful gases is insufficient

6

Examiners comments - Nearly all students attempted this question and most got some credit, usually for comparing the costs of the two methods. Many students gave vague statements where the science was weak and incomplete. Some of these students were the more able who wrote eloquently but failed to gain credit because of phrases such as "eco-friendly", "environmentally friendly" or made statements which did not go far enough such as "cause pollution", "harmful". Many students wrote about visual pollution, noise, harming birds, smells on the farm, etc. In the future, they need to elaborate ideas, giving more exact details. Most students made a choice and gave sensible reasons for that choice. The more able students were able to compare the advantages and disadvantages of both systems, and provide an overall conclusion at the end. Many students simply listed advantages and disadvantages of the two methods and did not attempt to fully answer the question by making a clear conclusion – as the question asked. Some students thought that the animal waste was dead animals or animals that need to be killed as the energy source. Other misconceptions included methane being non-renewable, the production of carbon dioxide being an advantage (helping the farmer's plants grow better) and that the major disadvantage of biogas was the smell. It was pleasing to see that more students were planning their answer before starting it.

National and Global Energy Resources – Level 3 Question.

coal has chemical energy
when burnt heat/energy produced longest
used to boil water/make steam sequence
used to turn turbine(s)
which now have ke
turbine(s) turn generator(s)
(where (ke) transferred electrical energy)
(or electrical energy produced)

any 5 for 1 mark each

5

Examiners comments - The vast majority of candidates made scoring responses. Few started with chemical energy stored in the coal, but many burnt the coal to produce heat energy and subsequently produced steam to power the turbine for three marks. Far fewer went on to turn the generators and so produce electrical energy. A large number of candidates were under the impression that the electrical energy was produced in the turbine. Of those candidates not attempting to explain in detail how electrical energy was produced, a fair number gained part marks for correctly listing the energy transfers involved, namely chemical to heat to kinetic energy to electrical energy.

Electricity

Level 2 Question.

water moves (from a higher level to a lower level)

1

transferring GPE to KE

1

rotating a turbine to turn a generator

accept driving or turning or spinning for rotating

moving is insufficient

1

transferring KE to electrical energy

*transferring GPE to electrical energy gains **1** mark of the **2** marks available for energy transfers*

1

Examiners comments - A very low proportion of students did not attempt this question. Out of those who did answer nearly one-quarter failed to score any marks; answers referring to burning fossil fuels, wind turbines, waves and tides were not uncommon. Some answers started correctly with water falling, but then reverted to the water being heated up. A significant number of students either failed to include the useful energy transfers taking place, or just referred to the kinetic energy of the moving water transferring to 'electricity'.

Level 3 Questions.

1.

$3 = I^2 \times 12$

1

$I = \sqrt{\left(\frac{3}{12}\right)}$

1

I = 0.5 (A)

1

Q = 0.5 × 60 = 30

allow Q =

their calculated I × 60

1

$Q_{total} = 60$

allow an answer that is consistent with their calculated value of I

1

or

$3 = I^2 \times 12$ (1)

$$I = \sqrt{\left(\frac{3}{12}\right)}$$

I = 0.5 (A) (1)

I_{total} = 1.0 (A) (1)

allow I_{total} = their I × 2

Q = 1.0 × 60 = 60 (1)

allow an answer that is consistent with their calculated value of I

coulombs **or** C

1

*an answer of 60 scores **5** calculation marks*

Examiners comments – Half of the students found this multistep calculation question very challenging and scored no marks. 13 % of students scored five marks for correctly calculating a charge flow of 30 C but did not double this to determine the total.

Those who were unable to calculate the correct current could still have scored three marks for multiplying their incorrectly calculated current by 60, then doubling this number and finally naming the correct unit. Very few of these scored anything other than the unit mark. Those that did multiply a number by 60 often did not gain credit because it was unclear what their number represented.

2.

