15th International Mathematics and Science Olympiad (IMSO)

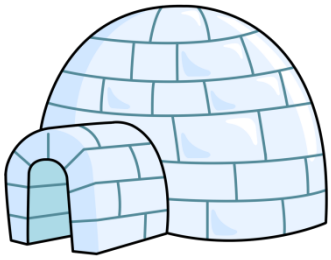
Science Theory Test 2

Zhejiang Province, China
28 September -4 October 2018

Instructions:

1. Do not turn this page until you are told to do so.
2. Follow all the instructions carefully.
3. Write your answers only in the separate Answer Booklet.
4. Answer all the questions in English.
5. There are 14 questions printed on a total of 10 pages, including the cover page.
6. You have 90 minutes to complete this test.

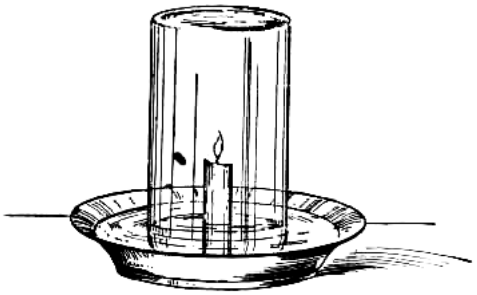
1. Igloos (meaning "snowhouses") is a type of shelter with walls made of blocks of compacted snow. It is built by the Inuit, people who lived in the harsh cold conditions in the Arctic or Greenland, where temperatures can reach as low as -45 °C! Through certain design features, the inside of the igloos can be raised up to 16 °C, just by body heat alone.



(a) Explain how the walls of the igloo can help keep the residents inside warm. [1 point]

(b) The residents normally make a fire inside the igloo so that the inside is warmer. A tourist made a statement that that this will cause the compacted snow walls of the igloo to melt and hence not be effective to keep the residents warm. Comment on whether the tourist is right or wrong, or partly correct. [1 point]

2. A burning candle is placed on a dish filled with water and the candle is covered with an inverted glass cylinder as shown in the diagram below.



After a while, the flame goes off and the water level rises in the cylinder.

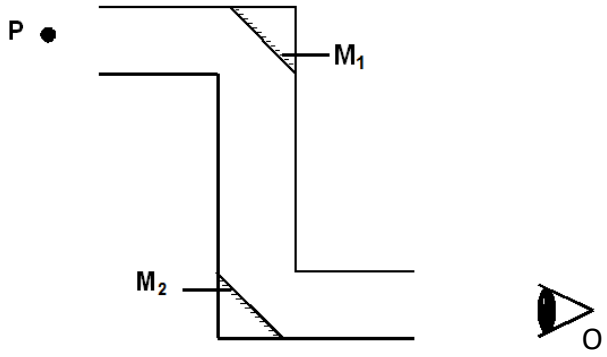
(a) Explain why the flame goes off. [1 point]

(b) Why does this resulted in the water level from rising? [1 point]

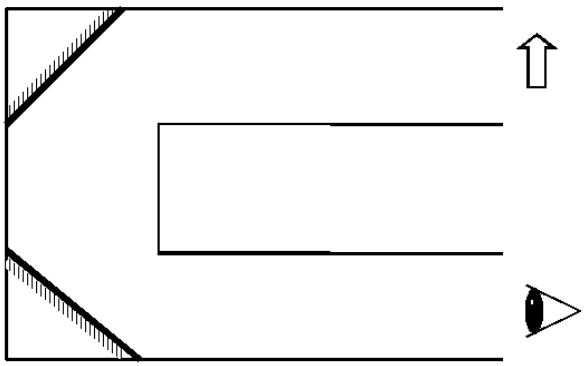
3. Periscopes are often used to view objects that are not able to be seen directly, such as objects around corners. A man at **O** looks through a periscope at an object **P** as shown in the figure below. Mirrors $\mathbf{M_1}$ and $\mathbf{M_2}$ are located inside the periscope.

By using construction lines on the figure below and/or relevant calculations with explanation, mark out accurately the position image as seen by the man in $\mathbf{M_2}$ and label it as **P'**. [1 point]

(a)



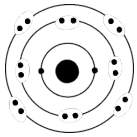
(b) A man designed a periscope in this manner to see what is behind him overhead.



By means of a ray diagram or otherwise, explain the main problem with this design.

