Final Examination - Grade 13 - 2016

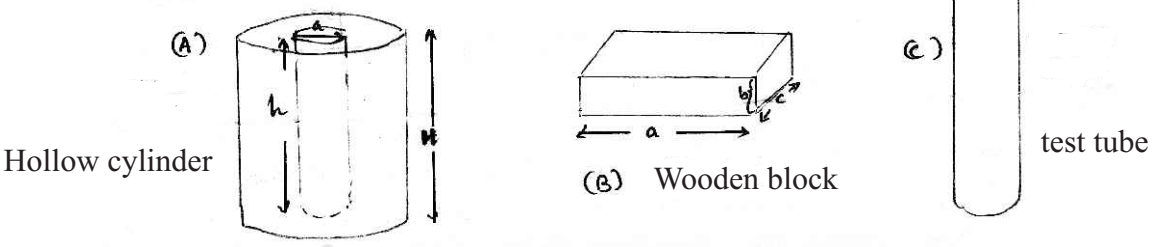
Index No. ..... Physics II Three hours only

Important

- The question paper is consisted of two parts, A and B.
  Part A
- Answer all the questions in this paper it self. Write down your answers in the spaces provided in the spaces provided in the question paper. Long answers are not expected.
  Part B
- Answers Only 4 questions.

Part A - Structured Essay

01. (a) You are provided with a vernier caliper used in the school laboratory and the following instruments.



Hollow cylinder (B) Wooden block test tube

(i) Name the parts of the vernier caliper you would use in order to determine the accurate values for the following measurements.

i. The depth of the hollow cylinder .....

ii. The thickness of the wooden block .....

iii. The external diameter of the test tube. .....

(ii) Before taking these measurements with the vernier caliper it is necessary to check the zero error of the instrument. How do you check it.?

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(iii) In the above vernier caliper the length of the main scale division is 1mm and the length of vernier scale division is 0.9mm. What is the least count of the instrument ?

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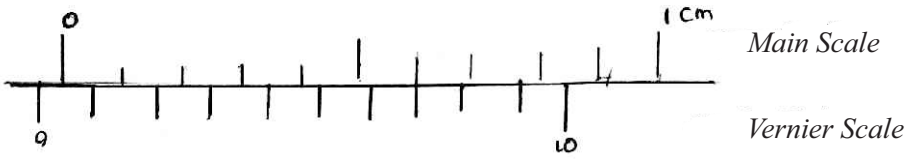
(b) The figure shows a situation in which the external jaws of the vernier caliper are adjusted to determine the zero error.



i. What is the zero error of the instrument ?

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ii. When the external diameter of (C) was measured the main scale reading was 28mm and the vernier scale reading was 7. What is the correct value of the external diameter of the test tube.?

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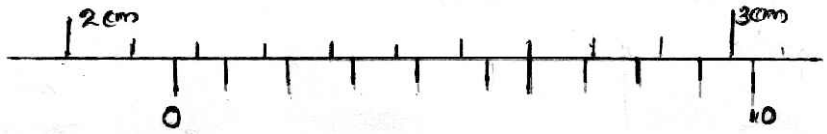
iii.



When the internal depth of (A) was measured using the vernier caliper used above, the position of the vernier scale obtained relative to the main scale is shown in the above figure. What is the depth of the cylinder.?

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iv. What is the correct value of the above reading in part b(iii) when the zero error is considered.

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(c) When the thickness of (B) was measured using above vernier caliper the reading obtained was 2mm.

i. What is the fractional error of the measurement?

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ii. What is the percentage error of the measurement ?

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iii. A student stated that the vernier caliper mentioned above is suitable to measure the internal diameter of a rubber tube. Do you agree with the student. Give reasons for your answer.

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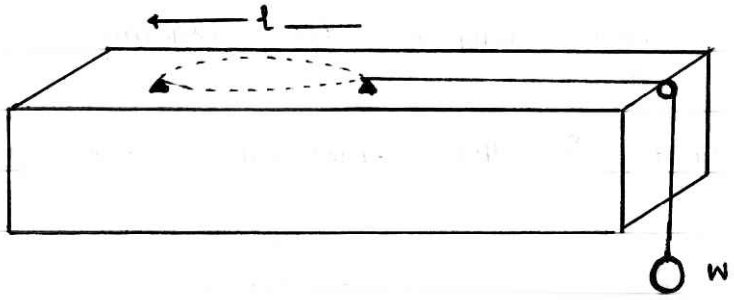
01. (a) A sonometer can be used to verify the laws of vibration in stretched strings.



