22136015

International Baccalaureate®
Baccalauréat International
Bachillerato Internacional

BIOLOGY
HIGHER LEVEL
PAPER 3

Candidate session number

0	0								

Tuesday 14 May 2013 (morning)

1 hour 15 minutes

Examination code

| 2	2	1	3	–	6	0	1	5

INSTRUCTIONS TO CANDIDATES

- Write your session number in the boxes above.
- Do not open this examination paper until instructed to do so.
- Answer all of the questions from two of the Options.
- Write your answers in the boxes provided.
- A calculator is required for this paper.
- The maximum mark for this examination paper is *[40 marks]*.

Option D — Evolution

1. Bone tools found in the Swartkrans site in South Africa were thought to be used by *Australopithecus robustus* when digging for food. Using replica tools, researchers dug around plants for bulbs, dug in soil for larvae and dug in termite mounds for termites. They compared the scratch marks found on the replica tools with those on the original Swartkrans tool to predict the food eaten by *A. robustus*.

Original tool	**Replica tools**		
Swartkrans	**Plant bulbs**	**Larvae**	**Termites**
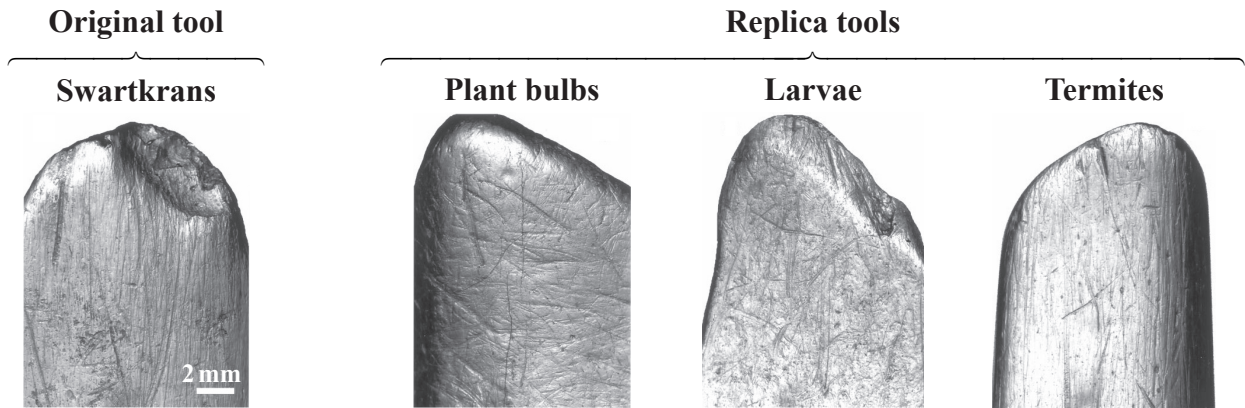
The graphs below show the ranges of angles from the vertical position of the scratch marks and the ranges of widths of the scratch marks on each tool. The solid line on each bar represents the mean value for the range.
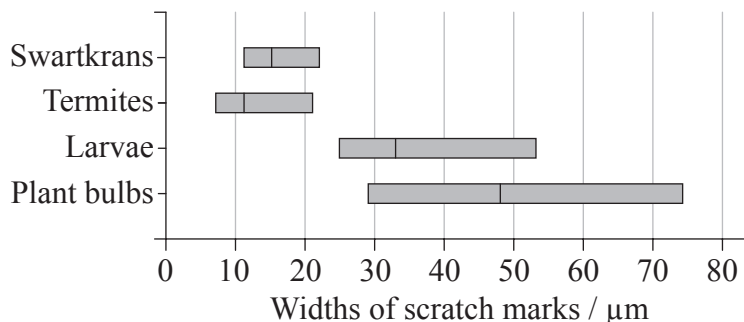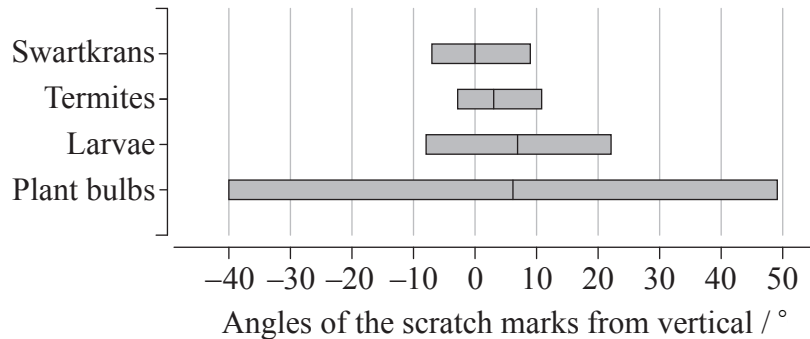
Angles of the scratch marks from vertical / °

