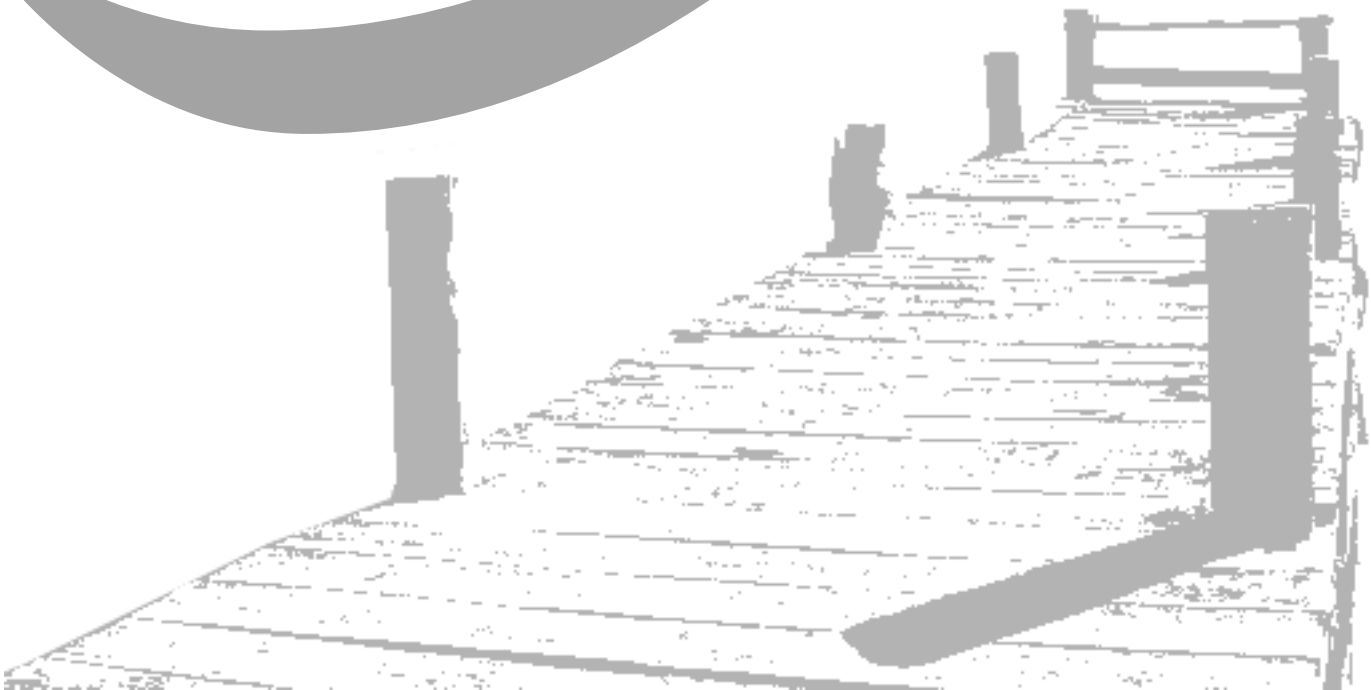
GCE
AS and A Level

General Studies A

AS exams 2009 onwards
A2 exams 2010 onwards

Unit 2:
Specimen question paper

Version 1.1



SPECIMEN PAPER TO PREPARE FOR THE JANUARY 2009 AND SUBSEQUENT EXAMINATIONS

General Certificate of Education
Advanced Subsidiary Examination

ASSESSMENT and QUALIFICATIONS ALLIANCE

GENERAL STUDIES (SPECIFICATION A) GENA2
Unit 2 AS Science and Society

Insert

Sources for use with **Questions 1.1** to **1.30**

PASSAGE AND FIGURES FOR QUESTIONS 1.1 TO 1.30

Uses of Superconductors

(1) As our knowledge of science increases, the development of new technologies becomes possible leading to designs and inventions that would previously have been little more than a dream. This however has been achieved with the design of the maglev train.