(i) How do you resonate the sonometer wire with the vibrating tunning fork.

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(ii) The experiment was done by keeping the two bridges close to each other at the beginning. Give reasons for this.

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(b) You are provided with a sonometer box and a set of tunning forks.

i. Write down an expression for the fundermental frequency (f) in terms of *l, w* and *m* where m is the mass per unit length of the wire.

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ii. Rearrange the above expression to draw a straight line graph.

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iii. Draw the rough sketch of the graph.

iv. How do you determine the mass per unit length (m) of the wire using the graph.

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c) i. In this experiment if you are given only one tunning fork instead of the set of tunning forks, name the suitable physical quantities for the independent and dependent variables of the graph.

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ii. Write down the rearranged equation to draw the suitable graph for the instance in part (C) (i).

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iii. If the gradient of the graph in part c(ii) is 2.5×10^{-3} and $m = 0.01kg$ find the frequency of the tunning fork to the nearest whole number.

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03. The figure shows an experimental setup used in the laboratory to determine the conductivity of good conductors.

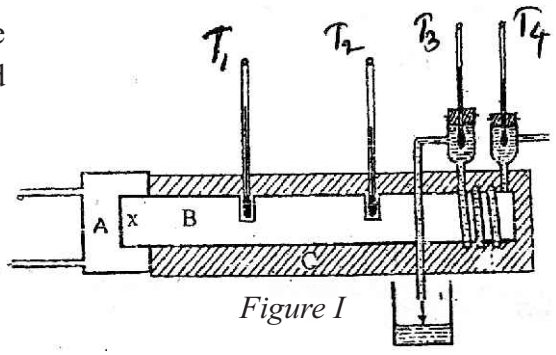

Figure I

a) Write down the uses of the parts named as A,B and C.

A .....

B .....

C .....

b) i. Mark the direction in which the water flows through the pipe.

ii. Briefly explain how you would maintain the end x at 100^0C using the setup in the figure I.

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c) i. Mark the path of the heat flow along the lagged bar with the arrows in the figure II.

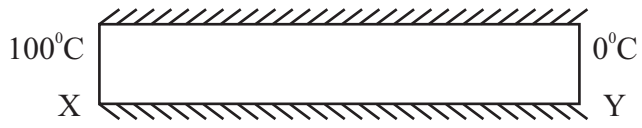

Figure II

ii. Mark the path of the heat flow along the unlagged bar in the figure III.

figure III

d) i. What are the readings required to determine the heat conductivity.

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e) Write down an expression for the heat conductivity of the bar (k) in terms of the cross sectional area (A) of the metal bar, the specific heat capacity of water (Sw) and the other basic measurements you obtained.

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f) i. The readings of the thermometers T_1, T_2, T_3 and T_4 are 80^0C, 50^0C, 35^0C and 30^0C respectively. If the cross sectional area of the metal bar is $38.5\ cm^2$, the mass of water flow per second is 2kg, the specific heat capacity of water is 4200 $Jkg^{-1}K^{-1}$ and the distance between the thermometers T_1 and T_2 is 10 cm, calculate the value of k.

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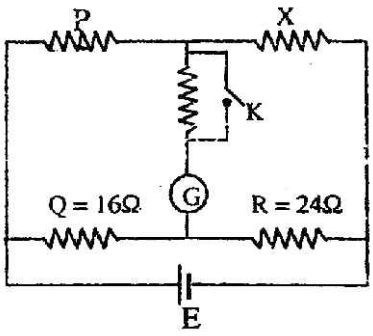
04. The figure shows a diagram of a circuit arranged by a student to measure the value of unknown resistor x.



a) When P = 32Ω the deflection of the galvanometer is zero. Find the value of x.

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b) i. What is the instrument in the laboratory to find the value of unknown resistor based on this principle?

