CERTIFICATES OF COMPETENCY IN THE MERCHANT NAVY
MARINE ENGINEER OFFICER

EXAMINATIONS ADMINISTERED BY THE
SCOTTISH QUALIFICATIONS AUTHORITY
ON BEHALF OF THE
MARITIME AND COASTGUARD AGENCY

STCW 78 as amended MANAGEMENT ENGINEER REG. III/2 (UNLIMITED)

040-34 - NAVAL ARCHITECTURE

FRIDAY, 19 OCTOBER 2018

0915 - 1215 hrs

Examination paper inserts:

Worksheet Q2
Worksheet Q5

Notes for the guidance of candidates:

1. Non-programmable calculators may be used.

2. All formulae used must be stated and the method of working and ALL intermediate steps must be made clear in the answer.

Materials to be supplied by examination centres:

Candidate's examination workbook
Graph paper

NAVAL ARCHITECTURE

Attempt SIX questions only

All questions carry equal marks

Marks for each part question are shown in brackets

1. A ship floats at a draught of 10 m in sea water of density 1025 kg/m^3.

In this condition the centre of gravity is 9.896 m above the keel and the second moment of area of the waterplane about the centreline is 94030 m^4.

Values of tonne per centimetre immersion (TPC) in sea water are given in Table Q1.

Draught (m)	0	1	2	4	6	8	10
TPC	8.6	10.9	12.6	15.1	16.6	17.6	18.1

Table Q1

A load is to be discharged from the ship's centreline by the ship's own heavy lift crane.

The crane head is 12 m above the original centre of gravity of the load and 16 m from the centreline of the ship when swung out.

During the discharge it is required that the metacentric height of the ship should not be less than 1.75 m.

Calculate EACH of the following:

(a) the maximum load the crane may lift; (14)

(b) the angle to which the ship will heel when discharging the maximum load. (2)

2. An inclining test carried out on a passenger vessel at a displacement of 10860 tonne in water of density 1012 kg/m^3 resulted in an angle of heel of 0.85° when an inclining mass of 10 tonne was moved 20 m transversely across the deck.

To obtain the lightship condition for the vessel, corrections for the following masses are required:

80 tonne to be removed at Kg 8.25 m.
60 tonne to be added at Kg 9.05 m.

The following masses in Table Q2 are to be added to give the load condition:

ITEM	MASS (tonne)	Kg (m)
Passengers & effects	120	10.00
Stores	320	8.45
Oil fuel	1780	3.65
Fresh water	540	2.125

Table Q2

In the above condition, free surfaces of liquid are present as follows:

- fresh water of density 1000 kg/m^3, in one rectangular tank, 10 m long and 10 m wide;
- oil fuel of density 925 kg/m^3, in four rectangular tanks, each 8 m long and 10 m wide.

Using the hydrostatic curves provided in Worksheet Q2, determine EACH of the following:

(a) the lightship KG; (8)

(b) the final mean draught in sea water; (2)

(c) the final effective metacentric height. (6)

3. A ship of length 240 m has draught marks 6.0 m aft of the forward perpendicular and 10.0 m forward of the after perpendicular.

The draughts at the marks are 8.8 m aft and 7.6 m forward.
For this condition, the following hydrostatic data are available:

LCF	=	2.4 m aft of midships
Displacement	=	65000 tonne
GM_L	=	120 m
LCB	=	1.4 m aft of midships

Calculate EACH of the following:

(a) the true mean draught; (4)

(b) the draughts at the perpendiculars; (4)

(c) the longitudinal position of the centre of gravity. (8)

4. A box shaped vessel is 80 m long, 12 m wide and floats at a draught of 4 m.

A full width midship compartment 15 m long is bilged. This results in the draught increasing to 4.75 m.

Calculate EACH of the following, using the lost buoyancy method:

(a) the permeability of the compartment; (4)

(b) the change in metacentric height due to bilging the compartment. (12)

5. A box barge of 70 m length has a hull mass of 560 tonne evenly distributed over its length.

Bulkheads located 5 m from the barge ends form peak tanks that remain empty.

