New Document 3

High Demand

Name: _____

Class: _____

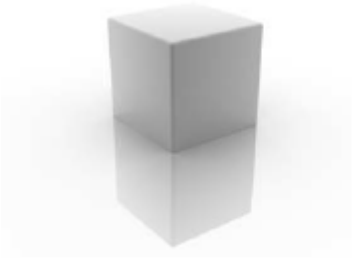
Date: _____

Time: **190 minutes**

Marks: **189 marks**

Comments:

1 A student wants to calculate the density of the two objects shown in the figure below.



Metal cube

© Whitehoune/iStock/Thinkstock,

Small statue

© Marc Dietrich/Hemera/Thinkstock

Describe the methods that the student should use to calculate the densities of the two objects.

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(Total 6 marks)

2 An electrician is replacing an old electric shower with a new one.

The inside of the old shower is shown in **Figure 1**.

Figure 1

(a) If the electrician touches the live wire he will receive an electric shock.

Explain why.

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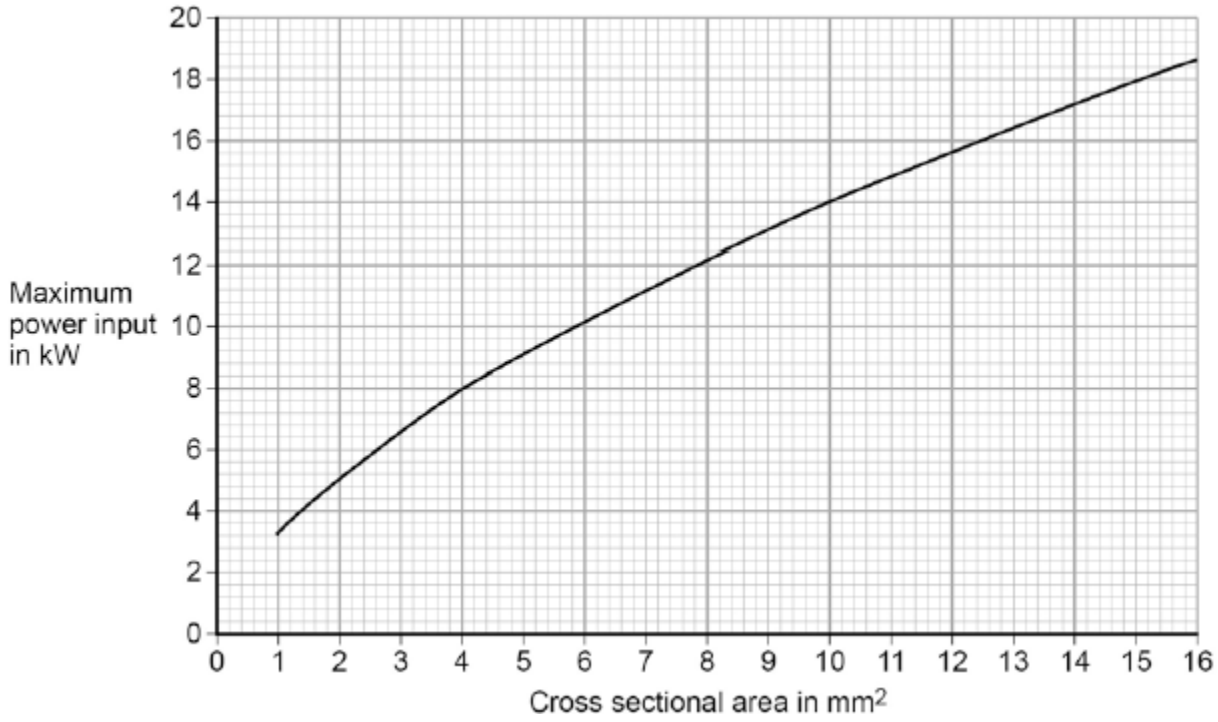
(4)

(b) Different electrical wires need to have a cross-sectional area that is suitable for the power output.

Figure 2 shows the recommended maximum power input to wires of different cross-sectional areas.

Figure 2



The new electric shower has a power input of 13.8 kW.

Determine the minimum **diameter** of wire that should be used for the new shower.

The diameter, d, can be calculated using the equation:

$$d = \sqrt{\frac{4A}{\pi}}$$

A is the cross-sectional area of the wire.

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Minimum diameter = ... mm

(2)

(c) The charge that flows through the new shower in 300 seconds is 18 000 C.
The new electric shower has a power of 13.8 kW.

Calculate the resistance of the heating element in the new shower.

Write down any equations you use.

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Resistance = ... Ω

(5)
(Total 11 marks)

3 Waves may be either longitudinal or transverse.

(a) Describe the difference between a longitudinal and a transverse wave.

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(2)

(b) Describe **one** piece of evidence that shows when a sound wave travels through the air it is the wave and not the air itself that travels.

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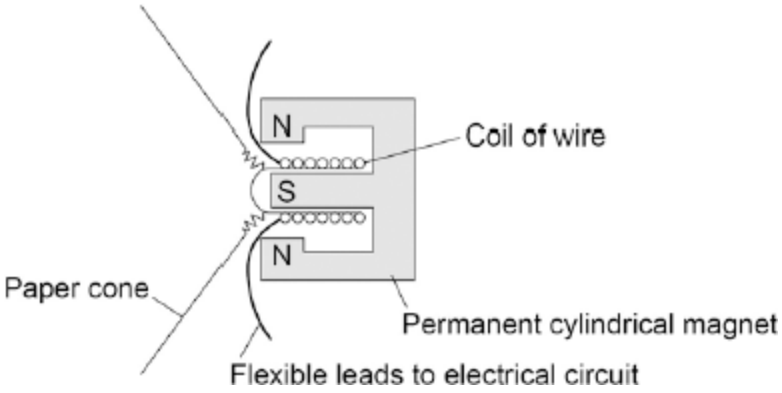
(1)

(c) The figure below shows the parts of a moving-coil loudspeaker.

A coil of wire is positioned in the gap between the north and south poles of the cylindrical magnet.



Explain how the loudspeaker converts current in an electrical circuit to a sound wave.

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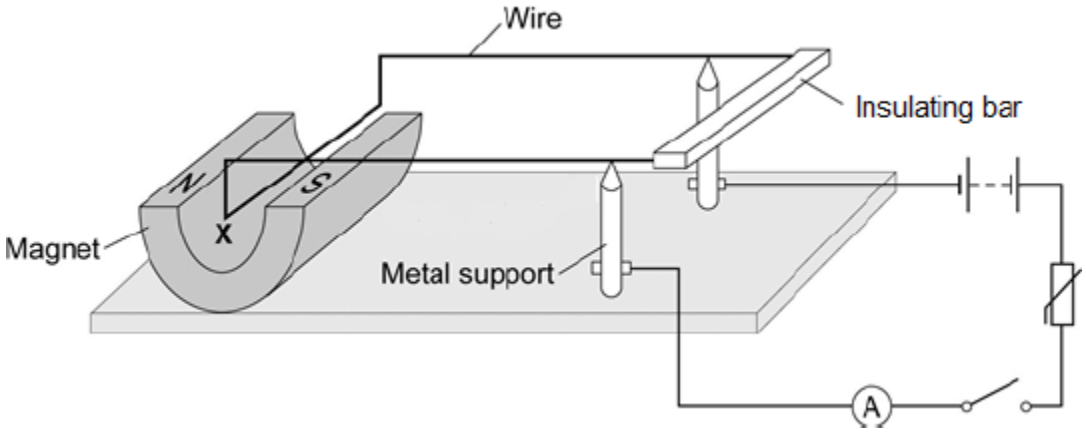
(6)
(Total 9 marks)

4 **Figure 1** shows a piece of apparatus called a current balance.

Figure 1



When the switch is closed, the part of the wire labelled **X** experiences a force and moves downwards.

(a) What is the name of the effect that causes the wire **X** to move downwards?

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(1)

(b) Suggest one change you could make to the apparatus in **Figure 1** that would increase the size of the force that wire **X** experiences.

