

Name and School:



OUNDLE

School

Academic Scholarship 2014

Preliminary Examination

SCIENCE

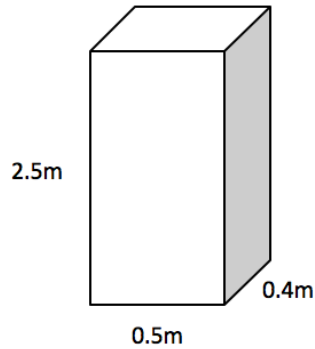
Time Allowed : One Hour

- Write your name on the question paper
- Write all your answers on the question paper

Physics Section – 32 marks

Take the gravitational pull of the Earth, g , to be 10N/kg

1. This is a question about pressure. Pressure is defined as the force per unit area.
 - a. What is the volume of a block of concrete which is 0.5m wide, 0.4 m deep and 2.5 m high?



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(2)

- b. The density of concrete is 2400kg/m^3 .
What is the mass of the block of concrete?

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(2)

- c. What is the weight of the block?

.....

(2)

- d. What is the area of the end of the block on which it stands?

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(2)

- e. What is the pressure exerted on the end of the block when it stands on a flat horizontal surface?

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(3)

f. The block is replaced by one that is 0.25m wide and 0.2 m deep. It is the same height and the made of the same material.

Repeat the calculations in parts a. to e. to find the pressure on the end of the new block.

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(3)

g. Comment on your answers to parts e. and f. How do the values compare?

.....

(1)

h. The block in part f. is replaced by one with the same dimensions but made of a material with density 3600kg/m^3 .

Write down, or calculate, the pressure on the end of this block.

.....

(1)

i. Suggest a formula for calculating the pressure on the end of a block in terms of:

Height h , width w , depth d , density D , gravitational pull g .

You may use all, or some, of the quantities in the list.

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(3)

j. The atmosphere can support a column of water which is 10m high. The density of water is 1000kg/m^3 . Use your formula from part i to calculate the atmospheric pressure.

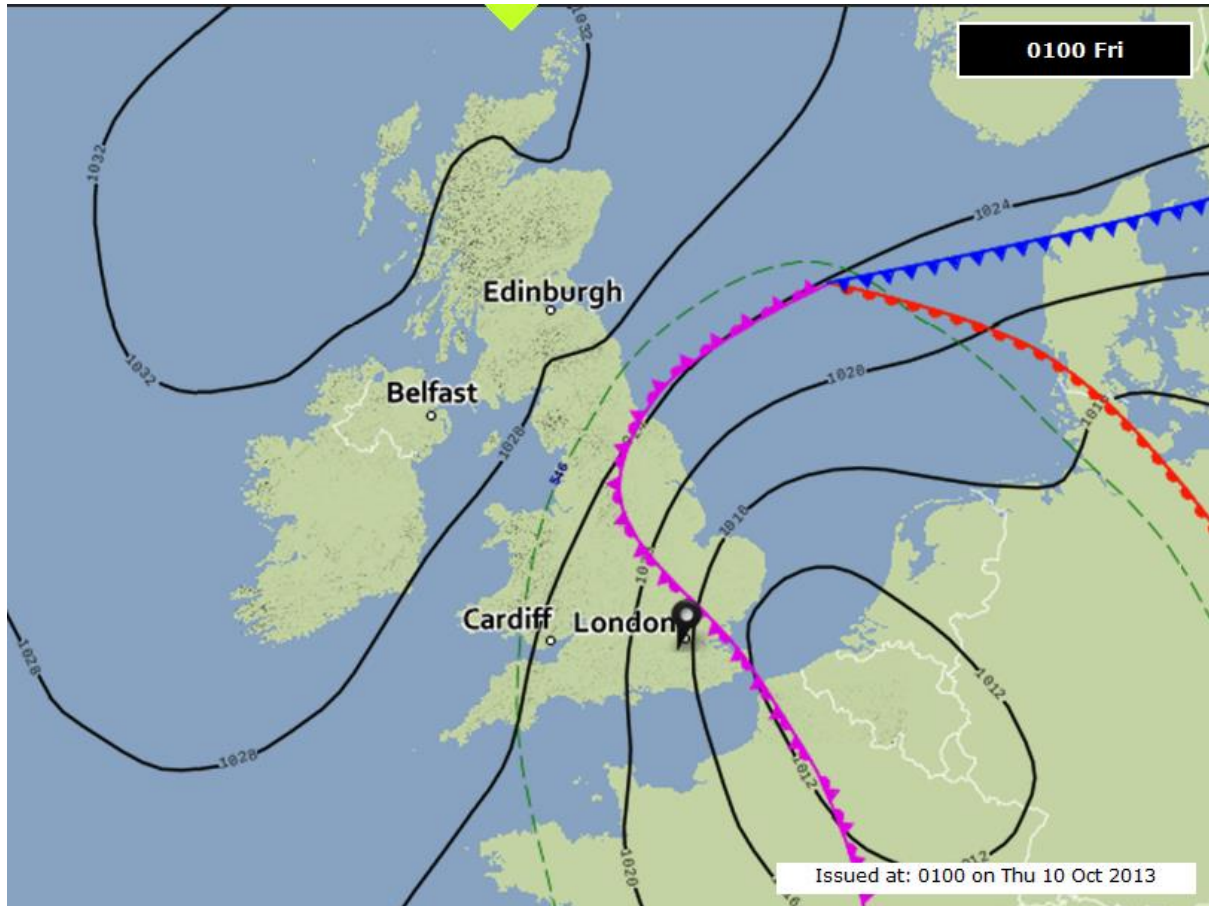
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(1)

