

13th INTERNATIONAL JUNIOR SCIENCE OLYMPIAD



THEORY COMPETITION

SOLUTIONS AND MARKING SCHEME

Problem II. Physics

Question	Content	Points	Total
II.1	Correct formula $p_{\text{total}} = p_{\text{atm}} + \rho gh$	0.5	1.0
	Correct total pressure = $3.03 \times 10^5 \text{ N/m}^2 = 3.03 \times 10^5 \text{ Pa} = 3.00 \text{ atm}$. $3.00 \leq p_{\text{total}} \leq 3.06 \times 10^5 \text{ N/m}^2$ or $2.97 \leq p_{\text{total}} \leq 3.03 \text{ atm}$ is acceptable	0.5	
	Incorrect/incomplete solutions:		
	Correct value without unit	0.3	
	Formula only $p_{\text{total}} = \rho gh$	0.2	
	Other formulas	0.0	
	Total pressure $2.70 \leq p_{\text{total}} < 2.97 \text{ atm}$ or $3.03 < p_{\text{total}} \leq 3.30 \text{ atm}$	0.2	
	Other values	0.0	
II.2	Correct formula total time $t = \frac{\text{Total volume of air consumed}}{r} = \frac{V_f - V_i}{r}$	0.4	2.0
	Correct Boyle law $P_i V_i = P_f V_f$ or $V_f = \frac{P_i V_i}{P_f}$	0.4	
	Correct formula for total pressure $p_f = p_{\text{atm}} + \rho_{\text{sw}} gh$	0.4	
	Correct formula for total time $t = \frac{V_i (p_i - (p_{\text{atm}} + \rho_{\text{sw}} gh))}{r (p_{\text{atm}} + \rho_{\text{sw}} gh)}$	0.4	
	Correct value of total time $t = 55.5 \text{ minute}$. The total time $54 \leq t \leq 57 \text{ minutes}$ is acceptable	0.4	
	Incorrect/incomplete solutions:		
	Total volume of air consumed = V_f	0.2	
	Total pressure $P_f = \rho_{\text{sw}} gh$	0.2	
	The total time is 50 minutes $< t \leq 54 \text{ minutes}$ or $57 \text{ minutes} < t \leq 60 \text{ minutes}$	0.2	
	Other total time	0.0	
II.3	Correct international unit: $1/(\text{watts}/(\text{m}^2\text{K})) = \text{m}^2\text{K}/\text{W} = \text{m}^2\text{K}/(\text{J/s}) = \text{m}^2\text{Ks}/\text{J}$	0.5	1.5
	Correct the best material: N	1.0	
	Incorrect/incomplete solutions:		
	Incorrect SI unit	0.0	
	Incorrect the best material	0.0	
II.4	Correct formula: $h = \Delta p / \rho g$	0.5	1.0
	Correct value of depth: $h = 3.47 \text{ m}$ The range of depth $3.41 \leq h \leq 3.55 \text{ m}$ is acceptable	0.5	
	Incorrect/incomplete solutions:		
	Correct depth without unit	0.3	
	Incorrect formula	0.0	
	The depth is $3.15 \text{ m} \leq h < 3.41 \text{ m}$ or $3.55 \text{ m} < h \leq 3.80 \text{ m}$	0.2	
	Other value of depth	0.0	

Question	Content	Points	Total
II.5	Pressure at the depth 30 m = 4 atm	0.3	1.0
	Correct formula: Boyle law	0.3	
	Correct value of volume $V = 1.50$ L The volume $1.45 \text{ L} \leq V \leq 1.55 \text{ L}$ is acceptable	0.4	
	Incorrect/incomplete solutions:		
	Correct volume without unit	0.2	
	Incorrect formula	0.0	
	The volume is $1.35 \text{ L} \leq V < 1.45 \text{ L}$ or $1.55 \text{ L} < V \leq 1.65 \text{ L}$	0.2	
	Other volume	0.0	
II.6	Correct equation of force with or without force diagram	1.0	2.0
	Correct formula of $b = \frac{m_s g}{v_t} \frac{\rho_s - \rho_{sw}}{\rho_s}$	0.5	
	Correct value of $b = 5.55 \times 10^{-2}$ kg/s The value b $5.45 \leq b \leq 5.65 \times 10^{-3}$ kg/s is acceptable	0.5	
	Incorrect/incomplete solutions:		
	Correct b without unit	0.3	
	All forces are written, however wrong signs	0.5	
	Not all forces are written	0.0	
	Incorrect formula of b	0.0	
	The value of b $5.35 \leq b < 5.45 \times 10^{-2}$ kg/s or $5.65 < b \leq 5.75 \times 10^{-2}$ kg/s	0.2	
	Other value of b	0.0	
II.7	Correct formula: Snell law	0.5	1.5
	Correct formula of angle in sea water	0.5	
	Correct value of angle = 48.8° . The angle rounded to 49° or $48.3^\circ \leq \theta \leq 49^\circ$ is acceptable.	0.5	
	Incorrect/incomplete solutions:		
	Incorrect Snell law	0.0	
	Incorrect formula of angle in water	0.0	
	The angle $47.0^\circ \leq \theta < 48.3^\circ$	0.2	
	Other angles	0.0	
Total points for Problem II			10

Notes:

- no double penalty
- this marking scheme is a guidance for all physics juries.
- other ways for physics formula derivations are acceptable, if physically correct.