Level 3: Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- resistance of LDR changes when light intensity changes
- when light intensity increase resistance of LDR decreases
- overall resistance of circuit decreases
- potential difference across total resistance remains unchanged
- current in ammeter increases
- potential difference across fixed resistor increases
- potential difference across LDR decreases
- reading on the voltmeter decreases
- potential difference is shared between the components in series
- the lower the resistance of the LDR the smaller the share of the potential difference
- reading on the voltmeter decreases

Examiners comments - Very few students achieved a level 3 response in this question. 38% of students gained at least one mark. A large number of students listed what they could recall about circuits despite this not being relevant to the question − information such as which meter is connected in series, which in parallel and what other components are in the circuit.

The majority of students were unable to recognise the symbol for the LDR with many stating it was a thermistor. Those that did recognise the symbol for the LDR often did not recall the correct link between light intensity and resistance or even the function of the LDR. Many students thought that the LDR was the actual light that was switched on and off by the light intensity. Many students who started the question well, correctly identifying the LDR and linking that correctly to how the resistance of the LDR would change, failed to explain how this change in resistance would affect the readings on the ammeter and voltmeter. Very few students demonstrated an understanding of how resistance affects current.

Particle Model of Matter

Level 2 Question.

0 marks

No relevant content.

Level 1 (1–2 marks)

Considers either solid or gas and describes at least one aspect of the particles.

or

Considers both solids and gases and describes an aspect of each.

Level 2 (3–4 marks)

Considers both solids and gases and describes aspects of the particles.

or

Considers one state and describes aspects of the particles and explains at least one of the properties.

or

Considers both states and describes an aspect of the particles for both and explains a property for solids or gases.

Level 3 (5–6 marks)

Considers both states of matter and describes the spacing and movement / forces between the particles. Explains a property of both solids and gases.

examples of the points made in the response

extra information

Solids

- (particles) close together
- (so) no room for particles to move closer (so hard to compress)
- vibrate about fixed point
- strong forces of attraction (at a distance)
- the forces become repulsive if the particles get closer
- particles strongly held together / not free to move around (shape is fixed)

  any explanation of a property must match with the given aspect(s) of the particles.

Gases

- (particles) far apart
- space between particles (so easy to compress)
- move randomly
- negligible / no forces of attraction
- spread out in all directions (to fill the container)

6

Examiners comments - A low proportion of students were able to make a relevant comment on the arrangements of particles in solids or gases.

Generally, most students made a good attempt at the question, with few students leaving it blank. Most were able to make sensible statements about the spacing and movement of particles in solids and gases, but rather fewer referred to the forces between the particles: fewer still attempted to use these statements to explain the properties given in the information box.

Too many students simply repeated the information given in the question and weaker students wrote all they knew, including about particles and their behaviour in a liquid. The use of the term 'kinetic theory' in the question distracted some students into describing conduction and convection. Others became obsessed with the fact that free electrons make metals good conductors.

More able students could select the relevant property of particles to explain the macroscopic property of solids and gases.

Level 3 Question.

energy transferred from athlete / skin / body to water / sweat

allow water / sweat heated by athlete

1

(so) more energetic (water / sweat) particles escape (from the liquid)

accept particles with higher speeds escape (from the liquid)

1

water / sweat <u>evaporates</u>

accept particles escape from the (surface of the) liquid

1

(which) lowers the <u>average</u> energy of (remaining) water / sweat particles

allow reference to the total energy of the liquid reducing

allow lowers the athlete's <u>temperature</u>

ignore cool down

1

Examiners comments - Many responses included biological explanations of thermoregulation, much of which did not relate to this question. Few students mentioned that energy is transferred from the athlete to the sweat. Some explained that the particles would gain energy, but did not go on to say that the most energetic or fastest particles would escape. The third marking point was the one that most students gained, for stating that the sweat evaporated. However, many thought that particles evaporated, rather than the liquid. Reference to lowering the average energy of the particles that were left on the skin was rarely seen. "Lowering temperature" was seen more often.

Atomic Structure and Radiation

Level 2 Question.

Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5-6
Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	3-4
Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.	1-2
No relevant content	0
Indicative content **uses** • used to diagnose problems • X-rays and CT scans • sterilising instruments • because it kills bacteria • radiotherapy • to treat cancer • used to kill cancer cells • medical tracers • gamma knives **harm** • can change / mutate DNA • causing cells to grow uncontrollably • causing tumours / cancer • from regular exposure causing increased dose • to eggs / sperm / embryos	

Level 3 Question.

ionising radiation turns atoms into ions

1

which can break up molecules

1

this can change DNA

1

causing mutations to genes

1

which can cause cancer

1

Forces

Forces and their Effects – Level 2 Question.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a brief attempt to explain why the velocity / speed of the parachutist changes.
or
the effect of opening the parachute on velocity/speed is given.

