



**BioMedical Admissions Test**

**4500/12**

**Thursday 2 November 2017**

**30 minutes**



**SECTION 2**

**Scientific Knowledge and Applications**

**INSTRUCTIONS TO CANDIDATES**

**Please read this page carefully, but do not open the question paper until you are told that you may do so.**

This paper is Section 2 of 3. Your supervisor will collect this question paper and answer sheet before giving out Section 3.

A separate answer sheet is provided for this section. Please check you have one. You also require a soft pencil and an eraser.

Please complete the answer sheet with your:

- BMAT candidate number
- Centre number
- Date of birth
- Name

Speed as well as accuracy is important in this section. ***Work quickly, or you may not finish the paper.*** There are no penalties for incorrect responses, only marks for correct answers, so you should attempt all 27 questions. Each question is worth one mark.

Answer on the sheet provided. Questions ask you to show your choice between options by shading one circle. If you make a mistake, erase thoroughly and try again.

You **must** complete the answer sheet within the time limit.

You can use the question paper for rough working or notes, but **no extra paper** is allowed.

Calculators are NOT permitted.

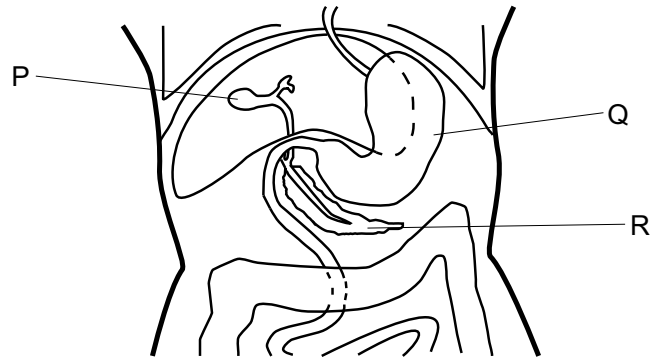
**Please wait to be told you may begin before turning this page.**

*This paper consists of 23 printed pages and 5 blank pages.*

**The question in this paper marked with an asterisk (\* Q7) assumes knowledge that is not currently on the BMAT specification.**

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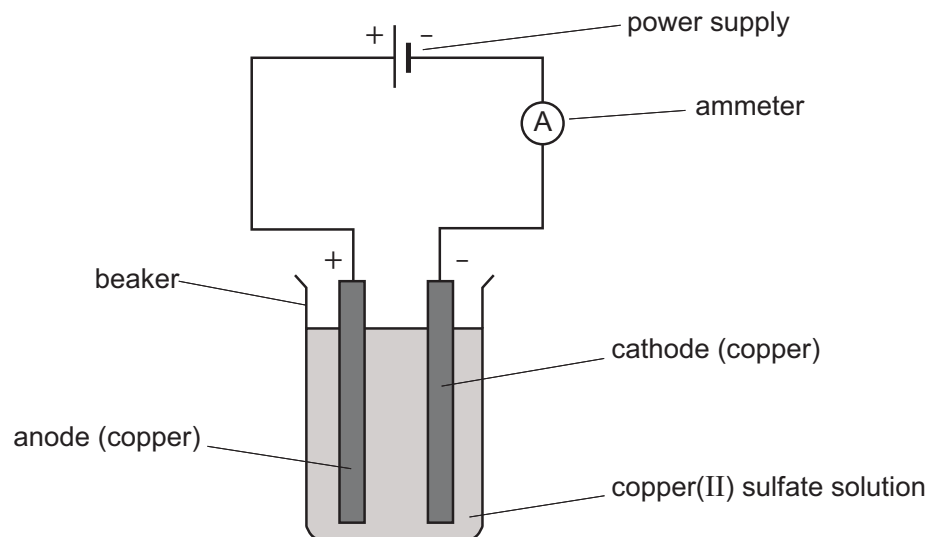
- 1 The diagram shows a section through part of a healthy human.



Which row in the table shows the correct secretions from P, Q and R?