Widths of scratch marks / μm

(This question continues on the following page)

(Question 1 continued)

(a)   State the greatest angle from the vertical of the scratch marks on the tool used on termite mounds. *[1]*

. . . .

(b)   Calculate the difference in the angle between the mean values for the Swartkrans tool and the tool used to dig for plant bulbs. *[1]*

. . . .

(c)   Compare the width of scratch marks on the tool used to dig for larvae with the Swartkrans tool. *[2]*

. . . .
. . . .
. . . .
. . . .

(d)   Using evidence from the photographs and the graphs, suggest what the researchers' main conclusion was. *[2]*

. . . .
. . . .
. . . .
. . . .

(This question continues on the following page)

Turn over

(Question 1 continued)

(e)   *A. robustus* was thought to have coexisted with *Homo habilis*, both becoming extinct at
the same time. State approximately how many years ago *A. robustus* became extinct.   *[1]*

....

2.   (a)   Define *gene pool*.   *[1]*

. . . .

. . . .

(b)   State **two** assumptions made when using the Hardy–Weinberg equation.   *[2]*

1.   . . . .

2.   . . . .

(c)   Distinguish between sympatric and allopatric speciation.   *[1]*

. . . .

. . . .

. . . .

. . . .

(d)   Outline the main features of **balanced** polymorphism using sickle-cell anemia as an example.   *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

3. Discuss how variations in proteins can indicate phylogeny and be used as an evolutionary clock. *[6]*

Please **do not** write on this page.

Answers written on this page
will not be marked.

Option E — Neurobiology and behaviour

4. Investigators studied the behaviour of two species of small fish, the sand goby (*Pomatoschistus minutus*) and the black goby (*Gobius niger*), while they foraged for mud shrimps. The amount of food foraged by the gobies was measured after they had been fed or after they had been starved. The measurements were repeated when a predator of the gobies was introduced to the tank where they were feeding.
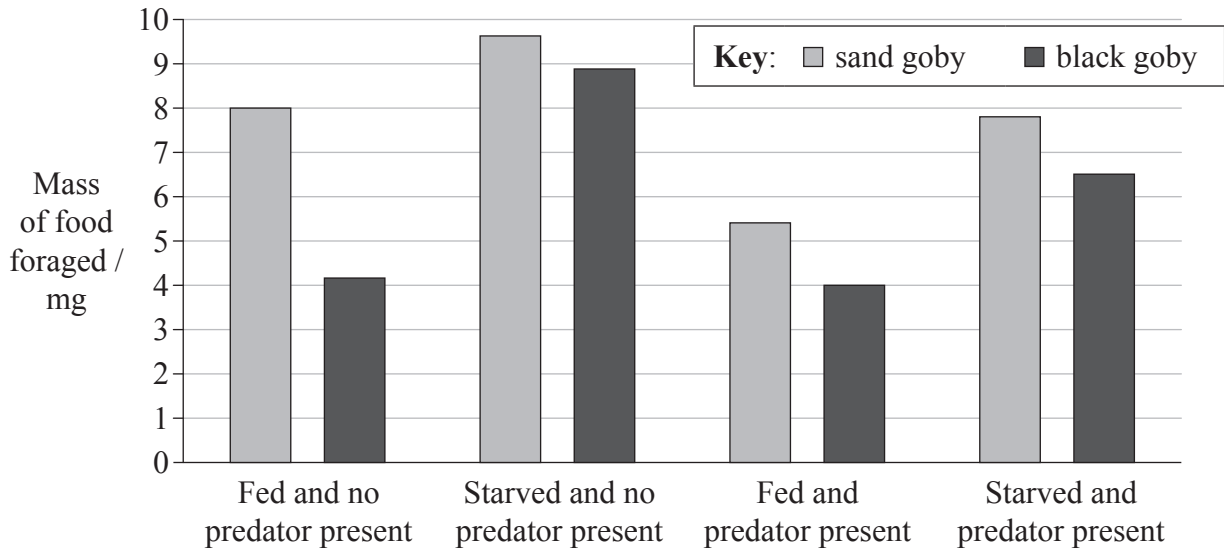
(a) Calculate the decrease in mass of food foraged by fed sand gobies when a predator was introduced, giving the units. *[1]*