Level 2 (3-4 marks)
The change in velocity / speed is clearly explained in terms of force(s)
or
a reasoned argument for the open parachute producing a lower speed.

Level 3 (5-6 marks)
There is a clear and detailed explanation as to why the parachutist reaches terminal velocity
and
a reasoned argument for the open parachute producing a lower speed

examples of the physics points made in the response to explain first terminal velocity

- on leaving the plane the only force acting is weight (downwards)

  accept gravity for weight throughout
- as parachutist falls air resistance acts (upwards)

  accept drag / friction for air resistance
- weight greater than air resistance
  or
  resultant force downwards
- (resultant force downwards) so parachutist accelerates
- as velocity / speed increases so does air resistance
- terminal velocity reached when air resistance = weight

  accept terminal velocity reached when forces are balanced

to explain second lower terminal velocity

- opening parachute increases surface area
- opening parachute increases air resistance
- air resistance is greater than weight
- resultant force acts upwards / opposite direction to motion
- parachutist decelerates / slows down

- the lower velocity means a reduced air resistance

  air resistance and weight become equal but at a lower (terminal) velocity

6

Examiners comments - Many students were able to supply some basic information as physics points, but often their responses lacked either the structure and organisation or the logical sequencing to achieve Level 2 and score three or four marks.

Forces and Motion – Level 2 Question.

0 marks

No relevant content.

Level 1 (1–2 marks)

There is an attempt to explain in terms of forces A and B why the velocity of the cyclist changes between any two points
or
a description of how the velocity changes between any two points.

Level 2 (3–4 marks)

There is an explanation in terms of forces A and B of how the velocity changes between X and Y and between Y and Z
or
a complete description of how the velocity changes from X to Z.
or
an explanation and description of velocity change for either X to Y or Y to Z

Level 3 (5–6 marks)

There is a clear explanation in terms of forces A and B of how the velocity changes between X and Z
and
a description of the change in velocity between X and Z.

examples of the points made in the response

extra information

X to Y

- at X force A is greater than force B
- cyclist accelerates
- and velocity increases
- as cyclist moves toward Y, force B (air resistance) increases (with increasing velocity)
- resultant force decreases
- cyclist continues to accelerate but at a smaller value
- so velocity continues to increase but at a lower rate

Y to Z

- from Y to Z force B (air resistance) increases
- acceleration decreases
- force B becomes equal to force A
- resultant force is now zero
- acceleration becomes zero
- velocity increases until…
- cyclist travels at constant / terminal velocity

accept speed for velocity throughout

6

Examiners comments - There was generally a lack of detail in the answers with most marks being achieved by a description of the velocity changes occurring with little reference to the forces involved. Popular misconceptions were that the graph represented a hill that the cyclist had to ascend or that the graph was a distance-time graph and the cyclist would become stationary at point Z. Many of the students described in great detail practical details of cycling and the fatigue of the cyclist without referring to the question asked. Many of the students used the term speed to refer to the constant force applied to the pedals resulting in answers such as ‘he moves at constant speed causing velocity to increase’. A significant number of the students answered in terms of direction changing, many doing so at the same time as mentioning that the cyclist was on a straight road. Few of the students realised that the graph indicates that the acceleration was decreasing but that the velocity was still increasing but at a slower rate to become steady between Y and Z with the forces being balanced. Most students achieved Level 1 to score 1 or 2 marks.

Forces and Motion – Level 2 Question.

tangent drawn at 12 s

1

correct readings of Δv and Δt from tangent

1

$$(\text{acceleration}) = \frac{\text{their value of } \Delta v}{\text{their value of } \Delta t}$$

1

−2.4 (m/s^2)

allow value in range −2.2 to −2.6 (m/s^2)

allow a correctly calculated answer from

$$-\frac{\text{their value of } \Delta v}{\text{their value of } \Delta t}$$

1

m/s^2

allow m/s/s

1

Examiners comments - To access the first four marking points, students had to draw a tangent. 4% of students who had the necessary mathematical skills were able to achieve full marks. A significant number used the co-ordinates of the point on the graph, whilst others made a triangle out of the deceleration part of the graph and tried to work from the *x* and *y* readings despite there being a curve on the third side. The unit mark was scored by the majority of students. Relatively few did not attempt this question.