	<i>secretion(s) from P</i>	<i>secretions from Q</i>	<i>secretion(s) from R</i>
<b>A</b>	bile	protease, high hydrogen ion concentration	insulin, protease, lipase, amylase
<b>B</b>	bile, high hydrogen ion concentration	protease, low hydrogen ion concentration	protease, lipase, amylase
<b>C</b>	insulin, protease, lipase	protease, high hydrogen ion concentration	bile
<b>D</b>	protease, lipase, amylase	protease, low hydrogen ion concentration	bile, high hydrogen ion concentration
<b>E</b>	insulin, protease, lipase, amylase	protease, high hydrogen ion concentration	bile
<b>F</b>	protease, lipase, amylase	protease, low hydrogen ion concentration	insulin

2 The diagram shows an electrolysis experiment.



Which reaction occurs at the anode and which reaction occurs at the cathode for this experiment?

	<i>anode</i>	<i>cathode</i>
<b>A</b>	$\text{SO}_4^{2-} \rightarrow \text{SO}_2 + \text{O}_2 + 2\text{e}^-$	$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$
<b>B</b>	$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$	$\text{SO}_4^{2-} \rightarrow \text{SO}_2 + \text{O}_2 + 2\text{e}^-$
<b>C</b>	$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2$	$\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$
<b>D</b>	$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$	$\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$
<b>E</b>	$\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$	$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu}$

- 3** Below are four statements about electromagnetic waves.
- 1** Microwaves have a smaller wavelength than visible light.
  - 2** The speed of visible light in a vacuum is higher than the speed of other types of electromagnetic wave.
  - 3** Gamma rays have the largest wavelength of any electromagnetic wave.
  - 4** Radio waves are used in hospital radiography to look for broken bones.

Which of the statements are correct?

- A** none of them
  - B** 1 and 2 only
  - C** 1 and 3 only
  - D** 1 and 4 only
  - E** 2 and 3 only
  - F** 2 and 4 only
  - G** 3 and 4 only
  - H** 1, 2, 3 and 4
- 4** Which one of the following is equivalent to  $(\sqrt{5} - 2)^2$ ?
- A** 1
  - B** 9
  - C** 21
  - D** 29
  - E**  $1 - 4\sqrt{5}$
  - F**  $9 - 4\sqrt{5}$
  - G**  $21 - 4\sqrt{5}$
  - H**  $29 - 4\sqrt{5}$

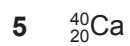
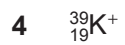
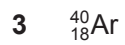
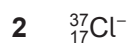
- 5** SCID is an inherited condition in humans. People with some types of SCID are unable to make a functional enzyme necessary for the production of healthy white blood cells.

A scientist studying these types of SCID compared features of the DNA and the structure of the enzyme in people who have this condition and people without SCID.

Which of the following features may have been different?

- 1** the allele of the gene coding for the enzyme
  - 2** the order of amino acids in the enzyme
  - 3** the order of bases in the gene coding for the enzyme
  - 4** the shape of the active site of the enzyme
- 
- A** 1 only
  - B** 4 only
  - C** 1 and 3 only
  - D** 2 and 3 only
  - E** 2 and 4 only
  - F** 1, 2 and 4 only
  - G** 1, 2, 3 and 4

6 Which of the following atoms and ions contain(s) 20 neutrons and 18 electrons?



A 3 only

B 1 and 2 only

C 1 and 3 only

D 2 and 4 only

E 2 and 5 only

F 4 and 5 only

G 2, 4 and 5 only

H 1, 2, 3 and 4 only



- 7** A puddle is left on a road after a rain shower. The water in the puddle slowly disappears by evaporation.

Three statements about the effect of changing different conditions on this process are given below.

- 1** The rate of evaporation is greater at higher temperatures.
- 2** The rate of evaporation is greater when the air above the puddle is still.
- 3** The rate of evaporation is greater when the puddle has a larger surface area.

Which of the statements is/are correct?

(Assume for each statement that all other conditions remain the same.)

- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3



**8** In a group of 20 patients at a medical centre, 5 suffered from migraines.

Two patients from the group of 20 were picked at random for a survey on the use of painkillers.

What is the probability that both of the patients picked suffered from migraines?

