13th INTERNATIONAL JUNIOR SCIENCE OLYMPIAD

IJSO

BALI, INDONESIA 2016

*Science for Creative Innovation*

# THEORY COMPETITION

## SOLUTIONS AND MARKING SCHEME

**Problem II. Physics**

| Question | Content | Points | Total |
|---|---|---|---|
| **II.1** | Correct formula $p_{total} = p_{atm} + \rho gh$ | 0.5 | 1.0 |
| | Correct total pressure = $3.03\times 10^5$ N/m$^2$ = $3.03\times 10^5$ Pa = 3.00 atm.<br>$3.00 \le p_{total} \le 3.06 \times 10^5$ N/m$^2$ or $2.97 \le p_{total} \le 3.03$ atm is acceptable | 0.5 | |
| | Incorrect/incomplete solutions: | | |
| | Correct value without unit | 0.3 | |
| | Formula only $p_{total} = \rho gh$ | 0.2 | |
| | Other formulas | 0.0 | |
| | Total pressure $2.70 \le p_{total} < 2.97$ atm or $3.03 < p_{total} \le 3.30$ atm | 0.2 | |
| | Other values | 0.0 | |
| | | | |
| **II.2** | Correct formula total time $t = \dfrac{\text{Total volume of air consumed}}{r} = \dfrac{V_f - V_i}{r}$ | 0.4 | 2.0 |
| | Correct Boyle law $P_iV_i = P_fV_f$ or $V_f = \dfrac{P_iV_i}{P_f}$ | 0.4 | |
| | Correct formula for total pressure $p_f = p_{atm} + \rho_{sw}gh$ | 0.4 | |
| | Correct formula for total time $t = \dfrac{V_i(p_i - (p_{atm} + \rho_{sw}gh))}{r(p_{atm} + \rho_{sw}gh)}$ | 0.4 | |
| | Correct value of total time $t$ = 55.5 minute.<br>The total time $54 \le t \le 57$ minutes is acceptable | 0.4 | |
| | Incorrect/incomplete solutions: | | |
| | Total volume of air consumed = $V_f$ | 0.2 | |
| | Total pressure $P_f = \rho_{sw}gh$ | 0.2 | |
| | The total time is 50 minutes < $t \le 54$ minutes or 57 minutes < $t \le 60$ minutes | 0.2 | |
| | Other total time | 0.0 | |
| | | | |
| **II.3** | Correct international unit:<br>1/(watts /(m$^2$K)) = m$^2$K/W = m$^2$K/(J/s) = m$^2$Ks/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 m<br>The range of depth $3.41 \le h \le 3.55$ m is acceptable | 0.5 | |
| | Incorrect/incomplete solutions: | | |
| | Correct depth without unit | 0.3 | |
| | Incorrect formula | 0.0 | |
| | The depth is 3.15 m $\le h <$ 3.41 m or 3.55 m < $h \le$ 3.80 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<br>The volume 1.45 L ≤ $V$ ≤ 1.55 L is acceptable | 0.4 | |
| | Incorrect/incomplete solutions: | | |
| | Correct volume without unit | 0.2 | |
| | Incorrect formula | 0.0 | |
| | The volume is 1.35 L ≤ $V$ < 1.45 L or 1.55 L < $V$ ≤ 1.65 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 $b = 5.55\times10^{-2}$ kg/s<br>The value $b$ $5.45 \le b \le 5.65\times10^{-3}$ 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 $b$ $5.35 \le b < 5.45\times10^{-2}$ kg/s or $5.65 < b \le 5.75\times10^{-2}$ 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°.<br>The angle rounded to 49° or 48.3° ≤ $\theta$ ≤ 49° is acceptable. | 0.5 | |
| | Incorrect/incomplete solutions: | | |
| | Incorrect Snell law | 0.0 | |
| | Incorrect formula of angle in water | 0.0 | |
| | The angle 47.0° ≤ $\theta$ < 48.3° | 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.