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Objective Questions of AMIE Exams (New Scheme)

Year 1993 (*Summer*) Exam

Q. Complete the sentences

(*i*) If the duty of water for a crop of base period 120 days is 1400 hec/cumec, then the delta (Δ) for the crop is

(*a*) 741 mm ; (*b*) 843 mm ;

(*c*) 949 mm ; (*d*) 1056 mm.

(*ii*) According to Khosla's theory the exit gradient is given by

(*A*) $\frac{d}{H}\frac{1}{\pi\lambda}$; (*B*) $\frac{H}{d}\frac{1}{\pi\sqrt{\lambda}}$;

(*C*) $\frac{H}{d}\pi\sqrt{\lambda}$ (*D*) $\frac{d}{H}\pi\lambda$.

(*iii*) If the dominant discharge of an alluvial river is 1800 cumecs, the waterway for a bridge on the river should be

(*A*) 101.5 m ; (*B*) 151.5 m ;

(*C*) 201.5 m ; (*D*) 251.5 m.

(*iv*) Slite excluder is provided

(*A*) in the canal on the downstream side of the head regulator

(*B*) in the river on the downstream side of the barrage ;

(*C*) in the river far away from the weir on the downstream side

(*D*) in the river adjacent to the head regulator.

(*v*) According to Dicken's formula, the peak flood discharge is proportional to

(*A*) area ; (*B*) $(\text{area})^{1/2}$;

(*C*) $(\text{area})^{2/3}$; (*D*) $(\text{area})^{3/4}$.

(*vi*) The head due to sudden expansion is expressed by

(*A*) $\frac{v_1^2 - v_2^2}{2g}$; (*B*) $\frac{(v_1 - v_2)^2}{g}$;

(*C*) $\frac{(v_1 - v_2)^2}{2g}$; (*D*) $\left(\frac{v_1 - v_2}{2g}\right)^2$.

(*vii*)* A rectangular channel of 4 m width carries water at the rate of 8 cumecs under critical conditions. Specific energy for the flow is...

(*viii*)* In a syphon aqueduct the most severe condition of uplift on the floor occurs when

(*A*) Canal runs full drain is dry but the water table is at stream bed ;

(*B*) Canal is dry and drain is at high flood level ;

(*C*) Canal runs dry and the drain also runs dry

(*D*) Both the canal and drain run full.

(*ix*)* If the conjugate depths for a horizontal rectangular channel 4 m wide are 0.2 m and 1 m the discharge in the channel is — m^3/s.

(*x*) If y_1 and y_2 are the depths of flow before and after the hydraulic jump in a rectangular channel then the loss of energy is given by

(*A*) $\frac{(y_2 - y_1)^3}{4y_1 y_2}$; (*B*) $\frac{(y_2 - y_1)^2}{4y_1 y_2}$;

(*C*) $\frac{(y_2 - y_1)^3}{y_1 y_2}$; (*D*) $\frac{(y_2 - y_1)^2}{y_1 y_2}$.

Answers to Questions of 1993 (*Summer*) Exam

(*i*)–(*a*) (*ii*)–*B* (*iii*)–C

(*iv*)–*D* (*v*)–*D* (*vi*)–*A*

(*vii*)–1.11 (*viii*)–*B* (*ix*)–4.34

(*x*)–*A*

Hints for Solving Starred Questions of 1993 (*Summer*) Exam.

Q. (*vii*) $B = 4$ m, $Q = 8$ cumecs at critical depth

q at critical depth $= \frac{8}{4} = 2\ m^3/s$

But $y_c = \sqrt[3]{\frac{q^2}{g}} = \sqrt[3]{\frac{2^2}{9.81}} = 0.74$ m

Also, $\frac{Q}{A} = v_c = \frac{8}{4 \times 0.74} = 2.7$ m/s

$$E_{fc} = y_c + \frac{v_c^2}{2g} = 0.74 + \frac{(2.7)^2}{2 \times 9.81} = \mathbf{1.11\ m} \quad \textbf{Ans.}$$

Q. (*ix*) $y_1 = 0.2$ m ; $y_2 = 1$ m

using eq. (10.6), we have,

$$y_2 = -\frac{y_1}{2} + \sqrt{\frac{y_1^2}{4} + \frac{2q^2}{g \cdot y_1}}$$

or $$1 = -\frac{0.2}{2} + \sqrt{\frac{0.2^2}{4} + \frac{2.q^2}{9.81 \times 0.2}}$$

or $$1 + 0.1 = \sqrt{0.01 + \frac{q^2}{0.981}}$$

$$1.1^2 = 1.21 = 0.01 + \frac{q^2}{0.981}$$

or $$q = \sqrt{1.20 \times 0.981} = 1.085$$

$$Q = q.B = 1.085 \times 4 = \mathbf{4.34\ m^3/s} \quad \textbf{Ans.}$$

Year 1993 (*Winter*) Exam

Q. (*A*) Fill in the blanks.:

(*i*) Where water must be raised by pumps or other means to irrigate crops is called ..... irrigation.

(*ii*) Soil in which the groundwater table rises so high as to affect the productivity of the soil due to air circulation to the plant root zone is called .....

(*iii*) An irrigation outlet whose discharge is independent of water levels in the distributary and the water course and which ensures constant supply within certain working limits is called a .....

(*iv*) The scour depth for a channel in fine silt is ..... than in coarse silt.

(*v*) Excess flood over a concrete dam is released through the .....

(*vi*) The loss of water from plant surfaces and utilised in its growth is known as .....

(*B*) Choose the correct statement for the following :

(*i*) The bed slope of a canal off taking from a barrage is kept

(*a*) steeper than the bed slope of the river

(*b*) milder than the bed slope of the river

(*c*) same as that of the river

(*d*) none of the above

(*ii*) For the same height and top width, the width at the bottom of the earth dam is

(*a*) less than that of a concrete dam

(*b*) same as that of a concrete dam

(*c*) more than that of a concrete dam

(*d*) none of the above

(*iii*) For a given discharge, the afflux for a pipe culvert will be

(*a*) the same as for a large opening

(*b*) independent of the size of the opening

(*c*) more than that for a large opening

(*d*) none of the above

(*iv*) Lining of a canal is required when

(*a*) the water table is above the full supply level of canal

(*b*) the water table is below the bed of the canal

(*c*) there is a natural impervious stratum below the bed

(*d*) none of the above

(*v*) In a deflecting spur, the angle between the axis of the spur and the bank on the upstream side is

(*a*) acute

(*b*) obtuse

(*c*) same as on the downstream side

(*d*) one of these

(*vi*) Khosla's theory of indpendent variables is applicable to structure founded on

(*a*) rock (*b*) clay

(*c*) sands (*d*) concrete

(*vii*) A cross regulator is provided on a main canal

(*a*) to minimise the amount of silt entering the branch canal

(*b*) to let maximum silt be carried into the branch canal

(*c*) for no specific purpose

(*d*) to carry the canal across the drain

(*C*) Match the sentences of Column A to that in Column -B :

	Column-A	*Column-B,*
(*i*)	(*a*) In storage irrigation	(*A*) a barrage or a weir is constructed to divert water directly into the canal
	(*b*) In direct irrigation	(*B*) water is supplied to individual trees as in orchards
	(*c*) In sprinkler irrigation	(*C*) a dam is constructed to store water during the monsoons and supply water to canals during non-monsoon season
	(*d*) In basin irrigation	(*D*) water is applied to the surface of the soil in the form of a spray.
(*ii*)	(*a*) In an aqueduct	(*A*) the drainage water is carried in a trough supported on piers while their irrigation canal passes below with its FSL below the slab of the trough above.
	(*b*) In a level crossing	(*B*) the drainage water is carried in a trough supported on piers while the irrigation canal passes below with its FSL above the slab of the trough above
	(*c*) In a super-passage	(*C*) the canal and the drain approach each other practically at the same level
	(*d*) In a syphon	(*D*) the irrigation canal is carried across the drain in a trough supported on piers with the canal bed level well above the HFL of the drain

(*iii*)	(*a*) Surface run-off is that form of	(*A*) precipitation in which the drops of water are under 0.5 mm in diameter and intensity is usually less than 1 mm per hour
	(*b*) Infiltration is that form of	(*B*) the hydrologic cycle in which water moves from the surface of the ground into the soil
	(*c*) Drizzle is that form of	(*C*) precipitation in which the water drops are greater than 0.5 mm diameter
	(*d*) Rain is that form of	(*D*) precipitation which travels over land surface or just below it
(*iv*)	(*a*) For an earthen dam	(*A*) the rock in the abutment must be stronger than in the foundation
	(*b*) For an arch dam	(*B*) the foundation may be rock or soil
	(*c*) For a solid gravity dam	(*C*) the foundation should consist of pervious material
	(*d*) For a barrage	(*D*) the foundation rock should be stronger than in the abutments
(*v*)	(*a*) Rabi season	(*A*) last from Ist April to 30th September
	(*b*) Kharif season	(*B*) is the total quantity of water needed for growth of crop to maturity
	(*c*) Delta	(*C*) is the relation between the volume of water and the area of the crop which it matures
	(*d*) Duty	(*D*) starts on Ist October and ends on 31st March
(*vi*)	(*a*) Undersluices	(*A*) regulates the supply of water in the canal
	(*b*) Canal head regulator	(*B*) enable the fish to migrate to their spawning grounds upstream of the barrage
	(*c*) Barrage bays	(*C*) preserve a clear and defined river channel approaching the canal regulator
	(*d*) Fish ladder	(*D*) are operated to release the excess water during floods
(*vii*)	(*a*) Cross drainage works include	(*A*) notches, escapes, sluices and syphon well drops
	(*b*) Works for regulation of water levels include	(*B*) bridges and culverts
	(*c*) Communication works include	(*C*) spurs, groynes, bunds, mattersses and aprons
	(*d*) River training works include	(*D*) aqueducts, syphons, syphon, aqueducts, superpassages and level crossings

Answers to Questions of 1993 (*Winter*) Exam.

A (*i*) – Lift **A** (*ii*) – saline **A** (*iii*) – rigid module or modular outlet

A (*iv*) – more **A** (*v*) – spillway **A** (*vi*) – transpiration loss

B (*i*)– (*d*) **B** (*ii*) – (*c*) **B** (*iii*) – (*c*)

B (*iv*) – (*d*) **B** (*v*) – (*a*) **B** (*vi*) –(*c*)

B (*vii*)– (*a*)

C (i) : (*a*)–(*C*), (*b*)–(*A*) (*c*)–(*D*), (*d*)–(*B*)

C (ii) : (*a*)–(*D*), (*b*)–(*C*) (*c*)–(*A*), (*d*)–(*B*)

C (iii) : (*a*)–(*D*) (*b*)–(*B*) (*c*)–(*A*) (*d*)–(*C*)

C (iv) : (*a*)–(*B*) (*b*)–(*A*) (*c*)–(*D*) (*d*)–(*C*)

C (v) : (*a*)–(*D*) (*b*)–(*A*) (*c*)–(*B*) (*d*)–(*C*)

C (vi) : (*a*)–(*C*) (*b*)–(*A*) (*c*)–(*D*) (*d*)–(*B*)

Year 1994 (*Summer*) Exam.

Q. Choose the correct answer for the following :

(*i*) Evaporation is measured by using

(*a*) an open pan (*b*) lysimeter

(*c*) infiltrometer (*d*) a neutron tube

(*ii*) The Standard Symon's Type Rain Gauge has a collecting a diameter

(*a*) 10 cm (*b*) 12.7 cm

(*c*) 5.08 cm (*d*) 25.4 cm

(*iii*) The average annual rainfall over whole of India is estimated as :

(*a*) 189 cm (*b*) 319 cm

(*c*) 89 cm (*d*) 117 cm

(*iv*) An Isohyet is a line joining points having

(*a*) equal evaporation value

(*b*) equal barometric pressure

(*c*) equal height above MSL

(*d*) equal rainfall depth in a given duration

(*v*) A coffer dam is

(*a*) kind of gravity dam

(*b*) an earthen dam of small height built to protect important areas

(*c*) a temporary structure constructed to exclude water from the work area during construction.

(*d*) an embankment built along a river to regulate the river

(*vi*) In an Inundation Irrigation System there will
- (*a*) be neither a diversion work nor a regulator
- (*b*) be only a diversion structure across the river
- (*c*) be both a regulator on the canal as well as a diversion structure across the river

(*vii*) In well drained soil, the useful soil moisture for plant growth essentially comes from
- (*a*) gravity water
- (*b*) capillary water
- (*c*) hygroscopic water
- (*d*) water of adhestion

(*viii*) A land is known as waterlogged when
- (*a*) the *p*H of soil reaches a value of 8.5
- (*b*) the soil in the root zone has high salinity
- (*c*) the soil pores in the root are saturated with water
- (*d*) there is water flowing on the surface of the land

(*ix*) Irrigation water having an SAR value of 20 is called as
- (*a*) very high sodium water
- (*b*) high sodium water
- (*c*) medium sodium water
- (*d*) low sodium water

(*x*) Alkali soils are reclaimed by
- (*a*) leaching only
- (*b*) addition of gypsum and leaching
- (*c*) addition of gypum only
- (*d*) provision of drainage

(*xi*) A groyne pointing upstream in a river is known as
- (*a*) attracting groyne
- (*b*) repelling groyne
- (*c*) fending groyne
- (*d*) Denehy's grone

(*xii*) The chemical suitable for use as a water evaporation retarding and reducing agent is
- (*a*) butyl alcohol
- (*b*) methyl alcohol
- (*c*) cetyl alcohol
- (*d*) ethyl alcohol

(*xiii*) The chemical dilution method of stream gauging is ideally suited for measuring discharges in
- (*a*) a large alluvial river
- (*b*) steady flow in a small turbulent stream
- (*c*) a stretch of a river having heavy pollution
- (*d*) a tidal estuary

(*xiv*) Consumptive use is
- (*a*) the water used up in plant metabolism
- (*b*) the sum of evapotranspiration and amount used up in plant metabolism
- (*c*) the sum of evapotranspiration and infiltration losses
- (*d*) the combined use of surface and ground water resources

(*xv*) Conjunctive use of water in a basin means
- (*a*) combined use of water for irrigation and for hydro-power generation
- (*b*) combined use of surface and groundwater resources
- (*c*) use of irrigation water for both Rabi and Kharif crops
- (*d*) use of irrigation water by a cooperative of farmers

(*xvi*)* Permanent wilting point is
- (*a*) a characteristic of the plant
- (*b*) a soil characteristic
- (*c*) a soil characteristic modified by the crop
- (*d*) dependent on soil water plant fertiliser interaction

(*xvii*) A hytograph is a plot of
- (*a*) cumulative rainfall versus time
- (*b*) rainfall depth versus duration
- (*c*) evaporation rate versus time
- (*d*) rainfall intensity versus time

(*xviii*) The doubles mass analysis is adopted to
- (*a*) estimate the missing rainfall data
- (*b*) obtain intensities of rainfall at various duration
- (*c*) check the consistency of data
- (*d*) obtain the amount of storage needed to maintain a demand pattern

(*xix*) There is minimum wastage of water in
- (*a*) furrow irrigation
- (*b*) check basin irrigation
- (*c*) sprinkler irrigation
- (*d*) border method of irrigation

(*xx*) The coefficient of roughness for an earthen canal in excellent condition is
- (*a*) 0.01
- (*b*) 0.0225
- (*c*) 0.025
- (*d*) 0.7.

Answers to Questions of 1994 (*Summer*) Exam

(*i*)–(*a*)	(*ii*)–(*b*)	(*iii*)–(*d*)
(*iv*)–(*c*)	(*v*)–(*c*)	(*vi*)–(*c*)
(*vii*)–(*b*)	(*viii*)–(*c*)	(*ix*)–(*b*)
(*x*)–(*b*)	(*xi*)–(*b*)	(*xii*)–(*c*)
(*xii*)–(*b*)	(*xiv*)–(*b*)	(*xv*)–(*b*)
(*xvi*)–(*b*)	(*xvii*)–(*d*)	(*xviii*)–(*c*)
(*xix*)–(*c*)	(*xx*)–(*b*)	

Hints for Solving Starred Questions of Year 1994 (*Summer*) Exam

Q. (*xvi*) *Permanent wilting percentage or permanent wilting point or wilting coefficient is a soil characteristic, since all plants whose root systems thoroughly permeats the soil wilt at nearly the same soil moisture content ; when grown in a particular soil in a humid atmosphere.*

Year 1994 (*Winter*) Exam.