**A**  $\frac{1}{19}$

**B**  $\frac{1}{16}$

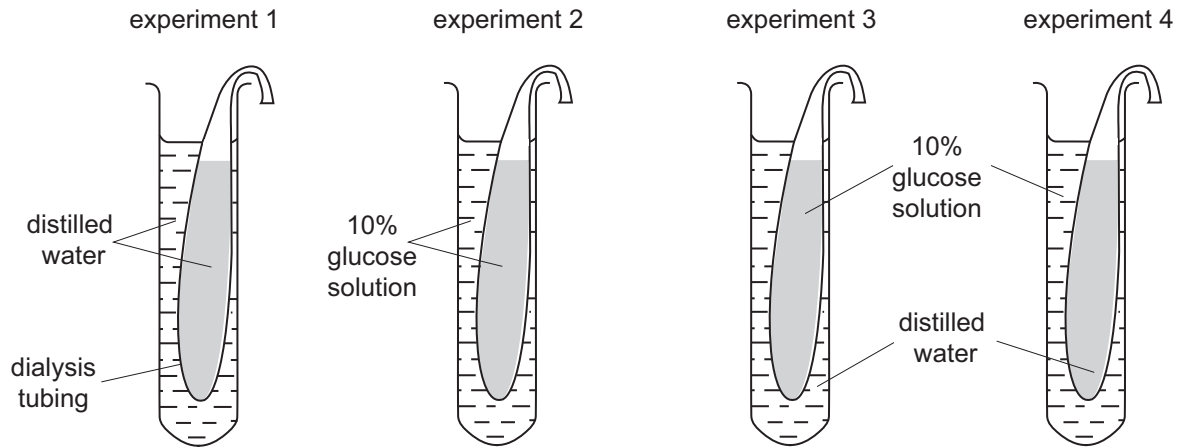
**C**  $\frac{35}{76}$

**D**  $\frac{1}{2}$

**E**  $\frac{21}{38}$

**F**  $\frac{9}{16}$

- 9 The diagram shows four experiments used to investigate movement of substances across dialysis tubing. This tubing is a partially permeable membrane which allows **both** glucose and water to pass through it.



Which row in the table shows the experiment(s) where there will be movement of glucose through the partially permeable membrane and the experiment(s) where there will be movement of water through the partially permeable membrane?

	<i>experiment(s) with movement of glucose through partially permeable membrane</i>	<i>experiment(s) with movement of water through partially permeable membrane</i>
<b>A</b>	4 only	3 only
<b>B</b>	3 only	4 only
<b>C</b>	2 and 4 only	1 and 3 only
<b>D</b>	2, 3 and 4 only	1, 3 and 4 only
<b>E</b>	2, 3 and 4 only	1, 2, 3 and 4

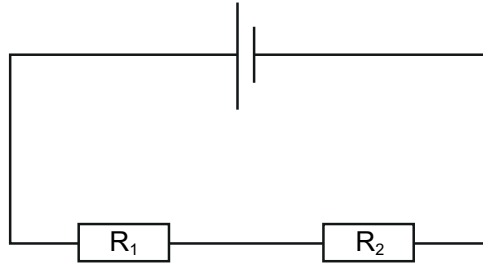
- 10** A piece of magnesium ribbon is dropped into a beaker of dilute aqueous hydrochloric acid at room temperature. After a while the production of bubbles of gas slows down.

Which of the following statements can correctly explain this observation?

- 1** The particles have less energy.
  - 2** The concentration of hydrochloric acid decreases.
  - 3** The activation energy for the reaction increases.
- 
- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 11 Two resistors  $R_1$  and  $R_2$  are connected in series with a cell.

Resistor  $R_1$  has twice the resistance of resistor  $R_2$ .



Six statements about this circuit are given below.

- 1 The voltage across each resistor is the same.
- 2 The voltage across  $R_1$  is twice that across  $R_2$ .
- 3 The voltage across  $R_2$  is twice that across  $R_1$ .
- 4 The current is the same in both resistors.
- 5 The current in  $R_1$  is twice the current in  $R_2$ .
- 6 The current in  $R_2$  is twice the current in  $R_1$ .

Which pair of statements is correct?

