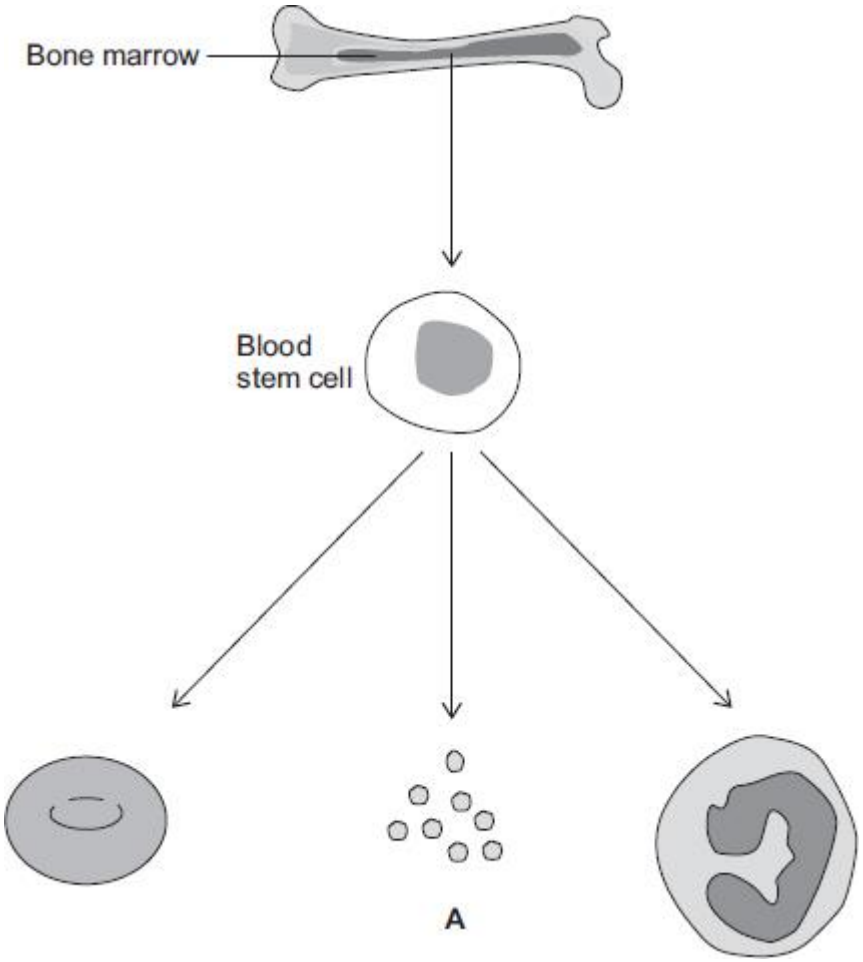
Q1.

Adult stem cells are found in human bone marrow.

Bone marrow stem cells can differentiate into many types of blood components.

The figure below shows the components the bone marrow stem cells can differentiate into.



(a) Name the component of the blood labelled **A**.

_____

(1)

(b) Damage to the bone marrow will lead to a reduction in the number of blood components produced in a person.

Describe the effect a reduction of component **A** will have on the person.

_____

_____

(1)

(c) A person has 5.1×10^9 red blood cells per cm^3 of blood.

The person has 4.25 dm^3 of blood in their body.

A total of 2.0×10^{11} of the red blood cells are replaced each day.

Calculate the percentage of red blood cells that are replaced each day.

1 dm^3 = 1000 cm^3

Percentage of red blood cells replaced each day = _____ %

(4)

(d) Explain why red blood cells **cannot** divide by mitosis.

(2)

(e) The different components of the blood can be used to treat different medical conditions.

The table below gives information about:
- blood from blood donation by volunteers
- the production of red blood cells from stem cells in laboratories.

Blood from blood donation	**Production of red blood cells from stem cells**
It can take 10 minutes to collect blood from a vein in the arm. A person can donate blood every 12 weeks. Blood can be stored for 35 days. Blood can be separated into different blood components and plasma.	Red blood cells can be produced when needed in small quantities. It takes 28 days to produce red blood cells. A patient's own stem cells can be used to make red blood cells.

Evaluate the use of blood donation to provide blood components compared with using stem cells to provide blood components.

Use information from the table above and your own knowledge.

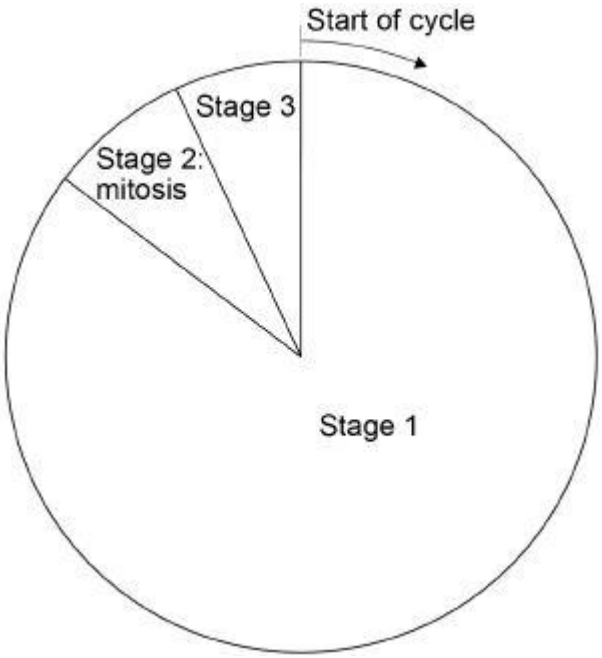
(6)
(Total 14 marks)

Q2.

