National Exams
May 2019
17-Pet-A5, Petroleum Production Operations
(Duration 3 hrs)

NOTES:

1. If doubt exists as to the interpretation of any question, the candidate is urged to submit with the answer paper, a clear statement of any assumptions made.

2. This is an OPEN BOOK EXAM. Any non-communicating calculator is permitted.

3. FOUR (4) questions constitute a complete exam paper. The first four questions as they appear in the answer book will be marked.

4. Each question is of equal value.

1. (25 points)

A well was tested for 10 hours at a rate of about 120 STB/D while the wellbore flowing pressure was recorded as 600 psi. After shutting the well in for 24 hours, the bottomhole pressure reached a static value of 1200 psi. The rod pump used in this well is considered undersized, and a larger pump can be expected to reduce wellbore flowing pressure to a level near 350 psi (bubble point pressure is 300 psi). Calculate the following:

a-) (5 points) Productivity index J
b-) (5 points) Absolute open flow based on constant productivity index
c-) (5 points) Wellbore flowing pressure required to produce 150 STB/D
d-) (5 points) Oil production rate for a wellbore flowing pressure of 350 psi.
e-) (5 points) Draw the IPR curve and indicate the calculated quantities.

2. (25 points)

Following data are pertinent to current reservoir condition:

Bubble Point Pressure:	4600	psig
Average Reservoir Pressure :	4500	psig
Wellbore Radius:	0.5	ft
Drainage Radius:	3000	ft
Water Cut, fw :	0	
Skin Factor, S' =	8	

Stabilized Test Data:

P_{WF}, psig	Q_L, STBL/Day
4000	500

a-) (10 points) Determine the oil production rate under current reservoir condition when the flowing bottomhole pressure is 2000 psig.

b-) (15 points) After performing a hydraulic fracturing job, well started producing 25% water ($f_w = 0.25$). A production test was conducted after the frac job and the following data were obtained:

P_{WF}, psig	Q_L, STBL/Day
3662	2000

Determine the anticipated Oil Production Rate (STBO/D) after the Frac Job at the flowing bottomhole pressure of 2000 psi. Is this a successful frac job? Explain!

3. (25 points)

Suppose that the IPR curve for a well is given by the following relationship:

$$q_o = 1500\left[1 - 0.2\frac{P_{wf}}{\overline{P}_r} - 0.8\left(\frac{P_{wf}}{\overline{P}_r}\right)^2\right]$$

The well is equipped with a choke located at the wellhead and the wellhead pressure is 400 psig. The other relevant data are given as follows:
Average Reservoir Pressure = 4000 psig
Bubble Point Pressure = 4500 psi
Well Depth = 8000 ft
Tubing ID = 2.441 in.
GOR = 400 SCF/STB
fw = 0

a-) (15 points) Determine the oil production rate (STB/Day) that can be obtained from this well under given conditions.

b) (10 points) Determine the size of the Choke (in.) currently installed at the wellhead. Note: You may use ROS Method for sizing the choke.

4. (25 Points)

It is hoped to flow a well at an oil production rate of 400 STBO/Day. The reservoir has a productivity index of 0.5 STBL/day/psi and the current static (average) reservoir pressure is 2800 psi. The well is equipped with a 4000 ft of 2 7/8 in (ID=2.441 in) tubing and the required wellhead pressure is 160 psi. The producing gas liquid ratio is 100 SCF/STBL and %50 water production is expected.
Other relevant information:
Bubble point pressure: 3000 psi
Gas Gravity: 0.65
Oil API Gravity: 35
Water Specific Gravity: 1.07
Average Flowing Temperature: 150 °F

a-) (12.5 Points) Will the well flow at the desired rate (i.e. 400 STBO/dav)?

b-) (12.5 points) If you would like to increase the oil production rate up to 500 STBO/Day. How much gas (SCF/Day) you would need to inject into the tubing? Assume reservoir pressure, productivity index, water cut, wellhead pressure, and the gas/liquid ratio provided by the reservoir are all the same as in part a.

