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ROYAL AIR FORCE

EXAMINATION FOR THE ENTRY OF AIRCRAFT APPRENTICES

1ST JUNE, 1943

PAPER I.—MATHEMATICS

Time allowed—Two hours

Read carefully the instructions on the front page of your answer book.

EIGHT questions to be answered. Answers should be sent in to ALL questions in Part I, and to any FOUR questions in Part II, but not to more.

Failure to show method and working will involve loss of marks.

PART I

Answer ALL questions in this Part

1. (a) Simplify—

$$\frac{(2\frac{1}{2} - 1\frac{1}{3}) \text{ of } (2\frac{1}{4} + 1\frac{7}{8})}{2\frac{1}{2} - 1\frac{1}{3} \text{ of } 2\frac{1}{4} + 1\frac{7}{8}}$$

(b) By expressing as decimals (but without using logarithms) arrange the following approximations for π in descending order of magnitude—

$$3\frac{1}{7}, \frac{355}{113}, 3\frac{17}{20}.$$

2. (a) Write down the values of—

$$(-1)^3, (-1)^{10}, 27^{\frac{1}{3}}, 16^{\frac{3}{4}}, 25^{-\frac{1}{2}}.$$

(b) Simplify—

$$\frac{4x^2 - 9}{2x^2 + x - 6} \times \frac{x^2 + 2x}{2x + 3}.$$

3. (a) Resolve into prime factors and find the highest common factor of 7315 and 8415.

(b) Four bells begin to toll simultaneously and sound at intervals of 25, 30, 36 and 40 seconds respectively. After what time will they again sound simultaneously?

4. The top of a flagstaff has an elevation of 50° from a point on the ground due north of it and of 40° from a point due south of it. These two points are 150 ft. apart. Find, by means of a scale drawing, the height of the flagstaff.

(Take 1 in. = 25 ft.)

PART II

Answer any FOUR questions in this Part

5. Solve the following equations—

$$(i) \frac{x+2}{3} + \frac{2x-3}{5} = \frac{x}{2} - \frac{x-10}{6}.$$

$$(ii) 3x^2 + 5x - 12 = 0.$$

$$(iii) x + 2y = 5$$

$$3x - y = 4\frac{1}{2}.$$

6 (a). The angle of inclination of a conical pendulum is given by the formula—

$$\cos \theta = \frac{g}{4n^2 \pi^2 l}$$

Find θ if $g = 32 \cdot 2$, $n = 1\frac{1}{2}$, $\pi = 3 \cdot 142$ and $l = 2 \cdot 65$.

(b) Rearrange the formula—

$$T = \frac{k(x-d)}{d}$$

so as to express d in terms of the other letters.

7. Two years ago a man was four times as old as his son and in eighteen years time he will be twice as old as his son. How old are they now?

8. The dam of a reservoir is 15 ft. thick at the top and 25 ft. thick at the bottom, its section being a trapezium with its parallel sides horizontal. The length of the dam is 350 yards; its weight is 33,750 tons and the material weighs 120 lb. per cu. ft. Find its height.

9. A wall, 6 ft. high, runs due east and west. Calculate the width of the shadow cast on horizontal ground by the wall at mid-day when the sun's elevation is 50° .

If the ground sloped downwards from south to north at an angle of 25° to the horizontal, what would the length of the shadow be?

(No marks will be given for results obtained by drawing.)

10. ABC is an equilateral triangle of side 2 in. The inscribed circle touches the sides BC , CA , AB at the points D , E , F respectively. Find the radius of this circle.

If the circle and triangle are revolved about the axis AD , what solid figures are described? Show that the volumes of these two solids are in the ratio of 4 to 9.

11. Draw the graph of—

$$y = x^3 - 3x^2 + 2x$$

plotting points corresponding to—

$$x = -1, -\frac{1}{2}, 0, \frac{1}{2}, 1, 1\frac{1}{2}, 2, 2\frac{1}{2}, 3.$$

(Take 1 in. to represent 1 on each axis.)

Explain what you mean by the gradient at any point on this graph, and find the gradient at the points on the curve corresponding to $x = 0$ and $x = 3$. Also mark points of zero gradient with the letter P .

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PAPER II.—SCIENCE

Read carefully the instructions on the front of your answer book.

Candidates may attempt only FIVE questions in all, TWO to be taken from Section I and THREE from Section II.

