This question paper consists of 23 printed pages and 1 blank page.

[Turn over
Here are pictures of five vertebrate organisms.

A
B
C
D
E

Here is a key to identify the organisms.

1  legs  go to 2
    no legs  Fish

2  4 legs  go to 3
    2 legs  Bird

3  hair  Mammal
    no hair  go to 4

4  scales  Reptile
    no scales  Amphibian

Use the key to work out which vertebrate group each organism belongs to.
Write your answers in the table.

<table>
<thead>
<tr>
<th>name of organism</th>
<th>vertebrate group</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

[4]
2 Ian used a microscope to look at some cells.

He drew a diagram of one cell.

(a) Finish labelling the diagram. Choose the best words from the list.

- cell membrane
- chloroplasts
- cytoplasm
- nucleus
- vacuole

(b) The table shows the names of some cell parts and the jobs they do.

(i) Finish the table. There are three gaps.

<table>
<thead>
<tr>
<th>cell part</th>
<th>job</th>
</tr>
</thead>
<tbody>
<tr>
<td>cell wall</td>
<td>provides support</td>
</tr>
<tr>
<td></td>
<td>where most chemical reactions take place</td>
</tr>
<tr>
<td>nucleus</td>
<td>controls what goes into and out of the cell</td>
</tr>
</tbody>
</table>

(ii) Put a ring around the process that takes place in a mitochondrion.

- excretion
- respiration
- transpiration
This is a photograph of a root tip. It shows a region with root hairs (B) and a region without root hairs (A).

(c) What is the job of root hairs?

(d) The table shows information about this root and its root hairs.

<table>
<thead>
<tr>
<th>surface area of the root (A and B) with the root hairs removed/ cm²</th>
<th>surface area of all the root (A and B) with root hairs/ cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>24</td>
</tr>
</tbody>
</table>

Root hairs increase the surface area of the root. How many times greater is the surface area of the root with root hairs than the surface area of the root without root hairs? You must show how you work out your answer.

Answer ___________________________________ times greater  [2]
(e) A gardener grows wallflower plants from seeds. He pulls them up and replants them in his flower beds. He waters these plants every day. The plants wilt for several days after replanting. Then they recover.

Explain why the plants wilt and then recover.

__________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________________
3 The diagram shows part of the human digestive system and some organs.

(a) Label the diagram.

Choose the best words from this list.

large intestine
liver
oesophagus
pancreas
small intestine
stomach

(b) Write on the diagram:

(i) an A to show where most of the digested food is absorbed into the blood stream.

(ii) a D to show where proteins are first digested.

(iii) an E to show where undigested food is egested.
(c) The diagram shows food moving through the digestive system.

Describe how food is moved through the digestive system.

___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________
___________________________________________________________________________

[2]
This question is about what animals eat.

(a) Choose words from the diagram to answer these questions.

(i) Write down the name of the producer.

(ii) Write down the name of a primary consumer.

(iii) Write down the name of a predator.

(b) What name is given to this type of diagram?

Put a (ring) around the correct answer.

food chain  food pyramid  food web  [1]

(c) Suggest what happens to the number of caterpillars if all the grasshoppers die. Explain your answer.

______________________________________________________________________________

______________________________________________________________________________

______________________________________________________________________________[2]
Doctors did a survey to investigate the effects of smoking on health.

The table and bar chart show some of the results of the survey.

<table>
<thead>
<tr>
<th>number of cigarettes per day</th>
<th>number of deaths per 100 000 people per year</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>from lung cancer</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1-14</td>
<td>6</td>
</tr>
<tr>
<td>15-24</td>
<td>35</td>
</tr>
<tr>
<td>25+</td>
<td>200</td>
</tr>
</tbody>
</table>

(a) Use the information provided to:

(i) finish the table. There are two gaps. [2]

(ii) draw the missing bar on the bar chart. [1]

(b) Describe the patterns shown by the two sets of results in the survey.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [3]
6 The fossil dinosaur was found in a piece of rock.

(a) Why is the dinosaur in the rock described as a fossil?

(b) Write down the name of a type of rock where fossils can be found.

(c) Why are fossils important to scientists?
(d) The diagrams show how an animal changes into a fossil.

Write about how fossils are formed.

Use the information in the diagrams and your biological knowledge to answer the question.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________[2]
(e) This question is about fossil fish.
    The diagram shows which fish were alive at different times in the past.

(i) Which type of fish is not alive today?

__________________________________________________________________________ [1]

The diagram below shows the layers of rock in a cliff.
The bottom of layer B is 410 millions of years old.

(ii) In which layers of rock could fossil lung fishes be found?

__________________________________________________________________________ [1]
7 This question is about variation.

(a) Here is a diagram of a holly leaf. A holly leaf has prickles around the edge.

In an investigation, Shaheen counted the number of prickles on thirty holly leaves. The table shows the results.

<table>
<thead>
<tr>
<th>number of prickles per leaf</th>
<th>number of leaves</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>2</td>
</tr>
</tbody>
</table>

On the grid, finish the bar chart of these results. Two bars have been drawn for you.
(b) Here is a list of human characteristics.

- blood group
- body mass
- height
- length of index finger
- sex (gender)

(i) Write down two of these characteristics which show continuous variation.

1. 

2. [1]

(ii) Write down two of these characteristics which show discontinuous variation.

1. 

2. [1]

Human characteristics may be controlled by genes.
Some may be modified by the environment.
Some may be caused by the environment.
Here is another list of human characteristics.

- blood group
- body mass
- natural eye colour
- scar
- sex (gender)
- skin colour

(c) Write one of these characteristics in each of the three boxes in the table.

<table>
<thead>
<tr>
<th>method of control</th>
<th>characteristic</th>
</tr>
</thead>
<tbody>
<tr>
<td>controlled by genes only</td>
<td></td>
</tr>
<tr>
<td>controlled by genes and modified by the environment</td>
<td></td>
</tr>
</tbody>
</table>
| caused by the environment                |                | [3]
8 This question is about skin sensitivity.

(a) Peter presses Susan's skin with a hairpin. He presses the skin on her wrist, fingertips and the back of her hand. He tests each part ten times. Sometimes he presses both points on to the skin and sometimes just one point.

Every time Peter presses her skin, Susan says the number of points she feels.

(i) What is the stimulus in this experiment?

___________________________________________________________________________[1]

(ii) Write down Susan's response in this experiment.

___________________________________________________________________________[1]
Peter writes down how many times she calls out the correct number of points.

The chart shows the results for the skin on different parts of Susan's body.

(b) Write down the name of the part of Susan's body where her skin was most sensitive to the stimulus.

____________________________________________________ [1]

(c) The skin on Susan's body was more sensitive in some parts than in others. Suggest two causes of this difference in sensitivity.

____________________________________________________

____________________________________________________

____________________________________________________ [2]
(d) Peter's teacher gave him a diagram of a sensory and a motor neurone. Finish labelling the diagram. Choose the best words from this list.

- axon
- dendron
- effector
- receptor
- synapse

sensory neurone

B

motor neurone

C
9 This question is about liquids in the body.

(a) Some liquids are used to defend the body.

Put ( ) around two liquids that help to do this.

- stomach acid
- sweat
- tears
- urine

[2]

(b) A boy falls off his bike and cuts his leg.
Microbes may get into the cut.
Microbes may cause an infection in the cut.

(i) Platelets and white blood cells are found in the blood.

Explain how these parts of the blood help to defend the body against infection.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

[3]

(ii) Name two parts of our blood other than platelets and white blood cells.

Describe the jobs they do.
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

[2]
10 Plants make their own food.

(a) (i) Finish the word equation for this process.

\[ \text{water} + \underline{\phantom{0}} \rightarrow \text{glucose} + \underline{\phantom{0}} \] [2]

(ii) Write down the name of this process.

\[ \underline{\phantom{0}} \] [1]

(b) (i) Where does the energy to drive this process come from?

\[ \underline{\phantom{0}} \] [1]

(ii) Write down the name of the substance in leaves which traps this energy.

\[ \underline{\phantom{0}} \] [1]

(c) (i) Glucose can be broken down by cells to release energy.
Write down the name of this process.

\[ \underline{\phantom{0}} \] [1]

(ii) The glucose can also be built up into different substances.
These substances can then be used in many different ways.

Name two of these substances and explain how they are used in a plant.

Name \[ \underline{\phantom{0}} \]

How used \[ \underline{\phantom{0}} \] [2]

Name \[ \underline{\phantom{0}} \]

How used \[ \underline{\phantom{0}} \] [4]
11 The table shows information about four different drugs.

<table>
<thead>
<tr>
<th>drug</th>
<th>type of action</th>
<th>habit-forming</th>
</tr>
</thead>
<tbody>
<tr>
<td>amphetamine</td>
<td>stimulant</td>
<td>yes</td>
</tr>
<tr>
<td>barbiturate</td>
<td>depressant</td>
<td>yes</td>
</tr>
<tr>
<td>cocaine</td>
<td>stimulant</td>
<td>yes</td>
</tr>
<tr>
<td>paracetamol</td>
<td>analgesic</td>
<td>no</td>
</tr>
</tbody>
</table>

Use the information in the table and your biological knowledge to answer the following questions.

(a) Paracetamol is an analgesic.

What does **analgesic** mean?

(b) Write down the name of the drug shown in the table that will slow down the action of the nervous system.

Name of drug ______________________________________________________ [1]

(c) People who have taken cocaine find it difficult to stop taking it.

Suggest why cocaine can be habit-forming.

__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________
__________________________________________________________________ [2]
12 Henry wanted to estimate the energy content of a biscuit. He placed 20g of water in a large test tube. He then measured the temperature of the water.

Henry burned the biscuit under the large test tube and measured the temperature of the water again.

(a) (i) Use Henry's results to fill in the table.

<table>
<thead>
<tr>
<th>temperature</th>
<th>°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>temperature before heating</td>
<td></td>
</tr>
<tr>
<td>temperature after heating</td>
<td></td>
</tr>
<tr>
<td>change in temperature</td>
<td></td>
</tr>
</tbody>
</table>

[2]
(ii) Henry knows that 1g of water needs 4.2 J of energy to increase its temperature by 1°C. Calculate how much energy the water obtained from Henry’s biscuit.

You must show how you work out your answer.

\[ \text{energy} = \quad \text{J} \]  

[3]

(b) Henry repeated his experiment using the following apparatus. He found that the water obtained more energy from the biscuit.

Write down two features of this apparatus which improved his result. Explain how these features improved his result.