The remainder of the barge length is divided by two transverse bulkheads into three holds of equal length.

A total of 1680 tonne is loaded, one quarter of which is placed in the middle hold, the remainder being equally distributed over the two outer holds.

Using Worksheet Q5, draw EACH of the following on a base of barge length:

(a) curves of weight and buoyancy per metre; (4)

(b) curve of loads; (3)

(c) curve of shearing forces; (4)

(d) curve of bending moments. (5)

6. (a) Explain, with the aid of an outline sketch, EACH of the following:

(i) unbalanced rudder; (2)

(ii) semi-balanced rudder; (2)

(iii) balanced rudder. (2)

(b) State the principal advantage of fitting a balanced rudder. (1)

(c) A ship travelling at full speed has its rudder put hard over to port, where it is held until the ship completes a full turning circle.

Describe how the ship will heel from the upright condition *during* the manoeuvre by illustrating the moments produced by the forces acting on the ship and rudder. (9)

7. The following data in Table Q7 were obtained during progressive speed trials on a ship of 12550 tonne displacement.

Ship speed (knots)	13	14	15	16	17
Shaft power (kW)	2733	3362	4097	4946	5922

Table Q7

Under normal service conditions, the ship operates within this range and has an Admiralty Coefficient of 446, based upon shaft power.

(a) (i) Determine the normal service speed of the ship. (6)

(ii) In a fouled hull condition, with the service shaft power being maintained, the ship's speed is found to have decreased by 8% from normal. Assuming that the specific fuel consumption remains constant at 195 g/kW hr, determine the increase in fuel consumed over a distance of 3000 nautical miles. (5)

(b) A geometrically similar ship is to be built having a displacement of 14500 tonne.

Determine the shaft power required for this ship at a speed of 16.5 knots. (5)

8. The wetted surface area of a container ship is 7135 m^2.

When travelling at service speed, the shaft power required is 22500 kW when residuary resistance is 25% of the total resistance and specific fuel consumption is 0.22 kg/kW hr.

Propulsive coefficient, based upon shaft power is 0.6.

Friction coefficient in sea water is 1.411 when speed is in m/s with speed index (n) 1.825.

(a) Calculate the service speed of the ship. (10)

(b) To conserve fuel the ship speed is reduced by 10%, the daily fuel consumption is then found to be 100 tonne.

The propulsive coefficient may be assumed constant at 0.6.

Calculate the percentage increase in specific fuel consumption when running at the reduced speed. (6)

9. A ballast tank watertight bulkhead 5.0 m deep is stiffened by vertical angle bar stiffeners 250 mm x 75 mm x 12 mm thick, spaced 610 mm apart.

The ends of the stiffeners in contact with the tank top are welded all around as shown in Fig Q9 and the thickness of the weld is 6 mm.

The bulkhead has sea water of density 1025 kg/m^3 on one side to a depth of 4.5 m.

Calculate the shear stress in the weld metal. (16)

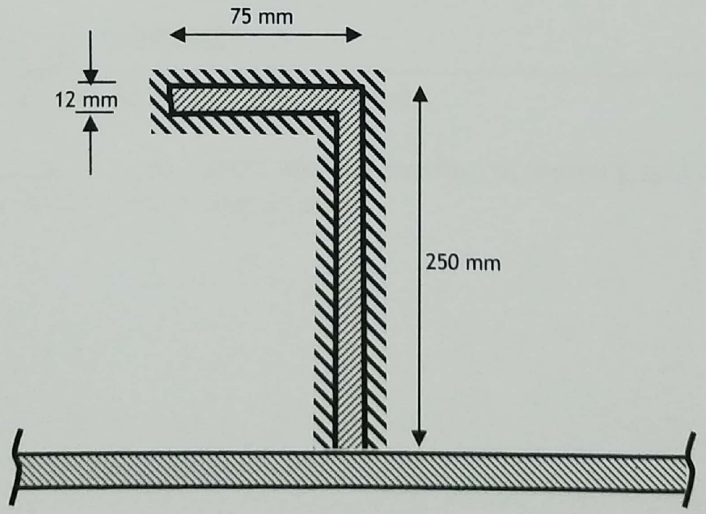

Fig Q9

HYDROSTATIC CURVES

(This Worksheet must be returned with your answer book)

Name .....

