This is a Class 1 exam

Lebanon Evangelical School for Boys and Girls

...lighting the fires that burn for eternity...

Loueizeh - Baabda

Lebanon Evangelical School

for Boys and Girls Loueizeh - Baabda

SE01 Exam

09NOV2026

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

Subject :	A Level : Physics 1 : SN
Class :	11A and 12A
Teacher :	Mr. Sam
Duration :	1 hour
You are to answer the questions to this exam on : this exam paper	

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.

A student carried out an experiment to determine the Young modulus of constantan.

The student had a constantan wire with cross-sectional area A of 3.97×10^{-7} m^2.

The unstretched length x of the wire was 4.00 m.

(a) The student had enough slotted masses to apply a weight of up to 150 N to the wire.

The breaking stress for constantan is about 420 MPa.

Deduce whether the wire could support a weight of 150 N.

(3)

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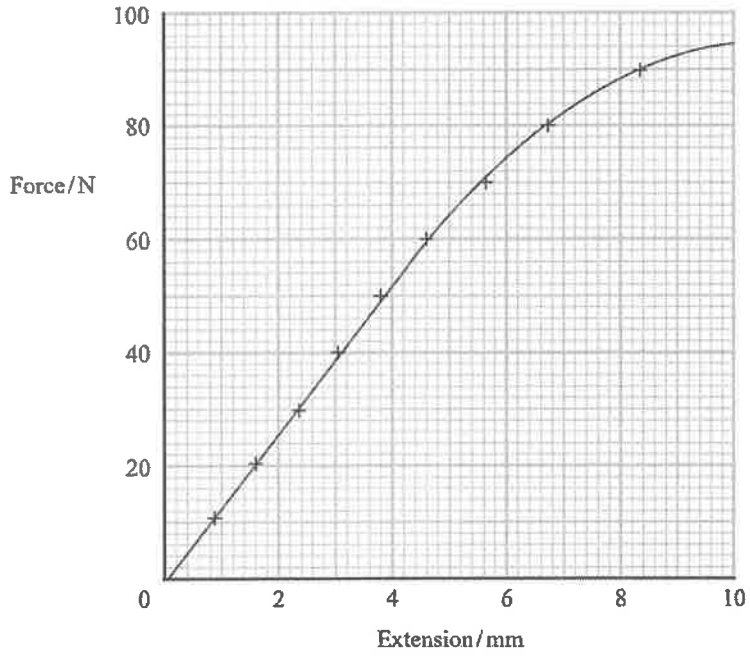
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(b) The student added slotted masses to the wire and determined the corresponding extensions. The student plotted a graph of force against extension, as shown.



(i) Show that the stiffness of the wire is about 1.3×10^4 N.m^{-1}.

(2)

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(ii) The relationship between the stiffness k of the wire and the Young modulus E is given by

$$k = \frac{EA}{x}$$

where x is the unstretched length of the wire and A is the cross-sectional area of the wire.

Determine a value for the Young modulus of constantan using the student's data.

(2)

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Young modulus = ...

(Total for question 1 = 7 marks)

Q2.

A small, spherical air bubble moves upwards in a glass of water. The drag force on the bubble can be calculated using Stokes' law.

(a) State the condition needed for Stokes' law to apply to the bubble.

(1)

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(b) The bubble moves upwards at a constant velocity.

The volume of the bubble is 5.3×10^{-11} m^3.

(i) Show that the upthrust on the bubble is about 5×10^{-7} N.

density of water = 998 kg.m^{-3}

(2)

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(ii) The bubble moves upwards at a constant velocity of 0.035 $m.s^{-1}$.

Deduce whether Stokes' law applies to the bubble.

You may ignore the weight of the bubble.

viscosity of water = 9.5×10^{-4} Pa.s

(4)

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(Total for question 2 = 7 marks)

Q3.

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)

(a) 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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Resultant force = ...

*(b) Immediately after the balloon is released, it begins to move upwards.

The density of the air remains constant and there is no wind.

Explain how the forces acting on the balloon affect its motion as it moves upwards from the moment it is released.

(6)

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(Total for question 3 = 10 marks)

Q4.