Cells divide in a series of stages called the cell cycle.

Stage 2 of the cycle is mitosis.

The diagram below shows a simplified cell cycle for a human body cell.



(a) Draw **one** line from each stage in the cell cycle to what happens during that stage.

Stage in the cell cycle	**What happens during that stage**
Stage 1	Nucleus divides
Stage 2	Cell divides into two
Stage 3	Copies of the DNA are made

(2)

(b) The mass of DNA in a human body cell at the start of the cell cycle is 6 picograms.

What mass of DNA will be in each of the new cells produced by this cell division?

Tick **one** box.

- 3 picograms ☐
- 6 picograms ☐
- 9 picograms ☐
- 12 picograms ☐

(1)

(c) Stem cells are undifferentiated cells.

Which statement about stem cells is correct?

Tick **one** box.

Animal stem cells are found in meristems	☐
Animal stem cells divide by meiosis	☐
Meristem cells in plants can differentiate throughout the life of the plant	☐
Meristem cells in plants can only differentiate into one type of cell	☐

(1)

Stem cells from human embryos can differentiate into most types of human cell.

Research is being done into the use of embryonic stem cells in medical treatments.

The long-term effects of using embryonic stem cells in patients are not well understood.

In therapeutic cloning, human embryos are produced using a donated human egg cell and a cell from the patient.

- The embryo produced contains the same genetic information as the patient.
- Stem cells are taken from the embryo and stimulated to divide to form cells the patient needs.
- The embryo is then destroyed.

(d) Suggest **two** advantages of therapeutic cloning.

1. _____

_____

2. _____

_____

(2)

(e) Suggest **two** disadvantages of therapeutic cloning.

1. _____

_____

2. _____

_____

(2)

(Total 8 marks)

Q3.

Two common medicines are paracetamol and ibuprofen. These medicines help to reduce high body temperature.

(a) Children who were ill with high body temperatures were identified at doctors' surgeries.

These children were put into two groups.
The children in each group were matched for age, gender and body mass.

Group 1: 50 children were given paracetamol.

Group 2: 50 children were given ibuprofen.

(i) Give **one** control variable in this investigation.

_____

_____

(1)

(ii) In some investigations when medicines are tested, a placebo is given to one group.

What is a placebo?

_____

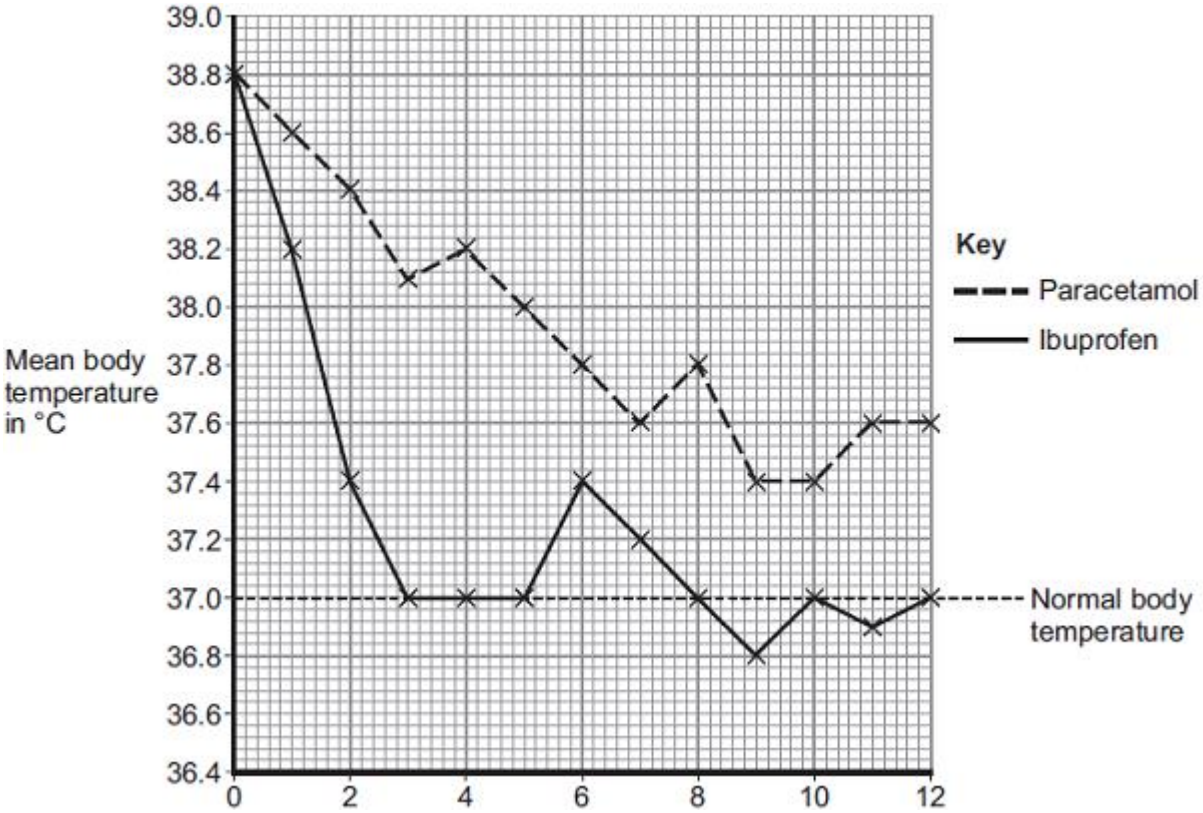
_____

(1)