Figure 1: The transport of the future? A maglev train

(2) 'Maglev' stands for magnetic levitation. Maglev trains travel along a set of rails, but without anything touching the train as it speeds along. This means that most of the energy loss caused by friction with conventional trains does not occur. The train itself has no engine so produces no emissions. The train is both raised above the track and propelled forwards by the interaction of superconducting magnets on the train and coils down the sides of the track.

(3) Such a train – the world's fastest – has operated commercially since 2004 on a 32 km stretch between Shanghai and its airport reaching speeds up to 450 kmh. It was built through a combined effort by German designers and Chinese engineers although much of the original technology was developed in the 1970s and 1980s in Britain. Some critics remain sceptical, citing the cost of travelling on the maglev, troublesome cables carrying the electrical charge, and sinking track. The biggest problem in pushing through ambitious expansion projects is that the system needs a brand-new dedicated track, although the Chinese government has the power to force through such projects and has plenty of cheap labour.

(4) In 2006, a maglev train crashed on a test track in Germany, killing 23 people. The crash has cast doubt on the driverless train's commercial prospects. Earlier in the year, the maglev train in Shanghai ran into problems when it overheated following a technical failure. Studies of maglev feasibility have been carried out in the Netherlands and the USA. Tony Blair is reported to be interested in incorporating the maglev in a new initiative to 'bring Britain together' amid growing criticism of a two-speed economy, with the south east and London powering ahead while the north remains relatively stagnant.

(5) How does the maglev train work? Electromagnets (coils of metal wire magnetized by electric currents) are chilled to super cold temperatures and conduct electricity without losing energy to resistance. This is unusual, because when a current flows in a wire it normally encounters resistance.

(6) Resistance (measured in ohms) is important because it determines the size of the current (measured in amps) for a particular potential difference (measured in volts) along the wire. At normal temperatures it has long been established that the resistance (R) is the ratio of the potential difference (V) to the current (I) produced; this relationship is commonly known as Ohm's law.

$$R = \frac{V}{I}$$

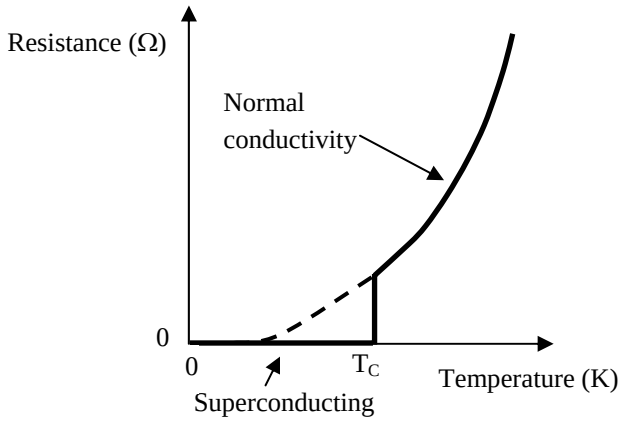
As current flows, energy is dissipated as wasted heat. The relationship between the energy dissipated per second (power, P, measured in watts), the current (I) and the resistance (R) is given by the following equation.

$$P = I^2 R$$

(7) However, in the 19th century, experiments determined that resistance generally decreases when the temperature is decreased significantly. Then, in the early 1900s, helium was liquefied for the first time when it was cooled to 4.2 K*. By using liquid helium (which has a boiling point of 4.25 K) it then became possible to conduct many electrical experiments at much lower temperatures than had previously been possible, leading to some surprising results.

(8) The first of these occurred in 1911 when the Dutch physicist Heike Kamerlingh Onnes was carrying out experiments using mercury. When he cooled mercury to the temperature of liquid helium its resistance suddenly disappeared. Subsequent research found that 21 pure metallic elements and many alloys suddenly lost their resistance **completely** at a particular 'critical' temperature, and so a current could circulate for days without any loss of energy. This property of some materials is what we now know as 'superconductivity'. The highest temperature at which this superconducting state occurred for any of the substances tested in those early days was 23 K.

