

2026 UIL CALCULATOR APPLICATIONS DISTRICT CHAMPIONSHIP EXAM – OFFICIAL SCORING KEY

CANONICAL ANSWERS (3 SIGNIFICANT DIGITS) • SCIENTIFIC NOTATION • GRADING TOLERANCES [PAGE 1 OF 6]

#	OFFICIAL CONTEST ANSWER (3 SIG FIGS)	SCIENTIFIC NOTATION	ACCEPTANCE INTERVAL (±2 UNITS)
1	193	1.93×10^2	[191, 195]
2	170	1.70×10^2	[168, 172]
3	18.2	1.82×10^1	[18.0, 18.4]
4	6.06	6.06×10^0	[6.04, 6.08]
5	0.0444	4.44×10^{-2}	[0.0442, 0.0446]
6	83.8	8.38×10^1	[83.6, 84.0]
7	13.7	1.37×10^1	[13.5, 13.9]
8	728	7.28×10^2	[726, 730]
9	\$117.72	1.18×10^2	[116, 120]
10	1.55×10^3 m	1.55×10^3	[1.53, 1.57] $\times 10^3$
11	1.19	1.19×10^0	[1.17, 1.21]
12	15.5	1.55×10^1	[15.3, 15.7]
13	0.258	2.58×10^{-1}	[0.256, 0.260]
14	136	1.36×10^2	[134, 138]
15	2.62	2.62×10^0	[2.60, 2.64]
16	7.64	7.64×10^0	[7.62, 7.66]
17	13.4	1.34×10^1	[13.2, 13.6]
18	0.00307	3.07×10^{-3}	[0.00305, 0.00309]
19	3.21 hrs	3.21×10^0	[3.19, 3.23]
20	1.08×10^3 m ²	1.08×10^3	[1.06, 1.10] $\times 10^3$
21	37.9	3.79×10^1	[37.7, 38.1]
22	25.2	2.52×10^1	[25.0, 25.4]
23	0.0188	1.88×10^{-2}	[0.0186, 0.0190]
24	71.4	7.14×10^1	[71.2, 71.6]
25	4.19	4.19×10^0	[4.17, 4.21]
26	8.24	8.24×10^0	[8.22, 8.26]
27	6.47	6.47×10^0	[6.45, 6.49]
28	28.0	2.80×10^1	[27.8, 28.2]
29	114 min	1.14×10^2	[112, 116]
30	76.2 deg	7.62×10^1	[76.0, 76.4]
31	0.691	6.91×10^{-1}	[0.689, 0.693]
32	1.01	1.01×10^0	[0.992, 1.03]
33	6.42	6.42×10^0	[6.40, 6.44]
34	0.796	7.96×10^{-1}	[0.794, 0.798]
35	8.26	8.26×10^0	[8.24, 8.28]

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CANONICAL ANSWERS (3 SIGNIFICANT DIGITS) • SCIENTIFIC NOTATION • GRADING TOLERANCES [PAGE 2 OF 6]

