Provincial Department of Education - NWP

01	E	I

First Term Test - Grade 13 - 2020

Index No. .....

Physics I

2 hours

- **This paper consists of 50 questions and Answer all the questions.**
- **Use of calculator is not allowed.**
- **Write your index number in the space provided in the answer sheet.**
- **In each of the questions 1 to 50 pick one of the alternatives from (1),(2),(3),(4),(5) which is correct or most appropriate and mark your response on the answer sheet with a cross (x) in the answer sheet.**

1. Units of wave intensity in fundamental units

(1) $\frac{m}{s^3}$ (2) $\frac{m}{kg\ s^3}$ (3) $\frac{kg}{m\ s^3}$ (4) $\frac{kg}{s^3}$ (5) $\frac{kg\ s}{m}$

2. The diameter of a capillary tube is 1.25 mm as measured with a certain measuring instrument. If it has been stated with correct number of significant figures, the percentage error is

(1) 0.1 % (2) 0.4 % (3) 1 % (4) 0.8 % (5) 0.5 %

3. If C_a,C_h, and C_m are the speeds of sound in air, hydrogen and a metal at the same temperature, then

(1) $C_h > C_a > C_m$ (2) $C_a > C_m > C_h$ (3) $C_m > C_a > C_h$

(4) $C_m > C_h > C_a$ (5) $C_a > C_h > C_m$

4. The units of capacitance are equivalent to

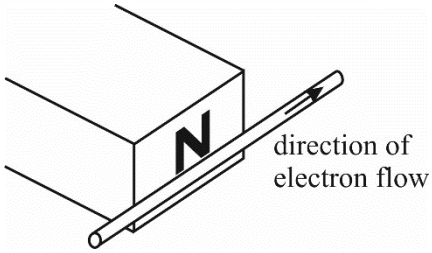
(1) $J\ C^{-1}$ (2) $V\ C^{-1}$ (3) $J^2\ C^{-1}$ (4) $C\ J^{-1}$ (5) $C^2\ J^{-1}$

5. The first law of thermodynamics is a statement which implies that

(1) all work is mechanical.
(2) energy is conserved.
(3) the change in internal energy equals the external work done.
(4) the internal energy depends on temperature.
(5) no work can be done without change of volume.

6. The figure shows the motion of electrons in a wire that is near the N pole of a magnet. The wire will be pushed:

(1) toward the magnet (2) away from the magnet
(3) downwards (4) upwards
(5) along its length

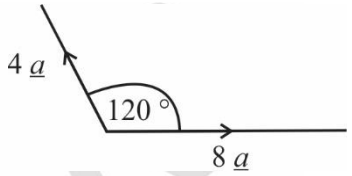


7. The capacitance of a parallel-plate capacitor can be increased by
(1) increasing the charge (2) decreasing the charge
(3) increasing the plate separation (4) decreasing the plate separation
(5) decreasing the plate area

8. The quality that is not in Thermocouple thermometer
(1) quick response. (2) wide range. (3) high sensitivity.
(4) high accuracy. (5) linear variation of thermometric property

9. *A* and *B* are two points in an electric field. A 16 J of work must be done to carry a 4 C charge from *A* to *B*. Then the potential difference between *A*and *B* is
(1) 16 V (2) 12 V (3) 8 V (4) 4 V (5) 0 V

10. The difference between two vectors shown in the figure is



(1) $4\sqrt{3}\,a$ (2) $4\sqrt{7}\,a$ (3) $4\sqrt{5}\,a$ (4) $2\sqrt{3}\,a$ (5) $2\sqrt{7}\,a$

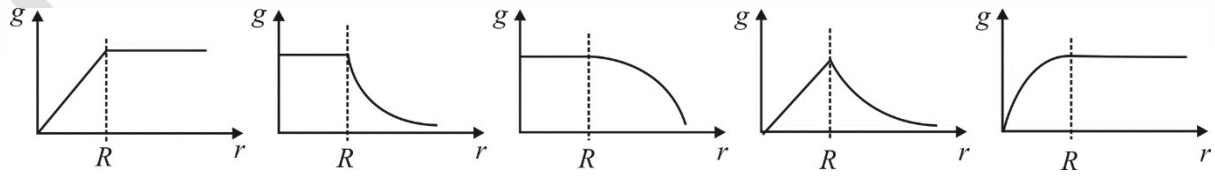
11. The temperature of an ideal gas is increased from 27 °C to 927 °C. The root mean square speed of its molecules becomes
(1) one-fourth (2) two-third (3) half (4) double (5) four times

12. The magnetic field due to a long straight current-carrying wire at a distance *r* from it is proportional to
(1) r (2) r^2 (3) $\frac{1}{r}$ (4) $\frac{1}{r^2}$ (5) $\frac{1}{\sqrt{r}}$

13. Velocity of sound in air is 320 m s^{-1}. A pipe closed at one end has a length of 1 m. Neglecting end corrections, the air column in the pipe can resonate for sound of frequency
(1) 80 Hz (2) 240 Hz (3) 320 Hz (4) 400 Hz (5) 440 Hz

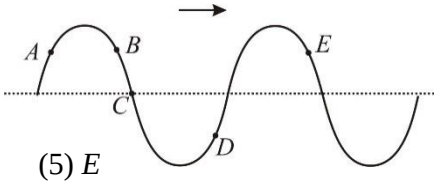
14. The velocity of sound in air is affected by change in the
(A) moisture content of air
(B) temperature of air
(C) composition of air
Of the above statements,
(1) only (A) is correct (2) only (B) is correct (3) only (A) and (B) are correct
(4) only (A) and (C) are correct (5) all (A), (B) and (C) are correct

15. Which of the followings best represent the variation of acceleration due to gravity with the distance *r* measured from the center of a planet of radius *R*?



(1) (2) (3) (4) (5)

16. The following figure shows an instantaneous position of a wave on water surface. Some particles on the surface are indicated in the figure. Which of the particle has the velocity and acceleration into the same direction?



(1) *A* (2) *B* (3) *C* (4) *D* (5) *E*

17. From the following statements concerning ideal gas at any given temperature *T*, select the correct one(s)
(A) The coefficient of volume expansion at constant pressure is the same for all ideal gases
(B) The average translational kinetic energy per molecule of oxygen gas is $3kT$ (*K* being Boltzman constant)
(C) In a gaseous mixture, the average translational kinetic energy of molecules of each gas is the same.
(1) Only (A) (2) Only (B) (3) Only (B) and (C)
(4) Only (A) and (C) (5) all (A) , (B) and (C)

18. A sonometer wire is in resonance with a tuning fork. Keeping the same tension, the length of the wire between the bridges is doubled. It can still be in resonance with the tuning fork provided it vibrates with
(1) 2 loops (2) 3 loops (3) 4 loops (4) 5 loops (5) 6 loops

19. A man walks 1 km due east, 5 km due south, 2 km due east and finally 9 km due north. How far is he from starting point?
(1) 2 km (2) 3 km (3) 4 km (4) 5 km (5) between 5 km and 9 km.

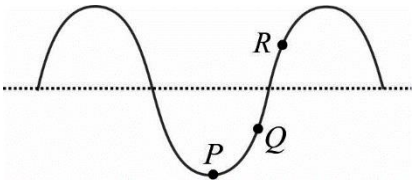
20. Two waves, superimposed on each other, produce an interference pattern. At a place where the intensity is minimum, the waves differ in phase by (*n* is an integer or zero)
(1) $2n\pi$ (2) $(2n+1)\pi$ (3) $(2n+1)\pi/2$ (4) $(2n+1)2\pi$ (5) $\frac{2n+1}{\pi}$

21. The average translational kinetic energy and the rms speed of molecules in a sample of oxygen gas at 300 K are 6.21×10^{-21} J and 484 m s^{-1} respectively. The corresponding values of 600 K, are nearly (assuming ideal gas behavior) ($\sqrt{2} = 1.414$)
(1) 12.42×10^{-21} J and 968 m s^{-1}
(2) 8.78×10^{-21} J and 968 m s^{-1}
(3) 6.21×10^{-21} J and 968 m s^{-1}
(4) 8.78×10^{-21} J and 684 m s^{-1}
(5) 12.42×10^{-21} J and 684 m s^{-1}

22. A pendulum bob of mass 4 g carrying a charge of 2 μC is at rest in a uniform horizontal electric field of intensity 20 000 V m^{-1}. The tension of the thread $\sqrt{2} = 1.41$
(1) 0.564 N (2) 0.00564 N (3) 5.64 N (4) 0.0564 N (5) 56.4 N

23. On heating a liquid of coefficient of cubical expansion α in a container having coefficient of linear expansion $\alpha/3$, the level of liquid in the container will
(1) rise
(2) fall
(3) remain almost the same
(4) rise or fall depending on the density of the liquid
(5) rise or fall depending on the volume of the liquid

24. The figure shows the instantaneous positions of points *P*, *Q* and *R* on a sinusoidal wave propagating to the right. The three points will reach their respective equilibrium positions at different times in the sequence

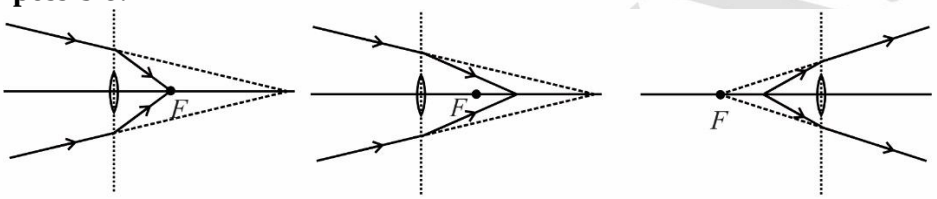


(1) *R*, *P*, *Q*. (2) *R*, *Q*, *P*. (3) *P*, *R*, *Q*. (4) *Q*, *P*, *R*. (5) *P*, *Q*, *R*.