(b) The children's body temperatures were measured before any medicine was given and every hour after treatment started.

Paracetamol was given every 4 hours. Ibuprofen was given every 6 hours.

The results for the two groups are shown in the figure below.



(i) What was the mean body temperature 4 hours after paracetamol was given?

_____ °C

(1)

(ii) Suggest which medicine a parent should give to their child to reduce a high body temperature to normal.

Use information from the graph.

Medicine: _____

Give **two** reasons for your answer.

_____

_____

_____

_____

(2)

(Total 5 marks)

Q4.

Carbon can exist in a number of different structures.

(a) What is the approximate radius of a carbon atom?

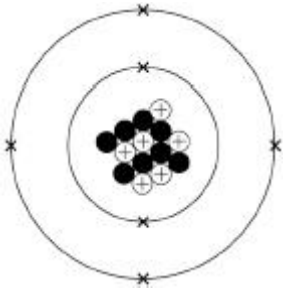
Tick (✓) **one** box.

0.1 m ☐ 0.1 mm ☐ 0.1 nm ☐

(1)

(b) **Figure 1** shows an atom of carbon.

Figure 1



Describe the atomic structure of this carbon atom.

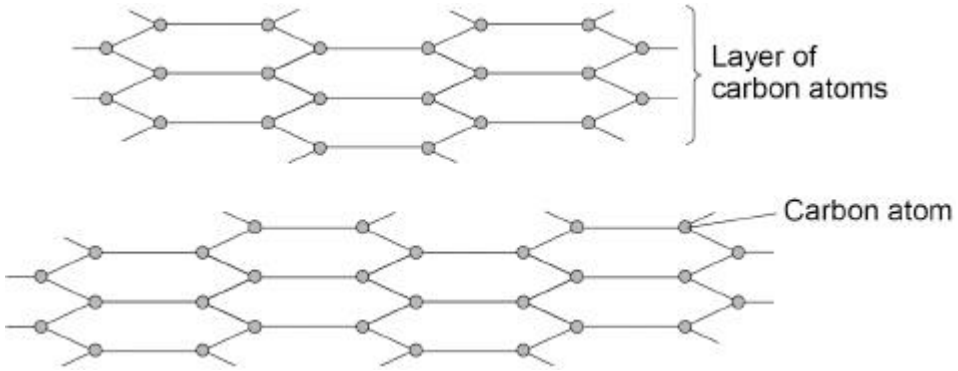
You should include the number of electrons, neutrons and protons.

(6)

In graphite the carbon atoms are held together by bonds.

Figure 2 represents part of the structure of graphite.

Figure 2



(c) How many bonds does each carbon atom have in graphite?

Use **Figure 2**.

Tick (✓) **one** box.

1 ☐ 2 ☐ 3 ☐ 4 ☐

(1)

(d) What type of bonds hold the carbon atoms together in graphite?

Tick (✓) **one** box.

Covalent ☐

Ionic ☐

Metallic ☐

(1)

(e) Lubricants allow objects to slide over each other easily.

Suggest why graphite can be used as a lubricant.

Use **Figure 2**.

_____

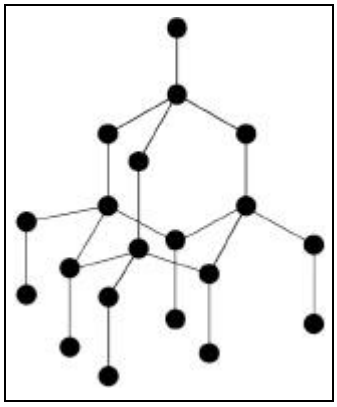
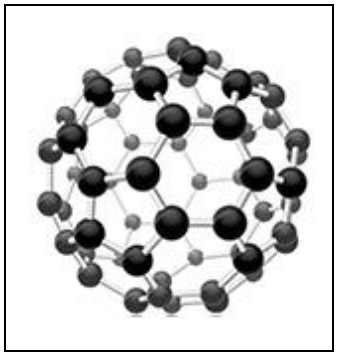
_____

(1)

(f) The two structures represent different forms of carbon.

Draw **one** line from each structure to the form of carbon.

