



UNIVERSITY OF ESWATINI
Faculty of Health Sciences
Department of Environmental Health Science

BACHELOR OF SCIENCE IN ENVIRONMENTAL
MANAGEMENT AND WATER RESOURCES

MAIN EXAMINATION PAPER DECEMBER 2019

TITLE OF PAPER : HYDROLOGY

COURSE CODE : EHS 319

DURATION : 2 HOURS

MARKS : 100

INSTRUCTIONS : READ THE QUESTIONS & INSTRUCTIONS CAREFULLY

: ANSWER ANY FOUR QUESTIONS

: EACH QUESTION CARRIES 25 MARKS.

: WRITE NEATLY & CLEARLY

: NO PAPER SHOULD BE BROUGHT INTO THE EXAMINATION ROOM.

: BEGIN EACH QUESTION ON A SEPARATE SHEET OF PAPER.

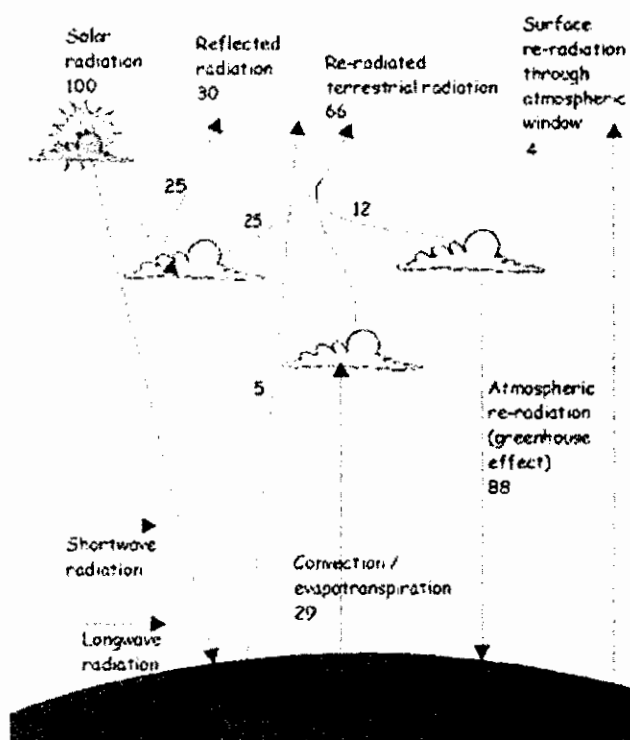
DO NOT OPEN THIS QUESTION PAPER UNTIL PERMISSION IS GRANTED BY THE INVIGILATOR.

QUESTION ONE (5 marks each)

1A. List the factors that affect evaporation from a water surface.

1B. Looking at the energy balance shown in the diagram below in terms of the long wave and short wave radiation, state whether each of the following statements are true or false. (1 mark each)

- i. The clouds reflect back less short wave length radiation than the earth.
- ii. The earth reradiates more long wave length radiation than the clouds in the atmosphere.
- iii. The greater proportion of the radiation that escapes to space is in the form of long wave radiation.
- iv. The direct long wave radiation from the earth is the highest.
- v. The net radiation is zero both during the day and at night.



1C. Describe the method used for the determination of transpiration.

1D. State the actual rate of infiltration for the following conditions:

- i. The intensity of rain fall was less than the infiltration capacity of the soil[2 and ½ marks]
- ii. The intensity of rain fall was greater than the infiltration capacity of the soil.[2 and ½ marks]

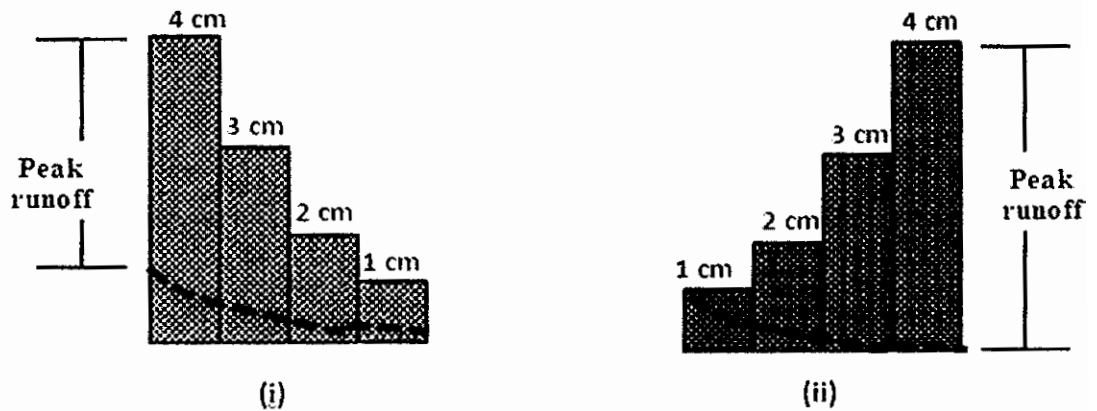
1E. Using the table determine the missing rainfall for the two rain gauge stations A and B