Q. (*A*) Fill in the blanks :

(*i*) A 6-hours storm had 6 cm of rainfall and the resulting runoff was 3 cm. If the ϕ-index remains at the same value, the runoff due to 12 cm of rainfall in 9 hours in the catchment is .... cm.

(*ii*) The duty for a crop with a base period of 140 days is 3456 hectare per cumec. The delta for the crop will be ..... m.

(*iii*) A one-day rainfall of 10.0 cm at a place was found to have return period of 100 years. The probability that a one day rainfall of this or larger magnitude will occur in the next year is .....

(*B*) Choose the correct answer for the following :

(*i*) Retrogression of downstream levels, generally considered in the design of weirs or barrages, is

(*a*) higher at high flood stage than at low water levels
(*b*) same at high flood stage and at low water levels
(*c*) higher at low water levels stage than at high flood stage
(*d*) independent of the stage of flow.

(*ii*) The average pan coefficient for the standard US Weather Bureau class A pan is

(*a*) 0.55 (*b*) 0.70
(*c*) 0.85 (*d*) 0.95.

(*iii*) To determine discharge of a stream from rating curve, at a section, one needs

(*a*) current meter readings at various verticals at the section
(*b*) slope of the water surface at the section
(*c*) stage at the section
(*d*) surface velocity at various sections.

(*iv*) The useful moisture of a soil is equal to its

(*a*) field capacity
(*b*) saturation capacity
(*c*) moisture content at permanent wilting point
(*d*) difference between field capacity and permanent wilting point within the root zone of plants.

(*v*) Distribution outlet is said to be proportional, if its flexibility is

(*a*) equal to unity (*b*) less than unity
(*c*) slightly greater than unity (*d*) equal to two.

(*vi*) If average particle size of silt in millimetres is m, then Lacey's silt factor (f) is proportional to

(*a*) m^2 (*b*) $m\ m^{1/2}$
(*c*) $m^{\frac{1}{2}}$ (*d*) $m^{1/3}$.

(*vii*) The basic assumptions of unit hydrograph theory are
- (*a*) linear response and non-linear time variance
- (*b*) linear response and time invariance
- (*c*) non-linear response and time invariance
- (*d*) linear response and linear time variance.

(*viii*) The monthly rainfall at a place is generally indicated as above or below *normal*. The term *normal* means
- (*a*) the rainfall in the same month of the previous year
- (*b*) the rainfall expected based on previous month's data
- (*c*) the average rainfall of the previous twelve months
- (*d*) the average monthly rainfall for the same month computed from 30 years of past record.

(*ix*) The optimum depth of kor-watering for rice crop, is
- (*a*) 22 cm (*b*) 19 cm
- (*c*) 16 cm (*d*) 13 cm.

(*x*) The main function of division headworks provided at the off-take of a canal from a river, is
- (*a*) to raise the water level in the river
- (*b*) to control the floods
- (*c*) to store water
- (*d*) to control entry of silt into the canal.

(*xi*)* The downstream expansion head of a guide bank is extended to subtend an angle at the centre between
- (*a*) 30° and 45° (*b*) 45° and 60°
- (*c*) 60°and 75° (*d*) 75° and 90°.

(*xii*)* Direct runoff is made up of
- (*a*) surface runoff, prompt interflow and channel precipitation
- (*b*) surface runoff, infiltration and evapotranspiration
- (*c*) overland flow and quick return flow
- (*d*) infiltration, rainfall and evaporation.

(*xiii*)* The velocity of drainage water in the barrels of syphon aqueduct is normally limited to
- (*a*) 1 to 2 m per second (*b*) 2 to 3 m per second
- (*c*) 3 to 4 m per second (*d*) 4 to 5 m per second.

(*xiv*) Cross-regulators in main canals are provided to
- (*a*) regulate water supply in the off-taking channel
- (*b*) regulate water supply in the main channel
- (*c*) regulate excessive flood water
- (*d*) head up water for adequate supply into the off-taking channel.

Answers to Question of 1994 (*Winter*) Exam.

A (*i*) – 7.5	*A* (*ii*) – 0.35	*A* (*iii*) – 0.01
B (*i*) – (*c*)	*B* (*ii*) – (*b*)	*B* (*iii*) – (*c*)
B (*iv*) – (*d*)	*B* (*v*) – (*a*)	*B* (*vi*) – (*c*)
B (*vii*) – (*b*)	*B* (*viii*)– (*d*)	*B* (*ix*) – (*b*)
B (*x*) – (*c*)	*B* (*xi*)– (*b*)	*B* (*xii*)– (*c*)
B (*xiii*) – (*b*)	*B* (*xiv*)– (*d*)	

Hints for Solving Starred Questions of 1994 (*Winter*) Exam

(*xi*) Please refer Fig. 8.19 on page 583

(*xii*) D.R.O = S.R.O = True S.R.O. + Sub surface storm flow or quick return flow

(*xiii*) Please refer articles 14.5.2 and 14.5.3 on page 850

Year 1995 (*Winter*) Exam

Q. (*A*) Choose the correct answer for the following :

(*i*) Conjuctive use of water in a basin means ;

(*a*) Combined use of water for irrigation and for hydropower generation ;

(*b*) Combined use of surface and ground water resources ;

(*c*) Use of irrigation water for both rabi and kharif season ;

(*d*) Use of irrigation water by cooperative of farmers.

(*ii*) Consumptive use is

(*a*) the water used up in plant metabolism

(*b*) the sum of evapotranspiration and the amount used up in plant metabolism;

(*c*) the sum of evapotranspiration and infiltration losses ;

(*d*) the combined use of surface and ground water resources.

(*iii*) A plot between rainfall intensity versus time is called

(*a*) mass curve ; (*b*) hyetograph ;

(*c*) isohyet ; (*d*) hydrograph.

(*iv*) The volume of water that can be extracted by force of gravity from a unit volume of aquifer material is known as

(*a*) specific yield ; (*b*) safe yield ;

(*c*) specific retention (*d*) specific storage.

(*v*) For plant's growth useful soil moisture is

(*a*) capillary water ; (*b*) gravity water ;

(*c*) hygroscopic water ; (*d*) chemical water.

(*vi*) The normal average annual rainfall over the whose of India is estimated as

(*a*) 88 cm ; (*b*) 217 cm ;

(*c*) 119 cm ; (*d*) 290 cm.

(*vii*)* The minimum free board recommended for lined canals carrying a discharge greater than 10 m^3/s is

(*a*) 0.15 m ; (*b*) 0.60 m ;

(*c*) 1.25 m ; (*d*) 0.75 m.

(*viii*) A land is known as water logged when

(*a*) the pH of the soil reaches a value of 8.5 ;

(*b*) the soil in the root zone has high salinity

(*c*) the soil pores in the root zone are saturated with water ;

(*d*) there is water flowing on the surface of the land.

(*ix*) A characteristic feature of a barrage is

(*a*) the provision of a raised crest ;

(*b*) the creation of a storage resevoir on the upstream side ;

(*c*) the provision of a series of gates across the river for flow regulation ;

(*d*) that it is built in delta areas only.

(*x*) The use of rational formula for estimating floods is limited to catchments of sizes less than

(*a*) 5000 km^2 ; (*b*) 500 km^2 ;

(*c*) 50 km^2 ; (*d*) 5 km^2.

(*xi*) The average pan coefficient for the standard U.S. Weather Bureau class *A* pan is

(*a*) 0.60 ; (*b*) 0.65 ;

(*c*) 0.70 ; (*d*) 0.75.

(*xii*) The standard Symon's type Rain Gauge has a collecting area of diameter

(*a*) 5.08 cm ; (*b*) 10 cm ;

(*c*) 12.7 cm ; (*d*) 25.4 cm.

(*xiii*) A medium head Hydroelectric Scheme is one where

(*a*) Gross head is between 15 m to 60 m ;

(*b*) Net head operating on turbine is between 15 m to 60 m ;

(*c*) Total loss of head in the penstocks is between 15 m to 60 m.

(*d*) The difference in the level of tail water and centre line of turbine is between 15 m to 60 m.

(*xiv*) Dicken's formula is the form of

(*a*) $Q = CM^{1/3}$; (*b*) $Q = CM^{2/3}$;

(*c*) $Q = CM^{1/4}$; (*d*) $Q = CM^{3/4}$.

where *M* is the catchment Area

(*B*) Fill in the blanks :

(*i*)* A 2 hour unit hydrograph of a catchment is triangular in shape with a time base of 60 hour and peak ordinate of 30 m^3/s. The area of the catchment is ..... km^2

(*ii*) The delta for a crop with a base period of 150 days is 50 cm. The duty for the crop will be ..... hectares per cumec.

(*iii*)* A mean annual runoff of 1 m^3/s from a catchment of area 10 km^2 represents an effective rainfall ..... cm.

Answers to Questions o 1995 (*Winter*) Exam

A (*i*) – (*b*)	*A* (*ii*)– (*b*)	*A* (*iii*)– (*b*)
A (*iv*) – (*a*)	*A* (*v*)– (*a*)	*A* (*vi*)– (*c*)
A (*vii*) – (*d*)	*A* (*viii*)– (*c*)	*A* (*ix*)– (*c*)
A (*x*) – (*c*)	*A* (*xi*)– (*c*)	*A* (*xii*)– (*c*)
A (*xiii*)– (*b*)	*A* (*xiv*)– (*d*)	*B* (*i*) – 648
B (*ii*)– 2592	*B* (*iii*)– 315.36	

Hints for Solving Starred Questions of 1995 (*Winter*) Exam

Q. A (*vii*) Please refer Table 4.11

Q. B (*i*) $\dfrac{\dfrac{30\,m^3}{s} \times (60 \times 60 \times 60s) \times 100}{\text{Catchment area } A \text{ in m}^2} = 1 \text{ cm}$

$\therefore A = 648 \times 10^6 \text{ m}^2 = 648 \text{ km}^2$

Q. B (*iii*) Vol. of water in 1 yr $= \dfrac{1\,m^3}{s} \times (365 \times 24 \times 60 \times 60$ secs in a yr

$= 315.36 \times 10^5 \text{ m}^3$

$$\text{Eff. rainfall depth} = \frac{\text{Volume of water}}{\text{Area}} = \frac{315.36 \times 10^5\,m^3}{10 \times 10^6 \text{ m}^2}$$

$$= \frac{315.36}{10^2} \text{m} = 315.36 \text{ cm.} \quad \textbf{Ans.}$$

Year 1996 (*Summer*) Exam

Q. (*A*) Fill in the blanks :

(*i*)* A canal is 80 km long and has an average surface width of 15 m. If the average evaporation measured in a standard U.S. Weather Bureau Class, a pan is 0.5 cm/day, the volume of water evaporation in the month of September is ..... cubic metres.

(*ii*)* If the wind velocity at a height of 2 m above ground is 5.0 km per hour, its value at a height of 10 m above ground can be expected to be about ..... km per hour.

(*iii*)* In a triangular channel the top width and depth of flow were 2.0 m and 0.9 m respectively. Velocity measurements on the centre line at 18 cm and 72 cm below the free water surface indicated velocities of 0.6 m/s and 0.4 m/s respectively. The discharge in the channel is ..... cumec.

(*iv*)* During a flood in a wide rectangular channel it is found that at a section the depth of flow increases by 50 per cent and at this depth the water surface slope is half its original value in a given interval of time. This marks an approximate change in the discharges of ..... per cent.

(*v*)* A triangular direct runoff hydrograph due to a storm has a time base of 80 hours and a peak flow of 50 m^3/s occurring at 20 hours from the start. If the catchment area is 144 km^2, the rainfall excess in the strom was ..... cm.

(*B*) Choose the correct answer for the following :

(*i*) Cold front precipitation is :

(*a*) very intense and of short duration
(*b*) very intense and of considerable duration
(*c*) light and of short duration
(*d*) Showery and of considerable duration.

(*ii*) A hyetograph is a plot against time of :

(*a*) cumulative rainfall (*b*) Rainfall intensity
(*c*) discharge (*d*) stage.

(*iii*) The mass curve of rainfall of a storm is plot of :

(*a*) rainfall depths for various equal durations plotted in decreasing order
(*b*) rainfall depths for various equal durations plotted in increasing order
(*c*) rainfall intensity *vs.* time in chronological order
(*d*) accumulated precipitation *vs.* time in chronological order.

(*iv*) The slope-area method is extensively used in :

(*a*) development of rating curve
(*b*) estimation of flood discharge based on high-water marks
(*c*) cases where shifting control exist
(*d*) cases where backwater effect is present.

(*v*) The term base flow denotes delayed flow reaching a stream from :

(*a*) groundwater only
(*b*) ground water and snow melt
(*c*) groundwater and inter flow
(*d*) groundwater, snow melt and inteflow.

(*vi*) A module is said to be 'proportional' when 'flexibility' equals :

(*a*) 0.8 (*b*) 0.9
(*c*) 1.0 (*d*) 1.1.

(*vii*)* For consolidation grouting, depth of *B*-holes drilled through the foundation rock generally varies between :

(*a*) 5 and 10 m (*b*) 10 and 15 m
(*c*) 15 and 20 m (*c*) 20 and 25 m.

(*viii*)* According to Gales the ratio of upstream length of guide bank to the length of structure between the aboutments for flood discharges more than 20000 cumecs shall be :

(*a*) 1.3 (*b*) 1.4
(*c*) 1.5 (*d*) 1.6.

(*ix*) For row crops, e.g., potatoes, sugarbeets, etc. the most commonly adopted method of surface irrigation is :

(*a*) check flooding (*b*) free flooding
(*c*) basin flooding (*d*) furrow and corrugation irrigation.

(*x*) According to Khosla, to keep the structure safe against piping, exit gradient to be provided lies between :

(*a*) 0.10 and 0.15 (*b*) 0.15 and 0.20

(*c*) 0.20 and 0.26 (*d*) 0.25 and 0.30.