A falling sphere viscometer is a device used to determine the viscosity of a liquid. A sphere falls through a cylinder containing a liquid, and the terminal velocity of the sphere is measured.

(a) State why the temperature of the liquid should **not** increase during the measurement.

(1)

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(b) A scientist measured the terminal velocity of an aluminium sphere as it fell through glycerol.

(i) Show that the weight of the sphere is about 4.8×10^{-3} N.

density of aluminium = 2.70×10^{3} kg.m^{-3}

diameter of sphere = 7.00×10^{-3} m

(4)

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(ii) The terminal velocity of the sphere was 4.05×10^{-2} m.s^{-1}.

Deduce whether Stokes' law applied to the falling sphere.

density of glycerol = 1.26×10^{3} kg.m^{-3}

viscosity of glycerol = 9.50×10^{-1} Pa.s

(3)

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(iii) State one condition that must be met for Stokes' law to apply.

(1)

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(c) A scientist used the viscometer to measure the viscosity of blood. The viscosity of blood is typically in the range 3×10^{-3} Pa s to 4×10^{-3} Pa.s.

Explain why the scientist should use an aluminium sphere with a much smaller diameter than the sphere used with the glycerol. Do not include calculations in your answer.

viscosity of glycerol = 9.50×10^{-1} Pa.s

(5)

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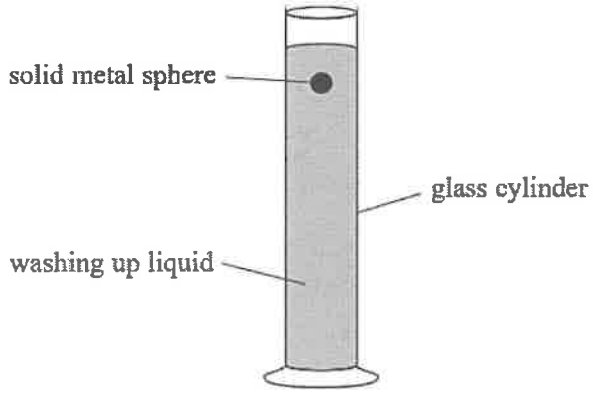
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(Total for question 4 = 14 marks)

Q5.

A student carried out an experiment to determine the viscosity of washing up liquid using the apparatus shown.



(a) The student released the sphere at the top of the cylinder and made measurements, using a stopwatch and metre rule, so the terminal velocity of the sphere could be determined.

(i) Describe a method that the student could use to determine an accurate value for the terminal velocity of the sphere. You may add to the diagram above.

(5)

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(ii) Explain why the use of a larger sphere would increase the percentage uncertainty in the calculated value of the terminal velocity.

(4)

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(b) (i) Complete the free-body force diagram for the sphere when travelling at terminal velocity.

(3)

(ii) The student obtained a value of 0.16 $m.s^{-1}$ for the terminal velocity of the sphere.

Calculate the viscosity η of the washing up liquid in Pa.s.

radius of sphere = 4.8×10^{-3} m

weight of sphere = 3.5×10^{-2} N

density of washing up liquid = 1.1×10^{3} $kg.m^{-3}$

(4)

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η = ... Pa.s

(Total for question 5 = 16 marks)

(Total for paper = 54 marks)

Q1.

A student carried out an experiment to determine the Young modulus of constantan.

The student had a constantan wire with cross-sectional area A of 3.97×10^{-7} m^2.

The unstretched length x of the wire was 4.00 m.

(a) The student had enough slotted masses to apply a weight of up to 150 N to the wire.

The breaking stress for constantan is about 420 MPa.