[1 point]

4. The diagram below shows the electronic arrangement of an unknown particle.



(a) How many protons are there if the diagram represents a neutral atom? [1 point]

(b) If the diagram represents an ion with a +1 charge and a relative atomic mass of 39, how many neutrons would it have? [1 point]

5. (a) Using the legend given, draw a particle diagram to represent two molecules of chlorine (Cl_2) and two molecules of hydrogen (H_2) mixed together in a closed container. Both substances are in the gaseous state. [1 point]

Legend:

An atom of hydrogen

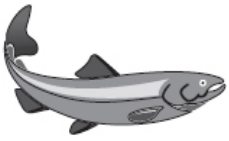
An atom of chlorine

(b) The mixture in (a) undergoes a chemical reaction and produces hydrogen chloride (HCl) gas. Assuming that all the molecules in (a) have reacted completely, draw a particle diagram (using the same legend) to show the arrangement of the hydrogen chloride molecules in the closed container. [1 point]

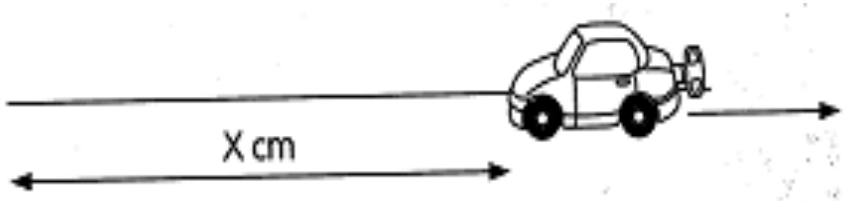
6. Animals can generally be grouped into those that have a backbone and those that do not have one. Which animals below have a backbone?

Circle the correct response for each animal. One has been done for you.

[0.25 points each]

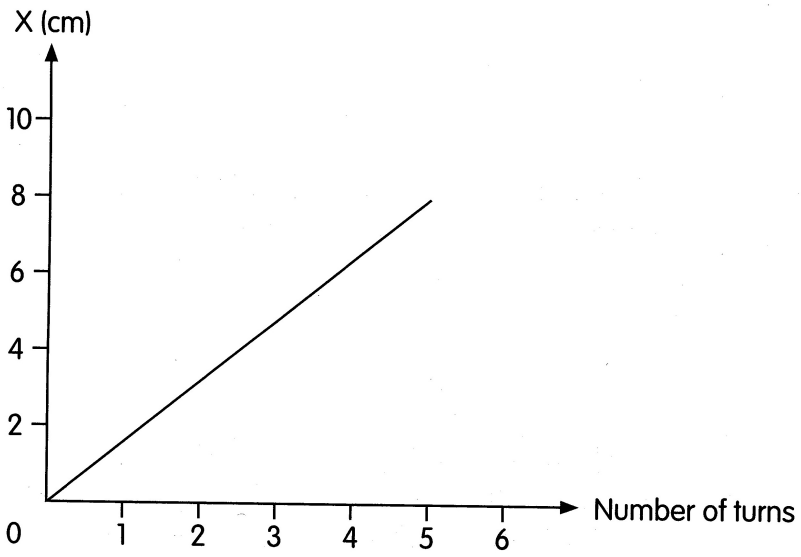
Animal	Has a Backbone	
	Yes	No
 heron	A	B
 spider	A	B
 crab	A	B
 fish	A	B
 centipede	A	B

7. Karen has a toy car that will move when its spring is turned. She wants to find out how the number of turns the spring is turned affects the distance the toy car can travel.



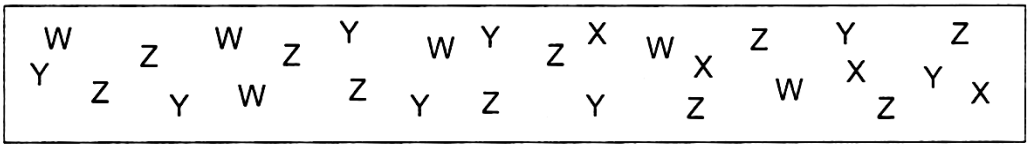
(a) What is the energy that moves the toy car? [1 point]

Karen carries out the experiment with different numbers of turns. She then plots her results on the graph below.

