Q1. **Diagram 1** shows a hairdryer.
Diagram 2 shows how the heaters and fan of the hairdryer are connected to a 3-pin plug.
The hairdryer does not have an earth wire.

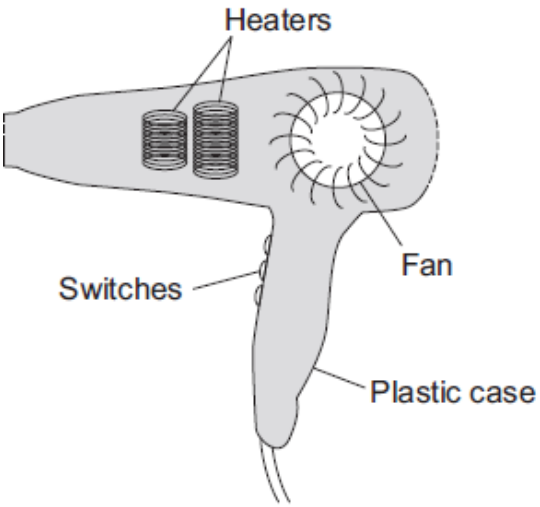


Diagram 1

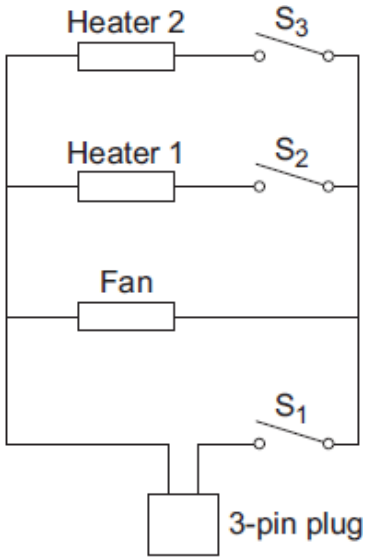


Diagram 2

(a) What colour is the insulation around the wire connected to the live pin inside the plug?

.....

(1)

(b) Why does the hairdryer **not** need an earth wire?

.....

.....

(1)

(c) All the switches are shown in the OFF position.

(i) Which switch or switches have to be ON to make:

(1) only the fan work; .....

(2) heater 2 work? .....

(2)

(ii) The heaters can only be switched on when the fan is also switched on.

Explain why.

.....

.....

.....

.....

.....

(2)

(d) The table shows the current drawn from the 230 volt mains electricity supply when different parts of the hairdryer are switched on.

	Current in amps
Fan only	1.0
Fan and heater 1	4.4
Fan and both heaters	6.5

Use the equation in the box to calculate the maximum power of the hairdryer.

power = current × potential difference

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

.....

.....

Maximum power = ...

(3)

(Total 9 marks)

Q2. (a) Nuclear fission is used in nuclear power stations to generate electricity. Nuclear fusion happens naturally in stars.

(i) Explain briefly the difference between *nuclear fission* and *nuclear fusion*.

.....

.....

.....

.....

.....

(2)

(ii) What is released during both nuclear fission and nuclear fusion?

.....

(1)

(b) Plutonium-239 is used as a fuel in some nuclear reactors.

(i) Name another substance used as a fuel in some nuclear reactors.

.....

(1)

(ii) There are many isotopes of plutonium.