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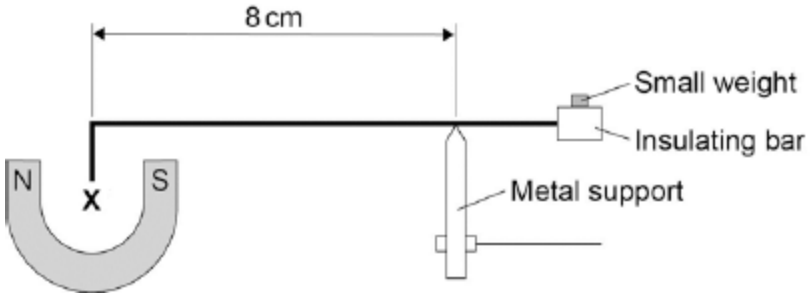
(1)

(c) **Figure 2** shows how a small weight placed on the insulating bar makes the wire **X** go back and balance in its original position.

Figure 2



The wire **X** is 5 cm long and carries a current of 1.5 A.

The small weight causes a clockwise moment of 4.8×10^{-4} Nm.

Calculate the magnetic flux density where the wire **X** is positioned

Give the unit.

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Magnetic flux density = ... Unit .....

(6)
(Total 8 marks)

5 Under the same conditions, different materials heat up and cool down at different rates.

(a) What is meant by specific heat capacity?

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(2)

(b) Quenching' is a process used to change the properties of steel by cooling it rapidly.

The steel is heated to a very high temperature and then placed in a container of cold water.

(i) A metalworker quenches a steel rod by heating it to a temperature of 900 °C before placing it in cold water. The mass of the steel rod is 20 kg.

The final temperature of the rod and water is 50 °C.

Calculate the energy transferred from the steel rod to the water.

Specific heat capacity of steel = 420 J / kg °C.

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Energy transferred = ... J

(3)

(ii) The temperature of the steel rod eventually returns to room temperature.

Compare the movement and energies of the particles in the steel rod and in the air at room temperature.

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(3)

(iii) When the steel rod is being quenched, the temperature of the water rises to 50 °C. After a few hours the water cools down to room temperature.

Some of the cooling of the water is due to evaporation.

Explain in terms of particles how evaporation causes the cooling of water.

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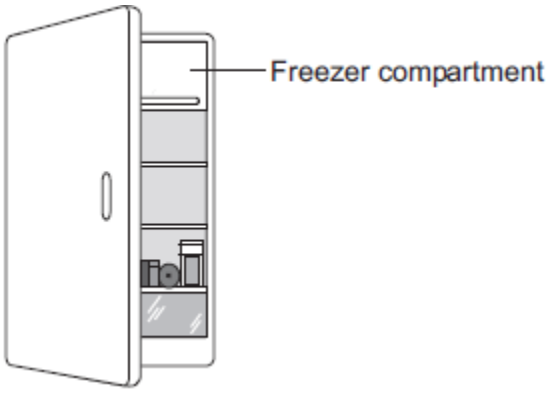
(4)
(Total 12 marks)

6 (a) The figure below shows a fridge with a freezer compartment.

The temperature of the air inside the freezer compartment is –5 °C.



The air inside the fridge forms a convection current when the fridge door is closed.

Explain why.

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(4)

(b) The table below shows information about four fridges.

Fridge	Volume in litres	Energy used in one year in kWh
A	250	300
B	375	480
C	500	630
D	750	750

A householder concludes that the energy used in one year is directly proportional to the volume of the fridge.

Explain why her conclusion is **not** correct.

Use data from the table in your answer.

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(2)

(c) New fridges are more efficient than fridges made twenty years ago.

Give **one** advantage and **one** disadvantage of replacing an old fridge with a new fridge.

Ignore the cost of buying a new fridge.

Advantage .....

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Disadvantage .....

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(2)
(Total 8 marks)

7 **Table 1** shows information about different light bulbs.

The bulbs all have the same brightness.

Table 1

Type of bulb	Input power in watts	Efficiency
Halogen	40	0.15
Compact fluorescent (CFL)	14	0.42
LED	7	0.85

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

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Useful power output = ... watts

(2)

(ii) Use your answer to part **(i)** to calculate the waste energy produced each second by a CFL bulb.

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Waste energy per second = ... joules

(1)

(b) (i) A growth cabinet is used to investigate the effect of light on the rate of growth of plants.

The figure below shows a growth cabinet.

In the cabinet the factors that affect growth can be controlled.

A cooler unit is used to keep the temperature in the cabinet constant. The cooler unit is programmed to operate when the temperature rises above 20 °C.

The growth cabinet is lit using 50 halogen bulbs.

Changing from using halogen bulbs to LED bulbs would reduce the cost of running the growth cabinet.

Explain why.

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(4)

(ii) A scientist measured the rate of growth of plants for different intensities of light.

What type of graph should be drawn to present the results?

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Give a reason for your answer.

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(1)

(c) **Table 2** gives further information about both a halogen bulb and a LED bulb.

Table 2

Type of bulb	Cost to buy	Lifetime in hours	Operating cost over the lifetime of one bulb
Halogen	£1.50	2 000	£16.00
LED	£30.00	48 000	£67.20

A householder needs to replace a broken halogen light bulb.

Compare the cost efficiency of buying and using halogen bulbs rather than a LED bulb over a time span of 48 000 hours of use.

Your comparison must include calculations.

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(4)
(Total 12 marks)

8 The figure below shows a skateboarder jumping forwards off his skateboard.

The skateboard is stationary at the moment the skateboarder jumps.

(a) The skateboard moves backwards as the skateboarder jumps forwards.

Explain, using the idea of momentum, why the skateboard moves backwards.

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(3)

(b) The mass of the skateboard is 1.8 kg and the mass of the skateboarder is 42 kg.

Calculate the velocity at which the skateboard moves backwards if the skateboarder jumps forwards at a velocity of 0.3 m / s.

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Velocity of skateboard = ... m / s

(3)

(Total 6 marks)

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

There are two types of traditional transformer; step-up and step-down.

Describe the similarities and differences between a step-up transformer and a step-down transformer.

You should include details of:

- construction, including materials used
- the effect the transformer has on the input potential difference (p.d.).

You should **not** draw a diagram.

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Extra space .....

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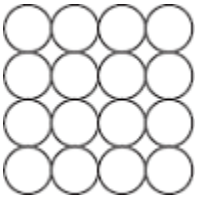
(Total 6 marks)

10 According to kinetic theory, all matter is made up of small particles. The particles are constantly moving.

Diagram 1 shows how the particles may be arranged in a solid.

Diagram 1



(a) One kilogram of a gas has a much larger volume than one kilogram of a solid.

Use kinetic theory to explain why.

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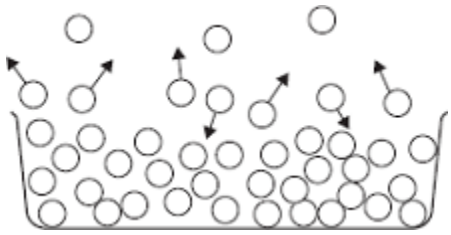
(4)

(b) **Diagram 2** shows the particles in a liquid. The liquid is evaporating.

Diagram 2



(i) How can you tell from **Diagram 2** that the liquid is evaporating?

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(1)

(ii) The temperature of the liquid in the container decreases as the liquid evaporates.

Use kinetic theory to explain why.

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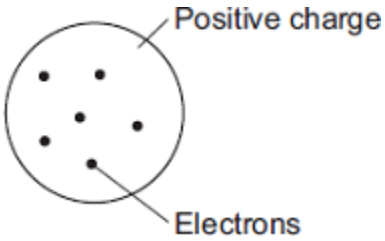
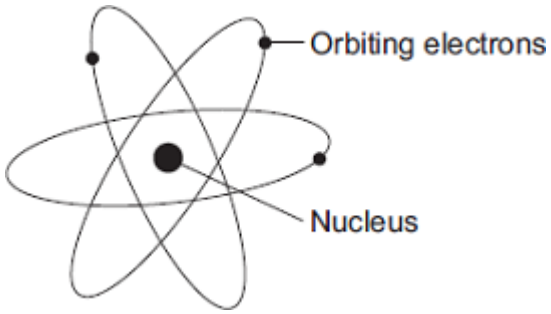
(3)
(Total 8 marks)

11 In the early part of the 20th century, scientists used the 'plum pudding' model to explain the structure of the atom.



Following work by Rutherford and Marsden, a new model of the atom, called the 'nuclear' model, was suggested.



Describe the differences between the two models of the atom.

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(Total 4 marks)

12 (a) Nuclear fuels and the wind are two of the energy sources used to generate electricity in the UK.