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Centre.....

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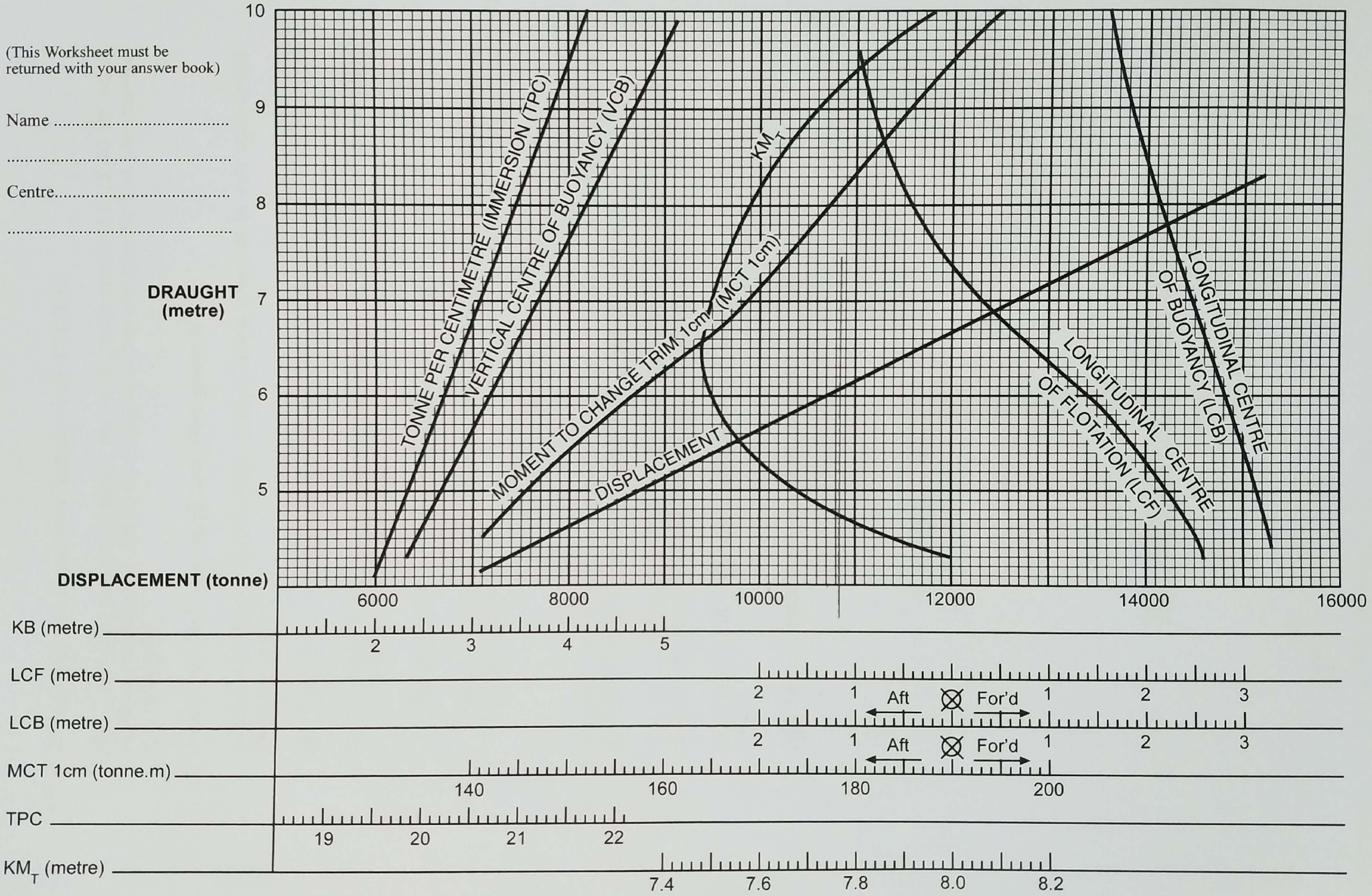