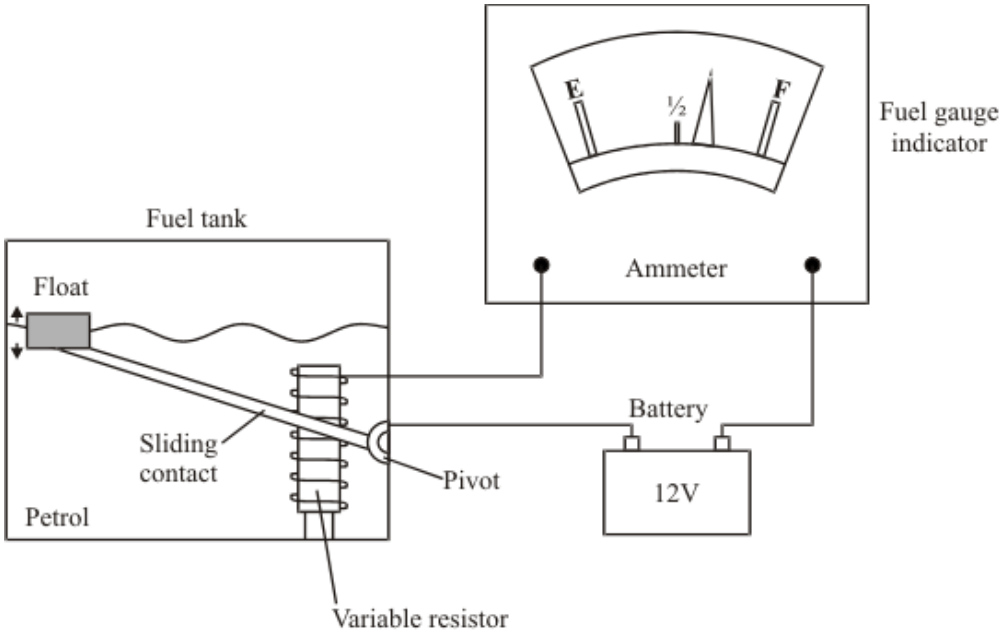
What do the nuclei of different plutonium isotopes have in common?

.....

(1)
(Total 5 marks)

Q3. The diagram shows the fuel gauge assembly in a car.

- The sliding contact touches a coil of wire and moves over it.
- The sliding contact and the coil form a variable resistor.
- The sliding contact is connected to a float via a pivot.
- The fuel gauge indicator is an ammeter.
- When the petrol level changes, the resistance of the circuit changes.
- This causes the pointer in the fuel gauge indicator to move.



(a) Use standard symbols to draw a circuit diagram for the fuel gauge assembly.

(3)

(b) How will the current in the circuit change as the level of petrol in the tank falls?

.....

Explain the reason for your answer.

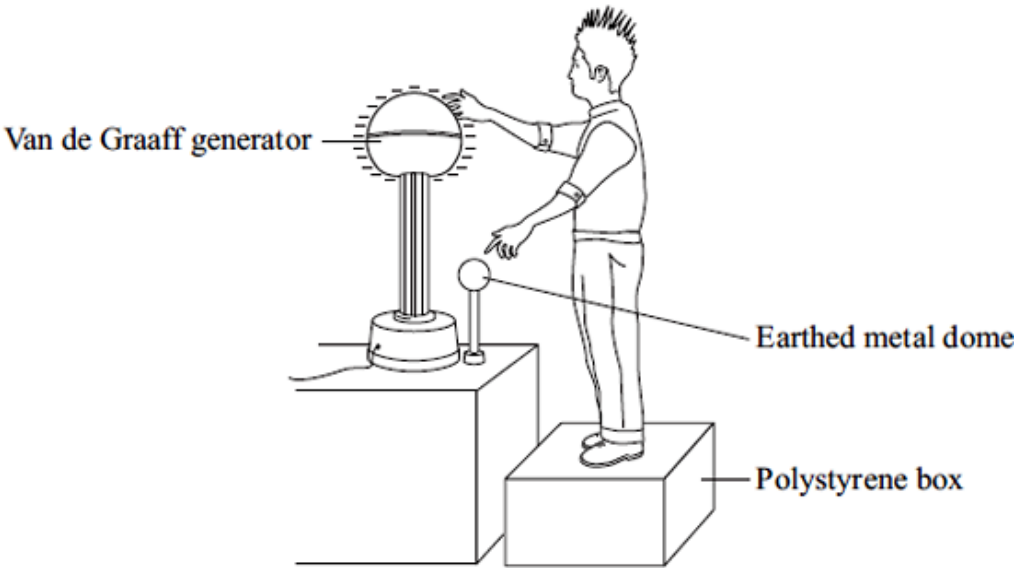
.....

.....

.....

(2)
(Total 5 marks)

Q4. (a) The diagram shows a student touching the metal dome of a Van de Graaff generator. When the generator is switched on, the metal dome becomes negatively charged.



