



**BioMedical Admissions Test**

**4500/12**

**November 2020**

**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 might 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 question paper consists of 22 printed pages and 2 blank pages.*



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1 Which two of the following statements about genetic variation are correct?

- 1 Asexual reproduction always produces genetic variation.
- 2 Gamete production is the only possible source of genetic variation in sexual reproduction.
- 3 The environment can cause genetic variation.
- 4 Mutations can produce genetic variation.

- A 1 and 2 only
- B 1 and 3 only
- C 1 and 4 only
- D 2 and 3 only
- E 2 and 4 only
- F 3 and 4 only

2 A sample of an element consists of two isotopes. The relative abundance of each isotope is shown in the table.

	<i>number of protons</i>	<i>number of neutrons</i>	<i>number of electrons</i>	<i>relative abundance</i>
isotope 1	31	38	31	60%
isotope 2	31	40	31	40%

What is the relative atomic mass of the element in this sample?

- A 31.0
- B 38.8
- C 39.0
- D 62.0
- E 69.8
- F 70.0

- 3 A supermarket has a large open-topped deep freezer to keep products frozen but still visible to customers.

Which statement about the air in this freezer explains why the products remain frozen, even though it is open-topped?

- A The temperature difference between the air inside and outside the freezer is too large for heat to enter the freezer.
- B The temperature difference between the air inside and outside the freezer is too small for heat to enter the freezer.
- C The warm air above the freezer is denser than cold air inside the freezer.
- D The cold air inside the freezer is denser than the hot air above the freezer.
- E The products inside the freezer trap the cold air so it cannot escape.

- 4 Which one of the following is a simplification of

$$2 - \frac{2x + 1}{4x^2 + 4x + 1}$$

A  $\frac{4x + 1}{2x + 1}$

B  $\frac{4x + 3}{2x + 1}$

C  $\frac{4x + 9}{2x + 5}$

D  $\frac{8x^2 + 4x + 1}{4x^2 + 2x + 1}$

E  $\frac{8x^2 + 4x + 1}{4x^2 + 2x + 2}$

F 2

- 5** Scientists are using human stem cells to develop treatments for a wide variety of health conditions.

Two types of stem cell that are available for this work are:

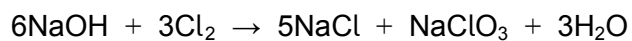
- stem cells collected from an early embryo
- bone marrow stem cells collected from an adult

Which of the following statements is/are correct?

(Assume that no mutations occur.)

- 1** Both of these types of stem cell can divide producing daughter cells. Each daughter cell will contain one haploid copy of the donor's genome.
  - 2** The stem cells collected from an embryo are able to differentiate into a wider variety of specialised cells than the adult bone marrow stem cells.
  - 3** The use of stem cell therapy to treat a medical condition can increase the risk of a person developing cancer.
- 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

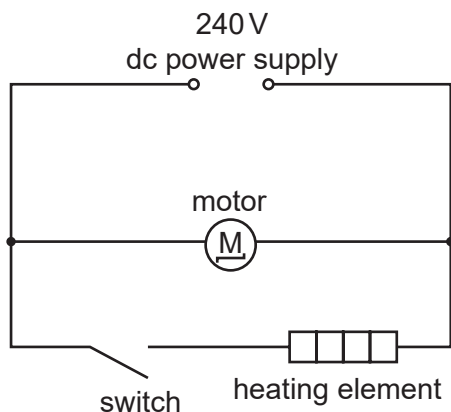
- 6 Hot, concentrated aqueous sodium hydroxide and chlorine react as shown in the equation:



Which of the following statements is/are correct?

- 1 Chlorine has oxidation state +5 in  $\text{NaClO}_3$ .
  - 2 This is an example of a disproportionation reaction.
  - 3 Some of the oxygen in the hydroxide ions is oxidised.
- 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

- 7 An electric fan heater contains a heating element and a motor that drives the fan. The circuit diagram is shown.