- A 1 and 4 only
- B 1 and 6 only
- C 2 and 4 only
- D 2 and 5 only
- E 2 and 6 only
- F 3 and 4 only
- G 3 and 5 only
- H 3 and 6 only

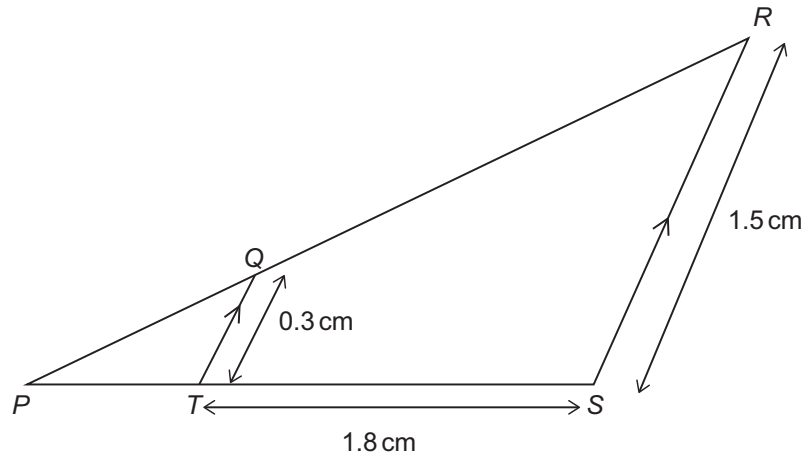
12 In triangle  $PRS$ , line  $QT$  is parallel to side  $RS$ .

$$RS = 1.5 \text{ cm}$$

$$TS = 1.8 \text{ cm}$$

$$QT = 0.3 \text{ cm}$$

[diagram not to scale]

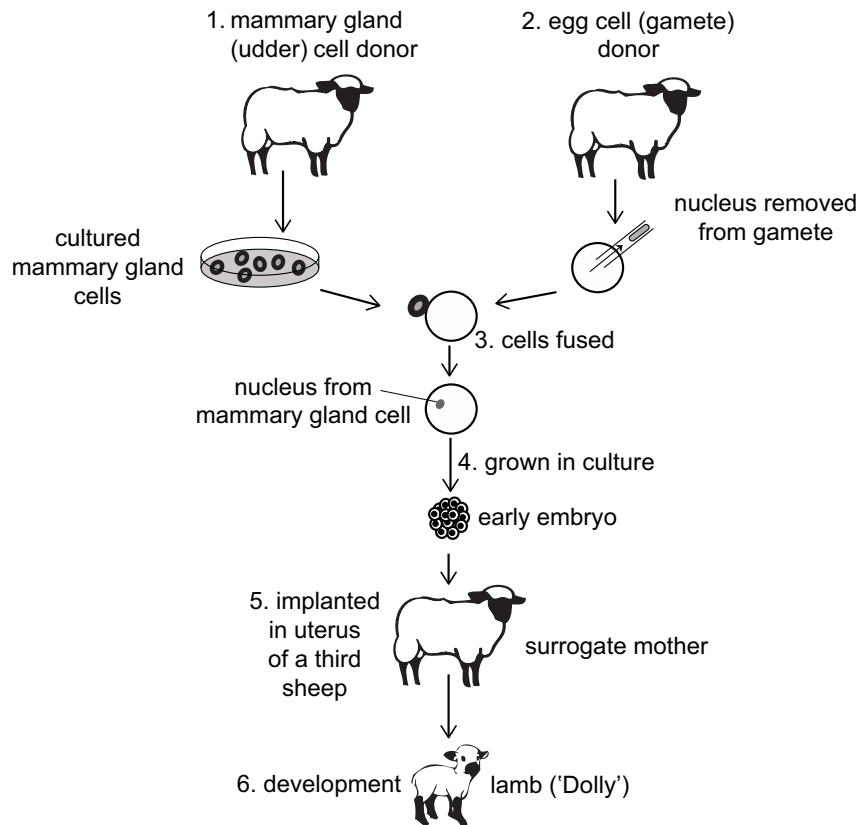


What is the length of  $PS$ ?

- A 0.25 cm
- B 0.36 cm
- C 0.45 cm
- D 2.05 cm
- E 2.16 cm
- F 2.25 cm

- 13** Dolly the sheep was born in 1996. She was unusual because she had no biological father. Sheep have a diploid number of 54 chromosomes in their body cells.

The diagram shows the process of how she was produced.



Which of the following statements about this process is/are correct?

- 1** The gamete cell nucleus contained 27 chromosomes.
  - 2** The cells produced in step 4 had the same properties as stem cells.
  - 3** None of the cells involved in the process were produced by meiosis.
- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 14** Disproportionation is the simultaneous oxidation and reduction of the same species in a reaction.

In which of the following chemical equations does disproportionation occur?