Explain why the student's hair stands on end when the generator is switched on.

.....

.....

.....

(2)

(b) When the potential difference between the student and a nearby earthed metal dome reached 15 kV, a spark jumped between the student and the earthed dome. The spark transformed 30 mJ of energy into heat, light and sound. (1 mJ = 0.001 J)

Use the equation in the box to calculate the charge carried by the spark.

energy transformed = potential difference × charge

.....

.....

Charge transferred =..... coulombs

(2)

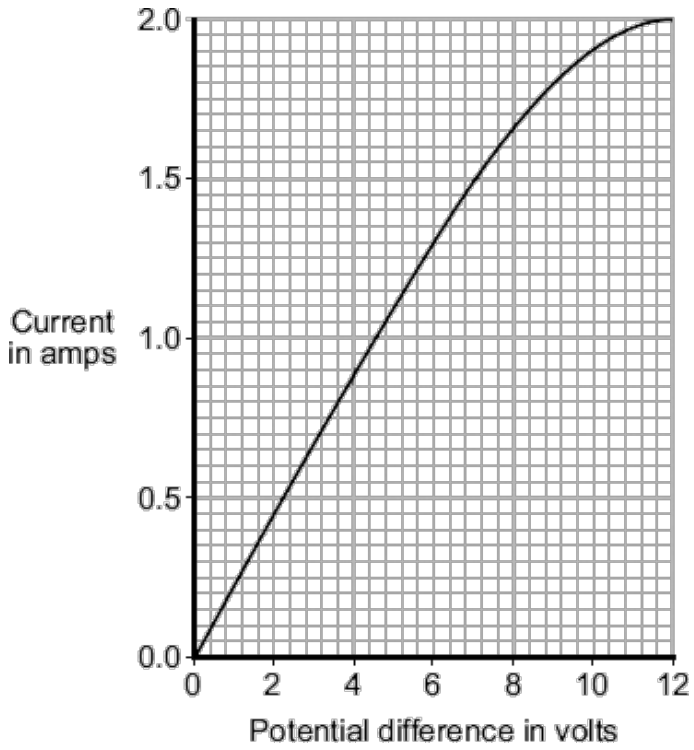
(c) What name is given to the rate of flow of charge?

.....

(1)

(Total 5 marks)

Q5. The graph shows how the electric current through a 12 V filament bulb varies with the potential difference across the bulb.



(a) What is the meaning of the following terms?

electric current

.....

.....

potential difference

.....

.....

(2)

(b) The resistance of the metal filament inside the bulb increases as the potential difference across the bulb increases.

Explain why.

.....

.....

.....

.....

.....

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.....

.....

(3)

(c) Use data from the graph to calculate the rate at which the filament bulb transfers energy, when the potential difference across the bulb is 6 V.

Use the correct equation from the Physics Equations Sheet.

Show clearly how you work out your answer.

.....

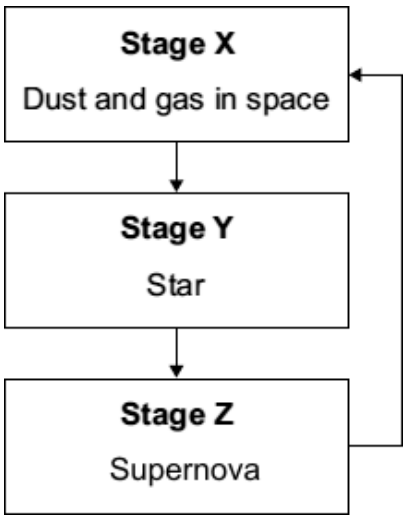
.....

Rate of energy transfer = ... W

(2)

(Total 7 marks)

Q6. The flowchart shows a simple version of the life cycle of a star that is much more massive than the Sun.



(a) What causes the change from **Stage X** to **Stage Y**?

.....

(1)

(b) For most of its time in **Stage Y**, the star is stable.

Explain why the star remains stable.

.....

.....

.....

.....

(2)

(c) (i) Explain how a star is able to produce energy in **Stage Y**.

.....