Feature 1 _____________________________________________________________

Explanation ________________________________________________________

Feature 2 _____________________________________________________________

Explanation ________________________________________________________

[4]
General Certificate of Secondary Education
former Midland Examining Group syllabus

SCIENCE: DOUBLE AWARD PAPER 2 1794/2
SCIENCE: BIOLOGY PAPER 2 1780/2
SCIENCE: BIOLOGY (NUFFIELD) PAPER 2 1785/2

HIGHER TIER

Tuesday 6 JUNE 2000 Afternoon 1 hour 45 minutes

Candidates answer on the question paper.
Additional materials required:
Ruler (cm/mm), Pencil.

TIME 1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer all questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
The marks allocated and the spaces provided for your answers are a good indication of the length of answers required.

FOR EXAMINER’S USE

1
2
3
4
5
6
7
8
9
10
11
12
13
TOTAL

This question paper consists of 27 printed pages and 1 blank page.
1  (a) The diagram shows part of the human digestive system and some organs.

Add labels to the diagram to show:

(i) oesophagus
(ii) pancreas
(iii) large intestine
(b) The diagram shows food moving through the digestive system.

Describe how food is moved through the digestive system.

(c) The liver makes bile.
Bile is stored in the gall bladder.
It is released into the digestive system.

Describe two ways in which bile helps in the digestion of food.
1

2

[2]
The table shows information about four different drugs.

<table>
<thead>
<tr>
<th>drug</th>
<th>type of action</th>
<th>habit-forming</th>
</tr>
</thead>
<tbody>
<tr>
<td>amphetamine</td>
<td>stimulant</td>
<td>yes</td>
</tr>
<tr>
<td>barbiturate</td>
<td>depressant</td>
<td>yes</td>
</tr>
<tr>
<td>cocaine</td>
<td>stimulant</td>
<td>yes</td>
</tr>
<tr>
<td>paracetamol</td>
<td>analgesic</td>
<td>no</td>
</tr>
</tbody>
</table>

Use the information in the table and your biological knowledge to answer the following questions.

(a) Paracetamol is an analgesic.

What does analgesic mean?

(b) Write down the name of the drug shown in the table that will slow down the action of the nervous system.

Name of drug

(c) People who have taken cocaine, find it difficult to stop taking it.

Suggest why cocaine can be habit-forming.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
3 (a) A boy falls off his bike and cuts his leg. Microbes may get into the cut. Microbes may cause an infection in the cut.

(i) Platelets and white blood cells are found in the blood.

Explain how these parts of the blood help to defend the body against infection.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [3]

(ii) Name two parts of our blood other than platelets and white blood cells.

Describe the jobs they do.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [2]

(b) Microbes also enter our bodies in the food we eat.

Explain how our digestive systems destroy these microbes.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [2]
Henry wanted to estimate the energy content of a biscuit. He placed 20 g of water in a large test tube. He then measured the temperature of the water.

20 g of water

Henry burned the biscuit under the large test tube and measured the temperature of the water again.

biscuit pin

(a) Henry knows that 1 g of water needs 4.2 J of energy to increase its temperature by 1°C.

Calculate how much energy the water obtained from Henry's biscuit.

You must show how you work out your answer.

energy = [ ] J [3]
(b) Henry repeated his experiment using the following apparatus.

He found that the water obtained more energy from the biscuit.

Write down two features of this apparatus which improved his result.

Explain how these features improved his result.

Feature 1
Explanation

Feature 2
Explanation

[4]
This is a photograph of a root tip. It shows a region with root hairs (B) and a region without root hairs (A).

(a) What is the job of root hairs?
(b) The table shows information about this root and its root hairs.

<table>
<thead>
<tr>
<th>surface area of all the root (A and B) with the root hairs removed / cm²</th>
<th>surface area of all the root (A and B) with root hairs / cm²</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>24</td>
</tr>
</tbody>
</table>

Root hairs increase the surface area of the root.

How many times greater is the surface area of the root with root hairs than the surface area of the root without root hairs?

You **must** show how you work out your answer.

Answer .................................................................................................................. [1]
(c) A gardener grows wallflower plants from seeds. He pulls them up and replants them in his flower beds. He waters these plants every day. The plants wilt for several days after replanting. They then recover.

![Wilted and recovered plants]

Explain why the plants wilt and then recover.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________ [3]

(d) Ian wants to look at stomata on a leaf from a plant that had recovered. He puts part of the epidermis of a leaf on a slide. This is shown in the diagram.

![Diagram showing slide and part of the epidermis]
Ian looks at the epidermis with a microscope. He draws what he sees. Add a label to the diagram to show a guard cell.

(e) Cobalt chloride paper is blue when it is dry. The paper turns pink when water vapour wets it.

Ian put a piece of dry cobalt chloride paper on the bottom surface of a wilted leaf and on the bottom surface of a recovered leaf. He covered the pieces of cobalt chloride paper with clear sticky tape. He left the pieces of cobalt chloride paper on the leaves for 30 minutes.

The table shows his results after 30 minutes.

<table>
<thead>
<tr>
<th>leaf</th>
<th>colour of the cobalt chloride paper at the beginning</th>
<th>colour of the cobalt chloride paper after 30 minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>wilted</td>
<td>blue</td>
<td>blue</td>
</tr>
<tr>
<td>recovered</td>
<td>blue</td>
<td>pink</td>
</tr>
</tbody>
</table>

Explain Ian’s results.

_________________________________________________________

_________________________________________________________

_________________________________________________________

(f) Explain how a closed stoma opens.

_________________________________________________________

_________________________________________________________

_________________________________________________________
6 This question is about skin sensitivity.

Peter presses Susan's skin with a hairpin.  
He presses the skin on her wrist, fingertips and the back of her hand.  
He tests each part ten times.  
Sometimes he presses both points on to the skin and sometimes just one point.

Every time Peter presses her skin, Susan says the number of points she feels.  
Peter writes down how many times she calls out the correct number of points.
The chart shows the results for the skin on different parts of Susan's body.

(a) The chart shows that the skin on Susan's body was more sensitive in some parts than in others.

Suggest two causes of this difference in sensitivity.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________ [2]

(b) Explain how the energy from the stimulus reaches Susan's central nervous system.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________ [3]
(c) Peter's teacher gives him a diagram of a sensory and a motor neurone. Finish labelling the diagram and choose the best words from this list.

- axon
- effector
- neurone
- receptor
- response
- stimulus
- synapse

(d) Explain how the structure of a neurone helps it to carry out its function.
7. (a) Kezia helps to look after the gerbils at school.
A pair of gerbils with brown fur had babies.
Three of the baby gerbils had brown fur and one had white fur.

(i) Finish the genetic diagram to explain this cross.
Write the possible genotypes of the gametes of the parents in the circles.
Write the expected genotypes of the babies in the squares.

Use B for the dominant allele for brown fur.
Use b for the recessive allele for white fur.

(ii) Kezia wants only baby gerbils with white fur.

Write down the genotypes of the parents that she needs to cross to produce only
gerbils with white fur.

(b) One of the gerbils is born with two extra toes.

Kezia thinks this could be a mutation.

Suggest a possible environmental factor that may increase the probability of random
gene mutation.

[Turn over]
8 This question is about what animals eat and energy flow.

(a) Suggest what happens to the number of caterpillars if all the grasshoppers die.

Explain your answer.


[2]

(b) The grasshopper and the greenfly belong to the same trophic level.

(i) What is a 'trophic level'?


[1]

(ii) Write down the name of the organism in the diagram which can be placed at two different trophic levels.


[1]
(c) Energy enters the food web as the energy of sunlight.

The diagram shows the flow of energy through part of the food web.

A small percentage of the energy of sunlight is transferred to the plant.
Part of the energy in the plant is transferred to the caterpillar.
Part of the energy in the caterpillar is transferred to the bird.

(i) Calculate the percentage of energy in the plant that is transferred to the bird.
Use the numbers in the diagram.
You must show how you work out your answer.

Answer ____________________________ % [2]

(ii) Energy moves through the food web in organic compounds.
Name one of these organic compounds.

_________________________________________ [1]

(iii) Write down two ways in which energy is ‘lost’ from the food web.

1 ________________________________________

2 ________________________________________ [2]
9 Plants make glucose by photosynthesis.

(a) Write down the balanced symbol equation for this process.

__________________________________________________________________________ [2]

(b) (i) Glucose can be broken down by cells to release energy.

Write down the name of this process.

__________________________________________________________________________ [1]

(ii) The glucose can also be built up into different substances. These substances can then be used in many different ways.

Name two of these substances and explain how they are used in a plant.

Name__________________________________________________________________________

How used__________________________________________________________________________

__________________________________________________________________________

Name__________________________________________________________________________

How used__________________________________________________________________________ [4]

Light intensity, wavelength of light and concentration of carbon dioxide affect the rate of photosynthesis.

(c) Write down the name of another environmental factor that can affect the rate of photosynthesis.

__________________________________________________________________________ [1]
(d) The graph shows the rate of photosynthesis as light intensity changes at three different concentrations of carbon dioxide.

![Graph showing rate of photosynthesis vs. light intensity, with labels A, B, C, D, E, and annotations for CO₂ concentrations.]

(i) Write down the letter (A, B, C, D or E) which shows where light is the only limiting factor.

\[\text{[1]}\]

(ii) Write down the letter (A, B, C, D or E) which shows where carbon dioxide is the only limiting factor.

\[\text{[2]}\]

Explain your answer.

\[\text{[2]}\]

(e) Explain how different wavelengths (colours) of light can affect the rate of photosynthesis.

\[\text{[3]}\]
10 Otters live on riverbanks and feed on fish. They are successful predators.

(a) (i) Explain what is meant by the term predator.

__________________________________________________________________________[1]

(ii) Describe two adaptations shown by otters and explain how these adaptations make them successful predators of fish.

1__________________________________________________________________________

2__________________________________________________________________________[2]

(b) Several years ago the otter population in the Midlands started to decline. Conservationists suggested that the decline could be because of the use of certain pesticides.

Suggest how the use of pesticides can cause a decline in the otter population over several years.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________[3]
(c) In 1998 conservationists announced that the otter population in the Midlands had recovered and was on the increase.

A few months later, over 2,000 mink were released from a mink farm.

Conservationists predict that the release of the mink into the wild will cause another decline in the otter population.

Suggest two reasons why the release of the mink will affect the otter population.

1

2

[2]
11 A scientist measured the volume of sweat and urine a student produced at different air temperatures.

<table>
<thead>
<tr>
<th>air temperature in °C</th>
<th>sweat produced in cm$^3$ per hour</th>
<th>urine produced in cm$^3$ per hour</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>4</td>
<td>100</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>90</td>
</tr>
<tr>
<td>10</td>
<td>8</td>
<td>80</td>
</tr>
<tr>
<td>15</td>
<td>20</td>
<td>62</td>
</tr>
<tr>
<td>20</td>
<td>40</td>
<td>54</td>
</tr>
<tr>
<td>25</td>
<td>60</td>
<td>40</td>
</tr>
<tr>
<td>30</td>
<td>100</td>
<td>30</td>
</tr>
<tr>
<td>35</td>
<td>200</td>
<td>20</td>
</tr>
</tbody>
</table>

(a) The graph shows the student's urine production.