[Total: 20 marks]

2. Weather, or more properly, surface pressure maps show how the pressure of the air near to the ground surface varies over a geographical region. The black contour lines are isobars, lines of equal pressure.

Here is a typical map:

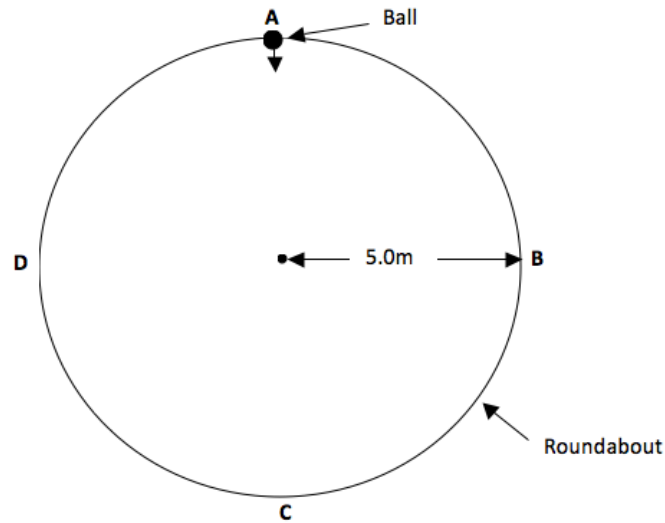


Ignore the lines coloured red, blue and mauve.

- a.
 - i. Find the contour line with the smallest number, 1012, on it and inside the loop on the map label it L, for Low pressure.
 - ii. Find the line with the highest number, 1032, on it and inside that loop label it H, for High pressure.
 - iii. On the map draw an arrow showing in which directions you would expect the air to move due to the pressure difference.

(3)

- b. The Earth is rotating. This affects how air moves due to differences of pressure. One way to understand how is to think about what happens on a roundabout at a playground.



Initially the roundabout is stationary and the ball is rolled gently from the point A towards the middle at 1.0m/s. The roundabout is 10.0m in diameter. Assuming that there is no friction and the speed of the ball does not change mark the position of the ball on the surface of the roundabout every second.

(2)

- c. Now the roundabout is made to rotate anticlockwise at a constant speed of one revolution in 20 seconds.
- i. How long does it take for the ball to cross the roundabout?

.....
(1)

- ii. Where will be the point A be when the ball has crossed the roundabout?

.....
(1)

- d. Imagine that you are sitting on the edge of the roundabout at the point A and you roll the ball at 1.0m/s and the roundabout rotates once in 20 seconds, (or if you think that is unrealistic speed it up so the ball is thrown at 10m/s and the roundabout rotates once in 2 seconds, but you will get very dizzy!).

Describe what you would see the ball doing from your perspective.

