



**DIRECTORATE OF MERCHANT SHIPPING
GOVERNMENT OF SRI LANKA**

CERTIFICATE OF COMPETENCY EXAMINATION

GRADE : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF
500 GT OR MORE (UNLIMITED)
SUBJECT : PRINCIPLES OF NAVIGATION
DATE : 17.08.2023

Time allowed THREE hours

Total marks : 180

Answer all questions

Pass marks : 60%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown.
You may draw sketches wherever required.

1) With the aid of diagrams explain the following;

a) i) GHA ii) SHA iii) Declination iv) Geographical Position

(16 marks)

b) With the aid of diagrams derive the followings;

i) $LHA^* = GHA\gamma + SHA^* + Long (E)$

ii) $LHA^* = GHA\gamma + SHA^* - Long (W)$

(04 marks)

2) a) Describe with the aid of a diagram the phases of the Moon.

(08marks)

b) Why does the duration of the Moon's Synodic Period is longer than Sidereal Period

(04 marks)

c) With the aid of a sketch describe 3 types of Lunar Eclipses.

(08 marks)

3) a) Explain how to find equation of time from Nautical Almanac with a suitable example.

(06 marks)

b) Find the equation of time at 1400hrs GMT, when the GHA of the Sun was $31^{\circ} 00'$.

(08 marks)

c) Describe the following;

i) Sidereal Year

ii) Tropical Year (06 marks)

4) a) Explain the Kepler's three laws of planetary motion (10 marks)

b) What are the approximate perihelion and aphelion distances and dates of the earth? (05 marks)

c) With the aid of a diagram explain the Apparent Motion of planet "Jupiter". (05 marks)

5) a) Describe the following:
i) Civil Twilight
ii) Nautical Twilight
iii) Astronomical Twilight (09 marks)

b) What condition must be satisfied for Twilight to last all night? (06 marks)

c) Explain the reason why Twilight last longer in higher latitudes. (05 marks)

6) a) Describe the following with suitable diagrams.
i) Elongation
ii) Conjunction
iii) Opposition
iv) Quadrature (14 marks)

b) Calculate the LHA of a star whose RA is 74° , for an observer in longitude 40°E , when GHA_γ is 205° . (06 marks)



**DIRECTORATE OF MERCHANT SHIPPING
GOVERNMENT OF SRI LANKA**

CERTIFICATE OF COMPETENCY EXAMINATION



GRADE : OFFICER IN CHARGE OF A NAVIGATIONAL WATCH ON SHIPS OF
500 GT OR MORE (UNLIMITED)

SUBJECT : MATHEMATICS

DATE : 01.06.2023

Time allowed THREE hours

Total marks : 120

Answer any SIX (6) questions

Pass marks : 50%

Formulae and all intermediate steps taken in reaching your answer should be clearly shown. You may draw sketches wherever required.

1.

- a. The sum of two numbers is 34 while their difference is 10. What are the two numbers? (4 marks)
- b. Divide $(x^5 - 4x^4 + 3x^3 - 12)$ by $(x - 3)$ (5 marks)
- c. Solve the logarithmic equation
 $\log_4(x-1) = \log_2(x-3)$ (5 marks)
- d. Solve the below triangle
 $a=22, b=18, C=65^\circ$ (6 marks)

2.

- a. Express with positive indices $\frac{1}{\sqrt{x-3}}$ (2 marks)
- b. Factorize
 $(x^2y^2 - 4)$ (3 marks)
- c. Prove the $kx^2 + 2x - (k-2) = 0$ has real roots for any value of "k" (5 marks)
- d. Prove
 $(\sin \theta + \cos \theta)^2 = 1 + \sin 2\theta$ (5 marks)
- e. Find the equation of the line passing through (1,-1) and perpendicular to the line $y=2x-3$ (5 marks)

3.

- a. Draw the graph $y = -x^2 + 5x - 6$ (5 marks)

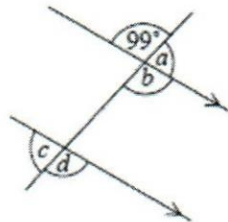
- b. The temperature of a cup of tea is recorded over time. The results are shown in the table below. Find the correlation (relation to each other) between the time and the temperature of the cup of tea. (8 marks)

Time (mins)	0	1	2	4	5	8	10
Temp (°C)	95	89	81	76	72	55	45

- c. Simplify
 $(16a^4 - 5a^4) - (a^4 + 12a^4) - (7a^4 - 11a^4 - 3a^4)$ (2 marks)
- d. A vessel's fuel consumption varies as the cube of the speed and when the speed is 15 knots the consumption is 30 tons, Find the consumption when the speed is increased by one knots (5 marks)

4.