Station	A	B
Average annual rainfall (mm)	1300	1600
September rain fall (mm)	150	??
October rain fall	??	260

QUESTION TWO (Marks are indicated for each question)

2A. The figure below shows two storm (rainfall) hyetographs that occurred in the same basin at different times. The rainfall amount is the same in both cases except that in the case of A it started raining heavily early while in the case of (ii) the highest rainfall came later. Indicate :

- i. Whether the peak (maximum) runoff will be the same for the two storms. Support your answer with reason. [2 and 1/2 marks]
- ii. Whether the total runoff will be the same for the two storms. Support your answer with reason.[2 and 1/2 marks]

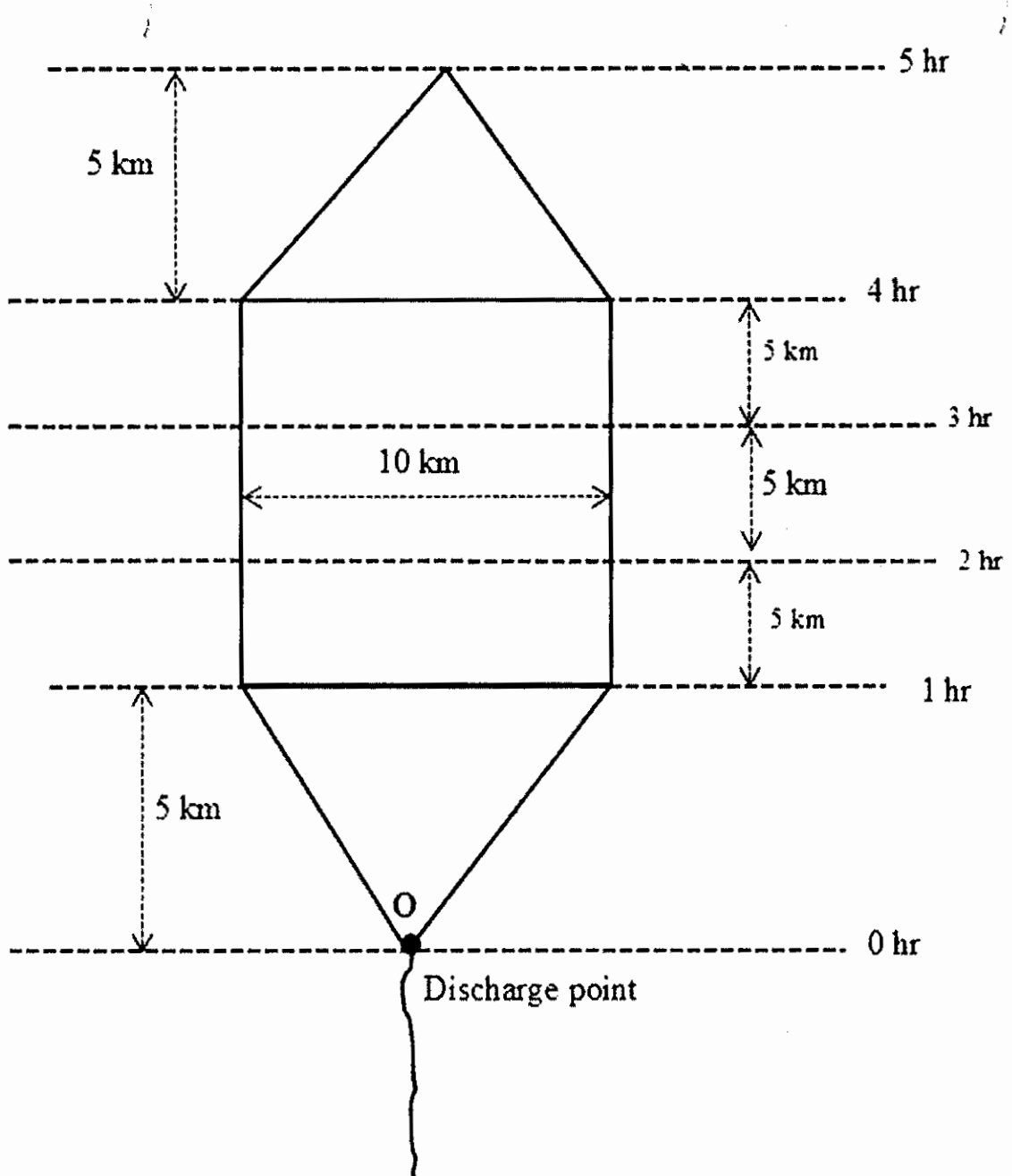


2B. A basin has an area of 44434 km², perimeter 1250 km and length of 300 km.