Answers to Questions of 1996 (*Summer*) Exam

A (*i*)– 126000	*A* (*ii*)– 6.29	*A* (*iii*)– 0.45
A (*iv*)– 39	*A* (*v*)– 5	
B (*i*)– (*a*)	*B* (*ii*)– (*b*)	*B* (*iii*)– (*d*)
B (*iv*)– (*b*)	*B* (*v*)– (*a*)	*B* (*vi*)– (*c*)
B (*vii*)– (*b*)	*B* (*viii*)– (*c*)	*B* (*ix*)– (*d*)
B (*x*)– (*c*)		

Hints for Solving Starred Questions of 1996 (*Summer*) Exam

Q. A (*i*) Actual Evaporation from canal during September month

$$= (\text{Area of Canal}) \times \text{Evaporation rate} \times \text{No of days} \times \text{Pan coeff.}$$

$$= (80\text{ km} \times 15\text{ m})\left(\frac{0.5\text{ m}}{100\text{ day}} \times 0.7\right) \times 30\text{ days}$$

$$= \left[80000 \times 15 \times \frac{0.35}{100} \times 30\text{ m}^3\right] = \mathbf{126000\ m^3}\ \textbf{Ans.}$$

Q. A (*ii*) Using Eqn. (7.43 a), we have

$$\frac{V_{z1}}{V_{z2}} = \left(\frac{z_1}{z_2}\right)^{0.143}$$

where $V_{z1} = V_{2m} = 5.0$ km/hr

$z_1 = 2$ m

$z_2 = 10$ m

$$\therefore \frac{V_{2m}}{V_{10m}} = \left(\frac{2}{10}\right)^{0.143} = \frac{5.0\text{ km/h}}{V_{10}} m$$

or $$V_{10m} = \frac{5\text{ km/h}}{0.794} = \mathbf{6.29\ km/h}\quad \textbf{Ans.}$$

Q. A (*iii*) Vel. at 0.2y depth =- vel at 0.18 m depth = 0.6 m/s

Vel. at 0.8y depth = vel. at 0.72m depth = 0.4 m/s

$$\text{Av. mean velocity} = \frac{0.6 + 0.4}{2} = 0.5\text{ m/s}$$

$$\text{Area of channel}(A) = \frac{1}{2} \times (2.0\text{ m} \times 0.9\text{ m}) = 0.9\text{ m}^2$$

Discharge $Q = V.A = 0.5 \text{ m/s} \times 0.9 \text{ m}^2$

$= 0.45 \text{ m}^3/\text{s} = \mathbf{0.45 \text{ cumecs}}$ **Ans.**

Q. A (*iv*) For wide rectangular channel.

$$Q = \frac{1}{n} \cdot A.R^{2/3} \sqrt{S_f}$$

$$= \frac{1}{n} \cdot (B \cdot y) \cdot (y)^{2/3} \cdot \sqrt{S_f}$$

or $$Q = \frac{1}{n} \cdot y^{5/3} \cdot \sqrt{S_f}$$

$$\therefore \quad \frac{Q_2}{Q_1} = \frac{y_2^{5/3} \cdot \sqrt{S_{f_2}}}{y_1^{5/3} \cdot \sqrt{S_{f_1}}}$$

But $y_2 = 1.5\, y_1$

$$S_{f_2} = \frac{1}{2} S_{f_1} = 0.5\, S_{f_1}$$

$$\therefore \quad \frac{Q_2}{Q_1} = \frac{(1.5)^{5/3} \cdot y_1^{5/3} \cdot \sqrt{0.5} \cdot \sqrt{S_{f_1}}}{y_1^{5/3} \cdot \sqrt{S_{f_1}}} = (1.5)^{5/3} \cdot \sqrt{0.5} = 1.39$$

%age change in discharge $= \frac{Q_2 - Q_1}{Q_1} \times 100$

$$= \left(\frac{Q_2}{Q_1} - 1\right) 100 = (1.39 - 1)\ 100 = \mathbf{39\%}$$ **Ans.**

Q. A (*v*) Vol. of water contained in the U.H =

$$= \frac{1}{2} \times 50 \text{ m}^3/\text{s} \times 80 \text{ h}$$

$$= \frac{2000\, m^3 \cdot h}{s} = 2000\, m^3 \times 3600 \frac{s}{s}$$

$$= 7.2 \times 10^6\, m^3.$$

$$\text{Depth of water} = \frac{\text{Volume of water}}{\text{C.A}} = \frac{7.2 \times 10^6\, m^3}{144 \times 10^6\, m^3}$$

$= 0.05 \text{ m} = 5 \text{ cm}$ **Ans.**

Q. B (*vii*) Please refer article 19.15 (2).

Q. B. (*viii*) Please refer article 8.5.3 (2) (*iii*).

Year 1996 (*Winter*) Exam

Q. (*A*) Choose the correct answer in the following

(*i*) The interval of supply of irrigation water depends on the type of

(*a*) crop only (*b*) soil and crop

(*c*) crop and climate (*d*) soil, crop and climate.

(*ii*) Increase in the duration of the unit hydrograph causes an increase in the
(*a*) peak discharge (*d*) rainfall intensity
(*c*) equilibrium discharge (*d*) time base.

(*iii*) Fish ladder is provided on the side of
(*a*) divide wall (*b*) diaphragm wall
(*c*) core wall (*d*) wing wall.

(*iv*) The volume of water stored between normal reservoir level and the maximum reservoir level is known as
(*a*) live storage (*b*) surcharge storage
(*c*) valley storage (*d*) bank storage.

(*v*) Consumptive use is the sum of
(*a*) evapotranspiration and infiltration losses
(*b*) evapotranspiration plus application losses
(*c*) evapotranspiration plus the amount of water used up in plant metabolism
(*d*) evapotranspiration plus the amount of water used up in plant metabolism plus percolation losses.

(*vi*) Other factors remaining same, the open water evaporation rate increases as
(*a*) sunshine hours increase
(*b*) altitude decreases
(*c*) barometric pressure increases
(*d*) salt content of water decreases.

(*vii*) For a barrage, the exit gradient is independent of
(*a*) the applied head of water
(*b*) the horizontal length of floor
(*c*) the depth of upstream cut-off
(*d*) the depth of downstream cut-off.

(*viii*) A syphon aqueduct is provided when
(*a*) the canal bed level is well above the HFL of the drain
(*b*) the canal bed level lies between the bed level and HFL of the drain
(*c*) the drain bed level is well above the FSL of the canal
(*d*) the drain bed level lies between the bed level and FSL of the canal.

(*ix*) An inundation irrigation system requires the construction of
(*a*) only a diversion structure
(*b*) only a canal regulator
(*c*) neither a diversion structure nor a canal regulator
(*d*) both a diversion structure and a canal regulator.

(*x*) In order to reduce uplift on a gravity dam, the type of grouting done is
(*a*) curtain grouting near the heel
(*b*) consolidation grouting near the heel
(*c*) curtain grouting near the toe
(*d*) consolidation grouting near the toe.

(*xi*) In order to keep the saturation line in a canal embankment well within the toe, it is necessary to provide

(*a*) spoil bank (*b*) counterberm

(*c*) free board (*d*) berm.

(*xii*) The term piping used in connection with diversion structures on permeable soil is associated with

(*a*) drainage of seepage water

(*b*) measurement of uplift pressure

(*c*) failure initiated by boiling

(*d*) consolidation of foundation.

(*xiii*) The upstream face of an earth dam is

(*a*) an equipotential line (*b*) a streamline

(*c*) a phreatic line (*d*) a streak line

(*xiv*) Silt ejector is provided on

(*a*) the river, just upstream of the undersluices

(*b*) the canal, just downstream of the canal head regulator

(*c*) the river, some distance downstream of the undersluices

(*d*) the canal, some distance downstream of the canal head regulator

(*B*) Fill in the blanks :

(*i*)* The area of a drainage basin is twice that on an adjoining one. Excepting area, other characteristics of the two basins are identical. Q1 and Q2 are the peak discharges, computed by Dicken's formula, for the smaller and larger basin respectively. Then $Q_2 = Q_1 \times$ .....

(*ii*)* In a field measuring 30 hectares, 40 cm of water was stored in the root zone when 6 cumecs of water was supplied for 8 hours. The field application efficiency is .....

(*iii*)* he dominant discharge of a river in alluvial plain is 3600 cumecs. The waterway on this river, according to Lacey's formula, should be ..... m.

Answers to Questions of 1996 (*Winter*) Exam.

A (*i*) – (*d*)	*A* (*ii*) – (*d*)	*A* (*iii*) – (*a*)
A (*iv*) – (*b*)	*A* (*v*) – (*c*)	*A* (*vi*) – (*d*)
A (*vii*)– (*c*)	*A* (*viii*)– (*b*)	*A* (*ix*) – (*d*)
A (*x*) – (*a*)	*A* (*xi*) – (*b*)	*A* (*xii*)– (*c*)
A (*xiii*)– (*a*)	*A* (*xiv*)– (*d*)	
B (*i*) – 1.6818	*B* (*ii*) – 69.44%	*B* (*iii*)– 285

Hints for Solving Questions of 1996 (*Winter*) Exam.

Q. **A** (*ix*) Please refer article 19.15 (2) (*b*) at page 1167

Q. B (*i*) $Q_1 = C \cdot A_1^{3/4}$

where Q_1 is the discharge of smaller basin

$$Q_2 = C \cdot A_2^{3/4} = C \cdot (2A_1)^{3/4}$$

$$\frac{Q_2}{Q_1} = (2)^{3/4} = 1.6818$$

or $Q_2 = Q_1 \times 1.6818$ **Ans.**

Q. B. (*ii*) Vol. of water actually stored in root zone

$$= (30 \times 10^4 \text{ m}^2)\ (0.4\ m) = 12 \times 10^4 \text{ m}^3$$

Vol. of water actually supplied

$$= 6 \text{ m}^3/s\ (8 \times 60 \times 60s)$$

$$= 48 \times 3600 = 172800 \text{ m}^3 = 17.28 \times 10^4 \text{ m}^3$$

$$\text{Field application efficiency} = \frac{\text{Vol. of water actually stored}}{\text{Vol. of water supplied}}$$

$$= \frac{12 \times 10^4}{17.28 \times 10^4} = 0.6944 = \mathbf{69.44\%} \quad \textbf{Ans.}$$

Q. B. (*iii*) From Eqn. (15.1),

$$L = 4.75\sqrt{Q} = 4.75 \times \sqrt{3600} = 4.75 \times 60 = \mathbf{285\ m.} \quad \textbf{Ans.}$$

Year 1997 (*Summer*) Exam

(*i*) An arch dam is constructed with

(*a*) Earth (*b*) Concrete
(*c*) Boulders (*d*) None of the above

(*ii*) A core wall is provided in

(*a*) An earth dam (*b*) A canal regulator
(*c*) An aqueduct (*d*) A gravity dam

(*iii*) A hydrograph is a relation between time in hours and

(*a*) Rainfall in mm (*b*) Percolation in cm
(*c*) Surface runoff in cumec (*d*) Evaporation in cm

(*iv*) The self weight of a gravity dam

(*a*) Favours stability (*b*) Causes overturning
(*c*) Causes sliding (*d*) Causes uplift

(*v*) A level crossing is a cross-drainage work where

(*a*) Canal flows under a specified level above the drain
(*b*) Canal flows under pressure
(*c*) Canal has a free flow
(*d*) None of the above

(*vi*) Evaporation is maximum

(*a*) When the temperature is very low
(*b*) When it is raining
(*c*) When the temperature is high
(*d*) During night

(*vii*) Other conditions remaining the same, runoff is maximum from precipitation occurring over

(*a*) Sandy strata

(*b*) Rocky area

(*c*) Alluvial tracts after a dry spell

(*d*) Boulders

(*viii*) Waterlogging is eliminated by

(*a*) Deep ploughing (*b*) Shallow ploughing

(*c*) Irrigation (*d*) Providing tile drains

(*ix*) Lacey's theory is applicable to flow

(*a*) Through pipes

(*b*) Over spillways

(*c*) In alluvial rivers and canals

(*d*) In concrete lined channels

(*x*) Lift irrigation is flow

(*a*) By gravity (*b*) From lower level to higher level

(*c*) By percolation (*d*) Through sprinkler heads

(*xi*) Critical velocity ratio is used in connection with the design of

(*a*) Alluvial canals (*b*) Earth dams

(*c*) Concrete lined canals (*d*) Barrages

(*xii*) Base flow separation is used in connection with

(*a*) Seepage flow (*b*) Infiltration

(*c*) Evaporation (*d*) Stream flow

(*xiii*) The time base of a hydrograph increases with

(*a*) Increase in intensity of the storm

(*b*) Decrease in duration of the storm

(*c*) Increase in time of concentration

(*d*) Decrease in infiltration capacity of the storm

(*xiv*) Thiessen polygon is used in connection with

(*a*) Average rainfall determination

(*b*) Catchment area computation

(*c*) Drawing hydrographs

(*d*) Estimating infiltration

(***B***) Fill in the blanks in the following statements :

(*i*) The depth of scour for a discharge intensity of 5 cumec/m and a silt factor of 1 is ____ m.

(*ii*) Friction loss through a pipe 100 m long, 1.5 m diameter, carrying a discharge of 6 cumec and rugosity coefficient of 0.014 is ____ m.

Answers to Questions of 1997 (*Summer*) Exam

A (*i*)–(*b*)	*A* (*ii*)–(*a*)	*A* (*iii*)–(*c*)	*A* (*iv*)–(*a*)
A (*v*)–(*d*)	*A* (*vi*)–(*c*)	*A* (*vii*)–(*b*)	*A* (*viii*)–(*d*)
A (*ix*)–(*c*)	*A* (*x*)–(*b*)	*A* (*xi*)–(*a*)	*A* (*xii*)–(*d*)
A (*xiii*)–(*c*)	*A* (*xiv*)–(*a*)	*B* (*i*)–3.95	*B* (*ii*)–1.52

Hints for Solving Starred Questions 1997 (*Summer*) Exam

Q. B (*i*) $R = \text{Scour depth} = 1.35\left(\frac{q^2}{f}\right)^{1/3} = 1.35\left(\frac{5^2}{1}\right)^{1/3} = \mathbf{3.95\ m}$ **Ans.**

Q. B (*ii*) From Manning's formula, we have

$$Q = \frac{1}{n} \cdot A \cdot R^{2/3} \cdot \sqrt{S}$$

or $$Q = \frac{1}{n} \cdot A \cdot R^{2/3} \cdot \sqrt{\frac{H_L}{L}}$$

or $$\frac{n^2 Q^2 L}{A^2 \cdot R^{4/3}} = H_L$$

or $$H_L = \frac{n^2 \cdot Q^2 \cdot L}{\left(\frac{\pi}{4} d^2\right) \cdot \left(\frac{d}{4}\right)^{4/3}} = \frac{(0.014)^2 \cdot (6)^2 \times 100}{\left(\frac{\pi}{4} \times 1.5^2\right)^2 \left(\frac{1.5}{4}\right)^{4/3}} = \mathbf{1.52\ m}$$ **Ans.**

Year 1997 (*Winter*) Exam

Q. A. *Fill in the blanks*

(*i*) Field capacity is defined as _____.

(*ii*) The delta for the crop with duty 864 hectares/cumec on the field and base period of 120 days is _____ cm.

(*iii*) Infiltration capacity is more than infiltration rate when _____.

(*iv*) A hyetograph is the plot of _____.

(*v*) In Kennedy's equation for non-silting non-scouring velocity, the critical velocity ratio was introduced to take into consideration the effect of _____.

(*vi*) Syphon aqueduct is the cross-drainage work provided to carry canal over natural drain when _____.

(*vii*) The ϕ_{index} is defined as the _____.

Q. B. *Choose the correct statement for the following :*

(*i*) Ravi crops are sown and harvested in the month of :

(*a*) April and September (*b*) October to March

(*c*) February and June (*d*) January and May

(*ii*) Mixed cropping is defined as :

(*a*) two or more crops grown during any year
(*b*) two or more crops grown during the same crop season in different fields
(*c*) two or more crop seasons of the year
(*d*) growing of two ore more crops together in the same field during the same crop season

(*iii*) For the upstream slope of an earth dam, the most critical condition is :

(*a*) sudden drawdown condition
(*b*) steady seepage condition
(*c*) neither sudden drawdown nor steady seepage condition
(*d*) during construction when the reservoir is allowed to be filled

(*iv*) Seepage endangers the stability of an earth dam built on pervious foundation because of piping which depends on :

(*a*) height of the dam (*b*) quantity of seepage flow
(*c*) value of exist gradient (*d*) total storage capacity of reservoir

(*v*)* If a river in alluvial plain has a dominant discharge of 1600 cumecs, the waterway for a bridge on the river should be approximately

(*a*) 250 m (*b*) 240 m
(*c*) 190 m (*d*) 180 m

(*vi*) For no tension at any point on a gravity dam, the criterion to be satisfied is :

(*a*) the resultant of all the forces must always pass through the mid point of the base of the dam
(*b*) the resultant force for all conditions of loading must pass through the middle third of the base
(*c*) the resultant of all forces must pass through the upstream extremity of the middle third of the base
(*d*) the resultant of all forces must always pass through the downstream extremity of the middle third of the base

(*vii*) Due to valley storage, the peak discharge of an outflow hydrograph is :

(*a*) increased (*b*) reduced
(*c*) not affected (*d*) sometimes increased and sometimes reduced

(*viii*) According to Dicken's formula for estimating floods, the peak discharge is proportional to :

(*a*) A (*b*) $A^{1/2}$
(*c*) $A^{2/3}$ (*d*) $A^{5/3}$

where A is the catchment area in km^2

Q. C. *Match the sentences of column A to that of column B*

(*i*)	*Column A*	*Column B*
	(*a*) Ryve's formula	(A) to determine average depth of rainfall
	(*b*) Theissen's polygon	(B) for estimation of peak flood
	(*c*) Lacey's theory	(C) design of alluvial channels

(*ii*)

Column A	*Column B*
(*a*) Isohyet	(A) line joining points on catchment having equal time of travel
(*b*) Isochrone	(B) lines having equal depth of evaporation
(*c*) Isopleths	(C) line joining points of equal rainfall magnitude

(*iii*)

Column A	*Column B*
(*a*) Lysimeter	(A) measurement of stage
(*b*) Current meter	(B) measurement of evapotranspiration
(*c*) Bubble gauge	(C) measurement of velocity of streamflow

(*iv*)

Column A	*Column B*
(*a*) Hydraulic jump	(A) Spillway
(*b*) Seepage	(B) Hydroelectric power project
(*c*) Penstock	(C) Earth dam

Answers to Questions of 1997 (*Winter*) Exam.