Explain the advantages of using energy from nuclear fuels to generate electricity rather than using energy from the wind.

Include in your answer a brief description of the process used to generate electricity from nuclear fuels.

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(4)

(b) In the UK, most electricity is generated in power stations that emit carbon dioxide into the atmosphere. The impact of these power stations on the environment could be reduced by the increased use of 'carbon capture' technology.

Describe how 'carbon capture' would prevent the build-up of carbon dioxide in the atmosphere.

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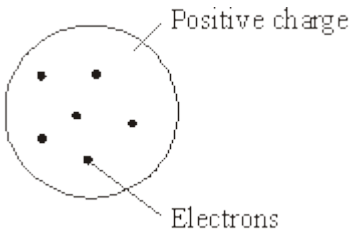
(2)
(Total 6 marks)

13 In the early part of the 20th century, scientists used the 'plum pudding' model to explain the structure of the atom.



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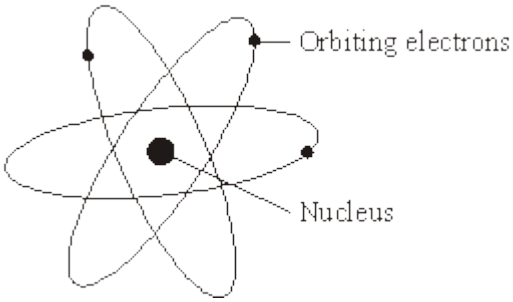

(a) Describe the differences between the two models of the atom.

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(4)

(b) In their investigation, Rutherford and Marsden fired positively charged alpha particles at a very thin sheet of gold. Over a period of several months, the scientists made over 100 000 measurements. These measurements showed that:

- a very small number of alpha particles were deflected backwards from the gold foil.

Use the nuclear model to explain this experimental result.

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(2)

(c) Why did the work of Rutherford and Marsden convince many scientists that the 'plum pudding' model of the atom was incorrect?

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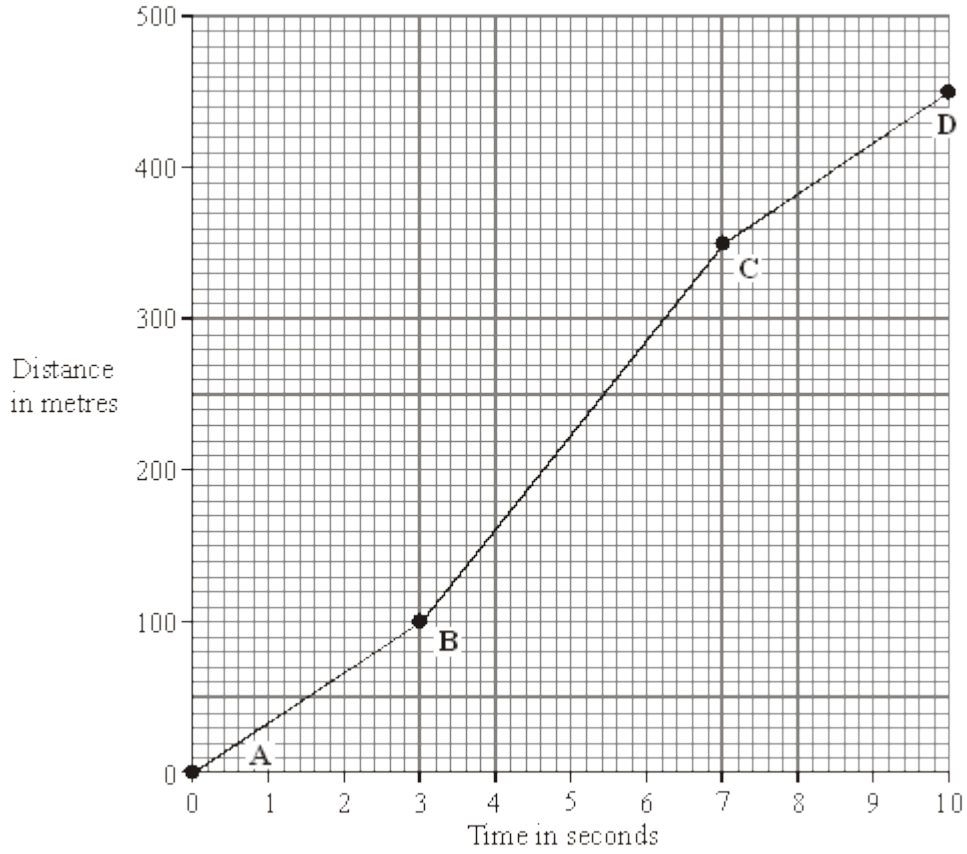
(2)
(Total 8 marks)

14 The distance-time graph represents the motion of a car during a race.



(a) Describe the motion of the car between point **A** and point **D**. You should not carry out any calculations.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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(3)

(b) Calculate the gradient of the graph between point **B** and point **C**. Show clearly how you get your answer.

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gradient = ...

(3)

(Total 6 marks)

15 Stars do not stay the same forever.

(a) Over billions of years the amount of hydrogen in a star decreases. Why?

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(1)

(b) Describe how a massive star (at least five times bigger than the Sun) will change at the end of the main stable period.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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(4)

(c) The inner planets of the solar system contain atoms of the heaviest elements.

(i) Where did these atoms come from?

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(1)

(ii) What does this tell us about the age of the solar system compared with many of the stars in the Universe?

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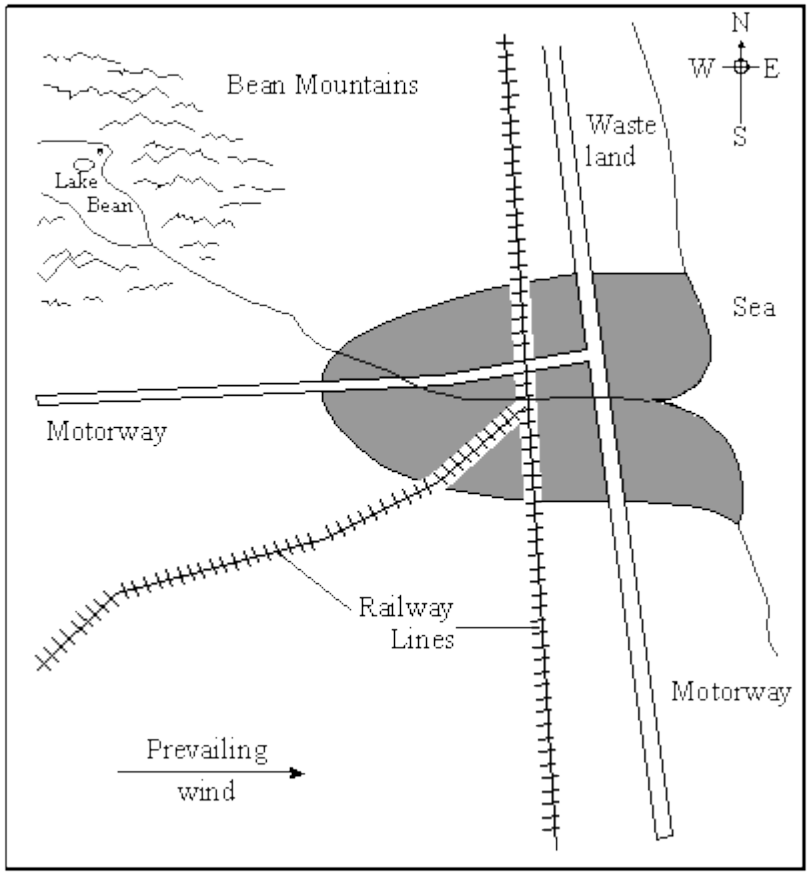
(1)
(Total 7 marks)

16 The map below shows an industrial region (shaded).



The prevailing wind is from the west. There is a nearby mountainous area, from which a river flows through the region. The major road and rail links are shown.

A power station is to be built to supply electrical energy to the region. The energy will be for a range of domestic and industrial uses.

The choice is between a coal fired power station, wind turbines and a hydroelectric scheme.

Three local groups each support a different option. Choose which option you would support and justify your choice by making reference to the financial, social and environmental implications of your choice compared with those of the alternative systems.