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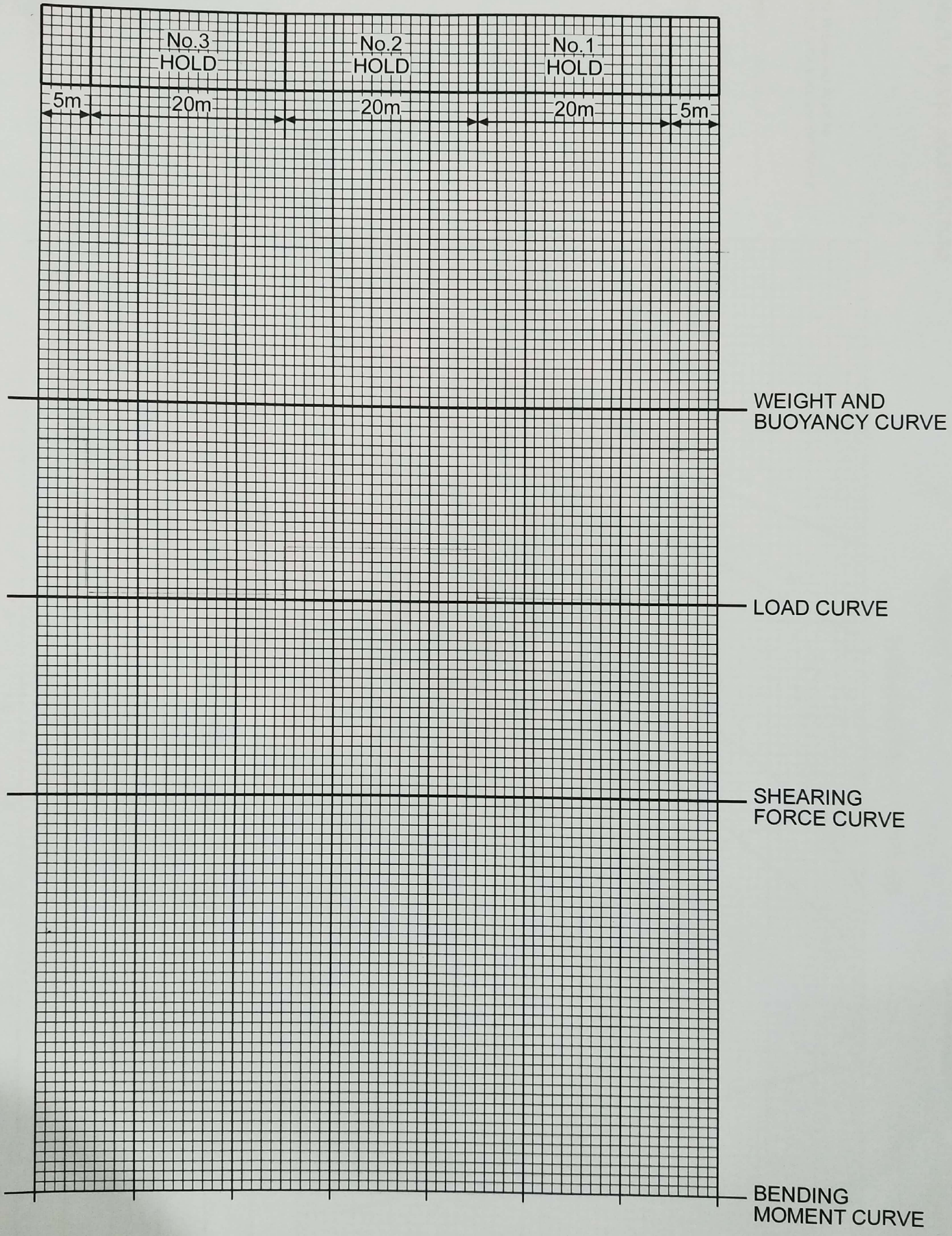

Candidate's Name .....

Examination Centre .....