A (*i*) the quantity of water retrained by a given soil against the pull of gravity, when expressed as depth of water spread over the basin

A (*ii*) 120

A (*iii*) the rainfall rate is less than the infiltration capacity

A (*iv*) rainfall rate Vs. time

A (*v*) silt grade

A (*vi*) HFL of drain is a little bit higher than the canal bed level

A (*vii*) rate of rainfall above which the rainfall volume becomes equal to runoff volume (Note. See Eqn. 7.102)

B (*i*) –(*b*) **B** (*ii*) –(*d*) **B** (*iii*) – (a) **B** (*iv*) – (*c*)

B (*v*) – (*a*) **B** (*vi*) – (b) **B** (*vii*) –(*b*) **B** (*viii*)– (*d*)

C (*i*) – (*a*)-(*B*), (*b*)-(*A*), (*c*)-(*C*) **C** (*ii*) – (*a*)-(*C*), (*b*)-(*A*), (c)-(*B*)

C (*iii*) – (*a*)-(*B*), (*b*)-(*C*), (*c*)-(*A*) **C** (*iv*) – (a)-(*A*), (*b*)-(*C*), (*c*)-(*B*)

Hints for Solving Starred Questions of 1997 (*Winter*) Exam

Q. B (*v*) Dominant discharge = 1600 cumecs

$$\text{Max. or Peak discharge} = \frac{16}{9} \times 1600 \text{ cumecs}$$

Waterway for a bridge = Lacey's Regime Perimeter $= 4.75\sqrt{Q}$

where Q is the peak design discharge

$$\therefore \text{Waterway} = 4.75\sqrt{\frac{16}{9} \times 1600} = 4.75 \times \frac{4}{3} \times 40$$

$$= 253.3 \text{ m} \cong \mathbf{250\ m} \quad \textbf{Ans.}$$

Year 1998 (*Summer*) Exam

Q. (A) *Choose the correct answer from the various alternatives for the following :* (1 × 14)

(*i*) For a crop, the consumptive use of water is equal to the depth of water :
- (*a*) transpired
- (*b*) evaporated
- (*c*) transpired and evaporated
- (*d*) used in transpiration, evaporation and evaporated from adjacent soil

(*ii*) Effective precipitation is defined as :
- (*a*) Precipitation minus the loss due to evaporation
- (*b*) Precipitation minus the loss due to infiltration
- (*c*) Precipitation occurred during the crop period
- (*d*) available water stored within the root zone

(*iii*) Irrigation canals are generally aligned along :
- (*a*) ridge line (*b*) contour line
- (*c*) valley line (*d*) straight line

(*iv*) The difference in elevation between top of dam and full reservoir level is called:
- (*a*) berm (*b*) free board
- (*c*) height of bank (*d*) wave height

(*v*) The land is said to be waterlogged, if the soil pores within :
- (*a*) a depth of 40 cm is saturated
- (*b*) a depth of 60 cm is saturated
- (*c*) root zone of crops is saturated
- (*d*) soil up to ground watertable is saturated

(*vi*) An outlet maintaining a constant discharge, irrespective of fluctuation in water levels of supplying canal and water course, is known as
- (*a*) non-modular outlet (*b*) semimodular outlet
- (*c*) flexible modular outlet (*d*) rigid modular outlet

(*vii*) A drop in canal bed is generally provided, if :
- (*a*) ground slope exceeds designed bed slope
- (*b*) design bed slope exceeds ground slope
- (*c*) ground slope is same as designed bed slope
- (*d*) none of the above.

(*vii*) Bligh's Creep theory of seepage assumes :
- (*a*) equal weightage to horizontal and vertical creep
- (*b*) more weightage to horizontal creep than vertical creep
- (*c*) less weightage to horizontal creep than vertical creep
- (*d*) loss of head follows a sine curve.

(*ix*) The structure constructed to allow drainage water to flow under pressure through an inverted syphon below a canal is called :

(*a*) syphon (*b*) superpassage
(*c*) syphon aqueduct (*d*) super aqueduct

(*x*) The meandering of river is due to :

(*a*) sediment load of streams
(*b*) discharge and hydraulic properties of stream
(*c*) erodibility of the bed and banks of streams
(*d*) all of the above.

(*xi*) According to thin cylinder theory, the volume of concrete required for an arch dam would be minimum if the central angle is

(*a*) 130°34′ (*b*) 133°34′
(*c*) 136°34′ (*d*) 139°34′

(*xii*) According to Ryve's formula for estimating floods, the peak discharge is proportional to :

(*a*) A (*b*) $A^{3/4}$
(*c*) $A^{2/3}$ (*d*) $A^{1/2}$

(*xiii*) Levees are constructed :

(*a*) parallel to river flow
(*b*) transverse to the river flow
(*c*) perpendicular to the river flow
(*d*) all the above.

(*xiv*) Hydrograph is a plot of :

(*a*) rainfall intensity against time
(*b*) discharge against time
(*c*) cummulative rainfall against time
(*d*) cummulative discharge against time

(B) Fill in the blanks in the following statements :

(*i*) If the duty for a base period of 120 days is 1500 hectares/cumec, then the delta for crop is ____ m.

(*ii*) If a river in alluvial plain has dominant charge of 1600 cumecs, the waterway for a bridge on this river should be ____ m (appx.)

(*iii*) For aone metre depth of flow in a canal, with CVR equal to 0.90, the velocity of flow according to Kennedy's theory will be ____ m/s.

Answers to Questions of 1998 (*Summer*) Exam

A (*i*)–(*d*)	*A* (*ii*)–(*b*)	*A* (*iii*)–(*a*)	*A* (*iv*)–(*b*)
A (*v*)–(*c*)	*A* (*vi*)–(*d*)	*A* (*vii*)–(*a*)	*A* (*viii*)–(*a*)
A (*ix*)–(*c*)	*A* (*x*)–(*d*)	*A* (*xi*)–(*b*)	*A* (*xii*)–(*c*)
A (*xiii*)–(*a*)	*A* (*xiv*)–(*b*)		
B (*i*)–0.69 m	*B* (*ii*)–250 m	*B* (*iii*)–0.495	

Year 1998 (*Winter*) Exam.

Q. (A) *Fill in the blanks :* (1 × 10)

(*i*) Consumptive use is defined as .....

(*ii*) The relationship between duty and delta is .....

(*iii*) Base period of an irrigated crop is the period from ..... to .....

(*iv*) Hydraulic mean depth is the ratio between ..... and .....

(*v*) Fan shaped catchment gives ..... run off than Fern leaf shaped catchment.

(*vi*) Tortuosity of a meandering river is the ratio between ..... and .....

(*vii*) Middle third rule is used in .....

(*viii*) ..... is used commonly to measure actual evapotranspiration.

(*ix*) The sequent peak algorithm is a technique used in the estimation of .....

(*x*) The surge tank is provided in the water supply line to reduce the effect of .....

Q. (B). *Choose the correct statement for the following* (1 × 10)

(*i*)* A rain-fall with an intensity of 5 mm/h is classified as

(*a*) trace (*b*) light rain

(*c*) moderate rain (*d*) heavy rain.

(*ii*) Double mass curve technique is adopted to :

(*a*) estimate the missing data.

(*b*) obtain intensities of rainfall at various durations

(*c*) check the consistency of data.

(*d*) obtain the storage capacity needed for a reservoir.

(*iii*) The drainage density is the :

(*a*) average length of streams per unit drainage are within the basin.

(*b*) stream discharge per unit drainage area

(*c*) drainage area per unit stream length

(*d*) number of streams per unit drainage area.

(*iv*) Streams that contribute to the ground water are called :

(*a*) effluent streams (*b*) ground water streams

(*c*) influent streams (*d*) perennial streams.

(*v*) The basic assumptions of unit hydrograph theory are :

(*a*) linear response and time variance

(*b*) linear response and time invariance

(*c*) non-linear response and time variance

(*d*) non-linear response and time invariance

(*vi*) The probable maximum flood is :

(*a*) an impossibly large flood discharge

(*b*) a flood discharge that is maximum over the past years.

(*c*) an extremely large but physically possible flood at the site.

(*d*) a flood with maximum probability of occurrence.

(*vii*) If γ' is the submerged unit weight of soil, ϕ is the angle of internal friction and h is the height to which the silt is deposited, they the pressure on the dam due to silt is given by :

(*a*) $P_s = \gamma' \cdot h^2 \left(\frac{1-\sin\phi}{1+\sin\phi}\right)$ (*b*) $P_s = \gamma' \cdot h^2 \left(\frac{1+\sin\phi}{1-\sin\phi}\right)$

(*c*) $P_s = \frac{1}{2}\gamma' h^2 \left(\frac{1-\sin\phi}{1+\sin\phi}\right)$ (*d*) $P_s = \frac{1}{2}\gamma' \cdot h^2 \left(\frac{1+\sin\phi}{1-\sin\phi}\right)$

(*viii*) In cross-drainage works, the function of an inlet is to admit drain water into a :

(*a*) canal (*b*) field

(*c*) drain (*d*) none of the above

(*ix*)* The points connecting equal evapotranspiration is known as :

(*a*) isobar (*b*) isopleth

(*c*) isohyet (*d*) isovel.

(*x*) Leaching is the process by which :

(*a*) water is excessively pumped from a water-logged area.

(*b*) excess salt in the soil is pushed down by standing water above the soil.

(*c*) improving the soil structure end texture by adding suitable chemicals.

(*d*) sodium ions are removed from irrigation water.

Answers to Questions of 1998 (*Winter*) Exam

A (*i*). the amount of water used in evapotranspiration from an area under vegetation including the water used by the plants in their metabolic process for building of plant tissues.

A (*ii*). $\Delta = \frac{8.64B}{D}$ m where D = duty in ha/cumec

B = Base period of crop in days

Δ = Delta in m.

A (*iii*)–the time between the first watering of a crop at the time of its sowing to its last watering before harvesting.

A (*iv*)–area of canal; Wetted perimeter of canal.

A (*v*)–greater

A (*vi*)–arcual length along the river reach; direct axial length of the river reach.

A (*vii*)–the design of concrete gravity dams.

A (*viii*)–A lysimeter

A (*ix*)–minimum storage capacity of a reservoir.

A (*x*)–water hammer -

B (*i*)–(*c*) **B** (*ii*)–(*c*) **B** (*iii*)–(*a*) **B** (*iv*)–(*b*)

B (*v*)–(*b*) **B** (*vi*)–(*c*) **B** (*vii*)–(*c*) **B** (*viii*)–(*a*)

B (*ix*)–(*b*) **B** (*x*)–(*b*)

Hints for Solving Starred Questions of 1998 (*Summer*) Exam

Q. B (*i*). On the basis of its intensity, the rainfall is classified as light, moderate or heavy, as shown in table 33.1.

Table 33.1. Types of Rainfalls

S. No.	*Type of rainfall*	*Intersity of rainfall*
1	Light rain	trace to 2.5 mm/h
2	Moderate rain	> 2.5 mm/h to 7.5 mm/h
3	Heavy rain	> 7.5 mm/h

Q.B. (*ix*). As defined in the text, an *isobar* is a curve which joins the points of equal atmospheric pressure; while an *isohyet* is the one which joins the points of equal rainfall in a catchment plan.

An **isovel** on the other hand, is a contour (a curve) connecting points of equal velocities is a river cross-section; while an **isopleth** is a curve which connects the points of equal evapotranspiration. IMD has provided isopleths-map for the country, showing isopleths of annual PET (cm), wherein Delhi is found to be on the isopleth curve of 160 cm.

Year 1999 (*Summer*) Exam.

Q. (A). *Fill in the blanks of the following statements* (1 × 10)

(*i*) Percolation losses are more from a canal that is .....

(*ii*) Lacey's theory is applicable only to ..... rivers and not to .....

(*iii*) Gross command area is the sum of ..... and .....

(*iv*) Piping under an earthen dam starts developing from the ..... side of the structure.

(*v*) The loss of water during the growth of a crop is termed as .....

(*vi*) The flow occurring in a tunnel with water level above the roof at the exit end is ..... flow.

(*vii*) The drainage holes provided inside the body of a concrete gravity dam are located on the ..... side of the grout curtain.

(*viii*) The type of hydraulic structure to raise or lower the vessel travelling in a navigation canal is called a .....

(*ix*) A syphon is a cross-drainage work in which the canal is taken ..... the river.

(*x*) Repelling spurs project from the bank and form an acute angle on the ..... side.

Q. B. *Pick up the right alternative from the various choices provided in the following questions :* (1 × 10)

(*i*) For conveying the same discharge, a lined canal can have a bed slope :

(*a*) steeper than an unlined canal

(*b*) milder than an unlined canal

(*c*) same as an unlined canal

(*d*) none of the above.

(*ii*) An arch dam requires that :
- (*a*) the foundation be stronger than the abutments
- (*b*) the abutments be stronger than the foundation
- (*c*) the foundation consists of gravel and sand.
- (*d*) None of the above.

(*iii*) By increasing the length of the floor on the upstream of the weir axis :
- (*a*) the uplift pressure will increase below the floor downstream of the weir.
- (*b*) the uplift pressure will decrease below the floor downstream of the weir.
- (*c*) the uplift pressure will remain the same in both the cases
- (*d*) none of the above.

(*iv*) The nose of the divide wall of a barrage is founded on :
- (*a*) firm rock which may be at any depth
- (*b*) well foundation
- (*c*) pile foundation
- (*d*) none of the above.

(*v*) The scour depth as measured below the highest flood level of a river :
- (*a*) will be more in a bouldery river than in an alluvial river
- (*b*) will be less in a bouldery river than in an alluvial river
- (*c*) will be the same in both cases
- (*d*) none of the above.

(*vi*) In a level crossing type of cross-drainage works :
- (*a*) the canal is above the drain
- (*b*) the canal is below the drain
- (*c*) the canal and the drain are at the same level
- (*d*) none of the above.

(*vii*) The tunnels of a sediment excluder are so designed that :
- (*a*) the longest tunnel is farthest from the canal head regulator.
- (*b*) the longest tunnel is nearest to the canal head regulator.
- (*c*) all the tunnels are of the same length
- (*d*) none of the above.

(*viii*) Khosla's theory is applicable to structures founded on :
- (*a*) rock
- (*b*) any type of material
- (*c*) permeable material only
- (*d*) none of the above.

(*ix*) To minimise the head losses at the entry of a branch canal taking off from the main canal, the centre line of the branch canal should make an angle with the centre line of the main canal that is :
- (*a*) obtuse in the direction of flow
- (*b*) acute in the direction of flow
- (*c*) obtuse or acute
- (*d*) none of the above.

(*x*) For a metering flume, the crest over which the head is measured should be :

(*a*) sharp (*b*) broad

(*c*) either sharp or broad (*d*) none of the above.

Answers to Questions of 1999 (*Summer*) Exam.

A (*i*)–Unlined

A (*ii*)–stable alluvial ; rocky or boulder river stages and unstable (aggrading or degrading) alluvial rivers.

A (*iii*)–cultivable ; non-cultivable area which can be economically irrigated without considering the limitation of the quantity of available irrigation water.

A (*iv*)–downstream **A** (*v*)–evapotranspiration **A** (*vi*)–submerged

A (*vii*)–upstream **A** (*viii*)–navigation lock **A** (*ix*)–below

A (*x*)–upstream

B (*i*)–(*b*) **B** (*ii*)–(*b*) **B** (*iii*)–(*b*) **B** (*iv*)–(*b*)

B (*v*)–(*b*) **B** (*vi*)–(*c*) **B** (*vii*)–(*b*) **B** (*viii*)–(*c*)

B (*ix*)–(*b*) **B** (*x*)–(*c*)

Year 1999 (*Winter*) Exam

Q. A. *Fill in the blanks :* (1 × 10)

(*i*) If the duty for a crop with base period of 120 days is 1500 ha/cumec, then its delta is ..... .