If more than five questions are attempted, only the first two from Section I and the first three from Section II will be marked.

Answers should be illustrated by sketches or diagrams whenever these will help to make the meaning clear.

All questions carry the same number of marks.

Time allowed—1½ hours

SECTION I

1. State the *Principle of Archimedes*, and describe how you would demonstrate it experimentally.

A piece of metal weighing 32·8 gm. in air is suspended from a spring balance. When the metal is immersed in water, the balance registers 24·6 gm. What is the specific gravity of the metal?

2. Explain what is meant by the *resultant of two forces at a point*, and state how this resultant may be determined.

Forces of 36 and 25 lb. weight act at an angle of 60° to one another. Determine by drawing (a) the magnitude of their resultant, and (b) the angle between the resultant and the force of 36 lb. weight.

(Use a scale of 1 in. to 10 lb. weight.)

3. State *Boyle's Law*.

A volume of air of 62.5 c.c. at 76 cm. of mercury pressure is allowed to expand at constant temperature until the pressure falls to 19 cm. of mercury. Calculate the final volume of the air.

4. Show by means of carefully labelled sketches how you would determine the two fixed points on an ungraduated Centigrade thermometer.

What temperature on the Fahrenheit scale corresponds to 50° C. ?

5. What is the distinction between a mixture and a chemical compound? Give a detailed description of an experiment to illustrate this distinction.

6. What is meant by the term *spectrum*? Describe how you would obtain a pure spectrum.

7. Show, by means of a labelled sketch, the arrangement of the component parts of a simple electric torch.

In a separate diagram show, in detail, the construction of the battery.

8. Write a short account of the broad differences between plants and animals.

SECTION II

9. State the *Principle of Moments*.

A uniform beam, 10 ft. long and weighing 30 lb., rests horizontally on a support at each end. Masses weighing 3, 6, 9 and 12 lb. are suspended from the beam at distances of 2, 4, 6 and 8 ft. respectively from one end. What force is exerted on each support?

10. Explain, with the help of simple examples, what you understand by *speed*, *uniform velocity* and *acceleration*.

A motor car starts from rest with a uniform acceleration of $1\frac{1}{2}$ ft. per sec. per sec. Calculate (a) its velocity 5 seconds after starting, and (b) the distance it has travelled in that time.

11. Explain what is meant in mechanics by the term *work*.

A crane lifts a grab weighing 2 cwt. and containing $3\frac{1}{2}$ cwt. of coal through a vertical height of 30 ft. in 14 seconds. Find the number of ft.-lb. of work done per second (a) on the grab, and (b) on the coal, and thence the horse-power required from the crane.

12. State *Ohm's Law*.

Calculate the current taken from 240-volts D.C. supply mains when connected with resistances of 100, 150 and 250 ohms, when these resistances are arranged (a) in series, and (b) in parallel.

13. State *Joule's Law* for the heating effect of an electric current.

Assuming that losses of heat to the surroundings are negligible, calculate the time taken to raise the temperature of 6 litres of water from 15°C ., to its boiling-point by means of an immersion heater of 24 ohms resistance operated from 240-volts supply mains.

14. Explain what is meant by the statement that the *coefficient of linear expansion* of iron is 0.000012 per degree Centigrade.

Using this value, determine to the nearest tenth of an inch the amount of expansion in iron rails totalling 1 mile in length at 0°C ., between a winter temperature taken as 0°C . and a maximum summer temperature of 30°C .

15. Write down the chemical equations for the reactions between :—

- (a) concentrated sulphuric acid and common salt ;
- (b) carbon dioxide and lime-water ;
- (c) dilute hydrochloric acid and washing soda ;
- (d) water and quick-lime ;
- (e) steam and red-hot iron.

16. How many lb. of metallic iron can be obtained by the reduction of 1 cwt. of an iron ore assumed to be of the composition Fe_2O_3 ?

(Atomic weights : Fe = 56 ; O = 16.)

17. State the *laws of reflection and refraction of light at plane surfaces* and give carefully labelled sketches to illustrate your answer.

A plane mirror is rotated through an angle, while the direction of a ray of light incident upon it remains unaltered. Show, with the aid of a diagram, that the reflected ray is rotated through twice the angle through which the mirror is rotated.

