READING PASSAGE 3

You should spend about 20 minutes on ***Questions 27-40****, which are based on Reading Passage 3 below.*

Insect-inspired robots

A recent conference reports on developments in biorobotics

A A tiny insect navigates its way across featureless salt-pans. A cockroach successfully works out how to scramble over an obstacle. The mantis shrimp scans its aquatic world through hyperspectral eyes. Using the most basic of equipment and brains tinier than a pin-head, insects constantly solve complex problems of movement, vision and navigation – processing data that would challenge a super-computer. How they do it is driving one of the most exciting new fields of technology – biomimetics and biorobotics, the imitation of insect systems to control man-made machines. Delegates at a recent conference presented some outcomes of their work in this area.

B Dr Alex Zelinsky suggested that the method by which wasps use landmarks to find their way back to the nest may one day be part of a system for navigating cars that *know* where to go. A research team led by Dr Zelinsky has shown that a robot can navigate its way among 50 different landmarks by recognising them individually using a panoramic camera. “The inspiration came from biology, where wasps use a practical method *turn back and look* to orient themselves as they emerge from their nest. By flying to and fro, they look at the wasp nest from different angles and perspectives so they can recognise it again,” he explained. The robot’s panoramic camera logs the surrounding area and its key landmarks, which are then stored in its computer according to how reliable they are as navigational aids. The landmarks are then scaled, from small to large, so that the robot can recognise whether it is getting closer to or further away from them. Their location is built into a map in its *mind*, which operates at different scales and instructs the robot whether to turn left or right at a particular mark. The technology provides a general way for a machine to navigate an unknown landscape.

C For three decades, Professor Ruediger Wehner has journeyed from Switzerland to the Sahara Desert where *Cataglyphis*, a tiny ant with a brain weighing just 0.1 mg, performs acts of navigational genius when it leaves its nest, forages for food and returns successfully. *Cataglyphis* uses polarised light, caused when air molecules scatter light, to orient and steer itself. Wehner’s team found that the ant has a set of specialised photoreceptors along the upper rim of its eyes that detect polarised light, while other receptors perform different navigational tasks. As the sun moves, the ant notes its direction each time it leaves the nest and updates its internal compass. Using other eye receptors it stores a *snapshot* image of landmarks close to the nest entrance in its eyes and compares this with what it sees as it returns. The ant also has a way of measuring distance travelled, while a *path integrator* periodically informs the ant of its current position relative to its point of departure. Rather than integrate all the information it receives in its brain, the ant actually performs a number of complex calculations in different organs. Like a super-computer, the ant has many separate sub-routines going on simultaneously.

Using the ant's ability to steer by polarised light and to store and reuse landscape images, Wehner and colleagues have built "Sahabot," a small vehicle that uses polarisers and a CCD camera to store 360° images of its surroundings. It navigates by using polarised sunlight and comparing the current images of landmarks to the ones in its memory.

D Professor Robert Michelson had a different desert challenge – to design a flying robot that can not only navigate but also stay aloft and hover in the thin atmosphere of Mars. Drawing inspiration from insect flight, he has gone beyond nature to devise a completely new concept for a flying machine. The "Entomopter" is a sort of double-ended dragonfly whose wings beat reciprocally. Michelson says that the flapping-wing design gives the craft unusually high lift compared with a fixed-wing flyer, enabling it to fly slowly or hover in the thin Martian air – whereas a fixed-wing craft would have to move at more than 400 km/h and could not stop to explore.

E Engineer Roger Quinn and entomologist Professor Roy Ritzmann are taking their inspiration from cockroaches. According to Quinn and Ritzmann, the ability of cockroaches to run very fast over rough terrain may one day give rise to a completely new all-terrain vehicle with six legs, or maybe even wheel-like legs called "whegs." The key to the cockroach's remarkable cross-country performance lies partly in the fact that its legs do a lot of the *thinking* without having to consult the brain. Quinn and Ritzmann are drawing on cockroach skills to create robotic walkers and control strategies that capture the remarkable capacity of these insects to traverse complex terrain and navigate safely toward goals while avoiding obstacles. The team has already designed a series of robots that run on six legs or on whegs, enabling them to handle surprisingly rugged terrain.

F International experts believe there are tremendous opportunities in biorobotics. However, delegates at the conference had differing visions for the future of the science. While some were concerned that the initial applications of biorobotics may be military, others, such as Dr Barbara Webb, predicted swarms of tiny, cheap, insect-like robots as society's cleaners and collectors. Sonja Kleinlogel hoped the study of the hyperspectral eyes of the mantis shrimp might yield remote sensors that can watch over the environmental health of our oceans. Several delegates were concerned about the ethical implications of biorobotics and urged that close attention be paid to this as the science and technologies develop.