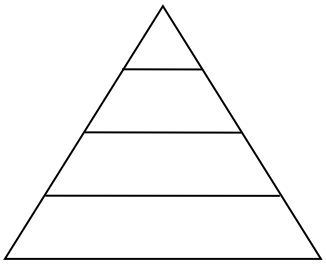


(b) What can Karen conclude from the experiment? [1 point]

8. The number of four organisms, W, X, Y and Z, is shown in the diagram below:



(a) Enter the letters representing these organisms in each level of the pyramid of numbers. [1 point]



(b) Which group of organisms are

(i) producers_____ [0.5 points]

(ii) primary consumers_____ [0.5 points]

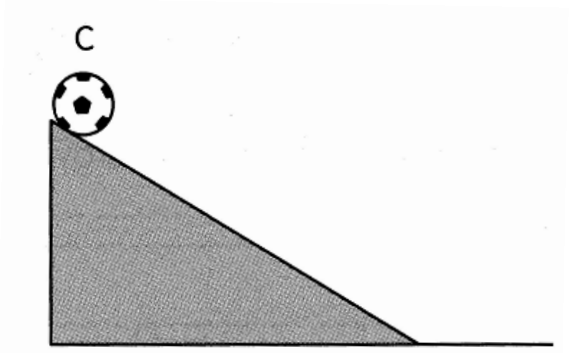
9. The diagram below shows the reading of an electricity meter (kWh) of a household.

2	4	3	5	8

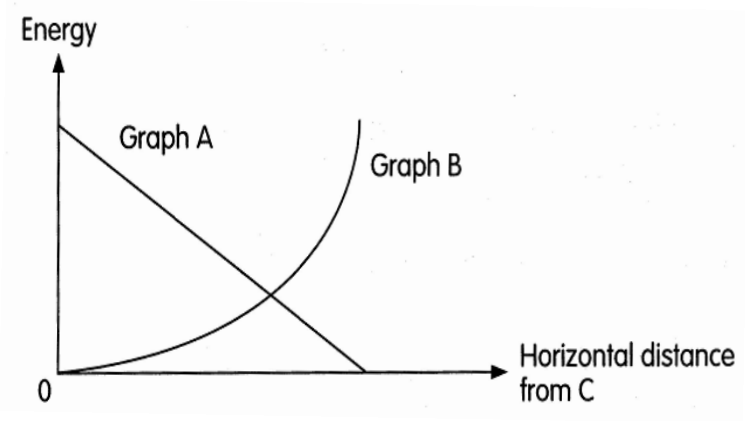
(kWh)

The owners of the house turn on 4 light bulbs of 100 W each, 2 air-conditioners of 3000 W each and 3 laptops of 200 W each for eight hours every day. What will be the meter reading after 1 week? [2 points]

10. The diagram below shows a ball at the top of a ramp (position C).



The graph below shows the potential and kinetic energy of the ball as it rolls down the ramp.



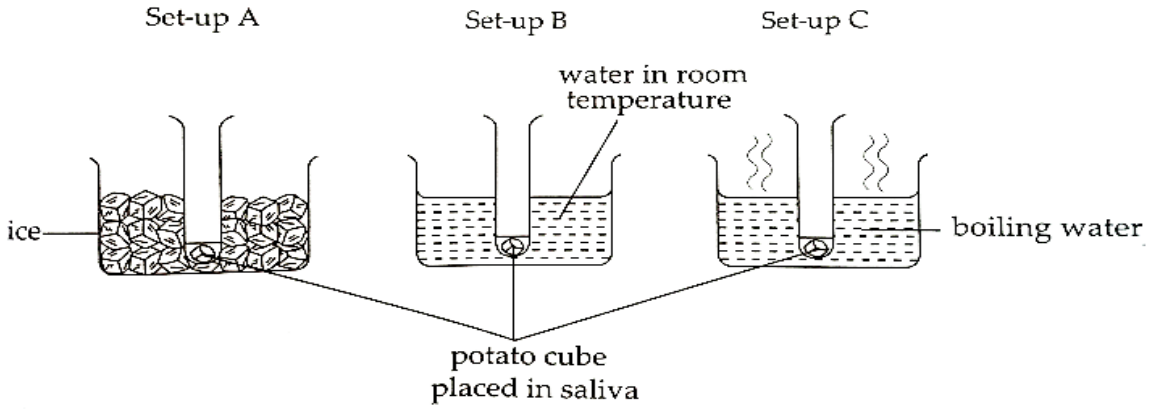
(a) Which graph represents the kinetic energy of the ball? Which graph represents the potential energy of the ball? [0.5 points each]

Kinetic energy: _____

Potential energy: _____

(b) Mark "X" on the graph to show the point where the ball possesses the same amount of kinetic and potential energy. [1 point]

11. Jay conducted an experiment to investigate enzyme activity in different conditions. He set up the experiment as shown below and left the set-ups in a room for one hour.