(i) Plot the points to show the student's sweat production at different temperatures. Use the same grid. [2]

(ii) Finish the graph by drawing the best curve through the points. [1]
(iii) Describe the changes in the volume of sweat and urine as the air temperature increases.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

[2]

(b) Explain why the volumes of sweat and urine change with air temperature.

__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________
__________________________________________________________________________

[5]
A company grows plants that are sold to the public. The company needs to produce many thousands of young plants at the same time.

One way of doing this is by micropropagation.

The diagrams show one method of micropropagation.

(a) (i) Explain why only a few cells are needed.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

(ii) Explain why this process is carried out in sterile conditions.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
(iii) The growth medium contains sucrose, amino acids, vitamins, nitrates and phosphates. It also contains hormones such as auxins.

Explain why the following substances are needed in the growth medium.

sucrose

amino acids

auxins

[3]

(b) There are economic and biological advantages of micropropagation for the commercial production of plants.

List four of these advantages.

1

2

3

4

[4]
13 This question is about controlling the rate of breathing.

The table shows how a person's breathing rate can vary.

<table>
<thead>
<tr>
<th>activity</th>
<th>carbon dioxide production in cm³ per minute</th>
<th>rate of breathing in breaths per minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>resting in bed</td>
<td>197</td>
<td>16</td>
</tr>
<tr>
<td>walking slowly</td>
<td>922</td>
<td>18</td>
</tr>
<tr>
<td>walking fast</td>
<td>2000</td>
<td>20</td>
</tr>
<tr>
<td>walking very fast</td>
<td>2400</td>
<td>21</td>
</tr>
</tbody>
</table>

(a) Explain why the amount of carbon dioxide produced changes.

(b) Explain how the carbon dioxide concentration of the blood results in the change of breathing rate shown in the table.
General Certificate of Secondary Education
former Midland Examining Group syllabus

SCIENCE: DOUBLE AWARD PAPER 3 1794/3
SCIENCE: CHEMISTRY PAPER 1 1781/1
SCIENCE: CHEMISTRY (NUFFIELD) PAPER 1 1786/1

FOUNDATION TIER

Monday 12 JUNE 2000 Morning 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials required:
Pencil,
Ruler (cm/mm).

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES
Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer all questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets [ ] at the end of each question or part question.
The marks allocated and the spaces provided for your answers are a good indication of the length of answers required.
A copy of the Periodic Table is printed on the back page.

<table>
<thead>
<tr>
<th>FOR EXAMINER'S USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>11</td>
</tr>
<tr>
<td>12</td>
</tr>
<tr>
<td>13</td>
</tr>
<tr>
<td>TOTAL</td>
</tr>
</tbody>
</table>

This question paper consists of 18 printed pages and 2 blank pages.

[Turn over
1 (a) Mrs. Brown is showing her class how to get some pure water from salty water.

She uses this apparatus.

Add labels to the diagram. Choose the best words from this list.

- condenser
- filter funnel
- pure water
- salty water
- thermometer

(b) You can use Universal Indicator solution to show if a liquid is an acid, neutral or an alkali.

<table>
<thead>
<tr>
<th>pH</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>acid</td>
<td>neutral</td>
<td>alkali</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>colour of Indicator</td>
<td>red</td>
<td>orange</td>
<td>green</td>
<td>blue</td>
<td>purple</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Pure water is neutral and has a pH value of 7.

How would you use the Universal Indicator solution to show this? Describe what you would see.
2 This question is about crude oil.

Which three useful substances do we get from crude oil?

Put ( ) around the three substances.

- aircraft fuel
- aluminium foil
- limestone chips
- paper
- propane gas
- road tar

3 Here are some statements about metals.

Only three of them are correct.

Put a tick (✓) in the box next to each correct statement.

- Metals conduct electricity. ✓
- Metals are always liquid. □
- Helium is a metal. □
- Metals conduct heat. ✓
- The halogens are metals. □
- Some metals react with water. □
Ranjan finds out how three metals react with some solutions.

Her results are shown in the table.

<table>
<thead>
<tr>
<th>name of solution</th>
<th>metal added</th>
</tr>
</thead>
<tbody>
<tr>
<td>copper(II) sulphate</td>
<td>blue colour fades no change blue colour fades</td>
</tr>
<tr>
<td></td>
<td>red-brown solid appears</td>
</tr>
<tr>
<td>iron(II) sulphate</td>
<td>pale green colour fades no change</td>
</tr>
<tr>
<td></td>
<td>dark grey solid appears</td>
</tr>
<tr>
<td>magnesium sulphate</td>
<td>no change no change</td>
</tr>
</tbody>
</table>

(a) (i) Which metal does not react with any of the solutions?

(ii) Which metal reacts with two solutions?

(iii) Put the metals copper, iron and magnesium in order of reactivity.

most reactive

least reactive

(b) Here is the equation for the reaction between magnesium and copper(II) sulphate.

magnesium + copper(II) sulphate → copper + magnesium sulphate

Ranjan sees a red-brown solid appear in this reaction.

She also sees that the blue colour fades.

(i) Which is the red-brown solid?

Put a tick (✓) in the correct box.

- copper
- copper(II) sulphate
- magnesium
- magnesium sulphate

[1]
(ii) Which substance has the blue colour that fades?

Put a tick (✓) in one box.

- copper
- copper(II) sulphate
- magnesium
- magnesium sulphate  [1]

(c) Ranjan's teacher tells her that the reaction between magnesium and copper(II) sulphate solution is **exothermic**.

Describe an experiment that Ranjan could do to see if this is correct.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________[2]

(d) (i) Two of the metals that Ranjan used in the experiment are **transition** metals.

Put a (ring) around each of the **two** transition metals.

- copper
- iron
- magnesium  [1]

(ii) Choose one of these metals.

Write down a use for this metal and explain why it is suitable for this use.

metal chosen = ____________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________[2]

(e) Zinc is more reactive than copper.

Describe what you would see when some zinc is added to copper(II) sulphate solution.

________________________________________________________________________

________________________________________________________________________[2]
5 (a) The exhaust gases from older cars are tested each year.

These exhaust gases contain carbon monoxide, unburned hydrocarbons and smoke.

If the amount of one of these is too high, the car will fail its test.

Look at these results from an exhaust test.

Use these results to answer the questions.

<table>
<thead>
<tr>
<th>item</th>
<th>test result</th>
<th>maximum limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbon monoxide</td>
<td>4.0 %</td>
<td>3.5 %</td>
</tr>
<tr>
<td>unburned hydrocarbons</td>
<td>197 ppm</td>
<td>1200 ppm</td>
</tr>
<tr>
<td>idle speed</td>
<td>pass</td>
<td></td>
</tr>
<tr>
<td>smoke level</td>
<td>pass</td>
<td></td>
</tr>
</tbody>
</table>

(i) What is the maximum limit of carbon monoxide allowed? [1]

(ii) This car failed its test. Why?

Put a tick (✓) in the correct box.

- There is too much carbon monoxide. [ ]
- There is too much unburned hydrocarbon. [ ]
- There is too much smoke. [ ] [1]

(b) Why is carbon monoxide dangerous?

__________________________________________________________________________ [1]

(c) As well as carbon monoxide, unburned hydrocarbons, smoke and water, car exhausts contain other gases.

One of these gases may cause a change in the Earth’s weather. Explain this.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [3]
6 Polythene and PVC are polymers.

The table shows some of the properties of these polymers.

<table>
<thead>
<tr>
<th>polymer</th>
<th>Does it melt easily?</th>
<th>Does it catch fire easily?</th>
<th>Does it conduct electricity?</th>
<th>Can it be coloured easily?</th>
<th>Can it be bent easily?</th>
</tr>
</thead>
<tbody>
<tr>
<td>polythene</td>
<td>yes</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>PVC</td>
<td>yes</td>
<td>no</td>
<td>no</td>
<td>yes</td>
<td>no</td>
</tr>
</tbody>
</table>

Use only the information in the table to answer these questions.

(a) Polythene is not used to make saucepans.

Suggest two reasons.

1. ____________________________________________

2. ____________________________________________ [2]

(b) A polymer is used to make the covering for electrical wires.

Explain why PVC is better than polythene for the covering on electrical wires.

______________________________________________

______________________________________________

______________________________________________ [2]

(c) PVC is better than polythene for making window frames.

Which property of PVC is the most important for this use?

______________________________________________ [1]

(d) Write down the name of a household item that is made from polythene.

______________________________________________ [1]
7 (a) (i) The diagram represents an atom of lithium.

Add labels to the diagram. Use all of the words from this list.

- electrons
- neutrons
- protons

.............................. and ..............................

(ii) What name is given to the central part of the atom?

................................................................. [1]

(b) Fill in the gaps in the sentences.

Use the Periodic Table to help you.

(i) Lithium is in Group ______ of the Periodic Table. [1]

(ii) Lithium is in Period ______ of the Periodic Table. [1]

(c) Write down the symbol of an element which has an atomic number smaller than lithium.

__________________ [1]

(d) Mr. Green is a science teacher.

He shows his class how lithium, sodium and potassium react with water.

What safety precautions should Mr. Green take?

.................................................................

.................................................................

.................................................................

.................................................................

.................................................................[3]
8 We can represent chemical reactions using equations.

(a) Look at these word equations.

A methane + oxygen → carbon dioxide + water
B sodium hydroxide + nitric acid → sodium nitrate + water
C hydrogen peroxide → oxygen + water
D sodium + water → sodium hydroxide + hydrogen

Answer the following questions by choosing from A, B, C or D.

Each letter may be used once, more than once or not at all.

(i) Which equation represents a neutralisation reaction?

(ii) Which equation represents a combustion reaction?

(iii) Which equation shows the formation of an alkali?

[3]

(b) Finish the symbol equation for C.

............ H₂O₂ → ............ H₂O + O₂

[1]
Jo and Andy are finding out about rates of reaction.

They react hydrochloric acid with marble chips (calcium carbonate).

\[
\text{hydrochloric acid} + \text{calcium carbonate} \rightarrow \text{calcium chloride} + \text{carbon dioxide} + \text{water}
\]

They use this apparatus.

(a) The mass of the flask and its contents decreases during the experiment.

Suggest why this happens.

__________________________________________________________________________________________

__________________________________________________________________________________________ [1]

(b) Jo and Andy measure the total mass of the flask and its contents as the reaction takes place.

The table shows their results.

