This is a Class 1 exam

Lebanon Evangelical School for Boys and Girls

Lebanon Evangelical School

for Boys and Girls — Loueizeh - Baabda

Stage Exam 02

08DEC2023

Do NOT write in this box. Your MARK will be placed here.

Subject :	A Level : Physics 1 : RB
Class :	11A and 12A
Teacher :	Dr Ruth Brett
Duration :	30 minutes

Write your answers in the spaces provided on this question paper. Give your final answers to an appropriate number of significant figures and write the unit if there is one. You should have a physics formula booklet.

Your name :		*Time taken to complete exam*
Your Class :		
Exam Room :		
How many sheets, including cover sheet :		

- Do not open this paper until the teacher in charge instructs you to do so.
- The most important thing to remember in taking an exam is NEVER PANIC.
- If you are caught cheating in this exam, you will be awarded zero for ALL exams that are taken on this day.

Q1. An object of volume V made from a material of density ρ_1 is placed into a fluid of density ρ_2.

Which of the following gives the upthrust on the object?

- ☒ **A** $\rho 1\ V g$
- ☒ **B** $\rho 2\ V g$
- ☒ **C** $(\rho_2 - \rho_1)\ V g$
- ☒ **D** $\frac{(\rho_2 + \rho_1)}{2} Vg$

(Total for question = 1 mark)

Q2. The mean diameter of a ball was measured to be 5.06 cm and the mass of the ball was measured to be 175 g.

Show that the density of the material of the ball is about 2600 kg m^{-3}.

(3)

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(Total for question = 3 marks)

Q3. A sphere of weight 2.5 N floats in water with ½ of its volume beneath the surface.

A force F is applied to the sphere, completely immersing it in the water as shown.



Which of the following is the minimum value of F?

- ☒ **A** 2×2.5 N
- ☒ **B** 1×2.5 N
- ☒ **C** $\frac{1}{2} \times 2.5$ N
- ☒ **D** $\frac{1}{4} \times 2.5$ N

Q4. A student used a balance to measure the mass of a small cube with sides of length x.



The student also measured the mass of a larger cube with sides of length $1.5\,x$.



Which of the following is the density ρ_L of the larger cube in terms of the density ρ_S of the smaller cube?

- ☒ **A** $\rho_L = 3.4\,\rho_S$
- ☒ **B** $\rho_L = 1.5\,\rho_S$
- ☒ **C** $\rho_L = 0.67\,\rho_S$
- ☐ **D** $\rho_L = 0.30\,\rho_S$

(Total for question = 1 mark)

Q5. A particular pendulum consists of a sphere of mass 28.0 kg, suspended by a long wire from a high ceiling.

During refurbishment, the pendulum is taken down and the wire is replaced.

Steel wires of the following diameters are available:

0.71 mm 0.91 mm 1.22 mm 1.63 mm 2.03 mm

(i) Explain which of these wires is the thinnest that could be used to support the sphere safely.

breaking stress of steel = 3.10×10^8 N m^{-2}

(3)

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(ii) The wire identified in part (i) is used for the pendulum, the unstretched length of the new wire is 11.2 m.

Calculate the extension of the new wire when the sphere is attached.
Young Modulus for steel = 200 GPa

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Extension = ...

(Total for question = 6 marks)

Q6. A child is holding a balloon by a string, as shown. The balloon contains helium gas. Helium gas is less dense than air.



(Source: © pinstock/Getty Images)

The child releases the balloon by letting go of the string.

Calculate the resultant force on the balloon immediately after it is released.
mass of balloon and string = 9.20×10^{-3} kg
volume of balloon and string = 5.00×10^{-2} m^3
density of air = 1.20 kg m^{-3}

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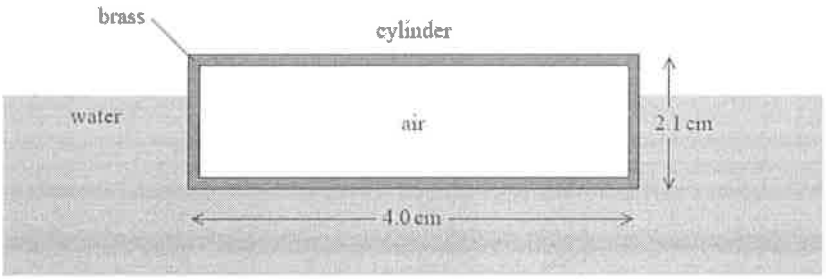
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Resultant force = ...