25. Consider the following statements about the vaporization (boiling) and evaporation
(A) The rate of vaporization depends on the surface area.
(B) The rate of evaporation depends on the surface area.
(C) The rate of vaporization depends on the atmospheric pressure because the boiling point depends on the atmospheric pressure.
Of the above statements,
(1) Only (A) is true (2) Only (B) is true (3) Only (B) and (C) are true
(4) Only (A) and (C) are true (5) Only (A) and (B) are true

26. A beaker contains 200 g of water. The heat capacity of the beaker is equal to that of 20 g of water. The initial temperature of water in the beaker is 20 °C. If 440 g of hot water at 92 °C is poured in, the final temperature, neglecting radiation loss, will be
(1) 36°C (2) 56 °C (3) 68 °C (4) 72 °C (5) 78 °C

27. In the following ray diagrams, *F* is one of the foci of a convex lens. Which of the ray diagrams is/are **impossible?**

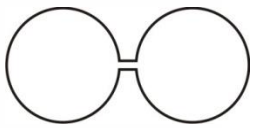


(A) (B) (C)

(1) Only (A). (2) Only (B). (3) only (B) and (C).
(4) only (A) and (B). (5) all (A), (B) and (C).

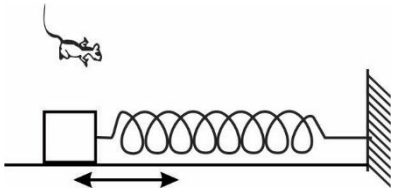
28. A thin, uniform, circular disc is rolling down an inclined plane of inclination 30° without slipping. Its linear acceleration along the plane is (the moment of inertia of a uniform disk $\frac{mr^2}{2}$)
(1) $g/4$ (2) $g/3$ (3) $g/2$ (4) $2g/3$ (5) g

29. Two identical spherical containers shown in the figure are connected by a narrow tube of negligible volume. The system contains an ideal gas and it is at a temperature T_1 and pressure P. Then one of the containers is heated to new temperature T_2 and the other is kept at the same temperature T_1. Then new pressure of the gas is



(1) $\frac{PT_2}{T_1+T_2}$ (2) $\frac{PT_1}{T_1+T_2}$ (3) $\frac{PT_1}{T_2-T_1}$ (4) $\frac{2PT_1}{T_1+T_2}$ (5) $\frac{2PT_2}{T_1+T_2}$

30. A light spring is mounted horizontally with one end fixed to a wall and the other end attached to a block. The block is set to oscillate on a smooth horizontal surface as shown. When the block is at its greatest displacement from the wall, a rat fell vertically on it so that they move together in the subsequent motion. Which of the following physical quantities of the system would become smaller?



(1) the period of oscillation
(2) minimum velocity of the block
(3) the amplitude of oscillation
(4) the maximum acceleration of the system
(5) the total mechanical energy of the system

31. Consider the following statements.
(A) Acceleration due to gravity decreases as we go from equator to pole.
(B) If the earth stops spinning, the acceleration due to gravity decreases.
(C) If the earth collapses to half the present radius (R) keeping the mass unchanged, acceleration due to gravity at R from the center remain unchanged.

Of the above statements,
(1) Only (A) is true
(2) Only (B) is true
(3) Only (C) is true
(4) Only (A) and (C) are true
(5) Only (B) and (C) are true

32. There is a tank of water on a trolley which is free to move on a horizontal track without friction. Initially the tank contains 10 kg of water and the trolley is moving with a velocity 5 m s^{-1}. Then water start leaking out due to a hole at the bottom of the tank. If the mass of the trolley without water is 10 kg the velocity of the empty trolley after all the water is leaked is
(1) 10 m s^{-1} (2) 8 m s^{-1} (3) 6 m s^{-1} (4) 5 m s^{-1} (5) 2.5 m s^{-1}

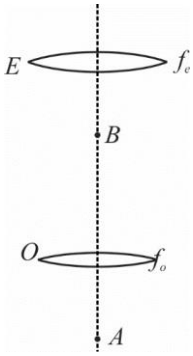
33. A box contains a perfect gas at pressure P_1 and temperature T_1. The number of molecules in the box is doubled keeping the total kinetic energy of the gas same as before. If the new pressure is P_2 and temperature is T_2, then
(1) $P_2 = P_1$; $T_2 = T_1$
(2) $P_2 = P_1$; $T_2 = \frac{T_1}{2}$
(3) $P_2 = 2\,P_1$; $T_2 = T_1$
(4) $P_2 = 2\,P_1$; $T_2 = \frac{T_1}{2}$
(5) $P_2 = \frac{P_1}{2}$; $T_2 = \frac{T_1}{2}$

34. One end of a well-covered metal rod of cross sectional area A and length l is kept in steam. Heat is loss to the surrounding only through the other end. Once the steady state is reached the heat passing through any cross-section of the rod per second is Q. Q will increase if
(A) A is increased
(B) l is increased
(C) the room temperature is increased
(D) the room temperature is decreased

Of the above statements
(1) only A and B are true.
(2) only B and D are true.
(3) only B and C are true.
(4) only A and D are true.
(5) only A and C are true.

35. Angles to which an object can be projected with a velocity 10 m s^{-1} for it to have a horizontal range 5 m are
(1) 70°,20° (2) 30°,60° (3) 45°,45° (4) 55°,35° (5) 15°,75°

36. The diagram represents a microscope at normal adjustment with the object at *A*. *O* and *E* represent objective and eyepiece respectively. The image of *A* is formed at *B* by the objective. Which of the following statements is correct?



(A) *AO* is less than f_o.

(B) *BE* is less than f_e.

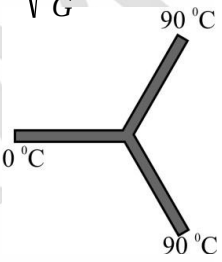
(C) The image at *B* is real.

(1)(A) only (2)(C)only (3) (A) and (B) only
(4) (B) and (C)only (5)All (A), (B) and (C)

37. A satellite is revolving close to the surface of a planet. If its time period is *T* and mean density of the planet is ρ then the value of the $T\sqrt{\rho}$ will be equal to

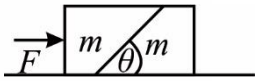
(1) $\sqrt{\frac{2\pi}{G}}$ (2) $\sqrt{G}$ (3) $\sqrt{\frac{G}{2\pi}}$ (4) $\sqrt{\frac{G}{3\pi}}$ (5) $\sqrt{\frac{3\pi}{G}}$

38. Three rods made of the same material and having the same cross-section has been joined as shown in the figure. Each rod is of the same length. The ends are kept at 0°C and 90°C as shown in the figure. The temperature of the junction of the three rods will be



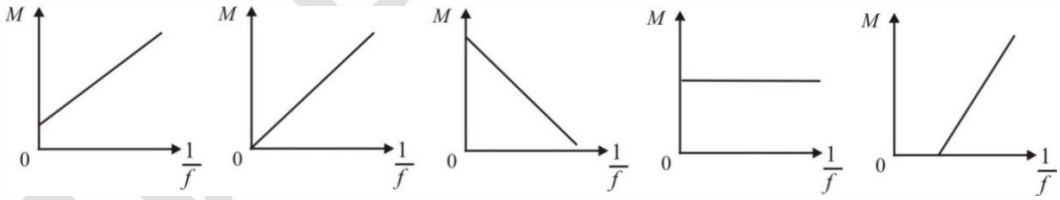
(1) 45 °C (2) 30 °C (3) 20°C (4) 25°C (5) 60°C

39. Two identical wedge shaped blocks, each of mass *m*, are placed on a smooth horizontal surface as shown. A horizontal force *F* is applied to one of the blocks so that the two blocks move together to the right with constant acceleration. If θ = 45° What is the maximum value of *F* so that the blocks are moving without relative slipping? (Assume all contact surfaces are smooth.)



(1) *mg* (2) $\sqrt{2}$ *mg* (3) $\sqrt{3}$ *mg* (4) 2 *mg* (5) $2\sqrt{2}$ *mg*

40. Which of the following graphs best represents the variation of the magnifying power *M* of a simple microscope with the inverse of its focal length *f*?