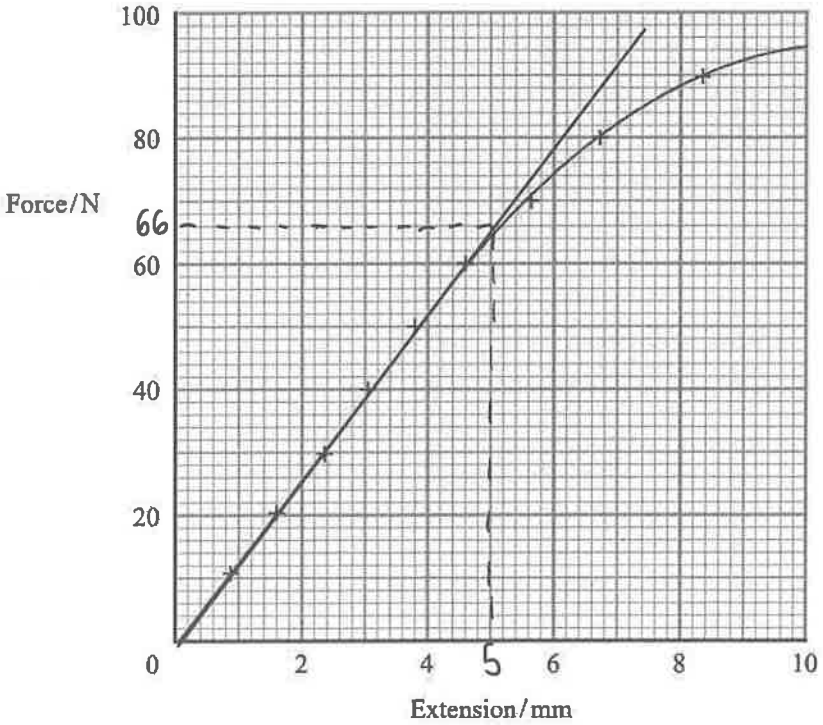
Deduce whether the wire could support a weight of 150 N.

(3)

$\sigma = \frac{F}{A} \overset{(1)}{=} \frac{150}{3.97 \times 10^{-7}} = 377.8 \text{ MPa}$ (1)

377.8 MPa < 420 MPa so wire can support the weight, it will not break. (1)

(b) The student added slotted masses to the wire and determined the corresponding extensions. The student plotted a graph of force against extension, as shown.



(i) Show that the stiffness of the wire is about 1.3×10^4 N m^{-1}

(2)

$K = \text{gradient} \overset{(1)}{=} \frac{\Delta y}{\Delta x} = \frac{(66-0)}{(5-0)\times 10^{-3}} = 1.32 \times 10^4 \text{ N m}^{-1}$ (1)

Allowed range: $1.27 \times 10^4 \rightarrow 1.33 \times 10^4$

(ii) The relationship between the stiffness k of the wire and the Young modulus E is given by

$$k = \frac{EA}{x}$$

where x is the unstretched length of the wire and A is the cross-sectional area of the wire.

Determine a value for the Young modulus of constantan using the student's data.

(2)

$E = \frac{kx}{A}$ (1) $= \frac{1.3 \times 10^4 \times 4}{3.97 \times 10^{-7}} = 1.31 \times 10^{11}$ Pa (1)

Young modulus = 1.3×10^{11} Pa

(Total for question = 7 marks)

Q2.

A small, spherical air bubble moves upwards in a glass of water. The drag force on the bubble can be calculated using Stokes' law.

(a) State the condition needed for Stokes' law to apply to the bubble.

(1)

The flow must be laminar (1)

(b) The bubble moves upwards at a constant velocity.

The volume of the bubble is $5.3 \times 10^{-11}\,m^3$.

(i) Show that the upthrust on the bubble is about 5×10^{-7}N.

density of water = $998\,kg\,m^{-3}$

(2)

$U = W_{fluid\ displaced}$ (1)

$= m_{fluid} \times g$

$= \rho_{fluid} \times V_{bubble} \times g$

$U = 998 \times 5.3 \times 10^{-11} \times 9.81 = 5.19 \times 10^{-7}\,N$ (1)

(ii) The bubble moves upwards at a constant velocity of $0.035\,m\,s^{-1}$.

Deduce whether Stokes' law applies to the bubble.