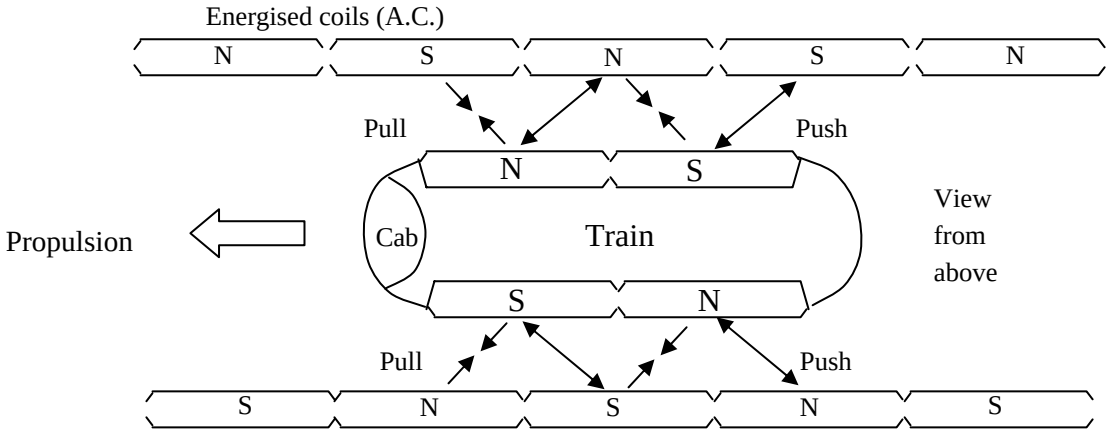
Figure 2: How resistance in a pure metal may fall suddenly at a particular temperature



(9) Since the mid-1980s it has been discovered that various ceramic compounds become superconducting at **much higher** temperatures than metals, even over 100 K. However, ceramics are brittle so a thin film or a fine thread needs to be mounted on to a less brittle substance to avoid breaking. A single thin tape, 1cm wide, may have a current density of 10^6 amps per square centimetre (A cm^{-2}) when superconducting. The maximum for a wire used at normal temperatures would be about 1000 A cm^{-2}. As these new conductors become commercially available more ambitious uses will arise because they are less expensive than metals as they do not require as much cooling. The possibility of such large currents flowing without producing any heat means that very strong magnetic fields can be created.

(10) In the case of the maglev train speeds in excess of 500 kmh^{-1} are possible due to a shifting magnetic field in the track. Reversing the electric currents in the coils quickly changes the polarity of the magnets to produce a push or a pull as required for propulsion. Tanks of liquid nitrogen and helium are carried on board together with a refrigeration system to recycle the helium when it becomes warm. Additional levitation and centering coils rely on induced currents which always flow to oppose the change causing them. If the train veers to one side it will be pushed back in line.

Figure 3: Diagram showing magnetic forces on a maglev train, seen from above



* To convert 4.2 K (kelvins) to °C (degrees Celsius), 273 must be subtracted, giving -268.8°C.

(11) A further use of powerful superconducting electromagnets which need very little energy input is Magnetic Resonance Imaging (MRI).

(12) People have known about magnetism and its effect on metals for thousands of years, but it is only recently that it has been possible to use magnetism to create internal images of the human body, with more detail than those produced by X-rays. Such images are produced by a process known as Magnetic Resonance Imaging.

Figure 4: A Magnetic Resonance Imaging scanner

(13) MRI is a very different application of the use of superconductors. The technique was originally developed in 1946 to study molecular structure, but in 1973 it was suggested that it could also be useful in medicine. The patient is placed in a very strong magnetic field (produced by a superconducting coil kept cool in liquid helium) and an image is produced by observing how hydrogen atoms in the body are affected. A major expense in diagnoses using MRI is the replacement of helium that has boiled away.

(14) Small differences in the size of the magnetic field applied in different directions through the body means each point in space can be identified. When a pulse of radio-frequency electromagnetic radiation is added the hydrogen atoms resonate and respond by returning signals. From an analysis of these signals a picture is built up of the concentration of hydrogen atoms and their immediate environment. This gives a clear image of the different tissues of the body. The method is particularly good for distinguishing between various soft tissues. A computer sorts the data and produces pictures as slices or as 3D images. Care has to be taken with any metallic object because of the strong magnetic field and heart pacemakers can be upset, but otherwise MRI scans are thought to be risk free. As they are relatively expensive, however, they have only been used extensively for images of the brain and nervous system.