Structure	**Form of carbon**

	Buckminsterfullerene
	Diamond
	Graphene
	Nanotube

(2)

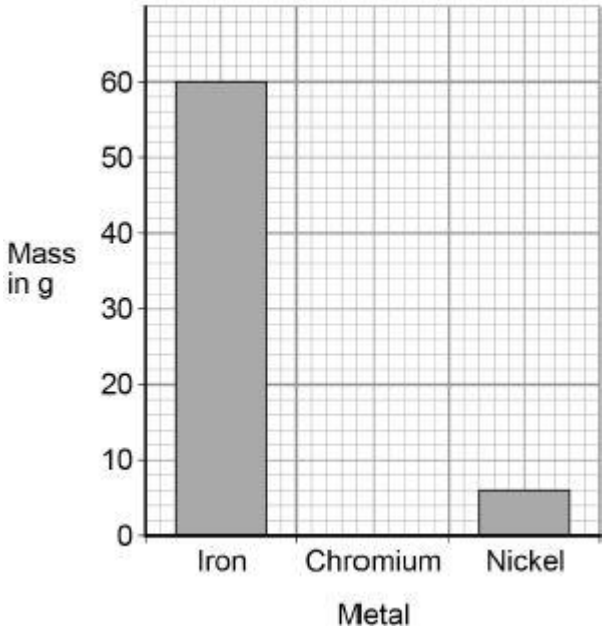
(Total 12 marks)

Q5.

One alloy contains iron, chromium and nickel.

Figure 1 shows the mass of iron and the mass of nickel in 80 g of this alloy.

Figure 1



(a) Determine the mass of iron and nickel in 80 g of the alloy.

Use **Figure 1**.

Mass of iron = _____ g

Mass of nickel = _____ g

(1)

(b) Calculate the mass of chromium in 80 g of the alloy.

Draw a bar on **Figure 1** to show the mass of chromium in 80 g of the alloy.

_____

_____

Mass of chromium = _____ g

(2)

(c) What mass of iron is present in **0.80 kg** of the alloy?

Give your answer in grams.

_____

_____

Mass of iron = _____ g

(1)

(d) What is an alloy?

_____

_____

(1)

(e) Give **one** reason why alloys are used instead of pure metals.

_____

_____

(1)

(f) Iron and nickel are both magnetic metals.

Which is also a magnetic metal?

Tick **one** box.

Cobalt ☐

Copper ☐

Sodium ☐

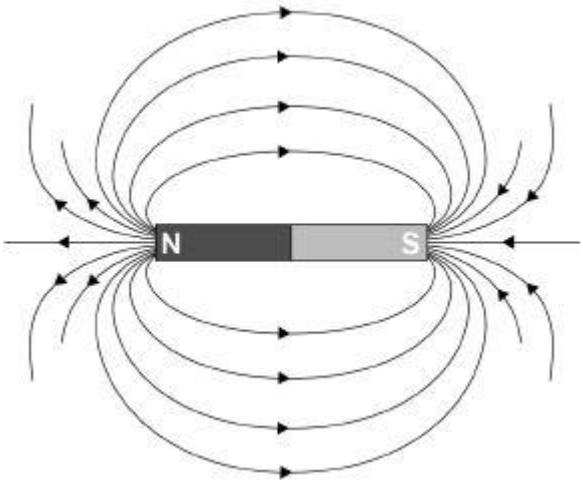
Zinc ☐

(1)

A student plotted the magnetic field pattern around a bar magnet.

Figure 2 shows the magnetic field pattern.

Figure 2



(g) Complete the sentence.

Choose the answer from the box.

induced	**permanent**	**temporary**

Bar magnets produce their own magnetic fields.

Bar magnets are described as _____ magnets.

(1)

(h) Which statement about the magnetic field around a bar magnet is correct?

Tick **one** box.

The magnetic field is the same strength all around the magnet.	☐
The magnetic field is strongest at the poles of the magnet.	☐
The magnetic field is strongest near the middle of the magnet.	☐

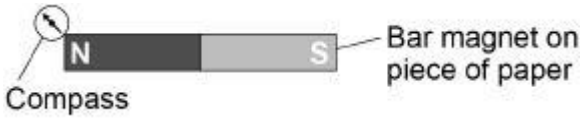
(1)

(i) This is the start of a method used to plot a magnetic field pattern around a bar magnet.

1. Place the magnet on a piece of paper.
2. Draw around the magnet.
3. Mark a dot by a pole of the magnet.
4. Place the compass on the dot.

Figure 3 shows the apparatus after steps 1−4.

Figure 3



Describe the rest of the method to plot the magnetic field pattern.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 13 marks)

Q6.

Carbon can exist in a number of different structures.

(a) The first fullerene to be discovered was Buckminsterfullerene.

What is the formula of Buckminsterfullerene?

Tick (✓) **one** box.

C40 ☐

C50 ☐

C60 ☐

C70 ☐

(1)

(b) Graphite is a form of carbon.

Explain why graphite conducts electricity.

_____

_____

_____

_____

(2)

Steel is an alloy of iron and carbon.

(c) Explain why steel is harder than iron.

_____

_____

_____

_____

_____

_____

(3)

(d) Iron is alloyed with carbon and other metals to make stainless steel.

A stainless steel fork contains 71.92% iron.

The table below shows the mass of each element in the fork.

Element	Iron	Carbon	Chromium	Nickel
Mass of element in g	**X**	0.05	10.44	5.80

Calculate the mass of iron (**X**) in the fork.