(Total for question = 4 marks)

Q7. A hollow brass cylinder with closed ends is floating on the surface of water.

The cylinder has a length of 4.0 cm and an external diameter of 2.1 cm as shown.



63% of the volume of the cylinder is submerged. The cylinder contains negligible weight of air.

(a) The density of water is 1.0×10^3 kg m^{-3}

(i) Show that the mass of the cylinder is about 9×10^{-3} kg.

(4)

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(ii) Deduce whether an identical hollow cylinder made of gold would also float.
Assume that the volume of gold is the same as the volume of brass.
density of gold = 19.3×10^3 kg m^{-3}
density of brass = 8.7×10^3 kg m^{-3}

(4)

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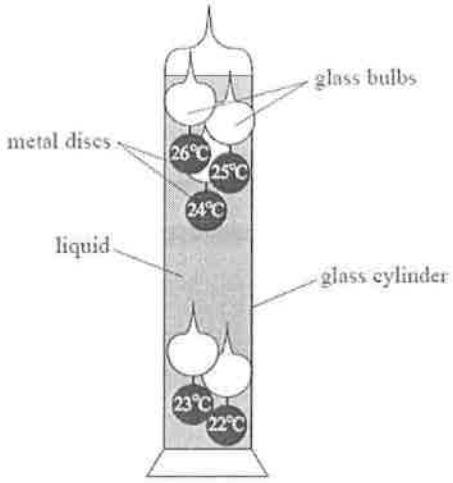
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(Total for question = 8 marks)

Q8. A Galilean thermometer consists of a closed glass cylinder containing a liquid. In the liquid there are several identical sealed glass bulbs, as shown. Attached to each bulb is a metal disc labelled with a temperature. Each disc has a different mass.



As the temperature increases, the density of the liquid decreases. This can cause the bulbs to move within the liquid.

Explain why a particular bulb will float until the temperature of the liquid exceeds a certain value.

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(Total for question = 6 marks)

Q1. An object of volume V made from a material of density ρ_1 is placed into a fluid of density ρ_2. Which of the following gives the upthrust on the object?

- ☐ **A** $\rho 1\, V g$
- (1) ☒ **B** $\rho 2\, V g$
- ☐ **C** $(\rho_2 - \rho_1)\, V g$
- ☐ **D** $\frac{(\rho_2 + \rho_1)}{2} V g$

(Total for question = 1 mark)

Q2. The mean diameter of a ball was measured to be 5.06 cm and the mass of the ball was measured to be 175 g. → 0.175kg

Show that the density of the material of the ball is about 2600 kg m^{-3}.

(3)

$r = \left(\frac{5.06 \times 10^{-2}}{2}\right) m = 2.53 \times 10^{-2} m$ (1)

$V = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi (2.53 \times 10^{-2})^3 = 6.78 \times 10^{-5} m^3$ (1)

$\rho = \frac{m}{V} = \frac{0.175}{6.78 \times 10^{-5}}$ (1) $= 2579.8 \rightarrow 2580 kgm^{-3}$

(Total for question = 3 marks)

Q3. A sphere of weight 2.5 N floats in water with ½ of its volume beneath the surface.

A force F is applied to the sphere, completely immersing it in the water as shown.



Which of the following is the minimum value of F?

- ☐ **A** 2×2.5 N
- (1) ☒ **B** 1×2.5 N
- ☐ **C** $\frac{1}{2} \times 2.5$ N
- ☐ **D** $\frac{1}{4} \times 2.5$ N

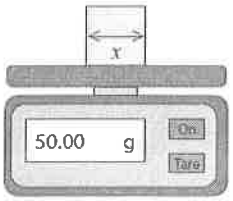
$U = W_S = 2{\cdot}5N$

If sphere is completely submerged, U doubles

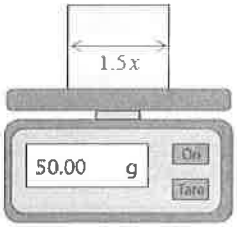
so $U_{new} = 5N$

$\therefore$ extra 2·5N needed downwards

Q4. A student used a balance to measure the mass of a small cube with sides of length x.