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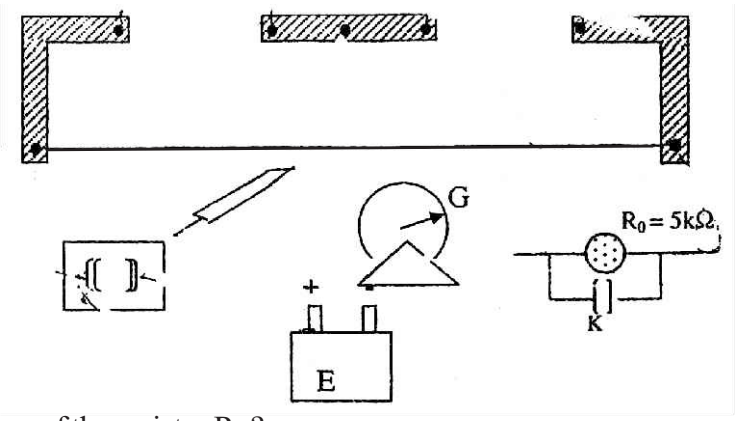
ii. Draw a complete diagram of a circuit used to determine the value of unknown resistor, with the

instruments given below. Name P and X.



c) What is the use of the resistor R_0 ?

d) In which instance, the key K is used?

e) i. A student states that this arrangement cannot be used to determine an accurate value of a resistor less than 1Ω. Do you agree with him? Give reasons for your answer.

ii. If he tries to use this arrangement to determines the value of a resistor greater than 1MΩ, What are the changes must be made in the arrangement for more accurate readings ?

f) If the accumulator (E) is discharged, what is the effect of it on this experiment?

g) When measuring the balanced length, at which position of the balance point will give a more accurate reading? Give reasons.

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Part B - Essay

Answer **four questions** Only.

05. Define the terms of the relationship $L = I\omega$ related to the rotational motion. Briefly explain the method of finding the direction of L.

a) 1. A merry - go - round is rotating about its own axis at a constant rate of 2.5 revolutions per minute. The mass of the merry - go - round is 500kg and its radius is 2m.

i. Calculate the angular momentum and the rotational kinetic energy of the merry - go - round. (The moment of the innertia of the plate with radius r and mass m about its axis is given by $1/2\ mr^2$)

ii. Two children mass 25kg each got on to the two ends of a diameter of the merry - go - round at once. If there is no external torque acting on the merry - go - round, calculate the new angular velocity of the system.

2. Instead of the two children getting on to the merry - go - round, a child runs along a tangent drawn to the circumference of the merry - go - round at a constant speed of $2ms^{-1}$ and got on to a point on the circumference of the merry - go - round. Suddenly if he comes to rest relative to the merry - go - round.

i. What is the new angular velocity of the merry - go - round ?

ii. Find the change in the total energy of the child and the merry - go - round.

b) A tangential force 180N is applied on to a grinding stone (a solid plate) of mass 75.0 kg and radius 280mm.

i. Calculate the torque acting on it.

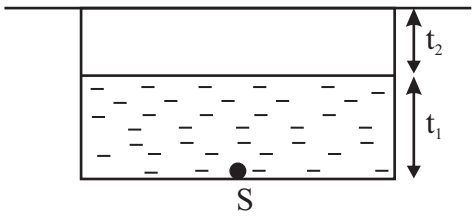
ii. Neglecting the friction calculate the angular acceleration.

iii. If a friction force of 20.0N is applied at a distance of 1.50 cm from its axis calculate the new angular acceleration.

06. i. A point source is kept on the bottom of a shallow circular pond filled with water. A person when looking at the pond from above, sees a circular patch of light on the top surface. Briefly explain

that how this circular light patch is formed.

ii. The figure shows a vertical cross section of a shallow circular pond covered with a thick glass plate G of thickness t_2. The pond contains water to a height t_1 up to the lower surface of the bottom of the glass plate. A point light source S is kept at the bottom of the pond. show that the radius (R) of the circular light patch seen on the glass plate from the top view is given by,



$$R = t_1 \tan \acute{\imath} + t_2 \tan C$$

$$\text{Sin } C = \frac{1}{n_g} \quad \text{and} \quad \text{Sin } \acute{\imath} = \frac{1}{n_w}$$

Where $\acute{\imath}$ is the angle of the incidence for the water glass interface, C is the critical angle for glass air interface and n_g , n_w are the absolute refractive indices of glass and water respectively.

iii. If the thickness of the glass plate is 4cm, the depth of water in the pond is 30cm and the refractive indices of glass and water are 3/2 and 4/3 respectively, calculate the radius of the circular light patch seen on the glass plate using the results obtained in part (ii) or using any other calculations.

iv. What will happen to the diameter of the circular patch of light when another layer of water is placed on the glass plate? Briefly explain your answer?

v. If the radius of the pond is 45cm, calculate the minium thickness of a water layer needed in (iii) to make sure that the light patch covers its entire top surface.