(b) Compare the effect that starvation had on both species of goby when no predator was present. *[2]*

0832

(Question 4 continued)

    (c)   (i)   Describe the effect the predator had on the foraging of the gobies.   *[2]*

        (ii)   Suggest a reason for the effect of the predator.   *[1]*

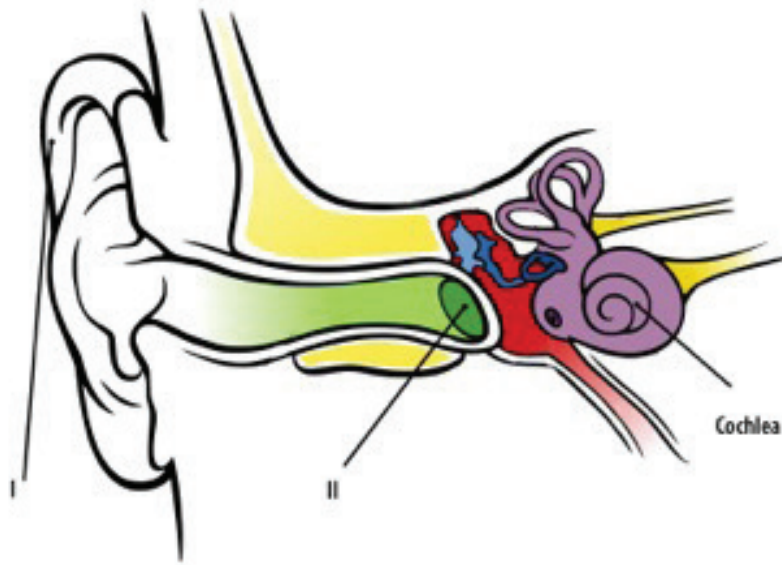**5.**   (a)   The diagram shows the structure of the human ear.

Cochlea

[Source: © International Baccalaureate Organization 2013]

   (i)   Label structures I and II.   *[1]*

   I.   . . . .

   II.   . . . .

   (ii)   Outline how sounds are perceived in the cochlea, including the name of the
         cell type involved.   *[1]*

   . . . .
   . . . .

(This question continues on the following page)

(Question 5 continued)

(b)   Outline how contralateral processing of visual stimuli occurs in the human eye.   *[2]*

. . . .
. . . .
. . . .
. . . .

(c)   Identify a function of the parts of the brain by using numerals II to V to complete the chart.   Hypothalamus has been completed for you.   *[2]*

Part of Brain			Function
Hypothalamus	I		Memory centre
Medulla oblongata	II	I	Homeostasis
Cerebellum	III		Secretes hormones regulating body functions
Pituitary gland	IV		Coordinates balance
Cerebral hemispheres	V		Controls breathing

(d)   Discuss how the pupil reflex can be used as a test for brain death.   *[2]*

. . . .
. . . .
. . . .
. . . .