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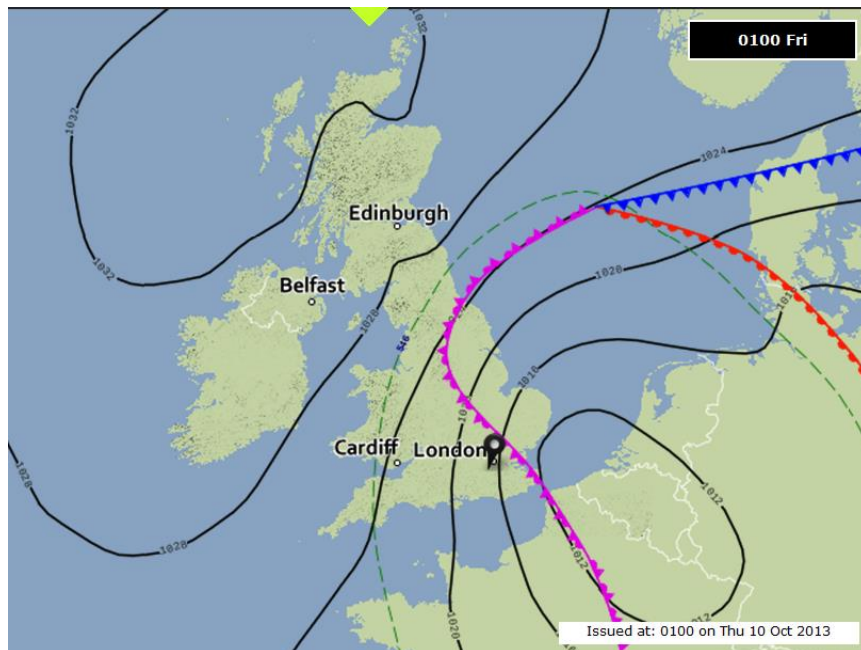
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(4)

- e. In the first part of this question you should have drawn arrows showing the directions of airflow, i.e. wind, due to the pressure difference. Do this again, but now take in to account the fact that the Earth is rotating.

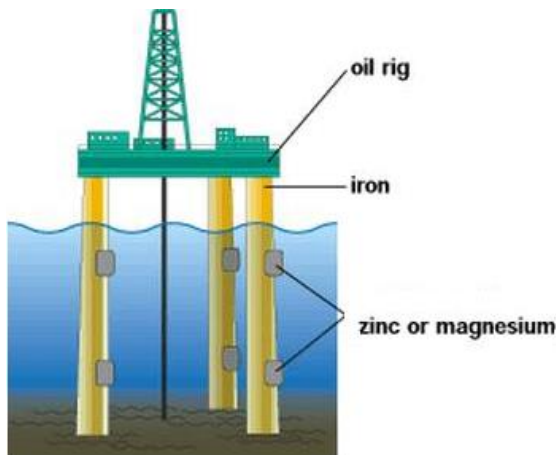


(1)

[Total: 12 marks]

Chemistry Section – 31 marks

3. Iron and steel can be protected from rusting by sacrificial protection. In this process, blocks of zinc or magnesium are attached to the iron e.g the hull of a ship, the legs of a pier or oil rig, or a steel pipeline. Whilst the blocks are in place, the iron or steel does not rust.



- a. What are the two substances required, apart from iron, for rusting to take place?

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(1)

- b. Explain how zinc or magnesium blocks can protect the legs of the oilrig from rusting.

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(2)

Instead of putting blocks in place, the company that owns the oilrig decides to paint the legs to protect them from rusting.

- c. Explain how painting protects the iron and what would happen if the paint was chipped or damaged in some way.

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.....
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(3)

[Total: 6 marks]

4. A cup of tea contains solids (solutes) dissolved in hot water. The solids are from the tea leaves.

a. In the space below, draw a neat and fully labelled diagram of the apparatus you would set up in order to separate and collect pure water from the tea using normal laboratory equipment.

Above your diagram, name the separation method being used.

(4)

b. What will be the temperature reading on the thermometer whilst the pure water is being collected? The unit must be included.

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(1)

- c. Could the same apparatus be used to separate ethanol from water? Explain why. If not, name and describe the method that should be used instead of that in (a).