7). When we operate the engines that we use in day to day activities the parts slide on one another, giving rise to frictional forces. This frictional force causes to produce heat and sound in the engine reducing the efficiency of the machine. Due to the friction between the surfaces in mutual contact the parts wear and tear.

A lubricating coil can be introduced to reduce the friction between the surface which are in contact. These oils can flow in layers and it reduces friction and the formation of ware particles. Lubricating oils are the most commonly used in sewing machines, engines and gear boxes of motor vehicles. A suitable type of lubricating oil must be selected for different machines because the coefficient of viscosity of this oil varies with the temperature change in the machine. For example a lubricating oil with the coefficient of viscosity 1.5×10^{-2} Nsm^{-2} can be used for a light machine and a lubricating oil with the coefficient of viscosity 1.0×10^{-1} NSm^{-2} can be used for a heavy machine with high speed motions.

The society of automobile engineers (SAE) has established a numerical code system for grading motor oil according to their viscosity characteristics. The higher viscosity has a higher SAE code. Generally the viscosity of a liquid decreases with the increase in temperature. Nowadays a special type of lubricant oil called multi grade is introduced to the market for the modern machines. In this oil the viscosity increases with the increase in temperature.

i. According to the paragraph, what is the main factor affecting the efficiency of a machine?

ii. What are the harmful effects caused by the friction of parts in the machine.?

iii. Draw a rough sketch of a graph of the variation of the coefficient of viscosity with the temperature.

iv. What is the special characteristic of multi grade oil?

v. Friction and the viscosity are two resistive forces, which one of these forces depend on the relative motion?

vi. How does SAE grade lubricating oil?

vii. Draw the speed distribution of the layers of a streamline flow on a surface with arrows.

viii. An oil layer thickness 0.5mm and the coefficient of viscosity $1.2NSm^{-2}$ is applied on a horizontal flat surface. A sheet with an area $0.2m^2$ is kept on the oil layer and it is moving with a speed of $2mms^{-1}$.

a.) Write down the Newton equation for the tangential stress acting on the sheet.

b.) What are the units and the dimensions of the coefficient of viscosity?

c.) Find the magnitude of the tangential force must be applied on the sheet.

8.) State Newton's law of gravitation.

1. Assume that the earth is a perfect sphere of mass M and radius R. G is the universal constant of gravitation. An object of mass m is kept on the earth surface.

i. Write an expression for the gravitational force acting on the mass.

ii. Hence obtain an expression for the acceleration due to gravity (g) at a point on the earth surface.

iii. Draw the variation of the acceleration due to gravity from the centre of the earth to the outside surface of the earth.

2. a) Obtain an expression for the acceleration due to gravity (g) acting on a satellite orbiting around the earth in a circular orbit of radius r, $(r > R)$, in terms of the acceleration due to gravity (g_0) on the earth surface.

b) A satellite of mass 600kg is orbiting around the earth in a circular orbit. The distance to the orbit from the earth surface is 600km and the radius of the earth is 6400km. If the gravitational field intensity on the earth surface is $10Nkg^{-1}$ calculate.

i. Speed of the satellite in the orbit.

ii. The kinetic energy of the satellite.

iii. The gravitational potential energy of the satellite.

3. i. Define the escape velocity.

ii. Calculate the escape velocity of an object if the acceleration due to gravity (g) on the earth surface is $10\ ms^{-2}$ and the radius of the earth is 6400km.

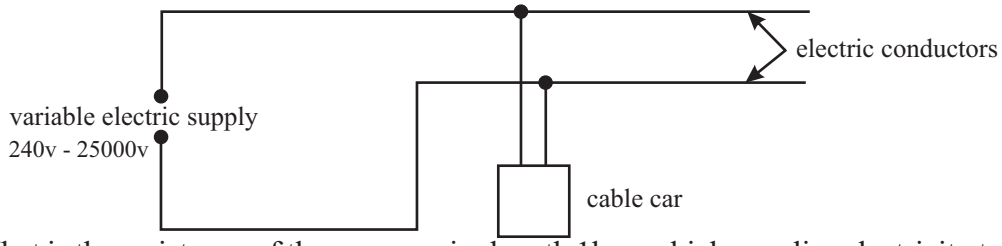
Answer either part (A) or part (B)