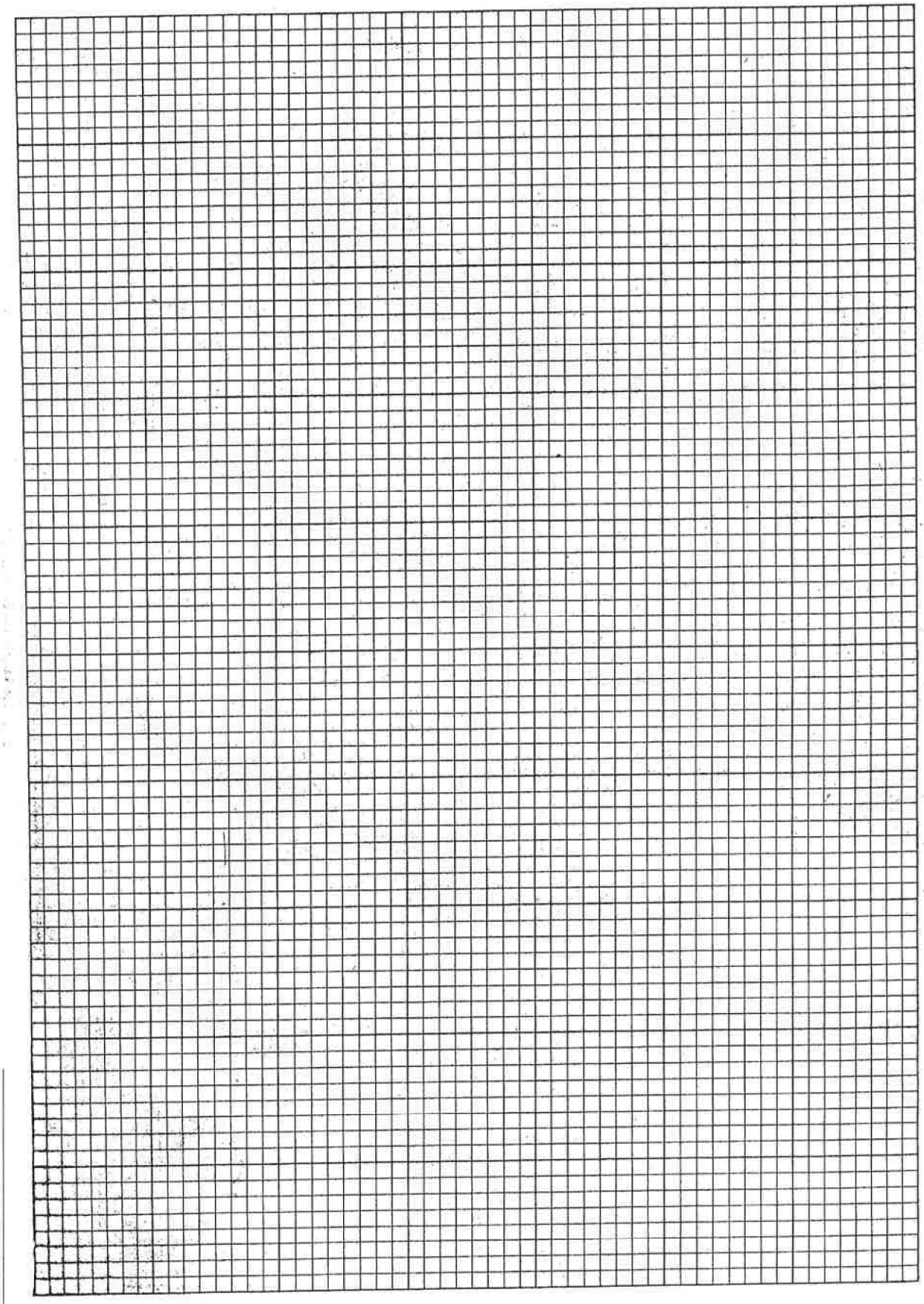
5) (25points)
The following well is going to be equipped with Electrical Submersible Pump (ESP) set at 6,000 ft from the surface. Assume that 50% of the free gas is separated at the pump. Assume that producing fluid flowing pressure gradient (psi/ft) in the 7in (ID) casing is given by:

$dP/dL = 0.0001 * q_L$

q_L = the total liquid flow(production) rate, STBL/day
dP: Pressure drop, psi
dL: Unit length of casing, ft

Other relevant data:
Depth of Well : 7, 000 ft
Productivity Index, J = 1 bbl/day/psi
Average Reservoir Pressure= 1800 psi
Average Flowing Temperature: 200 °F
Desired Oil Production Rate: 1000 STBO/day
Oil Gravity = 35°API
Bo = 1.1 Bbl/STB
Gas Gravity = 0.65
$f_w = 0$
Gas Liquid Ratio = 400 SCF/STBL
Tubing Wellhead Pressure: 160 psi
Tubing ID = 2.441 in.

Determine the required pump horsepower.



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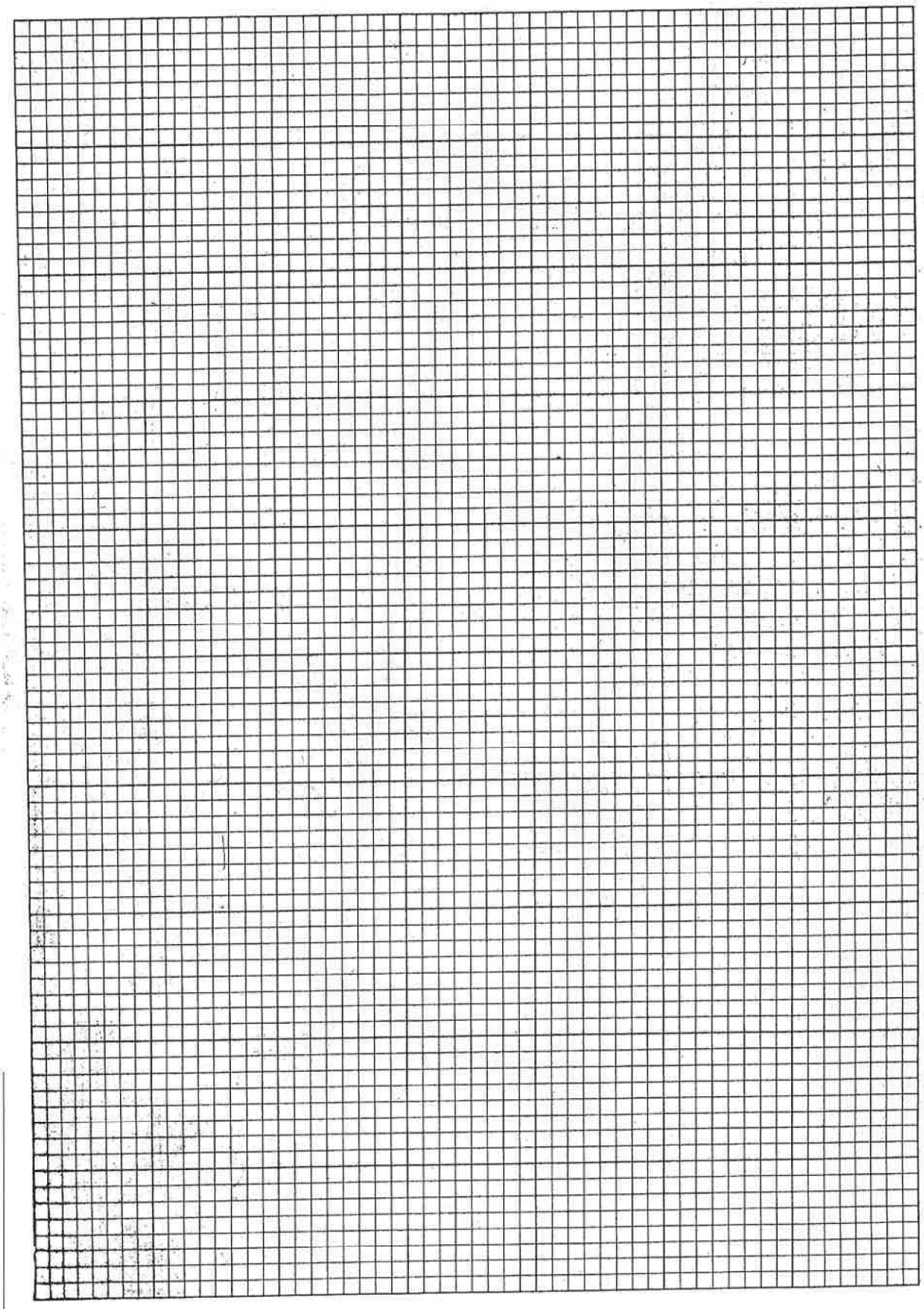