At first, the switch is open and the current in the motor is 0.40 A.

The switch is then closed.

Which of the following statements is/are correct after the switch is closed?

- 1 The current in the heating element added to the current in the motor is 0.40 A.
  - 2 The voltage across the heating element is 240 V.
  - 3 The resistance of the circuit is smaller than it is with the switch open.
- 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 sale, the normal price of a camera is reduced by 20%.

The sale price of the camera is £180.

Which expression gives the normal price of the camera?

A  $0.8 \times \text{£}180$

B  $1.02 \times \text{£}180$

C  $1.2 \times \text{£}180$

D  $\frac{\text{£}180}{0.8}$

E  $\frac{\text{£}180}{0.2}$

F  $\frac{\text{£}180}{0.08}$

9 Some rabbits have a genetic condition. The dominant allele codes for this condition.

A homozygous dominant rabbit mated with a rabbit that did not have the condition.

They had three offspring.

One of the offspring then mated with a rabbit that did not have the condition and they also produced three offspring. Two of the offspring had the condition and one did not.

One body cell that is in early interphase is taken from each of the rabbits in these three generations.

What is the total number of copies of the allele for the condition in this collection of cells?

A 6

B 7

C 8

D 11

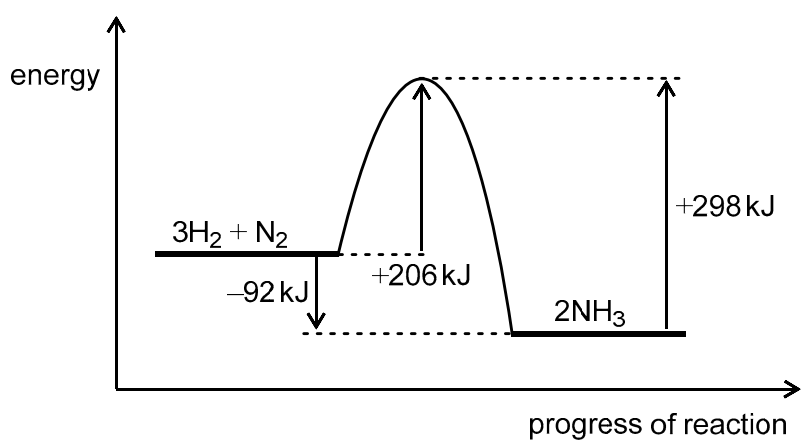
E 12

F 14



- 10 The reaction between hydrogen and nitrogen in the presence of an iron catalyst is known as the Haber process. It is a reversible reaction.

The energy profile for this reaction is shown.



What is the energy change when one mole of ammonia is decomposed into its component elements?

- A 46 kJ is absorbed
- B 46 kJ is released
- C 57 kJ is absorbed
- D 57 kJ is released
- E 92 kJ is absorbed
- F 92 kJ is released
- G 149 kJ is absorbed
- H 149 kJ is released

- 11** A 'gold medal' used in events such as the Olympic Games is made from a silver–nickel alloy with a coating of a gold–silver alloy.

The mass of the medal is 256 g, of which 24.0 g is the mass of the coating.

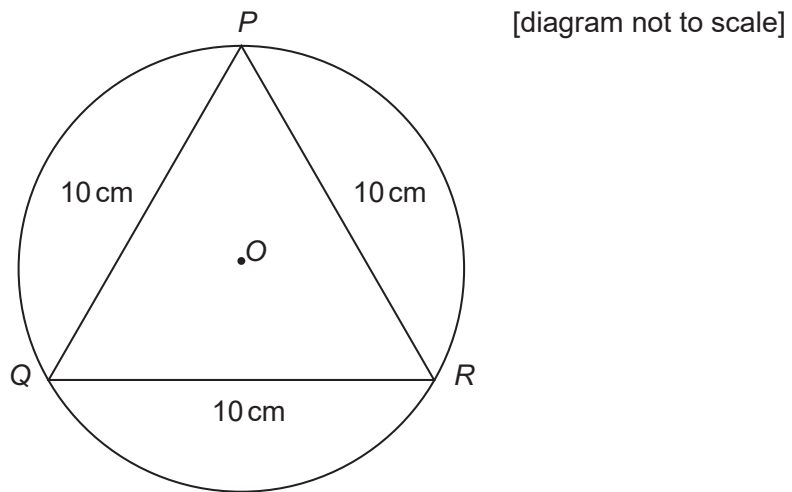
The density of the silver–nickel alloy is  $10.0 \text{ g cm}^{-3}$  and the density of the gold–silver alloy is  $16.0 \text{ g cm}^{-3}$ .