(15) Since 1997, the number of MRI scans carried out in the UK has more than doubled but a shortage of radiographers to read the results means the scanners often cannot be used to full advantage. There is no national record of delays for MRI scans but the fact that some patients have to wait for routine NHS scans to diagnose illnesses has triggered political concerns. Options may, therefore, be used to buy in scanning time and specialist radiographers from private healthcare firms, including foreign clinics.

(16) One university researcher uses magnetic resonance imaging to study how children learn to speak and read. He has permission to study children as young as seven. There is no evidence that MRI is harmful but he is worried about later discoveries and allowing his own seven-year-old to participate.

(17) As high-temperature superconductors become better established we may see great changes in the transmission system for electricity, in addition to finding many completely new uses for the superconductors.

END OF PASSAGE

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New GCE General Studies A for first time teaching 2008: version 1.1, approved (July 2007)

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ASSESSMENT and QUALIFICATIONS ALLIANCE

GENERAL STUDIES (SPECIFICATION A) GENA2
Unit 2 AS Science and Society

For this paper you must have:
- an objective test answer sheet
- a loose insert for Section A (enclosed)
- a 4-page answer book
- a black ball-point pen.

You may use a calculator

Time allowed: 1 hour 30 minutes

Instructions
- Use a black ball-point pen for recording your answers to Section A (Questions 1.1 to 1.30) on your objective test answer sheet.
- Use black ink or ball-point pen for answering Section B (one question from Questions 2 to 4).
- Write the information required on the front of your answer book for Section B. The *Examining Body* for this paper is AQA. The *Paper Reference* is GENA2.
- Answer Section A (Questions 1.1 to 1.30) using the answer sheet provided **and one** question from Questions 2 to 4 in a separate answer book.
- For each item in Section A there are several different responses. When you have chosen the response which you think is the best answer to a question, mark this response on your answer sheet.
- Do all rough work in this book, **not** on your answer sheet.
- Write your answer to either Question 2, 3 or 4 in the separate 4-page answer book.
- Hand in **both** your answer sheet **and** your answer book at the end of the examination.

Information
- The maximum mark for this paper is 65.
- This paper consists of **two** sections.
  Section A contains 30 objective test questions based on material provided as a separate insert. Each question carries 1 mark. You will not lose marks for wrong answers.
  Section B contains three alternative structured questions (2 to 4). Marks are shown after each question and total 35.

SECTION A

Each of the 30 questions carries 1 mark.

Read the passage entitled **Uses of Superconductors** which is printed in the separate insert and answer **Questions 1.1** to **1.30** by choosing the answer represented by the letter **A**, **B**, **C** or **D** that you think best.

1.1 It can be understood from paragraph 1 that

A scientific knowledge has been used to interpret dreams.
B science has achieved the impossible with the maglev train.
C the design of the maglev train will transform the environment.
D the progress of innovation is often difficult to predict.

1.2 According to paragraph 2, the maglev train has which of the following advantages over conventional trains?

1 There is virtually no energy loss because of friction.
2 The train does not need a special track.
3 The train produces very little noise as it travels.
4 There are no exhaust emissions to cause pollution.

Answer

A if **1** and **2** only are correct.
B if **2** and **3** only are correct.
C if **1**, **3** and **4** only are correct.
D if all are correct.

1.3 Each of the following is mentioned in paragraph 3 **except**

A the integration of transport facilities.
B the failure of British technology.
C cross-continental co-operation.
D uncertainty about the maglev's potential.

1.4 According to paragraph 3, the development of the maglev train is more likely in China because

1 it has the comparative advantage in lower construction costs.
2 all opposition is ruthlessly crushed by the government.
3 its engineers have improved on German design methods.
4 the land is particularly suitable for high-speed train tracks.

Answer

A if **1** only is correct.
B if **1** and **2** only are correct.
C if **2** and **3** only are correct.
D if **3** and **4** only are correct**.**

1.5 On the basis of information in paragraph 4 Tony Blair's interest in the maglev train was most likely to

A cool following events that took place in Germany and China in 2006.
B depend on feasibility studies in the Netherlands and the USA.
C reflect his concern to narrow regional differentials in the British economy.
D be part of a wider political plan to promote feelings of 'Britishness'.