(*ii*) An isohyet is a line joining points of ..... .

(*iii*) The infiltration capacity of a soil ..... with time.

(*iv*) Canals taken directly from the rivers with or without head regulators are called ..... .

(*v*) When the canal with bed level higher than the high flood level in drain cross each other, then the cross drainage structure is called ..... .

(*vi*) The suction pressure on the ogee spillway is caused, when the head on spillway is ..... the design head.

(*vii*) An example of vertical lift gate is ..... .

(*viii*) Cross drainage works are not needed when canal is aligned as ..... .

(*ix*) Movement of water under or around an impervious structure is called ..... .

(*x*) The type of dam preferred for a narrow gorge with strong abutments is ..... .

Q. B. *Choose the correct statement for the following :* (1 × 10)

(*i*) Enveloping curve is a method to :

(*a*) determine the peak flood (*b*) determine the infiltration capacity

(*c*) estimate interception (*d*) route the flood through reservoir.

(*ii*) The maximum water application efficiency is in :

(*a*) surface irrigation (*b*) lift irrigation

(*c*) sprinkler irrigation (*d*) furrow irrigation.

(*iii*) Evaporation depends on :
(*a*) temperature (*b*) humidity
(*c*) wind velocity (*d*) all the above.

(*iv*) Canals meant for the purpose of draining off water from water-logged areas are called :
(*a*) seepage canals (*b*) laterals
(*c*) drains (*d*) water courses.

(*v*) Cross drainage work, where the bed levels of canal and drain are equal is called :
(*a*) aqueduct (*b*) level crossing
(*c*) super passage (*d*) siphon aqueduct.

(*vi*) The most economical central angle of an arch dam is :
(*a*) 93° (*b*) 123°
(*c*) 133° (*d*) 183°.

(*vii*) Radial gate is also known as :
(*a*) tainter gate (*b*) stoney gate
(*c*) drum gate (*d*) rolling gate.

(*viii*) Guide banks are provided to :
(*a*) decrease depth of flow in river (*b*) confine the width of river
(*c*) reduce the flood peak (*d*) maintain minimum depth in river.

(*ix*) River intake is usually situated on :
(*a*) convex side of curve (*b*) concave side of curve
(*c*) straight reach (*d*) downstream side of sewer outfall.

(*x*) Stability of the upstream slope of an earthen dam becomes critical for the condition of :
(*a*) reservoir full (*b*) reservoir empty
(*c*) sudden drawdown (*d*) slow filling of reservoir.

Answers to Questions of 1999 (*Winter*) Exam.

***A* (*i*)**–69 cm ***A* (*ii*)**–equal rainfall ***A* (*iii*)**–varies
***A* (*iv*)**–main canals ***A* (*v*)**–aqueduct ***A* (*vi*)**–more than
***A* (*vii*)**–stoney gate ***A* (*viii*)**–water-shed canal ***A* (*ix*)**–seepage flow
***A* (*x*)** an arch dam

***B* (*i*)**–(*a*) ***B* (*ii*)**–(*c*) ***B* (*iii*)**–(*d*) ***B* (*iv*)**–(*c*)
***B* (*v*)**–(*b*) ***B* (*vi*)**–(*c*) ***B* (*vii*)**–(*a*) ***B* (*viii*)**–(*b*)
***B* (*ix*)**–(*c*) ***B* (*x*)**–(*c*)

Year 2000 (*Summer*) Exam.

Q. A. *Fill in the blanks :* (1 × 10)

(*i*) Thiessen polygon method is used to find ..... .
(*ii*) Sugar-cane, according to crop period is ..... crop.
(*iii*) Base period is ..... than the crop period.

(*iv*) Weed growth in unlined canal is ....., if the velocity of water is less than 60 cm/sec.

(*v*) Fish ladder is a component part in ..... .

(*vi*) Passage provided in gravity dam to drain seepage water is called ..... .

(*vii*) If bed level of canal is at higher level than that of drain, then the cross-drainage work is called ..... .

(*viii*) Gibb's module is an example for ..... outlet.

(*ix*) Deflecting groynes are constructed on ..... bank of river.

(*x*) Water-logging, takes place due to ..... in ground water table.

Q. B. *Choose the correct statement for the following :* (1 × 10)

(*i*) Kharif crops are sown and harvested in the months of :

(*a*) January and May (*b*) July and January

(*c*) April and September (*d*) October and March.

(*ii*) If the pan evaporation indicates a total yearly evaporation of 1.5 m, then the annual water loss by evaporation from reservoir of water surface area of 100 km^2 will be :

(*a*) 1.5×10^3 ha-m (*b*) 1.5×10^4 ha-m

(*c*) 1.5×10^5 ha-m (*d*) 1.5×10^6 ha-m.

(*iii*) Water enters the soil at capacity rate when intensity of rainfall is

(*a*) more than the infiltration capacity of the soil

(*b*) less than the infiltration capacity of the soil

(*c*) equal to the infiltration capacity of the soil

(*d*) slightly less than the infiltration capacity of the soil.

(*iv*) With the increase in quantity of water supplied, the yield of most crops :

(*a*) continuously increases

(*b*) continuously decreases

(*c*) increases up to certain limit and then decreases

(*d*) decreases up to certain limit and then increases.

(*v*) The ordinates of unit hydrograph may be obtained by dividing the ordinates of the direct runoff hydrograph of a storm by :

(*a*) duration of unit hydrograph (*b*) storm duration

(*c*) base flow volume (*d*) direct runoff volume.

(*vi*) For triangular dam section of height 'H', for just no tension, under action of water pressure, self weight and uplift pressure, the minimum base width required with usual notation is :

(*a*) $\frac{H}{S-1}$ (*b*) $\frac{H}{(S-1)^{-1}}$

(*c*) $\frac{H}{\sqrt{S}}$ (*d*) $\frac{H}{\sqrt{S-1}}$.

(*vii*) Due to valley storage, the peak discharge of an outflow hydrograph :

(*a*) increases (*b*) reduces

(*c*) is not affected (*d*) not any of the above.

(*viii*)* The upstream face of the earth dam is considered as :

(*a*) equipotential line (*b*) stream line

(*c*) streak line (*d*) path line.

(*ix*) A super passage is a cross-drainage work provided when bed of natural drain is :

(*a*) at the same level as the canal bed

(*b*) well above the full supply level in canal

(*c*) below the full supply level of canal

(*d*) below the bed level of canal.

(*x*) River training works are seldom required in

(*a*) rocky stage of a river (*b*) meandering river

(*c*) trough stage of a river (*d*) deltaic stage of river.

Answers to Questions of 2000 (*Summer*) Exam.

A (*i*)–mean rainfall over a drainage area *A* (*ii*)–an overlapping

A (*iii*)–slightly less *A* (*iv*)–more *A* (*v*)–canal head works

A (*vi*)–drainage gallery *A* (*vii*)–an aqueduct or a syphon aqueduct

A (*viii*)–modular or rigid *A* (*ix*)–concave *A* (*x*)–rise

B (*i*)–(*c*) *B* (*ii*)–(*b*) *B* (*iii*)–(*a*) *B* (*iv*)–(*c*)

B (*v*)–(*d*) *B* (*vi*)–(*d*) *B* (*vii*)–(*b*) *B* (*viii*)–(*a*)

B (*ix*)–(*b*) *B* (*x*)–(*a*)

Hints for Solving Starred Questions

B (*viii*) Equipotential lines are the lines of equal energy, since every point on the upstream face of an earth dam will be under equal total energy (pressure head + datum head + vel. head), this line acts as an equipotential line. Similarly, the upstream floor of a weir acts as an equipotential line.

Year 2000 (*Winter*) Exam.

Q. A. Fill in the blanks in the following statements : (1 × 10)

(*i*) A groyne projecting from the river bank and with its nose pointing upstream is a ..... groyne.

(*ii*) A canal in which the amount of excavation is same as in the fill portion is called a ..... section.

(*iii*) A lined canal leading water to a power house has a slope ..... than an unlined canal for irrigation.

(*iv*) An arrangement for removal of silt that has already entered a channel is called a silt ..... .

(*v*) A cistern in a canal fall serves as a ..... .

(*vi*) The structure provided in a concrete dam to release excess water during floods is called a ..... .

(*vii*) Failure of an earth dam due to flow of water under the foundation and emerging on the downstream side is termed as a failure due to ..... .

(*viii*) A cross dreinage work in which the canal water and the drainage meet at the same level is called a ..... .

(*ix*) Crops grown during winter months and harvested in March-April are called ..... crops.

(*x*) A device to release water from a canal to the water course is called an ..... .

Q. B. *Choose the right answer from the list given below each question :* (1 × 10)

(*i*) Lacey's regime theory was developed after extensive research in :

(*a*) Israel (*b*) Indonesia
(*c*) India (*d*) Iraq.

(*ii*) A chute spillway is generally provided with :

(*a*) a weir (*b*) a barrage
(*c*) a concrete gravity dam (*d*) an earth dam.

(*iii*) A siphon spillway in a concrete gravity dam is in the shape of :

(*a*) latter U
(*b*) an inverted U
(*c*) horizontal bend through the abutment
(*d*) any straight line.

(*iv*) Energy will be required to irrigate land :

(*a*) under gravity (*b*) much above the river bed level
(*c*) in delta region (*d*) in all the above cases.

(*v*) On a meandering river, the current is strongest on :

(*a*) the concave bend (*b*) the convex bend
(*c*) both banks (*d*) the middle of the stream.

(*vi*) A barrage is a hydraulic structure provided on :

(*a*) deep narrow valleys (*b*) wide shallow valley
(*c*) rock foundation (*d*) silts, clays and gravels.

(*vii*) Conjunctive use of water means :

(*a*) use of surface water alone
(*b*) use of ground water alone
(*c*) use of pumped water alone
(*d*) combined use of surface water and ground water.

(*viii*) A straight concrete gravity dam should have :

(*a*) strong abutments (*b*) clay foundations
(*c*) strong foundations (*d*) None of the above.

(*ix*) Flexibility of an outlet is the ratio of :

(*a*) rate of change of discharge in an outlet to the normal depth in the channel
(*b*) rate of change of discharge in an outlet to the rate of change of discharge in the parent channel.
(*c*) rate of depth of crest level of outlet and FSL of channel to its full supply depth.
(*d*) head recovered to head put in.

(*x*) A canal on a watershed requires :

(*a*) a level crossing (*b*) a syphon

(*c*) a super passage (*d*) None of the above.

Answers to Questions of 2000 (*Winter*) Exam.

A (*i*)–repelling (or deflecting) *A* (*ii*)–balance

A (*iii*)–steeper *A* (*iv*)–ejector *A* (*v*)–device for energy dissipation

A (*vi*)–spillway *A* (*vii*)–piping *A* (*viii*)–level crossing

A (*ix*)–Rabi *A* (*x*)–Outlet

B (*i*)–(*c*) *B* (*ii*)–(*d*) *B* (*iii*)–(*b*) *B* (*iv*)–(*b*)

B (*v*)–(*a*) *B* (*vi*)–(*b*) *B* (*vii*)–(*d*) *B* (*viii*)–(*c*)

B (*ix*)–(*b*) *B* (*x*)–(*d*)

Year 2001 (*Summer*) Exam.

Q. A. *Fill in the blanks :* (2 × 5)

(*i*) In a hydraulic structure, the position of hydraulic gradient line is 2.0 m from the top of the impervious floor. The relative density of the material of impervious floor is 2.40. From uplift consideration, floor thickness at this location should be ..... .

(*ii*) A launching apron in a hydraulic structure provides safety against ..... .

(*iii*) In a hydro-power scheme, the pipe between surge tank and power house is known as ..... .

(*iv*) The difference in water level u/s and d/s of a bridge is known as ..... .

(*v*) Equation ..... given by Laccy is used for fixing the waterway of bridges and barrages in alluvial streams.

Q. B. *Choose the correct statement for the following :* (1 × 10)

(*i*) In a design of canal, falls are provided :

(*a*) to dissipate the energy

(*b*) when ground slope is steeper than the canal bed slope

(*c*) when the canal bed slope is steeper than the ground slope

(*d*) to reduce hydraulic losses.

(*ii*) Permeable spurs are used to :

(*a*) promote siltation along the banks of the river

(*b*) deflect the flow

(*c*) attract the flow

(*d*) contract the width of the river for navigation purposes.

(*iii*) Lacey's silt factor *f* for the average size of the river bed material of 0.30 mm is :

(*a*) 0.96 (*b*) 1.0

(*c*) 1.2 (*d*) 0.3.

(*iv*) For the estimation of flood peak, the value of Q in Dicken's formula is given by :

(*a*) $CM^{3/4}$ (*b*) $CM^{2/3}$

(*c*) $CM^{3/2}$ (*d*) $CM^{4/3}$.

(*v*) Seepage losses in a canal are more when it is :

(*a*) completely in filling (*b*) partly in filling and partly in cutting

(*c*) fully in cutting (*d*) lined.

(*vi*) Current meters are used for measurement of :

(*a*) velocity (*b*) discharge

(*c*) depth of flow (*d*) scour depth.

(*vii*) In a diversion headworks, the crest of the undersluice portion is kept :

(*a*) at the minimum river bed level

(*b*) higher than the crest level of canal head regulator

(*c*) at the same level as that of canal head regulator

(*d*) higher than the minimum bed level of the river.

(*viii*) In a syphon aqueduct, the maximum uplift pressure on the floor occurs when :

(*a*) canal is dry and drain is running full

(*b*) canal is running full and drain is dry

(*c*) both canal and drain are running

(*d*) both are dry.

(*ix*) Phreatic line in seepage analysis is defined as the line on which pressure is :

(*a*) equal to the atmosphere (*b*) greater than atmosphere

(*c*) lower than atmospheric (*d*) varying.

(*x*) Hydraulic jump occurs when flow changes from :

(*a*) super critical to sub-critical (*b*) subcritical to supercritical

(*c*) critical to turbulent (*d*) laminar to turbulent.

Answers to Questions of 2001 (*Summer*) Exam.

A **(*i*)**–min. of 1.43 m	***A*** **(*ii*)**–*scouring* of river bed		
A **(*iii*)**–penstock	***A*** **(*iv*)**–afflux	***A*** **(*v*)**–$P = 4.75\sqrt{Q}$	
B **(*i*)**–(*b*)	***B*** **(*ii*)**–(*a*)	***B*** **(*iii*)**–(*a*)	***B*** **(*iv*)**–(*a*)
B **(*v*)**–(*a*)	***B*** **(*vi*)**–(*b*)	***B*** **(*vii*)**–(*a*)	***B*** **(*viii*)**–(*a*)
B **(*ix*)**–(*a*)	***B*** **(*x*)**–(*a*)		

Year 2001 (*Winter*) Exam

Q. A. *Fill in the blanks :* (1 × 10)

(*i*) Lysimeter method is used for direct measurement of ..... .

(*ii*) The commonly used rain gauge in India is ..... .

(*iii*) According to Kennedy, non silting and non scouring velocity is called ..... .

(*iv*) Escope provided across the channel at its fag end to maintain required full supply level is called ..... .

(*v*) Canal should be ..... in order to reduce the chances of water-logging.

(*vi*) Arch dam transfers major port of hydrostatic load to ..... .

(*vii*) The commonly used earth dam is ..... .

(*viii*) Outlet, whose discharge depends on the difference in water levels in distributary and water course is called ..... .

(*ix*) Earthen embankments provided to confine flood water of alluvial river, without allowing to change its course is called ..... .

(*x*) Overflow spillway is also called ..... .

Q. B. *Choose the correct answer for the following :* (1 × 10)

(*i*) The best method of applying irrigation water to sandy undulating area is :

(*a*) free flooding (*b*) furrow method

(*c*) sub-irrigation (*d*) sprinkler irrigation.

(*ii*) The evaporation from an open water surface :

(*a*) depends upon the difference of saturation vapour pressure and actual vapour pressure in air

(*b*) is independent of wind velocity

(*c*) is independent of the area of water surface

(*d*) cannot be altered by any means.

(*iii*) Unit hydrograph resulting from a storm of specified unit duration and areal distribution gives :

(*a*) 1 mm direct run off (*b*) 1 cm direct run off

(*c*) 1 ha-m of direct run off (*d*) 1 million m^3 of direct run off.