(1) (2) (3) (4) (5)

41. The moon orbits the earth once every 27.3 days, with a mean orbital radius of *R*. What is the period (approximately) of an earth satellite with an orbital radius of $R/30$? ($\sqrt{0.3} \approx 0.55$) (1 day = 24 hours)

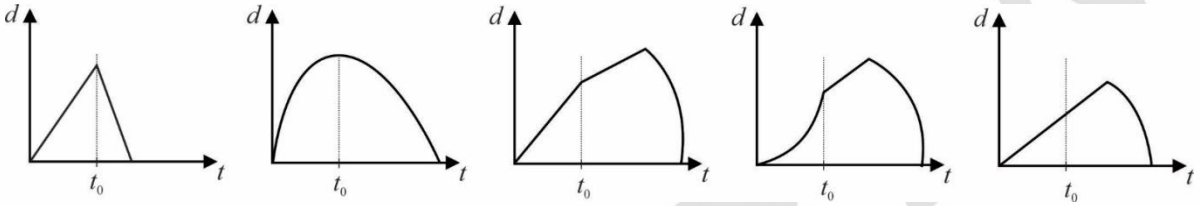
(1) 4 hr (2) 22 hr (3) 68 hr (4) 260 days (5) 4500 days

42. Two metallic spheres S_1 and S_2 are made of the same material and have got identical surface finish. The mass of S_1 is three times that of S_2. Both the spheres are heated to the same temperature and they are thermally insulated from each other. The ratio of the initial rate of cooling of S_1 to that of S_2 is

(1) $\frac{1}{3}$ (2) $\frac{1}{\sqrt{3}}$ (3) $\sqrt{3}$ (4) $\sqrt[3]{3}$ (5) $\left(\frac{1}{3}\right)^{\frac{1}{3}}$

43. Which of the following statements made about thermocouple is **not** true?
(1) It is made up of two different conductors.
(2) Its thermometric property is the e.m.f. between the junctions.
(3) it has a high heat capacity.
(4) it has a wider range than that of mercury-glass thermometer.
(5) variation of thermometric property can not be considered as linear.

44. Two stones *A* and *B* are dropped form a tall building. The stone *B* is released t_0 after the *A*. (note that is smaller than the time taken by *A* to reach the ground.) which of the following graphs best represents the variation of separation *d* between two stones with time?

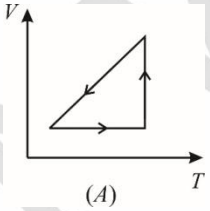


(1) (2) (3) (4) (5)

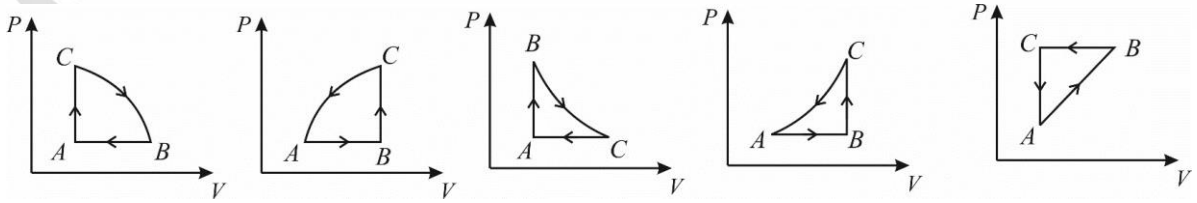
45. A source of sound is moving with a constant speed of 20 m s^{-1} emitting a note of a fixed frequency. The ratio of the frequencies observed by a stationary observer when the source is approaching him and after it has crossed him is (speed of sound = 340 m s^{-1})
(1) 9 : 8 (2) 10 : 9 (3) 11 : 9 (4) 11:8 (5) 8:7

46. A one liter flask contains some mercury. It is found that at different temperatures the volume of air inside the flask remains the same. The volume of mercury in the flask is (coefficient of linear expansion of glass = 9 x 10^{-6} °C^{-1}, coefficient of volume expansion of mercury = l.8 x 10^{-4} °C^{-1})
(1) 150 cm^3 (2) 225 cm^3 (3) 300 cm^3 (4) 450 cm^3 (5) 500 cm^3

47. The figure *A* represents a cyclic process. Which of the following best represent its *PV* variation?

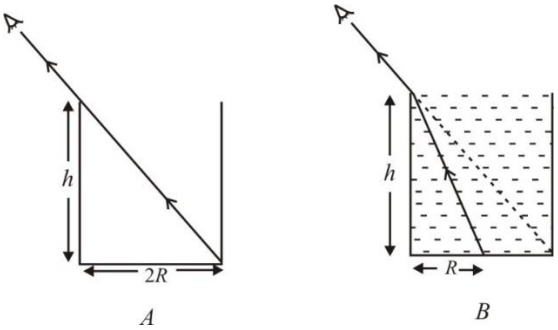


(*A*)



(1) (2) (3) (4) (5)

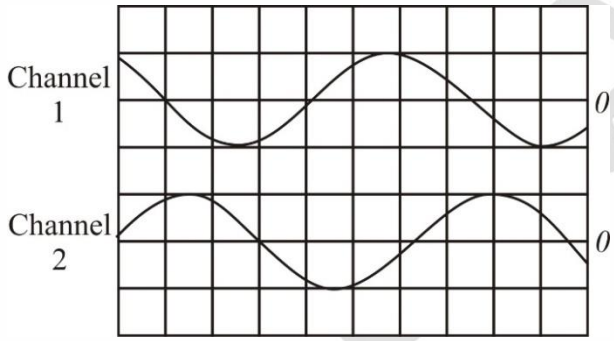
48. A person can just see the opposite edge of the bottom of an empty vessel over its brim as shown in figure (*A*). While keeping the eye in the same position, the vessel is filled with a clear liquid of refractive index *n* up to its brim. Then he is able to see a small mark at the centre of the bottom of the vessel as shown in figure (*B*). Then The height of the container is given by



(1) $R\sqrt{\frac{n^2-1}{1-n^2}}$ (2) $R\sqrt{\frac{4n^2-1}{4-n^2}}$ (3) $R\sqrt{\frac{1-4n^2}{4-n^2}}$

(4) $R\sqrt{\frac{4-n^2}{4n^2-1}}$ (5) $R\sqrt{\frac{4n^2+1}{4-n^2}}$

49. Two sinusoidal waveforms of the same frequency are displayed on an oscilloscope screen, as indicated above. The zero-voltage level of each channel is given at the right in the figure. If both channels are displayed in same scale, The phase difference between the two waveforms is most nearly



(1) 30° (2) 45° (3) 60° (4) 90° (5) 120°

50. A uniform flexible chain of mass *m* is hung between two fixed supports *X* and *Y* at the same horizontal level as shown. The chain makes an angle θ with the horizontal at each support. Find the tension in the chain at *A* or *B*.

(1) $\frac{mg}{2}$ (2) $\frac{mg}{2\sin\theta}$ (3) $\frac{mg}{\cos\theta}$ (4) $\frac{mg}{2\tan\theta}$ (5) $\frac{mg}{2\cos\theta}$

Provincial Department of Education - NWP

01	E	II

First Term Test - Grade 13 - 2020

Index No. ..... Physics II 3 hours

- This paper consists of two parts A and B allowed time for both parts is 3 (three) hours.
- Answer all the questions of **part A** on this paper itself. You must use th given space to answer. No lengthy answers are expected.
- **Part B** consists of 6 questions. Answer only four of them. After the exam, attach part A and part B and hand over to the staff.
- Use of calculators is not allowed.

Part - A (Structured Essay)

01. In an experiment to find the density of glass and cork, you are provided with only the following.

A glass stopper, a cork, a beaker of water, a piece of thread, a small bench

a. (i) In order to determine the density of the glass stopper, you have to take two measurements. Name them as m_1 and m_2.

m_1.....

m_2.....

(ii) Obtain an expression for the density of glass using the above symbols. Take the density of water as ρ_w.

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(iii) What is the principle you used in physics to obtain the above expression and state it.

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b. (i) What are the additional measurements you would take to determine the density of cork?

m_3.....

m_4.....

(ii) Obtain an expression for the density of cork interms of the measurements you obtained.

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c. (i) You have provided a sample of alcohol. You can determine the density of alcohol obtaining only one additional measurement. What is it?

m_5.....

(ii) Write down an expression for the density of alcohol using the above measurements.

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d. Write down two precautions in order to increase the accuracy of the results.

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02. You are supplied three lenses with the powers given below.

(1) + 6.25 D

(2) - 12.50 D

(3) + 5.00 D

a) Draw a figure to represent each lens and write down their focal lengths with the sign according to the Cartesian convention.

(1) (2) (3)

$f_1 =$ ..... $f_2 =$ ..... $f_3 =$ .....

b). A ray parallel to the principle axis is incident on each lens mentioned above. Draw the path of the ray after refraction through each lens.

(1)

(2)

(3)

c). A parallel beam of light with a diameter of 4 cm is converted to a narrow parallel beam using the two lenses with powers $+ 6.25D$ and $- 12.5\ D$.

(i) draw a ray diagram to show the above situation.

(ii) What is the separation between two lenses?

.....

.....

(iii) Find the diameter of the narrow parallel beam of light.

.....

d). An astronomical telescope of angular magnification, 10 is made by a student using the lens of power $+5D$ as eyepiece lens and another one as objective lens. If the telescope is in normal adjustment,

(i) What is the type of the objective lens? .....

(ii) What is the power of it in diopters (D) .....

(iii) What is the length of the telescope .....

e). Draw the path of two light rays coming towards the eye when the above telescope is used to observe an object at infinity.

f). Find the eye ring position from the eyepiece lens .....