.....

.....

.....

(2)

(ii) Why is a star in **Stage Y** able to give out energy for millions of years?

.....

.....

(1)

(d) What happens to the elements produced in a supernova?

.....

.....

(1)

(Total 7 marks)

Q7. (a) Nuclear power stations generate about 14% of the world's electricity.

(i) Uranium-235 is used as a fuel in some nuclear reactors.

Name **one** other substance used as a fuel in some nuclear reactors.

.....

(1)

(ii) Energy is released from nuclear fuels by the process of nuclear fission.

This energy is used to generate electricity.

Describe how this energy is used to generate electricity.

Do **not** explain the nuclear fission process.

.....

.....

.....

.....

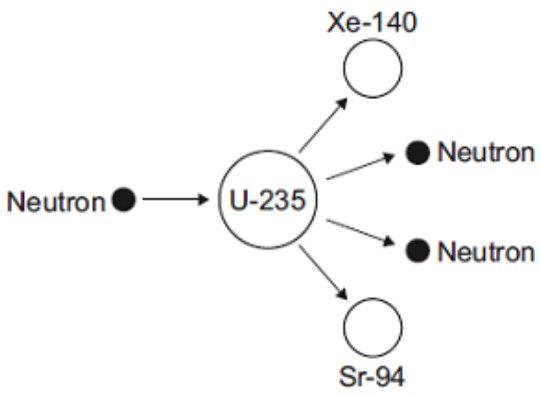
.....

.....

(3)

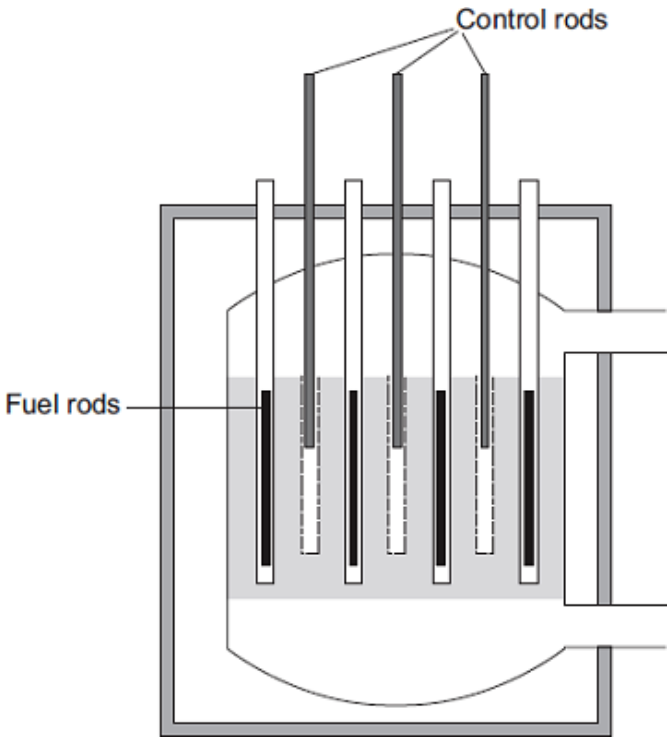
(b) The diagram shows the nuclear fission process for an atom of uranium-235.

Complete the diagram to show how the fission process starts a chain reaction.



(2)

(c) The diagram shows the cross-section through a nuclear reactor.



The control rods, made from boron, are used to control the chain reaction. Boron atoms absorb neutrons without undergoing nuclear fission.

Why does lowering the control rods reduce the amount of energy released each second from the nuclear fuel?

.....