#	OFFICIAL CONTEST ANSWER (3 SIG FIGS)	SCIENTIFIC NOTATION	ACCEPTANCE INTERVAL (±2 UNITS)
36	0.0357	3.57×10^{-2}	[0.0355, 0.0359]
37	1.39	1.39×10^0	[1.37, 1.41]
38	1.00	1.00×10^0	[0.998, 1.00]
39	22.8 g	2.28×10^1	[22.6, 23.0]
40	138 m	1.38×10^2	[136, 140]
41	1.77	1.77×10^0	[1.75, 1.79]
42	58.5	5.85×10^1	[58.3, 58.7]
43	4.25	4.25×10^0	[4.23, 4.27]
44	0.986	9.86×10^{-1}	[0.984, 0.988]
45	0.514	5.14×10^{-1}	[0.512, 0.516]
46	6.23	6.23×10^0	[6.21, 6.25]
47	1.37	1.37×10^0	[1.35, 1.39]
48	245	2.45×10^2	[243, 247]
49	64.5 cm	6.45×10^1	[64.3, 64.7]
50	516 m ²	5.16×10^2	[514, 518]
51	817190 [INT]	8.17×10^5	[817190]
52	57657600 [INT]	5.77×10^7	[57657600]
53	19.5	1.95×10^1	[19.3, 19.7]
54	41.9	4.19×10^1	[41.7, 42.1]
55	6.56	6.56×10^0	[6.54, 6.58]
56	2.09	2.09×10^0	[2.07, 2.11]
57	9.00	9.00×10^0	[8.98, 9.02]
58	3.28	3.28×10^0	[3.26, 3.30]
59	$6.28 \times 10^3 \text{ cm}^3$	6.28×10^3	[6.26, 6.30] $\times 10^3$
60	$2.22 \times 10^4 \text{ cm}^3$	2.22×10^4	[2.20, 2.24] $\times 10^4$
61	16.3	1.63×10^1	[16.1, 16.5]
62	0.242	2.42×10^{-1}	[0.240, 0.244]
63	0.652	6.52×10^{-1}	[0.650, 0.654]
64	1.59	1.59×10^0	[1.57, 1.61]
65	3.38	3.38×10^0	[3.36, 3.40]
66	5.09	5.09×10^0	[5.07, 5.11]
67	10.1	1.01×10^1	[9.95, 10.3]
68	36.9	3.69×10^1	[36.7, 37.1]
69	$1.41 \times 10^3 \text{ in}^3$	1.41×10^3	[1.39, 1.43] $\times 10^3$
70	$1.12 \times 10^3 \text{ m}$	1.12×10^3	[1.10, 1.14] $\times 10^3$

STACKCALC32 RPM BENCHMARK: 580 KEYSTROKES vs. 1175 ALGEBRAIC (SAVING 595 KEYS, 50.6% FASTER)

GRADER 1 INITIALS: _____ GRADER 2 INITIALS: _____ CONTEST DIRECTOR: _____

SCORING RULE: +5 points for each correct answer; -4 points for each error or skipped question up to last attempted.

PART II: DETAILED WORD PROBLEM & GEOMETRY WORKED SOLUTIONS

Formal Mathematical Modeling, Formula Setups & StackCalc RPN Keystroke Workflows

PROBLEM 9 • TEST BENCH TOOL DISCOUNT & SALES TAX**ANSWER: \$117.72**

A StackCalc32 hardware developer kit priced at \$145.00 is discounted by 25%. With 8.25% sales tax applied to the net discounted price, calculate the total final purchase cost.

GOVERNING MODEL: Final Cost = Original Price $\times$ (1 - Discount Rate) $\times$ (1 + Tax Rate)

NUMERICAL SETUP: Final Cost = $P_0 \times (1 - d) \times (1 + t)$

STEP-BY-STEP MATHEMATICAL REASONING:

Calculate net purchase price after lab equipment discount: $P_{\text{net}} = P_0 \cdot (1 - d)$. Then apply sales tax: $P_{\text{final}} = P_{\text{net}} \cdot (1 + t)$. In competition scoring, currency answers [\$] are rounded to the nearest cent.

CALCULATOR FLOW: [145] [ENTER] [0.75] [$\times$] [1.0825] [$\times$] -> \$117.72

PROBLEM 10 • 3D PRINTING FILAMENT & LINEAR DENSITY**ANSWER: 1.55×10^3 m**

Heavy-duty carbon-fiber reinforced PETG 3D printing filament weighs 4.85 grams per meter. How many meters of filament are wound onto a 7.50 kilogram industrial spool?

GOVERNING MODEL: Length = Total Mass / Linear Density [with kg $\rightarrow$ g conversion]

NUMERICAL SETUP: Length (m) = [Mass (kg) $\times$ 1000 g/kg] / Linear Density (g/m)

STEP-BY-STEP MATHEMATICAL REASONING:

Convert spool shipping mass from kg to grams (multiply by 1,000). Divide total grams by filament linear density in grams per meter to obtain total printable filament length in meters.

CALCULATOR FLOW: [7.5] [ENTER] [1000] [$\times$] [4.85] [$\div$] -> 1.55×10^3 m

PROBLEM 19 • PARALLEL PROCESSING & VACUUM CHAMBER EVACUATION**ANSWER: 3.21 hrs**

A dual-channel resin dispenser on an SLA 3D printer fills a photopolymer vat using primary line A in 5.20 hours and auxiliary line B in 8.40 hours. How many hours will it take to fill the vat if both lines operate concurrently?