(*iv*) The crest level of under sluices is :

(*a*) higher than the crest level of head regulator

(*b*) equal to the crest level of the weir

(*c*) equal to the bed level of the river channel

(*d*) equal to the crest level of head regulator.

(*v*) By providing seepage drains, the chances of water-logging :

(*a*) decrease (*b*) increase

(*c*) will not alter (*d*) None of the above.

(*vi*) Bhakra dam is a :

(*a*) non rigid gravity dam (*b*) rigid earth dam

(*c*) rigid gravity dam (*d*) rock fill dam.

(*vii*) In gorges with steep and strong side slopes, the most suitable type of dam is :

(*a*) earth dam (*b*) gravity dam

(*c*) buttress dam (*d*) arch dam.

(*viii*) The upstream face of an earth dam is :

(*a*) a flow line (*b*) an equipotential line

(*c*) a phreatic line (*d*) a stream line.

(*ix*) If the eccentricity of the resultant falls outside the middle third, the ultimate failure of dam occurs by :

(*a*) tension (*b*) crushing

(*c*) sliding (*d*) overturning.

(*x*) Spurs provided for the river training works are :

(*a*) parallel to the river banks (*b*) transverse to the river flow

(*c*) usually made of earth bends (*d*) provided to guide the flow to a bridge.

Answers to Questions of 2001 (*Winter*) Exam.

***A* (*i*)**–Actual evapotranspiration

***A* (*ii*)**–Simon's type of standard non-recording rain gauge

***A* (*iii*)**–critical velocity ***A* (*iv*)**–tail escape ***A* (*v*)**–lined

***A* (*vi*)**–abutments ***A* (*vii*)**–of homogenous type

***A* (*viii*)**–non-modular ***A* (*ix*)**–dykes (or levees) ***A* (*x*)**–ogee spillway

***B* (*i*)**–(*d*) ***B* (*ii*)**–(*a*) ***B* (*iii*)**–(*b*) ***B* (*iv*)**–(*c*)

***B* (*v*)**–(*a*) ***B* (*vi*)**–(*c*) ***B* (*vii*)**–(*d*) ***B* (*viii*)**–(*b*)

***B* (*ix*)**–(*a*) ***B* (*x*)**–(*b*)

Year 2002 (*Summer*) Exam

Q. A. *Choose the correct answer for the following :* (1 × 10)

(*i*) Float type rain gauge belongs to the type :

(*a*) recording rain gauge (*b*) Non-recording rain gauge

(*c*) May be both of the above (*d*) None of the above.

(*ii*) The length of stream per unit area is known as :

(*a*) Overflow density (*b*) Drainage density

(*c*) Stream density (*d*) Average density.

(*iii*) Which of the following is a costlier system ?

(*a*) Gravity irrigation (*b*) Lift irrigation

(*c*) Drip irrigation (*d*) Combination of (*a*) and (*b*) above.

(*iv*) Water supply system may be managed by artificial recharge of :

(*a*) Water-logged area (*b*) Aquifers

(*c*) Pond (*d*) All of the above.

(*v*) An earthen embankment running parallel to the river to protect the area behind it is called :

(*a*) Dam (*b*) Gully

(*c*) Dyke (*d*) Flood wall.

(*vi*) For medium silt whose average grain size is 0.16 mm, Lacey's silt factor is likely to be :

(*a*) 0.30 (*b*) 0.45

(*c*) 0.70 (*d*) 1.32.

(*vii*)* The discharge per metre width at the foot of a spillway is 10 m^3/s at a velocity of 20 m/s. A perfect free hydraulic jump will occur at the foot of the spillway when the tail water depth is approximately equal to

(*a*) 4.50 m (*b*) 5.00 m
(*c*) 5.50 m (*d*) 6.50 m.

(*viii*) The foundation soil under toe of a dam has a void ratio *e*. The specific gravity of the soil solids is *G*. Factor of safety against piping is to be taken as 2.5. The maximum permissible upward exit gradient is given by

(*a*) $i = 2.5\left(\frac{G-1}{1+e}\right)$ (*b*) $i = 2.5\left(\frac{1+e}{G-1}\right)$
(*c*) $i = 0.4\left(\frac{1+e}{G-1}\right)$ (*d*) $i = 0.4\left(\frac{G-1}{1+e}\right)$

(*ix*) According to Khosla's theory, if downstream sheet file is not provided, the exit gradient will be

(*a*) 0 (*b*) 1
(*c*) ∞ (*d*) 2.

(*x*) An attractive groyne is one which is

(*a*) Inclined upstream (*b*) Inclined downstream
(*c*) Normal to bank (*d*) Same as a repelling groyne.

Q. B. *Fill in the blanks*

(*i*) A hyetograph is a graph representing rainfall intensity ..... .

(*ii*) During seepage through an earthen mass, the direction of seepage ..... to the equipotential lines.

(*iii*) When a river starts meandering, the sediment carrying capacity of the river first ..... and ultimately ..... .

(*iv*) The agriculture product ..... has the maximum demand of water.

(*v*) Facility of irrigation is preferable in the region which is ..... .

(*vi*) Electrical logging method of groundwater investigations belongs to ..... method.

(*vii*) Cheapest mode of irrigation is ..... .

(*viii*) The volume of water taken into the storage of aquifer per unit surface per unit slope of head is known as ..... coefficient.

(*ix*) Empirical formulas to estimate evaporation is ..... .

(*x*) 'Afforestation' is a method of flood control by ..... .

Answers To Questions Of 2002 (*Summer*) Exam

A (*i*)–(*a*) ***A*** (*ii*)–(*b*) ***A*** (*iii*)–(*c*) ***A*** (*iv*)–(*b*)
A(*v*)—(*c*) ***A*** (*vi*)–(*a*) ***A*** (*vii*)–(*d*) ***A*** (*viii*)–(*d*)
A (*ix*)–(*c*) ***A*** (*x*)–(*b*) ***B*** (*i*)–(V_s time) ***B*** (*ii*)–(*is* $\perp$)
B (*iii*)–decreases ; becomes constant ***B*** (*iv*)–Sugarcane
B (*v*)–Tropical ***B*** (*vi*)—resistivity surveys ***B*** (*vii*)–flow irrigation
B (*viii*)–storage ***B*** (*ix*)–Meyer formula and Rowher's formula
B (*x*)–soil and water conservation methods of flood control

Hints for Solving Storred Questions of 2002 (*Summer*) Exam.

Q .A (*vii*) $y_1 = \frac{q}{v_1} = \frac{10}{20} = 0.5$

$$y_1\, y_2\, (y_1 + y_2) = \frac{2q^2}{g}$$

or $$0.5\, y_2\, (0.5 + y_2) = \frac{2 \times 10^2}{9.81} = 20.387$$

or $$y_2\, (0.5 + y_2) = 40.77$$

or $$0.5\, y_2 + y_2^2 - 40.77 = 0$$

or $$y_2^2 + 0.5\, y_2 - 40.77 = 0$$

or $$y_2 = \frac{-0.5 \pm \sqrt{0.25 + 4 \times 40.77}}{2}$$

or $$y_2 = \frac{-0.5 \pm 12.78}{2}$$

or $$y_2 = \frac{12.28}{2} = 6.14 \text{ m} \quad \text{(ignoring the un feasible } -ve \text{ sign)}$$

Nearest given choice to this value of 6.14m is at choice (*d*); and hence choice (*d*) is to be marked as the correct answer.

Year 2002 (*Winter*) Exam

Q. A. *Match List P with that of List Q* (1 × 10)

List P	*List Q*
(*i*) Leguminous crops	(*a*) Average rainfall
(*ii*) Thiessen polygon	(*b*) Average infiltration
(*iii*) S-curve hydrograph	(*c*) Increase nitrogen content of soil
(*iv*) Ridge canals	(*d*) Summation of unit hydrograph
(*v*) Canal lining	(*e*) Non rigid dam
(*vi*) Rock fill dam	(*f*) Relieves pore pressure in earth dam
(*vii*) Toe drain	(*g*) Energy dissipator
(*viii*) Chute-spillway	(*h*) Diversion head works
(*ix*) Fish ladder	(*i*) Have no cross-drainage works
(*x*) River intake	(*j*) Reduces water-logging
	(*k*) Flow is super critical
	(*l*) Helps to draw water in controlled manner.

Q. 3. *(Choose the correct answer for the following* (1 × 10)

(*i*) Average annual rainfal at any station is mean of average annual rainfalls over a period of

(*a*) 14 years (*b*) 21 years

(*c*) 28 years (*d*) 35 years.

(*ii*) For a crop, consumptive use of water is equal to the depth of water

(*a*) transpired by the crop

(*b*) evaporated by the crop

(*c*) used in transpiration, evaporation and quantity evaporated from adjacent soil.

(*d*) transpired and evaporated by the crop.

(*iii*) Channel is said to be in regime condition, if

(*a*) discharge is constant

(*b*) silt grade and silt charge are constant

(*c*) flows uniformly in incoherent alluvium, as that transported in suspension

(*d*) All of the above.

(*iv*) Canal fall is provided, if

(*a*) ground slope exceeds the designed bed slope

(*b*) designed bed slope exceeds the ground slope

(*c*) ground slope and bed slope are almost same

(*d*) None of the above.

(*v*) When a canal is carried over a natural drain, at crossing, the structure provided is called

(*a*) syphon (*b*) aqueduct

(*c*) super passage (*d*) level crossing.

(*vi*) Silt storage in the reservoir is same as

(*a*) dead storage (*b*) live storage

(*c*) effective storage (*d*) total storage.

(*vii*) Economic height of a dam is that height corresponding to which

(*a*) amount of silt collected is minimum

(*b*) cost of dam per unit of storage is minimum

(*c*) cost of dam per unit of storage is maximum

(*d*) free board provided is maximum.

(*viii*) Outlet is said to be proportional, if its flexibility is

(*a*) equal to zero (*b*) less than unity

(*c*) equal to unity (*d*) more than unity.

(*ix*) In a barrage, crust level is kept

(*a*) low with large gates (*b*) high with large gates

(*c*) high with no gates (*d*) low with no gates.

(*x*) River training work is required, when the river is

(*a*) aggrading (*b*) degrading

(*c*) meandering (*d*) in super-critical flow.

Answers to Questions of 2002 (*Winter*) Exam

A (*i*)—(*a*)	(*ii*)—(*a*)	(*iii*)—(*d*)	(*iv*)—(*i*)
(*v*)—(*j*)	(*vi*)—(*e*)	(*vii*)—(*f*)	(*viii*)—(*k*)
(*ix*)—(*h*)	(*x*)—(*l*)		
B (*i*)—(*d*)	***B*** (*ii*)—(*c*)	***B*** (*iii*)—(*d*)	***B*** (*iv*)—(*a*)
B (*v*)—(*b*)	***B*** (*vi*)—(*a*)	***B*** (*vii*)—(*b*)	***B*** (*viii*)—(*c*)
B (*ix*)—(*a*)	***B*** (*x*)—(*c*)		

Years 2003 (*Summer*) Exam

Q. A. *Choose the correct answer for the following [use the codes given at the end of questions to indicate your answer]* (10 × 2)

(*i*) Match the following two lists :

List I		*List II*	
(*a*)	Maxmum quantity of water that a soil can retain against gravity	1	Specific yield
(*b*)	Moisture content of a soil at which the water is no longer available in sufficient quantity to sustain growth	2	Infiltration capacity
(*c*)	Volume of water that can be extracted by gravity from a unit volume of saturated earth material	3	Field capacity
(*d*)	Maximum rate at which a soil can absorb water through the surface.	4	Permanent wilting point

Codes :

	A	B	C	D
(*a*)	3	1	4	2
(*b*)	4	3	1	2
(*c*)	3	4	1	2
(*d*)	3	4	2	1

(*ii*)* Which of the following instruments are concerned with streamflow measurements ?

(1) Sounding weight (2) Echo-depth recorder

(3) Hydrometer (4) Bubble gauge

(5) Stevenson Box

Codes

(*a*) 1, 2 and 5 (*b*) 3, 4 and 5

(*c*) 1, 2 and 4 (*d*) 2 and 5.

(*iii*) Match the following two lists :

	List I (*Plots of*)		*List II* (*Known as*)
(*a*)	Accumulated precipitation Vs time in chronological order	1	Hydrograph
(*b*)	Streamflow Vs time in chronological order	2	Hyetograph
(*c*)	Rainfall intensity Vs time	3	Flow duration curve
(*d*)	Stream discharge Vs Percentage time the flow is equalled to or exceeded	4	Flow mass curve
(*e*)	Cumulative discharge Vs time in chloronological order	5	Mass curve of rainfall

Codes :

	A	B	C	D
(*a*)	2	1	5	3
(*b*)	5	1	2	3
(*c*)	5	4	2	1
(*d*)	5	1	2	4

(*iv*) A 596 km^2 catchment has a 12 hour unit hydrograph which can be approximated as a triangle. If its time base is 144 hours, its peak ordinate is

(*a*) 23 m^3/s (*b*) 2 m^3/s

(*c*) 50 m^3/s (*d*) 13 m^3/s.

(*v*) Identify the correct statement in the following :

In the analysis of seepage through an earthen dam

(1) the upstream face is an equipotential line

(2) the upstream face is a stream line

(3) The phreatic line is a stream line

(4) the phreatic line is an equipotential line

(5) the upstream face is neither a streamline nor an equipotential line.

Code

The statements

(*a*) 4 and 5 are correct (*b*) 1 and 2 are correct

(*c*) 2 and 3 are correct (*d*) 1 and 3 are correct.

(*vi*) A coffer dam is

(*a*) a kind of gravity dam

(*b*) an earthen dam of small height built to protect important areas like townships from floods

(*c*) a temporary structure constructed to exclude water from work area during construction

(*d*) an embankment built along a river to regulate the river for navigation.

(*vii*) A non-cohesive soil has a porosity of 30% and the relative density of soil particles is 2.70. The value of critical exit gradient for this soil is

(*a*) 0.81 (*b*) 1.19

(*c*) 1.00 (*d*) 1.89.

(*viii*)* Which of the following pairs are matched correctly ?

(1) Total time from sowing of crop to its harvesting ..... base period

(2) Winter crops ..... Rabi

(3) Monsoon crop ..... Kharif

(4) Total time between the first watering for preparation of land to last watering before harvesting ..... crop period.

Codes

(*a*) 1, 2, 3 and 4 are correct

(*b*) 1, 2 and 3 are correct

(*c*) 2 and 3 are correct

(*d*) 1 and 4 are correct.

(*ix*) Water-table drops by 3 m in an irrigable area of 50 hectares. If porosity and specific retention are 0.30 and 0.10, respectively, the change in storage in hectare metres is

(*a*) 15 (*b*) 30

(*c*) 45 (*d*) 60.

(*x*) Match the following two lists relating to irrigation outlets :

List I *(Name of outlet)*		*List II* *(Type)*	
(*a*)	Kennedy gauge outlet	1	Modular
(*b*)	Gibb's outlet	2	Non-Modular
(*c*)	Submerged pipe outlet	3	Semi-modular
(*d*)	Pipe outlet discharging free		
(*e*)	Open flume outlet.		

Answers to questions of 2003 (*Summer*) Exam

A (*i*)—(*c*) *A* (*ii*)—(*a*) *A* (*iii*)—(*d*) *A* (*iv*)—(*a*)

A (*v*)—(*d*) *A* (*vi*)—(*c*) *A* (*vii*)—(*d*) *A* (*viii*)—(*c*)

A (*ix*)—(*c*) *A* (*x*)—(A)—(III), (B)—(I), (C)—(II), (D)—(III), (E)—(III)

Hints for Solving Starred Questions of 2003 (*Summer*) Exam

Q. A. (*ii*) **Sounding weights.** Current meters, which are basically used to measure velocity of streams, are weighted down by *lead weights*, called **balancing weights** or *sounding weights*, to enable them to be positioned in a stable manner at the required

location in flowing water. These weights are of streamlined shape with a fin in the rear, as shown in Fig. 7.70, and are connected to the current meter by a hanger bar and pin assmebly. Sounding weights come in different sizes and the minimum weight in N is estimated as equal to $50\bar{v}.y$, where $\bar{v}$ is the average stream velocity in the vertical in m/s and y = depth of flow at the vertical in m. These wts are hence essentially required in stream flow measurements

Echo depth recorder is an automatic recording device used in current meter measuring operations to mark the various vertical sections and to know the depths at these points. This instrument can hence be useful for quick and automatic depth reading, and is essential for current meter measurements in rivers passing heavy floods, where moving boat method is used for streamflow measurements.

