Name: …… **School: ……**

TONBRIDGE SCHOOL

Scholarship Examination Sample Paper

Science II – Biology, Chemistry and Physics

Time allowed: 1 hour 15 minutes

Please write your name at the top of each of the subject specific sections, as indicated.

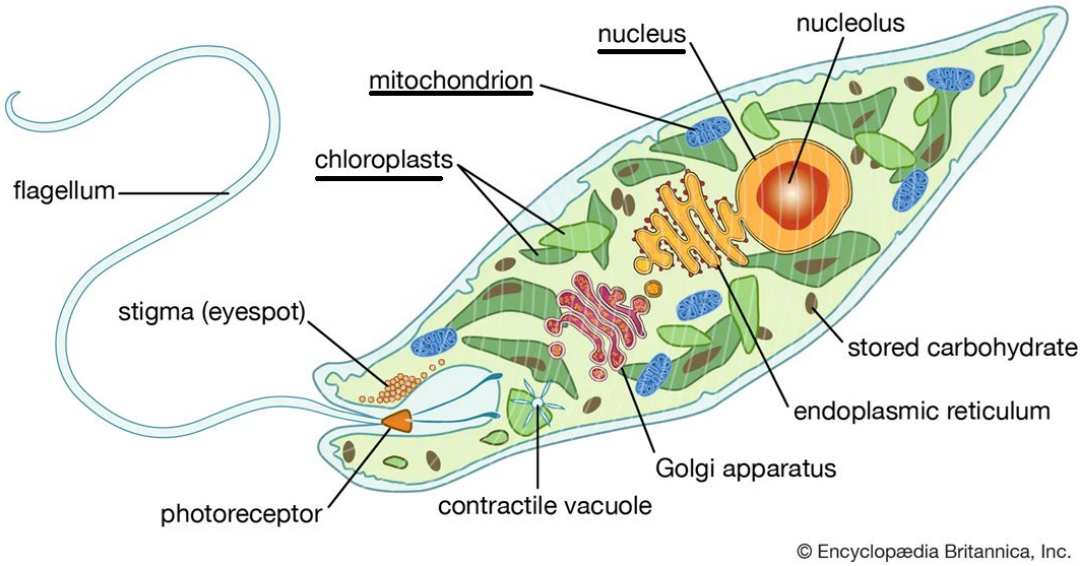
Answer all the Questions.

You may use a calculator.

The entire paper is worth 60 marks and the number of marks for each question is shown in brackets.

Biology

1. The diagram below shows an unusual single-celled organism called *Euglena*. A number of internal structures have been labelled but you are only expected to know the ones that have been underlined.



a) Explain why Euglena needs mitochondria. (3)

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b) Animal cells store carbohydrate as glycogen whilst plant cells store carbohydrate as starch. Describe a simple test you could perform to tell whether a sample of stored carbohydrate from *Euglena* was glycogen or was starch. (2)

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c) Euglena has chloroplasts like a plant and an eye spot like an animal. Suggest why this might be a useful combination of features. (3)

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d) *Euglena* has both plant-like and animal-like features. Which kingdom should it be placed into, and why? (2)

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2. Biologists and fruit farmers are very concerned about an invasive species, the Asian hornet, which is spreading into the British Isles from Europe. Asian hornets are large insects that eat honey bees. The advertisement below is trying to get people to report Asian hornets when they see them. All the insects in the advertisement can sting.

a) Why are honey bees important to fruit farmers? (2)

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b) Honey bees eat nectar from the flowers of fruit trees. Show a food chain connecting bees, trees and hornets – you do not have to try and draw them! (1)

c) If a fruit tree is a producer, what term describes an Asian hornet? (1)

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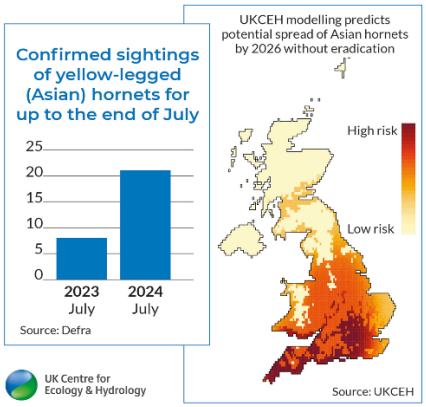
When people report sightings of Asian hornets, government scientists use it to study patterns and make predictions about how the hornets might spread.