_____

_____

_____

_____

_____

_____

X = _____ g

(4)

(Total 10 marks)

Q7.

The stopping distance of a car is the sum of the thinking distance and the braking distance.

(a) The thinking distance is affected by the reaction time of the driver.

Which **two** of the following can affect the reaction time of the driver?

Tick (✓) **two** boxes.

Damaged brakes ☐

Taking drugs ☐

Tiredness ☐

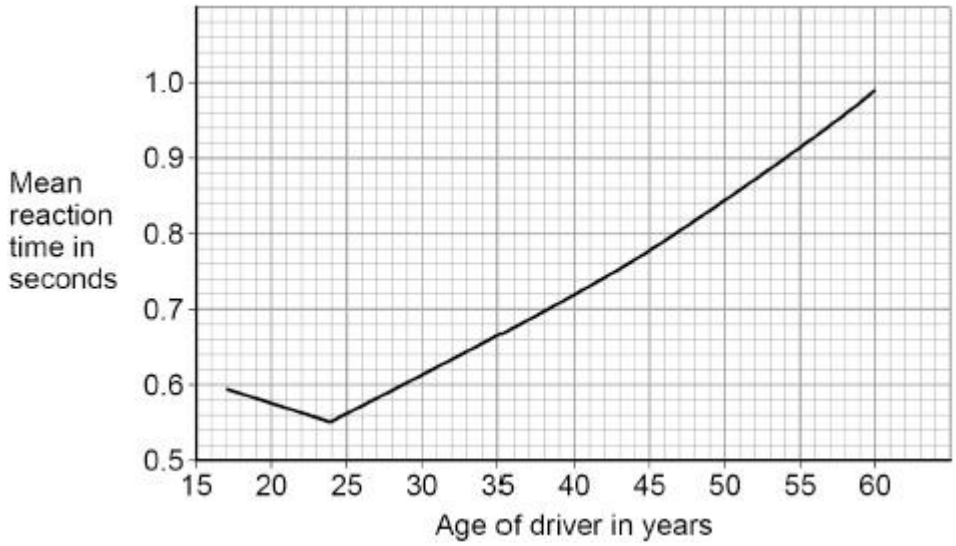
Wet roads ☐

Worn tyres ☐

(2)

Scientists measured the reaction time for drivers of different ages.

The graph below shows the results.



(b) At what age did the drivers have the lowest mean reaction time?

Age = _____ years

(1)

(c) What was the lowest mean reaction time?

Time = _____ seconds

(1)

The braking distance of a car is the distance travelled between the driver applying the brakes and the car stopping.

(d) Complete the sentences.

Choose answers from the box.

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

decreases	**stays the same**	**increases**

When the brakes are applied, the kinetic energy of the car _____.

The temperature of the brakes _____.

(2)

(e) A car is travelling at a speed of 12 m/s.

The driver applies the brakes and the car decelerates at a constant 3.0 m/s^2.

Calculate the braking distance of the car.

Use the equation:

$$\text{braking distance} = \frac{(\text{speed})^2}{2 \times \text{deceleration}}$$

Choose the unit from the box.

m	kg	s

Braking distance = _____ Unit _____

(3)

(f) To pass the UK driving test, people must know the typical stopping distance of a car at certain speeds.

Suggest **one** reason why.

(1)

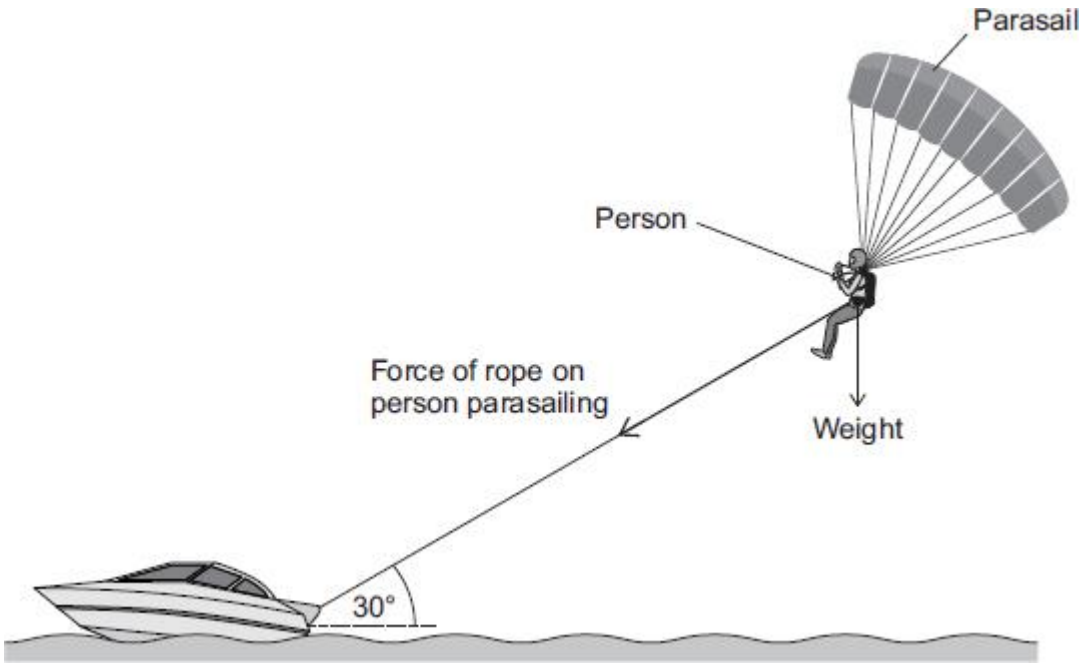
(Total 10 marks)

Q8.