- 1**  $\text{Fe} + \text{CuCl}_2 \rightarrow \text{FeCl}_2 + \text{Cu}$
- 2**  $\text{Cu}_2\text{O} \rightarrow \text{Cu} + \text{CuO}$
- 3**  $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HCl} + \text{HClO}$
- 4**  $\text{BaCl}_2 + \text{Na}_2\text{SO}_4 \rightarrow \text{BaSO}_4 + 2\text{NaCl}$
- 5**  $\text{Hg}_2\text{Cl}_2 \rightarrow \text{Hg} + \text{HgCl}_2$

- A** 2 only
- B** 2 and 3 only
- C** 3 and 4 only
- D** 1, 4 and 5 only
- E** 2, 3 and 5 only
- 15** Uranium-238 is a naturally-occurring alpha emitter. It can be used in the manufacture of the isotope plutonium-239, during which it is bombarded by neutrons.

The process of converting a nucleus of uranium-238 to a nucleus of plutonium-239 is a three-stage sequence of nuclear reactions.

What is this sequence?

(Atomic numbers: uranium = 92; plutonium = 94)

	<i>1st stage</i>	<i>2nd stage</i>	<i>3rd stage</i>
<b>A</b>	emission of an $\alpha$ particle	emission of a $\beta$ particle	absorption of a neutron
<b>B</b>	emission of an $\alpha$ particle	absorption of a neutron	emission of an $\alpha$ particle
<b>C</b>	emission of a $\beta$ particle	emission of an $\alpha$ particle	absorption of a neutron
<b>D</b>	emission of a $\beta$ particle	absorption of a neutron	emission of a $\beta$ particle
<b>E</b>	absorption of a neutron	emission of an $\alpha$ particle	emission of an $\alpha$ particle
<b>F</b>	absorption of a neutron	emission of a $\beta$ particle	emission of a $\beta$ particle

- 16 The acceleration due to gravity at the surface of a planet is given by  $g = \frac{GM}{R^2}$ , where  $M$  and  $R$  are the mass and radius of the planet respectively, and  $G$  is the gravitational constant.

It is given that

$$g = 10 \text{ N/kg}$$

$$G = 7 \times 10^{-11} \text{ N m}^2/\text{kg}^2$$

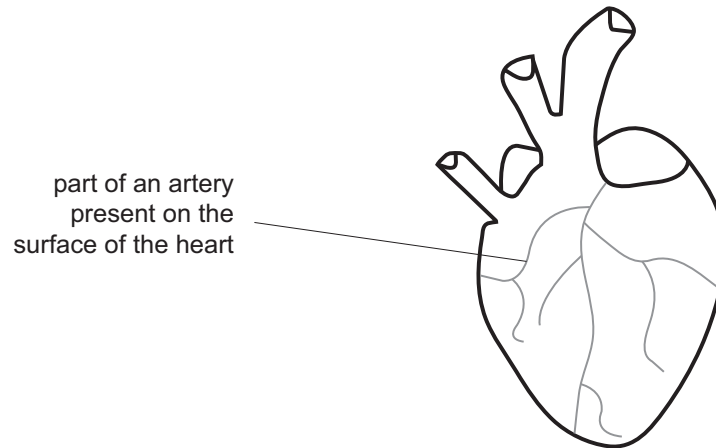
$$R = 6 \times 10^6 \text{ m}$$

What is  $M$ , correct to one significant figure?

- A  $5 \times 10^{24} \text{ kg}$
- B  $2 \times 10^{24} \text{ kg}$
- C  $5 \times 10^{20} \text{ kg}$
- D  $2 \times 10^{20} \text{ kg}$
- E  $5 \times 10^{18} \text{ kg}$
- F  $2 \times 10^{18} \text{ kg}$



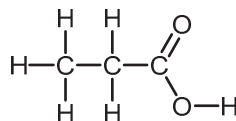
17 The diagram shows an external view of the human heart.



Which of the following statements about the artery shown on the diagram is/are correct?

- 1 It is the site of diffusion of glucose and oxygen into the muscle cells of the heart.
  - 2 It transports blood at high pressure.
  - 3 It contains muscle cells.
- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 18 Propanoic acid is a monoprotic acid.



Magnesium is a Group 2 metal.