- a. Find the size of the each of the angles marked with letters in the diagram below

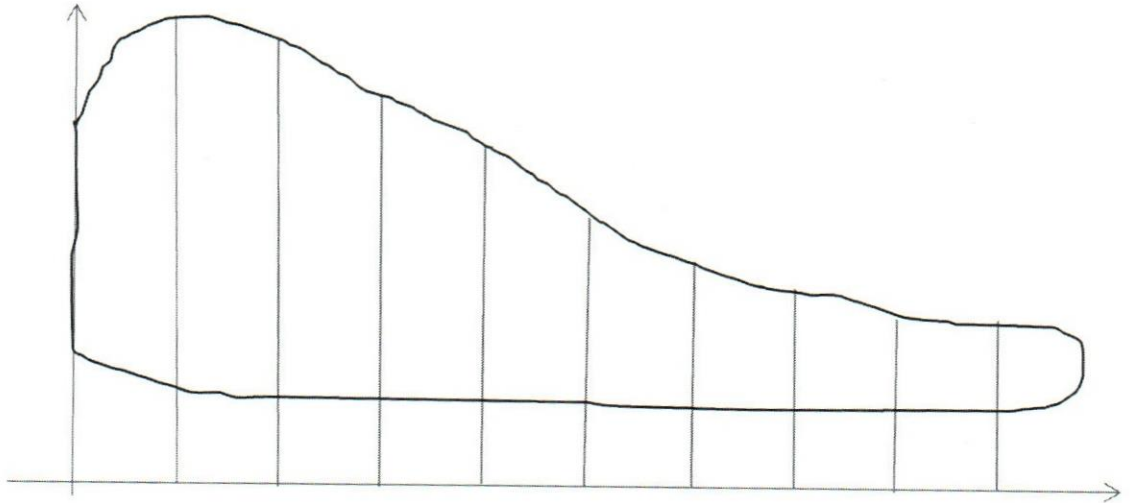


(4 marks)

- b. In spherical triangle WXY, $W = 88^{\circ}24.5'$, $x = 98^{\circ}10'$, $y = 100^{\circ}09'$. Find w and X . (8 marks)
- c. Construct the triangle ABC where $AB=6$ cm, $BC=4$ cm, $C=7$ cm and draw In-circle. Find the radius of it. (8 marks)

5.

- a. Find General solution
 $\cos \theta = \frac{1}{2}$ (4 marks)
- b. Draw the graph of trigonometric function $y = 3 \sin \frac{x}{2}$ (4 marks)
- c. Find the volume of a square pyramid whose base has edge 4 cm, and whose height is 11 cm? (4 marks)
- d. The following figure shows the indicator card of a steam engine. Using Simpson's rule find the area enclosed by the curve.



Number of ordinate	1	2	3	4	5	6	7	8	9	10	11
Length of ordinate	410	530	520	500	390	300	280	230	220	200	80

(8 marks)

6.

a. A ellipse is given by the equation

$$\frac{x^2}{9} + \frac{y^2}{25} = 1$$

find

- I. Major axis
- II. Minor axis
- III. vertices
- IV. Foci
- V. Eccentricity
- VI. Equation of directrix

(12 marks)

b. In spherical triangle LMN, $M = 44^{\circ}16.0'$, $L = 90^{\circ}$ and $m = 39^{\circ}37'$. Calculate l and ns. (8 marks)

7.

a. Define rational numbers

(2 marks)

b. The length of a room is three times its breadth and its area is 108cm^2 . Find its length and breadth (4 marks)

c. Find the formula for a volume of a donut. Consider inner radius of donut as r and outer radius of donut as R (6 marks)

d. Find the component forms of the vector and magnitude and unit vector

$$a = 2i + j$$

$$b = i + 5j$$

$$c = -2i + 3j$$

I. $a+b$

II. $a-2c$

(8 marks)