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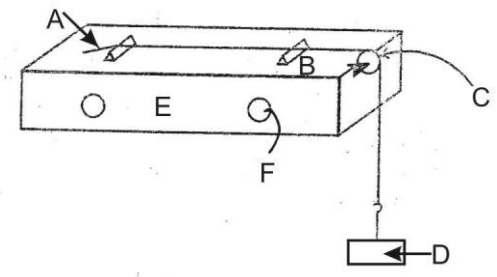
03. In order to determine the unknown frequency of a given tuning fork, you are provided a sonometer setup as shown in figure. You are also provided with a set of tuning forks P,Q,R and S.



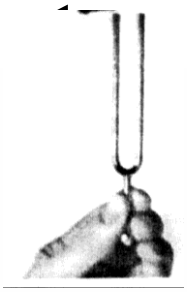
(i) Name the parts *A,B,C,D,E* and *F*

A - : ..... D - : .....

B - : ..... E - : .....

C - : ..... F - : .....

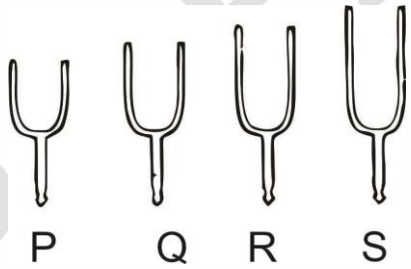
(ii) Vibrating direction of one prong of a sounded tuning fork at a given moment is indicated by the arrow head as shown below. Mark the vibrating direction of the right prong.



(iii) What type of wave transmits along the stem of the tuning fork at the same moment.

.....

(iv) The frequencies of given tuning forks are $512. Hz, 256, HZ, 420\ Hz, and\ 326\ Hz$. Identify *P,Q,R* and *S.*



P ..... Q .....

R ..... S .....

(v) To start the experiment with the shortest resonance length of the wire, which tuning fork is selected first?

.....

(vi) If the fundamental resonance length is L for a given tuning fork, write down an expression for the wavelength λ.

.....

(vii) Write down an expression for the speed V of transverse waves along a stretched wire in terms of the load attached to the wire(M) , mass per unit length (m) and acceleration due to gravity (g).

.....

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.....

(viii) Obtain the relation between frequency f and L .

.....

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.....

.....

(ix) Rearrange the above expression to draw a straight line graph taking $\frac{1}{f}$ as the independent variable of the graph.

.....

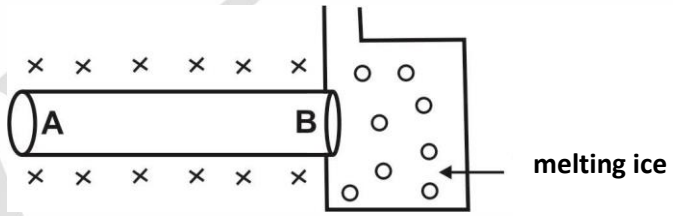
.....

.....

(x) What is the data taken from the graph to determine the unknown frequency of the tuning fork?

.....

04. The figure shows an experimental setup to determine the thermal conductivity k of a uniform metal rod (AB) of cross sectional area A. End A of the rod is maintained at 100^0C and the end B has been soldered into the wall of a metal tank containing melting ice. The rod AB of length ℓ and diameter d is well lagged.



a. How would you maintain the end A of the bar at a steady temperature of 100^0C ? Draw the necessary item with the proper connection of steam in the above figure.

b. Write down an expression for the rate of heat flow $\left(\frac{Q}{t}\right)$ through the rod.

.....

.....

c. According to the above expression, thermal conductivity (k) can be determined after finding the rate of heat flow $\left(\frac{Q}{t}\right)$. How would you find it?

.....

.....

.....

.....

d. The readings are taken after the rod has reached to a special condition.

(i) What is the condition?

.....

(ii) How do you observe whether the system has reached that condition?

.....

.....

(iii) Explain the reason of reaching the rod to this special condition.

.....

.....

.....

e. In this experiment, It is found that the ice melts at a rate of $0.05gs^{-1}$. $d = 4cm$, $\ell = 25\ cm$ and the latent heat of fusion of ice $(L) = 3x10^5\ J\ kg^{-1}$. Determine k.

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f. Can we use the above experiment to find the thermal conductivity of rubber rod? Explain the answer.

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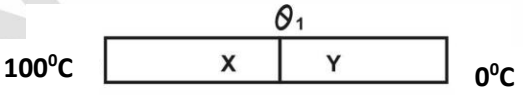
g. 

Two rods X and Y with same dimensions are made of different materials having thermal conductivities k_x and k_y respectively. X and Y are welded together to form a composite rod. $k_x > k_y$. Ends of the composite rod are maintained at 100^0C and 0^0C as shown.

(i) The temperature at the junction of the bars is θ_1. When the temperatures of the ends of the composite rod are interchanged, the temp.at the junction becomes θ_2. Compare θ_1 and θ_2.

.....

.....

.....

.....

(ii) Plot the variation of temperature (θ) along the rod.

First Tem Test - 2020
Physics Part II - Grade 13
Part B (Essay)
(g = 10 N kg^{-1})

- **Answer four questions only.**

05. **Read the following paragraph carefully and answer the questions given below.**

There are many natural sources of energy in the world, but the chemical energy from burning coal, oil and gas, called fossil fuels is widely used. These fuels are non- renewable after they are burnt. Since the fossil fuels are being used up at a fast rate, in the near future the people will have to face to an energy crisis.

Since there is a limit to the reserves of fossil fuels, considerable work is being done to develop other alternative sources of energy.

The following facts are concerned when testing about the alternative energy sources.

1. Use of them for a long period of time (renewable energy sources)
2. Some environmental problems(pollution) that can be created when using the sources.
3. Constructing power stations more easily.
4. Economic benefits obtained from the energy transformation.

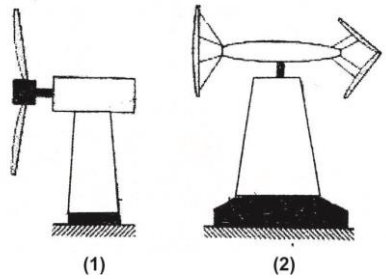
According to the above facts wind can be used as an alternative source of energy. In the earlier days, wind mills are used for pumping out water from wells and grinding grain to obtain flour.

When the solar energy is incident on the earth, unequal heating of air layers near the land surface and near the sea water surface produces a pressure difference between two regions. As a result of this, air blow as a wind in order to equalize the pressure difference. The kinetic energy of wind is converted to the electrical energy by wind mills and generators. The blades connected to the top of the tower of a wind mill rotates at a rate of (20 – 50) rev. min^{-1} according to the wind speed.

Blades are connected to the generators through a gear system. The part with the blades is called the turbines. The two main types of wind turbines are horizontal axis and vertical axis types. The blades of both turbines rotates in a vertical plane.

The horizontal axis turbine has two or more long vertical blades rotating about a horizontal axis. (fig.1) This machine needs to be turned into the wind by an external source to extract the wind energy effectively, which is a disadvantage in view of the cost of the device needed. The alternator is placed at the top of the supporting tower.

In the vertical- axis turbine, the blades are long and vertical and can accept wind from any direction (fig. 2). This is an advantage over the horizontal axis type. The alternator can be placed on the ground at the base of the tower.



Height to the blades and long blades give high electrical power. The maximum power available for a wind speed v and blade length r is given by

$$P = \frac{1}{2}\pi r^2 \rho v^3$$ where ρ is the density of air.

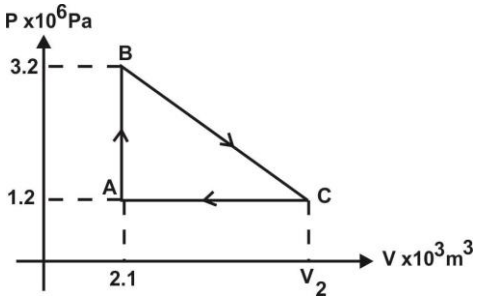
Wind mills are working when there is a wind of speed between $21\ km\ h^{-1}$ and $97\ km\ h^{-1}$. When the wind speed is greater than $97\ km\ h^{-1}$, for the protection of wind mills, the rotation of blades automatically stops.

(i) Give 3 examples for alternative sources of energy.
(ii) Which type of energy is finally converted to the electrical energy using the sources of energy?
(iii) Mention 3 facts that are concerned when using alternative energy sources.
(iv) What is wind?
(v) Explain how a wind mill can be used to generate electricity.
(vi) Calculate the average angular velocity of rotating blades.
(vii) The amount of electrical energy generated by a wind mill depends on two factors. What are they?
(viii) a) What is the disadvantage of a horizontal axis turbine.
b) Explain how the above disadvantage is prevented in a vertical axis turbine.
(ix) a) Write down an expression for the kinetic energy per unit volume when the wind blows at a steady speed of v . Take ρ as the density of air.
b) Hence, obtain the expression $p = \frac{1}{2}\rho\pi\ r\ ^2 v^3$ mentioned in the above paragraph.
c) The moment of inertia of blades of a wind mill with a horizontal axis is $5000\ kgm^2$. The blades are rotating at an average rate. The blades come to rest in 2 minutes due to the stop of blowing wind. Calculate the resistive torque against the rotation of the wind blades.