(Total 8 marks)

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

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(Total 5 marks)

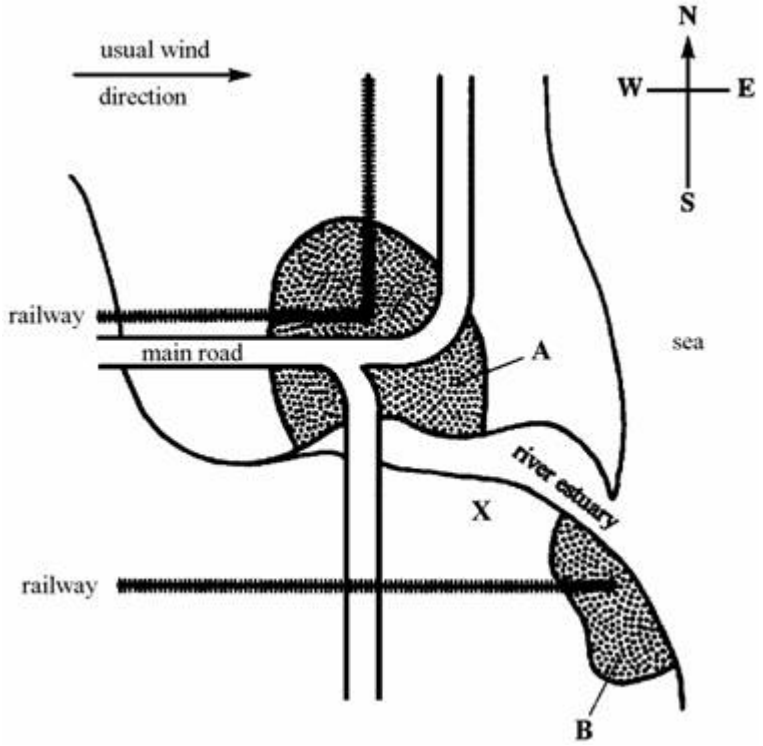
18 The map below shows the position of two towns, **A** and **B**, on the banks of a large river estuary.

A is an important fishing and ferry port.

The wind usually blows from the west. The major roads and railways are shown.

A power station is to be built in area X to generate electricity for the region.

The choice is between a nuclear power station and a coal fired power station.



(a) State the advantages and disadvantages of the two methods of generating electrical energy.

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(6)

(b) Which method would you choose for this site?

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Explain the reason for your choice.

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(3)
(Total 9 marks)

19 (a) The Sun is at the stable stage of its life.

Explain, in terms of the forces acting on the Sun, what this means.

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(3)

(b) At the end of the stable stage of its life a star will change.

Describe and explain the changes that could take place.

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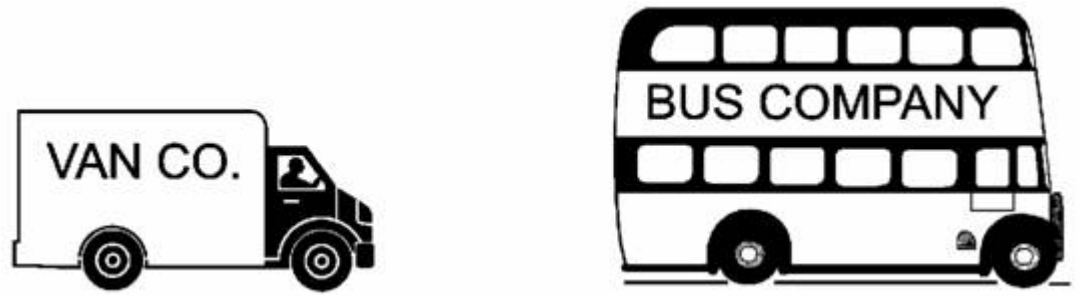
(6)
(Total 9 marks)

20 **'SPEED KILLS' -** was the heading of an advertising campaign. The scientific reason for this is that energy is transferred from the vehicle to the person it knocks down.



(a) The bus and the van are travelling at the same speed. The bus is more likely to cause more harm to a person who is knocked down than the van would. Explain why.

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(2)

(b) A car and its passengers have a mass of 1200 kg. It is travelling at 12 m/s.

(i) Calculate the increase in kinetic energy when the car increases its speed to 18 m/s.

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

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Increase in kinetic energy = ...

(5)

(ii) Explain why the increase in kinetic energy is much greater than the increase in speed.

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(1)

(Total 8 marks)

21 One theory of the origin of the Universe was that billions of years ago all matter was in one place, then it exploded ('big bang').
Describe, in as much detail as you can, how our star (the Sun) formed from the time when there was just dust and gas (mostly hydrogen) up to now when it is in its main stable period.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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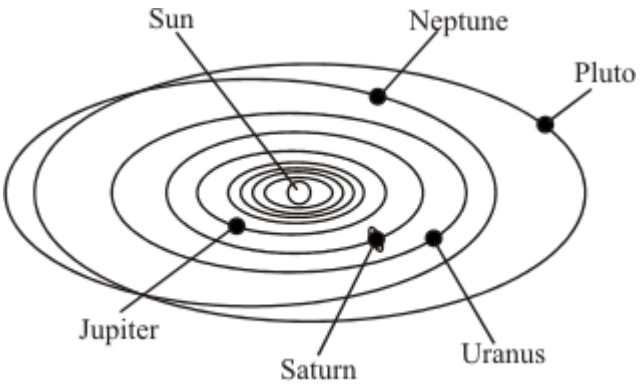
(Total 5 marks)

22 The Sun at the centre of our solar system is a star.



(a) The Sun contains nuclei of the heaviest elements. Atoms of these heaviest elements are also present in the planets of the solar system. What does this suggest about the material from which the solar system is formed?

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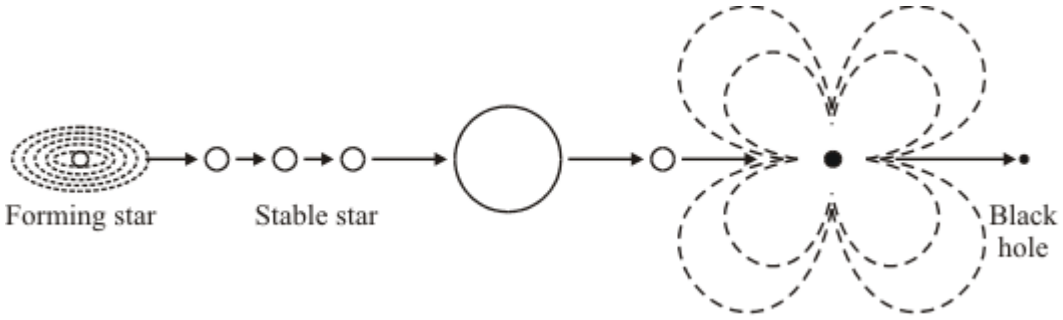
(1)

(b) Stars form from gas (mostly hydrogen) and dust.



Describe, in as much detail as you can, what forces allow a stable star to exist and how the star may eventually form a black hole.

To gain full marks in this question you should write your ideas in good English. Put them into a sensible order and use the correct scientific words.

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(6)
(Total 7 marks)

23 Explain, in as much detail as you can, the scientific evidence for the “big bang” theory of the origin of the Universe.

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(Total 5 marks)

24 Describe, in as much detail as you can, the life history of a star like our Sun.

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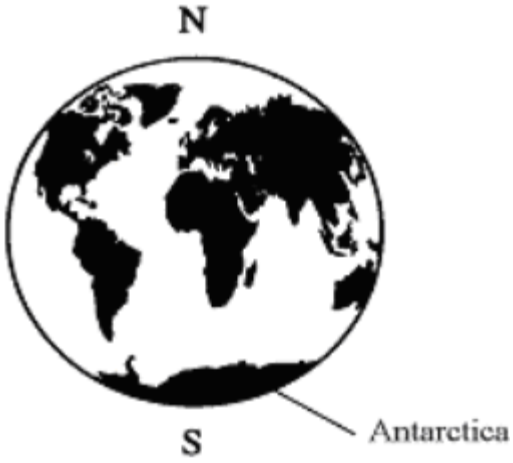
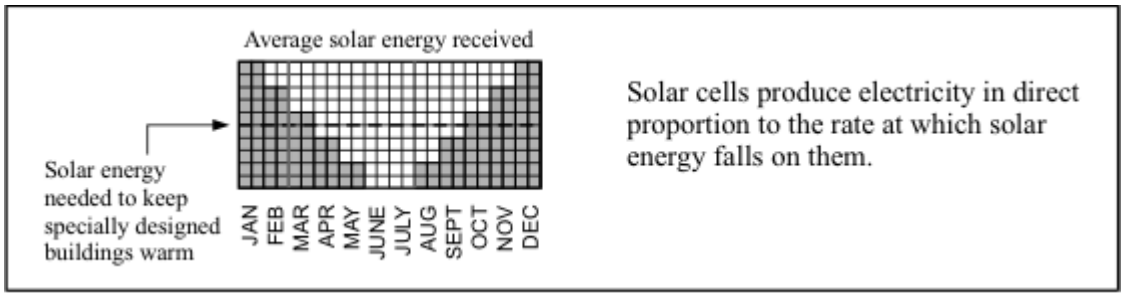
(Total 6 marks)