d) The hornets appear earlier in the spring, and further north, each year. Suggest reasons why this should be the case. (4)

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e) This picture shows a hover fly. Flies belong to a different family of insects from bees and wasps and do not sting. Suggest why hover flies may have evolved their appearance. (2)

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Biology Total Marks 20

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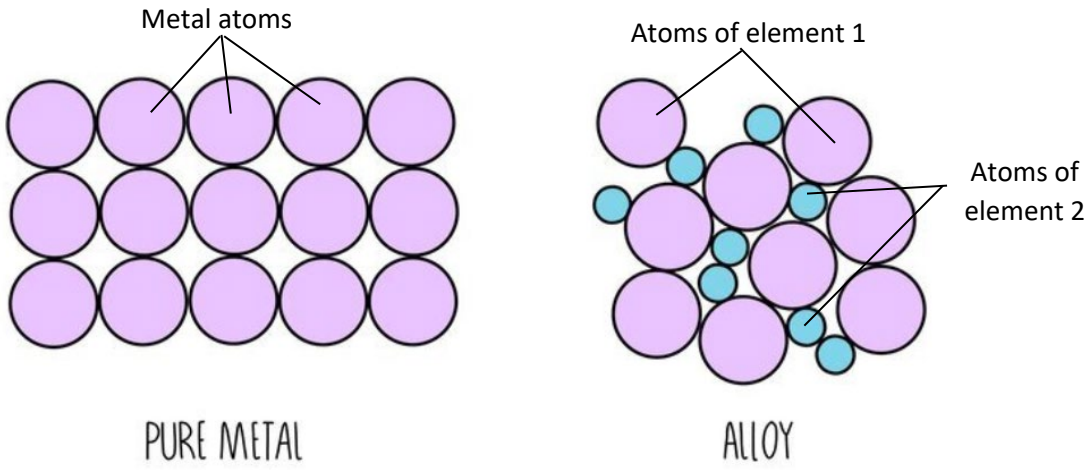
Chemistry Name:

1. One of the bigger sporting events of the last twelve months was the 2024 European Football Championships ("UEFA Euro 24") which was held in Germany and won by Spain who beat England in the final.

   The trophy "The Henri Delaunay Trophy" is an *alloy* of copper and silver and is shown below:

An *alloy* is a mixture made up of a metal with a small amount of another element (often another metal). The structures of a pure metal and an alloy are shown below:



Pure metals are malleable because the layers of metal atoms can slide over each other reasonably easily.

a. Using the diagrams on the previous page, suggest why alloys are less malleable than pure metals.

(2)

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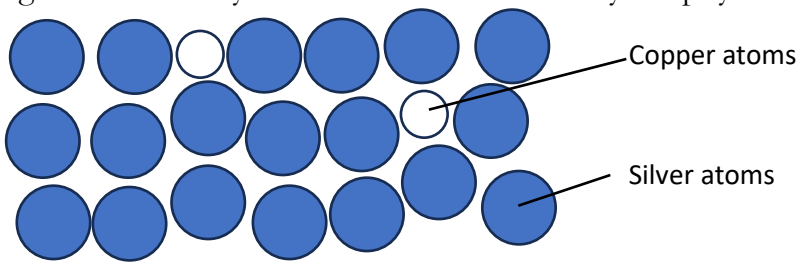
b. Below is a diagram of the alloy used in the Henri Delaunay Trophy.



Calculate the percentage of the alloy that is copper. Give your answer to 1 decimal place

(2)

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c. The Henri Delaunay Trophy has a mass of 10kg

The table below shows the density of copper and silver.

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Metal	Copper	Silver
Density / gcm^{-3}	8.96	10.49

If the alloy used to make the trophy was melted down into a solid sphere, calculate the radius of the sphere that could be formed from the metal in the trophy.