The student also measured the mass of a larger cube with sides of length 1.5 x.



Which of the following is the density ρ_L of the larger cube in terms of the density ρ_S of the smaller cube?

- ☐ **A** $\rho_L = 3.4\,\rho_S$
- ☐ **B** $\rho_L = 1.5\,\rho_S$
- ☐ **C** $\rho_L = 0.67\,\rho_S$
- (1) ☒ **D** $\rho_L = 0.30\,\rho_S$

$\rho_S = \frac{50}{x^3}$

$\rho_L = \frac{50}{(1{\cdot}5x)^3}$

$\frac{\rho_L}{\rho_S} = \rho_S \left(\frac{1}{1{\cdot}5^3}\right)$

$\rho_L = 0{\cdot}3\rho_S$

(Total for question = 1 mark)

Q5. A particular pendulum consists of a sphere of mass 28.0 kg, suspended by a long wire from a high ceiling.

During refurbishment, the pendulum is taken down and the wire is replaced.

Steel wires of the following diameters are available:

0.71 mm 0.91 mm 1.22 mm 1.63 mm 2.03 mm

(i) Explain which of these wires is the thinnest that could be used to support the sphere safely.

breaking stress of steel = 3.10×10^8 N m^{-2}

$\sigma = \frac{F}{A}$ $A = \frac{F}{\sigma} = \frac{28 \times 9.81}{3.1 \times 10^8} = 8.86 \times 10^{-7}\ m^2$ (1) (3)

$A = \pi r^2$

$r = \sqrt{\frac{A}{\pi}} = \sqrt{\frac{8.86 \times 10^{-7}}{\pi}} = 5.31 \times 10^{-4}\ m$ (1)

minimum diameter $= 2r = 1.06 \times 10^{-3}$ m (1)

∴ choose 1.22 mm (1) because it's the thinnest wire that will not break

(ii) The wire identified in part (i) is used for the pendulum, the unstretched length of the new wire is 11.2 m.

Calculate the extension of the new wire when the sphere is attached.
Young Modulus for steel = 200 GPa

$E = \frac{\sigma}{\varepsilon}$ $\sigma = \frac{F}{A} = \frac{28 \times 9.81}{\pi(6.1 \times 10^{-4})^2} = 2.35 \times 10^8\ Nm^{-2}$ (1) (3)

$\varepsilon = \frac{\sigma}{E} = \frac{2.35 \times 10^8}{200 \times 10^9} = 1.175 \times 10^{-3}$ (1)

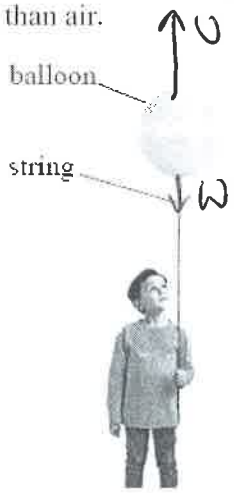
$\varepsilon = \frac{\Delta x}{x}$ $\Delta x = \varepsilon x$ (1) MUST HAVE BOTH

$\Delta x = 1.175 \times 10^{-3}\ (11.2) = 0.0132\ m$

Extension = 1.32 cm (1)

(Total for question = 6 marks)

Q6. A child is holding a balloon by a string, as shown. The balloon contains helium gas. Helium gas is less dense than air.



(Source: © pinstock/Getty Images)

The child releases the balloon by letting go of the string.

Calculate the resultant force on the balloon immediately after it is released.
mass of balloon and string = 9.20×10^{-3} kg
volume of balloon and string = 5.00×10^{-2} m^3
density of air = 1.20 kg m^{-3}

(4)

$\Sigma F = U - W$ (1)

$U = V_s \rho_{air} g = 0.05 \times 1.2 \times 9.81 = 0.5886\,N$ (1)

$W = mg = 9.2 \times 10^{-3} \times 9.81 = 0.0903$ (1)