1.6 To produce the largest current at room temperature you would need

A a large resistance and a large potential difference.
B a large resistance and a small potential difference.
C a small resistance and a large potential difference.
D a small resistance and a small potential difference.

1.7 When the resistance is 2 ohms, a potential difference of 2 volts produces a current of 1 amp. If the resistance is changed to 20 ohms and the potential difference remains the same, the current would be

A 0.1 A
B 2 A
C 10 A
D 20 A

1.8 When the current doubles, the waste heat produced per second by the same resistance changes by a factor of

A $\frac{1}{4}$

B $\frac{1}{2}$

C 2

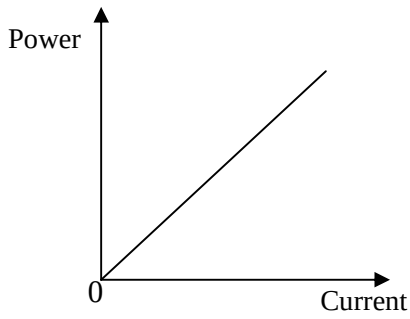
D 4

1.9 What is the resistance of a wire carrying a current of 3 A, if the heat loss per second is 36 W?

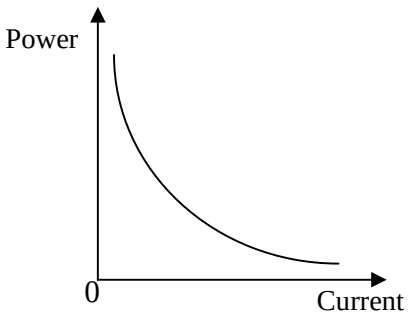
A 4 ohms
B 12 ohms
C 108 ohms
D 1296 ohms

1.10 For a constant resistance, at a fixed temperature, the graph that shows how the power varies for different currents has the form

A



B



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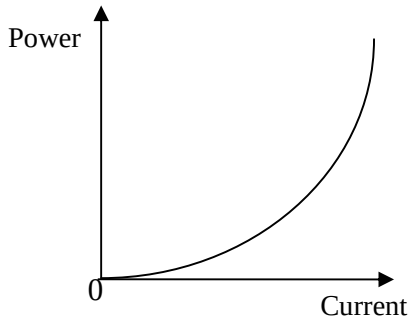
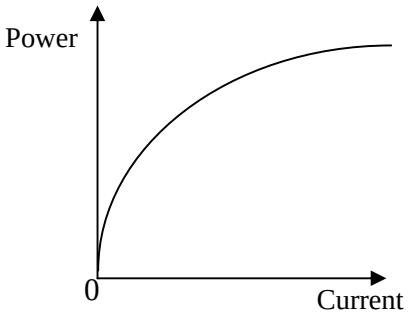


D



1.11 Measured on the temperature scale of kelvins (K) the boiling point of water is

A 173 K
B 273 K
C 373 K
D 473 K

1.12 Upon reaching superconductivity the resistance of a pure material (paragraph 8 and **Figure 2**)

A reduces steadily to zero over several degrees.
B reduces suddenly to zero.
C does not quite reduce to zero.
D follows the same decrease as above critical temperature.

1.13 The early substances found to superconduct (paragraph 8) were

A superconducting below 23 K.
B superconducting above 23 K.
C all elements.
D all pure substances.

1.14 Which of the following is **not** a ceramic (paragraph 9)?

A brick
B plasticine
C earthenware
D china

1.15 Current density (paragraph 9) can be defined by the current per unit cross-sectional area of the conductor.
A thin tape conductor with a cross-sectional area of 1mm by 1cm carries a current of 10A.
The current density is

A 0.1 A cm^{-2}
B 1.0 A cm^{-2}
C 10 A cm^{-2}
D 100 A cm^{-2}

1.16 A current flows down a thin tape of rectangular cross-section.
If the same current were to flow in another tape of the same material, but half the width and half the thickness, how would the new current density differ from its previous value?