9) A i. Write an expression for the resistance (R) of a conducting wire of length ℓ. radius of the cross section r and the resistivity ρ

ii. When the potential difference (v) is supplied to the ends of the wire in part (i) show that the heat produced is given by,

$$\frac{\pi v^2 r^2}{\rho \ell}$$

iii. Nowadays cable car is a good solution for the heavy traffic in town areas. Most of the cable cars work with electric energy. The following figure shows an electric circuit of a cable car system designed by an advance level student.



a) What is the resistance of the copper wire length 1km, which supplies electricity to the cable car. The radius of the wire is 0.5mm and the resistivity of copper is $1.75 \times 10^{-8} \Omega m$?

b) A constant potential difference 240 V / 20A must be supplied to the motor of the cable car and a variable potential difference 240v - 2500v is connected to the main power supply. When the cable car is at a distance 1km from the main power supply what is the potential difference must be supplied by the main power supply ?

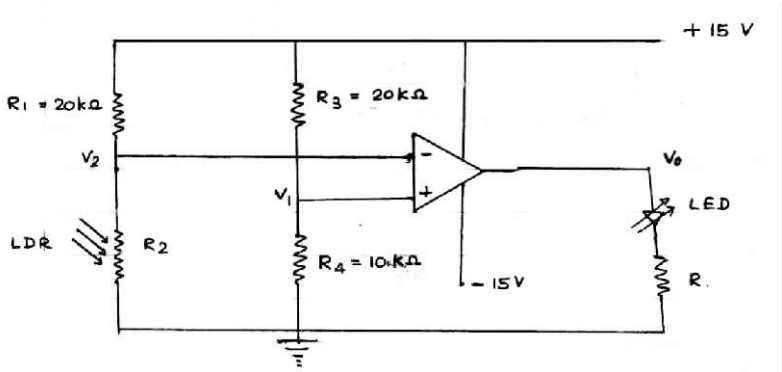
c) What is the ratio of the consumed power of the motor to the supplied power ?

d) According to the above power supply, how long will the cable car move from the power supply?

e) What are the advantages of using these motor cars in the town areas ?

f) What are the main weakness of this design ?

B. Draw the diagrams of the circuits for the inverted and non-inverted operational amplifiers. Write the voltage gain of each separately.



The figure as a switching circuit. Here LDR d resistance in dark is 130KΩ. LED is a light emitting diode. The maximum value of the output voltage is $V_{sat} = \pm 13V$.

(i) Find the voltage V_1

(ii) Find the voltage V_2 when the LDR is in light and in dark.

(iii) Find the value of V_0 when the LDR is in light and in dark.

(iv) When the LDR is in dark or light, will the LED emit light ?

(v) If the LED emits light under opposite condition of light intensity in part (iv) what is the change must be made in the circuit ?

Answer either part (A) or part (B)

10) A The rate of heat flow of a material is given by,

i. Identify each quality of this formula.

ii. This expression $\frac{Q}{t} = KA\frac{\Delta\theta}{l}$ can be log into the formula ,

Where R is the heat resistance. Obtain an expression for R in terms of *l*, K and A.

iii. If the two rods AB and CD length *l*, with equal cross sectional area and the heat conductivities of K_1 and K_2 respectively are thermally in series. $\frac{Q}{t} \quad \frac{\Delta\theta}{R}$

Show that thermal resistance R is given by, $R = R_1 + R_2$

and when the two rods are thermally in parallel R is given by,

Where R_1 and R_2 are thermal resistance of two rods.

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}$$

iv. In a house, glass tiles are made of 2 glass plates 2mm thick with an air space 1mm thick between them. The thermal conductivities of glass and air are $1.2 Wm^{-1}K^{-1}$ and $0.024 Wm^{-1}k^{-1}$ respectively. Calculate the rate of heat conducted per unit area through the glass tiles when the outside and the inside surfaces are at the temperatures 32^0 and 26^0 respectively.

B) State the Stefans' law. Express the law as an equation.

Assuming that the temperature on the earth is T_e, radius of the sun is r_S, the temperature of the sun is T_S and the distance between the sun and the earth is R.

i. What is the power radiated from the sun?

ii. Considering the power received by the earth show that,

$$T_e = T_s \times \left(\frac{r_S}{2R}\right)^{\frac{1}{2}}$$

iii. Estimate the temperature T_e of the earth, assuming it is in radioactive equilibrium with the sun (Assume radius of the sun r_S 7×10^8m, temperature of the sun is 6000K, the distance to the earth from the sun R = 1.5×10^{11}m)

iv. Generally the temperature of the earth is differ from the calculated value in part (iii). Explain with reasons. (Assume that the sun is a perfect black body.)