This problem corresponds to PEENPP chapter 7, problem number 12.

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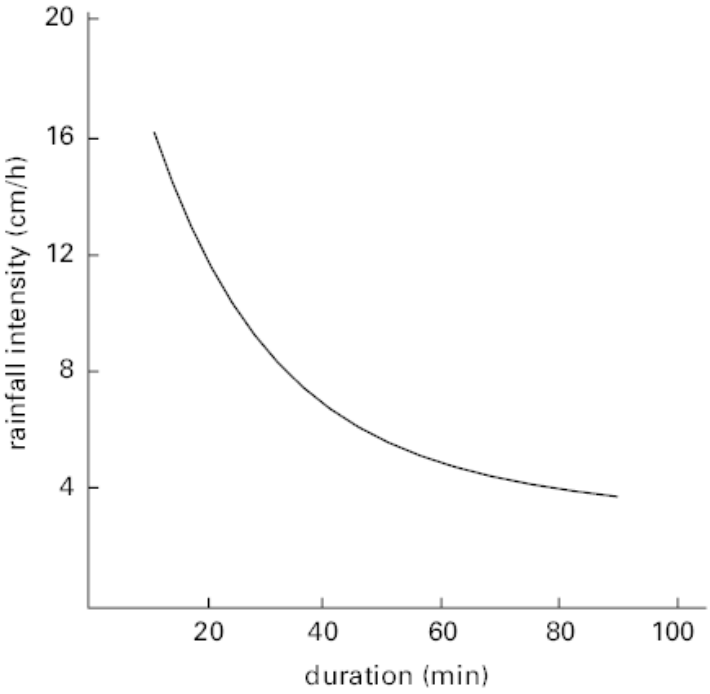
Test Bank Question preview

Question

A watershed occupies a 30 ha site. 18 ha of the site have been cleared and are used for pasture land; 1 ha is occupied by farm buildings, a house, and paved surfaces; the remaining 11 ha are woodland. The average land slope is 2.1%. Because the site is upland from a residential development, the rainfall runoff from the site is collected in a catchment that discharges directly to a culvert. The overland flow distance to the catchment is 212 m. The 20 yr storm is characterized by the intensity duration curve presented in the figure.



For a 15 min storm duration and average runoff coefficient of 0.18, the time of overland flow for the watershed is most nearly

Answers

(A) ~~5.6~~ min

(B) ~~18~~ min

(C) ~~26~~ min

(D) ~~47~~ min

The answer is (B).

Solution

Content in blue refers to the NCEES Handbook.

From the figure, for a storm duration of 15 min, rainfall intensity, *i*, is 14 cm/hr.

QUESTION DATA

Vendor
0000153298
Solving Time

Difficulty
easy
Quantitative?
No
Status
Active
Created On
03/04/2019 11:34:57 PM
Published On
03/04/2019 11:34:57 PM
Modified On
05/23/2019 05:00:56 PM
OTHER VERSIONS

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$$i = \frac{14 \ \frac{\text{cm}}{\text{hr}}}{2.54 \ \frac{\text{cm}}{\text{in}}} = 5.51 \ \text{in/hr}$$

Find the time of overland flow.

$$\begin{aligned}
t_i &= \text{time of overland flow, min} \\
C &= \text{runoff coefficient} = 0.18 \\
L &= \text{overland flow distance} \\
&= (212 \ \text{m}) \left(3.28 \ \tfrac{\text{ft}}{\text{m}}\right) = 696 \ \text{ft} \\
S &= \text{slope} = 2.1\%
\end{aligned}$$

Time of Concentration

$$\begin{aligned}
t_i &= C\left(L / S \, i^2\right)^{1/3} \\
&= (0.18) \left(\left(\frac{696 \ \text{ft}}{0.021 \ \frac{\text{ft}}{\text{ft}}} \right) (5.51 \ \tfrac{\text{in}}{\text{hr}})^2 \right)^{1/3} \\
&= 18 \ \text{min}
\end{aligned}$$

This problem corresponds to PEENPP chapter 2, problem number 5.

Test Bank

Question preview

Question

A sharp-edged flow-restricting orifice with a 2 cm opening is placed inside a 5 cm pipe. The orifice coefficient is most nearly

Answers

(A) 0.58

(B) 0.61

(C) 0.63

(D) 0.65

The answer is (C).

Solution

Content in blue refers to the NCEES Handbook.

Find the coefficients of velocity and contraction for a sharp-edged orifice. [Orifices]

$$C_{\text{v}} = \text{coefficient of velocity} = 0.98$$
$$C_c = \text{coefficient of contraction} = 0.62$$

Calculate the orifice coefficient.

$$C = \text{orifice coefficient}$$
$$A_0 = \text{orifice opening cross-sectional area or orifice diameter} = 2 \text{ cm}$$
$$A_1 = \text{pipe cross-sectional area or pipe diameter} = 5 \text{ cm}$$

$$C = \frac{C_{\text{v}} C_c}{\sqrt{1 - C_c^2 (A_0/A_1)^2}}$$
$$= \frac{(0.98)(0.62)}{\sqrt{1 - (0.62)^2 \left(\frac{2 \text{ cm}}{5 \text{ cm}}\right)^2}}$$
$$= 0.63$$

QUESTION DATA

Vendor
0000158383

Solving Time

Difficulty
easy

Quantitative?
No

Status
Active

Created On
10/10/2018 07:05:37 PM

Published On
10/10/2018 07:05:37 PM

Modified On
05/23/2019 05:00:53 PM

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This problem corresponds to PEENPP Chapter 40, problem number 6.