GOVERNING MODEL: $1/t_{\text{total}} = 1/t_A + 1/t_B \Rightarrow t_{\text{total}} = 1 / (1/t_A + 1/t_B)$

NUMERICAL SETUP: $t_{\text{total}} = 1 / [(1 / t_A) + (1 / t_B)]$

STEP-BY-STEP MATHEMATICAL REASONING:

Each degassing pump, printer, or resin dispenser operates at rate $1/t$. Running concurrently, their combined rate is $R = 1/t_A + 1/t_B$. Time to complete is reciprocal $1 / R$. In RPN: enter t_A , press [$1/x$], enter t_B , press [$1/x$], add [$+$], and invert with [$1/x$].

CALCULATOR FLOW: [5.2] [$1/x$] [8.4] [$1/x$] [$+$] [$1/x$] -> 3.21 hrs

PROBLEM 20 • TURNTABLE FLANGE & COMMUTATOR RING AREA**ANSWER: 1.08×10^3 m²**

A 3D printed circular slip-ring commutator bezel has an inside radius of 28.5 meters and an exterior guard ring extending out to a radius of 34.0 meters. Calculate the surface area of the circular border in square meters.

GOVERNING MODEL: Area = $\pi \times (R_{\text{outer}}^2 - r_{\text{inner}}^2)$

NUMERICAL SETUP: Area = $\pi \times [(R_{\text{outer}})^2 - (r_{\text{inner}})^2]$

STEP-BY-STEP MATHEMATICAL REASONING:

The area of an annular region between concentric circles equals outer circle area minus inner cutout area: $\pi \cdot (R^2 - r^2)$. Compute both radii squared on the stack, subtract, and multiply by π .

CALCULATOR FLOW: [34] [$\times^2$] [28.5] [$\times^2$] [-] [π] [$\times$] -> 1.08×10^3 m²

PROBLEM 29 • AUTONOMOUS ROBOTICS & AGV KINEMATICS**ANSWER: 114 min**

Two autonomous mobile robotics platforms separated by 78.0 miles travel toward each other on parallel tracks at constant speeds of 18.4 mph and 22.6 mph. In how many minutes will they pass each other?

GOVERNING MODEL: Closing Speed = $v_1 + v_2$; Time = Distance / Closing Speed

NUMERICAL SETUP: $t = \text{Distance} / (v_1 + v_2)$ [or Separation = $(v_1 + v_2) \times t$]

STEP-BY-STEP MATHEMATICAL REASONING:

For autonomous robotic shuttles or gantry carriages moving relative to each other, closing velocity is $v_{\text{rel}} = v_1 + v_2$. Divide initial distance by closing speed to find encounter time, or multiply combined speed by time for separation distance.

CALCULATOR FLOW: [78] [ENTER] [18.4] [ENTER] [22.6] [+] [+] [60] [×] -> 114 min

PROBLEM 30 • ARTICULATED BOOM ANGLE OF INCLINE**ANSWER: 76.2 deg**

An articulated PCB inspection microscope boom measuring 44.0 feet long leans against a vertical equipment frame with its base 10.5 feet from the frame. What acute angle in degrees does the boom make with the horizontal floor?

GOVERNING MODEL: $\cos(\theta) = \text{Base} / \text{Length} \Rightarrow \theta = \arccos(\text{Base} / \text{Length})$

NUMERICAL SETUP: $\theta = \arccos(\text{Distance_to_Pivot} / \text{Boom_Length})$

STEP-BY-STEP MATHEMATICAL REASONING:

The articulated camera boom forms a right triangle with the base plane. Horizontal offset is adjacent to θ while boom length is hypotenuse: $\cos(\theta) = \text{Base} / \text{Length}$. Evaluate $\arccos$ in Degree mode.

CALCULATOR FLOW: [DEG] [10.5] [ENTER] [44] [÷] [ACOS] -> 76.2 deg

PROBLEM 39 • SENSOR CALIBRATION & EXPONENTIAL RADIOACTIVE DECAY**ANSWER: 22.8 g**

An electronic scintillation sensor uses a radioactive calibration isotope with a half-life of 18.5 days. If a test capsule initially holds 160.0 grams of the isotope, what mass in grams remains active after 52.0 days?