The current density would be

A a quarter of its previous value.
B a half of its previous value.
C twice its previous value.
D four times its previous value.

1.17 The propulsion and guidance of the maglev train comes from the attraction and repulsion of magnetic forces on the train and rails. Which of the following is/are correct?

1 The forces are produced by large currents through superconductors.
2 The forces have their polarity reversed very rapidly by changing the current direction.
3 The forces are produced by permanent magnets sited on the track and the train.
4 The forces are powerful enough to raise the train.

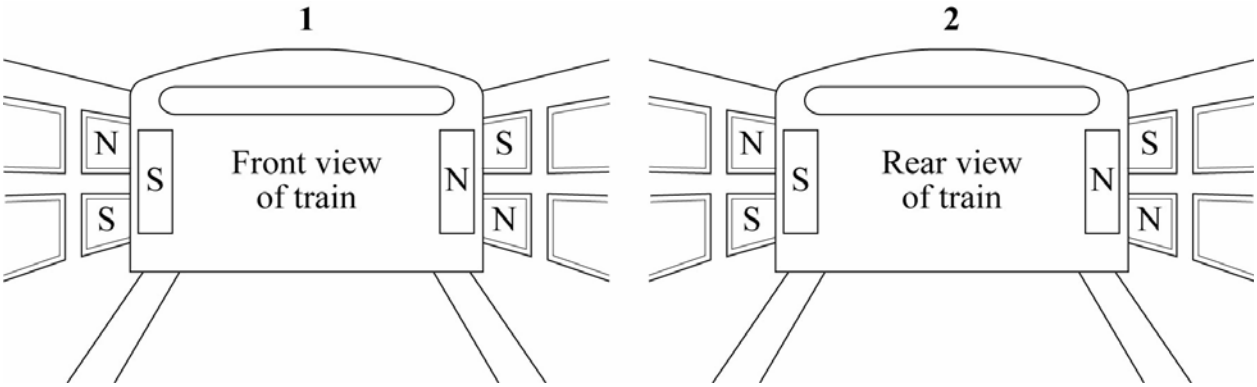
Answer

A if **4** alone is correct.
B if **1** and **2** only are correct.
C if **1**, **2** and **3** only are correct.
D if **1**, **2** and **4** only are correct.

Turn over for the next question

1.18 As indicated in paragraphs 2, 10 and **Figure 3** the levitation of a maglev train above the rails is achieved through the use of additional magnetic fields.

Which, if either, of the following diagrams indicates a possible arrangement(s) of the magnetic fields on the train and alongside the track to support the train above the rails?



Answer

A if both are possible.
B if **1** alone is possible.
C if **2** alone is possible
D if neither is possible.

1.19 The temperature of the superconducting coil in an Magnetic Resonance Imaging (MRI) scanner (paragraphs 7 and 13) is about

A 4 K
B 5 K
C 4 °C
D 5 °C

1.20 In MRI the radiation which makes the hydrogen atoms resonate (paragraph 14) is

A gamma rays.
B microwaves.
C radio waves.
D ultrasound.

Turn over for the next question

1.21 Which of the following statements are true about Magnetic Resonance Imaging (paragraphs 13 and 14)?

1 Different sizes of magnetic fields in different directions are used to identify points in space.
2 Helium atoms resonate, produce a pulse of electromagnetic radiation and return signals.
3 Signals are analysed and a picture built up of the concentration of hydrogen atoms and their environment.
4 The procedure is safe but care needs to be taken with any metallic objects such as a pacemaker.

Answer

A if **1** and **2** only are correct.
B if **2** and **3** only are correct.
C if **1**, **3** and **4** only are correct.
D if all are correct.

1.22 A patient lies face up on the bed of an MRI scanner, as shown in **Figure 4.** The bed is then moved into the scanner. What instruction should the accompanying radiographer give if, as she looks at the patient from beside the patient's feet, she wants the patient to move his head to her right and turn his head so the right side of his face is uppermost?

A Move your head to the right and turn your face to the right.
B Move your head to the right and turn your face to the left.
C Move your head to the left and turn your face to the right.
D Move your head to the left and turn your face to the left.