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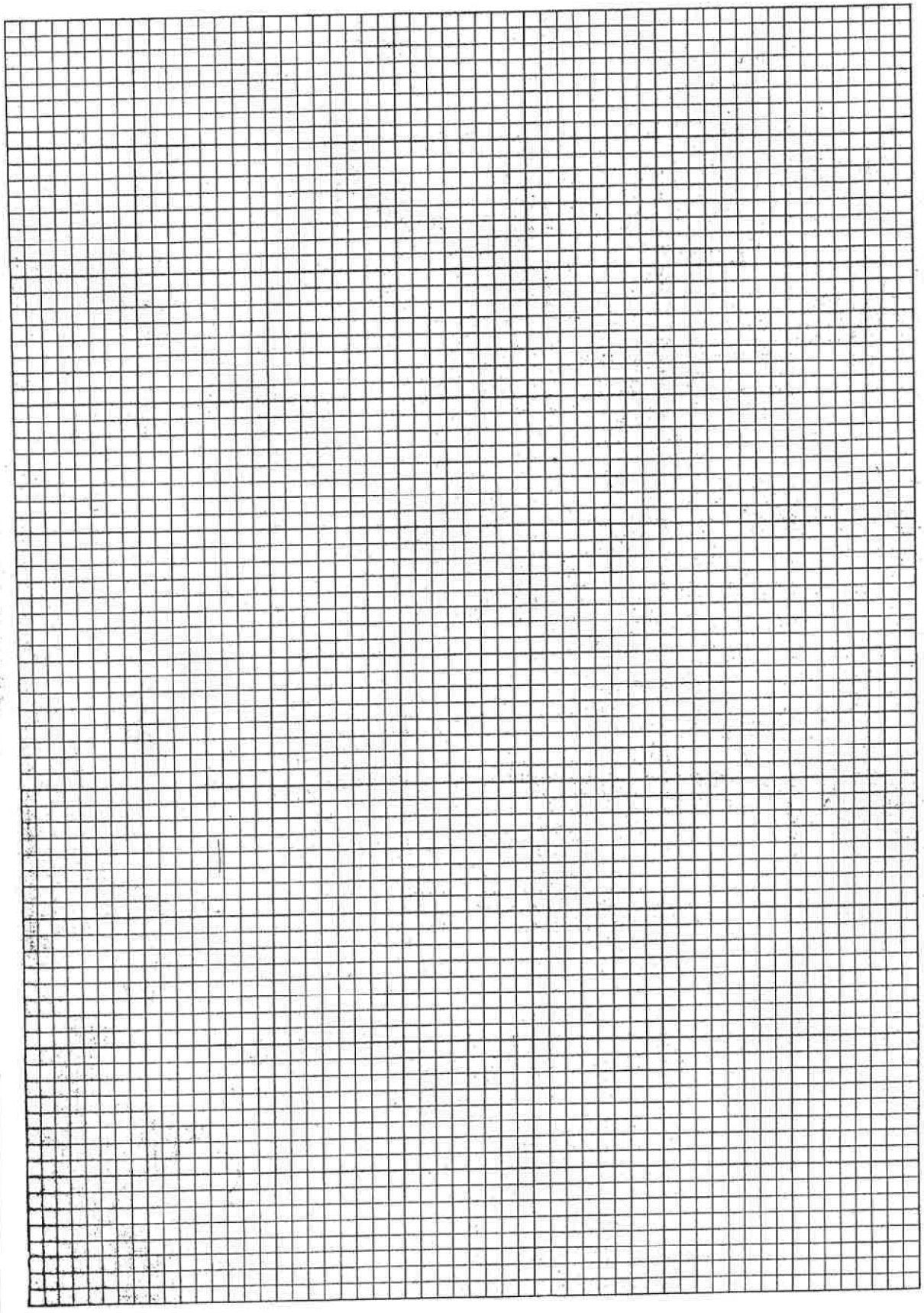