GOVERNING MODEL: $M(t) = M_0 \times (1/2)^{(t / t_{\text{half}})}$

NUMERICAL SETUP: $M(t) = M_0 \times (0.5)^{(\text{Elapsed_Time} / \text{Half_Life})}$

STEP-BY-STEP MATHEMATICAL REASONING:

Radioactive decay follows exponential halving. The number of elapsed half-life cycles is $n = t / t_{\text{half}}$. Raise 0.5 to power n and multiply by initial sensor activity M_0 .

CALCULATOR FLOW: [52] [ENTER] [18.5] [÷] [0.5] [x<>y] [y^x] [160] [×] -> 22.8 g

PROBLEM 40 • LASER GANTRY TRIANGULATION & VERTICAL MAST HEIGHT**ANSWER: 138 m**

From calibration point M on a level test facility, the angle of elevation to an automated 3D printer gantry apex is 41.8°. Moving 62.0 meters closer to point N, the angle of elevation is 56.2°. Find the vertical height of the gantry in meters.

GOVERNING MODEL: $h = \text{Baseline Distance} / [\cot(\theta_1) - \cot(\theta_2)]$

NUMERICAL SETUP: $h = d / [(1 / \tan(\theta_1)) - (1 / \tan(\theta_2))]$

STEP-BY-STEP MATHEMATICAL REASONING:

From two calibration baseline positions separated by advance distance d , vertical height h satisfies $\cot(\theta_1) - \cot(\theta_2) = d / h$. Invert $\tan(\theta_1)$ and $\tan(\theta_2)$, subtract on the stack, take reciprocal $[1/x]$, and multiply by distance d .

CALCULATOR FLOW: [DEG] [41.8] [TAN] [1/x] [56.2] [TAN] [1/x] [-] [1/x] [62] [×] -> 138 m

PROBLEM 49 • RIGHT TRIANGLE TRIGONOMETRY**ANSWER: 64.5 cm**

RIGHT TRIANGLE: In the right triangle shown below, hypotenuse $c = 92.5$ cm and acute angle $\theta = 44.2^\circ$. Calculate the length of opposite side a .

GOVERNING MODEL: $a = c \times \sin(\theta)$ or $b = c \times \cos(\theta)$

NUMERICAL SETUP: $a = 92.5 \times \sin(44.2^\circ)$

STEP-BY-STEP MATHEMATICAL REASONING:

In a right triangle, the opposite leg equals hypotenuse c multiplied by $\sin(\theta)$. With $c = 92.5$ and acute angle $\theta = 44.2^\circ$, calculate in Degree mode and round non-integers to 3 significant figures.

CALCULATOR FLOW: [DEG] [92.5] [ENTER] [44.2] [SIN] [×] -> 64.5 cm

PROBLEM 50 • CIRCULAR SECTOR AREA**ANSWER: 516 m²**

CIRCULAR SECTOR: For the circular sector diagrammed below, radius $r = 26.8$ m and central angle $\theta = 82.4^\circ$. Determine the total area of the shaded sector in square meters.

GOVERNING MODEL: $\text{Area} = \pi \times r^2 \times (\theta / 360^\circ)$

NUMERICAL SETUP: $\text{Area} = \pi \times (26.8)^2 \times (82.4^\circ / 360^\circ)$

STEP-BY-STEP MATHEMATICAL REASONING:

A circular sector represents a fraction $(\theta / 360^\circ)$ of a full circle. Square radius $r = 26.8$, multiply by angle $\theta = 82.4^\circ$, multiply by π , and divide by 360.

CALCULATOR FLOW: [26.8] [x²] [82.4] [×] [π] [×] [360] [÷] -> 516 m²

PROBLEM 59 • RIGHT CIRCULAR CONE VOLUME**ANSWER: 6.28×10^3 cm³**

RIGHT CIRCULAR CONE: The solid cone shown has base radius $r = 13.8$ cm and vertical height $h = 31.5$ cm. Calculate the volume of the cone in cubic centimeters.