06. a. (i) Write down a symbolic expression for the first law of thermodynamics. Introduce all the symbols you used.
(ii) Use the above expression to explain the following processes.
1) Isothermal process
2) Adiabatic process
3) Isochoric process
(iii) Write down an expression for the work done during an isobaric process. Introduce all the symbols. Represent the isobaric process in a $p - V$ curve and mention the way of taking the work done during the process from a $p - V$ curve.

b. $0.5\ kg$ of steam at 100^0C and $1.01x10^5\ Pa$ is changing to water at the same temperature and pressure. The density of water $1000\ kgm^{-3}$, the density of steam $1.67\ kgm^{-3}$ and the specific latent heat of vaporization of water $= 2.26x10^6\ Jkg^{-1}$
(i) Find the amount of heat exchanged (ΔQ)
(ii) Calculate the work done (Δw) during the process. Is it a work done by the system or work done on the system?
(iii) Calculate the change in internal energy (Δu) during the phase change, steam to water. For what process is this energy used?

c. $0.75\ moles$ of an ideal gas performs a cyclic process shown in the $P - V$ curve given below.



The process $B \longrightarrow C$ is nearly isothermal

(i) Identify the processes $A \longrightarrow B$ and $C \longrightarrow A$

(ii) Find the temperatures of the gas at A and B.

(iii) Find the volume occupied by the gas (V_2) at C

(iv) Calculate the net work done by the gas.

(v) What is the internal energy change during the cyclic process?

(vi) Find the amount of heat exchanged during the cyclic process.

07. a. What is the value of the period (T) of a geostationary satellite (GSS) in seconds.

b. Draw a $3-$ dimensional diagram of the orbit of a GSS around the earth. Clearly indicate the geometrical North, South and the equatorial plane of the earth.

c. (i) Write down an expression for the force of attraction between the earth of mass M and a satellite of mass m at a distance r from the center of the earth. Identify the constant G used in the expression?

(ii) Write down an expression for the centripetal force required for a mass m moving in a circular orbit of radius r with a constant angular speed ω

(iii) Show that the orbital radius r of a GSS is given by $r = \left(\frac{GMT^2}{4\pi^2}\right)^{\frac{1}{3}}$

(iv) Show that $GM = 2gR$ where g is the acceleration due to gravity on the earth surface and R is the radius of the earth

(v) If $g = 10Nkg^{-1}, R = 6.4x10^6 m \ and \ \pi^2 = 10$, calculate r .

d. (i) Explain how geostationary satellites are used in communication.

(ii) 3 geostationary satellites are in an orbit round the earth such that they are located at the vertices of an equilateral triangle. Find the distance between 2 satellites.

(iii) Calculate the time taken by an electromagnetic signal to travel between two satellites. (Speed of light$(C) = 3\ x\ 10^8 ms^{-1}$)

08. a. (i) State the laws of refraction.

(ii) Explain the difference between more optically dense medium and less optically dense medium using the velocity of light.

(iii) Consider a ray passing from one medium to a more optically dense medium. The velocity, wavelength and frequency of light ray increases, decreases or remains constant.?

b. A and B are two transparent media. The refractive index of B relative to A is 1.6. The velocity of light passing through A is $2.2x10^8 ms^{-1}$. Find the velocity of light in B.

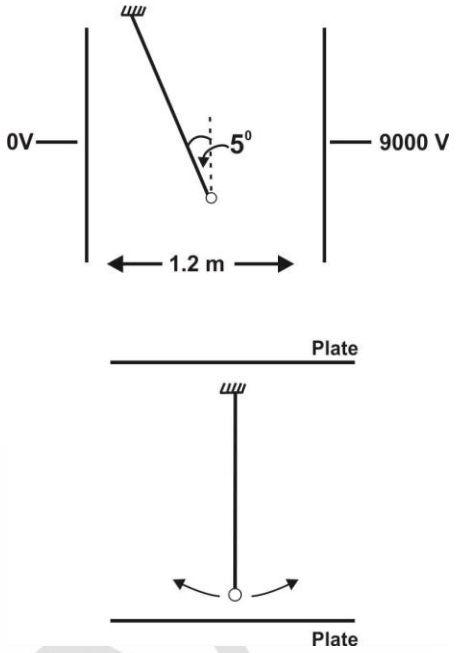
c. (i) Draw the path of a light ray passing through a prism when the ray is at the minimum deviation position.

(ii) The prism is made of glass of absolute refractive index, n_g and it is placed in a medium of absolute refractive index, n_W . Write down an expression for the minimum deviation D in terms of n_g, n_W and A. A is the prism angle.

(iii) Calculate D if $n_w = \frac{4}{3}$, $n_g = \frac{3}{2}$ and $A = 60^0$.

09. **Answer either Part (A) or Part (B) only**

A. (a) In an experiment to determine the charge on a small insulated charged ball, the ball is suspended by an insulated light thread between oppositely charged parallel plates as shown below. The plates are $1.2m$ apart in a vacuum at a potential difference of $9000V$ and the ball's mass is $5.0x10^{-5}kg$. If the thread lies at $5^0$to the vertical, calculate.



i) The tension in the thread.

ii) The electric field intensity E between two plates.

iii) The static electric force on the ball.

iv) The charge on the ball.

(b). If the plates are in a horizontal position now. When the,

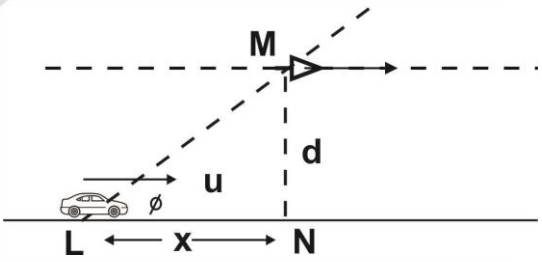
i) Electric field E is directed vertically upwards

ii) E is directed vertically down wards.

Write down expressions for the time periods (T) assuming the ball oscillates as a simple pendulum. Length of the string is $1.0m$. Substitute the given values for the expressions. Simplification is not necessary.

B. (a) What is meant by Doppler effect.

(b) Aero plane is flying with a constant velocity parallel to a horizontal straight path and it is at a vertical height d from the path. The frequency of sound emitted by the aero plane is f . A motor car is moving along the straight road with a velocity U . The velocity of sound in air is C. Assume that air is at rest.



$LN = x, M\hat{L}N = \phi$ (When the motor car is at the position L)

(i) What is the velocity component of motor car along the direction LM?

(ii) What is the velocity component of aero plane along the direction LM?

(iii). Write down an expression for the velocity of sound in air along the line LM relative to the driver of the motor car.

(iv). Write down an expression for the velocity of sound in air along the line LM relative to the pilot.

(v). What is the shape of the sound wave fronts emitted by the aero plane considering it as a point source of sound?

(vi). If the aero plane remains at rest, write down an expression for the wave length λ of sound wave emitted by it.

(vii). There is a change in wavelength λ of waves emitted by the aero plane due to the motion of it. Write down an expression for the new wavelength λ' due to the motion of the source.

(viii). Obtain an expression for the apparent frequency f' heard by the driver of the car in terms of f, c, u, v and ϕ.

(ix). Write down an expression for f' in terms of f, c, u, v, d and x .

(x). Obtain the relation between f' and f when $x = 0$

(xi). If $d \gg x$, show that $\frac{f'}{f} = \frac{1+\frac{ux}{dc}}{1+\frac{vx}{dc}}$

10. **Answer either Part (A) or Part (B) only**

A. (i) **Calculate the following, if a current of 6A is passing through a certain instrument with in** $200s$.

1) the amount of charge passing through a single point of the instrument.
2) the number of electrons passing through a single point of the instrument.

(ii). Following circuit (Figure 1) is used to study the $I - V$ characteristics of a bulb shown in the figure II

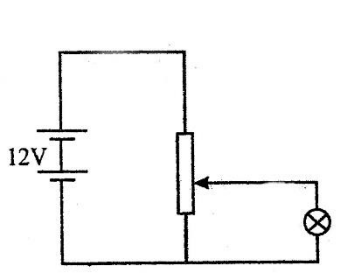


Figure (i)

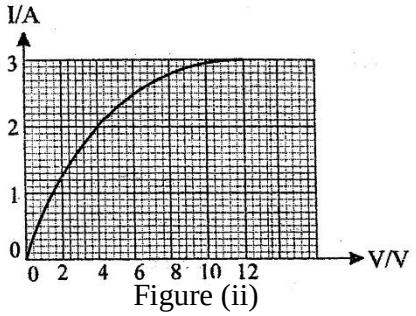
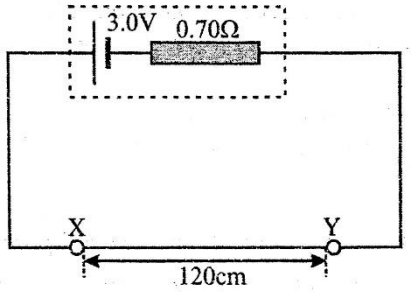


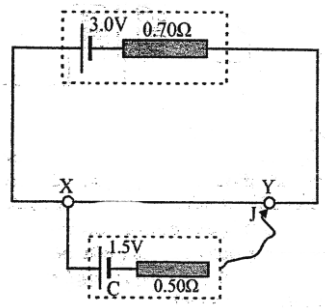
Figure (ii)

1) To obtain readings, voltmeter & ammeter are connected to the circuit in the correct way. Copy the figure (1) in your answer script. Draw the voltmeter and ammeter connected to the circuit correctly.
2) If the bulb lights normally under $12.0V$ potential difference. Find the followings.
   a) Resistance of the bulb.
   b) The power supplied to the bulb.
   c) The resistance of the bulb when the potential difference across the bulb is $6.0V$.
   d) What are the reasons of decreasing the resistance of the bulb in above part (c) than part(a).
   e) Draw a graph to show the variation of resistance of the bulb with the potential difference across it.
   f) The voltmeters of 1Ω, $10\Omega, 100\Omega, 1000\Omega$ can be used in this experiment. Which voltmeter is suitable for this experiment. Give reasons.