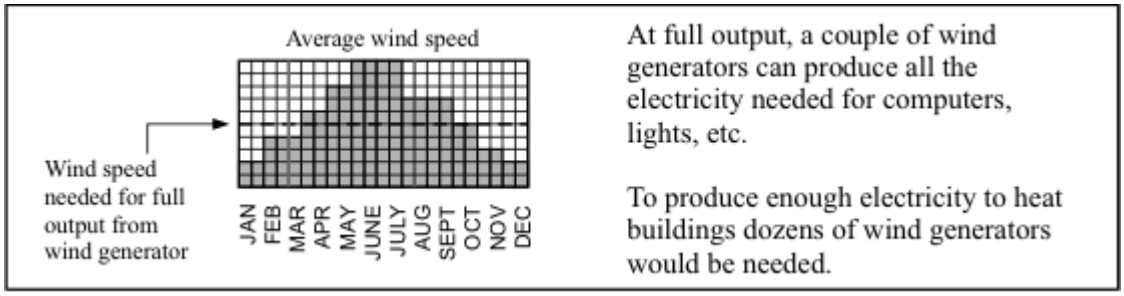
25 Antarctica is a huge land mass surrounding the Earth's south pole. It is covered in a very thick layer of ice and is the only remaining large area of the Earth's surface that has not been affected very much by humans.



There are, however, teams of scientists from various countries studying Antarctica. These scientists need electricity for lighting, for their computers and other scientific instruments and to communicate, via satellite, with the rest of the world. The temperature in Antarctica is always sub-zero, so the scientists need some way of keeping their buildings warm. They also need fuel to be able to get around on their snowmobiles.

Scientists cannot avoid affecting the environment. However, they want to affect it as little as possible.





Atmospheric pollution produced in one country eventually affects the whole of the Earth's atmosphere. The hole that appears each year in the ozone layer above Antarctica, for example, is mainly caused by pollutants such as CFCs from countries in the northern half of the Earth.

Discuss the advantages and disadvantages of using the following energy sources to meet the scientists' needs:

- solar energy
- energy from the wind
- natural gas (present in large quantities deep down in the Antarctic land mass)
- diesel oil (which would have to be imported)

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(Total 10 marks)

1

Level 3 (5–6 marks):
Clear and coherent description of both methods including equation needed to calculate density. Steps are logically ordered and could be followed by someone else to obtain valid results.

Level 2 (3–4 marks):
Clear description of one method to measure density **or** partial description of both methods. Steps may not be logically ordered.

Level 1 (1–2 marks):
Basic description of measurements needed with no indication of how to use them.

0 marks:
No relevant content.

Indicative content

For both:
- measure mass using a balance
- calculate density using ρ = m / V

Metal cube:
- measure length of cube's sides using a ruler
- calculate volume

Small statue:
- immerse in water
- measure volume / mass of water displaced
- volume of water displaced = volume of small statue

[6]

2

(a) (because the) potential of the live wire is 230 V

1

(and the) potential of the electrician is 0 V

1

(so there is a) large potential difference between live wire and electrician

1

charge / current passes through his body

allow voltage for potential difference

1

(b) diameter between 3.50 and 3.55 (mm)

*allow correct use of value of cross-sectional area of 9.5 to 9.9 (mm^2) with no final answer given for **1** mark*

2

(c) 18000 = I × 300

1

I = 18000 / 300 = 60

1

$13\ 800 = (60^2) \times R$

1

$R = 13\ 800 / 60^2$

1

3.83 (Ω)

1

*allow 3.83(Ω) with no working shown for **5** marks*

answer may also be correctly calculated using P = IV and V = IR if 230 V is used.

[11]

3 (a) in a longitudinal wave the oscillations / vibrations are parallel to the direction of energy transfer.

accept wave travel for energy transfer throughout

1

in a transverse wave the oscillations / vibrations are perpendicular to the direction of energy transfer.

1

(b) accept any sensible suggestion eg a vibrating drum skin does not move the air away to create a vacuum (around the drum)

1

(c) **Level 3 (5–6 marks):**
A detailed explanation linking variations in current to the pressure variations of a sound wave, with a logical sequence.

Level 2 (3–4 marks):
A number of relevant points made, but not precisely. A link between the loudspeaker and a sound wave is made.

Level 1 (1–2 marks):
Some relevant points but fragmented with no logical structure.

0 marks:
No relevant content.

Indicative content

the current in the electrical circuit is varying

the current passes through the coil

the coil experiences a force (inwards or outwards)

reversing the current reverses the force

the size of the current affects the size of the force

the varying current causes the coil to vibrate

the (vibrating) coil causes the cone to vibrate

the vibrating cone causes the air molecules to move

the movement of the air molecules produces the pressure variations in the air needed for a sound wave

the air molecules bunch together forming compressions and spread apart forming rarefactions

6

[9]

4

(a) motor effect

1

(b) increase the strength of the magnet

or

increase the current

1

(c) $4.8 \times 10^{-4} = F \times 8 \times 10^{-2}$

1

$F = 6 \times 10^{-3}$ (N)

1

$6 \times 10^{-3} = B \times 1.5 \times 5 \times 10^{-2}$

1

$B = \frac{6 \times 10^{-3}}{7.5 \times 10^{-2}}$

1

$B = 8 \times 10^{-2}$ or 0.08

1

allow 8×10^{-2} ***or*** *0.08 with no working shown for* ***5*** *marks*

a correct method with correct calculation using an incorrect value of F gains ***3*** *marks*

Tesla

accept T

1

do not accept t

[8]

5 (a) energy required to raise the temperature of a substance by 1 °C

accept heat for energy

1

unit mass / 1 kg

1

(b) (i) 7 140 000 (J)

allow 2 marks for a correct substitution, ie

E = 20 × 420 × 850

provided no subsequent step

850 gains ***1*** *mark if no other mark awarded*

3

(ii) particles in the air have more (kinetic) energy than the particles in the steel

allow particles in the air have a greater speed.

1

steel

particles vibrate (about fixed positions)

1

air

particles move freely

1

(ii) the most energetic particles

accept molecules for particles throughout

accept the fastest particles

1

have enough energy to escape from (the surface of) the water

1

therefore the mean energy of the remaining particles decreases

accept speed for energy

1

as energy decreased, temperature has decreased

1

[12]

6 (a) air near freezer compartment is cooled or loses energy

accept air at the top is cold

1

cool air is (more) dense or particles close(r) together (than warmer air)

*do **not** allow the particles get smaller / condense*

1

so (cooler) air falls

1

air (at bottom) is displaced / moves upwards / rises

*do **not** allow heat rises*

accept warm air (at the bottom) rises

1

(b) if volume is doubled, energy use is not doubled

or

volume ÷ energy not a constant ratio

1

correct reference to data, eg 500 is 2×250 but 630 not 2×300

1

(c) accept suitable examples, eg

advantage:

- reduces emissions into atmosphere
- lower input power or uses less energy or wastes less energy
- costs less to run

cost of buying or installing new fridge is insufficient

ignore reference to size of fridge

1

disadvantage:

- land fill
- energy waste in production
- cost or difficulty of disposal
- transport costs

1

[8]

7 (a) (i) 5.88 (watts)

*an answer of 5.9 scores **2** marks*

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

$0.42 = \frac{\text{power out}}{14}$

*allow **1** mark for an answer of 0.0588 or 0.059*

2

(ii) 8.12

allow 14 – their (a)(i) correctly calculated

1

(b) (i) input power / energy would be (much) less (reducing cost of running)

accept the converse

electricity is insufficient

1

(also) produce less waste energy / power

accept 'heat' for waste energy

1

(as the waste energy / power) increases temperature of the cabinet

1

so cooler on for less time

1

(ii) line graph

need to get both parts correct

accept scattergram or scatter graph

both variables are continuous

allow the data is continuous

1

(c) number of bulbs used-halogen=24 (LED=1)