<table>
<thead>
<tr>
<th>time in minutes</th>
<th>mass of flask and contents in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>190.0</td>
</tr>
<tr>
<td>2</td>
<td>188.0</td>
</tr>
<tr>
<td>4</td>
<td>187.0</td>
</tr>
<tr>
<td>6</td>
<td>186.3</td>
</tr>
<tr>
<td>8</td>
<td>186.1</td>
</tr>
<tr>
<td>10</td>
<td>186.0</td>
</tr>
<tr>
<td>12</td>
<td>186.0</td>
</tr>
</tbody>
</table>
(i) Plot their results on the grid. [2]

(ii) Finish the graph by drawing the best curve through the points. [1]

(iii) Jo says that the reaction was faster between 0 and 2 minutes than between 2 and 4 minutes.

How do the results show this? [2]

(c) In the first experiment the hydrochloric acid was at room temperature.

Jo and Andy repeat the experiment.

The only difference is that the hydrochloric acid is at a higher temperature.

Sketch a curve on the grid to show the results they get. [2]
10. The table shows information about some compounds.

<table>
<thead>
<tr>
<th>formula</th>
<th>name</th>
<th>type of structure</th>
<th>melting point in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaO</td>
<td>calcium oxide</td>
<td>giant</td>
<td>2900</td>
</tr>
<tr>
<td>H₂O</td>
<td>water</td>
<td>molecular</td>
<td>0</td>
</tr>
<tr>
<td>NaCl</td>
<td></td>
<td>giant</td>
<td>808</td>
</tr>
<tr>
<td>SO₂</td>
<td></td>
<td>molecular</td>
<td>-75</td>
</tr>
</tbody>
</table>

(a) Finish the table by writing in the names for NaCl and SO₂. [2]
(b) What links the melting point and the type of structure?
Use the information in the table to help you.

________________________________________________________________________
________________________________________________________________________ [2]

(c) Put a (ring) around the word which best finishes this sentence.
The forces holding the particles together in calcium oxide are called chemical ____________.

atoms   bonds   magnets   molecules [1]
(d) Calcium and oxygen react together to form calcium oxide.

During the reaction two electrons move from a calcium atom to an oxygen atom.

Calcium ions, Ca\(^{2+}\), and oxide ions, O\(^{2-}\), are formed.

Finish the table. There are two spaces.

<table>
<thead>
<tr>
<th>element</th>
<th>number of electrons in an atom</th>
<th>arrangement of electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium Ca</td>
<td>20</td>
<td>2.8.8.2</td>
</tr>
<tr>
<td>oxygen O</td>
<td>8</td>
<td>2.6</td>
</tr>
<tr>
<td>ion</td>
<td>number of electrons in an ion</td>
<td>arrangement of electrons</td>
</tr>
<tr>
<td>calcium Ca(^{2+})</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>oxide O(^{2-})</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

(e) Calculate the relative formula mass of calcium oxide, CaO.

Use the Periodic Table to help you.

________________________________________________________________________

________________________________________________________________________

(f) Strontium, Sr, reacts with oxygen in a similar way to calcium.

It forms a compound, strontium oxide, SrO.

Explain these facts.

Use your Periodic Table and your knowledge of the structure of atoms to help you.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
11 The diagram shows how rocks are broken down and new rocks formed in the rock cycle.

(a) These are four processes involved in forming sedimentary rocks:

They are in the wrong order.

A depositing sediments
B cementation
C transporting sediments
D weathering and erosion

Fill in the boxes to show the correct order. Use the diagram to help you.

[3]

(b) Write down two processes taking place when metamorphic rocks turn into igneous rocks.

1

2 [2]

(c) What conditions of temperature and pressure are needed to turn sedimentary rocks into metamorphic rocks?

[2]
(d) This table shows some information about slate, chalk and granite.

<table>
<thead>
<tr>
<th>rock</th>
<th>Is the rock crystalline?</th>
<th>Can the rock contain fossils?</th>
</tr>
</thead>
<tbody>
<tr>
<td>slate</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>chalk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>granite</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finish the table by putting ‘yes’ or ‘no’ in each of the four spaces.

The diagram may help you. [2]
12 Nitrogen and hydrogen react to form ammonia.

The equation for the reaction is

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$

(a) Finish the sentence by choosing the best word from this list.

fertiliser neutralisation reversible

The reaction between nitrogen and hydrogen to form ammonia is a __________ reaction. [1]

(b) Large quantities of nitrogen and hydrogen are used to make ammonia.

(i) Which raw material is used to get nitrogen?

Put a (ring) around the correct answer.

air limestone sea water [1]

(ii) Which raw material is used to get hydrogen?

Put a (ring) around the correct answer.

air crude oil limestone [1]

(c) Using too much fertiliser can cause pollution in rivers and can kill fish.

(i) Here are five sentences describing how this happens. They are in the wrong order.

Fill in the boxes to show the right order. The first one has been done for you.

A Algae grow well on the fertiliser and cover the river.
B Excess fertiliser dissolves in rain and drains into rivers.
C There is little oxygen left for the fish and they die.
D The algae die and bacteria decompose them.
E The bacteria use up most of the oxygen in the water.

B __________ __________ __________ [3]

(ii) What word is used to describe this process?

Put a (ring) around the correct answer.

distillation eutrophication fertilisation neutralisation [1]
13 The table shows the approximate composition of the atmosphere.

<table>
<thead>
<tr>
<th>name of gas</th>
<th>percentage of gas in the atmosphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>argon</td>
<td>1</td>
</tr>
<tr>
<td>carbon dioxide</td>
<td>0.03</td>
</tr>
<tr>
<td>nitrogen</td>
<td>78</td>
</tr>
<tr>
<td>oxygen</td>
<td>20</td>
</tr>
</tbody>
</table>

Use the names of gases from the table to answer the questions.
Each name may be used once, more than once or not at all.

(a) Which gas makes up most of the atmosphere?
    ______________________  [1]

(b) Which gas makes up about 1/5th of the atmosphere?
    ______________________  [1]

(c) Which gas is made when animals respire?
    ______________________  [1]

(d) Which gas do plants use in photosynthesis?
    ______________________  [1]

(e) Which gas is in Group 0 of the Periodic Table?
    ______________________  [1]
DATA SHEET
The Periodic Table of the Elements

<table>
<thead>
<tr>
<th>Group</th>
<th>I</th>
<th>II</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Li</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>Be</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Na</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Mg</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Al</td>
<td>13</td>
<td></td>
</tr>
<tr>
<td>Si</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>15</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>Cl</td>
<td>17</td>
<td></td>
</tr>
<tr>
<td>Ar</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Ca</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Sc</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Ti</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Cr</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Mn</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Fe</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Co</td>
<td>27</td>
<td></td>
</tr>
<tr>
<td>Ni</td>
<td>28</td>
<td></td>
</tr>
<tr>
<td>Cu</td>
<td>29</td>
<td></td>
</tr>
<tr>
<td>Zn</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>Ga</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Ge</td>
<td>32</td>
<td></td>
</tr>
<tr>
<td>As</td>
<td>33</td>
<td></td>
</tr>
<tr>
<td>Se</td>
<td>34</td>
<td></td>
</tr>
<tr>
<td>Br</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Kr</td>
<td>36</td>
<td></td>
</tr>
<tr>
<td>Rb</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Sr</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Y</td>
<td>39</td>
<td></td>
</tr>
<tr>
<td>Zr</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Nb</td>
<td>41</td>
<td></td>
</tr>
<tr>
<td>Mo</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>Tc</td>
<td>43</td>
<td></td>
</tr>
<tr>
<td>Ru</td>
<td>44</td>
<td></td>
</tr>
<tr>
<td>Rh</td>
<td>45</td>
<td></td>
</tr>
<tr>
<td>Pd</td>
<td>46</td>
<td></td>
</tr>
<tr>
<td>Ag</td>
<td>47</td>
<td></td>
</tr>
<tr>
<td>Cd</td>
<td>48</td>
<td></td>
</tr>
<tr>
<td>In</td>
<td>49</td>
<td></td>
</tr>
<tr>
<td>Sn</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Sb</td>
<td>51</td>
<td></td>
</tr>
<tr>
<td>Te</td>
<td>52</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>Xe</td>
<td>54</td>
<td></td>
</tr>
<tr>
<td>Cs</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td>Ba</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>La</td>
<td>57</td>
<td></td>
</tr>
<tr>
<td>Hf</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Ta</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>W</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Re</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Os</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Ir</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>Pt</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Au</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Hg</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Tl</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Pb</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Bi</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Po</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>At</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>Rn</td>
<td>72</td>
<td></td>
</tr>
<tr>
<td>Fr</td>
<td>73</td>
<td></td>
</tr>
<tr>
<td>Ra</td>
<td>74</td>
<td></td>
</tr>
<tr>
<td>Ac</td>
<td>75</td>
<td></td>
</tr>
<tr>
<td></td>
<td>76</td>
<td></td>
</tr>
<tr>
<td>Ce</td>
<td>58</td>
<td></td>
</tr>
<tr>
<td>Pr</td>
<td>59</td>
<td></td>
</tr>
<tr>
<td>Nd</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Pm</td>
<td>61</td>
<td></td>
</tr>
<tr>
<td>Sm</td>
<td>62</td>
<td></td>
</tr>
<tr>
<td>Eu</td>
<td>63</td>
<td></td>
</tr>
<tr>
<td>Gd</td>
<td>64</td>
<td></td>
</tr>
<tr>
<td>Tb</td>
<td>65</td>
<td></td>
</tr>
<tr>
<td>Dy</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Ho</td>
<td>67</td>
<td></td>
</tr>
<tr>
<td>Er</td>
<td>68</td>
<td></td>
</tr>
<tr>
<td>Tm</td>
<td>69</td>
<td></td>
</tr>
<tr>
<td>Yb</td>
<td>70</td>
<td></td>
</tr>
<tr>
<td>Lu</td>
<td>71</td>
<td></td>
</tr>
<tr>
<td>Th</td>
<td>81</td>
<td></td>
</tr>
<tr>
<td>Pa</td>
<td>82</td>
<td></td>
</tr>
<tr>
<td>U</td>
<td>83</td>
<td></td>
</tr>
<tr>
<td>Np</td>
<td>84</td>
<td></td>
</tr>
<tr>
<td>Pu</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Am</td>
<td>86</td>
<td></td>
</tr>
<tr>
<td>Cm</td>
<td>87</td>
<td></td>
</tr>
<tr>
<td>Bk</td>
<td>88</td>
<td></td>
</tr>
<tr>
<td>Cf</td>
<td>89</td>
<td></td>
</tr>
<tr>
<td>Es</td>
<td>90</td>
<td></td>
</tr>
<tr>
<td>Fm</td>
<td>91</td>
<td></td>
</tr>
<tr>
<td>Md</td>
<td>92</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>93</td>
<td></td>
</tr>
<tr>
<td>Lr</td>
<td>94</td>
<td></td>
</tr>
<tr>
<td>a = relative atomic mass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X = atomic symbol</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b = proton (atomic) number</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
General Certificate of Secondary Education
former Midland Examining Group syllabus

SCIENCE: DOUBLE AWARD PAPER 4 1794/4
SCIENCE: CHEMISTRY PAPER 2 1781/2
SCIENCE: CHEMISTRY (NUFFIELD) PAPER 2 1786/2

HIGHER TIER

Monday 12 JUNE 2000 Morning 1 hour 45 minutes

Candidates answer on the question paper.
Additional materials required:
Pencil,
Ruler (cm/mm).