Which of the following chemical equations is correct for the reaction between magnesium carbonate and propanoic acid?

- A**  $2\text{CH}_3\text{CH}_2\text{COOH} + \text{MgCO}_3 \rightarrow \text{Mg}(\text{C}_3\text{H}_5\text{O}_2)_2 + \text{H}_2\text{O}$
- B**  $\text{C}_3\text{H}_6\text{O}_2 + \text{MgCO}_3 \rightarrow \text{MgC}_3\text{H}_5\text{O}_2 + \text{CO}_2 + \text{H}_2\text{O}$
- C**  $2\text{C}_3\text{H}_6\text{O}_2 + \text{MgCO}_3 \rightarrow \text{Mg}(\text{C}_3\text{H}_5\text{O}_2)_2 + \text{CO}_2 + \text{H}_2\text{O}$
- D**  $2\text{CH}_3\text{COOH} + \text{MgCO}_3 \rightarrow \text{Mg}(\text{CH}_3\text{COO})_2 + \text{CO}_2 + \text{H}_2\text{O}$
- E**  $\text{C}_3\text{H}_6\text{O}_2 + 3\text{MgCO}_3 \rightarrow \text{Mg}_3\text{C}_3\text{O}_2 + 3\text{CO}_2 + 3\text{H}_2\text{O}$
- 19 A swimming pool is 10 m wide. A loud sound is made in the water 2.0 m from one wall and the reflected sounds are detected with a microphone placed next to the sound source. The reflection from the wall 8.0 m away arrives 0.010 s after the reflection from the wall 2.0 m away.

What is the speed of sound in water?

- A** 270 m/s
- B** 330 m/s
- C** 530 m/s
- D** 600 m/s
- E** 1200 m/s

20 Express  $\frac{1}{2x} + \frac{1}{x-1} - \frac{1}{x}$  as a single algebraic fraction.

A  $\frac{1}{2x-1}$

B  $\frac{1}{2(x-1)}$

C  $\frac{2x-1}{x(x-1)}$

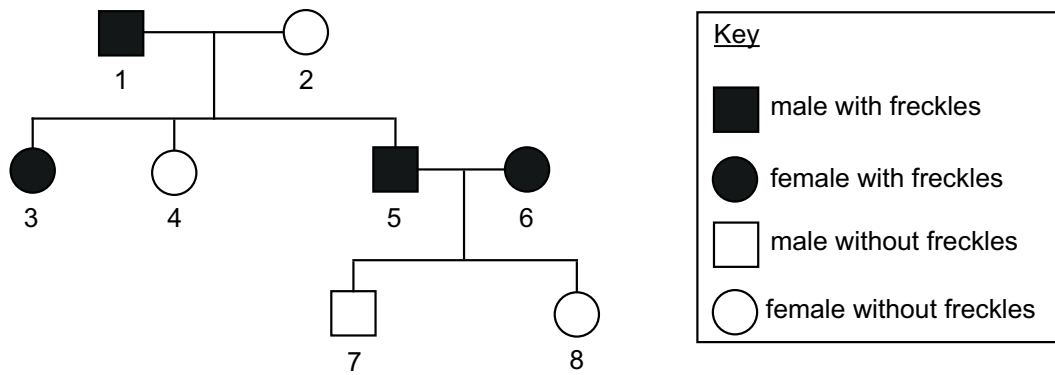
D  $\frac{x-3}{2x(x-1)}$

E  $\frac{x+1}{2x(x-1)}$

F  $\frac{1}{x(x-1)}$

G  $\frac{-1}{x(x-1)}$

21 The family tree shows the inheritance of freckles.



Which row in the table shows the probability that the next child produced by parents 1 and 2, and the probability that the next child produced by parents 5 and 6 will have freckles?

	<i>probability that the next child produced by parents 1 and 2 will have freckles</i>	<i>probability that the next child produced by parents 5 and 6 will have freckles</i>
<b>A</b>	1	1
<b>B</b>	0.5	1
<b>C</b>	1	0.75
<b>D</b>	0.5	0.75
<b>E</b>	1	0.5
<b>F</b>	0.5	0.5
<b>G</b>	1	0.25
<b>H</b>	0.5	0.25

**22** Hydrated copper(II) sulfate has the formula  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ .

100 cm<sup>3</sup> of a solution contained 10 g of hydrated copper(II) sulfate. What is the concentration, in mol/dm<sup>3</sup>, of this solution?

