| | | |
|---|---|---|
| **1** | **D** | Depth of swimming pool = 2m<br>Pressure at the bottom of the pool = $p_o + \rho gh = 10^5 + (10^3)(10)2 = 10^7$ Pa |
| **2** | **C** | |
| **3** | **C** | $s_x = u_x t$<br>$220 = (72)t$<br>$t = 3.06$ s<br>$s_y = u_y t + \frac{1}{2}at^2$<br>$= 0 + \frac{1}{2}(9.81)(3.06)^2$<br>$= 46$ m |
| **4** | **B** | |
| **5** | **B** | |
| **6** | **A** | $F_{\text{resistive}} = -\text{thrust}$<br>$= -v_{rel}\frac{dm}{dt}$<br>$= -(-100)(20)$<br>$= 2\ 000$ N |
| **7** | **D** | $\Delta a = 0.80 - (-0.30) = 1.10$ m s$^{-2}$<br>$\Delta F = m\Delta a = (70)(1.10) = 77$ N<br>Apparent difference in mass $= \frac{77}{9.81} = 7.8$ kg |
| **8** | **D** | |

<table>
<tr><td>9</td><td>C</td><td>When the string just slackens, the tension in the string is zero. The component of the weight acting in the radial direction provides for the centripetal force.<br>$$mg\cos\theta = \frac{mv_B^2}{r}$$<br>$$g\cos\theta = \frac{v_B^2}{r}$$<br>$$\theta = \cos^{-1}\left(\frac{v_B^2}{rg}\right) = \cos^{-1}\left[\frac{2.2^2}{(1.5)(9.81)}\right]$$<br>$$= 71°$$</td></tr>
<tr><td>10</td><td>D</td><td></td></tr>
<tr><td>11</td><td>D</td><td></td></tr>
<tr><td>12</td><td>D</td><td>At steady state, pressure in both flasks are the same.<br>Applying ideal gas law<br>$$P_P = P_Q$$<br>$$\frac{n_P R T_P}{V_P} = \frac{n_Q R T_Q}{V_Q}$$<br>$$\frac{M_P}{M_Q} = \frac{T_Q}{T_P}\frac{V_P}{V_Q} = 9$$</td></tr>
<tr><td>13</td><td>A</td><td>$$pV = nRT$$<br>$$pV = nR(t + 273.15)$$<br>$$p = \frac{nR}{V}(t + 273.15)$$</td></tr>
<tr><td>14</td><td>D</td><td>Heat loss by block of higher temp = Heat gained by block of lower temp<br>$$Q = mc\Delta T$$<br>$$15c(T_f - 35) = 30c(95 - T_f)$$<br>$$T_f - 35 = 190 - 2T_f$$<br>$$T_f = 75$$</td></tr>
<tr><td>15</td><td>C</td><td>$$E = \frac{1}{2}m(2\pi f)^2 x^2$$<br>$$\frac{1}{2}(0.5m)(2\pi)^2(3.0f)^2(0.40x)^2 = (0.72)\left(\frac{1}{2}m(2\pi f)^2 x^2\right)$$<br>$$= 0.72E$$</td></tr>
<tr><td>16</td><td>A</td><td></td></tr>
<tr><td>17</td><td>D</td><td></td></tr>
<tr><td>18</td><td>A</td><td><table><tr><th>Freq / Hz</th><th>wavelength / m</th><th>9.0 cm tube</th><th>13.5 cm tube</th></tr><tr><td>5500</td><td>0.060</td><td>1.50</td><td>2.25</td></tr><tr><td>7330</td><td>0.045</td><td>2.00</td><td>3.00</td></tr><tr><td>7940</td><td>0.042</td><td>2.17</td><td>3.25</td></tr><tr><td>11000</td><td>0.030</td><td>3.00</td><td>4.50</td></tr></table></td></tr>
</table>

<table>
<tr><td>19</td><td>A</td><td>
<table>
<tr><th></th><th>$\lambda$ / nm</th><th>$x$</th><th>$n$</th></tr>
<tr><td>A</td><td>400</td><td>200</td><td>12.5</td></tr>
<tr><td>B</td><td>400</td><td>500</td><td>5.0</td></tr>
<tr><td>C</td><td>650</td><td>200</td><td>7.7</td></tr>
<tr><td>D</td><td>650</td><td>500</td><td>3.1</td></tr>
</table>
</td></tr>
<tr><td>20</td><td>C</td><td>
gain in kinetic energy = loss in electric potential energy

$$\begin{aligned} &= qV_{\text{initial}} - qV_{\text{final}} \\ &= qE\left(d - \frac{d}{4}\right) - qE\left(d - \frac{3d}{4}\right) \\ &= \frac{1}{2}qEd \\ &= \frac{1}{2}q\left(\frac{V}{d}\right)d \\ &= \frac{1}{2}qV \end{aligned}$$

The gain in kinetic energy of the positive ion is independent of *d.*
</td></tr>
<tr><td>21</td><td>C</td><td></td></tr>
</table>

| | | |
|---|---|---|
| **22** | **A** | $I = nevA$<br>$v = \frac{I}{neA}$<br>$= \frac{I}{ne\pi\left(\frac{d}{2}\right)^2}$<br>$v \propto \frac{1}{d^2}$<br>If *d* increases linearly with position *x*, $d \propto x$.<br>$v \propto \frac{1}{x^2}$<br>When *x* increases, *v* decreases at a decreasing rate. |
| **23** | **C** | |
| **24** | **D** | $I = \frac{\varepsilon}{R} = \frac{BLv}{R}$<br>$F = BIL = B(\frac{BLv}{R})L$<br>$F = \frac{B^2L^2v}{R}$<br>$P = Fv = \frac{B^2L^2v^2}{R}$<br>*L* is the length of the rod in contact with the rail. |
| **25** | **B** | Centripetal force when entering is upwards hence magnetic force is upwards.<br>Using Fleming's right hand rule, current is in the same direction as the path so it must be positively charged.<br>If direction of magnetic force is upwards, electric force must be downwards so electric field must also be downwards. |
| **26** | **C** | Laminating the iron core in a transformer narrows the eddy current paths which reduces the induced e.m.f. and hence the eddy currents. |
| **27** | **D** | For a 4-level system, the number of possible transitions is ${}^4C_2 = 6$ |
| **28** | **A** | Higher p.d. → higher KE → max energy of photon is higher → $\lambda_{min}$ is smaller |
| **29** | **B** | |
| **30** | **B** | |