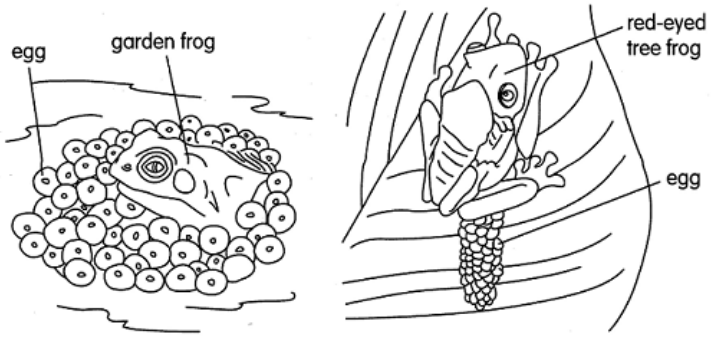
(a) Identify the enzyme in the above experiment. [1 point]

(b) What test should Jay conduct in order to obtain the results of his experiment? [1 point]

(c) Describe his observations in all three set-ups upon conducting the test named in (b). [1 point]

(d) Explain what caused the results obtained in (c). [1 point]

12. The diagrams below show a garden frog and a red-eyed tree frog.



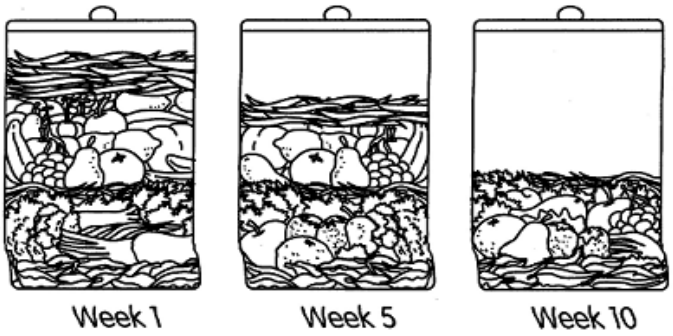
Tadpoles of both frogs live in the water where they can find food.
The red-eyed tree frog lays its eggs on the underside of a leaf that is hanging above a body of water such as a pond.

(a) Explain how laying eggs on the underside of a leaf helps increase the chance of survival of the eggs. [1 point]

(b) Why does the red-eyed tree frog lay its eggs above the pond? [1 point]

13. A compost tumbler is an enclosed container that turns biodegradable waste into rich compost. This tumbler helps to reduce the amount of waste that needs to be sent to the incinerator for burning.

    Tom collected dried leaves and cut them into small pieces. He put them into a compost tumbler together with some compost. He measured the height of the compost over a few weeks.



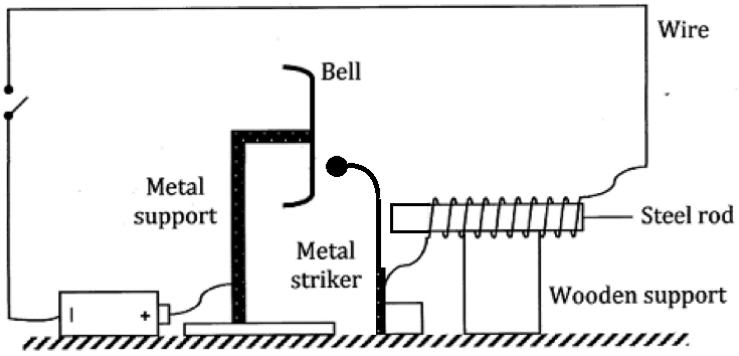
(a) Why did the height of the compost decrease after a few weeks? [1 point]

(b) What was the purpose of adding the compost? [1 point]

(c) How can farmers make use of the compost from the compost tumbler?

[1 point]

14. Study the set-up below.



(a) Explain why the metal striker is pulled towards the steel rod when the switch is closed. [1 point]

(b) Trace the energy change that should occur for the bell to ring. [1 point]

END OF PAPER