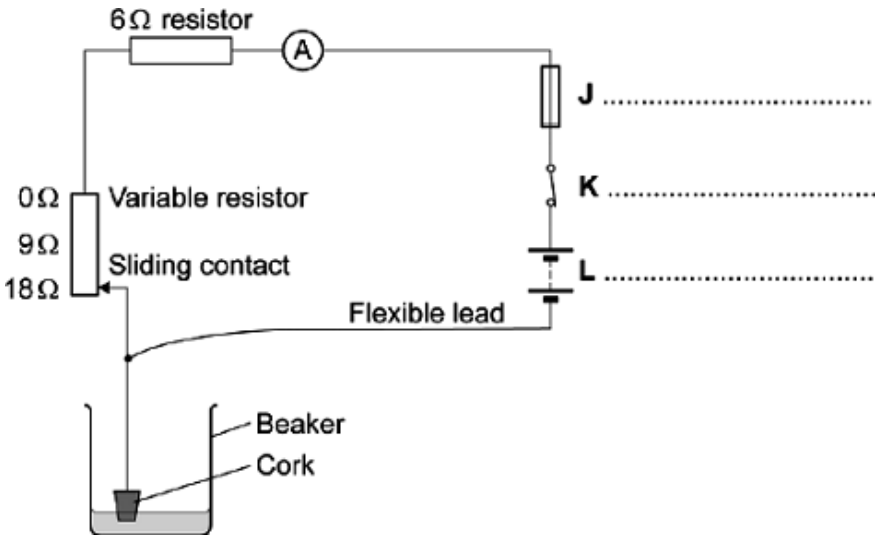
.....

.....

.....

(2)
(Total 8 marks)

Q8. A student has designed the circuit shown in the diagram to measure the water level in a beaker. The student is going to use the ammeter to indicate the water level.



(a) Use words from the box to label the three components, **J**, **K** and **L**, on the diagram.

battery	**cell**	**fuse**	**lamp**	**resistor**	**switch**

(3)

(b) The resistance of the variable resistor changes as the cork moves up and down inside the beaker. This changes the *electric current* flowing in the circuit.

(i) What is meant by the term *electric current*?

.....

.....

(1)

(ii) When a voltmeter was mistakenly added to the circuit in series, the reading on the ammeter was zero.

Suggest why.

.....

.....

(1)

(c) The table gives the variable resistor value and the ammeter readings for different water levels. The table is not complete.

Water level	**Variable resistor value in ohms**	**Ammeter reading in amps**
Full	0	2.0
Half full	9	0.8
Empty	18	

Calculate the reading on the ammeter, in amps, when the beaker is empty.

Assume the ammeter, battery, fuse and wires have zero resistance.

.....

.....

.....

Ammeter reading = ... A

(3)

(d) A second student copied the design using a 2A fuse, but he forgot to include the 6Ω resistor.

What will happen to the fuse in this circuit as the water reaches the top of the beaker?

Explain your answer.

.....

.....

.....

.....

.....

.....

.....

(5)

(Total 13 marks)

M1. (a) brown

1

(b) outside / case is plastic / an insulator

accept is double insulated

accept non-conductor for plastic

*do **not** accept it / hairdryer is plastic*

1

(c) (i) (1) S_1

and no other

1

(2) S_1 and S_3

both required, either order

1

(ii) S_1 must be ON (for either heater to work)

*do **not** accept reference to 'fan' switch*

1

S_1 switches the fan on

1

(d) 1495

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

ie, 6.5 × 230

2

watt(s) or W

*an answer of 1.495 kW gains **3** marks*

although the unit is an independent mark for full credit

the unit and numerical value must be consistent

accept joules per second or J/s

1

[9]

M2. (a) (i) (nuclear) fission is the splitting of a (large atomic) nucleus

*do **not** accept particle/atom for nucleus*

1

(nuclear) fusion is the joining of (two atomic) nuclei (to form a larger one)

do not accept particles/atoms for nuclei

1

(ii) energy

accept heat/radiation/nuclear energy
accept gamma (radiation)
do not accept neutrons/neutrinos

1

(b) (i) uranium (–235)

accept U (–235)
ignore any numbers given with uranium
accept thorium
accept MOX (mixed oxide)
*do **not** accept hydrogen*

1

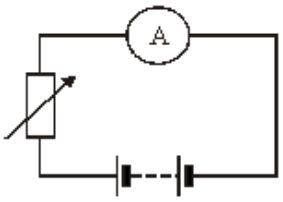
(ii) (same) number of protons

accept (same) atomic number
accept (same) positive charge
ignore reference to number of electrons

1

[5]

M3. (a)