GOVERNING MODEL: $V = (1/3) \times \pi \times r^2 \times h$

NUMERICAL SETUP: $V = (1/3) \times \pi \times (13.8)^2 \times (31.5)$

STEP-BY-STEP MATHEMATICAL REASONING:

The cone volume equals one-third base area times vertical height. Square base radius $r = 13.8$, multiply by vertical height $h = 31.5$, multiply by π , and divide by 3.

CALCULATOR FLOW: [13.8] [x²] [31.5] [×] [π] [×] [3] [÷] -> 6.28×10^3 cm³

PROBLEM 60 • CONICAL FRUSTUM VOLUME**ANSWER: 2.22×10^4 cm³**

CONICAL FRUSTUM: A truncated cone has lower base radius $R = 21.0$ cm, upper base radius $r = 11.2$ cm, and vertical height $h = 26.5$ cm. Calculate the frustum volume in cubic centimeters.

GOVERNING MODEL: $V = (1/3) \times \pi \times h \times (R^2 + R \cdot r + r^2)$

NUMERICAL SETUP: $V = (1/3) \times \pi \times 26.5 \times [(21.0)^2 + (21.0)(11.2) + (11.2)^2]$

STEP-BY-STEP MATHEMATICAL REASONING:

A truncated cone volume is $\pi/3 \cdot h \cdot (R^2 + R \cdot r + r^2)$. On StackCalc, accumulate $R^2 + R \cdot r + r^2$ on the stack, multiply by vertical height 26.5, multiply by π , and divide by 3.

CALCULATOR FLOW: [21.0] [x²] [21.0] [ENTER] [11.2] [×] [+] [11.2] [x²] [+] [26.5] [×] [π] [×] [3] [÷] -> 2.22×10^4 cm³

PROBLEM 69 • CALCULUS OPTIMIZATION: MODULAR ELECTRONICS ENCLOSURE**ANSWER: $1.41 \times 10^3 \text{ in}^3$**

A 3D printed electronics project housing with an open top and square base is fabricated using 600 square inches of polymer material. Using calculus optimization, determine the maximum theoretical volume of the housing in cubic inches.

GOVERNING MODEL: $V(x) = x \cdot (S - x^2) / 4$; Critical Point: $x = \sqrt{S / 3}$

NUMERICAL SETUP: Max Volume = $\sqrt{S / 3} \times [S - (S / 3)] / 4$

STEP-BY-STEP MATHEMATICAL REASONING:

For a 3D printed modular electronics enclosure with open top and square base of surface area $S = x^2 + 4xh$, height is $h = (S - x^2)/(4x)$. Maximizing volume $V(x)$ via $dV/dx = 0$ yields $x = \sqrt{S/3}$. Evaluate maximum internal capacity in cubic units.

CALCULATOR FLOW: [200] [√x] [100] [×] -> $1.41 \times 10^3 \text{ in}^3$

PROBLEM 70 • TACTILE KEY SWITCH EJECTION DYNAMICS & KINEMATICS**ANSWER: $1.12 \times 10^3 \text{ m}$**

In an accelerated life-cycle test rig for mechanical keyboard switches, a spring-driven actuator pin is propelled from ground level with launch velocity $v_0 = 105.0 \text{ m/s}$ at an elevation angle of 44.5° above horizontal. With gravitational acceleration $g = 9.81 \text{ m/s}^2$, determine the horizontal range in meters.

GOVERNING MODEL: Range = $(v_0^2 \times \sin(2\theta)) / g$ [$g = 9.81 \text{ m/s}^2$]

NUMERICAL SETUP: Range = $[(v_0)^2 \times \sin(2 \times \theta)] / 9.81$

STEP-BY-STEP MATHEMATICAL REASONING:

In switch drop-and-ejection reliability testing over a level test bench, horizontal flight range is $R = v_0^2 \cdot \sin(2\theta) / g$. Square launch velocity v_0 , multiply by $\sin(2\theta)$ in DEG mode, and divide by gravitational constant 9.81 m/s^2 .

CALCULATOR FLOW: [DEG] [105] [x^2] [44.5] [ENTER] [2] [×] [SIN] [×] [9.81] [÷] -> $1.12 \times 10^3 \text{ m}$