You may assume that there is no change in total volume when two metals are alloyed together.
(Volume of a sphere = $4/3\ \pi\ r^3$)
(if you have not been able to calculate the percentage of the alloy that is copper in part (b), assume the percentage of the alloy that is copper is 23%. This is not the correct answer)

(4)

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2. Fuels are substances that combust in oxygen (from the air) to release heat. The gas that comes out of gas taps in the Tonbridge Chemistry labs is methane, CH_4.

   Word and balanced symbol equations for the combustion of methane are given below.

   Complete combustion of methane:

   methane + oxygen → carbon dioxide + water

   $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

   Incomplete combustion of methane:

   methane + oxygen → carbon monoxide + water

   $CH_4 + 1½O_2 \rightarrow CO + 2H_2O$

   a. What are the differences between complete combustion and incomplete combustion?

   (2)

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   b. Incomplete combustion can sometimes produce carbon in the form of soot instead of carbon monoxide. Give a word equation for incomplete combustion of methane where soot is produced and not carbon monoxide.

   (1)

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c. Methane is an alkane. Alkanes all have a molecular formula which has the form C_nH_{2n+2}.. The first 5 alkanes are listed in the table below:

Name	Molecular formula
Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}
Pentane	C_5H_{12}

Give the molecular formula of the alkane with 16 carbon atoms.

(1)

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d. Alkenes are similar to alkanes but they have two fewer hydrogen atoms. Complete the table below comparing alkanes and alkenes:

(2)

Number of C atoms	Name of alkene	Molecular formula of alkene
2	Ethene	C_2H_4
3	……..	C_3H_6
4	Butene	……..

e. The *general formula* of alkanes is C_nH_{2n+2}. Suggest a general formula for alkenes.

(1)

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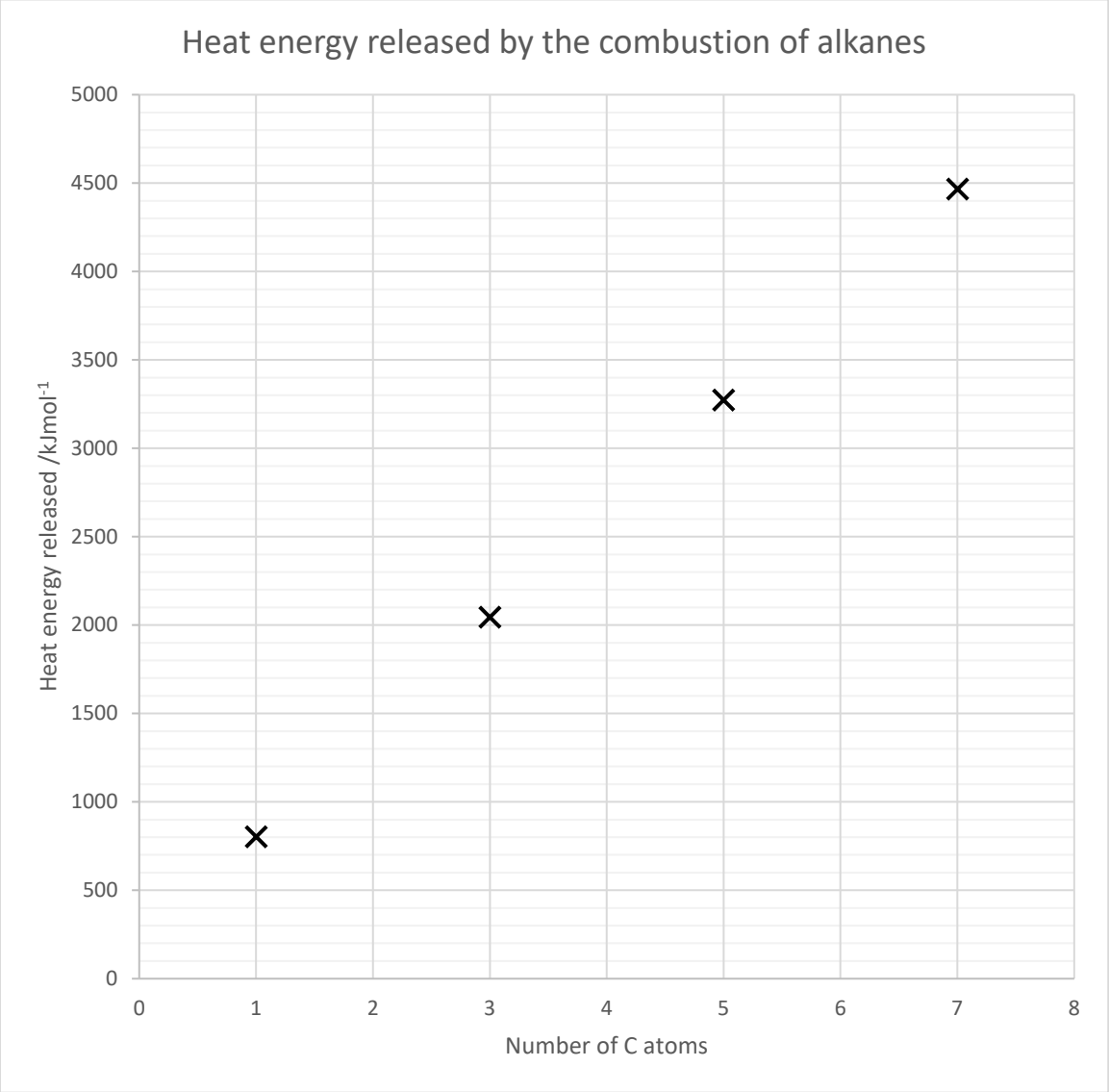
f. Different fuels produce release different amounts of heat energy when they combust. The graph below shows how much heat energy is given out when alkanes of increasing numbers of carbon atoms combust completely.