3

one mark for each symbol
allow more than 2 cells joined

max. 2 marks if symbols incorrectly allow rheostat arrow in either direction

(b) current will decrease

1

since resistance greater

1

[5]

M4. (a) each hair gains the same (type of) charge

or

(each) hair is negatively charged

*do **not** accept hair becomes positively charged*

or

(each) hair gains electrons

1

similar charges repel

accept positive charges repel

providing first marking point is in terms of positive charge

or

negative charges repel

or

electrons repel

1

(b) 0.000002

*accept correct substitution and transformation for **1** mark*

or

2×10^{-6}

ie 30 / 15 or .03 / 15000 or 30 / 15000 or .03 / 15

or

2 μ C

*answers 2 and 0.002 gain **1** mark*

2

(c) current

*do **not** accept amp / amperes*

1

[5]

M5. (a) electric current

(rate of) flow of (electric) charge / electrons

accept $I = \frac{Q}{t}$

with Q and t correctly named

1

potential difference

work done / energy transferred per coulomb of charge

(that passes between two points in a circuit)

accept $V = \frac{W}{Q}$

with W and Q correctly named

1

(b) metals contain free electrons (and ions)

accept mobile for free

1

as temperature of filament increases ions vibrate faster /

with a bigger amplitude

accept atoms for ions

accept ions/atoms gain energy

accept vibrate more for vibrate faster

do not accept start to vibrate

1

electrons collide more (frequently) with the ions
or
(drift) velocity of electrons decreases

do not accept start to collide
*accept increasing the p.d. increases the temperature (**1** mark)*
and
*(and) resistance increases with temperature (**1** mark) if no other marks scored*

1

(c) 7.8

*allow **1** mark for obtaining value 1.3 from graph*
***or** allow **1** mark for a correct calculation using an incorrect current in the range 1.2-1.6 inclusive*

2

[7]

M6. (a) gravitational attraction

accept 'gravity'
accept (nuclear) fusion

1

(b) radiation 'pressure' and gravity / gravitational attraction

must be in correct context

1

are balanced / in equilibrium

accept are equal and opposite
*do **not** accept 'equal'*
or
there is sufficient / a lot of hydrogen / fuel

*do **not** accept constant supply of hydrogen*

to last a very long time / for (nuclear) fusion

this mark only scores if linked to the supply of hydrogen / fuel
reference to burning negates both marks

1

(c) (i) (conversion of) hydrogen to helium

accept (conversion of) lighter elements to heavier elements

1

by (nuclear) fusion

*note do **not** credit spelling of 'fusion' which could be 'fission'*
reference to burning negates both marks

1

(ii) massive supply / lots of hydrogen

1

(d) distributed throughout the Universe / space

*do **not** accept Solar System for Universe*

1

[7]

M7. (a) (i) plutonium (239)

accept Pu / Thorium / MOX (mixed oxide)

*do **not** accept uranium-238 **or** hydrogen*

1

(ii) (energy) used to heat water and

1

produce (high pressure) steam

1

the steam drives a turbine (which turns a generator)

1

(b) Neutron(s) shown 'hitting' other U-235 nuclei

one uranium nucleus is sufficient

1

U-235 nuclei (splitting) producing 2 or more neutrons

1

(c) any **two** from:

- neutrons are absorbed (by boron / control rods)
- there are fewer neutrons
- chain reaction slows down / stops

accept fewer reactions occur

2

[8]

M8. (a) **J** fuse

1

K switch

1

L battery

1

(b) (i) a flow of (electrical) charge

1

(ii) because voltmeters have a very high resistance

1

(c) total resistance = 24 Ω

1

$\frac{12}{24}$

1

0.5 (A)

*correct answer with or without working gains **3** marks*

*an answer of 0.66˙ or 0.67 gains **2** marks*

$\frac{12}{18}$ *alone gains **1** mark*

1

(d) the fuse melts

1

therefore breaking the circuit

1

because without the 6 Ω resistor as the water reaches the top of the beaker the total resistance approaches 0 Ω

1

therefore the current rises above the 2 A fuse rating

1

and the heating effect increases

1

[13]