Turn over

6. Explain the effects of cocaine on the brain.   *[6]*

END OF OPTION E

Please **do not** write on this page.

Answers written on this page
will not be marked.

1332

Option F — Microbes and biotechnology

7. In 2003, the Integrated Approach to Community Development (IACD) organization introduced the chulli water purifier to homes in Bangladesh that had not previously had access to safe drinking water. It was designed to be made cheaply from local materials. The purifier uses sand filtration to remove organic particles and heat pasteurization to eliminate microbes from water.

Water samples from 15 different locations containing high levels of the bacterium *E. coli* were passed through the purifier at different flow rates and temperatures to test its effect on contaminated water. The shaded area of the graph below represents the recommended temperature and flow rate for using the purifier.

Key: ▪ no bacteria ● contains *E. coli*
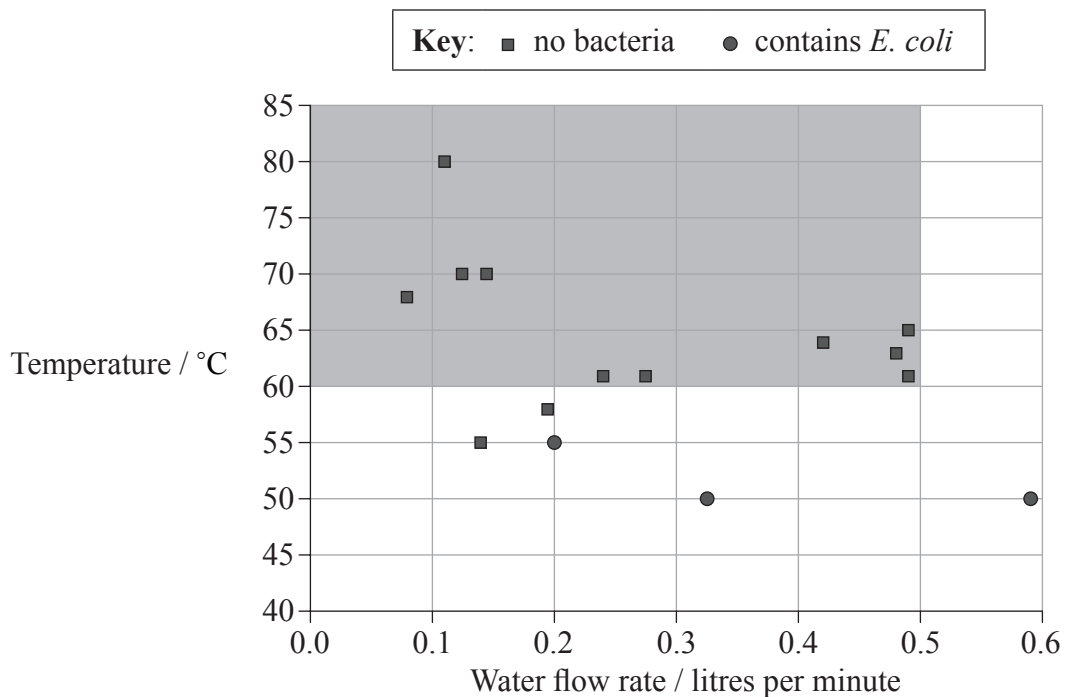
[Source: S. K. Gupta et al. (2008) *American Journal of Tropical Medicine and Hygiene*, 78, pages 979–984]

(a) State the highest temperature at which bacteria were found in water that had passed through the chulli purifier. *[1]*

....

(This question continues on the following page)

(Question 7 continued)

(b)   Calculate the maximum volume of safe drinking water that could be produced by the chulli purifier in one hour.   *[1]*

(c)   Discuss whether 80 °C is the best temperature to operate the chulli purifier.   *[2]*

(d)   The results suggest that there may be a relationship between the water flow rate and the minimum temperature needed to eliminate microbes. State this relationship.   *[1]*

(e)   Evaluate pasteurization as a method of controlling microbial growth.   *[2]*

8. (a) Outline how the nucleic acids used as the genetic material in viruses may vary. *[2]*

. . . .
. . . .
. . . .
. . . .