1

total cost of LED = £30 + £67.20 = £97.20

accept a comparison of buying costs of halogen £36 and LED £30

1

total cost of halogen= 24 x £1.50 + 24 x £16.00 = £420

or

buying cost of halogen is £36 **and** operating cost is £384

accept a comparison of operating costs of halogen £384 and LED £67.20

*allow for **3** marks the difference in total cost is £322.80 if the number 24 has not been credited*

1

statement based on correct calculations that overall LED is cheaper

*must be **both** buying **and** operating costs*

an alternative way of answering is in terms of cost per hour:

buying cost per hour for LED $\left(\frac{£30.00}{48000}\right)$ = 0.0625p/£0.000625

buying cost per hour for halogen = $\left(\frac{£1.50}{2000}\right)$ = 0.075p/£0.00075

*a calculation of both buying costs scores **1** mark*

operating cost per hour for LED = $\left(\frac{£67.20}{48000}\right)$ = 0.14p/£0.0014

operating cost per hour for halogen= $\left(\frac{£16.00}{2000}\right)$ = 0.8p/£0.008

*a calculation of both operating costs scores **1** mark*

all calculations show a correct unit

***all** units correct scores **1** mark*

statement based on correct calculations of **both** buying **and** operating costs, that overall LED is cheaper

*correct statement scores **1** mark*

1

[12]

8 (a) momentum before (jumping) = momentum after (jumping)

accept momentum (of the skateboard and skateboarder) is conserved

1

before (jumping) momentum of skateboard and skateboarder is zero

accept before (jumping) momentum of skateboard is zero

accept before (jumping) total momentum is zero

1

after (jumping) skateboarder has momentum (forwards) so skateboard must have (equal) momentum (backwards)

answers only in terms of equal and opposite forces are insufficient

1

(b) 7

*accept –7 for **3** marks*

*allow **2** marks for momentum of skateboarder equals 12.6*

or

0 = 42 × 0.3 + (1.8 × –v)

or

*allow **1** mark for stating use of conservation of momentum*

3

[6]

9 Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also apply a 'best-fit' approach to the marking.

0 marks
No relevant / correct content.

Level 1 (1–2 marks)
Either there is an attempt at a description of the construction of a transformer

or

a correct statement of the effect of one type of transformer on the input p.d.

Level 2 (3–4 marks)
There is a description of the construction of a transformer
and
a correct statement of the effect of one type of transformer on the input p.d.

Level 3 (5–6 marks)
There is a clear description of the construction of a transformer
and
there is a correct description of how transformers affect the input p.d.

details of construction:

extra information

a (laminated) core

core is made from a magnetic material / iron

2 coils

the coils are made from an electrical conductor / copper

the coils are covered in plastic / insulation

the coils are (usually) on opposite sides

step-up transformer has more turns on secondary coil than (its) primary (or vice versa)

step-down transformer has fewer turns on secondary coil than (its) primary (or vice versa)

effect on input p.d. :

step-up transformer, the output p.d. is greater (than the input p.d.)

accept voltage for p.d.

step-down transformer, the output p.d. is lower (than the input p.d.)

6

[6]

10 (a) there are strong forces (of attraction) between the particles in a solid

accept molecules / atoms for particles throughout
accept bonds for forces

1

(holding) the particles close together

particles in a solid are less spread out is insufficient

1

or

(holding) the particles in a fixed pattern / positions

but in a gas the forces between the particles are negligible

accept very small / zero for negligible
accept bonds for forces

1

so the particles spread out (to fill their container)

accept particles are not close together
gas particles are not in a fixed position is insufficient

1

(b) (i) particles are (shown) leaving (the liquid / container)

accept molecules / atoms for particles throughout
accept particles are escaping
particles are getting further apart is insufficient

1

(ii) *accept molecules / atoms for particles throughout*
accept speed / velocity for energy throughout

particles with most energy leave the (surface of the) liquid

accept fastest particles leave the liquid

1

so the <u>mean / average</u> energy of the remaining particles goes down

1

and the lower the average energy (of the particles) the lower the temperature (of the liquid)

1

[8]

11 any **two** pairs from:

to gain credit it must be clear which model is being described

*do **not** accept simple descriptions of the diagram without comparison*

- nuclear model mass is concentrated at the centre / nucleus (1)

  *accept the nuclear model has a nucleus / the plum pudding model does not have a nucleus for **1** mark*

  plum pudding model mass is evenly distributed (1)

- nuclear model positive charge occupies only a small part of the atom (1)

  plum pudding model positive charge spread throughout the atom (1)

- nuclear model electrons orbit some distance from the centre (1)

  accept electrons in shells / orbits provided a valid comparison is made with the plum pudding model

  plum pudding electrons embedded in the (mass) of positive (charge) (1)

  *do **not** accept electrons at edge of plum pudding*

- nuclear model the atom mainly empty space (1)

  plum pudding model is a 'solid' mass (1)

[4]

12 (a) *answers must be in terms of nuclear fuels*

concentrated source of energy

idea of a small mass of fuel able to generate a lot of electricity

1

that is able to generate continuously

accept it is reliable

***or** can control / increase / decrease electricity generation*

idea of available all of the time / not dependent on the weather

ignore reference to pollutant gases

1

the energy from (nuclear) <u>fission</u>

1

is used to heat water to steam to turn turbine linked to a generator

1

(b) carbon dioxide is not released (into the atmosphere)

1

but is (caught and) stored (in huge natural containers)

1

[6]

13 (a) any **two** pairs from:

- nuclear model mass is concentrated at the centre / nucleus (1)

  plum pudding model mass is evenly distributed (1)

  accept the nuclear model has a nucleus/the plum pudding model does not have a nucleus for 1 mark

- nuclear model positive charge occupies only a small part of the atom (1)

  plum pudding model positive charge spread throughout the atom (1)

  accept electrons in shells/ orbits provided a valid comparison is made with the plum pudding model
  *do **not** accept on its own*
  *do **not** accept electrons at edge of plum pudding*

- nuclear model electrons orbit some distance from the centre / nucleus (1)

  plum pudding electrons embedded in the (mass) of positive (charge) (1)

- nuclear model the atom mainly empty space (1)

  plum pudding model is a 'solid' mass (1)

  to gain credit it must be clear which model is being described
  *do **not** accept simple descriptions on the diagram without comparison*

4

(b) nucleus must be positive to deflect/ repel alpha particles

answers in terms of electrons/negative charge causing deflection negates mark answers in terms of reflection negates mark

1

nucleus (very) small so few alpha particles deflected backwards

accept most of atom empty space so most pass through

1

(c) many/ 100 000 measurements taken

accept results for measurements accept data valid / reliable

1

findings could not be explained by plum pudding model

accept a specific finding that could not be explained
eg some alpha particles were deflected backwards

1

[8]

14 (a) **Quality of written communication**

for correct use of term speed in all correct examples
Q ✓ Q ✗

1

*describes all 3 sections correctly for **2** marks*
*describes 2 or 1 section correctly for **1** mark*

max 2

A – **B** constant speed

*do **not** accept pace for speed*

B – **C** (has accelerated) to a higher (constant) speed

C – **D** goes back to original / lower (constant) speed

*allow for **1** mark, initial and final (constant) speeds are the same*
accept velocity for speed
ignore reference to direction

(b) 62.5

allow answer to 2 s.f.

*allow **1** mark for drawing a correct triangle **or** for using two correct pairs of coordinates*

*allow **1** mark for correct use of y/x*

ignore units

3

[6]

15 (a) converted into helium

accept helium created
accept converted into heavier elements
accept used up in nuclear fusion / to produce energy
*do **not** accept any reference to burning*

1

(b) turns / expands into a red giant

contradictions negate mark

1

contracts **and** explodes **or** becomes a supernova

1

may form a (dense) neutron star **or** (if enough mass shrinks to) form a black hole

accept forms a neutron star and (then) a black hole

1

Quality of written communication

correct points must be in sequence

1

(c) (i) supernova **or** remains of an earlier star

ignore super nebula

1

(ii) younger **or** not formed at the time of the Big Bang

1

[7]

16 To gain marks the candidate must

1. Select one option — Advantages) Max 4
2. State 8 valid advantages/disadvantages/relevant comparisons with either of the alternatives — Disadvantages) Min 1 Comparisons)
   If no A or D or C then Max 4
   No option then Max 4

Look for As, Ds for chosen scheme.
Then for Cs compared with A/D for chosen scheme.