What is the volume of the medal?

- A**  $16.0 \text{ cm}^3$
- B**  $16.9 \text{ cm}^3$
- C**  $23.2 \text{ cm}^3$
- D**  $24.7 \text{ cm}^3$
- E**  $25.6 \text{ cm}^3$
- F**  $27.1 \text{ cm}^3$

12 Triangle  $PQR$  is equilateral with sides of length 10 cm.

$P$ ,  $Q$ , and  $R$  are points on the circumference of a circle with centre  $O$ .



Which one of the following is an expression, in centimetres, for the radius of the circle?

A  $5 \cos 60^\circ$

B  $\frac{5}{\tan 60^\circ}$

C  $5 \sin 60^\circ$

D  $\frac{5}{\sin 60^\circ}$

E  $5 \tan 60^\circ$

F  $\frac{5}{\cos 60^\circ}$

- 13 Several processes can change the proportion of gases in the atmosphere by adding or removing carbon dioxide or oxygen.

Which row is correct?

	<i>adds carbon dioxide</i>	<i>removes carbon dioxide</i>	<i>adds oxygen</i>	<i>removes oxygen</i>
<b>A</b>	combustion	aerobic respiration in animals	photosynthesis	activity of decomposers
<b>B</b>	anaerobic respiration in animals	activity of decomposers	aerobic respiration in plants	combustion
<b>C</b>	activity of decomposers	photosynthesis	anaerobic respiration in animals	aerobic respiration in animals
<b>D</b>	aerobic respiration in plants	photosynthesis	photosynthesis	activity of decomposers
<b>E</b>	photosynthesis	activity of decomposers	aerobic respiration in plants	combustion
<b>F</b>	aerobic respiration in animals	aerobic respiration in plants	anaerobic respiration in animals	aerobic respiration in animals

**14** Four metals, labelled R, T, X and Z, have the following characteristics:

- R fizzes when added to dilute hydrochloric acid.
- T is precipitated when R reacts with an aqueous solution of a compound of T.
- X is the only one of these metals that occurs naturally on Earth uncombined with other elements.
- Z is the only one of these metals manufactured commercially by electrolysis of one of its molten compounds, whereas R and T can be manufactured by heating their oxides with carbon.

What is the order of reactivity of these metals, from most to least reactive?

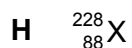
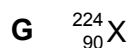
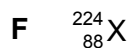
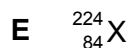
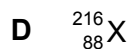
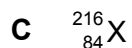
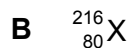
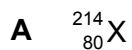
- A** R, Z, T, X
- B** R, T, X, Z
- C** T, X, R, Z
- D** X, R, T, Z
- E** X, T, R, Z
- F** Z, R, T, X
- G** Z, T, R, X
- H** Z, R, X, T

- 15 Thorium-232 ( ${}^{232}_{90}\text{Th}$ ) is an unstable nuclide that decays through a sequence of radioactive emissions to form a stable nuclide of lead.

All of the emissions during this sequence are either alpha or beta ( $\beta^-$ ) particles.

One of the intermediate nuclides, reached after four alpha and two beta decays, is a nuclide of an element labelled X.

What is the symbol for this nuclide of X?



- 16 The graphs of the following functions are drawn:

1  $y = 2x - 1$

2  $y = 1 - x^2$

3  $y = (1 - x)^2$

4  $y = 2 - x$

Which two graphs do **not** intersect?