TIME 1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES
Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer all questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets [ ] at the end of each question or part question.
The marks allocated and the spaces provided for your answers are a good indication of the length of answers required.
A copy of the Periodic Table is printed on the back page.

FOR EXAMINER’S USE
1
2
3
4
5
6
7
8
9
10
11
TOTAL

This question paper consists of 19 printed pages and 1 blank page.
1  (a)  (i) The diagram shows an atom of lithium.

Add labels to the diagram. Use all of the words from this list.

- electrons
- neutrons
- protons

(iii) What name is given to the central part of the atom?  

(ii) Fill in the gaps in the sentences. 

Use the Periodic Table to help you.

(i) Lithium is in Group ______ of the Periodic Table.  

(ii) Lithium is in Period ______ of the Periodic Table.  

(c) Write down the symbol of an element which has an atomic number smaller than lithium.

(d) Mr. Green is a science teacher.

He shows his class how lithium, sodium and potassium react with water.

What safety precautions should Mr. Green take?

______

______

______

______

______

______

______

______

______

______

[2]

[1]

[1]

[1]

[3]
(e) Finish and balance the symbol equation for the reaction of sodium and cold water.

\[ \text{Na} + \text{H}_2\text{O} \rightarrow \underline{\text{_______}} + \text{H}_2 \]  

[2]

(f) Describe the trend in reactivity of alkali metals.

Use your knowledge of electron arrangement to explain this trend.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

[4]
2 The table shows information about some compounds.

<table>
<thead>
<tr>
<th>formula</th>
<th>name</th>
<th>type of structure</th>
<th>melting point in °C</th>
</tr>
</thead>
<tbody>
<tr>
<td>CaO</td>
<td>calcium oxide</td>
<td>giant</td>
<td>2900</td>
</tr>
<tr>
<td>H₂O</td>
<td>water</td>
<td>molecular</td>
<td>0</td>
</tr>
<tr>
<td>NaCl</td>
<td>sodium chloride</td>
<td>giant</td>
<td>808</td>
</tr>
<tr>
<td>SO₂</td>
<td>sulphur dioxide</td>
<td>molecular</td>
<td>−75</td>
</tr>
</tbody>
</table>

(a) What links the melting point and the type of structure?

Use the information in the table to help you.

[2]

(b) Calcium and oxygen react together to form calcium oxide.

During the reaction two electrons move from a calcium atom to an oxygen atom.

Calcium ions, Ca²⁺, and oxide ions, O²⁻, are formed.

Finish the table. There are two spaces.

<table>
<thead>
<tr>
<th>element</th>
<th>number of electrons in an atom</th>
<th>arrangement of electrons</th>
</tr>
</thead>
<tbody>
<tr>
<td>calcium Ca</td>
<td>20</td>
<td>2.8.8.2</td>
</tr>
<tr>
<td>oxygen O</td>
<td>8</td>
<td>2.6</td>
</tr>
<tr>
<td>ion</td>
<td>number of electrons in an ion</td>
<td>arrangement of electrons</td>
</tr>
<tr>
<td>calcium Ca²⁺</td>
<td>18</td>
<td></td>
</tr>
<tr>
<td>oxide O²⁻</td>
<td>10</td>
<td></td>
</tr>
</tbody>
</table>

[2]

(c) Calculate the relative formula mass of calcium oxide, CaO.

Use the Periodic Table to help you.

__________________________________________

[2]
(d) Strontium, Sr, reacts with oxygen in a similar way to calcium. It forms a compound, strontium oxide, SrO.

Explain these facts.

Use your Periodic Table and your knowledge of the structure of atoms to help you.

3 We can represent chemical reactions using equations.

(a) Look at these word equations.

A methane + oxygen $\rightarrow$ carbon dioxide + water

B sodium hydroxide + nitric acid $\rightarrow$ sodium nitrate + water

C hydrogen peroxide $\rightarrow$ oxygen + water

D sodium + water $\rightarrow$ sodium hydroxide + hydrogen

Answer the following questions by choosing from A, B, C or D.

Each letter may be used once, more than once or not at all.

(i) Which equation represents a neutralisation reaction? [ ]

(ii) Which equation represents a combustion reaction? [ ]

(iii) Which equation shows the formation of an alkali? [ ]

(b) Finish the symbol equation for C.

$$\text{H}_2\text{O}_2 \rightarrow \text{H}_2\text{O} + \text{O}_2$$ [1]
4 The diagram shows how rocks are broken down and new rocks formed in the rock cycle.

(a) These are four processes involved in forming sedimentary rocks.

They are in the wrong order.

A depositing sediments
B cementation
C transporting sediments
D weathering and erosion

Fill in the boxes to show the correct order. Use the diagram to help you.

[3]

(b) Write down two processes taking place when metamorphic rocks turn into igneous rocks.

1

2

[2]

(c) What conditions of temperature and pressure are needed to turn sedimentary rocks into metamorphic rocks?

__________________________________________________________________________

__________________________________________________________________________

[2]
(d) This table shows some information about slate, chalk and granite.

<table>
<thead>
<tr>
<th>rock</th>
<th>is the rock crystalline?</th>
<th>can the rock contain fossils?</th>
</tr>
</thead>
<tbody>
<tr>
<td>slate</td>
<td>no</td>
<td>yes</td>
</tr>
<tr>
<td>chalk</td>
<td></td>
<td></td>
</tr>
<tr>
<td>granite</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Finish the table by putting 'yes' or 'no' in each of the four spaces.

The diagram may help you.  

(e) Igneous rocks can be described as **extrusive** or **intrusive**.

- Basalt is an extrusive rock.
- Granite is an intrusive rock.

Describe how extrusive rocks and intrusive rocks are formed from magma.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________  [2]
5 Jo and Andy are finding out about rates of reaction.

They react hydrochloric acid with marble chips (calcium carbonate).

\[
\text{hydrochloric acid} + \text{calcium carbonate} \rightarrow \text{calcium chloride} + \text{carbon dioxide} + \text{water}
\]

They use this apparatus.

(a) The mass of the flask and its contents decreases during the experiment.

Suggest why this happens.

(b) Jo and Andy measure the total mass of the flask and its contents as the reaction takes place.

The table shows their results.

<table>
<thead>
<tr>
<th>time in minutes</th>
<th>mass of flask and contents in grams</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>190.0</td>
</tr>
<tr>
<td>2</td>
<td>188.0</td>
</tr>
<tr>
<td>4</td>
<td>187.0</td>
</tr>
<tr>
<td>6</td>
<td>186.3</td>
</tr>
<tr>
<td>8</td>
<td>186.1</td>
</tr>
<tr>
<td>10</td>
<td>186.0</td>
</tr>
<tr>
<td>12</td>
<td>186.0</td>
</tr>
</tbody>
</table>
(i) Plot their results on the grid.

(ii) Finish the graph by drawing the best curve through the points.

(iii) Jo says that the reaction was faster between 0 and 2 minutes than between 2 and 4 minutes.

How do the results show this?

__________________________________________________________________________

__________________________________________________________________________

(c) In the first experiment the hydrochloric acid was at room temperature.

Jo and Andy repeat the experiment.

The only difference is that the hydrochloric acid is at a higher temperature.

Sketch a curve on the grid to show the results they get.
(d) Jo and Andy do the original experiment at room temperature again.

This time they add an equal volume of water to the hydrochloric acid before adding the marble chips.

How would the rate of reaction be different from the first experiment?

Use your knowledge of particles to explain your answer.

________________________________________

________________________________________

________________________________________

________________________________________

[3]
6 This question is about fertilisers and chemicals used to make them.

(a) Using too much fertiliser can cause pollution in rivers and can kill fish.

(i) Here are five sentences describing how this happens. They are in the wrong order.

Fill in the boxes to show the right order. The first one has been done for you.

A Algae grow well on the fertiliser and cover the river.
B Excess fertiliser dissolves in rain and drains into rivers.
C There is little oxygen left for the fish and they die.
D The algae die and bacteria decompose them.
E The bacteria use up most of the oxygen in the water.

B [3]

(ii) What word is used to describe this process?

Put a (ring) around the correct answer.

distillation  eutrophication  fertilisation  neutralisation [1]

(b) Ammonium nitrate, \( \text{NH}_4\text{NO}_3 \), can be used as a fertiliser.

The flow chart shows how ammonium nitrate can be made.

raw materials
air → ............................................ catalyst X → acid Y → ammonium nitrate
natural gas → ............................................

(i) Finish the flow chart by adding the three missing labels. [2]

(ii) Write down the name of catalyst X.

........................................................................................................... [1]

(iii) Write down the name of acid Y.

........................................................................................................... [1]
Octane is a saturated hydrocarbon. Its graphical (displayed) formula is

(a) Put a (ring) around the family to which octane belongs.
alkanes  alkenes  carbohydrates  carbonates [1]

(b) The products formed when octane burns in air depend upon the amount of air. Explain this statement.

________________________________________________________
________________________________________________________
________________________________________________________
________________________________________________________
________________________________________________________
[4]

(c) When octane vapour is passed over a heated catalyst a reaction takes place. Ethene and hydrogen are the only products.

(i) What type of reaction is taking place?

________________________________________________________ [1]

(ii) Finish and balance the symbol equation for this reaction.

\[
\begin{align*}
\text{octane} & \rightarrow \text{ethene} + \text{hydrogen} \\
C_8H_{18} & \rightarrow \ldots \ldots C_2H_4 + \ldots \\
\end{align*}
\]
[2]

(iii) Excess ethene is bubbled through bromine water. What colour change would you see?

From________________________________________________________ to ________________ [2]
(d) Ethene is used as the raw material for making poly(ethene).

(i) Draw the graphical (displayed) formula of ethene and of poly(ethene).

ethene

poly(ethene)  [3]

(ii) Poly(ethene) has replaced paper and cardboard for many packaging uses.

Suggest one advantage and one disadvantage of poly(ethene) compared to paper and cardboard. Do not consider the relative costs of the materials.