You may ignore the weight of the bubble.

viscosity of water = 9.5×10^{-4} Pa s

(4)

$V = \frac{4}{3}\pi r^3$ (1)

$r = \sqrt[3]{\frac{3V}{4\pi}} = \sqrt[3]{\frac{3(5.3\times10^{-11})}{4\pi}}$

$r = 2.33 \times 10^{-4}\,m$

$F_{drag} = 6\pi\eta rv$ (1)

$= 6\pi(9.5\times10^{-4})(2.33\times10^{-4})\times(0.035)$

$= 1.46 \times 10^{-7}\,N \neq U$ (1)

If Stoke's Law apply $U = F_{drag}$

Stoke's Law Does not apply (1)

(Total for question = 7 marks)

Q3.

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)

(a) 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)

$F_{net} = U - W_{balloon}$

$= W_{fluid\ displaced} - W_{balloon}$ (1)

$= (\rho_{fluid} \times V_{balloon} \times g) - (m_{balloon} \times g)$ (1)

$= (1.2 \times 5 \times 10^{-2} \times 9.81) - (9.2 \times 10^{-3} \times 9.81)$

$F_{net} = 0.5\,N$

Resultant force = 0.5N (1)

*(b) Immediately after the balloon is released, it begins to move upwards.

The density of the air remains constant and there is no wind.
Explain how the forces acting on the balloon affect its motion as it moves upwards from the moment it is released.

(6)

Initially the resultant force is upwards. (1)
Therefore, the balloon accelerates upwards. (1)
As the velocity of the balloon increases the air resistance downwards also increases. (1)
Eventually U = W + Fdrag and the forces balance each other. (1)
The balloon reaches terminal velocity and so it continues to move upwards at a constant velocity. (1)
+ (1) For Coherent & Logical Structure

(Total for question = 10 marks)

Q4.

A falling sphere viscometer is a device used to determine the viscosity of a liquid. A sphere falls through a cylinder containing a liquid, and the terminal velocity of the sphere is measured.

(a) State why the temperature of the liquid should **not** increase during the measurement.

(1)

As temperature increases the viscocity decreases. (1)

(b) A scientist measured the terminal velocity of an aluminium sphere as it fell through glycerol.

(i) Show that the weight of the sphere is about 4.8×10^{-3} N.

density of aluminium = $2.70 \times 10^{3}\ \text{kg m}^{-3}$
diameter of sphere = 7.00×10^{-3} m

(4)

$W = mg$ (1)

$= \rho \times V \times g$ (1)

$= \rho \times \frac{4}{3}\pi r^3 \times g$ (1)

$= \rho \times \frac{4}{3}\pi \left(\frac{d}{2}\right)^3 \times g$

$= 2.7\times10^{3} \times \frac{4}{3} \times \pi \times \left(\frac{7\times10^{-3}}{2}\right)^3 \times 9.81$

$= 4.76\times10^{-3}\ \text{N}$ (1)

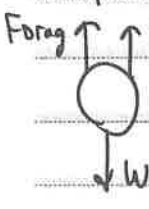
(ii) The terminal velocity of the sphere was $4.05 \times 10^{-2}\,\text{m s}^{-1}$.

Deduce whether Stokes' law applied to the falling sphere.

density of glycerol = $1.26 \times 10^{3}\,\text{kg m}^{-3}$
viscosity of glycerol = $9.50 \times 10^{-1}\,\text{Pa s}$

(3)

If Stoke's Law $F_{drag} + U = \text{Weight sphere}$



$6\pi r \eta v$ (1) $+ \rho_{fluid} \times V_{sphere} \times g = 4.76 \times 10^{-3}$ (1)

$6\pi \times \left(\frac{7\times10^{-3}}{2}\right)(9.5\times10^{-1})(4.05\times10^{-2}) + (1.26\times10^{3})\left(\frac{4}{3}\pi\left(\frac{7\times10^{-3}}{2}\right)^{3}\right) \times 9.81$

$4.76 \times 10^{-3}\,\text{N} = 4.76 \times 10^{-3}\,\text{N}$

So Stoke's Law is Conserved (1)

(iii) State one condition that must be met for Stokes' law to apply.

(1)

Laminar Flow. (1)

(c) A scientist used the viscometer to measure the viscosity of blood. The viscosity of blood is typically in the range 3×10^{-3} Pa s to 4×10^{-1} Pa s.