A 1 and 2

B 1 and 3

C 1 and 4

D 2 and 3

E 2 and 4

F 3 and 4

- 17 Six test tubes were set up. Two different solutions were added to each test tube as shown in the table.

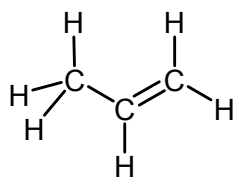
The temperature, pH and all concentrations were optimal.

Which three mixtures would lead to the presence of amino acids in the test tube?

<i>test tube</i>	<i>mixture of solutions</i>
1	lipase and lipid
2	lipase and boiled protein
3	protease and lipase
4	boiled protease and protein
5	protease and boiled protein
6	protease and protein

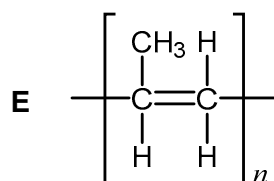
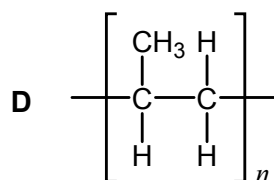
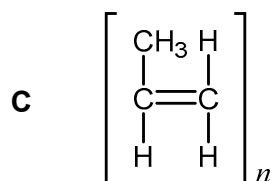
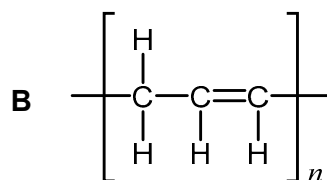
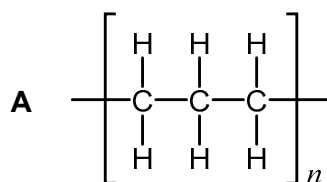
- A 1, 2 and 6 only
- B 1, 4 and 6 only
- C 2, 3 and 4 only
- D 2, 4 and 5 only
- E 3, 4 and 6 only
- F 3, 5 and 6 only
- G 4, 5 and 6 only

18 Propene is an alkene. The structural formula of propene is shown.



A polymer can be made from propene.

What is the correct structural formula of this polymer?





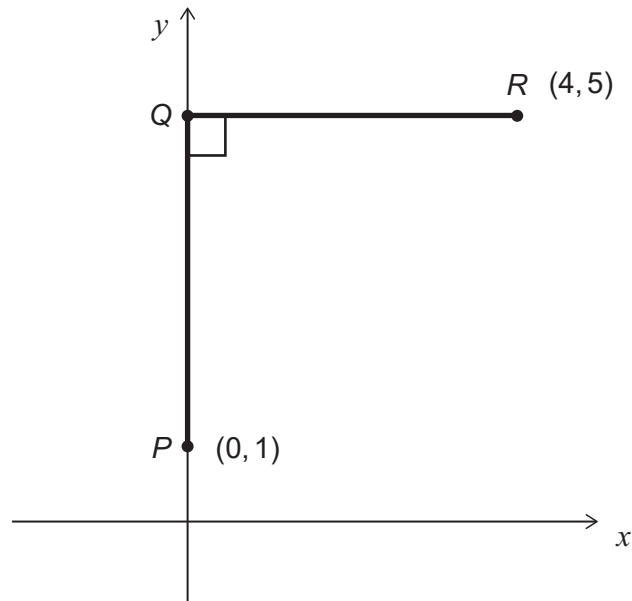
- 19 A diver of mass 45 kg jumps from a diving board and reaches a maximum height of 10 m above the surface of the water in a swimming pool.

Assume Earth's gravitational field strength is  $10 \text{ N kg}^{-1}$ , that air resistance is negligible, and that the diver is treated as a point particle.

What is the diver's kinetic energy as she hits the water, and at what speed does she hit the water?