(iii). As shown in the following figure, a uniform wire XY of length $120cm$ and radius $0.55mm$ is connected with a cell of emf $3.0V$ and internal resistance 0.70Ω in series.



1) If the resistivity of the material of wire is $1.1\ x\ 10^{-6}\Omega m$, show that the resistance of the wire XY is 1.4Ω.
2) Find the potential difference per unit length of XY.
3) As shown in the following figure, a cell (C) of emf $1.5V$ and internal resistance, 0.50Ω is connected to the above circuit.



J is a sliding key which can be moved along the wire XY.

a) When the key, J is connected to the end Y, the potential difference across XY is same as the potential difference across the cell, C. Using an arrow head indicate the direction of current flowing through the cell C in the above circuit.
b) If a current is not flowing across the cell C, find the position of the key (J) on the wire XY.
c) What is the change that can be done to the circuit such that the position of J on XY found in (b) is close to the end Y.

B. (i)

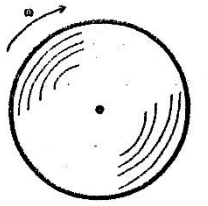


Figure (i)

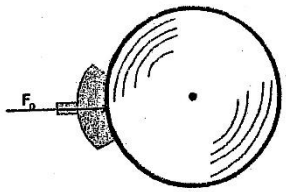


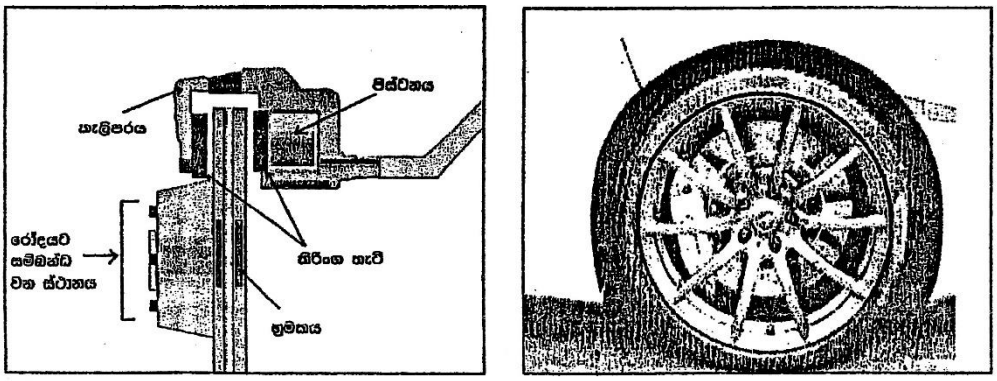
Figure (ii)

As shown in the 1st figure, A wheel of mass $m = 2\ kg$ and radius 40 cm rotates freely in the clockwise direction with an angular velocity of $30\ rads^{-1}$. As shown in the figure (ii), a part of carbon in contact with the wheel pushes the wheel radially with a force F_0 (the radius of the part that pointed to the wheel is equal to the radius of wheel)

1) Explain how the angular velocity of the wheel is reduced gradually due to the force F_0 exerted on the wheel. Mark the forces acting on the wheel clearly.
2) After applying the force, If the wheel stopped completing 10 revolutions, find the magnitude of the angular deceleration (take $\pi = 3$)
3) If $\mu_k = 0.5$ (between wheel and the part of carbon). find the magnitude of F_0

(ii). The above phenomenon is used in disk brake system in vehicles to reduce the rotating speed of wheels and to stop the vehicle. soft iron (specific heat capacity $4.6\,x\,10^2\,J\,kg^{-1}K^{-1}$ and melting point 1200^0C)is used to make disk brake normally. Brake pads are connected to the piston to exert a force on the rotor. The part that consists piston and brake pads is called brake caliper.

By pressing the brake paddle, the pressure is transmitted through the brake oil. The force obtained by the pressure transmission creates a frictional force between brake pads and rotor. Due to this frictional force the rotating speed of the wheel is reduced or the motion of the wheel can be stopped.



The vehicle of mass $2\,x\,10^3kg$ consisting above brake system applies the brake when it is moving with a speed of $20\,ms^{-1}$. It completely stopped after 4s.

Write down the answers for the questions given below after reading the above description.

1) Find the loss of translational kinetic energy of the vehicle in this period of time (Neglect the rotational kinetic energy of the wheels of the vehicle).
2) Find the magnitude of the deceleration of the vehicle.
3) Find the distance moved by the vehicle after applying the brakes.
4) The loss of kinetic energy of the vehicle is used to work done against the frictional force created between disk brake (brake pads) and rotor. Calculate the work done against the friction by a disk brake of a wheel.
5) If the wheel stopped after rotating 10 revolutions in this time period, find the mean frictional force applied on the wheel by the brake pads. (consider the distance to the mean frictional force from the center of the axle is $1/3\ m$ and $\pi = 3$)
6) If the coefficient of kinetic friction between brake pads and circular plate of axle is 0.5 ($\mu_k = 0.5$), find the force exerted by the hydraulic system on the brake pads.

First Term Test - Grade 13 - 2020
Physics - answer I

(1) 4	(11) 4	(21) 5	(31) 3	(41) 1
(2) 4	(12) 3	(22) 4	(32) 4	(42) 5
(3) 4	(13) 1	(23) 3	(33) 2	(43) 3
(4) 5	(14) 5	(24) 1	(34) 4	(44) 4
(5) 2	(15) 4	(25) 2	(35) 5	(45) 1
(6) 4	(16) 1	(26) 3	(36) 4	(46) 1
(7) 4	(17) 4	(27) 1	(37) 5	(47) 3
(8) 5	(18) 1	(28) 2	(38) 5	(48) 2
(9) 4	(19) 4	(29) 5	(39) 4	(49) 5
(10) 2	(20) 2	(30) 4	(40) 1	(50) 2

Physics - answer II

(01) (a) i) m_1 – mass of glass stopper in air. —(01)
m_2 – mass of glass stopper in water —(01)

ii) density of glass $= \frac{m_1}{(m_1 - m_2)/\rho_\infty} = \frac{m_1 \rho_\infty}{(m_1 - m_2)}$ —(02)

(2) →

iii) Archimedes' principle —(04)

(b)(i) m_3 – mass of cork in air. —(01)
m_4 – mass of cork and glass stopper in water. —(01)

ii) density of cork $= \frac{\text{mass of cork}}{\text{vol. of cork.}}$

volume of cork $= \frac{(m_2 + m_3) - m_4}{\rho_\infty}$ —(02)

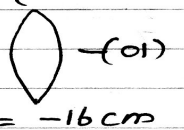
density of cork $= \frac{m_3}{(m_2 + m_3 - m_4)/\rho_\infty}$ —(02)

(c) (i) mass of glass stopper in alcohol $= m_5$ —(01)

(ii) density of alcohol $= \frac{(m_1 - m_5) \cdot \rho_\infty}{(m_1 - m_2)}$ —(01)

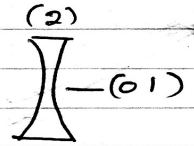
(d) • The object should not be in contact with the bottom of the beaker or walls of it when measuring mass. —(01)
• The experiment should be done at a place without a turbulent air flow. —(01)

(02) (a) (1) —(01)



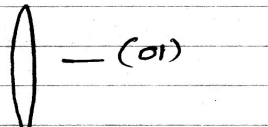
$f_1 = -16\,cm$ (01)

(2) —(01)



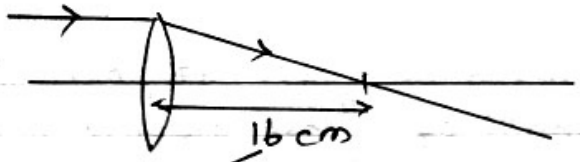
$f_2 = +8\,cm$ (01)

(3) —(01)



$f_3 = -20\,cm$ (01)

(b) (i)

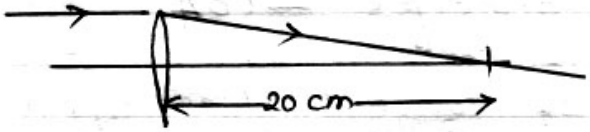


—(01)

2)

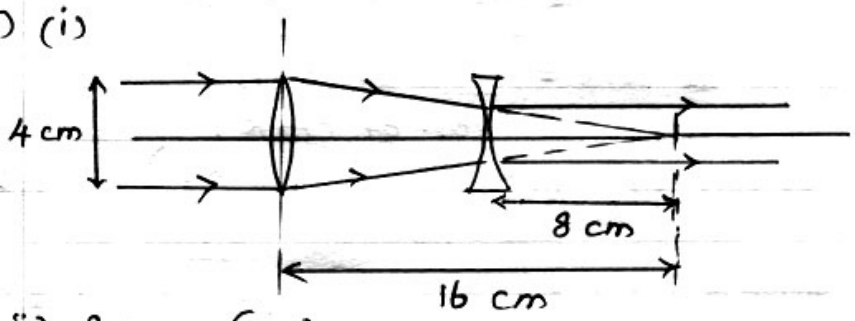
(01)