1.23 Use of the option 'to buy in scanning time and specialist radiographers from private healthcare firms' (paragraph 15) would most likely suggest that

A the National Health Service has proved that it is an inefficient failure.
B record keeping in the National Health Service needs to be improved.
C politicians recognise that health is a sensitive issue and may lose them votes.
D private provision for health is superior to services provided by the state.

1.24 In paragraph 16 it can be seen that

A ethical dilemmas faced by scientific researchers may be difficult to resolve.
B magnetic resonance imaging should not be used on young children.
C the university researcher is not concerned about using double standards.
D parents should be more responsible in monitoring their children's behaviour.

1.25 Uses are continually being developed for superconductors. A possible future use may be in the transmission of electricity. The main reason that this is being considered a possibility is because

A high temperatures can be used.
B low winter temperatures will cause less effect on the network.
C more heat will be generated making the transmission more efficient.
D there will be less heat generated and a smaller heat loss.

1.26 Which of the following are facts rather than opinions?

1 More patients should have access to MRI technology if it is the best available.
2 Existing UK railway track should be replaced to allow the use of maglev trains for environmental reasons.

Answer

A if neither is a fact.
B if **1** alone is a fact.
C if **2** alone is a fact.
D if both are facts.

1.27 To examine the brain for a tumour it would be best to use

A ultrasound.
B X-rays.
C beta rays.
D magnetic resonance.

Turn over for the next question

Assertion / Reason questions

For **Questions 1.28** to **1.30** you are given an assertion followed by a reason. Use the following grid to decide which of the options **A**, **B**, **C**, or **D** is correct.

	Assertion	Reason	Argument
A	True	True	Reason is **a correct** explanation of assertion
B	True	True	Reason is **not a correct** explanation of assertion
C	True	False	Not applicable
D	False	–	Not applicable

	ASSERTION		REASON
1.28	Superconductivity has been used in transport since the beginning of the 20^{th} century	because	that is when helium was first liquefied.
1.29	MRI scans have been mainly used for images of the brain and nervous system	because	pacemakers can be upset by the strong magnetic field.
1.30	The cost of helium for MRI has been justified	because	the image of soft tissue is superior to other methods.

END OF QUESTION 1

SECTION B

Answer **one Question** from **2**, **3** and **4**.

Wherever possible **use your own words** to show you understand the arguments.

You will be marked on your ability to use good English, to organise information clearly and to use specialist vocabulary where appropriate.

EITHER

2

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Source: Adapted from ANDREW TAYLOR, 'The ups and downs of working at home', *The Sunday Times*, 23 July 2006

(a) For what reasons have the number of people doing paid work from home increased considerably in the last 10 years? *(17 marks)*

(b) Discuss the potential disadvantages of this form of work for some individuals. *(18 marks)*

Turn over for the next question

OR

3

SIR – As young people in today's "fast-moving, hyper-competitive culture", we feel that an all-out assault on junk food, as proposed by Jamie Oliver, is the wrong path. Banning junk food will only make it more desirable and children will go to further lengths to ensure they can taste this "forbidden fruit". Making sure children can differentiate between "junk food" and "real food" is far more important.

As to the matter of exercise, even if children did turn to the type of play that some writers may fondly remember, these children would be reprimanded for causing a disturbance. Parents are under pressure to make sure their children get exercise and play outside but leaving them without supervision is criticised. The problem is not parents being overly protective: it is, instead, the fault of meddlers.

Source: Adapted from a letter written by a group of sixth formers, *The Daily Telegraph*, 20 September 2006

(a) For what social and scientific reasons is a varied and balanced diet beneficial to all individuals? *(17 marks)*

(b) Discuss the difficulties involved in improving the diet of many young people and increasing their amount of exercise. (*18 marks)*

OR

4

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Source: Adapted from MICHAEL MCCARTHY,
'The Prime Minister must choose: air travel or cuts to greenhouse gases', *The Independent*, 16 October 2006

(a) For what reasons are many scientists and environmentalists concerned about air travel? (*17 marks)*

(b) Discuss the view that policies to discourage air travel are socially, economically, and politically unthinkable. *(18 marks)*

END OF QUESTIONS