Advantage of poly(ethene) ____________________________________________

Disadvantage of poly(ethene) ____________________________________________ [2]
8 The Earth's crust is broken up into large plates. The diagram shows some of these plates and the sites of major earthquakes.

(a) Look at the pattern of earthquakes. Look at the boundaries of the plates. What is the connection between the pattern of earthquakes and the plate boundaries? [2]

(b) Draw on the diagram a line to show where you would expect there to be another plate boundary. [1]

(c) What causes a major earthquake? [1]

(d) The city of San Francisco is built along the San Andreas Fault. It is an area where earthquakes occur. The buildings in San Francisco are designed and built of materials to reduce the effects of earthquakes. Suggest what else can be done to reduce the social, economic and environmental effects of a future earthquake. [2]
9 This question is about phosphine.

Phosphine is a compound of phosphorus and hydrogen.

A sample of phosphine of mass 100 g contains 91.2 g of phosphorus.

(a) Work out the simplest formula of phosphine.
    (Relative atomic masses: $\text{H} = 1$, $\text{P} = 31$)
    You must show how you work out your answer.

    formula .......................................................... [3]

(b) Calculate the relative formula mass of phosphine.

    relative formula mass ........................................... [1]

(c) Draw a 'dot and cross' diagram to show the arrangement of electrons in a phosphine molecule. You need only show electrons in outer shells.

    [2]
10 A waste solution from a factory contains copper(II) sulphate.

Copper is recovered from this solution.

After further treatment the water goes into a local river.

(a) Suggest one reason why copper is recovered from the solution.

__________________________________________________________________________ [1]

(b) To recover the copper, excess iron filings are added to the solution containing copper(II) sulphate.

The reaction taking place is shown in the equation.

\[
\text{Fe(s)} + \text{CuSO}_4(aq) \rightarrow \text{Cu(s)} + \text{FeSO}_4(aq)
\]

(i) How is solid copper removed from the solution?

__________________________________________________________________________ [1]

(ii) Suggest why iron filings react faster than lumps of iron.

__________________________________________________________________________ [1]

(iii) Calculate the maximum mass of copper that could be recovered using 1 tonne of iron. (Relative atomic masses: Fe = 56, Cu = 64)

You must show how you work out your answer.

Maximum mass ____________ tonnes [2]
11 This question is about the halogen elements in Group 7 of the Periodic Table.

The reactivity of the elements in Group 7 decreases down the group.

(a) Write down the name and symbol of the most reactive halogen in Group 7.

Element ___________________________    Symbol ________  [1]

(b) The table gives information about three halogens.

<table>
<thead>
<tr>
<th>halogen</th>
<th>colour</th>
<th>melting point in °C</th>
<th>boiling point in °C</th>
<th>state at room temperature and pressure</th>
</tr>
</thead>
<tbody>
<tr>
<td>chlorine</td>
<td>greenish-yellow</td>
<td>-101</td>
<td>-34</td>
<td>gas</td>
</tr>
<tr>
<td>bromine</td>
<td>red</td>
<td>-7</td>
<td>60</td>
<td>liquid</td>
</tr>
<tr>
<td>iodine</td>
<td>dark grey</td>
<td>114</td>
<td>185</td>
<td>solid</td>
</tr>
</tbody>
</table>

Astatine is in Group 7 of the Periodic Table. It is below iodine.
Use the information in the table and your knowledge to answer the following.

(i) Predict the state of astatine at room temperature and pressure.

__________________________________________________________________________[1]

(ii) Suggest a melting point for astatine. Use the data to explain your choice.

Melting point ________________

Explanation ____________________________________________________________[2]

(iii) Predict the colour of astatine.

__________________________________________________________________________[1]

(iv) What are the name and formula of the compound formed by sodium and astatine?

Name ___________________________    Formula ___________________________  [2]
(c) The table summarises the results of reactions when halogens are added to solutions of sodium halides.

(i) Finish the table by adding a tick (✔) if a reaction takes place and a cross (✗) if a reaction does not take place. Some have been done for you.

<table>
<thead>
<tr>
<th>halogen added</th>
<th>solutions of</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>sodium chloride</td>
<td>sodium bromide</td>
<td>sodium iodide</td>
</tr>
<tr>
<td>bromine</td>
<td>✓</td>
<td>✓</td>
<td>✔</td>
</tr>
<tr>
<td>chlorine</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>iodine</td>
<td></td>
<td></td>
<td>✓</td>
</tr>
</tbody>
</table>

(ii) Finish the sentence by choosing the best word from the list.

decomposition

displacement

neutralisation

The reaction of bromine with sodium iodide is an example of a ________________ reaction.

(iii) Write an equation for the reaction taking place when bromine, Br₂, is added to potassium iodide solution, KI.

__________________________________________________________

[2]

(d) Sodium chloride is used as a raw material for producing other sodium compounds.

These include

sodium carbonate

sodium hydrogencarbonate

sodium hydroxide

Choose two of these. For each one, write down a use of the sodium compound.

<table>
<thead>
<tr>
<th>sodium compound</th>
<th>use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[2]
The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).
General Certificate of Secondary Education
former Midland Examining Group syllabus

SCIENCE: DOUBLE AWARD PAPER 5 1794/5
SCIENCE: PHYSICS PAPER 1 1782/1
SCIENCE: PHYSICS (NUFFIELD) PAPER 1 1787/1

FOUNDATION TIER

Friday 16 June 2000 Afternoon 1 hour 30 minutes

Candidates answer on the question paper.
Additional materials required:
Pencil
Ruler (cm/mm)

TIME 1 hour 30 minutes

INSTRUCTIONS TO CANDIDATES
Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer all questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets [ ] at the end of each question or part question.
The marks allocated and the spaces provided for your answers are a good indication of the length of answers required.

<table>
<thead>
<tr>
<th>FOR EXAMINER'S USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>TOTAL</td>
</tr>
</tbody>
</table>
1 This question is about light.

(a) Stars are luminous objects.

They give out light.

Look at the five pictures below.

Two of the objects are not luminous. They can only reflect light.

Put *rings* around the two objects which are not luminous.

1 Sun
2 cell
3 candle flame
4 glowing bulb
5 Moon

(b) Bill uses a periscope to watch a bird from a hideout in the woods.

(i) Finish the diagram to show how light from the bird reaches Bill's eye.

The ray has been started for you.
(ii) The periscope produces an image of the bird.

Describe this image that Bill sees in the periscope.

Put ticks (✓) in the three boxes next to the correct statements.

- The image is larger than the bird. 
- The image is real. 
- The image is the right way up. 
- The image is the same size as the bird. 
- The image is smaller than the bird. 
- The image is upside down. 
- The image is virtual.

(c) Bill sees the bird by light waves and hears it by sound waves.

A teacher shows Bill models of light waves and sound waves using a slinky spring.

Describe how the transverse wave is different from the longitudinal wave.
2 This question is about magnetism.

(a) The diagram shows the magnetic field between the ends of two bar magnets.

A, B, C and D are plotting compasses.

The needles of A and B point in the directions shown.

(i) Draw arrows in the circles C and D to show the directions of the needles. [2]
(ii) Label the two poles of the magnets nearest each other in the boxes shown. [2]

(b) Graham makes a simple electric bell.
He closes the switch.

(i) The hammer moves to the right and hits the gong.

Explain why.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________[2]

(ii) The hammer now moves back to the left.

Explain why.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________[2]

(c) Graham wants the hammer to hit the gong harder.

Alex says ‘Why not replace the iron core with a permanent bar magnet?’

(i) Why is this not a good idea?

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________[1]

(ii) Suggest two ways Graham could make the hammer hit the gong harder.

1._____________________________________________________________________

2._____________________________________________________________________

________________________________________________________________________[2]
3 This question is about the electromagnetic spectrum.

(a) The diagram shows the parts of the electromagnetic spectrum and their wavelength ranges.

Draw a **straight** line from each part of the spectrum to the correct range.

Each part must be joined to a different range. Two have been done for you.

<table>
<thead>
<tr>
<th>part of spectrum</th>
<th>wavelength in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>X-rays</td>
<td>0.000 000 000 000 1</td>
</tr>
<tr>
<td></td>
<td>0.000 000 000 001</td>
</tr>
<tr>
<td>gamma rays</td>
<td></td>
</tr>
<tr>
<td>ultraviolet</td>
<td>0.000 000 1</td>
</tr>
<tr>
<td>infrared</td>
<td>0.000 01</td>
</tr>
<tr>
<td>visible light</td>
<td>0.001</td>
</tr>
<tr>
<td>radio</td>
<td>0.1</td>
</tr>
<tr>
<td>microwaves</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>1000</td>
</tr>
<tr>
<td></td>
<td>10 000</td>
</tr>
<tr>
<td></td>
<td>10 000 000</td>
</tr>
</tbody>
</table>

(b) Finish the sentences by choosing the **best** words from this list.

Each word may be used once, more than once, or not at all.

- gamma rays
- infrared
- microwaves
- radio
- ultraviolet
- X-rays

The Sun's rays contain ____________ which can cause sunburn and ____________ which can cause skin cancer.

Cancer can be treated with ____________.

Night photography uses ____________.

[4]
(c) Two computers are linked by optical fibre. Data pulses are sent between them.

(i) Write down the name of a part of the electromagnetic spectrum which is used to transmit the data pulses.

(ii) The diagram shows part of an optical fibre.

Describe and explain the path of the electromagnetic wave passing along the fibre.

You may add to the diagram or draw other diagrams to help your answer.

[3]
4 This question is about the supply of electricity to the home.

The diagram shows how the electricity supply is connected to the house circuits.

(a) Finish the sentence by choosing the best word from this list.

charge
current
energy
voltage

The electricity meter measures the amount of __________________ transferred. [1]

(b) (i) Each cable in a house circuit has three wires in it.

Two of these are called the live wire and neutral wire.

Write down the name of the third wire. ____________________________ [1]

(ii) Which of these three wires carries no current when appliances are working properly?

______________________________ [1]
(iii) A fault occurs in a house circuit.
    The current in the live wire is now too big.
    What happens in the consumer unit?

(c) The circuit to the immersion heater has thicker wires than the lighting circuit.
    Suggest why.

(d) James writes down information about the appliances used in his home between 6 p.m.
    and 7 p.m.
    This is what he wrote.

<table>
<thead>
<tr>
<th>appliance</th>
<th>power rating in kW</th>
<th>time switched on in hours</th>
<th>energy used in kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>fan heater</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>TV and video</td>
<td>0.1</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>kettle</td>
<td>2.0</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>water heater</td>
<td>3.5</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>all lights</td>
<td>0.5</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

(i) Finish the table by calculating the energy used by each appliance.
    The first one has been done for you. [2]

(ii) Which appliance has cost the most to use between 6 p.m. and 7 p.m.? [1]

(iii) The meter reading was 15128.5 kWh at 6 p.m.
    What is the new meter reading at 7 p.m.?
    You must show how you work out your answer.

new meter reading

[Turn over]
5 This question is about radioactivity and its uses.