(b) Outline how bacteria can be classified by Gram staining. *[2]*

. . . .
. . . .
. . . .
. . . .

(c) Compare chemoautotrophs and chemoheterotrophs by completing the table. *[2]*

	Chemoautotroph	Chemoheterotroph
Energy source	. . . .	. . . .
Carbon source	. . . .	. . . .

(This question continues on the following page)

(Question 8 continued)

(d)   The diagram shows a filament of *Anabaena*, a cyanobacterium. Label structure X.   *[1]*

X   . . . .

Turn over

9. Explain how methane can be generated from biomass. *[6]*
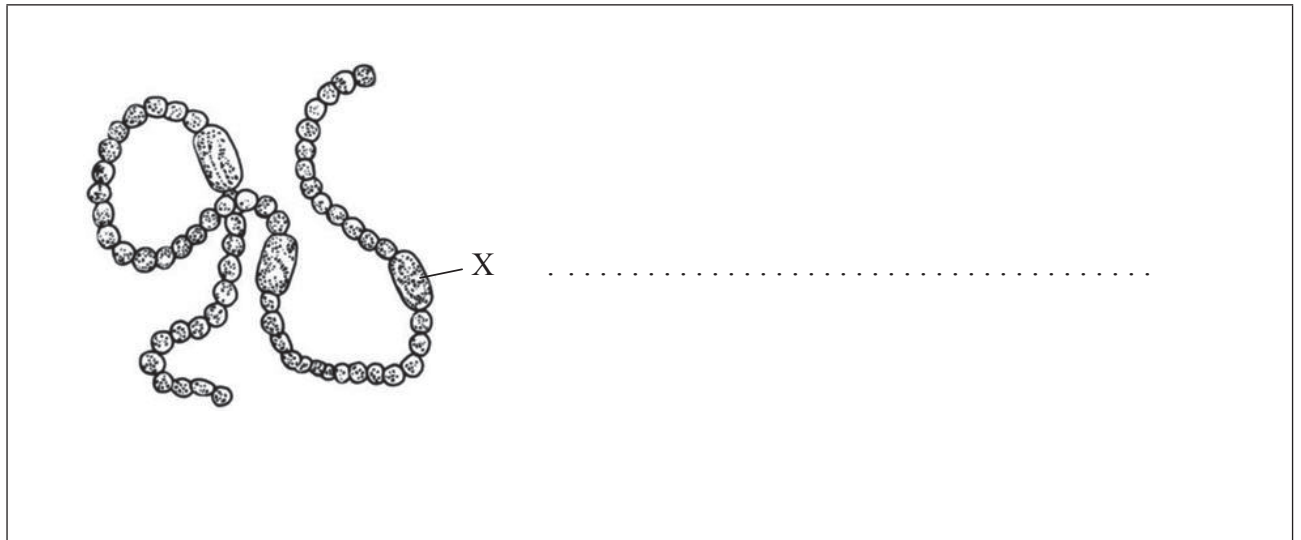
Please **do not** write on this page.

Answers written on this page
will not be marked.

Option G — Ecology and conservation

10. In 2009, the town council of Dumfries in Scotland tested a project to prevent lesser black-backed gulls (*Larus fuscus*) from nesting in the town where they were causing problems. They released trained falcons into the town centre for 10 hours each day during a 10-week period when the gulls normally lay their eggs. Although the falcons are predators of the gulls, they did not kill the gulls during the study. The behaviour of the gulls was observed and the percentage time spent on three activities was recorded. The results were compared to a control group not exposed to falcons in another part of town.
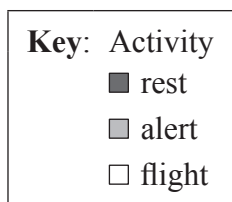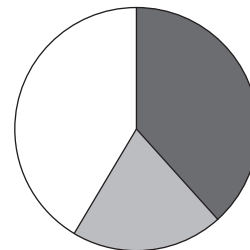
- **Rest**: sitting on their nests, standing or preening their feathers
- **Alert**: remaining on the ground but disturbed and visibly agitated
- **Flight**: flying regardless of the cause