Stevenson box is a water-depth recorder which may be used for measuring water depth in stream flow measurements. This instrument is hence very much concerned with streamflow measurements.

A **bubble gauge** is a permanent installation made on the bank of a stream to record water depths in the river (upto the reference level at the bed of the stream). Such an installation is hence not connected with streamflow measurements, though may be useful in computing Gauge-Discharge curves.

A (*viii*) Time taken from sowing of a crop to its harvesting is actually known as the crop period, while time between first watering and last watering before harvesting is the base period. The choices given at (1) and (4) are reverse, and hence do not match.

Kharif crops include all those crops which are grown during the summer (Kharif) season between April to September. Kharif crops, therefore includes **monsoon crops**, which are grown during the period 16th june to 15th october.

Years 2003 (*Winter*) Exam

Q. 1. *Match the List P with the List Q* (1 × 10)

List P	*List Q*
(*i*) Flow net	(*a*) Piping failure
(*ii*) Irrigation capacity	(*b*) Flood estimation
(*iii*) Isohyetal method	(*c*) Duty
(*iv*) Exit gradient	(*d*) River training
(*v*) Pan method	(*e*) Seepage control
(*vi*) Spurs	(*f*) Water-logging
(*vii*) Stilling basin	(*g*) Evaporation
(*viii*) Salinity problems	(*h*) Seepage characteristic
(*ix*) Rock toes	(*i*) Average rainfall
(*x*) Unit hydrograph	(*j*) Hydraulic energy

Q. B. *Select the correct answer for the following* (1 × 10)

(*i*) The ordinate of mass curve at any time is

(*a*) the ordinate of flood hydrograph at that time

(*b*) the area under flood hydrograph upto that time

(*c*) sum of the ordinates of flood hydrograph upto that time

(*d*) average of the area under flood hydrograph upto that time.

(*ii*) Base flow is

(*a*) the flow that seeps below the base of a dam

(*b*) the ground water flow that enters the aquifer

(*c*) the ground water flow that enters the river

(*d*) seepage flow across the earth dams.

(*iii*) Levees in the river training works are constructed

(*a*) parallel to the rive flow

(*b*) across the river flow

(*c*) inclined to the bank in U/S direction

(*d*) inclined to the bank in D/S direction.

(*iv*) Upstream and downstream cut-off at the weir base are meant to control

(*a*) seepage and uplift respectively

(*b*) uplift and seepage respectively

(*c*) exit gradient and uplift respectively

(*d*) uplift and exit gradient respectively.

(*v*) Sodium-Absorption Ratio (SAR) is expressed as

(*a*) $\dfrac{Na^+}{\left[\frac{1}{2}(Ca^{++}+Mg^{++})^2\right]}$ (*b*) $\dfrac{Na^+}{\left[\frac{1}{2}(Ca^{++}+Mg^{++})^{1/2}\right]}$

(*c*) $\dfrac{Na^+}{[(Ca^{++}+Mg^{++})^{1/2}]}$ (*d*) $\dfrac{Na^+}{[2(Ca^{++}+Mg^{++})^{1/2}]}$.

(*vi*) Balancing depth of a canal is achieved when

(*a*) the depth of cutting and height of embankment are equal

(*b*) the discharge in cutting section and between the embankment section are equal

(*c*) the volume of excavated portion and the banks is the same

(*d*) the discharge carried by the canal is maximum.

(*vii*) A land is said to be water-logged

(*a*) when the moisture content of the root zones rises to the field capacity of soil

(*b*) wen water-table touches the surface

(*c*) when water ponding occurs

(*d*) when pores of the root zone get saturated to cut-off air circulation.

(*viii*) Canal bed level is + 100 m and FSL is 104.5 m. Bed level of a natural drain crossing canal is 102.0 m and HFL is 106.0 m. Suitable cross-drainage work is :

(*a*) aqueduct (*b*) super-passage

(*c*) canal syphon (*d*) level crossing.

(*ix*) The upward acceleration of dam due to seismic activity will

(*a*) decrease the base pressure

(*b*) increase the base pressure

(*c*) not affect the effective weight of dam

(*d*) increase the horizontal dynamic force.

(*x*) A canal aligned at right angles to the contours is called

(*a*) ridge canal (*b*) contour canal

(*c*) branch canal (*d*) side slope canal.

Answers to Questions of 2003 (*Winter*) Exam

A (*i*)—(*h*)	(*ii*)—(*c*)	(*iii*)—(*i*)	(*iv*)—(*a*)
(*v*)—(*g*)	(*vi*)—(*d*)	(*vii*)—(*j*)	(*viii*)—(*f*)
(*ix*)—(*e*)	(*x*)—(*b*)		
B (*i*)—(*b*)	***B*** (*ii*)—(*c*)	***B*** (*iii*)—(*a*)	***B*** (*iv*)—(*d*)
B (*v*)—(*b*)	***B*** (*vi*)—(*c*)	***B*** (*vii*)—(*d*)	***B*** (*viii*)—(*c*)
B (*ix*)—(*b*)	***B*** (*x*)—(*d*)		

Year 2004 (*Summer*) Exam

Q1. (*i*) Match the following two lists.

List I	*List II*
A Sandy soil	1 Venturi Flume
B Hilly region	2 Drip irrigation
C Consumptive use	3 Contour farming
D Water flow measurement	4 Blaney-Criddle equation
	5 Storage capacity

Codes :

	A	B	C	D
(*a*)	1	2	3	4
(*b*)	2	3	5	1
(*c*)	3	2	5	4
(*d*)	2	3	4	1

Q2. Match the following two lists :

List I	*List II*
A Arch dam	1 Rock foundation
B Gravity dam	2 Strong abutment
C Earth dam	3 Any type of foundation
D Buttress dam	4 Multiple arch
	5 Sandy soils

Codes :

	A	B	C	D
(*a*)	2	1	3	4
(*b*)	2	3	4	5
(*c*)	1	2	4	5
(*d*)	4	2	3	1

Q3. Match the following two lists :

List I	*List II*
A Bandhara	1 Spurs
B Groynes	2 Anicut
C Weir	3 Maharastra
D Spillway	4 Ogee
	5 Punjab

Codes :

	A	B	C	D
(*a*)	2	5	4	3
(*b*)	3	4	5	1
(*c*)	3	1	2	4
(*d*)	1	2	4	3

Q4. *Which of the following pairs are correctly matched.*

1. C.D. structure, where canal bed level and drainage bed level are same – level crossing
2. C.D. structure, when it receive and discharge drainage water from a canal-Inlet and Outlet
3. C.D. structure when canal bed level is lower than drainage bed level – Aqueduct
4. C.D. structure when canal bed level is higher than drainage bed level-Super passage.

Codes :

(*a*) 1, 2, 3 ; (*b*) 1, 2, 4 ; (*c*) 1, 2, 3, 4 ; (*d*) 1, 2.

Q5. Assertion (A) : Thickness of u/s floor of weir is nominal

Reason (R) : Thickness of impervious floor is governed by net uplift pressure.

Codes :

(*a*) Both *A* and *R* are true but *R* is not correct explanation of *A*

(*b*) Both *A* and *R* are true but *R* is correct explanation of *A*

(*c*) *A* is true but *R* is false

(*d*) *A* is false but *R* is true

(*e*) Both are false.

Q6. The following structure serves as safety valve for the canal :

(*a*) head regulator (*b*) cross regulator

(*c*) escape (*d*) canal outlet

(*d*) module.

Q7. Base period of a particular crop is 120 days. If duty is 1500 ha/cumec, the delta is :

(*a*) 69 cm (*b*) 138 cm

(*c*) 35 cm (*d*) 54 cm

(*e*) 86.4 cm.

Q8. The following is *not* the basis for the design of an arch dam :

(*a*) thin cylinder theory (*b*) elastic theory

(*c*) unit column theory (*d*) trial load theory

(*e*) creep theory.

Q9. In the empirical formula, for estimating peak flow

$Q = CA^n$ match the value of n in Lists I and II

Dicken, Ryves, Inglis, Rational	List I
1, 1/2, 2/3, 3/4, 4/5	List II

Q10. The following type of lining material of canal is *not* exposed to atmosphere :

(*a*) cement concrete (*b*) tiles

(*c*) asphaltic concrete ; (*d*) bentonite clay membrane

(*e*) reinforced concrete.

Answers to Questions of 2004 (*Summer*) Exam

1. (*d*)	**2.** (*a*)	**3.** (*c*)	**4.** (*d*)
5. (*b*)	**6.** (*c*)	**7.** (*a*)	**8.** (*e*)

9. Dicken-3/4, Ryves-2/3, Inglis-1/2, Rational-1 **10.** (*e*).

Appendix Table A-I : Some Important Properties of Water

Temp. °C	Sp. gravity	Unit. wt. in kN/m^3 i.e. Sp. gravity × 9.807 ($S_s \cdot \rho_w$)	Vapour pressure kN/m^2	Viscosity	
				Dynamic or Absolute $kN\text{-}sec/m^2$	Kinematic $\left(\nu = \frac{\mu}{\rho}\right)$ $m^2/sec.$
0	0.99987	9.806	0.611	1.797×10^{-6}	1.78×10^{-6}
5	0.99999	9.807	0.872	1.517×10^{-6}	1.518×10^{-6}
10	0.99975	9.805	1.226	1.306×10^{-6}	1.310×10^{-6}
15	0.99907	9.800	1.703	1.126×10^{-6}	1.124×10^{-6}
20	0.99810	9.788	2.334	1.003×10^{-6}	1.009×10^{-6}
30	0.99574	9.765	4.609	0.802×10^{-6}	0.804×10^{-6}
40	0.99228	9.731	7.60	0.652×10^{-6}	0.654×10^{-6}
60	0.98338	9.644	19.34	0.470×10^{-6}	0.478×10^{-6}
80	0.97196	9.532	46.583	0.356×10^{-6}	0.366×10^{-6}
100	0.95865	9.401	101.50	0.282×10^{-6}	0.295×10^{-6}

Appended Table A-II : Other Important Properties of Water

Standard Atmospheric Pressure

$= P_{atm} = 760$ mm of Mercury

$= 1$ bar (b)

$= 1000$ m.b.

$= 101.325$ kPa*

$= 10.33$ m of water head**

Density of water (ρ) *at 4°C*

in MKS Units $= 1000\ kg/m^3$

in SI units $= 1000\ kg/m^3$

$^*P_{atm} = 760$ mm of Hg $= \frac{760}{1000}$ (m of Hg) $\times 13.595 \times 9.807\ kN/m^3$

$\because$ Unit wt of Hg $= S_s \cdot \rho_w = 13.595 \times 9.807\ kN/m^3$

$= 101.325\ kN/m^2$

$= \mathbf{101.325\ kPa}$

$^{**}P_{atm}$ = m of water height (h_w) × unit wt of water

$= h_w\ (m) \times 9.807\ kN/m^3 = 9.807\ h_w$

$\therefore \quad 101.325 = 9.987\ h_w$

$\therefore\ h_w = \mathbf{10.33\ m.}$

Unit weight of water (γ or w) at 4°C

in MKS units = 1000 kgf/m^3, usually written as 1000 kg/m^3

in SI Units = 9.807 kN/m^3

Dynamic Viscosity of water at 4°C

in MKS Units = 1.598×10^{-4} kgf. sec/m^2

in SI Units = 1.567×10^{-3} Ns/m^2

= 1.567×10^{-2} Poise (P)

Kinematic Viscosity of water (ν) at 4°C

in MKS Units = 1.567×10^{-6} m^2/s

in SI Units = 1.567×10^{-6} m^2/s

= 1.567×10^{-6} Stoke (St)

Appendix Table A-III. Water Resources Potentials of River Basins of India

Sl. No.	River Basin	Average Annual Surface Water Availability (50% dependability)		Utilisable Surface Water (at 75% dependability) excluding ground water	Utilisable or Replenishable Ground Water	Present Exploitation (storage)	
		Water Reesources Potential b.cum (BCM)	Per Capita (m^3)	b.cum (BCM)	b.cum	Surface water	Ground water
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(A) Major River Basins						
1.	Indus	73.30	1757	46.0	26.49	16.29	21.26
2.	Ganga-Brahmaputra-Meghna						
	(*a*) Ganga	525.02	1473	250.0	170.99	39.44	74.62
	(*b*) Brahmaputra	537.2	18417	24.0	26.55	2.33	4.74
	(*c*) Barak	48.4	7646				
		585.60					
3.	Godavari	110.54	2026	76.3	46.65	25.12	15.71
4.	Krishna	78.12	1312	58.0	26.41	41.80	11.91
5.	Cauvery	21.36	666	19.0	12.30	8.60	7.62
6.	Brahmani-Baitarani	28.48	2696	18.3	4.05	4.65	0.90
7.	Mahanadi	66.88	2546	50.0	16.46	12.33	3.44
8.	Pennar	6.31	648	6.9	4.93	2.65	2.27
9.	Mahi	11.02	1057	3.1	7.19	4.72	3.53
10.	Sabarmati	3.81	421	1.9	—	1.31	
11.	Narmada	45.64	2855	34.5	10.93	7.23	3.64
12.	Tapi	14.88	1091	14.5	8.27	9.41	4.30
	(B) Composite River Basins						
1.	Subernarekha	12.37	1392	6.8	1.82	0.67	0.42
2.	West Flowing rivers from Tapi to Tadri	87.41	3194	11.9	8.27	11.27	6.51
3.	West Flowing rivers from Tadri to Kanyakumari	113.53	3539	24.3	8.52	10.24	
4.	East Flowing rivers between Mahanadi and Pennar	22.52	919	13.1	18.22	1.60	11.66
5.	East Flowing rivers between Pennar and Kanyakumari	16.46	383	16.7	18.84	1.84	5.58
6.	West Flowing rivers of Kutch and Saurashtra including Luni	15.10	631	15.0	11.23	4.73	6.59
7.	Area of inland drainage in Rajasthan desert	negl.	—	—	—	—	—
8.	Minor rivers draining into Myanmar (Burma) and Bangladesh)	31.0	14616	—	—	0.31	—
	Total	1869.35	2214	690.3 Say 690	431.42 Say 432	**206-54***	184.70

* An additional live storage of 6.24 b.cum has been created through medium projects each having a capacity less than 10 Mcum (not included in above data) ; thus making a total storage of 212.78 b.cum ; say **213 b.cum**

Appendix Table A-IV : Fresh Water Supplies and their Storages on Different Rivers in India

Sl. No.	Name of the River Basin	Catchment area in Mha	Average annual flow in the river basins in b.cum	Live Storage Created/Likely to be Created in b.cum		
			50% Dependability	Through Completed projects (upto 2004)	Through Ongoing projects	Through projects under consideration
1	2		4	5	6	7
1.	Indus (Up to Border)	32.13	73.30	16.29	0.28	2.58
2.	(*a*) Ganga	86.15	525.02	39.46	21.22	30.08
	(*b*) Brahmaputra Barak and Others	23.61	585.60	2.33	9.35	41.26
3.	Godavari	31.28	110.54	25.12	6.21	5.84
4.	Krishna	25.89	78.12	41.80	7.74	1.31
5.	Cauvery	8.12	21.36	8.60	0.27	0.26
6.	Pennar	5.52	6.31	2.65	2.17	—
7.	East Flowing Rivers from Mahandi to Godavari and Krishna to Pennar	8.66	22.52	1.60	1.42	0.95
8.	East Flowing Rivers Between Pennar and Kanyakumari	10.01	16.46	1.84	0.07	—
9.	Mahanadi	14.16	66.88	12.33	1.87	10.09
10.	Brahamani and Baitarni	5.18	28.48	4.65	0.88	8.72
11.	Subernarekha	—	12.37	0.67	1.65	1.38
12.	Sabarmati	2.17	3.81	1.31	0.66	0.10
13.	Mahi	3.48	11.02	4.72	0.26	0.01
14.	West Flowing Rivers of Kutch, Saurashtra including Luni	32.19	15.10	4.73	0.80	2.85
15.	Narmada	9.88	45.64	7.23	16.38	0.47
16.	Tapi	6.51	14.88	9.41	0.85	0.29
17.	West Flowing Rivers from Tapi to Tadri	5.29	87.41	11.27	3.46	0.08
18.	West Flowing Rivers from Tadri to Kanyakumari	5.62	113.53	10.24	1.32	1.45
19.	Area of Inland Drainage in Rajasthan desert	6.0	Negligible	—	—	—
20.	Minor River Basins draining into Bangladesh and Burma	3.63	31.00	0.31	—	Negligible
	Total		**1869.35**	206.54	76.26	107.54