Explain why the scientist should use an aluminium sphere with a much smaller diameter than the sphere used with the glycerol. Do not include calculations in your answer.

viscosity of glycerol = 9.50×10^{-1} Pa s

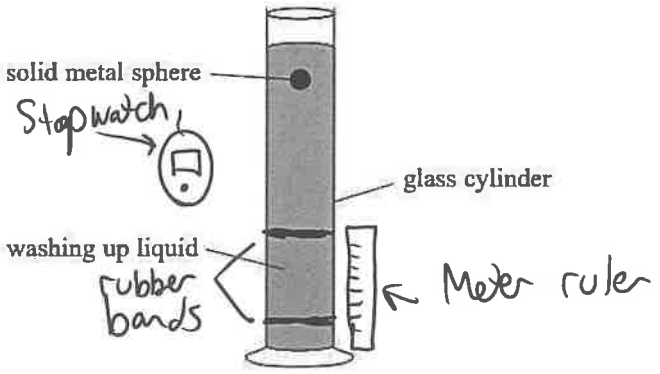
(5)

The viscocity of blood is much lower. (1)
So the drag on the sphere will be lower
$F = 6\pi r \eta v$. (1)
Reducing the diameter will give the sphere less weight. (1)
So the sphere will have a lower terminal velocity. (1)
To have laminar flow we need low speeds. (1)

(Total for question = 14 marks)

Q5.

A student carried out an experiment to determine the viscosity of washing up liquid using the apparatus shown.



(a) The student released the sphere at the top of the cylinder and made measurements, using a stopwatch and metre rule, so the terminal velocity of the sphere could be determined.

(i) Describe a method that the student could use to determine an accurate value for the terminal velocity of the sphere. You may add to the diagram above.

(5)

Place two rubber bands on the cylinder (1) far enough down to make sure the sphere reached terminal velocity. (1)
Use a meter ruler to measure the distance between the two rubber bands.
Use the stopwatch to measure the time taken to fall in between the bands. (1) Together
Repeat many times and average the time (1)
Find $V = \frac{d}{t}$ (1)

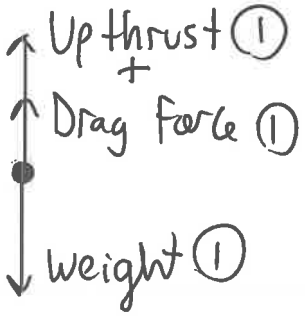
(ii) Explain why the use of a larger sphere would increase the percentage uncertainty in the calculated value of the terminal velocity.

(4)

A large sphere will have a higher terminal velocity. (1)
The weight is also greater so the sphere takes more time to reach terminal velocity. (1)
The time of the sphere falling would be less. (1)
So since the person's reaction time is the same the uncertainty in time increases. (1)

(b) (i) Complete the free-body force diagram for the sphere when travelling at terminal velocity.

(3)



(ii) The student obtained a value of $0.16\,m\,s^{-1}$ for the terminal velocity of the sphere.

Calculate the viscosity η of the washing up liquid in Pa s.

radius of sphere = 4.8×10^{-3} m
weight of sphere = 3.5×10^{-2} N
density of washing up liquid = 1.1×10^{3} kg m^{-3}

(4)

$U = W_{fluid\ displaced}$

$= \rho_{fluid} \times V_{sphere} \times g$

$= 1.1 \times 10^{3} \times 4.63 \times 10^{-7} \times 9.81$

$U = 5 \times 10^{-3}$ N (1)

$U + F_{Drag} = W$

$F_{Drag} = W - U$ (1)

$= 3.5 \times 10^{-2} - 5 \times 10^{-3}$

$F_{Drag} = 3 \times 10^{-2}$ N

$V_{sphere} = \frac{4}{3}\pi r^{3} = \frac{4}{3}\pi (4.8 \times 10^{-3})^{3} = 4.63 \times 10^{-7}$

$F = 6\pi r \eta v$ (1)

$\eta = \frac{F}{6\pi r v} = \frac{3 \times 10^{-2}}{6\pi (4.8 \times 10^{-3})(0.16)}$

$\eta = 2.07$ Pas

$\eta =$ 2.1 (1) Pas

(Total for question = 16 marks)