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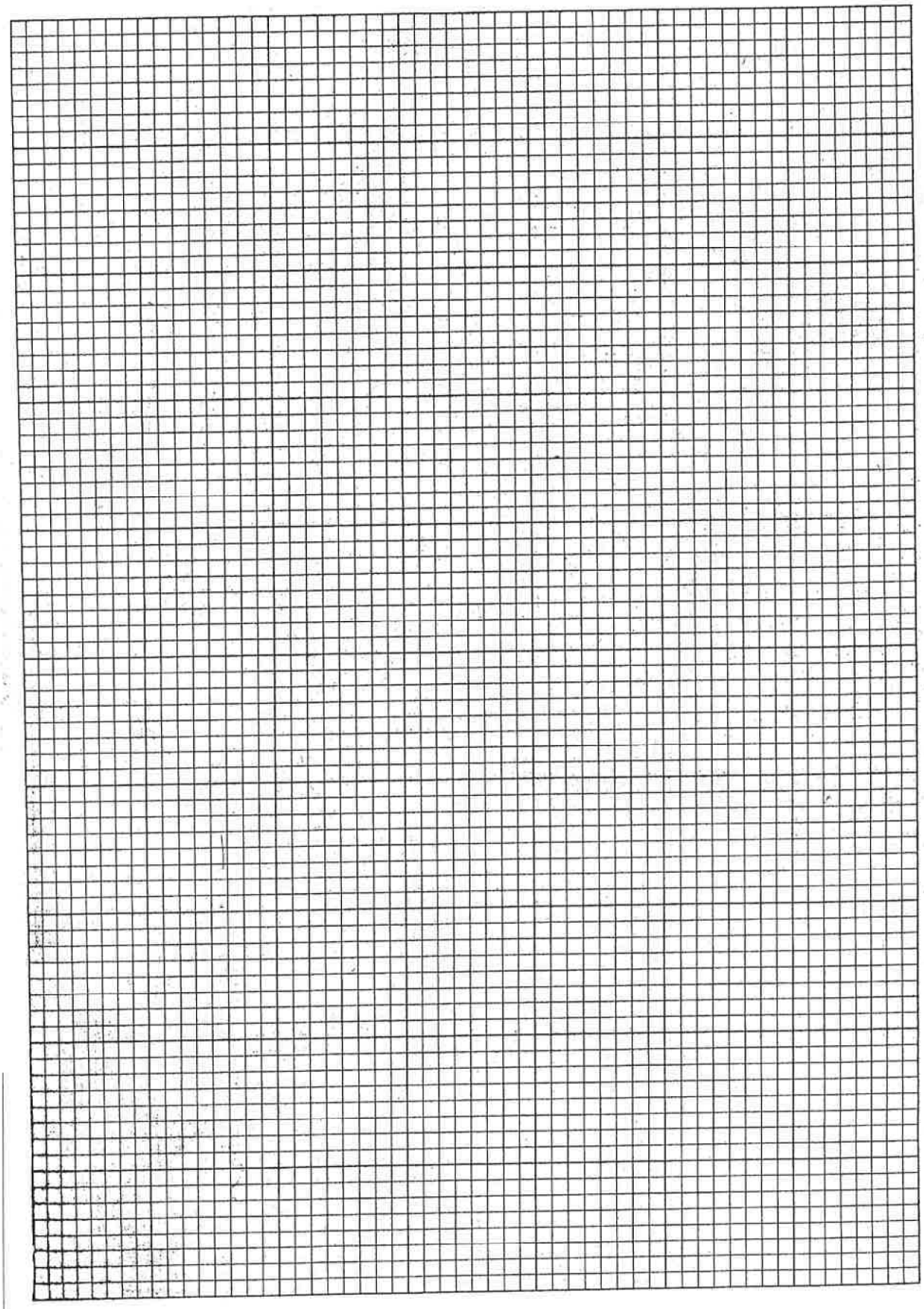