( $A_r$  values: H = 1.0; O = 16; S = 32; Cu = 64)

- A** 0.100 mol/dm<sup>3</sup>
- B** 0.400 mol/dm<sup>3</sup>
- C** 0.495 mol/dm<sup>3</sup>
- D** 0.532 mol/dm<sup>3</sup>
- E** 0.562 mol/dm<sup>3</sup>
- F** 0.625 mol/dm<sup>3</sup>

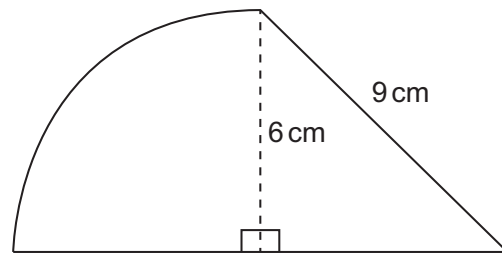
**23** A book rests on a table, which in turn rests on the floor. The floor exerts a force  $P$  on the table.

Force  $P$  and one other force constitute a Newton's Third Law interaction pair of forces.

What is the other force?

- A** the force that the book exerts on the table
- B** the force that the book exerts on the Earth
- C** the force that the Earth exerts on the book
- D** the force that the Earth exerts on the table
- E** the force that the floor exerts on the Earth
- F** the force that the table exerts on the floor

- 24 The diagram shows a shape made from a quarter circle of radius 6 cm and a right-angled triangle with a hypotenuse of length 9 cm.

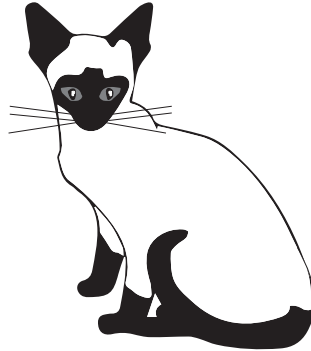


[diagram not to scale]

Which of the following expressions gives the area, in square centimetres, of the shape?

- A  $3\pi + 9\sqrt{5}$
- B  $3\pi + 9\sqrt{13}$
- C  $9\pi + 9\sqrt{5}$
- D  $9\pi + 9\sqrt{13}$
- E  $9\pi + 18\sqrt{5}$
- F  $9\pi + 27\sqrt{5}$
- G  $36\pi + 9\sqrt{5}$

- 25** The picture shows a Siamese cat. This type of cat has a gene which is sensitive to temperature. When this gene is inactive in the cells, the coat colour is pale. When the gene is active, it produces an enzyme which causes the coat colour to be darker. If this cat had grown up in a warmer environment its ears, front of face, paws and tail would be paler than those shown in the picture below.



A student wrote the following statements using this information.

- 1** The enzyme is denatured at the internal body temperature of the cat so the coat colour is pale.
- 2** The temperature of the ears, front of face, paws and tail was cooler than the body temperature so they are darker.
- 3** The coat colour in Siamese cats depends on both genes and the environment.

Which of these statements is/are correct?

- A** none of them
- B** 1 only
- C** 2 only
- D** 3 only
- E** 1 and 2 only
- F** 1 and 3 only
- G** 2 and 3 only
- H** 1, 2 and 3

- 26** What is the volume of hydrogen gas formed (measured at room temperature and pressure) when 0.23 g of pure sodium reacts completely with an excess of water?

( $A_r$  values: H = 1.0; Na = 23.)

Assume that the molar volume of gas at room temperature and pressure is  $24 \text{ dm}^3$ .)

- A**  $0.10 \text{ dm}^3$
- B**  $0.12 \text{ dm}^3$
- C**  $0.20 \text{ dm}^3$
- D**  $0.24 \text{ dm}^3$
- E**  $0.48 \text{ dm}^3$
- 27** A graph of kinetic energy, in joules ( $y$ -axis) against the square of the speed in  $(\text{m/s})^2$  ( $x$ -axis) is plotted for an object of mass 2.5 kg travelling along the surface of the Earth. The result is a straight line.

What is the numerical value of the gradient of this line?

- A** 0.40
- B** 0.80
- C** 1.25
- D** 2.50
- E** 5.00
- F** 6.25

**END OF TEST**



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