18. Write a short account, illustrated with suitable sketches, of the process of animal respiration.

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PAPER III.—GENERAL PAPER (WITH ENGLISH COMPOSITION)

Read carefully the instructions on the front page of your examination answer book. Candidates must attempt Part I, to which about ONE HOUR should be given. In Part II, answers are to be sent in to any FIVE questions, but not to more.

Time allowed—2½ hours

PART I

ESSAY (100 marks)

1. Write an essay on any *one* of the following subjects :—

- (a) Town planning.
- (b) The war against U-boats.
- (c) The Air Training Corps.
- (d) A walking tour.
- (e) "Peace hath her victories no less renowned than War."

PART II

GENERAL PAPER (100 marks)

Answers to be sent in to any FIVE questions in this Part. All questions carry the same number of marks.

2. Write short notes on *three* of the following :—The Statute of Labourers ; the Wars of the Roses ; the Protestant Reformation in England ; Bill of Rights ; the work of Warren Hastings in India ; Parliamentary Reform Act, 1832 ; the Indian Mutiny ; the Treaty of Versailles, 1919.

3. State briefly what you know about *two* of the following :—Sir Thomas More ; John Knox ; John Hampden ; Squire Coke of Holkham ; Robert Owen ; William Cobbett ; John Wesley ; Charles Stuart Parnell ; Cecil Rhodes.

4. Explain in some detail what is meant by the Industrial Revolution. In what sense can the industrial revolution be said to be still in progress ?

5. Explain the differences between dominions, colonies and mandated territories, and name examples of each.

Wherein does the unity of the British Commonwealth of Nations lie ?

6. Draw a sketch map, to fill a page of your answer book, to show Northern Australia and the belt of islands to the north of it. Indicate the positions of :—the Equator ; Singapore ; Guadalcanal ; Timor ; Port Darwin ; the Solomons ; Papua ; Port Moresby ; Cape York and Rabaul.

What are the approximate distances between Timor and Port Darwin and between Port Moresby and Cape York ?

7. Draw *two* contour maps showing respectively (a) a volcano, 14,000 ft. high, on an island ; and (b) a cañon, with sides a mile high, in a mountainous country.

8. Explain, with the aid of diagrams, the reasons for the different seasons of the year. Your explanation should cover the following points :—

- (a) Why at any place the altitude of the sun at noon changes with the season ;
- (b) why the length of the day changes ;
- (c) the periods of continuous light or darkness in polar regions.

9. Name the authors of *five* of the following :—*Paradise Lost* ; *Gulliver's Travels* ; *Robinson Crusoe* ; *The Rape of the Lock* ; *Elegy written in a Country Churchyard* ; *She Stoops to Conquer* ; *John Gilpin* ; *St. Agnes Eve* ; *Ivanhoe* ; *Vanity Fair* ; *The Lady of Shalott* ; *Saint Joan*.

Name one other work by each of the *five* authors. Show your acquaintance, in a few sentences, with one of the works you have named.

10. Read the following passage from Milton's "Areopagitica" and answer the questions below it.

"I deny not but that it is of greatest concernment in the Church and Commonwealth to have a vigilant eye how books *demean* themselves as well as men; and thereafter to confine, imprison, and do sharpest justice on them as *malefactors*; for books are not absolutely dead things, but do contain a *potency* of life in them to be as active as that soul whose *progeny* they are . . . as good almost kill a man as kill a good book; who kills a man kills a reasonable creature, God's image; but he who destroys a good book, kills reason itself, kills the image of God as it were in the eye. Many a man lives a burden to the earth; but a good book is the precious life-blood of a master spirit, embalmed and treasured up on purpose to a life beyond life."

- (a) What are the meanings of the words in *italics*?
- (b) Give, in your own words, Milton's reasons for censoring books and for taking care not to destroy a good book.
- (c) In what way does a book contain in it "a potency of life"?

11. Give some account of the functions of *four* of the following officials:—

The Speaker of the House of Commons; The Chancellor of the Exchequer; The Lord Chancellor; The Attorney General; Justice of the Peace; a Diocesan Bishop; a Lord Mayor.

12. Explain with the help of diagrams, the principles involved in *two* of the following:—

- (a) A centrifugal governor;
- (b) The Davy safety lamp for miners;
- (c) A thermos flask;
- (d) A seismograph.

13. If you were wrecked on a desert island and could carry only a very limited number of tools to land, which would you choose? Explain clearly from the use of each tool why you would choose it.