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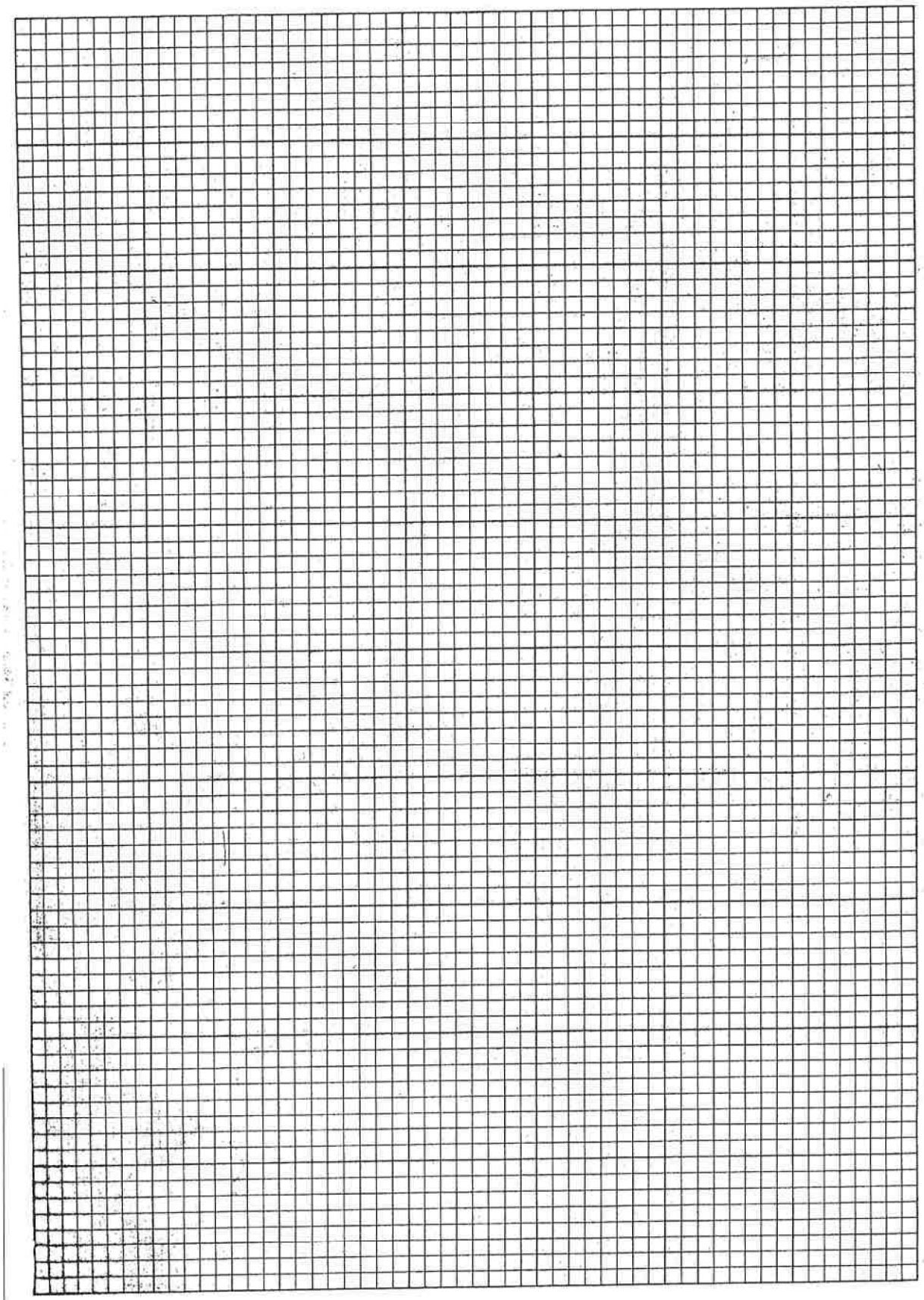

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