Figure 1 shows a boat pulling a person parasailing.

Figure 1 is not drawn to scale.

Figure 1



not drawn to scale.

(a) Write down the equation which links gravitational field strength (*g*), mass (*m*) and weight (*W*).

_____

(1)

(b) The weight of the person is 735 N.

Calculate the mass of the person.

gravitational field strength = 9.8 N/kg

_____

_____

_____

_____

_____

Mass = _____ kg

(3)

(c) The person is moving at a constant velocity.

What is the resultant force acting on the person?

_____

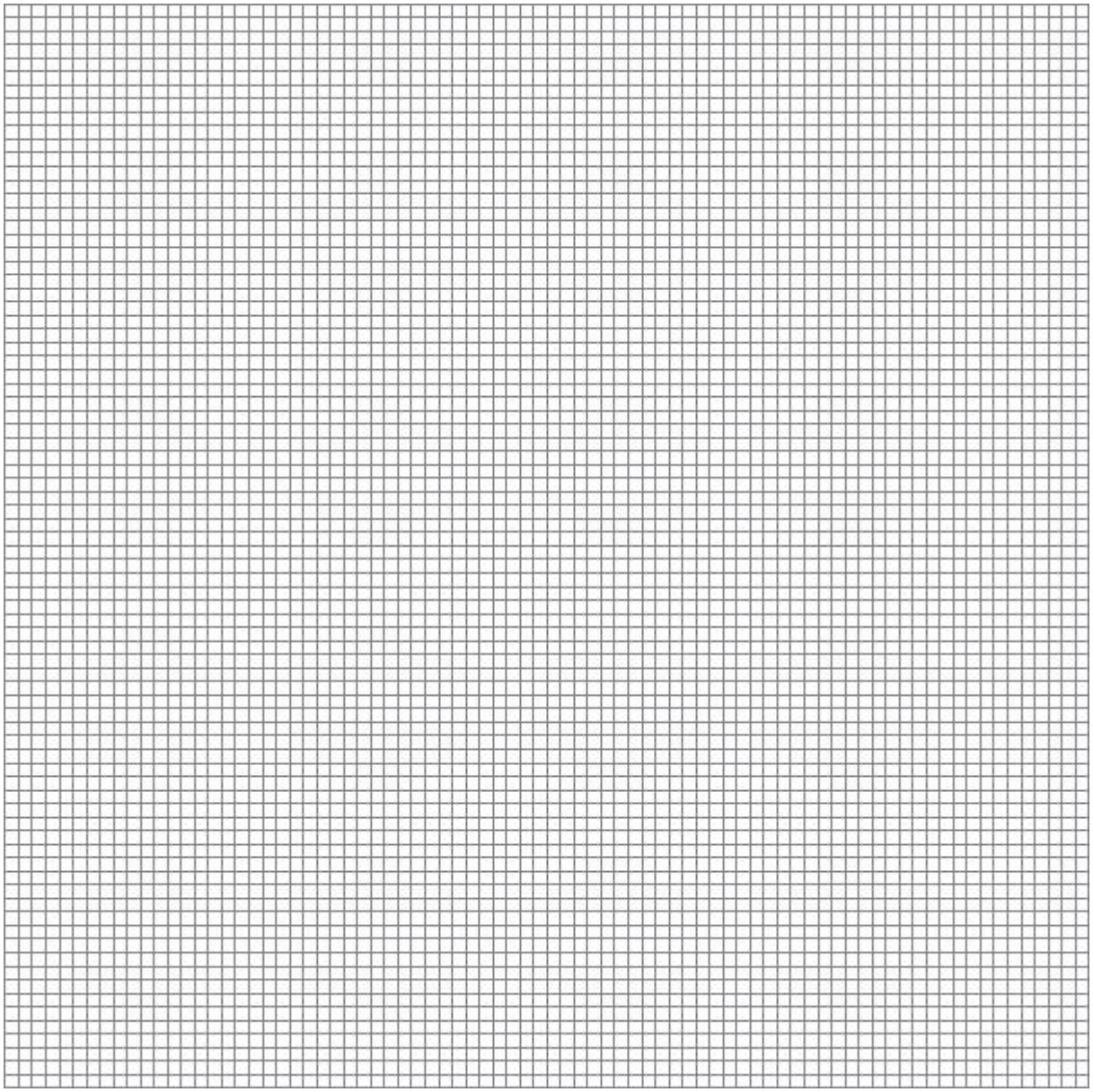
(1)

(d) The magnitude of the force of the rope on the person is 5000 N.

Draw a vector diagram on **Figure 2** to determine the vertical component and the

horizontal component of the force on the rope.

Figure 2



Vertical component = _____ N

Horizontal component = _____ N

(3)

(e) The force of the rope on the person parasailing is 5000 N.