Below are listed some of the relevant mark scoring points.

	Advantages	Disadvantages
Wind	Land available to North	Initial cost
	No pollution	Many windmills/much land
	Close/low transmission costs	Calm day problem
	No fuel costs	Few long term jobs
	Renewable energy resource	
Coal	Waste land to North	Pollution
	Prevailing wind to East	Initial costs
	Good road/rail transport	Fuel costs
	Close/low transmission costs	Non-renewable energy
	Save coal industry	Resource
	Overall labour intensive	

Hydroelectric	No pollution	Possible drought
	Mountains/lake/river nearby	Distant/transmission costs
	No fuel costs	Few jobs created
	Renewable energy source	Possible expensive underground transmission cable
		Construction of dam affects environment

[8]

17

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

longest sequence

any 5 for 1 mark each

[5]

18

(a) m*ust give one advantage and one disadvantage of each to get 4 marks and 2 further scoring points*

Advantages and disadvantages relevant to:
(1) health risk
(5) cost
(6) environmental factors
(7) transport/ storage
e.g. common coal / nuclear – high cost of building both

<u>anti-nuclear</u> examples
nuclear fuel transported on roads/rail in region
possible effects on public health in surrounding area
high cost of de-commissioning
long life very active waste materials produced
how waste materials stored safely for a long time

<u>anti-coal</u> examples
unsightly
pollution
supplies of fuel limited
acid rain
non-renewable

<u>pro-nuclear</u> examples
fuel cheap
no foreseeable fuel shortage

pro-coal examples
safe
reliable
large coal reserves
disposal of solid waste is easier

to max 6

6

(b) choice 0 marks

any three valid reasons each with explanation, which may or may not be comparisons with other fuel

But

at least two of which must be relevant to this site

3

[9]

19

(a) the Sun is subject to two balancing forces / 2 forces in equilibrium
the forces are: gravity making it contract **or** inward force due to gravity
and a force due to temperature / heat / energy / radiation pressure making it expand **or** outward force due to temperature / heat / energy / radiation pressure

for 1 mark each

3

(b) Read all the answer first. Stop after 6 marks.

hydrogen / fuel used up owtte the star will expand and become a red giant
it will contract under gravity become a white dwarf
it may explode and become a supernova throwing dust and gas into space
leaving a dense neutron star / black hole

(no mark for contradiction)
any six for 1 mark each

6

[9]

20

(a) the greater the mass / weight

1

then the greater the kinetic energy

accept the greater the momentum
accept greater mass / weight therefore greater force = 2

1

(b) (i)

Note: this calculation requires candidates to show clearly how they work out their answer

k.e. $\frac{1}{2}$ mv^2

accept evidence of equation

1

86 400 (J) at 12 m/s

accept ½ × 1200 × 12^2 ***or*** *86.4 KJ*

1

194 400 (J) at 18 m/s

accept ½ × 1200 × 18^2 ***or*** *194.4KJ*

1

increase in k.e. = 108 000
NB 10800 = 0 marks

N.B. if no working at all then max 3 for a correct numerical answer

1

joules **or J**

accept 108 kilojoules ***or*** *kJ*

1

(ii) explanation that ke $\propto$ v^2

1

[8]

21 Quality of written communication: One mark for using correct scientific sequence : gravity → fusion → balance

1

any **four** from

- (dust and gas) pulled together by gravity
- (star formed when) it is hot enough

  accept (as mass is pulled together) it gets very hot
- <u>hydrogen</u> (and helium) nuclei <u>fuse</u>
- (these nuclear fusion reactions) release the energy / heat / light (which is radiated by stars)
- energy causes expansion
- gravitational pull is balanced by the expansion (force)

4

[5]

22 (a) materials produced when earlier stars exploded

accept the Sun is a second generation star

accept formed from nebulae

1

(b) **Quality of written communication:**
1 mark for correct sequencing balanced forces → expansion → contraction / explosion

1

any **five** from

gravity pulling matter together

accept idea that a star is very massive so its force of gravity is very strong

high temperatures that create expansion forces

nuclear fusion releases energy that causes the very high temperatures

these forces balance

star expands greatly

since expansion is greater than gravity

accept fuel runs out

forms a red giant

give no further marks if red giant → white dwarf, red dwarf etc

collapses inwards and explodes outwards

called a supernova

neutron star may form

leaves a small, dense object (a black hole)

accept nothing can escape from it

5

[7]

23 *ideas that:* galaxies show a red-shift

gains 1 mark

but more distant galaxies show bigger red-shift

gains 2 marks

galaxies moving away/Universe expanding

gains 1 mark

but more distant galaxies moving away faster

gains 2 marks

so all Universe once in one place

for 1 further mark
(only if the previous 2 marks are also gained)

[5]

24 ideas that

- formed from dust/gases
- pulled together by gravity
- massive so very large gravitational forces (pulling inwards)
- hydrogen → helium / fusion releases energy [<u>not</u> fission or just 'nuclear']
- high temperature creates high pressure (pushing outwards)
- long period when forces balance
- then expands → red giant / red star
- then contracts to (dense) white dwarf / white star

[<u>credit</u> if massive enough / more massive than sun, red giant → supernova → (very dense) neutron star but do not accept w.r.t. Sun itself]

[The whole of the (non bracketed part of) each idea <u>must</u> be present in some appropriate for in of words for each mark to be credited. To gain more than a single mark ideas must also be in correct sequence and/or appropriately related.]

any six 1 mark each

[6]

25 ideas that

- direct solar radiation will provide enough energy to heat the (specially designed) buildings during the period Oct-Mar / summer
- solar cells will produce plenty of electricity in Oct-Mar / summer (when wind generators produce little)
- a couple of wind generators will produce all electricity needed (for all but heating) Apr-Oct / winter
- number required makes wind generators unsuitable for heating / buildings
- no solar energy in June and July / little in winter
- solar / wind have little effect on environment
- **or** cause no air pollution
- solar and wind complement each other
- **or** together provide energy all year
- fuel / gas / diesel can provide energy all the time / at any time
- fuel / gas / diesel needed for transport
- fuel / gas / diesel needed for heating <u>in winter</u>
- diesel has to be imported
- diesel likely to freeze
- gas wouldn't have to be imported
- drilling for gas difficult / harms environment
- but atmospheric pollution a global rather than local matter so any produced in Antarctic doesn't matter much

(deduct 1 mark (to min^{m}. zero) for incorrect claims about destroying ozone layer)

- gas produces less carbon dioxide (for the same energy released) than diesel*
- gas produces less sulphur dioxide (for the same energy released than diesel*

(* these ideas met by candidates in Q.16 so must be <u>allowed</u>, though not <u>required</u>)

any ten for 1 mark each

[10]

5

(a) The definition of specific heat capacity was well known, with nearly two-thirds of students gaining both marks. A small minority achieved one mark, either failing to specify a mass of 1 kg or a rise in temperature of 1 °C. A common error was to attempt to define latent heat.

(b) (i) This calculation was very well answered with almost all students scoring all three marks. Few gained two marks, usually for substituting into the correct equation, but failing to perform the calculation correctly. Another common error was to use the final temperature instead of the change in temperature.

(ii) Around a third of students gained all three marks, with a further third scoring two marks and around a fifth scoring one mark. Whilst most students attempted to describe the movement of the particles, many failed to address the comparison of energies. Of those who failed to gain a mark, many appeared to answer a different question - for example comparing the particles in the steel at high and low temperatures or comparing energy transfer in solids and gases.

(iii) More than one-quarter failed to score any marks, with just over 10% achieving all four marks. Most did not refer to the reduction in the mean energy of the remaining particles and how this links to a fall in temperature. Despite the question saying 'explain in terms of particles', many answers were seen which made no reference to particles at all − this is an example of a situation where it would benefit students to highlight key words in the question.

6

(a) This question was well answered on the whole, with around half of students scoring at least three of the four marks. Many answers started with warmer air rising, rather than with the cooler air falling. Whilst many students made reference to changes in density, they often incorrectly referred to the 'particles becoming denser'.

