

SECTION A - BIOLOGY

Read the following passage:

More than 300 million dung pats are deposited by cattle on the surface of Australia every day causing considerable pollution. This problem is being tackled biologically by the introduction of exotic dung beetles.

There are three major problems resulting from this pollution. Two important blood-sucking cattle pests, the buffalo fly and the bushfly, breed in the pats and it is in them that a gut-dwelling roundworm completes its life-cycle. If the pats are not removed, they smother the ground and encourage the growth of tough grass which the cattle will not eat, resulting in loss of pasture. Finally the cycling of nutrients such as nitrogen is retarded.

Dung beetles may be divided into two groups; those which bury dung by taking it down a tunnel beneath the pat and those which shape dung into balls and roll them away for burial elsewhere. Female beetles lay a single egg in a small chamber within each brood ball, the inner wall of which is consumed by the developing larva. Some of the beetles carry mites from one pat to another and these feed on fly eggs and larvae.

Australia has 250 species of dung beetle, but these are adapted to deal with the small, fibrous faecal pellets of indigenous marsupials. Most species are unable to cope with the large, soft cow-pats. Knowing that large herbivores (including cattle) are indigenous to Europe and Africa, Australian researchers sought out beetles associated with the pats of these placental mammals for introduction. They have, in fact, been successful in establishing several suitable species.

Research has shown that beetles which bury cow-pats within 48 hours can reduce the fly population by 96% and prevent 85% of roundworms from developing and re-infecting the cattle. In addition, it has been shown that beetle activity hastens the recycling of nutrients and frees the ground from pollution.

(Adapted from: Biological Control of Pests and Weeds. M.J. Samways)

Using information in the passage and your own knowledge, answer the following questions.

1. What is meant in the passage by
 - i. exotic
 - ii. gut-dwelling
 - iii. brood
 - iv. larva
 - v. indigenous

2. Identify one example of each of the following from the passage:
 - i. a parasite
 - ii. a predator
 - iii. a producer
 - iv. a secondary consumer (4)
3. Describe the habitat of the buffalo fly and its larva (3)
4. Explain how a cow might be reinfected with roundworm. (2)
5. Suggest why the dung pats encourage the growth of tough grass. (2)
6. Using only organisms mentioned in the passage, construct a food web. Remember to link species with an arrow pointing in the direction that energy passes. (5)
7. Suggest an explanation for the fact that beetles which bury the cow-pats within 48 hours can reduce the fly population by such a large amount. (2)
8. State two elements that are recycled in Nature. (2)

(25 marks)

SECTION B - PHYSICS

1. In the film 'The Hunt For Red October', a Russian submarine sends a pulse of sound, or ping' that reflects off an American submarine and is received back on the Russian submarine.
 - a. It takes 1.2 s between sending the ping and the Russians hearing the echo. The speed of sound in water is 1500 m/s. How far apart are the two submarines ? (2)
 - b. The atmosphere inside each submarine is at a pressure of 10N/cm². The sea outside is at a pressure of 130N/cm². The entrance hatch to one submarine has an area of 106 cm². What is the force acting on the outside of the hatch ? (2)
 - c. Do you think the hatches should be designed to open inwards or outwards? (Explain your answer with a diagram.) (2)

The pressure in water increases by 0.98 N/cm² for every metre of depth.

- d. How deep is the submarine ? (2)
 - e. Why does the pressure increase as you go deeper ? (2)

2. A recent space probe crashed into the surface of Mars, because some of the data for the pressure of the rocket thrusters was given in pounds per square inch, rather than N/cm².
 - a. 2.4 cm is equal to one inch. How many cm² is 1 inch² (2)
 - b. 1 pound is equivalent to a mass of 0.454 kg. How many Newtons are exerted by the weight of 1 pound. (2)
 - c. So what is the thruster pressure in N/cm² of 100 pounds per square inch ? (2)

3.
 - a. Why does hot air rise ? (2)
 - b. Why do midges often circle around above a person's head ? (2)
 - c. How do clothes help to keep us warm ? (2)
 - d. Why do astronauts only need to wear shorts and a t-shirt on a space station which is kept at a temperature that would require them to wear more clothing on Earth ? (3)

(25 marks)

SECTION C - DESIGN AND TECHNOLOGY

The automata shown below was designed and manufactured in a school workshop.