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Test Bank Question preview

Question

The chemical characterization of a municipal solid waste is summarized in the following table. The chemical characterization is based on typical published values for the waste components listed.

waste component	dry mass (kg/100 kg)	dry elemental chemical composition (%)						
	C	H	O	N	S	ash		
food	4.9	48.0		6.4	37.6	2.6	0.4	5.0
glass/metal	3.2		–	–	–	–	–	100
paper	12.6	43.5		6.0	44.0	0.3	0.2	6.0
plastic	8.7	60.0		7.2	22.8	–	–	10
wood debris	2.1	49.5		6.0	42.7	0.2	0.1	1.5
yard clippings	29.5	47.8		6.0	38.0	3.4	0.3	4.5

If the energy content of the solid waste is represented by 333C + 1428(H − O/8) + 95S, the ash-free energy content of the waste is most nearly

Answers

(A) 2100 kJ/kg

(B) 12 000 kJ/kg

(C) 110 000 kJ/kg

(D) 240 000 kJ/kg

The answer is (B).

Solution

The energy content in kJ/kg is

QUESTION DATA

Vendor
0000153878
Solving Time

Difficulty
easy
Quantitative?
No
Status
Active
Created On
10/10/2018 07:07:28 PM
Published On
10/10/2018 07:07:28 PM
Modified On
08/27/2020 09:14:40 PM
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PRODUCTS USED IN

$$337\text{C} + (1428)\left(\text{H} - \frac{\text{O}}{8}\right) + 95\text{S}$$

$$\text{C, H, O, S} = \text{elements, \% of total}$$

Find the mass of each component using a 100 kg sample as the basis for calculations.

waste component	dry mass (kg/100 kg)	elemental chemical mass(kg/100 kg)				
C	H	O	N	S		
food	4.9	2.4	0.31	1.8	0.13	0.020
glass/metal	3.2	–	–	–	–	–
paper	12.6	5.5	0.76	5.5	0.038	0.025
plastic	8.7	5.2	0.63	2.0	–	–
wood debris	2.1	1.0	0.13	0.90	0.0042	0.0021
yard clippings						
	61	28	3.6	21	1.2	0.14

The moisture content is

$$100\text{ kg} - 61\text{ kg} = 39\text{ kg}$$

The chemical content of moisture is

$$\text{hydrogen} = \left(\frac{2}{18}\right)(39\text{ kg}) = 4.3\text{ kg}$$

$$\text{oxygen} = \left(\frac{16}{18}\right)(39\text{ kg}) = 34.7\text{ kg}$$

The total hydrogen is

$$3.6\text{ kg} + 4.3\text{ kg} = 7.9\text{ kg}$$

The total oxygen is

$$21\text{ kg} + 34.7\text{ kg} = 56\text{ kg}$$

From the values in the table of mass of each component in the 100 kg sample, the following table can be derived.

element	mass (kg)	mole weight(kg/kmol)	kmol	% mass
carbon	28	12	2.3	30

element	mass (kg)	mole weight(kg/kmol)	kmol	% mass
hydrogen	7.9	1	7.9	8.5
oxygen	56	16	3.5	60
nitrogen	1.2	14	0.086	1.3
sulfur	_____	32	0.0044	_____
	93			99.95

From the percent mass in the table, the energy content is

$$\begin{aligned}&(337)(30) + (1428)\left(8.5 - \frac{60}{8}\right) + (95)(0.15)\\ &= 11\,552\ \mathrm{kJ/kg} \quad (12\,000\ \mathrm{kJ/kg})\end{aligned}$$

Erratum 4592

Test Bank Question 0000153878

Question Table

Table 1

		Dry Elemental Chemical Composition (%)					
Waste Component	Dry Mass (kg/100kg)	C	H	O	N	S	Ash
Food	4.9	48.0	6.4	37.6	2.6	0.4	5.0
Glass/Metal	3.2	--	--	--	--	--	100
Paper	12.6	43.5	6.0	44.0	0.3	0.2	6.0
Plastic	8.7	60.0	7.2	22.8	--	--	10
Wood Debris	2.1	49.5	6.0	42.7	0.2	0.1	1.5
Yard Clippings	29.5	47.8	6.0	38.0	3.4	0.3	4.5

Answer Table

Table 2

		Dry Elemental Chemical Composition (%)			
Waste Component	Dry Mass (kg/100kg)	C	H	O	N
Food	4.9	2.4	0.31	1.8	0.13
Glass/Metal	3.2	--	--	--	--
Paper	12.6	5.5	0.76	5.5	0.038
Plastic	8.7	5.2	0.63	2.0	--
Wood Debris	2.1	1.0	0.13	0.90	0.0042
Yard Clippings	--	--	--	--	--
	61	28	3.6	21	1.2

This problem corresponds to PEENPP Chapter 25, problem number 10.

