Practice questions for Fluids and Waves - Answers

1

Question Number	Answer	Mark
17(a) (i)	Show that the resultant upward force at the moment it is released is about 200 N Use of density x volume **(1)** Use of mass x *g* **(1)** Correct answer [215 (N) to at least 2 sf] **(1)** **[no ue]** <u>Example of calculation</u> Mass of displaced air = density x volume = 1.2 kg m^{-3} x 2830 m^3 = 3396 kg upthrust = weight of displaced air = 3396 kg x 9.81 N kg^{-1} = 33 315 N resultant force = 33 315 N – 33 100 N = 215 N [If candidate starts from difference in densities, apply mark scheme in the same way.]	**(3)**
17(a) (ii)	Find the initial upward acceleration Use of $F = ma$ **(1)** Correct answer [0.06 m s^{-2}] **(1)** <u>Example of calculation</u> $F = ma$ a = 215 N / 3370 kg = 0.064 m s^{-2} [Use of 200 N gives 0.059 m s^{-2}]	**(2)**
17(a) (iii)	Justify that effect of air resistance is negligible Use of Stokes' law equation, $F = 6\pi\eta rv$ **(1)** Find viscous drag (6.0 x 10^{-3} (N)) **(1)** **(no ue)** Relevant comment, e.g. **very** small **in comparison** to other forces (not just "small")/ **much** small**er** than other forces (not just smaller) **(1)** <u>Example of calculation</u> $F = 6\pi\eta rv$ $F = 6 \times \pi \times 1.8 \times 10^{-5}$ kg m^{-1} s^{-1} x 8.8 m x 2 m s^{-1} = 6.0 x 10^{-3} N This is very much less than upthrust and so is negligible	**(3)**
17(b)	Add labelled arrows Correctly show weight (W, mg), upthrust (U), and viscous drag /drag/friction/air resistance (V, F, D) 3 correct = 2, 2 correct = 1 [4 labels, max 1 for 3 correct forces, zero for 2 correct forces, 5 labels or more = zero] [Forces do not need to be co-linear. Accept two correct labels on the same arrow. Accept buoyancy force for upthrust]	**max (2)**

	[Do not accept 'gravity']	
17(c)	Explain why this density change limits the height to which the balloon will rise. Mass/weight of displaced air decreases / upthrust decreases / density of air in balloon eventually equals density of surrounding air [accept density greater than surrounding air] **(1)** Net upward force would decrease / no resultant upward force / no more upwards acceleration **(1)**	**(2)**
	Total for question	**12**

2 A

3 D

4 B

5 C

6 A

7 D

8 A

9 A

10 **(a)** density = mass / volume

(b) density of liquids and solids same order as spacing similar / to about 2×
density of gases much less as spacing much more
or density of gases much lower hence spacing much more

(c) **(i)** density $= 68 / [50 \times 600 \times 900 \times 10^{-9}]$
$= 2520$ (allow 2500) kg m^{-3}

(ii) $P = F / A$
$= 68 \times 9.81 / [50 \times 600 \times 10^{-6}]$
$= 2.2 \times 10^{4}$ Pa

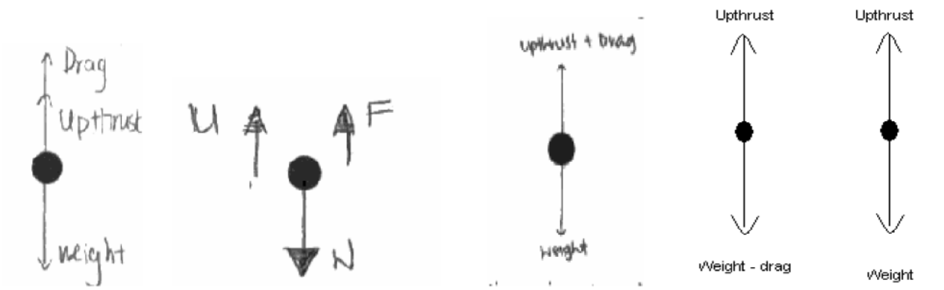
11 C

12 (a)	Show that the upthrust is about 8×10^{-4} N Use of mass = density x volume Correct answer for upthrust (= 8.3×10^{-4} (N)) <u>Example of calculation</u> mass of liquid displaced = density x volume = $1300 \text{ kg m}^{-3} \times 6.5 \times 10^{-8} \text{ m}^3 = 8.45 \times 10^{-5}$ kg upthrust = $8.45 \times 10^{-5} \text{ kg} \times 9.81 \text{ m s}^{-2}$ = 8.3×10^{-4} N	 **(1)** **(1)**
(b)	Show that the viscosity of the liquid is about 2 kg $\text{m}^{-1} \text{ s}^{-1}$ Correct summary of forces, e.g. V = W - U Use of $F = 6\pi\eta rv$ Correct answer for viscosity (1.8 (kg $\text{m}^{-1} \text{ s}^{-1}$)) <u>Example of calculation</u> Viscous drag = W – U = 4.8×10^{-3} N - 8.3×10^{-4} N = 3.97×10^{-3} N $F = 6\pi\eta rv$ $\eta = 3.97 \times 10^{-3} \text{ N} / (6 \times \pi \times 4.6 \times 10^{-2} \text{ m s}^{-1} \times 2.5 \times 10^{-3} \text{ m})$ = 1.8 kg $\text{m}^{-1} \text{ s}^{-1}$ [Watch out for out of clip answers]	 **(1)** **(1)** **(1)**
(c)	State a relevant variable to control <u>Temperature</u>	 **(1)**
	Total for question 14	6