Americium-241 (\(^{241}\)Am) is a radioactive material which emits gamma radiation.

(a) Put ticks (✓) in the boxes next to the two correct statements about gamma radiation.

- Gamma radiation is harmless. [ ]
- Gamma radiation travels as a wave. [ ]
- Gamma radiation has a range of only a few centimetres in air. [ ]
- Gamma radiation will penetrate several centimetres of lead. [ ] [2]

(b) A brewery uses Americium-241 in its bottling plant.

The diagram shows bottles of drink passing through a liquid level detector.

If the bottle is not full enough, the bottle is rejected.

The gamma radiation passes through the bottle and its contents.

The radiation is detected on the other side.
(i) What happens to the amount of radiation detected if the bottle is not full enough?

__________________________________________________________________________[1]

(ii) What happens to the amount of radiation detected if the bottle is too full?

__________________________________________________________________________[1]

(iii) For this process to work, all of the bottles must be accurately made to be the same thickness.

Suggest why.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________[2]

(iv) Why is gamma radiation used instead of alpha radiation?

__________________________________________________________________________[1]

(v) Some modern bottling machines use ultrasound instead of gamma radiation to check the liquid level.

Suggest why ultrasound is used instead of gamma radiation.

__________________________________________________________________________

__________________________________________________________________________[2]
6 This question is about satellites.

More than 8000 objects orbit the Earth.

(a) Which of the following are satellites orbiting the Earth?

Put ticks (√) in the three correct boxes.

- the comet Hale-Bopp
- the Hubble space telescope
- the Mir space station
- the Moon
- the planet Pluto
- the star Alpha Centauri

The diagram shows two satellites orbiting the Earth.

W is a weather satellite which takes 102 minutes to orbit the Earth.

C is a communications satellite which takes 24 hours to orbit the Earth.

(b) The weather satellite takes less time than the communications satellite to orbit the Earth.

Explain why.
(c) Write down the name of the force which keeps the satellites in orbit.

[1]

(d) Asif, in London, telephones his friend, Miguel, in New York.

The microwave signal goes to the communications satellite and back to Earth, a total distance of 90 000 km.

The time delay between when Miguel starts speaking and when Asif hears his voice is 0.3 s.

Calculate the speed of the signal.

You **must** show how you work out your answer.

\[
\text{speed} \quad \underline{\underline{\text{km/s}}} \quad [3]
\]
7 This question is about transferring energy.

Energy can be transferred by conduction, convection, evaporation and radiation.

(a) Finish these sentences.

The Sun transfers energy to the Earth by _______________________.

Air rises above hot areas of the land. This transfers energy by _______________________. [2]

This marathon runner has been running for more than 23 miles.

He is very hot and sweaty.

(b) Sweating helps the runner to lose energy.

Use your ideas about energy transfer to explain how this happens.

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________ [3]

(c) After the race, the runner is given a shiny foil blanket.

This stops him cooling down too quickly.

Use your ideas about energy transfer to explain two ways in which this happens.

1. _______________________________________________________________________

__________________________________________________________________________

2. _______________________________________________________________________

__________________________________________________________________________ [4]
8 This question is about forces.

Phil lives on a farm.

One of the farm gates has a very stiff spring attached between the gate and the gate post.

This spring keeps the gate closed.

Phil can open the gate if he pushes it at the end \( E \).

He cannot open the gate if he pushes it in the middle \( M \).

(a) Use your knowledge of moments to explain this.

________________________________________________________________________
________________________________________________________________________ [1]
At school, Phil stretches a similar spring using this equipment.

(b) He measures the length of the spring as he adds weights to the scalepan.

The table shows his results.

<table>
<thead>
<tr>
<th>load on scalepan in N</th>
<th>length of spring in mm</th>
<th>extension of spring in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>212</td>
<td>12</td>
</tr>
<tr>
<td>20</td>
<td>225</td>
<td>25</td>
</tr>
<tr>
<td>30</td>
<td>234</td>
<td>34</td>
</tr>
<tr>
<td>40</td>
<td>248</td>
<td>48</td>
</tr>
<tr>
<td>50</td>
<td>262</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>270</td>
<td></td>
</tr>
<tr>
<td>70</td>
<td>285</td>
<td></td>
</tr>
<tr>
<td>80</td>
<td>294</td>
<td></td>
</tr>
<tr>
<td>90</td>
<td>307</td>
<td></td>
</tr>
</tbody>
</table>

(i) Phil has not worked out all the extensions. Finish the table by writing in the shaded boxes. [2]

(ii) Plot the points for load and extension on the grid opposite. The first five have been done for you. [1]

(iii) Finish the graph by drawing the best straight line. [1]

(iv) Use your graph to find the load needed to stretch the spring by 65 mm. You must show clearly, on the graph, how you get your answer.

load needed = ________________ N [2]
(c) Look back at the diagram of the equipment Phil used.

The distance from the pivot to where the **spring** is attached is 12 cm.

The distance from the pivot to where the **scalepan** is attached is 90 cm.

Calculate the force on the **spring** caused by a load of 80 N in the scalepan.

Use the equations below. You **must** show how you work out your answer.

\[
moment \text{ of a force} = \text{force} \times \text{perpendicular distance to pivot}
\]

\[
\text{sum of clockwise moments} = \text{sum of anticlockwise moments}
\]

force on spring = \[ \text{N} \] [3]
Karen wires up this circuit.

(M) is the symbol for an electric motor.

(a) Finish the table by writing the names of components S, P and X.

Choose your answers from this list.

diode
LED
LDR
resistor
switch
variable resistor

<table>
<thead>
<tr>
<th>component</th>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td>S</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

(b) Karen wants to make the motor spin faster.

(i) Which component must she adjust?

(ii) Explain why this works.
(c) Karen closes S. She writes this down.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Motor spins</td>
<td>Red lamp is on</td>
</tr>
<tr>
<td>Green lamp is off</td>
<td></td>
</tr>
</tbody>
</table>

Use your ideas about current in circuits to explain her observations.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________
________________________________________________________________________

[3]

(d) Karen reverses the cell. The motor spins in the opposite direction.

What happens to the lamps? Finish the sentences.

The red lamp ____________________________.
The green lamp ____________________________.

[1]
General Certificate of Secondary Education
former Midland Examining Group syllabus

SCIENCE: DOUBLE AWARD PAPER 6 1794/6
SCIENCE: PHYSICS PAPER 2 1782/2
SCIENCE: PHYSICS (NUFFIELD) PAPER 2 1787/2

HIGHER TIER
Friday 16 JUNE 2000 Afternoon 1 hour 45 minutes

Candidates answer on the question paper.
Additional materials required:
Pencil
Ruler (cm/mm)

TIME 1 hour 45 minutes

INSTRUCTIONS TO CANDIDATES
Write your name, Centre number and candidate number in the spaces at the top of this page.
Answer all questions.
Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES
The number of marks is given in brackets [ ] at the end of each question or part question.
The marks allocated and the spaces provided for your answers are a good indication of the length of answers required.

<table>
<thead>
<tr>
<th>FOR EXAMINER'S USE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td>7</td>
</tr>
<tr>
<td>8</td>
</tr>
<tr>
<td>9</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>TOTAL</td>
</tr>
</tbody>
</table>
1 This question is about transferring energy.

Energy can be transferred by conduction, convection, evaporation and radiation.

(a) The Sun transfers energy to the Earth.
Before reaching the Earth only one process is involved in this transfer.

State the process and give a reason for your answer.

Process

Reason

[2]

This marathon runner has been running for more than 23 miles.
He is very hot and sweaty.

(b) Sweating helps the runner to lose energy.
Use your ideas about energy transfer to explain how this happens.

[3]

(c) After the race, the runner is given a shiny foil blanket.

This stops him cooling down too quickly.

Use your ideas about energy transfer to explain two ways in which this happens.

1.

2.

[4]
This question is about forces.

Phil lives on a farm.

One of the farm gates has a very stiff spring attached between the gate and the gate post. This spring keeps the gate closed.

Phil can open the gate if he pushes it at the end E.

He cannot open the gate if he pushes it in the middle M.

(a) Use your knowledge of moments to explain this.

(b) Phil holds open the gate. Ruth starts to drive the tractor through.

The mass of the tractor is 3000 kg.

The force causing the tractor to accelerate is 1500 N.

Calculate the acceleration of the tractor.

You must show how you work out your answer.

\[
\text{acceleration} = \text{_____ unit _____} \quad [4]
\]
At school, Phil stretches a similar spring using this equipment.

(c) He measures the length of the spring as he adds weights to the scalepan.

The table shows his results.

<table>
<thead>
<tr>
<th>load on scalepan in N</th>
<th>length of spring in mm</th>
<th>extension of spring in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>200</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>212</td>
<td>12</td>
</tr>
<tr>
<td>20</td>
<td>225</td>
<td>25</td>
</tr>
<tr>
<td>30</td>
<td>234</td>
<td>34</td>
</tr>
<tr>
<td>40</td>
<td>248</td>
<td>48</td>
</tr>
<tr>
<td>50</td>
<td>262</td>
<td>62</td>
</tr>
<tr>
<td>60</td>
<td>270</td>
<td>70</td>
</tr>
<tr>
<td>70</td>
<td>285</td>
<td>85</td>
</tr>
<tr>
<td>80</td>
<td>294</td>
<td>94</td>
</tr>
<tr>
<td>90</td>
<td>307</td>
<td>107</td>
</tr>
</tbody>
</table>

(i) Plot the points for load and extension on the grid opposite.

The first five have been done for you.  

(ii) Finish the graph by drawing the best straight line.

(iii) Use your graph to find the load needed to stretch the spring by 65 mm.

You must show clearly, on the graph, how you get your answer.

load needed = __________ N  

[1]  

[1]  

[2]
(d) Look back at the diagram of the equipment Phil used.

The distance from the pivot to where the spring is attached is 12 cm.

The distance from the pivot to where the scalepan is attached is 90 cm.

Calculate the force on the spring caused by a load of 80 N in the scalepan.

Use the two equations below. You must show how you work out your answer.

\[
\text{moment of a force} = \text{force} \times \text{perpendicular distance to pivot}
\]

\[
\text{sum of clockwise moments} = \text{sum of anticlockwise moments}
\]

\[
\text{force on spring} = \underline{\underline{}} \ \text{N} \quad [3]
\]
3 This question is about the supply of electricity to the home.

The diagram shows how the electricity supply is connected to the house circuits.

(a) An alternating current passes through the cables.

Use your knowledge of particles and how they move to describe this current.