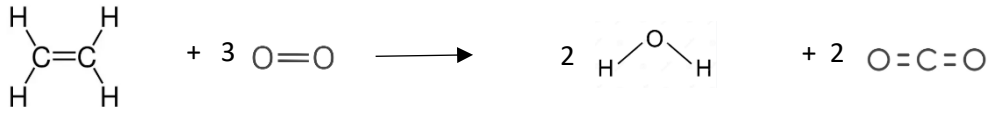
Use the graph to work out how much heat is given out by completely combusting butane.
Ensure that you show on the graph how you have arrived at your answer.

(3)

Heat energy given out =…….……kJmol^{-1}

g. The energy given off in a reaction can also be calculated by determining how much energy is taken in by breaking the bonds in the reactants and subtracting the amount of energy given out when new bonds are formed. The table below shows the energy stored in bonds of different types and the equation for the complete combustion of ethene, showing all the bonds broken and formed:

Bond	C-H	C=C	O=O	O-H	C=O
Energy /kJmol^{-1}	413	614	495	463	799



The total energy change for this reaction is -1297 kJmol^{-1}.
Calculate the heat energy taken in in breaking the bonds of the reactants and the heat energy given out in forming new bonds:

(2)

Heat energy taken in breaking old bonds =…….……kJmol^{-1}

Heat energy given out in forming new bonds =…….……kJmol^{-1}

Chemistry Total Marks 20

Physics Name: _____

1. The Tonbridge boys enjoyed terrific weather on a recent ski trip to France. It snowed overnight and was warm and sunny during the day making for comfortable conditions to ski.

   While travelling on the chair lift, it was noticed the snow around the base of the metal pylon appeared to have melted, as shown in the photograph:

   Snow at the base of the metal pylon

   Chair lift pylon

   a. Explain why the snow at the base of the metal pylon has melted faster than the surrounding snow. (2)

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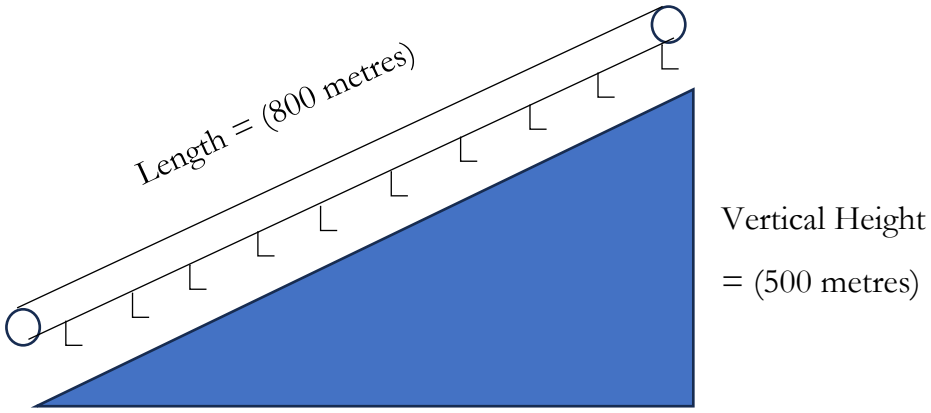
On a sign by the entrance, it claims the chair lift can carry 3,600 skiers every hour through a height of 500 metres. We can assume the chair lift is travelling at a constant speed.