13

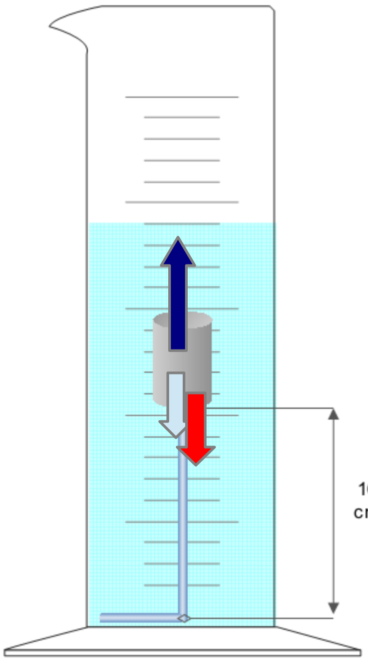
(a)(i)	3 correct labelled arrows: Upthrust, *U* (1) weight, *W*, *mg* (1) (viscous) drag, water resistance, viscous force, V, F, D [upwards] (1) ('resistance' not sufficient) Each incorrect force decreases the maximum possible mark by one U and D can share an arrow. Arrows need not touch particle. Ignore unlabelled arrows.	**3**
(a)(ii)	upthrust + drag = weight or with unambiguous symbols (allow ecf from diagram) (1) forces in equilibrium / balanced forces / no resultant force / no acceleration / constant velocity (1)	**2**
(b) (i)	Down and along (1) (shape of trajectory not important)	**1**

14 C

15 (a)(i)	Upthrust/*U* Weight/*W*/*mg*/gravitational force/force due to gravity (Viscous) drag/fluid resistance/friction/*F*/*D*/*V* (3 correct = 2 marks, 2 correct = 1 mark. All arrows must touch the dot and straight, vertical lines required, no curving around dot, arrows can be of any length)  2 marks 0 marks 2 marks 2 marks 1 mark		**2**
(a)(ii)*	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) Initially viscous drag = 0 **OR** viscous drag is very small **OR** resultant force is downwards **OR** $W > U$ **OR** $W > U + D$ Viscous drag increases (Until) forces balanced **OR** resultant/net force zero **OR** forces in equilibrium (Therefore) no <u>acceleration</u> (To gain all 4 marks, any letters used to indicate forces must be defined in either parts (a)(i) or (a)(ii)).	 **(1)** **(1)** **(1)** **(1)**	**4**
(a)(iii)	$W = U + D$ (allow ecf from diagram in part (a)(i))	**(1)**	**1**

15 (b)(i)	Use of mass = density × volume Upthrust = 2.1×10^{-5} (N) <u>Example of calculation</u> Mass = 1.0×10^{3} kg m^{-3} × 2.1×10^{-9} m^{3} = 2.1×10^{-6} kg Upthrust = 2.1×10^{-6} kg × 9.81 N kg^{-1} = 2.1×10^{-5} N	**(1)** **(1)**	**2**
(b)(ii)	State or use viscous drag = W – U ($F = 3.6 \times 10^{-5}$ N) Use of $F = 6\pi\eta rv$ Speed = 2.0 m s^{-1} (ecf from (b)(i)) <u>Example of calculation</u> $F = 5.7 \times 10^{-5}$ N – 2.1×10^{-5} N = 3.6×10^{-5} N $v = \frac{3.6 \times 10^{-5}\ \text{N}}{6\pi\eta r}$ $= \frac{3.6 \times 10^{-5}\ \text{N}}{6 \times \pi \times 1.2 \times 10^{-3}\ \text{Pa s} \times 8 \times 10^{-4}\ \text{m}}$ = 2.0 m s^{-1}	**(1)** **(1)** **(1)**	**3**
(c)	larger particles have higher terminal/maximum/average velocity **OR** smaller particles reach terminal velocity quicker **MAX 2** Viscous drag varies in proportion to radius (or area in proportion to radius squared) but weight varies in proportion to radius cubed (terminal) velocity proportional to radius squared	**(1)** **(1)** **(1)** **(1)**	**3**
	Total for question 17		**15**

16 We have a cork attached to a free metallic chain in a measuring cylinder (see picture). The cork is stable at a height of 16cm from the basis. Data: (density of water) ρ_{water}=1 g/cm^3, (Volume of the cork) V=8.41cm^3 , (mass of the cork) M=7.55g, (lineal density of the chain) d_{chain}=0.365g/cm.



a) (3p)Draw and name the forces acting on the cork.

Upthrust , weight of the cork, pull down from the chain.

b) (3p)Compute the upthrust over the cork.

$$U_{cork} = \rho g V = 0.001\frac{Kg}{cm^3}\cdot 9.81\frac{N}{Kg}\cdot 8.41\text{cm}^3 = 0.0825\text{N}$$

c) (4p)Compute the weight of the cork and of the 16cm of chain.

$$W_{cork} = Mg = 0.00755\text{Kg}\cdot 10\frac{N}{Kg} = 0.0755\text{N}$$

$$Massofchain = d_{chain}\cdot length = 0.365\frac{g}{cm}\cdot 16\text{cm} = 5.84\text{g}$$

$$W_{chain} = 0.00584\text{Kg}10\frac{N}{Kg} = 0.0584\text{N}$$

d) (4p)With the previous results, find out the upthrust upon the 16cm of chain. **It is balanced, so the net force is cero.**

$$U_{total} = W_{total} \rightarrow U_{cork} + U_{chain} = W_{cork} + W_{chain}$$

$$0.0825\text{N} + U_{chain} = 0.0755\text{N} + 0.0584\text{N} = 0.1339\text{N}$$

$$U_{chain} = 0.1339\text{N} - 0.0825\text{N} = 0.0514\text{N}$$