(b) Around a fifth of students achieved both marks. Many answers indicated that 'directly proportional' meant that the two values had to be the same, as in fridge D. Some students worked out the difference in volume between each fridge and the previous one, and also the difference in energy used. As these were not the same, they stated that the data did not show proportionality.

To check if results are directly proportional, either the ratio of the volume to energy used needs to be a constant or the volume and energy used needs to change by the same multiplier.

(c) Nearly two-thirds scored at least one mark, but only around a fifth scored both. Many students seem to have overlooked the instruction to ignore the cost of buying a new fridge. Many answers indicated that 'more efficient' meant that the new fridge was colder, or kept food fresher for longer.

7

(a) (i) Three fifths of the students were able to substitute into the equation and rearrange it to find the useful power output. The main error was not selecting the equation using efficiency as a fraction rather than as a percentage.

(ii) Around half of the students answered correctly. Common incorrect responses were to subtract their answer to the previous part from 1 or from 100.

(b) (i) Around three-quarters of students scored at least one mark, usually for stating that the input power was less for the LED bulbs. Whilst many appreciated that the efficiency was also less, few explained the consequence of this in terms of less energy wasted meaning the temperature of the cabinet would increase more slowly, resulting in the cooler unit being used less often.

(ii) This was a standard demand question. Whilst the majority of answers recognised that a line graph (or scattergram) should be drawn, a small proportion gave a correct reason by saying that both variables were continuous. It would appear that many students do not think to transfer their knowledge from ISAs to this written paper.

(c) Around a fifth of students scored full marks. Good answers included clearly drawn, mathematically-based conclusions, showing all calculations. Those who chose to write a larger amount of prose often missed a vital part of the information, for instance just comparing the purchase costs and ignoring the operating costs.

8

(a) A large proportion of the students scored zero on this question, many because of their failure to use the idea of momentum. The majority of these answers included reference to forces, commonly beginning ‘every action has an equal and opposite reaction’ etc. Some of the students picked up marks for stating that momentum is conserved or words to that effect and a smaller number picked up a mark for realising that the initial momentum was zero. Some students related the situation to an explosion but still struggled to score more than one mark. However, those who understood the situation were able to give clear answers gaining full marks.

(b) Over half of the students scored zero on this calculation. Many added the masses together before attempting to calculate any momentum, and there was a general lack of clear understanding. Very few of the students scored a mark for stating that momentum was conserved but some compensation marks were scored for finding the final momentum of the skateboarder.

9

This question also assessed the quality of written communication. The vast majority of students produced a level 1 answer worth 1 or 2 marks. Many students either did not attempt the question or discussed the use of transformers, rather than their construction. Those students who did score, many referred correctly to the number of turns on respective coils, but failed to carry this through to the effect on p.d. Many students referred to current, electricity, energy or power instead of or alongside p.d. often contradicting a correct statement. Many made no reference to the iron core, which limited their access to higher levels. There were a number of answers that described the iron core as a good conductor of electricity rather than mentioning its magnetic properties.

10

(a) Whilst many answers referred to the arrangement of particles in solids and gases, fewer responses referred to the forces between the particles.

(b) (i) Just under half of the students answered correctly in terms of particles leaving the container / liquid. Other answers seen just referred to the particles 'rising.'

(ii) Many answers referred to particles needing energy to escape, but often just stated 'gaining energy', without specifying that they had more energy than the particles that remained. Very few students gained the second marking point because they did not refer to "mean / average" energy. A fair number of students gained the third mark by linking a decrease in energy to the decrease in temperature.

11

A very small number of the students scored all 4 marks, and a majority of the students scored zero. A major problem was again a lack of clear description or a failure to read the question carefully which resulted in a description of one or the other models without reference to differences.

12

(a) The term 'nuclear fission' was well known. However, it is alarming how many students think that nuclear fuels are burned in order to release energy. The process of generating electricity was not well described; many students seem to think that it is the turbine that generates the electricity. An advantage of nuclear fuels 'reliability' was often given. However, many students spent a lot of time and filled a lot of space describing numerous disadvantages of nuclear energy and / or the advantages and disadvantages of wind with no reference at all to nuclear energy.

(b) Nearly a fifth of students did not attempt this question. Many students simply repeated the stem of the question and had no idea about the storage of the carbon dioxide following its 'capture'. A common error was the assumption that 'carbon capture' involves the removal of the existing carbon dioxide from the atmosphere.

13

This question was generally not well answered.

(a) The major issue with candidate responses is that few have any idea about writing an answer structured to contrast the differences. The second part of a comparison often appearing in a different part of the text. Some candidates failed to identify which model was which and many candidates merely described the two diagrams. There was a commonly expressed belief that the plum pudding model was a positively charged particle overall and often that it was a large nucleus. The position of the electrons in this structure was frequently thought to be superficial, and in a significant number of cases it was thought that the label on the model meant that the electrons were positive.

(b) Answers were often unclear, with evidence that candidates had not always read the information given in the stem of the question. Many candidates wrote about alpha particles passing through rather than about the deflections. Others wrote about electrons being deflected. Many candidates believed that the deflections were due to interaction with electrons.

(c) Most candidates were unable to link the information provided to the idea of change and the reasons why scientists may decide a scientific model is no longer acceptable.

14

(a) The poor use of English seemed to hinder many candidates. A significant number had difficulty expressing that speed had changed at a point rather than between points. However, the vast majority of candidates did seem to realise that the speed was constant between each pair of points. There were a few who thought the car was accelerating throughout.

(b) The calculation of gradient was correctly completed by a good range of candidates. However, it was common to see 5/4 rather than the actual coordinates.

15

Answers to this question seemed either centre dependent or interest dependent, with some candidates scoring highly and some scoring virtually no marks. In part (a) the term fusion was not well known with many candidates incorrectly referring to ‘burning’. Part (b) was often confused, with some candidates eventually getting to the correct answer having presumably spotted the ‘at least 5 times bigger than the Sun’ in brackets. Part (c) either scored full marks or none.

16

This question produced many pleasing answers, candidates making a choice and then giving reasoned arguments for their choice. However some interpreted the question as ‘Write everything you can about coal fired power stations, wind turbines and hydroelectric schemes’. Such candidates were unable to score full marks on the mark scheme. A few chose the hydroelectric scheme and proceeded to generate power on the lake, river and coastal waters, skipping from one to the other with ease.

17

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.

19 In part (a) only the most able candidates were able to identify the two forces acting on the Sun correctly, though more of them realised that the forces are balanced. A number of candidates referred to the stability of the Solar System.

The answers to part (b) varied in quality form those where candidates were fortunate to pick up marks by mentioning 'red giant', 'white dwarf' etc. amongst a lot of mis-ordered or irrelevant information; to those which covered the whole range of possibilities in a well-structured order and could have gained ten marks if these had been available. For the really able candidates, or the candidate with a genuine interest in Astronomy, this must have been a satisfying way to end the examination.

20 (a) Most candidates recognised correctly that the bus was heavier but there were relatively few answers that referred to both mass and kinetic energy.

(b) Many candidates used the correct equation but only the most able could cope with the v^2 part of this. Weaker candidates subtracted 12 m/s from 18 m/s and then used the equation. Candidates who did not follow the instruction, 'Show clearly how you work out your answer', could not be credited with full marks even if the final answer was correct. In the final part, the majority of candidates failed to refer to v^2.

21 Responses were generally disappointing. Too many candidates simply restated information from the stem and then went on to describe the sequence of events once the main stable period had ended. Many candidates could describe how 'dust and gas' were pulled together by gravity, but then wrote very vague explanations of what happened next. A minority of candidates realised that the process that released energy was called 'nuclear fusion'. There were as many candidates who thought this energy was from the burning of hydrogen. Very few candidates understood the idea that during the main stable period of the Sun the gravitational pull is balanced by expansion forces, caused by the very high temperatures.

22 There were mostly poor responses to all parts of this question. The sequence of the life cycle of a star was given to candidates in diagrammatic form and many candidates were still unable to describe the sequence in the correct order.

23 Many weaker candidates produced answers relating to the origin of the solar system or of individual stars. Amongst creditworthy responses, the expansion of the Universe as indicated by galaxies moving away from each other was frequently mentioned but the fact that the speed of this movement increases with distance was mentioned much less frequently. It is the latter, proportional, relationship which implies that all the galaxies were once all at the same point. Some candidates correctly described observations of red-shifts as evidence for the above. In some scripts, however, the word “red-shift” was used in a way that indicated no understanding of the concept or of its significance.