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Test Bank Question preview

Question

For a partial pressure of water vapor of 0.023 atm, what is the mass of water vapor in 100 kg of dry air at 1 atm and 20°C?

Answers

(A) ~~1.43~~ g/100 kg

(B) ~~1.46~~ g/100 kg

(C) ~~2.30~~ g/100 kg

(D) ~~6.08~~ g/100 kg

The answer is (B).

Solution

Content in blue refers to the NCEES Handbook.

$$P_a = \text{partial pressure of dry air, atm}$$
$$P_v = \text{partial pressure of water vapor} = 0.023 \text{ atm}$$
$$P = \text{pressure of air-water mixture} = 1 \text{ atm}$$

Psychrometrics

$$P = P_a + P_v$$
$$P_a = P - P_v = 1 \text{ atm} - 0.023 \text{ atm}$$
$$= 0.977 \text{ atm}$$

Psychrometrics

$$\omega = \text{specific humidity}$$

$$\omega = 0.622 P_v / P_a$$
$$= (0.622)\left(\frac{0.023 \text{ atm}}{0.977 \text{ atm}}\right)$$
$$= 0.0146 \text{ or } 0.0146 \text{ g water vapor/g dry air}$$

$$m_a = \text{mass of dry air}$$
$$m_v = \text{mass of water vapor}$$

Let m_a = 100 kg.

Psychrometrics

QUESTION DATA

Vendor
0000158394
Solving Time

Difficulty
easy
Quantitative?
Yes
Status
Active
Created On
03/04/2019 11:35:11 PM
Published On
03/04/2019 11:35:11 PM
Modified On
05/23/2019 05:01:08 PM

OTHER VERSIONS

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FE Chemical (/admin/questions/index?sfield=discipline&stext=Chemical)

KNOWLEDGE AREAS

Fluid Mechanics/Dynamics (/admin/questions/index?sfield=area&stext=Fluid Mechanics/Dynamics)

PRODUCTS USED IN

$$
\begin{aligned}
\omega &= m_v / m_a \\
m_v &= \omega m_a \\
&= \left(0.0146 \ \frac{\text{g}}{\text{g}} \right) (100 \text{ kg}) \\
&= 1.46 \ \text{g water vapor in 100 kg air} \quad (\sout{1.46} \ \text{g}/100 \text{ kg})
\end{aligned}
$$

This problem corresponds to PEENPP Chapter 62, problem number 5.

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Test Bank Question preview

Question

A maintenance facility is constructed at a cost of $7,800,000 with financing at 4% interest over a five-year term. The facility has the following anticipated annual operating costs also financed at a 4% annual interest rate.

year	cost
1	$430,000
2	$440,000
3	$480,000
4	$510,000
5	$560,000

The equivalent uniform annual cost of the facility is most nearly

Answers

(A) $701,000

(B) $894,000

(C) $1,185,000

(D) $2,233,000

The answer is (B).

Solution

Content in blue refers to the NCEES Handbook.

The gradient is not uniform, so the uniform annual cost needs to be calculated for each year. Calculate the total present value then calculate the uniform annual cost based on the total present value. The first-year operating cost is not realized until the end of the year. [Economics]

$$P = (P/F, 4\%, x \text{ yr})\, F$$

Using a factor table, for *i* = 4%,

year 1: $P = (0.9615)\,(\$430{,}000) = \$413{,}445$

year 2: $P = (0.9246)\,(\$440{,}000) = \$406{,}824$

year 3: $P = (0.8890)\,(\$480{,}000) = \$426{,}720$

year 4: $P = (0.8548)\,(\$510{,}000) = \$435{,}948$

year 5: $P = (0.8219)\,(\$560{,}000) = \$460{,}264$

QUESTION DATA

Vendor
0000162719
Solving Time

Difficulty
easy
Quantitative?
No
Status
Active
Created On
05/23/2019 05:01:36 PM
Published On
05/23/2019 05:01:36 PM
Modified On
08/27/2020 09:14:57 PM
OTHER VERSIONS

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DISCIPLINES
KNOWLEDGE AREAS
PRODUCTS USED IN

Calculate total present value.

$$\begin{aligned} P &= \$7{,}800{,}000 + \$413{,}445 + \$406{,}824 \\ &\quad + \$426{,}720 + \$435{,}948 + \$460{,}264 \\ &= \$9{,}943{,}200 \end{aligned}$$

Calculate the uniform annual cost. [Economics]

$$\cancel{A} = (\cancel{A/P}, 4\%, 5 \text{ yr})\, \cancel{P}$$

Using a factor table, for *i* = 4%,

$$A = (0.2246)\,(\$9{,}943{,}200) = \$2{,}233{,}240 \quad (\$2{,}233{,}000)$$