	<i>kinetic energy / J</i>	<i>speed / m s<sup>-1</sup></i>
<b>A</b>	450	$\sqrt{10}$
<b>B</b>	450	$2\sqrt{5}$
<b>C</b>	450	10
<b>D</b>	4500	10
<b>E</b>	4500	$10\sqrt{2}$
<b>F</b>	4500	100

20



$PQRS$  is a kite. Points  $P$ ,  $Q$  and  $R$  are plotted on the diagram.

$P$  is the point  $(0, 1)$  and  $R$  is the point  $(4, 5)$ .

angle  $PQR = 90^\circ$

The point  $Q$  lies on the  $y$ -axis.

The line  $PS$  is a segment of the line  $2y + x = 2$

The coordinates of  $S$  are  $(l, m)$ .

What is  $2l + m$ ?

- A -3
- B 1
- C 2
- D 10
- E 12
- F 13

- 21 The table below gives some information about the number and biomass of organisms in the food chain:

rose bush → aphid → ladybird

<i>organism</i>	<i>number of organisms</i>	<i>biomass at each level (arbitrary units)</i>
rose bush	1	800
aphid	4000	200
ladybird	50	10

What percentage of the biomass in the producer is transferred into the biomass of each individual secondary consumer, in this food chain?

- A 0.025
- B 0.0625
- C 0.1
- D 1.25
- E 5.0
- F 25.0
- 22 The compounds BrCl and BrI melt at  $-66^{\circ}\text{C}$  and  $42^{\circ}\text{C}$ , respectively.
- What is the best explanation for this difference in melting points?
- A The Br–I covalent bond is stronger than the Br–Cl covalent bond.
- B Chlorine is more reactive than iodine so chlorine breaks away from bromine more readily than iodine.
- C The forces between BrI molecules are stronger than the forces between BrCl molecules.
- D Iodide ions are larger than chloride ions so bromide ions form stronger ionic bonds with iodide ions than with chloride ions.
- E Iodine atoms are larger than chlorine atoms so the BrI giant covalent lattice is more difficult to break up than the BrCl giant covalent lattice.

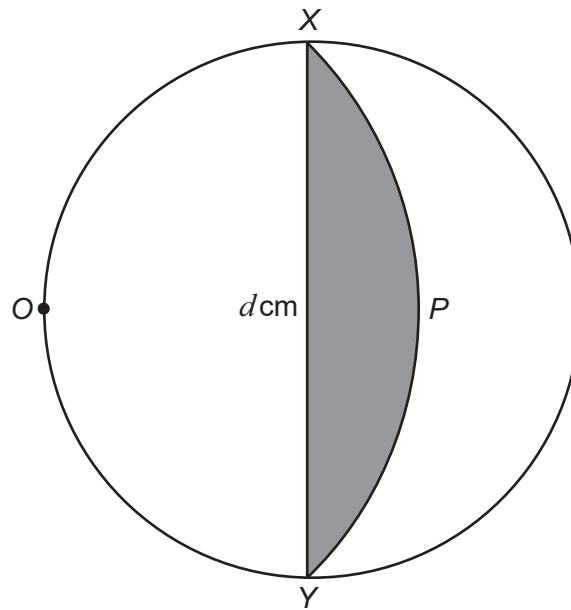
**23** A submarine uses sound of frequency 6000 Hz to locate obstructions ahead of it in the sea.

A pulse of this sound reflects off an object that is 750 m in front of the submarine. The pulse returns to the submarine 1.00 s after it is transmitted.

What is the wavelength of this sound in the sea water?

- A** 12.5 cm
- B** 25.0 cm
- C** 4.00 m
- D** 8.00 m
- E** 4.50 km
- F** 9.00 km

- 24 The diameter  $XY$  of a circle has length  $d$  cm.



$O$  is a point on the circumference of this circle such that a new circle with centre  $O$  passes through points  $X$  and  $Y$ .

