

Solutions to Practice Examination #2: Morning Session

Question 101: Open channel Hydraulics

(Answer D)

References: Isco Open Channel Flow Measurement Handbook

$$Q(m^3 / dy) = 158832[L - 0.2H]H^{1.5}$$

$$Q(m^3 / dy) = 158832[0.8 - 0.2(0.265)](0.265)^{1.5}$$

$$Q(m^3 / dy) = 16,182$$

Question 102: Principles of hydrology

(Answer A)

References: Most hydrology and non-point environmental engineering texts

$$K = \frac{Q}{2 \Pi b(h_2 - h_1)} \ln \frac{r_2}{r_1}$$

Datum :

$$h_0 = 80 - 38 = 42 \text{ ft}$$

$$h_w = 42 - 24 = 18 \text{ ft}$$

$$h_1 = 42 - 16.1 = 25.9 \text{ ft}$$

$$h_2 = 42 - 9.2 = 32.8 \text{ ft}$$

$$K = \frac{0.3 \text{ cfs}}{2 \Pi (30 \text{ ft})(32.8 - 25.9)} \ln \left[\frac{92}{41} \right]$$

$$K = 1.86 \times 10^{-4} \text{ ft / s}$$

Question 103: open channel hydraulics

(Answer D)

Due to supercritical flow conditions, a hydraulic jump could be used to dissipate energy. The jump should occur in the stilling basin to avoid erosion, open entry to the natural channel.

Question 104: Soil Mechanics

(Answer C)

References: Soil Mechanics texts (e.g. Principles of Geotechnical Engineering – Das, 1994) and/or

Fluid Mechanics texts:

$$\gamma_{\text{sat}} = [(G_s + S \cdot e) * \gamma_w] / [1 + e], \text{ where:}$$

γ_{sat} = saturated unit weight (lbs/ft³),

G_s = specific gravity of the soil (dimensionless),

S = soil saturation percentage (decimal),

e = void ratio of the soil (decimal), and,

γ_w = unit weight of water (lbs/ft³).

Therefore,

$$\gamma_{\text{sat}} = [(2.75 + (1.0 * 0.5)) * 62.4 \text{ lbs/ft}^3] / [1 + 0.5],$$

$$\gamma_{\text{sat}} = [202.8 \text{ lbs/ft}^3] / [1.5],$$

$$\gamma_{\text{sat}} = 135.2 \text{ lbs/ft}^3; \text{ Ans. (c)}$$

Solutions to Practice Examination #2: Morning Session

Question 105: slope stabilization

(Answer B)

References: Soil Mechanics texts (e.g. Principles of Geotechnical Engineering – Das, 1994) and/or

Fluid Mechanics texts:

$Q_u = k * H * (N_f / N_e)$, where:

Q_u = (total) volumetric flow rate per unit length [$\text{ft}^3 / (\text{ft} * \text{min.})$],

k = permeability of the soil (ft./min.)

H = total head loss across the section (ft.),

N_f = number of flow channels (dimensionless), and,

N_e = number of equipotential drops (dimensionless).

Since the excavation is symmetrical about the centerline, this represents a flow line equivalent to an impervious boundary. Each of the two sides can be considered a separate flow net with $N_f / N_e = 2 / 6$.

Therefore, the above equation becomes:

$$Q_u = (0.1 \text{ ft./min.}) * (12 \text{ ft.}) * (2/6) * 2 \text{ sides} = 0.8 \text{ ft}^3/(\text{ft} * \text{min.}),$$

Now, over 100 linear feet of excavation, $Q_{\text{total}} = Q_u * 100 \text{ ft.} = 80 \text{ ft}^3/\text{min.}$; Ans.

(b)

Question 106: Soil physics

(Answer C)

References: USDA – NRCS National Engineering Handbook – Part 651 Agricultural Waste Management Field Handbook, Appendix 10D-Geotechnical, Design, and Construction Guidelines

$$v = ki$$

v = specific discharge, (inches/day),

k = hydraulic conductivity, (inches/day),

i = gradient = $(H + d)/d$, (inch/inch),

H = head = fluid depth, (inches),

d = soil liner thickness, (inches)

Therefore,

$$0.25 \text{ inches/day} = (1.9 \times 10^{-6} \text{ cm/s})(34015.75 \text{ inches/day}/(\text{cm/s}))((1212.0 - 1200.0 \text{ ft})(12 \text{ in/ft}) + d)/d,$$

$$0.18537(d) = 0.77556,$$

$$\delta = 50.2 \text{ inches}; \text{ Ans. (c)}$$

Question 107: Principles of irrigation

(Answer B)

References: ASAE Standards, S376.2 or general irrigation texts –

Solutions to Practice Examination #2: Morning Session

Thrust blocking is required where the pipe changes slope.