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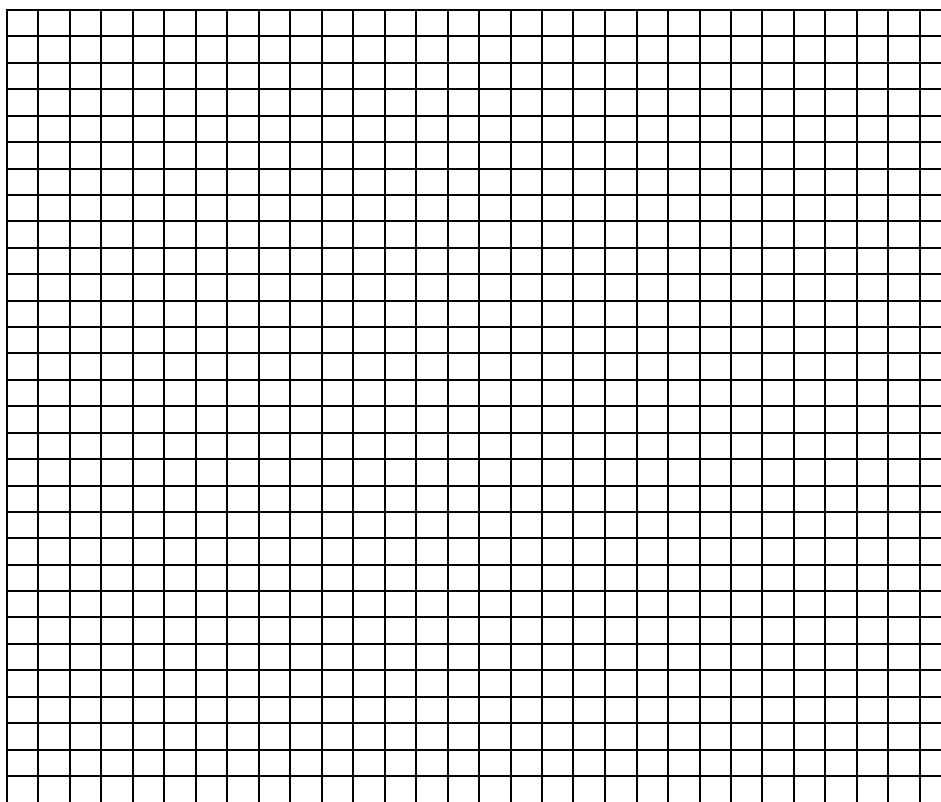
(4)

[Total: 9 marks]

5. A group of chemists were in a café and they collected together a number of different sized glasses. They decided to find out how long it would take each glass to put out the burning candle on their table. They placed each glass in turn over the top of the candle and one of the students timed the burning time in seconds on their digital stop watch. The results of the café café experiment are shown below:

Volume of glass (cm³)	Burning time (s)
0	0
75	7
140	11
210	17
325	27
440	35
580	46
650	53
725	59

- a. On the grid below, plot a line graph of the results, with the volume of glass on the x-axis and burning time on the y-axis, and draw a best-fit straight line for the results.



- b. What happens to the burning time of the candle when the glass volume increases and why?

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(3)

- c. What does the straight line tell us about the relationship between volume of the glass and the burning time of the candle?

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(1)

- d. Use your graph to work out the burning time of a 250cm³ glass. You must show clearly on your graph how you reached this answer.

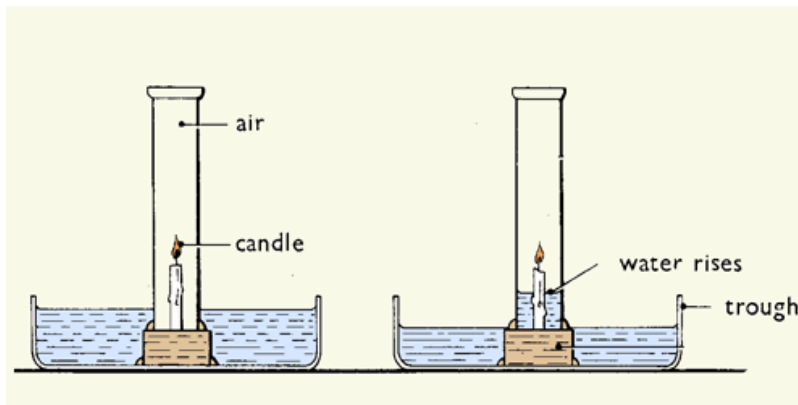
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(2)

Hentriacontane, or C₃₁H₆₄, is a hydrocarbon found naturally in a variety of plants and composes about 8-9% of beeswax.

- e. Assuming complete combustion, write the word equation for the combustion of C₃₁H₆₄.

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(2)

The following day the group of chemists conducted another experiment: a candle was placed in a trough of water. A gas jar of air was put over the top as shown in the diagram below. The water level rose in the jar and the candle went out.



f. Is the air in the gas jar an element, compound, or mixture?

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(1)

g. Why did the water level rise and by what percentage would you expect the water to rise? Be sure to explain why you have given this percentage.