The boat pulls the person for a horizontal distance of 1000 m.

The work done by the force of the rope on the person is **not** calculated by multiplying 5000 N by 1000 m.

Explain how the work done by the force of the rope on the person could be calculated.

_____

_____

_____

_____

(2)

(Total 10 marks)

Q1.

(a) platelets

1

(b) increase in time taken for blood to clot

allow decrease in clotting of the blood

allow blood will not be able to clot

allow blood does not stop flowing out of cuts

1

(c) 5.1×10^9 per cm^3
$= 5.1 \times 10^{12}$ per dm^3
or
4.25 dm^3 = 4250 cm^3

1

$5.1 \times 10^{12} \times 4.25$
$= 2.1675 \times 10^{13}$
or
$4250 \times 5.1 \times 10^9$
$= 2.1675 \times 10^{13}$

allow correct calculation using incorrectly / not converted value from step 1

1

$$\frac{2.0 \times 10^{11}}{2.1675 \times 10^{13}} \times 100$$

1

= 0.92…(%)

1

(d) (red blood cells) do **not** have chromosomes

ignore nucleus

*allow (red blood cells) do **not** have DNA / genes*

*allow (red blood cells) do **not** have genetic material*

1

(so chromosomes) cannot replicate and separate into two new cells

1

(e) **Level 3:** A judgement, strongly linked and logically supported by a sufficient range of correct reasons, is given.

5–6

Level 2: Some logically linked reasons given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. They are not logically linked.

1–2

No relevant content

0

Indicative content

(allow converse points if clearly referring to red blood cells from stem cells)

Blood donations **advantages**
- it is an easier / quicker process
- blood can be donated / collected regularly so good supply
- blood available for emergencies / immediately
- can store blood longer than it takes to make (red) blood cells using stem cells
- the components of the blood can be used for different treatments
- the components of the blood can be used to treat more people / different people
- known to work / tested treatment
- free / inexpensive

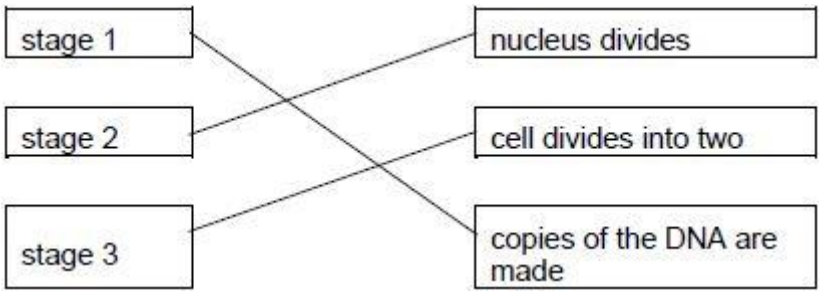
disadvantages
- relies on volunteers / donors
- inconvenience / discomfort for donors
- may not have enough blood / a regular supply of blood
- may not have enough of the right blood component
- blood may be wasted / not needed
- risk of infection from donated blood
- not patient's own cells so may be rejected

For **level 3** advantages and disadvantages supported by own knowledge

[14]

Q2.

(a)



*allow **1** mark for 1 or 2 correct*

credit can be given where students have matched the boxes correctly, for example numbering the boxes

2

(b) 6 picograms

1

(c) meristem cells in plants can differentiate throughout the life of the plant

1

(d) any **two** from:
- may cure / treat diseases

or

cure medical conditions
or
produce replacement cells / tissues / organs

allow example e.g. diabetes / paralysis
allow cells can be stored for future use
ignore used in medical treatments
ignore patient makes / grows cells / tissues / organs

- cells unlikely to be **rejected** by patient)

  ignore same genetic information

- cells / tissues of any type can be produced

  ignore differentiated into most types of cells

- many cells produced

- cells produced could be used for research

- would reduce waiting time for transplants

2

ignore references to cost
ignore all reference to producing babies / IVF

(e) any **two** from:

- (potential) life is killed / destroyed

  allow embryo is killed
  ignore embryo is destroyed
  ignore embryo is a life / becomes a baby

- shortage of donors / eggs

- egg donation / collection has risks

- do not yet know risks / side effects of the procedure on the patient

  ignore long term effects are not well understood
  allow may cause tumours / cancer

- may transfer (viral) infection

- poor success rate

  allow in terms of viable egg / embryo / cell / tissue / organ production

2

ignore references to cost
ignore unethical unqualified
Ignore reference to religion / beliefs

[8]

Q3.

(a) (i) any **one** from:

- age
- gender
- body mass

- number in group / 50
  allow number of children
- high body temperature
  allow starting temperature
  allow dose / amount of drug given

1

(ii) any **one** from:

- tablet that does not contain a drug / anything
  allow sugar pill
  *do **not** allow a different drug*
- fake drug

1

(b) (i) 38.2 (°C)

1

(ii) ibuprofen

no mark for drug
no marks if wrong drug selected

any **two** from:

- reduced body temperature fast(er)
  allow acts fast(er)
- maintained temperature in normal range / around 37 °C (longer / for several hours)
- paracetamol did not reduce temperature to normal / 37 °C
  accept ibuprofen did reduce temperature to normal / 37 °C
- ibuprofen given less frequently
  allow less drug needed
  ignore cheaper unless qualified

2

[5]

Q4.