Questions 27 – 32

Reading Passage 3 has six sections, ***A–F****.*

Which section contains the following information?

Write the correct letter, ***A–F****, in boxes 27–32 on your answer sheet.*

27 positive and negative possibilities for the use of insect-inspired robots

28 how perceived size is used as an aid to navigation

29 an example of decision-making taking place in the limbs

30 a description of a potential aid in space exploration

31 the range of skills that have inspired biorobotics

32 how a variety of navigational methods operate at the same time

Questions 33 – 36

Answer the questions below.

Choose ***NO MORE THAN THREE WORDS*** *from the passage for each answer.*

Write your answers in boxes 33–36 on your answer sheet.

33 Which creature sees particularly well under water?

34 In addition to a computer, what technical equipment is fitted in Dr Zelinsky's robot?

35 Where is the *Cataglyphis* ant found?

36 What atmospheric effect helps the *Cataglyphis* ant to know its direction?

Questions 37 – 40

Look at the following people (Questions 37–40) and the list of robots below.

Match each person or people with the correct robot, ***A–G****.*

Write the correct letter, ***A–G****, in boxes 37–40 on your answer sheet.*

37 Dr Alex Zelinsky

38 Professor Ruediger Wehner

39 Professor Robert Michelson

40 Roger Quinn and Professor Roy Ritzmann

List of Robots

A a robot that makes use of light as well as stored images for navigational purposes

B a robot that can contribute to environmental health

C a robot that can move over difficult surfaces

D a robot that categorises information from the environment according to its usefulness

E a robot that can be used to clean surfaces and collect rubbish

F a robot that has improved on the ability of the insect on which it is based

G a robot that can replace soldiers in war

题号	答案	详细定位与解释
27	F	Section F 首句 “International experts believe there are tremendous opportunities…” 紧接着列举军事 *negative* → 环保清洁 *positive* → 伦理担忧。正好呈现积极与消极两面。
28	B	Section B 中段：“*The landmarks are then* ***scaled, from small to large****, so that the robot can recognise whether it is getting closer to or further away from them.*” 说明 ‘感知到的大小’ 被用来判断距离（导航辅助手段）。
29	E	Section E：“*…the key to the cockroach's remarkable cross-country performance lies partly in the fact that* ***its legs do a lot of the "thinking" without having to consult the brain.***” 典型表现——决策直接在肢体完成。
30	D	Section D 通篇描述 **Entomopter** 用于在 “*thin Martian air*” 中悬停、探索——即作为太空（火星）探测辅助。
31	A	Section A 开头连续罗列盐碱地小虫、蟑螂翻越障碍、螳螂虾高光谱视觉等 **多种本领**，并引出 “*imitation of insect systems*”——展示了激发仿生机器人的 “技能范围”。
32	C	Section C 描述蚂蚁同时运用多导航方式：“*…the ant actually performs a number of complex calculations in different organs… many separate sub-routines going on* ***simultaneously***。” 说明多种导航机制并行运行。

题号	答案	关键词定位 & 引用
33	**mantis shrimp**	Section A：“*The* ***mantis shrimp*** *scans its aquatic world through hyperspectral eyes.*” 暗示其水下视力极佳。
34	**(a) panoramic camera**	Section B：“*A research team… by recognising them individually using* ***a panoramic camera***。” 题干已给出 computer，因此新增设备即 *panoramic camera*。
35	**the Sahara Desert**	Section C 开头：“*…journeyed … to the* ***Sahara Desert*** *where Cataglyphis…*”
36	**polarised light**	Section C：“*Cataglyphis uses* ***polarised light****, caused when air molecules scatter light, to orient and steer itself.*” 说明这种大气光学效应帮助其辨向。

(33-36 须符合 “NO MORE THAN THREE WORDS” 要求，已压缩为 ≤3 词)

配对题 37-40

题号	人物	选项	解释性定位
37	Dr Alex Zelinsky	D	Section B 说明其机器人会把环境信息按 “可靠度” 分类并存储：“…panoramic camera logs… then stored in its computer **according to how reliable they are**.” → 对应 *categorises information…*
38	Prof Ruediger Wehner	A	Section C 描述 **Sahabot** 同时利用 “polarised light + stored 360° images” 导航 —— 正吻合 “makes use of light as well as stored images”。
39	Prof Robert Michelson	F	Section D 强调 **Entomopter** 的设计 “*has gone* ***beyond nature*** *to devise a completely new concept… unusually high lift…*” —— 即在昆虫基础上性能 “更上一层楼”。
40	Roger Quinn & Prof Roy Ritzmann	C	Section E 聚焦仿蟑螂六足 / “**whegs**” 机器人，强调 “*run very fast over rough terrain*” —— 对应 *can move over difficult surfaces*。