* Additional 6.24 b.cum storage is created through medium projects having live storage of less then 0.01 b.cum which have not been accounted here, thus creating a total storage of 212.78; say **213 b.cum**

Appendix Table A-V : Statewise Position of Live Storages Created and Likely to be Created in b.cum (2004)

S. No.	*State*	*Live storage Created in in b. cum through completed projects*	*Live storages to be created in b.cum through ongoing projects*	*Live storage to be created through projects under consideration*
1.	Andhra Pradesh	27.305	6.148	1.611
2.	Arunachal Pradesh	Nil	0.241	37.934
3.	Assam	0.012	Nil	0.726
4.	Bihar	1.842	0.675	5.822
5.	Chatisgarh	6.217	0.788	0.819
6.	Goa	0.044	0.217	Nil
7.	Gujarat	16.138	7.407	3.446
8.	Haryana	Nil	Nil	0.258
9.	Himachal Pradesh	13.917	0.189	0.986
10.	Jammu & Kashmir	Nil	0.094	1.832
11.	Jharkhand	2.472	6.878	0.476
12.	Karnataka	33.631	1.413	0.066
13.	Kerala	5.384	1.336	1.686
14.	Madhya Pradesh i/c Chhatisgarh	17.156	16.776	7.335
15.	Maharashtra	25.523	13.243	0.763
16.	Manipur	0.397	8.450	Nil
17.	Meghalaya	0.698	Nil	0.516
18.	Mizoram	Nil	0.663	1.561
19.	Nagaland	1.220	Nil	0.526
20.	Orissa	17.225	1.998	21.100
21.	Punjab	2.369	Nil	Nil
22.	Rajasthan	8.285	1.426	1.807
23.	Sikkim	Nil	Nil	0.001
24.	Tamil Nadu	6.501	0.068	0.013
25.	Tripura	0.312	Nil	Nil
26.	Uttranchal	3.056	5.341	154.00
27.	Uttar Pradesh	15.345	2.712	18.407
28.	West Bangal	1.475	0.184	Nil
29.	Andaman & Nicobar island (U.T.)	Nil	Nil	Nil
30.	Chandigarh (U.T.)	Nil	Nil	Nil
31.	Dadar Nagar Haveli (U.T.)	Nil	Nil	Nil
32.	Daman & Diu (U.T.)	Nil	Nil	Nil
33.	N.C.T of Delhi	Nil	Nil	Nil
34.	Lakshdeep (U.T.)	Nil	Nil	Nil
35.	Pondicherry	0.014	Nil	Nil
	Total	206.548 Say 206.54 b.cum*	76.257 Say 76.26 b.cum	107.545 Say 107.54 b.cum

* An additional live storage capacity of 6.24 b.cum is estimated to have been created through medium projects, each having capacity of less than 0.010 b.cum (which are not included here, thus making total storage capacity of **212.78 ; say 213 b.cum** in completed projects.

Appendix Table A-VI : Levels/Capacities of Important Dam Reservoirs of India

S. No.	Name of Reservoir	Location	Dead Storage level in m	Full reservoir level in m	Capacity at Dead Storage level in M.cum	Capacity at Full Reservoir level in M. cum
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Nagarjunasagar	A.P.	149.05	179.83	4719	11561
2.	Sriram Sagar	A.P.	324.31 (MDDL)	332.54	849	3454
3.	Srisailum	A.P.	214.88	269.75	434	8722
4.	Ukai	Gujarat	82.30	105.16	1411	8511
5.	Sabarmati	Gujarat	170.90	189.58	54	908
6.	Kadana	Gujarat	99.08	127.71	340	1542
7.	Krishnarajasagar	Karnataka	18.29	38.04	125	1400
8.	Linganamakki	Karnataka	527.30	554.43	295	4497
9.	Tungabhadra	Karnataka	472. 44	49.74	2	3429
10.	Ghataprabha (Hidkal)	Karnataka	629.11	662.95	60	1440
11.	Malaprabha	Karnataka	619.35	633.83	96	1068
12.	Kabini	Karnataka	674.57	694.33	100	553
13.	Bhadra	Karnataka	30.48	56.70	241	26
14.	Idukki	Kerala	681.23	732.43	292	997
15.	Gandhi Sagar	M.P.	381.00	399.90	586	7413
16.	Tawa	M.P.	334.24	355.40	263	2312
17.	Mahandadi	M.P.	336.21	348.70	144	811
18.	Jayal wadi	Maharashtra	452.17	463.91	352	2909
19.	Khadakvasla	Maharashtra	574. 24	582.47	0	86
20.	Koyna	Maharashtra	609.60	657.91	120	2797
21.	Hirakud	Orissa	179.83	192.02	2318	8146
22.	Machkund	Orissa	818.35	838.16	78	971
23.	Balimala	Orissa	438.91	462.08	934	3610
24.	Salandi	Orissa	50.30	80.30	8	566
25.	Gobind Sagar	H.P.	445.62	515.11	95	9351
26.	Pong Dam	H.P.	384.00	436.70	1288	8579
27.	Rana Pratap Sagar	Rajasthan	342.90	352.91	1332	2905
28.	Lower Bhawani	Tamil Nadu	248.41	280.22	0	929
29.	Mettur	Tamil Nadu	204.22	240.79	62	2647
30.	Vaigai	Tamil Nadu	257.56	279.20	1	193
31.	Parambikulam	Tamil Nadu	534.31	556.26	125	505
32.	Adiyar	Tamil Nadu	283.46	320.04	0	109
33.	Matatila	U.P.	295.65	308.46	50	883
34.	Ramganga	U.P.	323.00	365.30	395	2448
35.	Rihand	U.P.	236.22	268.22	1640	10607
36.	Mayurkshi	West Bengal	106.38	121.31	68	617
37.	Kangsabati	West Bengal	120.43	134.14	138	52
38.	Maithon	DVC	132.59	146.30* / 152.40	165	1275
39.	Panchet Hill	DVC	119.48	120.47*	170	1475
40.	Konar DVC	DVC	410.57	427.94	61	336
41.	Tilaiya	DVC	363.32	372.47	75	394

*In case of Maithon and Panchet reservoirs, F.R. levels are given without and with flood storage, both.

Appendix Table A-VII : The Highest Dams of the World

S. No.	*Name of the Dam*	*Country where situated*	*Type of Dam*	*Height in metres*	*Year in which completed*
1	Jafar Masadi dam (Sahid Yaqobi)	Iran	Earth dam	611	1996
2	Rogun dam	Russia	—do—	335	
3	Nurek dam	Russia	—do—	300	1961
4	**Grand Dixence dam**	Switzerland	Gravity dam	285*	1961
5	Inguri dam	Russia	Arch dam	272	1980
6	Vaiont dam	Italy	Arch dam	262	1961
7	Chicoasen dam	Mexico	Earth/Rockfill dam	261	1980
8	Kambaratinish dam	Russia	—do—	255	—
9	Mauvoisin dam	Switzerland	Erch dam	250	1990
10	Guavio dam	Colombia	Earth/Rockfill	250	1990
11	Sayano- Shushensk dam	Russia	Arch/gravity	245	1989
12	Mica dam	Canada	Earth/Rockfll	242	1973
13	Chivor dam (La Esmeraisa)	Colombia	Rockfill	237	1975
14	Oroviolle dam	USA	Earth dam	235	1963
15	Chirkey dam	Russia	Arch dam	233	1975
16	**Bhakra dam**	India	Gravity dam	226**	1963
17	Luzzone dam	Switzerland	Arch dam	225	1998
18	Hoover dam	USA	Arch/gravity dam	223	1936
19	Contra dam	Switzerland	Arch dam	220	1965
20	Mrantinje dam	Yogoslavia	Arch dam	220	1976
21	Dworshak dam	USA	Gravity dam	219	1973
22	Glen Canyan dam	USA	Arch dam	216	1964
23	Toktogul dam	Russia	Gravity dam	215	1978
24	Daniel Johnson dam	Canada	Multi arch dam	214	1968
25	Manicouagan 5PA dam	Canada	Multi arch dam	214	1989

* Grand Dixence is at present, the highest existing concrete gravity dam of the world.

** Bhakra dam is the highest concrete gravity dam of India, and is the second highest such dam in the world.

Appendix Table A-VIII : Largest Dams of the World

S. No.	*Name of the Dam*	*Type of Dam*	*Country where Situated*	*App. Vol. of Fill Material in M. cum.*	*Year in which completed*
1	Katum dam	Earth/Rock fill	Russia	4742	—
2	635 dam	Earthfill	China	458	2000
3	Ali E-delvari (Jarreh) dam	Arch	Iran	395	—
4	Sihwaho dam	Barrage Mobile (Moveable dam)	Korea (Republic)	342	1996
5	Talequan dam	Earth	Iran	329	—
6	Chapeton dam	Gravity	Argentina	296	—
7	Youngamho dam	Gravity	Korea (Republic)	245	1993
8	Penzadahe Khurded dam	Earth	Iran	175	—
9	Gumganho	Gravity	Korea (Republic)	138	1990
10	Tarbela dam	Earth/Rockfill	Pakistan	129	1976
11	Kambaratunsk	Gravity	Russia	112	—
12	Fortpeck dam	Rockfill	USA	96	1957
13	Cipasang dam	Earth/Rockfill	Indonesia	90	—
14	Ataturk dam	Rockfill	Turkey	85	1992
15	Yacyreta Apipe dam	Gravity	Argentina	68	—
16	Lee dam	Earthfill	Zimbabwe	66	—
17	Gardiner dam	Earthfill	Canada	65	1968
18	Afslulidijk	Earth	Netherland	63	1932
19	San Luis dam	Rockfill	USA	59	1967
20	Nurek dam	Earthfill	Russia	58	1980
21	**Nagarjuna Sagar dam**	Masonry gravity	India	56**	1976
22	Xiaolangdi dam	Rockfill	China	52	2002
23	Garrison dam	Rockfill	USA	51	1956
24	Oostersch-idekerng dam	Gravity	Netherland	50	1986
25	Cochiti dam	Rockfill	USA	50	1975

*Maximum Volume

**Nagarjuna Sagar dam across Krishna river is the largest dam of India, and is the highest masonry dam of the world (124.7 m high). As against this, Hirakud dam across Mahanadi river is the longest earthen dam of the world (25.3 km long).

Appendix Table A-IX : Useful Conversions Between Different Units

Length

1 metre = 3.281 ft ; 1 ft = 0.3048 m
1 km = 0.622 mi ; 1 mi = 1.6093 km
1 cm = 0.394 in ; 1 in = 2.54 cm
1 mm = 1000 μ (micron) 1 micron (μ) = 10^{-6} m

Area

1 m^2 = 10.761 ft^2 ; 1 ft^2 = 0.0929 m^2
1 km^2 = 10^6 m^2 = 100 ha 1 mi^2 = 2.59 km^2
= 0.386 mi^2 = 247 acres = 251 ha
= 640 acres
1 ha = 10^4 m^2 1 acre = 4840 sq. yards
= 2.47 acres ; = 0.4047 ha

Volume and Discharge

1 m^3 = 35.307 ft^3 ; 1 ft^3 = 0.02832 m^3
1 ha.m = 8.13 acre ft. **1 acre ft** = 43560 ft^3
= 1233.6 m^3
= 0. 123 ham
= $\frac{1}{2}$ **cusec day**

1 m^3 = 1000 litres (*L*) **1 gallon** (*i.e.* imp gallon) = 4.546 litres
1 *L* = 1.76 pints (imp)
= 0.22 gallon (imp) 1 U.S. gallon = 3.785 litres.
1 cumec = 35.307 cusec ; 1 cusec = 0.02832 cumec
or 1 cusec = 28.32 L/s
or 1 cusec = 2.447 MLD (million litre per day)
or 1 cusec = 0.538 MGD (million gallon per day)
1 MGD = 1.86 cusec.

Force

1 kg wt = 9.807 N (Newton) : 1 N = 0.102 kg wt
1 gm wt = 980.7 dynes
1 lb wt = 32.2 poundals
1 kg wt = 2.204 lb wt.

1 kg (w) = 9.807 N = 2.204 lb (wt) = 9.807×10^5 dynes

or

1 N = 0.102 kg (wt) = 0.2247 lb (wt) = 10^5 dynes

1 poundal = 138.26 dynes = 14.102 gm (wt).

Pressure

Units : N/m^2 = Pascal (*Pa*) ; kg/m^2 (*i.e.* kgf/m^2) : lb wt/ft^2

1 kg/m^2 = 9.807 N/m^2 1 P_a = 1 N/m^2 = 0.102 kg/m^2
= 9.807 P_a 1 kP_a = 102 kg/cm^2

1 kg/cm^2 = 10^4 kg/m^2 100 kp_a = 10,200 kg/m^2
= 1.02 kg/cm^2

1 Atmosphere
= 760 mm of Hg
= 1 bar = 1000 mb
= 101.325 kPa = 1.033 kg/cm^2
= 10.33 m water head

1 kg/cm^2 = 98.07 kP_a = 10 m of water	100 kP_a = 1.02 kg/cm^2 = 10.2 m of water

1 lb/ft^2 = 47.88 k.P_a 100 k.P_a = 2.089 lb/ft^2
= 16.02 ft of water = 33.45 ft of water
1 psi = 1 lb/in^2 = 0.0703 kg/cm^2
1 lb/ft^2 = 4.882 kg/m^2 1 kg/cm^2 = 14.22 psi
1 kg/m^2 = 0.205 lb/ft^2

Density (ρ)

1 kg/m^3 = 0.0624 lb/cft ; 1 lb/cft = 16.02 kg/m^3

Unit wt. (γ or w = ρ. g.)

Units. N/m^3, kg/m^3 (*i.e.* kg-f/m^3) ; lb wt/ft^3

1 kg/m^3 (*i.e.* kg wt/m^3) 1 N/m^3 = 0.102 kg/m^3
= 9.807 N/m^3

Engery

Units : Joule (N.m) ; kg (wt.) m; lb (wt). m

1 Joule (j) = 1 Nm
1 kg (wt) m = 9.807 N.m
i.e. 1 kg (wt) m = 9.807 J ; 1 J = 0.102 kg (wt) m
1 ft lb (wt) = 0.138 kg (wt) m = 1.356 J
1 kg (wt) m = 7.23 ft lb (wt) = 9.807 J
1 J = 0.102 kg (wt) m = 0.737 ft lb (wt)

Power

Units : J/s ; kgm/sec ; ft lb/sec

1 J/s = 1 watt.
1 J/s = 1 N.m/s = 1 watt = 0.102 kg (wt) m/sec = 0.737 ft lb (wt)/sec
1 HP (fps) = 550 ft lbs/sec = 746 J/s = 746 watts.
1 HP (metric) = 75 kg (wt) m/sec = 75 × 9.807 = 735 J/s = 735 watts.

Dynamic Viscosity (μ or η)

Units : $N.s/m^2$; $kgf.sec/m^2$; dyne sec/cm^2 (Poise)

1 $N{\cdot}s/m^2$ = 1 Pa.s = 10 Poise = 0.102 kgf sec/m^2

1 dyne. sec/cm^2 (Poise) = 0.0102 kgf sec/m^2

Kinematic Viscosity (v)

Units : m^2/s ; m^2/sec ; cm^2/sec (Stoke)

1 $m^2/s = 10^4$ $cm^2/sec = 10^4$ Stoke (S)

1 centi stoke (CS) = $\frac{1}{100} S$