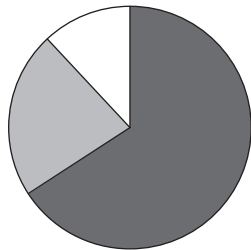The pie charts show the results of the project.

Control group – Weeks 1 to 5   Gulls exposed to falcons – Weeks 1 to 5
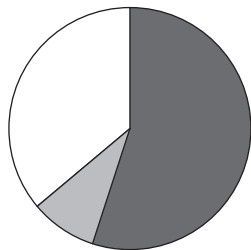
Key: Activity
◼ rest
◻ alert
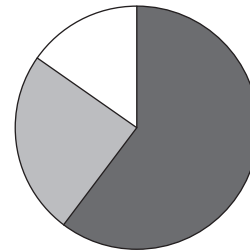☐ flight

Control group – Weeks 6 to 10   Gulls exposed to falcons – Weeks 6 to 10

[Source: © International Baccalaureate Organization 2013]

(a) State which activity decreased in weeks 1 to 5 as a result of exposure to the falcons. *[1]*

....

(Question 10 continued)

(b)   Estimate the total percentage of time the gulls exposed to falcons spent flying and at rest in weeks 6 to 10.   *[1]*

. . . . %

(c)   Compare the behaviour of the gulls exposed to falcons with the control group over the period of study.   *[3]*

. . . .

. . . .

. . . .

. . . .

. . . .

. . . .

(d)   Predict, using the data in the pie charts for weeks 1 to 5 and weeks 6 to 10, if the use of falcons will succeed in causing a long-term reduction in the number of gull nests in problem areas.   *[2]*

. . . .

. . . .

. . . .

. . . .

Turn over

11. (a) Distinguish between *in situ* and *ex situ* conservation. *[1]*

> . . . .
>
> . . . .

(b) The Atlantic cod is considered in many countries to be endangered due to overfishing. Describe **two** methods that could be used to estimate the cod population. *[2]*

> . . . .
>
> . . . .
>
> . . . .
>
> . . . .
>
> . . . .
>
> . . . .
>
> . . . .

(c) Distinguish between *K*-strategies and *r*-strategies for reproductive success by placing a "K" or an "r" beside the correct characteristic. *[2]*

Characteristic	*K*- or *r*-strategy
Few offspring	
Short life span	
Late maturity	
Show parental care	

(This question continues on the following page)

(Question 11 continued)

(d)   Outline **one** reason for the extinction of a **named** animal species.   *[1]*

. . . .
. . . .
. . . .
. . . .

(e)   State **one** use of the Simpson index in ecology.   *[1]*

. . . .
. . . .

12. Explain the causes and consequences of biomagnification with reference to a **named** example. *[6]*

Please **do not** write on this page.

Answers written on this page
will not be marked.

2532

Option H — Further human physiology

13. In a long-term study carried out in New Zealand, 9-year-old children were tested for asthma by checking if they had difficulty in breathing (wheezing). The children were then re-tested periodically until they were 26 years old. In addition, a measure was made of how well the lungs functioned by calculating the maximum volume of air exhaled in one second (VE1) as a percentage of the maximum volume of air inhaled (VI). The graph shows the lung function for males and females with or without asthma.