3)



(01)

(c) (i)



(02)

(ii) 8 cm —(01)

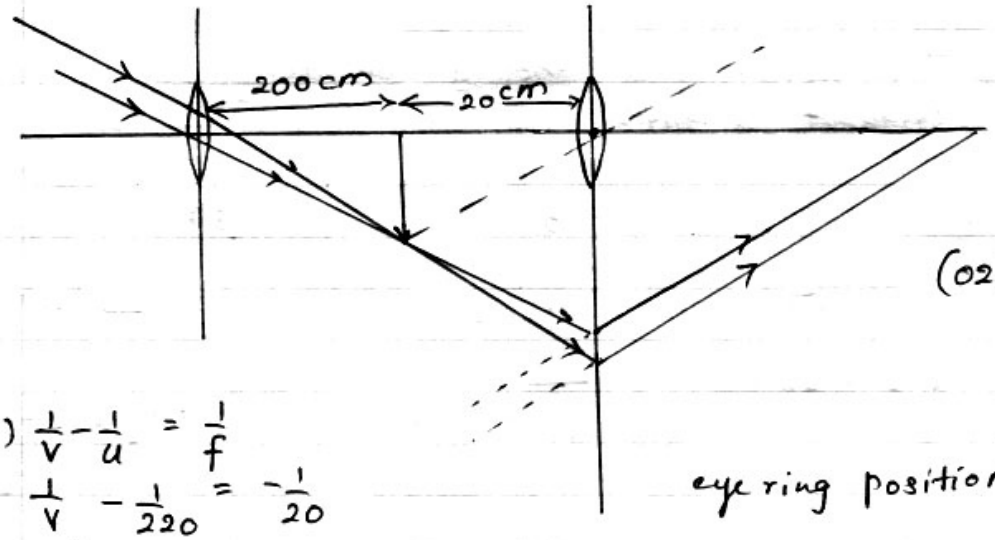
(iii) $\frac{d}{8} = \frac{4}{16}$; $d = 2$ cm —(02)

(d) i) Convex lens (converging lens) —(01)

ii) $\frac{f_o}{f_e} = 10$, $f_o = 10 \times 20 = 200$ cm ; $P = \frac{1}{f} = \frac{1}{200 \times 10^{-2}}$

iii) $200 + 20 = 220$ cm —(01) $= \underline{0.5\ D}$ —(01)

(e)



(02)

(f) $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

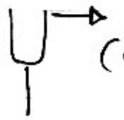
$\frac{1}{v} - \frac{1}{220} = -\frac{1}{20}$

$\frac{1}{v} = \frac{1}{220} - \frac{1}{20} = \frac{-16}{220}$; $v = \underline{-22\ cm}$ —(01)

eye ring position $= \underline{22\ cm}$.

(03) (i) A – Sonometer wire D – Weight attached to the wire.
B – movable bridge E – hollow wooden box
C – pulley F – holes (02)

ii)



(02)

iii) longitudinal wave —(02)

iv) P – 512 Hz , Q – 420 Hz
R – 326 Hz , S – 256 Hz } (02)

v) 512 Hz or (P) —(02)

vi) $\lambda = 2L$ —(02)

vii) $V = \sqrt{\frac{Mg}{m}}$ —(02)

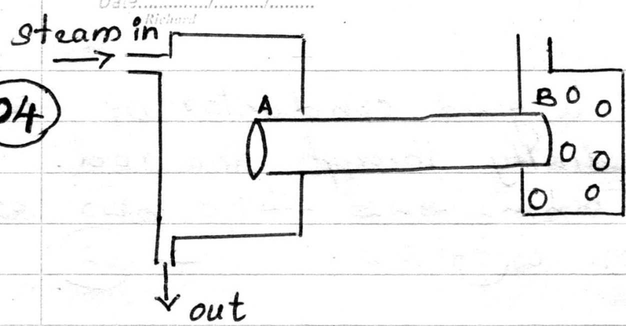
viii) $\sqrt{\frac{Mg}{m}} = f \cdot 2L$ —(02)

ix) $L = \frac{1}{2} \cdot \sqrt{\frac{Mg}{m}} \left(\frac{1}{f}\right)$ —(02)

x) The x coordinate corresponding to the resonance length L. —(02)

(04)

a)



— (02)

b) $\frac{Q}{t} = kA\frac{(\theta_1 - \theta_2)}{d}$ — (01)

A – cross sectional area of the rod (හරස්කඩ වර්ගඵලය)
k – heat conductivity of the rod. (තාප සන්නායකතාව)

$\frac{\theta_1 - \theta_2}{d}$ = temp. gradient – උෂ්ණත්ව අනුක්‍රමණය — (01)

c) දණ්ඩ තුලින් ගලායන තාප ප්‍රමාණය සම ශීඝ්‍රතාවයෙන්ම අයිස් දියවීම සඳහා වැයවෙන නිසා, දණ්ඩ තුලින් තාපය ගලායාමේ ශීඝ්‍රතාවය ලෙස අයිස් දියවීමේ ශීඝ්‍රතාවය ලබා ගත හැක. — (02)

In this situation, the rate of heat flow through the rod is same as the rate of melting ice.

d) i) අනවරත අවස්ථාව - Steady state. — (01)

ii) If the thermometers are placed in holes bored in the bar, the thermometer's readings become constant. — උෂ්ණත්වමාන පාඨාංක නියත වේ. — (01)

iii) එක් කෙළවරකින් ලබාදෙන තාපය සම්පූර්ණයෙන්ම අයිස් දියවීම සඳහා පමණක් වැය වේ.

The heat given from one end of the rod is used only for the melting ice. — (01)

e) $\dot{Q} = \frac{mL}{t} = kA\left(\frac{\theta_1 - \theta_2}{d}\right)$ — (01)

$0.05 \times 10^{-3} \times 3 \times 10^{5} = k \times \frac{22}{7} \times (2 \times 10^{-2})^2 \frac{100}{25 \times 10^{-2}}$ — (01)

$k = 29.82 \ Wm^{-1}K^{-1}$ — (01)

RICHARD

f) Rubber is not a good conductor of heat.
∴ heat flow radially through the rod.
රබර් හොඳ තාප සන්නායකයක් නොවන නිසා දණ්ඩ තුළින් අරීයව තාපය ගලා යයි. — (02)

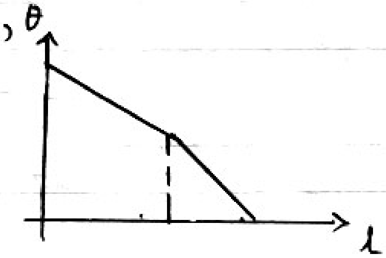
g) (i) $k_x(100 - \theta_1) = k_y(\theta_1 - 0)$

$\theta_1 = \frac{100 k_x}{k_x + k_y}$ — (01) $\theta_2 = \frac{100 k_y}{k_x + k_y}$ — (01)

$k_x > k_y$ — (01)

$\therefore \theta_1 > \theta_2$ — (01)

(ii)



— (02)

Essay .

(05) (i) Wind energy , solar energy, geothermal energy, tidal energy , hydro electricity.
for any three — (03)

(ii) Mechanical energy (kinetic energy) — (02)

(iii) Four facts are given in the paragraph. for any 3 facts — (03)

(iv) When the solar energy is incident on the earth, unequal heating of air layers near the land surface and near the sea water surface produces a pressure diff^{ce} bet. two regions. As a result of this, air blow as a wind . — (02)

v) The kinetic energy taken from air by the blades of a wind mill rotates the armature of a current generator .∴ The KE of wind is converted to the electrical energy by wind mills and generators. — (02)

vi) Average angular velocity , $\omega = 2\pi f$ — (02)

$$= 2\pi \frac{(20+50)/2}{60}$$

$$= 3.66 \text{ rad } s^{-1} \text{ — (02)}$$

vii) Height to the blades } (02)
length of blades }

viii)

a) This machine needs to be turned into the wind by an external source. Blades are not rotating by the wind from any direction — (02)

b) The blades can accept wind from any direction — (02)

RICHARD

ix) a) mass of unit volume of air = ρ

kinetic energy = $\frac{1}{2}\rho v^2$ — (02)

b) The area swept out by a rotating blade

$A = \pi r^2$

The air volume swept out in unit time = $\pi r^2 . v$ — (01)

The rate at which the wind energy is extracted by the rotating blades of the wind mill

$= \frac{1}{2}\rho v^2 \times \pi r^2 v = \frac{1}{2}\rho \pi r^2 v^3$ — (01)

(c) angular deceleration = $\alpha = \frac{\omega - 0}{t}$

$= \frac{3.66}{2 \times 60} = 0.03 \text{ rads}^{-2}$ — (02)

Angular torque, $\tau = I\alpha$

$= 5000 \times 0.03$

$= 150 \text{ Nm}$ — (02)

06 (a) (i) $\Delta Q = \Delta U + \Delta W$ — (01)

(01) —
- ΔQ – පද්ධතිය හා හුවමාරු වූ තාප ප්‍රමාණය – amount of heat exchanged
- ΔU – පද්ධතියේ අභ්‍යන්තර ශක්ති වෙනස – internal energy change
- ΔW – පද්ධතිය මගින් කරන ලද කාර්යය – Work done by the system

(ii) 1) සමෝෂ්ම ක්‍රියාවලිය – උෂ්ණත්වය නියතව පවතින තාප ගතික ක්‍රියාවලියක. මෙහි $\Delta U = 0$ නිසා $\Delta Q = \Delta W$ වේ. — (02)

Isothermal process – The temperature remains constant during the thermodynamic process.