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(3)

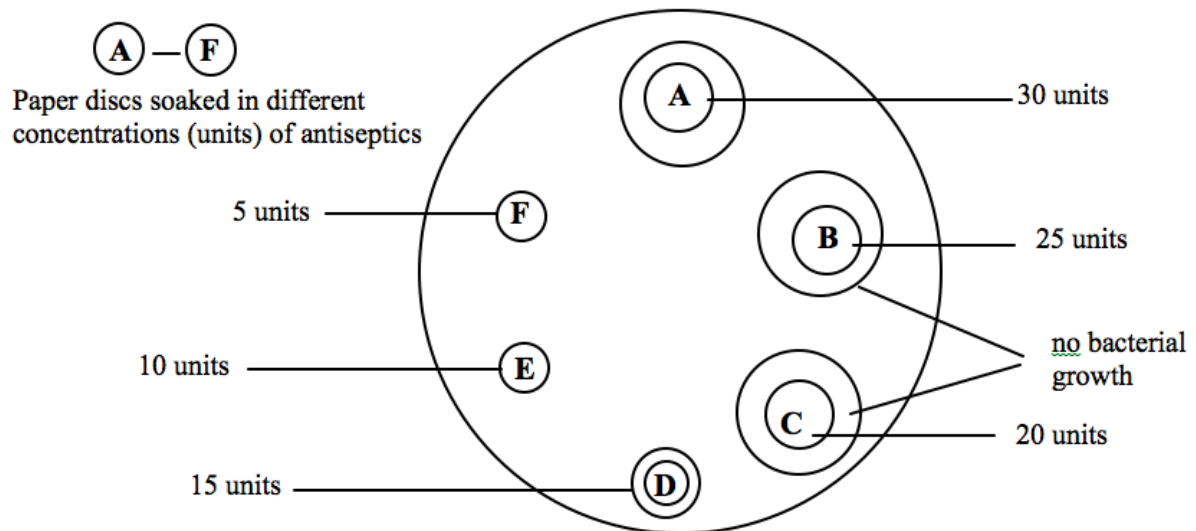
h. What is the primary gas left in the jar at the end of the experiment?

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(1)

[Total: 16 marks]

Biology Section – 36 marks

6. Bacteria living in plaque produce acids that dissolve the enamel of teeth. These bacteria were grown on a nutrient agar plate and used to test a new antiseptic mouthwash. The diagram shows the results of testing different concentrations of this antiseptic mouthwash on plaque bacteria.



- a. Which concentration of antiseptic would you recommend the manufacturer to use? Explain your answer.

Concentration:

.....
(1)

Explanation:

.....
(1)

- i. Suggest how an antiseptic mouthwash could help to prevent tooth decay.

.....
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(2)

ii. Some mouthwashes contain an alkali. Suggest why this may help to prevent tooth decay.

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(1)

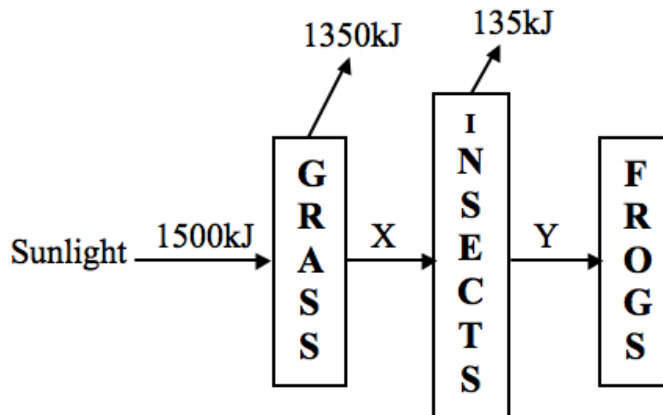
b. To help prevent tooth decay people are advised to brush their teeth at least once each day and use a toothpaste containing fluoride.

Explain the reasons for this advice.

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(3)

[Total: 8 marks]

7. The diagram shows the energy passing through a food chain.



a. Calculate the amount of energy available to insects (X). Show your working.

..... (1)

b. Calculate the amount of energy available to the frogs (Y). Show your working.

..... (1)

c. What percentage of the original energy from sunlight reaches the insects? Show your working.

Answer: (2)

d. Name two ways in which energy is lost by insects.

- 1.
- 2.

(2)

- e. Use the information on the diagram to explain why food chains rarely have more than five stages.