b. If each chair can seat up to 6 skiers, calculate the number of chairs lifted every hour. (1)

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c. If the distance between each chair is 12 metres, calculate the average speed of each chair when the chair lift is operating at maximum capacity. Give your answer in metres per second. (2)

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d. Some people may also ride the chair lift down from the top of the mountain (if they have just visited a restaurant at the top). Do you think the electric motor powering the chair lift will have to work harder if it must also take people down the mountain as well as carry people up? Explain your answer. (2)

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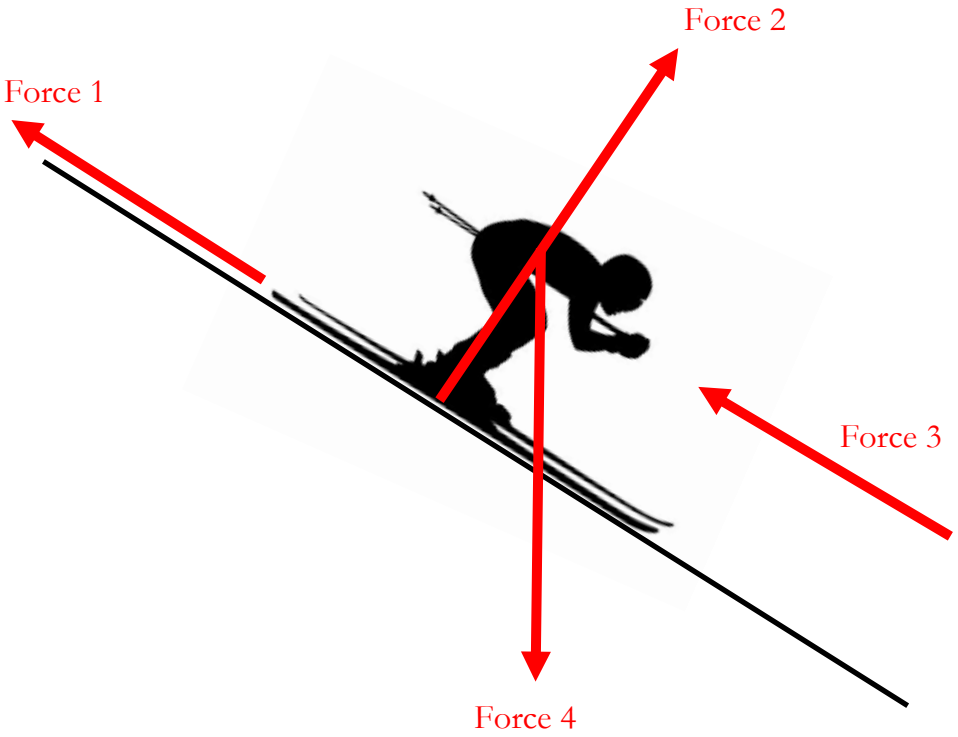
2. The diagram below shows the forces acting on a skier sliding down the mountain.



a. Complete the names of the forces. (2)

i. Force 1 = Friction

ii. Force 2 = ...

iii. Force 3 = ...

iv. Force 4 = ...

b. If the skier has a mass of 72 kg, and the total area of contact made with the snow by both skis combined is 3600 cm^2, calculate the pressure exerted on the snow **by each ski**. (Take the gravitational field strength, g, to be 10 ms^{-2}.) (2)

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c. Why does the skier adopt the position he has taken? (1)

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d. As the skier slides down the slope snow will be pushed forwards, especially during any turns. What force is responsible for pushing the snow forward? (1)