Wave Properties

Level 2 Question.

Level 3: Relevant points (reasons/causes) are identified, given in detail and logically linked to form a clear account.	5-6
Level 2: Relevant points (reasons/causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.	3-4
Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical thinking.	1-2
No relevant content	0
Indicative content **equipment** • a stopclock / stopwatch should be used to time the waves • a metre rule should be used to measure distance **determining the frequency of the waves** • the frequency could be determined by finding the time for several waves to pass a point • the frequency could be determined by finding the how many waves pass a point in a fixed time • frequency is the average time for one wave to pass a point • frequency = $\frac{\text{no.of waves}}{\text{total time for waves to pass}}$ **determining the speed of the waves** • the speed can be determined by measuring the distance travelled by a wave and the time taken to travel that distance • the distance used to determine speed should be as long as possible • speed = distance/time **determining the wavelength of the wave** • the wavelength can be calculated using the speed and frequency of the wave • wavespeed = frequency × wavelength • $\text{wavelength} = \frac{\text{wavespeed}}{\text{frequency}}$ • $\text{wavelength} = \frac{\left(\frac{\text{distance}}{\text{time}}\right)}{\left(\frac{\text{no. of waves}}{\text{second}}\right)}$	

Level 3 Question.

0.42 = 1 / f

1

f = 2.38

1

v = 2.38 × 0.34

1

= 0.809

*allow 0.809 with no working shown for **4** marks*

1

*incorrect sig. figs max **3** marks*

m / s

correct unit

1

Magnetism

Level 2 Question.

Level 3: Relevant points (reasons / causes) are identified, given in detail and logically linked to give a clear account.

5–6

Level 2: Relevant points (reasons / causes) are identified, and there are attempts at logically linking. The resulting account is not fully clear.

3–4

Level 1: Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

1–2

No relevant content

0

Indicative content

- completing the circuit
- turns the electromagnet on
- there is a current in the coil
- a magnetic field is produced around the coil
- the iron core becomes magnetised
- move electromagnet towards the blocks
- the block is attracted to the electromagnet
- moving the crane moves the block
- switching off the current switches off the electromagnet
- releasing the block

Examiners comments – (Foundation) There were many very vague responses to this question, with few inclusions of the level of detail expected. Many students simply stated that the electromagnet could be switched on, moved to a different position and then switched off. There were few descriptions of how the electromagnet worked.

Many believed that the magnetic blocks were themselves magnets and talked about attraction and repulsion between the blocks and the electromagnet. As a result, only 2% gave answers worthy of level three and only a further 10% gave answers worthy of level two. 13% did not attempt this question with 28% scoring no marks.

(Higher) There were many very vague responses to this question, with few inclusions of the level of detail expected. Many referred to the ability to turn the electromagnet on and off but there were few descriptions of how the electromagnet worked with many incorrect references to 'electricity' passing through the core.

Many believed that the magnetic blocks were, in fact, magnets themselves and talked about the attraction and repulsion between the blocks and the electromagnet. As a result, only about 8% gave answers worthy of level three and a further 32% gave answers worthy of level two.

Level 3 Question.

an answer of 18 000 (s) scores **6** marks

(P = VI)

P = 15.0 × 3.00

1

P = 45.0 (W)

1

0.81 MJ = 810 000 J

allow standard form

1

(E = Pt)

810 000 = 45.0 × t

1

$$t = \frac{810\ 000}{45.0}$$

1

t = 18 000 (s)

1

allow full credit for alternative approach using

Examiners comments – Almost a third of the students gained one mark or more on this question for calculating the time to charge the battery. Many students calculated the power to be 45 watts, but often could go no further.

Some students did not lay out their working clearly, making it difficult to see what they were trying to calculate. The most common mistake converting megajoules to joules incorrectly. Many students multiplied by one thousand instead of one million.