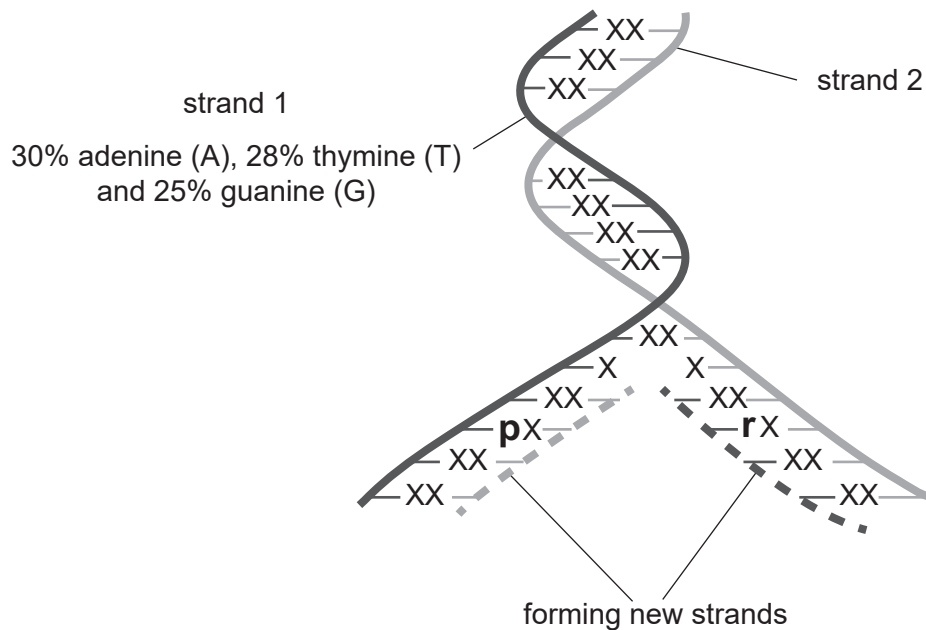
$P$  is a point on the new circle and the arc  $XPY$  is shown in the diagram.

Which of the following is an expression for the **perimeter**, in cm, of the shaded region?

- A  $\frac{d(2 + \pi)}{2}$
- B  $\frac{d(2 + \sqrt{2}\pi)}{2}$
- C  $\frac{d(4 + \pi)}{4}$
- D  $\frac{d(4 + \sqrt{2}\pi)}{4}$
- E  $\frac{d(8 + \pi)}{8}$
- F  $\frac{d(8 + \sqrt{2}\pi)}{8}$

25 The diagram shows part of a DNA double helix being copied.

<p><u>Key</u>  X = unnamed bases  XX = unnamed base pairs</p>
---



Which of the following statements, considered independently, is/are correct?

- 1 The probability of any base in strand 2 being guanine (G) is 0.17.
- 2 If **p** is guanine and **r** cytosine, a mutation must have taken place.
- 3 The copying process shown is taking place during mitosis.

- 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** Diammonium hydrogen phosphate,  $(\text{NH}_4)_2\text{HPO}_4$ , can be used as a fertiliser.

The following equation shows how it can be synthesised:



What is the mass of diammonium hydrogen phosphate that is produced when 3.40 kg of ammonia is reacted with phosphoric acid ( $\text{H}_3\text{PO}_4$ ), in excess, with a yield of 80%?

( $M_r$  values:  $\text{NH}_3 = 17.0$ ;  $\text{H}_3\text{PO}_4 = 98.0$ ;  $(\text{NH}_4)_2\text{HPO}_4 = 132$ )

- A** 5.28 kg
  - B** 10.6 kg
  - C** 13.2 kg
  - D** 15.8 kg
  - E** 21.1 kg
  - F** 26.4 kg
- 27** A bar magnet is rotating at a constant rate of 120 revolutions per minute inside a circular coil of wire, causing an induced voltage across the coil.
- Which of the following statements is/are correct?
- 1** Increasing the number of turns of wire on the coil would increase both the maximum value and the frequency of the induced voltage.
  - 2** The direction of the induced voltage in this coil reverses every 0.25 seconds.
  - 3** There is always an induced current in a conductor which is experiencing a change in magnetic field.
- 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

**END OF TEST**

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