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e. The snow pushed forward by the skier will cause bumps and lumps in the snow. Skiers following behind will try to avoid these bumps but only if they can see them. They are easier to see on a sunny day even though all the snow is white. Explain how a skier can see the ridges and other features in the snow. (1)

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f. If it is snowing or the cloud is low, the light is scattered. It then becomes very difficult to see any features in the snow. Why is it more difficult to see any lumps and bumps in the snow under these conditions? (1)

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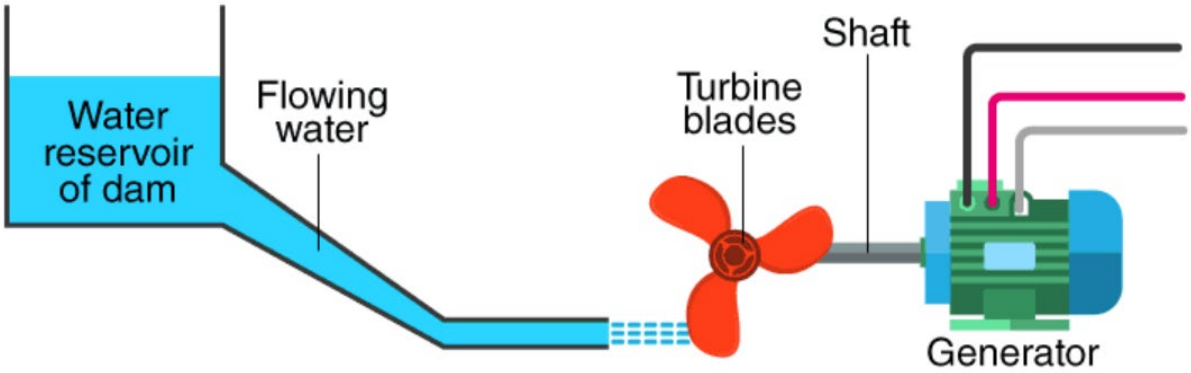
3. The electricity to power the chair lifts, such as the lift described in question 1, is generated using a hydroelectric power station. The melted snow from the slopes runs to the bottom of the mountain where it is kept in a lake using a dam. Gates in the dam are opened to allow this water to flow and spin turbines.



Hydro-power plants

a. Describe the energy transfer that occurs when water in the dam is used to spin the turbine blades. Include any wasted energy in your description. (2)

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b. When the turbine is spinning, the ends of the blades are travelling faster than the part of the blade closer to the shaft. Why is there a danger the turbine blades may snap if they spin too fast? (1)

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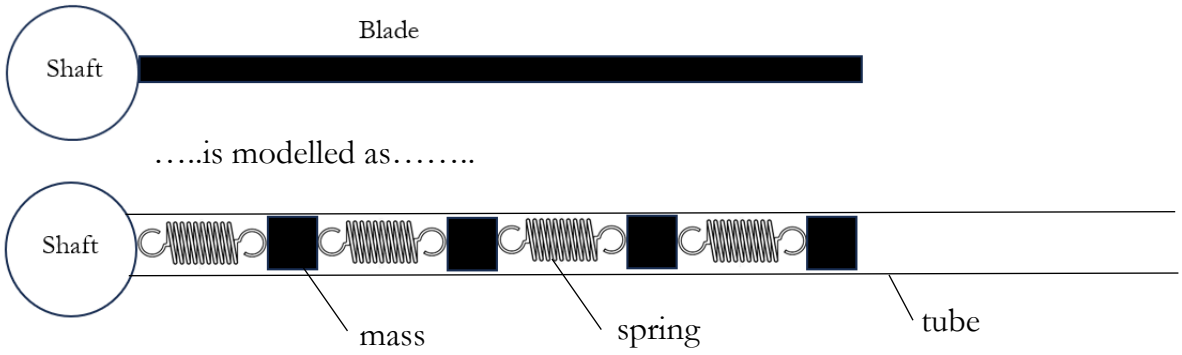
c. To model a turbine, a Tonbridge student connected masses together with springs inside a tube.



He rotated this arrangement at speed to simulate the turbine blade turning.

Draw a diagram to show how the lengths of the springs and the positions of the masses inside the tube will change if the model of the blade is now **rotating**. (2)

Physics Total Marks 20

END OF PAPER 2