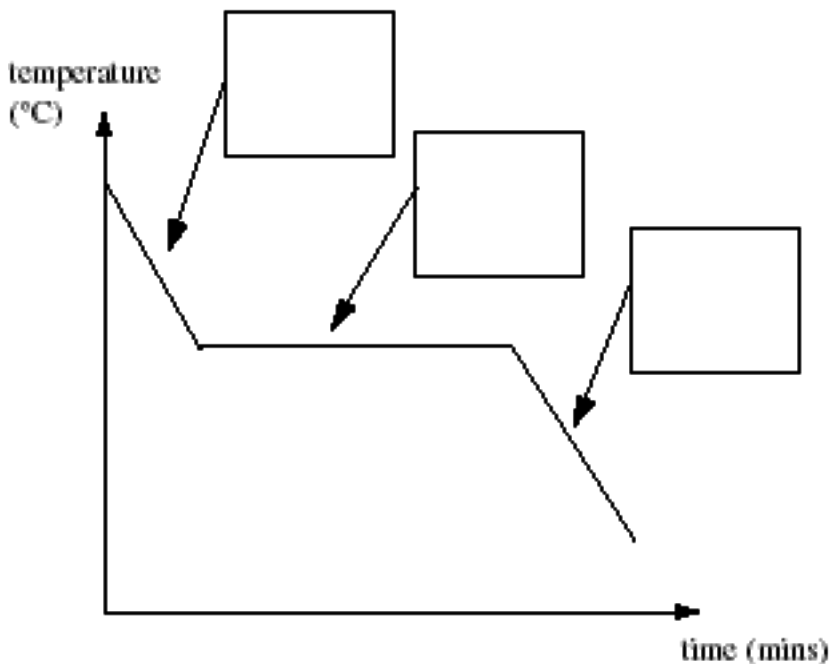


1. Suggest a suitable material from which the automata could be made. Give two reasons why the material you have chosen would be suitable for this application. (3)
2. The rectangular frame around the mechanism lacks rigidity. Suggest two ways in which the frame of the automata could be strengthened. (4)
3. Suggest a suitable method of joining the corners of the rectangular frame. (2)
4. Name a suitable finish which could be applied to the frame after assembly. (1)
5. Name the components labelled A, B and C in the mechanism above. (3)
6. The mechanism converts motion from the input to the output. Describe the way in which the Rotary input motion is converted through the mechanism to achieve the desired output motion for the dog's head and tail. (6)
7. Using notes and sketches, show how the mechanism could be altered to make the dog's mouth open and close twice with each rotation of the input. (2)
8. When the mechanism was tested it did not move freely. Using notes and sketches, explain two ways in which the automata could be improved to allow the mechanism to move more easily. (4)

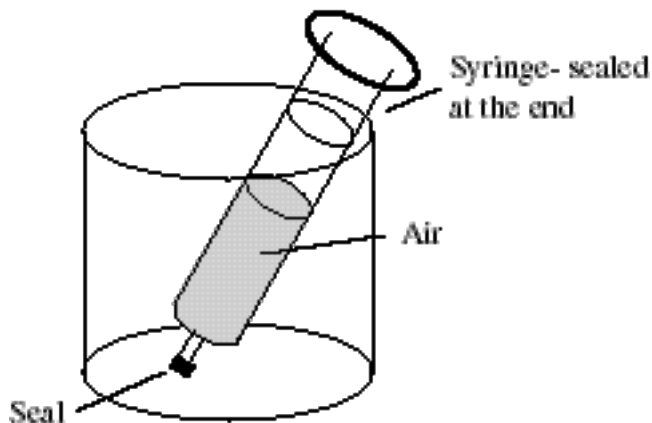
(25 marks)

SECTION D - CHEMISTRY

1. Look at this cooling curve for substance X as it turns from a liquid to a solid-



- a. What is the (1)
 - b. Sketch out the above diagram as shown. In the boxes, draw the arrangement of the particles present at that stage of the cooling, as appropriate. (3)
 - c. Explain in terms of bonds why the graph becomes horizontal. (2)
2. A sealed syringe containing some air is placed in a beaker as shown below-



- a. What happens if hot water is poured into the beaker? (1)
- b. Give your reasoning for your answer in (a). Mention pressure and the movement of air particles. (2)

3. The list shows some metals in the reactivity series-

magnesium (Mg) most reactive

aluminium (Al)

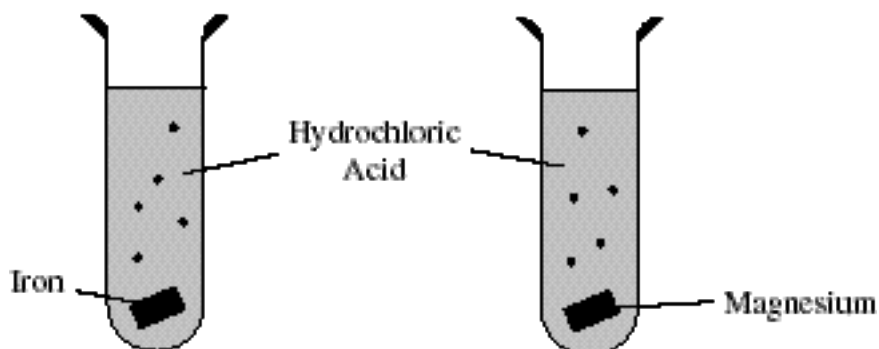
zinc (Zn)

iron (Fe)

lead (Pb)

copper (Cu) least reactive

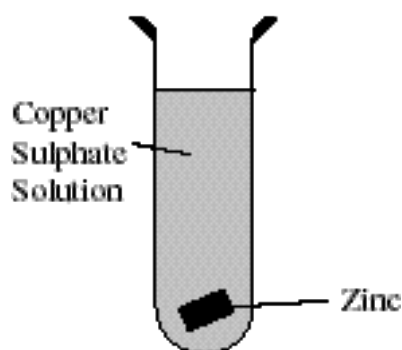
a. Pieces of iron and magnesium of the same size are placed in dilute hydrochloric acid.



i. What happens to show that the reaction with magnesium is exothermic? (1)

ii. Give two differences you would observe between these reactions. (2)

b. A piece of zinc is added to copper sulphate (CuSO_4) solution.



What would you observe? Explain your observations. (3)

4. Comment on the following-
- a. Carbon dioxide has a freezing point of -78°C and a boiling point of -78°C and is sometimes called “dry ice”. (2)
 - b. The burning of hydrocarbon fuels (eg. coal) leads to the production of carbon dioxide as the major pollutant. However, other pollutants are also produced, although in smaller amounts. (2)
 - c. Metals like copper and iron can be extracted from their ores using carbon but metals such as calcium and magnesium cannot. (2)
 - d. When potassium metal is burned in air the percentage by volume of air used up is found to be much MORE than the expected 20%. (2)
 - e. A green powder is heated in a test-tube. A colourless gas is given off and a black solid is left remaining. (2)

(25 marks)