1. Name of particles

2. How they move

[2]
(b) The circuit to the immersion heater has thicker wires than the lighting circuit.

Suggest why.

______________________________________________________________________________
______________________________________________________________________________
______________________________________________________________________________

(c) James writes down information about the appliances used in his home between 6 p.m. and 7 p.m.

This is what he wrote.

<table>
<thead>
<tr>
<th>appliance</th>
<th>power rating</th>
<th>time switched</th>
<th>energy used</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>in kW</td>
<td>on in hours</td>
<td>in kWh</td>
</tr>
<tr>
<td>fan heater</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>TV and video</td>
<td>0.1</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>kettle</td>
<td>2.0</td>
<td>0.1</td>
<td></td>
</tr>
<tr>
<td>water heater</td>
<td>3.5</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>all lights</td>
<td>0.5</td>
<td>1.0</td>
<td></td>
</tr>
</tbody>
</table>

(i) Finish the table by calculating the energy used by each appliance.

The first one has been done for you.

(ii) Which appliance has cost the most to use between 6 p.m. and 7 p.m.?

______________________________________________________________________________

(iii) The meter reading was 15128.5 kWh at 6 p.m.

What is the new meter reading at 7 p.m.?

You must show how you work out your answer.

new meter reading ________________
4 This question is about optical fibres.

(a) The diagram shows part of an optical fibre.

Describe and explain the path of the electromagnetic wave passing along the fibre.
You may add to the diagram or draw other diagrams to help your answer.

(b) Doctors use endoscopes (fibrescopes) to see inside a patient's stomach.

The diagram shows part of the endoscope. It shows **two** bundles of optical fibres inside a plastic tube.

(l) Explain why endoscopes must have **two** bundles of optical fibres.

[3]

[2]
(ii) The fibres in one of the bundles must be arranged in the same pattern at both ends. Explain why. 

_________________________________________________________ [1] 

(iii) How does using an endoscope help a doctor to study a patient's stomach? 

_________________________________________________________ [1] 

5 This question is about telecommunications. 

The BT (Telecom) Tower in London has many dishes which receive and transmit signals using microwaves. 

(a) The signal received from another transmitter is very weak. 

Suggest a way of overcoming this problem. 

_________________________________________________________ [1] 

[Turn over]
(b) The diagram shows how two concave microwave dishes transmit and receive signals. The microwave signal is represented by rays A, B and C.

(i) Write a T on the diagram to show the exact position of the transmitter. [1]

(ii) Write an R on the diagram to show the exact position of the receiver. [1]

(iii) The paths taken by the rays A and C from the transmitter to the receiver are shown.

Part of the path of ray B is shown on the diagram.

Complete the path of ray B from the transmitter to the receiver. [2]

(iv) Three microwave wavefronts are shown on the diagram.

Draw on the diagram these three wavefronts after they have been reflected by the concave microwave dish. [3]

(c) Why are microwaves preferred to radiowaves for transmitting signals in narrow beams?

__________________________________________________________________________

__________________________________________________________________________ [2]
6 This question is about electromagnetism.

(a) Graham makes a simple electric bell.

He closes the switch.

(i) The hammer moves to the right and hits the gong.

Explain why.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________ [2]

(ii) The hammer now moves back to the left.

Explain why.

________________________________________________________________________
________________________________________________________________________
________________________________________________________________________ [2]
(b) Graham wants the hammer to hit the gong harder.

Alex says 'Why not replace the iron core with a permanent bar magnet?'

(i) Why is this not a good idea?

__________________________________________________________________________

__________________________________________________________________________ [1]

(ii) Suggest two ways Graham could make the hammer hit the gong harder.

1. ________________________________________________________________

2. ________________________________________________________________ [2]

(c) The diagram shows a simplified view of a model electric motor.

The coil is between the poles of a permanent magnet.
When the switch is closed the coil ABCD starts to spin.

(i) Use your ideas about forces on conductors in magnetic fields to explain why it starts to spin.

Drawing on the diagram may help your answer.


[3]

(ii) What will happen if the battery terminals are reversed?

Explain why.


[2]

(iii) The diagrams show the split-ring commutator as the coil of the motor spins through the vertical position.

Explain how the split-ring commutator allows the motor to continue to spin.

Drawing forces on the diagram may help your answer.


[2]
7 Karen wires up this circuit.

(M) is the symbol for an electric motor.

(a) Karen closes S. She writes this down.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Motor spins</td>
</tr>
<tr>
<td></td>
<td>Red lamp is on</td>
</tr>
<tr>
<td></td>
<td>Green lamp is off</td>
</tr>
</tbody>
</table>

She now reduces the resistance of P. What observations will she make about the motor and the lamps now?

motor _____________________________
red lamp _____________________________
green lamp _____________________________ [3]

(b) She replaces X, Y and the lamps with red and green LEDs.

current-voltage graph for a red LED

![Graph Image]
The graph shows how current varies with voltage across a red LED.

The graph for a green LED is very similar.

(i) Use the graph to find the current through the red LED when the voltage across it is 1.6 V.

You must show clearly on the graph how you get your answer.

\[ \text{current} = \underline{\text{\phantom{000}}} \text{ mA} \] [2]

(ii) Calculate the resistance of the red LED when the voltage across it is 1.6 V.

You must show how you work out your answer.

\[ \text{resistance} = \underline{\text{\phantom{000}}} \text{ unit} \] [4]

(iii) Use information from the graph to explain how the resistance changes as the voltage increases from zero to 2.0 V.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________ [2]

(iv) When the voltage across the green LED is 2.0 V, the current through the motor is 25 mA.

Use the graph and your ideas about circuits to explain why.

______________________________________________________________________

______________________________________________________________________

______________________________________________________________________ [3]
This question is about static electricity.

Frances is using a Van de Graaff generator to make sparks.

The lower roller is turned.

Negative charge is carried by the belt up to the upper roller.

The negative charge is transferred by the brush to the metal dome.

(a) (i) The discharge ball becomes positively charged.

The supporting rod must be conducting for this to happen. Explain why.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________ [2]

(ii) Write an X on the metal discharge ball to show where there is most positive charge. [1]
(b) A spark occurs when enough negative charge collects on the metal dome.

The air becomes conducting.

(i) Use your knowledge of particles and how they move to describe the current between the dome and the ball.

(ii) 0.001 mC of charge is transferred in a spark. 90 mJ of energy is released.

Calculate the voltage between the dome and the ball which causes this transfer.

You must show how you work out your answer.

\[
voltage = \underline{\phantom{12345678901234567890123456789}} \text{V} \quad [3]
\]
9 This question is about radioactivity and its uses.

Americium-241 ($^{241}_{95}$ Am) is a radioactive material which emits gamma radiation.

A brewery uses Americium-241 in its bottling plant.

The diagram shows bottles of drink passing through a liquid level detector.

If the bottle is not full enough, the bottle is rejected.

The gamma radiation passes through the bottle and its contents.

The radiation is detected on the other side.

bottle filled to correct level
(a) (i) For this process to work, all of the bottles must be accurately made to be the same thickness.

Suggest why.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________ [2]

(ii) Why is gamma radiation used instead of alpha radiation?

________________________________________________________________________ [1]

(iii) Some modern bottling machines use ultrasound instead of gamma radiation to check the liquid level.

Suggest why ultrasound is used instead of gamma radiation.

________________________________________________________________________

________________________________________________________________________ [2]
(b) Americium-241 has a half-life of 460 years.

(i) Explain what is meant by the term half-life.

(ii) The machinery at the bottling plant is designed to last for twenty years.

   Cobalt-60 is another radioactive material used in industry which emits gamma radiation.
   It has a half-life of 5 years.
   **Plot accurately** on the grid the activity of the Cobalt-60 after 5, 10, 15 and 20 years.
   The activity at the start has been marked for you (×).
   Finish the graph by drawing the best line through the points.

(iii) **Sketch** on the grid how the activity of the Americium-241 (half-life 460 years) changes during the twenty years.

   Use the same starting point (×) as before.
   Label your line A.

(iv) Use your graph to explain why Cobalt-60 is not a suitable radioactive source to use in the bottling plant.
The Hubble Space Telescope orbits the Earth at a height of 600 km.

(a) Calculate the time it takes for a microwave signal to reach Earth from the satellite. The speed of the microwave signal is 300 000 km/s. You must show how you work out your answer.

\[ \text{time} = \underline{\phantom{0}000} \text{s} \]
(b) This picture was taken by the Hubble Space Telescope in August 1997.

It shows the birth of binary stars. These are a pair of stars which orbit around each other.

Read the following sentences from the NASA press release.

Then use them to help you answer the questions.

**HUBBLE’S FIRST DIRECT LOOK AT POSSIBLE PLANET AROUND ANOTHER STAR**

This NASA Hubble Telescope infra-red picture of new-born binary stars shows a long thin nebula pointing towards a faint object. This could be the first planet outside our solar system to be pictured directly.

The brightest objects in the picture are the binary stars. These illuminate a large cloud of gas and dust from which the stars formed. So much dust surrounds these stars that they are almost invisible at optical wavelengths. However, infra-red light penetrates the dust, revealing the new-born stars.

At the bottom left of the picture, there is a point of light many times fainter than the stars. Calculations show that this object is much too dim to be an ordinary star. The brightness of this object suggests it could be a hot planet several times the mass of Jupiter. The planet is 200 billion kilometres from the star (1400 times the Earth’s distance from the Sun). A bright streak (nebula) stretches from the star towards the planet. This may suggest that the planet was ejected from the star system.

Present ideas predict that very young giant planets are still warm from being formed by gravitational contraction. Temperatures can be as high as a few thousand degrees Celsius. This makes them relatively bright in infra-red light compared with old giant planets such as Jupiter.
(i) The picture of the star system has been formed using infra-red light rather than visible light.

Use your knowledge of waves to explain the difference between infra-red light and visible light.

__________________________________________________________________________________________________________________________________________ [1]

(ii) Why was visible light not used?

__________________________________________________________________________________________________________________________________________ [1]

(c) Stars form from clouds of gas and dust. Explain how.

__________________________________________________________________________________________________________________________________________ [1]

(d) Calculations show that the object referred to in line 9 is a planet rather than a star.

(i) What information about the planet in the passage supports this?

__________________________________________________________________________________________________________________________________________ [1]

(ii) Suggest what process cannot be occurring in the planet’s core.

__________________________________________________________________________________________________________________________________________ [1]

(e) Why would you expect the acceleration due to gravity at the surface of the planet to be much greater than that on the surface of Jupiter?

__________________________________________________________________________________________________________________________________________ [1]

(f) What information in the passage suggests it will take many Earth years for the planet to orbit the binary stars?

__________________________________________________________________________________________________________________________________________ [1]