Take off 0.5 point for incorrect units.
Equivalent answers are accepted.

Hovercraft - key

Max points possible: ↓

[1] 1a. $470 = F\cos(25)$

$F = \boxed{518.6\ N}$ +1 for correct answer

[2] 1bi. $W = Fd$

$= 470 \times 2500$ +1 for correct equation for work

$= \boxed{1175000\ J}$ +1 for correct answer

[2] 1bii. $P = \frac{W}{t}$ or $P = Fv$

$= \frac{1175000}{4320}$ +1 for correct eq for power

$= \boxed{272\ W}$ +1 for correct answer

[5] 2. $V_c = \pi(0.0092)^2 \times 0.25$

$= 6.65 \times 10^{-5}\ m^3$ +1 for correct calculation of cylinder volume

$W_c = 0.0375 \times 9.8$

$= 0.3675\ N$

Let V_w = volume underwater
= volume displaced

$\therefore M_w = V_w \rho_w$ +1 for indication that buoyant force = weight of displaced fluid

$\therefore W_w = M_w g$

$= V_w \rho_w g$ +1 for indication that buoyant force = weight of cylinder (because it is floating)

$F_B = W_c = W_w$

$0.3675 = V_w (865)(9.8)$

$V_w = 4.335 \times 10^{-5}\ m^3$ +1 for correct volume displaced

$4.335 \times 10^{-5} = \pi(0.0092)^2 \times l$

$l = 0.163\ m$

$= \boxed{16.3\ cm}$ +1 for correct length

[2] 3a. +1 for indication that horizontal forces have resultant of 0

+1 for use of 1st or 2nd law to indicate that an unbalanced force / non-zero net force is required for the object to accelerate / change speed

[2] 3b. $v^2 = v_i^2 + 2as$

$0 = 16^2 + 2a(1100)$

$a = 0.116\ m/s^2$ +1 for correct acceleration

$F = ma$

$m = \frac{76000}{0.116}$

$= \boxed{6.5 \times 10^5 \text{ kg}}$ +1 for correct mass

[1] 4a. $a = \boxed{0 \text{ m/s}^2}$ +1 for correct answer

[2] b. $x = \frac{1}{2}at^2$

$110 = \frac{1}{2} 9.8 t^2$ +1 for work

$t = \boxed{4.7 \text{ s}}$ +1 for correct answer

[2] c. $x = vt$

$x = 5 \times 4.7$ +1 for work

$= \boxed{23.7 \text{ m}}$ +1 for correct answer

[2] 5a. $v^2 = v_i^2 + 2as$

$2.8^2 = 4.3^2 + 2a(15)$

$a = -0.355 \text{ m/s}^2$ +1 for correct acceleration (positive sign ok)

$\Delta v = at$

$2.8 - 4.3 = -0.355t$

$t = \boxed{4.22 \text{s}}$ +1 for correct Time

[2] b. $\Delta KE = \Delta \frac{1}{2} mv^2$

$= \frac{1}{2}(2.2 \times 10^3)(4.3^2 - 2.8^2)$

$= 11715 \text{ J}$ +1 for correct Δ in KE

$P = \frac{\Delta E}{\Delta t}$

$= \frac{11715}{4.22}$ ← answer from a)

$= \boxed{2772.55 \text{ W}}$ +1 for correct rate using their answer from a)

[2] c. $p_i = p_f$

$2.2 \times 10^3 \times 2.8 = (2.2 \times 10^3 + 3 \times 10^3) V$ +1 for indication of momentum conservation

$V = \boxed{1.18 \text{ m/s}}$ +1 for right answer

[2] 6a. $mgh = \frac{1}{2}mv^2$

$9.8 \times 1.6 = \frac{1}{2}v^2$

$v = \boxed{5.6 \text{ m/s}}$

+1 for appropriate work

+1 for correct answer

[4] b. $3.5 \times 5.6 = (3.5 + 0.8)v$

$v = 4.56 \text{ m/s}$

$KE_i = \frac{1}{2}(3.5)(5.6)^2$

$KE_f = \frac{1}{2}(4.3)(4.56)^2$

$\Delta KE = 54.88 - 44.66 = \boxed{10.2 \text{ J}}$

+1 for indication of conservation of momentum

+1 for correct v

+1 for calculation of energy before and after

+1 for correct answer

[2] 7. $\frac{F_1}{A_1} = \frac{F_2}{A_2}$

$\frac{F}{\pi(0.0085)^2} = \frac{1210 \times 9.8}{\pi(0.045)^2}$

$F = \boxed{423 \text{ N}}$

+1 for indication of Pascal's law

+1 for correct answer

[2] 8a. $E_{top} = E_{bottom}$

$(0.5)(9.8)(1)\sin 30 = KE$

$KE = \boxed{2.45 \text{ J}}$

+1 for indication of conservation of energy

+1 for correct answer

[3] b. $x = v_0 t + \frac{1}{2}at^2$

$0.75 = 0 + \frac{1}{2}(9.8)t^2$

$t = 0.39 \text{ s}$

+1 for correct time to reach ground

KE from a) → $2.45 = \frac{1}{2}mv^2$

$\frac{1}{2}(0.5)v^2 = 2.45$

$v = 3.13 \text{ m/s}$

+1 for correct calculation of speed using KE from a)

$D = vt$

$= 3.13 \times 0.39$

$= \boxed{1.22 \text{ m}}$

+1 for correct answer

[2] 9a. $A_A v_A = A_B v_B$

$(\pi \times 0.025^2) \times 0.5 = (\pi \times 0.015^2) v_B$

$v_B = \boxed{1.39 \text{ m/s}}$

+1 for use of continuity equation

+1 for correct answer

[3] b. +1 for check on "less than point A"

sample explanation:

water at B is moving faster and higher, so the KE and PE terms on the Bernoulli eq are higher. Pressure must be lower such that the equation results in the same constant at points A and B.

+1 for correct indication of how speed affects pressure using Bernoulli effect

+1 for correct indication of how height affects pressure using Bernoulli effect

[1] c. $P + \rho g y + \frac{1}{2}\rho v^2 = \text{constant}$

$2\times10^5 + 0 + \frac{1}{2}\times1000\times0.5^2 = P + 1000\times9.8\times5 + \frac{1}{2}\times1000\times1.39^2$

$P = \boxed{1.5\times10^5 \text{ Pa}}$

+1 for correct answer