(a) 0.1 nm

1

(b) 6 protons

1

8 neutrons

1

6 electrons

allow electron (structure) 2,4

1

protons in nucleus

1

neutrons in nucleus

1

electrons (around nucleus) in energy levels / shells

1

(c) 3

1

(d) covalent

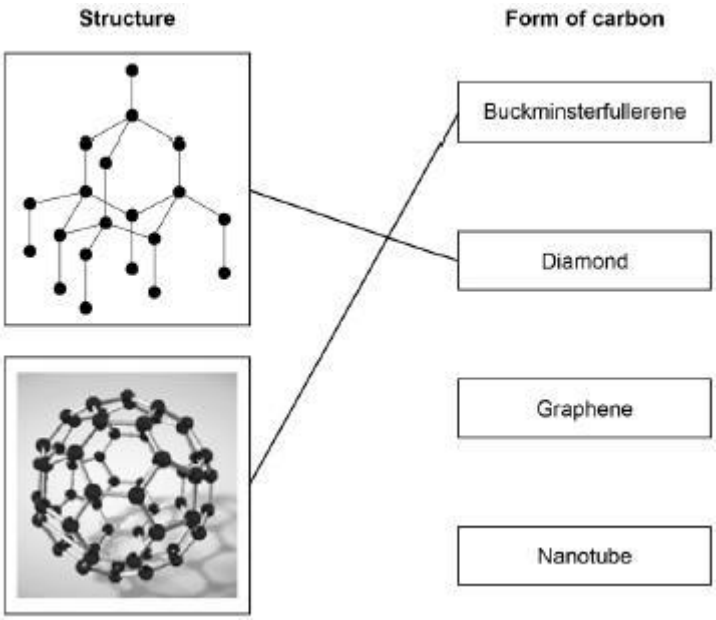
1

(e) layers slide (over each other)

allow atoms slide over each other

1

(f)



do **not** accept more than **one** line from a box on the left

1

1

[12]

Q5.

(a) iron = 60 (g)
and
nickel = 6 (g)

both required for a mark

1

(b) 14 (g)

*allow ecf from part **(a)***

1

bar drawn at 14 g

allow an incorrectly calculated value for mass of chromium correctly drawn

allow a tolerance of ± half a small square

1

(c) 600 (g)

*allow ecf from part **(a)***

1

(d) mixture of metals

allow a mixture of elements with at least one being a metal

1

(e) alloys are harder

allow alloys are stronger
allow alloys can be designed for specific purposes
allow alloys are corrosion resistant
ignore references to cost, reactivity

1

(f) cobalt

1

(g) permanent

1

(h) the magnetic field is strongest at the poles of the magnet

1

(i) **Level 2:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- make a dot at the tip of the compass needle
- move the compass tail to the new dot
- make a dot at the tip
- repeat until the compass reaches the other pole of the magnet
- draw a line through the dots
- add arrow to show direction of field line (from north to south)
- repeat for different starting positions at the poles

[13]

Q6.

(a) C_{60}

1

(b) (graphite has) delocalised electrons

1

(so the delocalised electrons) carry electrical charge through the structure

allow (so the delocalised electrons) move through the structure

1

(c) carbon atoms have different sizes to iron atoms / ions

1

(so carbon atoms) distort the layers of iron atoms / ions

1

(therefore) the layers cannot slide

1

(d) (percentage and mass of other elements)
28.08 (%) = 16.29 (g)

1

(mass of fork) = $\frac{16.29}{28.08} \times 100$ (g)

1

= 58.01 (g)

1

(mass of iron = $\frac{71.92}{100} \times 58.01$
71.92

allow (mass of fork – mass of other elements) = 41.72 (g)

allow 41.7 (g)

allow correct use of incorrect calculation of mass and / or percentages

1

[10]

Q7.

(a) taking drugs

1

tiredness

1

(b) 24 (years)

1

(c) 0.55 (s)

allow answer in range 0.54 to 0.56

1

(d) decreases

this order only

1

increases

1

(e) braking distance = $\frac{(12)^2}{(2 \times 3)}$

1

braking distance = 24

1

unit = m

1

(f) so they know how far behind another car they should drive

or

so they can stop safely if the car in front stops

1

[10]

Q8.

(a) weight = mass × gravitational field strength
or
W = mg

1

(b) 735 = m × 9.8

1

$m = \frac{735}{9.8}$

1

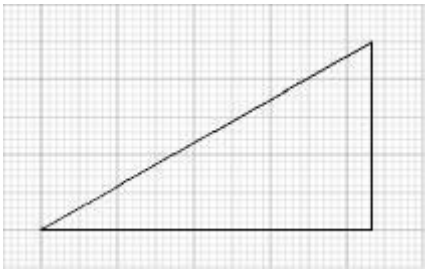
m = 75 (kg)

1

(c) zero / 0

1

(d)



1

vertical component = 2500 (N)

1

horizontal component = 4330 (N)

1

(e) the horizontal component of the force / 4330 (N)
*allow ecf from question **(d)***

1

must be multiplied by the horizontal distance / displacement / 1000 m

this mark is dependent on scoring the first mark

1

[10]