Key:
with asthma — △— males, —●— females
without asthma --△-- males, --●-- females
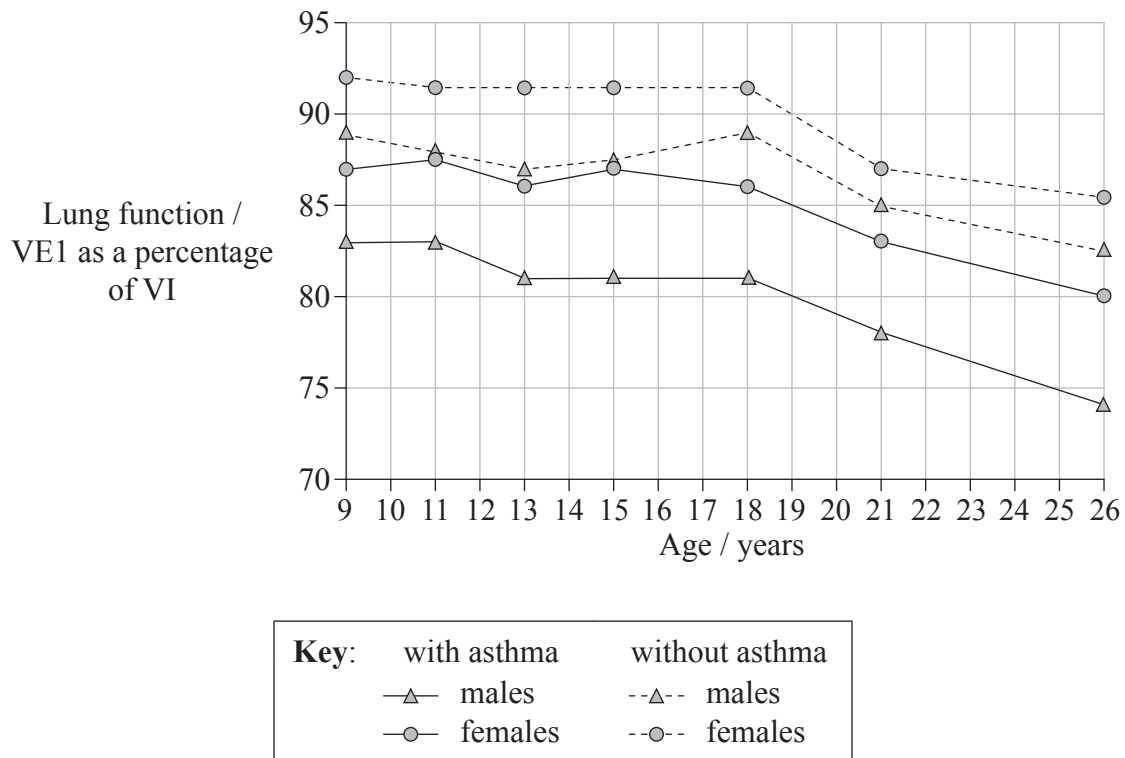
[Source: From *The New England Journal of Medicine*, Malcolm R. Sears, Justina M. Greene, Andrew R. Willan, et al., *A Longitudinal, Population-Based, Cohort Study of Childhood Asthma Followed to Adulthood*, 349, pages 1414–1422. Copyright © (2003) Massachusetts Medical Society. Reprinted with permission from Massachusetts Medical Society.]

(a) State the relationship between asthma and lung function. *[1]*

....

....

(This question continues on the following page)

2632

(Question 13 continued)

(b) Calculate the change in lung function of females with asthma between the ages of 11 and 26. *[1]*

(c) Compare the data for 26-year-old males and females. *[2]*

(d) Explain how the units used to measure lung function are useful in showing if a person suffers from asthma. *[2]*

(e) State **one** possible cause of asthma. *[1]*

Turn over

14. (a) State **one** example of a hormone that is a protein. *[1]*

(b) Outline the activation of pepsin in the digestive system. *[2]*

(c) Outline how bile helps in lipid digestion. *[1]*

(d) Describe how bile pigment is formed. *[3]*

15. Explain the events of the cardiac cycle, including the heart sounds. *[6]*

END OF OPTION H

3132