Determine:

- i. The form factor[2 and 1/2 mark]
- ii. Compactness coefficient[2 and 1/2 mark]

2C. A 3 hour duration rain of average intensity 1.5 cm/ hr falls over the area shown in the figure below. The isochrones are shown over the dotted line. The runoff coefficient can be taken as 0.5 throughout the duration of the rain and throughout the catchment area. Using the rational method, determine the maximum runoff at the downstream discharge point O.[15 marks]



QUESTION THREE (Marks are indicated for each question)

The table below shows the rainfall data recorded together was the stream runoff at a gauging station for a storm in a particular day. The basin area is 10 km^2 . Construct the base flow diagram from the runoff data itself.

3A. Derive the unit hydrograph of 1.5 hr. duration[15 marks]

3B. Determine the runoff coefficient[5 marks]

3C. Determine the percentage of infiltration.[5 marks]

Time (min)	Rainfall (cm)	Total Runoff m^3/sec
0	0.0	0
15	1.0	0.49
30	3.6	59.57
45	4.8	110.215
60	5.8	129.08
75	6.4	137.025
90	6.6	134.05
105		127.12
120		110.215
135		78.435
150		45.675
165		23.835
180		10.92
195		5.845
210		3.465
225		1.995
240		1.19
255		0.7
270		0.385
285		0.21
300		0

QUESTION FOUR (5 marks each)

4A. Although water vapour is lighter than the air it is mostly restricted to the lower layer of the atmosphere. Explain the reasons for this restriction of water vapour in the lower layer of the atmosphere.

4B. Describe the following processes of formation of rain drops and state the conditions under which they may occur.

- i. Aggregation[2 marks]
- ii. Accretion and formation of hail.[2 marks]
- iii. Coalescence.[1 mark]

4C. Figure Q4C shows the variation of saturation vapour pressure with temperature in the lower atmosphere. Meteorological measurement data of a certain day in a given region showed that the temperature was 30°C whereas the vapour pressure was 30 mb. Calculate the relative humidity and dew point of the air corresponding to this temperature and vapour pressure.

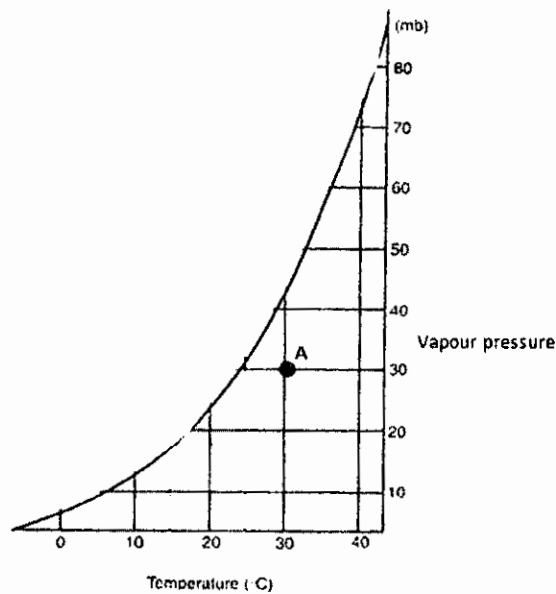
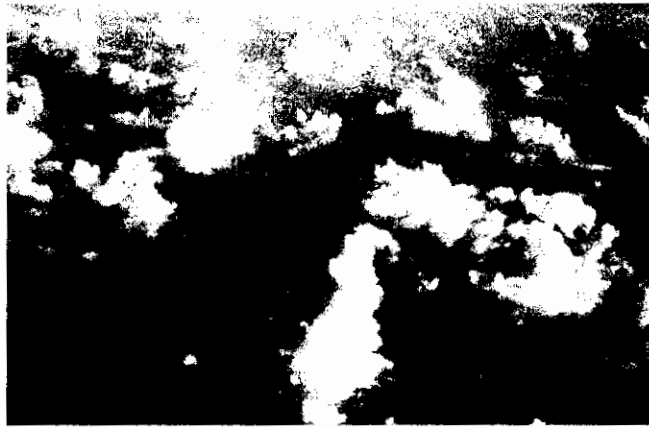


Fig Q4C: variation of saturation vapour pressure with temperature

4D. Write the equation for the computation of net radiation. Assuming that the albedo of the earth to be 0.4 and 35% of the incoming short wave solar radiation that impinges on earth is reradiated back in the form of long wave radiation, make an estimate of the net radiation as percent of the incoming radiation for i) night conditions , ii) day light clear sky conditions and ii) cloudy day

4E. Characterize the cumulus cloud shown below and state what each portion in the picture represents.



QUESTION FIVE (Marks are indicated for each question)

A fully penetrating well in an unconfined aquifer without recharge is pumped with a constant discharge of $0.07\text{m}^3/\text{sec}$ until steady state condition was reached. Drawdowns were then obtained from observation wells as indicated below:

Distance r (meters)	20	30	50	90	130	210
Drawdown, s (meters)	1.20	1.10	0.81	0.60	0.47	0.31

Assuming the depth of the aquifer to be 50 meters, determine

- 5A. The permeability of the aquifer.[9 marks]
5B. The storage coefficient ...[8 marks]
5C. The radius of influence of the well. ...[8 marks]