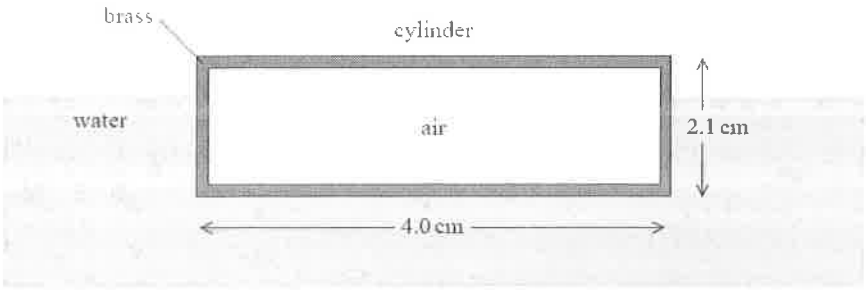
$\Sigma F = 0.5886 - 0.903 = 0.4983$ (1)

Resultant force = 0.498 N

(Total for question = 4 marks)

Q7. A hollow brass cylinder with closed ends is floating on the surface of water.

The cylinder has a length of 4.0 cm and an external diameter of 2.1 cm as shown.



63% of the volume of the cylinder is submerged. The cylinder contains negligible weight of air.

(a) The density of water is 1.0×10^3 kg m^{-3}

(i) Show that the mass of the cylinder is about 9×10^{-3} kg.

(4)

mass of cylinder = mass of water displaced

$r = \frac{2.1\text{cm}}{2} = 0.0105\text{m}$ (1) (1)

Volume of water displaced = $\frac{63}{100} \times \pi (0.0105)^2 (0.04) = 8.728 \times 10^{-6} \text{m}^3$

$\rho = \frac{m}{V}$ $m = \rho V = 1 \times 10^3 \times 8.728 \times 10^{-6} = 8.728 \times 10^{-3}$ kg (1)

mass of cylinder = 8.73×10^{-3} kg (1)

(ii) Deduce whether an identical hollow cylinder made of gold would also float.
Assume that the volume of gold is the same as the volume of brass.
density of gold = 19.3×10^3 kg m^{-3}
density of brass = 8.7×10^3 kg m^{-3}

(4)

$\rho = \frac{m}{V}$ $V_{brass} = \frac{m}{\rho} = \frac{8.73 \times 10^{-3}}{8.7 \times 10^3}$ (1) $= 1.003 \times 10^{-6} \text{m}^3$

For gold $m = \rho V = 19.3 \times 10^3 \times 1.003 \times 10^{-6} = 1.936 \times 10^{-2}$ kg $= 0.01936$ kg (1)

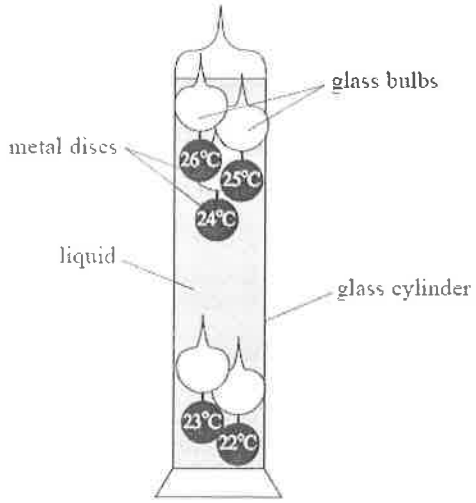
Max mass of water that can be displaced = ρV

$= \pi (0.0105)^2 (0.04) \times 1000 = 0.01385$ kg (1)

A gold cylinder would not float since $0.019\text{kg} > 0.014\text{kg}$ (1)

(Total for question = 8 marks)

Q8. A Galilean thermometer consists of a closed glass cylinder containing a liquid. In the liquid there are several identical sealed glass bulbs, as shown. Attached to each bulb is a metal disc labelled with a temperature. Each disc has a different mass.



As the temperature increases, the density of the liquid decreases. This can cause the bulbs to move within the liquid.

Explain why a particular bulb will float until the temperature of the liquid exceeds a certain value.

The upthrust upthrust on any bulb is equal to the weight of fluid displaced (1) and is calculated using $U = \rho_f V_s g$

If the upthrust is greater than the weight, the bulb will float. (1)

When the temperature increases, the density of the fluid decreases, so the upthrust will decrease. (1)

The weight of the bulb is constant, (1) so there will be a resultant force on the bulb and the bulb will sink (1) when the upthrust becomes less than the weight. (1)

(Total for question = 6 marks)