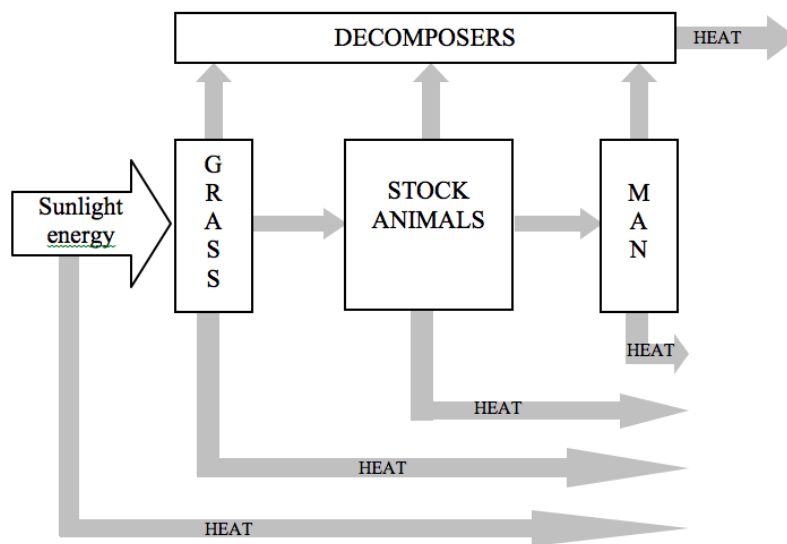
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 (2)

Pests can reduce the yield of crop plants. The amount of energy transferred from crops to the stock animals and, eventually, to man can be significantly reduced.

The diagram shows how energy flows through a managed grass crop.

The width of the arrows in the diagram represents the amount of energy being transferred.



- f. A significant amount of the energy transferred to the stock animals is not transferred to man.

Suggest two strategies a farmer could adopt in order to minimise this energy loss from his stock animals.

Strategy

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 (1)

Explanation

.....
 (1)

Strategy

..... (1)

Explanation

..... (1)

g. Name two different groups of organism that can be classified as decomposers.

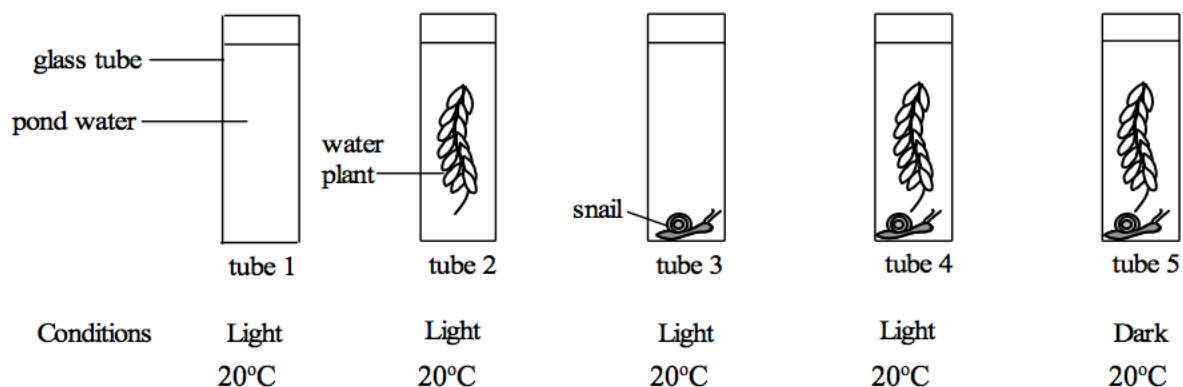
..... (1)

h. Write the best equation you can for the process which produces the heat given off by the decomposers.

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..... (2)

[Total: 15 marks]

8. The diagram shows the apparatus used in an investigation.



An equal amount of a harmless blue indicator was added to each tube. The indicator changes from blue in alkaline conditions to green in acid conditions. The pH of the pond water and the colour of the indicator were recorded at the start and again after 6 hours.

a. The table shows some of the results.

Number of tube	Colour at start	pH at start	Colour after 6 hours	pH after 6 hours
1	blue	alkaline	blue	alkaline
2	blue	alkaline		alkaline
3	blue	alkaline	green	
4	blue	alkaline	blue	alkaline
5	blue	alkaline		

Carbon dioxide dissolves in water to form a weak acid.

i. State the colour of the pond water in tube 2 after 6 hours.

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(1)

ii. Give a reason for your answer.

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(2)

iii. What was the pH of tube 3 after 6 hours?

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(1)

- iv. State the colour and pH of the pond water in tube 5 after 6 hours.
Give a reason for each answer.

Colour of tube 5

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(1)

Reason

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.....
(4)

pH of tube 5

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(1)

Reason

.....
.....
(2)

- b. In which of the tubes was photosynthesis taking place?

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(1)

- c. In which of the tubes was respiration taking place?

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(1)

[Total: 13 marks]