Question 108: Agricultural Mechanization (Answer: C)

Question 109: Machine Soil Interactions

Question 110: Stability Analysis

Question 111: Machine Commodity Interactions

Question 112: Agricultural Mechanization

Question 113: Machine Component Design

Question 114: Stress Strain Relationships

Question 115.

Question 116: Mass Transfer between phases (Answer C)

Reference: psychrometric chart

State point of air, move up to saturation line along a line of constant wet bulb.

Question 117: Principles of post harvest storage (Answer D)

Reference: ASAE D245.5 Moisture relationships of plant-based agricultural products. (ASAE Standards)

13% moisture is the equilibrium moisture content for 20°C and 60% relative humidity.

Question 118: Bulk solids characterization (Answer C)

Solids content or the complement moisture content is a primary factor affecting the fluidity and handling character of manure.

References: NRCS Agricultural Waste Field Handbook

Question 120: Structural Analysis (Answer A)

Question 121: Structural loads and standards (Answer D)

Question 122: Structural loads and standards (Answer C)

Question 123: Construction materials (Answer C)

Many factors affect concrete strength but w:c ratio is by far the most important.

Question 124: Functional and space requirements for agriculture (Answer B)

References Midwest plan services publications

Solutions to Practice Examination #2: Morning Session

Finishing pigs should be housed in pen groups of 20 to 40 and provided 8 or more sqft per head. Additional space will be required for alleys. Also buildings that are 40 to 80 feet wide are generally desired. For this problem at least 16,000 sqft are needed and there should be 50 to 100 pens.

Question 125: Moisture Control Standards for Building Const. (Answer D)
Increasing insulation, increasing air flow, and/or increasing air temperature will all increase the surface temperature and reduce the potential for condensation.

Question 126: Moisture Control Standards for Building Const. (Answer A)
The temperature drops across a wall in accordance to insulation; as the temperature drops the saturation vapor pressure also drops. The purpose of a vapor barrier is to prevent vapor from moving into the wall and keeps the vapor pressure below the saturation vapor pressure.

Question 127: Ventilation System Requirements (Answer D)
MWPS recommends a ventilation capacity of 35 cfm per nursery pig.

Question 128: Ergonomics (Answer D)
References: Konz, Stephan and Steven Johnson. Work Design, Industrial Ergonomics. © 2000 Chapter 10, Section 1.3
Maximizing Productivity is a constant goal in industry. However, focusing on individual workers is not practical. This may require resetting a work center each time a new worker was assigned. In many engineering and scientific applications we target an average. In Ergonomics we strive to include as many body forms and physical capacities as possible. This allows for maximum worker flexibility and increases safety.

Question 129: Awareness of ecological processes (Answer A)
References: Novotny and Olem
Working equation:

$$M = C_M V_A$$

$$V_A = 4\pi r^2 H$$

$$V_A = 4\pi (6.3 \times 10^6 \text{ m})^2 (3,000 \text{ m})$$

$$V_A = 1.5 \times 10^{18} \text{ m}^3$$

$$M = (0.3 \text{ ng/m}^3)(10^{-10} \text{ g/ng})1.5 \times 10^{18} \text{ m}^3$$

$$M = 4.5 \times 10^9 \text{ g or } 4.5 \times 10^6 \text{ kg}$$

Question 130: Biological Systems/Biological Processes

Question 131: Principles of organic and biochemistry

Solutions to Practice Examination #2: Morning Session

Question 132: Core Knowledge

$$q = \left(\frac{250 \text{ ft}}{1.5 \text{ hours}} \right) \left(\frac{1 \text{ dough}}{5 \text{ inches}} \right) \left(\frac{12 \text{ inches}}{1 \text{ foot}} \right) \left(\frac{100 \text{ BTU}}{\text{dough}} \right) = 40,000 \text{ BTU/hr, or } 4 \times 10^4 \text{ BTU/hr}$$

Distractor:

- a. 3.3×10^3 is failure to convert into ft
 - b. 1.9×10^4 is using doughs end-to-end instead of side-by-side
 - d. 8.0×10^4 is same as b) but converts into ft
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