$\Delta U = 0 \Longrightarrow \Delta Q = \Delta W$.

2) පද්ධතිය හා පරිසරය අතර තාප හුවමාරුවක් සිදු නොවේ.
මෙහි $\Delta Q = 0$ වන විට $\Delta U = -\Delta W$ — (02)

During the process, no heat exchange between the system and the environment.

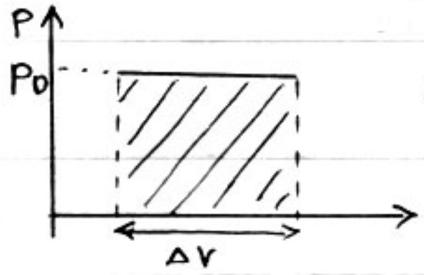
$\Delta Q = 0 \Rightarrow \Delta U = -\Delta W$

3) පද්ධතියේ පරිමාව වෙනස් නොවී තාප ගතිකීය ක්‍රියාවලිය සිදුවේ. $\Delta W = 0 \Rightarrow \Delta Q = \Delta U$. — (02)

The volume of the system remains constant during the thermodynamic process.

$\Delta V = 0 \Rightarrow \Delta W = 0 \rightarrow \Delta Q = \Delta U$.

(iii) $\Delta W = p\,dV = p\Delta V$ — (01)



Area of the shaded region = $p\Delta V$
අඳුරු කළ කොටසේ වර්ගඵලය. = ΔW
(02)

(b) (i) $\Delta Q = mL = 0.5 \times 2.26 \times 10^6 = 1.13 \times 10^6$ J — (01)

(ii) Volume of steam = $\frac{0.5}{1.67} = 299 \times 10^{-3}$ m^3

vol. of water = $\frac{0.5}{10^3} = 0.5 \times 10^{-3}$ m^3 — (01)

change in volume of water = $(299 - 0.5)10^{-3}$
$= 298.5 \times 10^{-3}$ m^3 — (01)

$\Delta W = p\Delta V = 1.01 \times 10^5 \times 298.5 \times 10^{-3}$
$= 301.49 \times 10^2$ J. — (01)

This is a work done on the system — (01)

(iii) $\Delta Q = \Delta U + \Delta W$.

$\Delta U = \Delta Q - \Delta W = -1.13 \times 10^6 + 301.49 \times 10^2$ — (01)
$= -109.986 \times 10^4$ J — (01)

ජල අණු අතර අන්තර්අණුක ආකර්ෂණ බල වැඩි කරවීම
To increase the intermolecular attractive forces between water molecules. — (01)

isochoric process

between water molecules. (01)

(c) i) A → B : පරිමාව නියතව පවතී. (const. volume) (01) isochoric process

C → A : පීඩනය නියතව පවතී. - isobaric process (01)

ii) $PV = nRT$

$1.2 \times 10^6 \times 2.1 \times 10^{-3} = 0.75 \times 8.3 \times T_A$ — (01)

$T_A = 404.82\ K$ — (01)

$3.2 \times 10^6 \times 2.1 \times 10^{-3} = 0.75 \times 8.3\ T_B$ — (01)

$T_B = 1079.52\ K.$ — (01)

iii) $P_1V_1 = P_2V_2$

$3.2 \times 10^6 \times 2.1 \times 10^{-3} = 1.2 \times 10^6\ V_2$ — (01)

$V_2 = 5.6 \times 10^{-3}\ m^3$ — (01)

iv) $\Delta W = \frac{1}{2} \times 3.5 \times 10^{-3} \times 2 \times 10^6 = 3.5 \times 10^3\ J$ — (01)

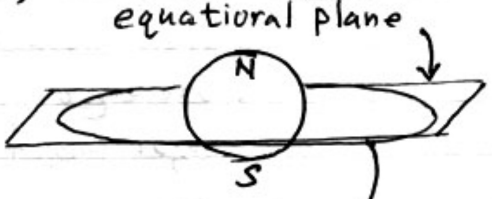
v) $\Delta U = 0$ — (01)

vi) $\Delta Q = \Delta W = 3.5 \times 10^3\ J$ — (01)

07 (a) 24×3600

$8.64 \times 10^4\ s$

(b) සමක තලය
equatorial plane



භූ. සෙ. ව. කක්ෂය
G. SS. orbit

(c) (i) $F_{gravitational} = \frac{GMm}{r^2}$

G. සර්වත්‍ර ගුරුත්වාකර්ෂණ නියතය
Universal gravitational constant.

(ii) $F_{cp} = mr\omega^2$

$mr\omega^2 = \frac{GMm}{r^2}$

$r^3 = \frac{GM}{\omega^2} = \frac{GM}{\left(\frac{2\pi}{T}\right)^2}$

$r^3 = \left(\frac{GMT^2}{4\pi^2}\right)^{1/3}$

(iv) පෘථිවි පෘෂ්ඨය මත ඇති m ස්කන්ධයක් මත බලය.
Force on mass m on the surface of the earth

$$F = \frac{GMm}{R^2}$$

$$g = \frac{F}{m} = \frac{GM}{R^2}$$

$$GM = gR^2$$

(v)
$$r = \left[\frac{gR^2T^2}{4\pi^2}\right]^{1/3}$$

$$= \left[\frac{10 \times (6.4\times10^6)^2 (8.64)^2}{4\times10}\right]^{1/3}$$

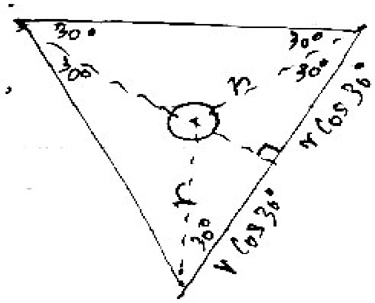
$$= (76.4\times10^{21})^{1/3}$$

$$= 4.24\times10^7 m.$$

RICHARD

d (i). භූස්ථාවර සන්නිවේදන කරන චන්ද්‍රිකාව
මධ්‍යස්ථානයකට සාපේක්ෂව පෘ ස්ථාවර ලක්ෂ්‍යයක
නිශ්චලව පවතී. එවැනි මධ්‍යස්ථානයකින්
නිකුත් කරන ඇති සංඥා, ඇති සංඥා
කරන මගින් රූපවාහිනී, රේඩියෝ, ජංගම
දුරකථන, fax යන්ත්‍රවලට අදාලවන විද්‍යුත් සංඥා
ගු.ස.ව, ආදිය. එසේනිසා භූස්ථාවර
චන්ද්‍රිකා ස්ථානයට ආදිය.
මෙලෙස සමපාද ත්‍රිකෝණයක ශීර්ෂවල පිහිටුවා ඇති
චන්ද්‍රිකා තුනක් මගින් ධ්‍රැව ප්‍රදේශ හැර පෘථිවියේ
සම්පූර්ණ සන්නිවේදන ජාලයක් පවත්වාගනී.

G.S.S. appears to be stationary on the sky relative to the communication station of the earth. Entire earth (except the polar regions) can be linked or covered by the communication network of 3 G.S.S. placed in the vertices of the equilateral triangle. Each of satellite covers $\frac{1}{3}$ of the earth globe.



(ii)
$$d = 2r\cos 30°$$
$$= 2 \times 4.24\times10^7 \times \frac{\sqrt{3}}{2}$$
$$= 1.732 \times 4.24\times10^7$$
$$= 7.34\times10^7 m$$

(iii)
$$t = \frac{7.34\times10^7 m}{3\times10^8 ms^{-1}}$$
$$= \underline{2.44 s}$$

(08) (a) (i) laws of refraction — (02)

(ii) • More optically dense medium –: The velocity of light is less through the medium.

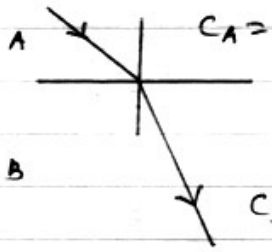
• less optically dense medium (rare) –: The velocity of light is higher through this medium. — (02)

(iii) velocity decreases — (01)

wavelength decreases — (01)

frequency - not changed (01)

(b)



$c_A = 2.2 \times 10^8 ms^{-1}$ (01)

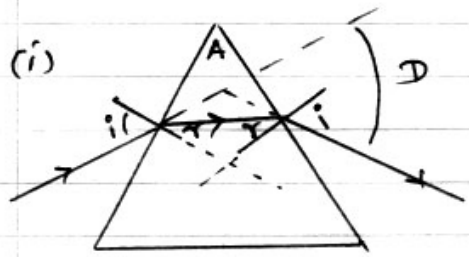
${}_A n_B = 1.6$

${}_A n_B = \frac{c_A}{c_B}$ — (01)

$c_B = \frac{c_A}{{}_A n_B} = \frac{2.2 \times 10^8}{1.6}$ — (01)

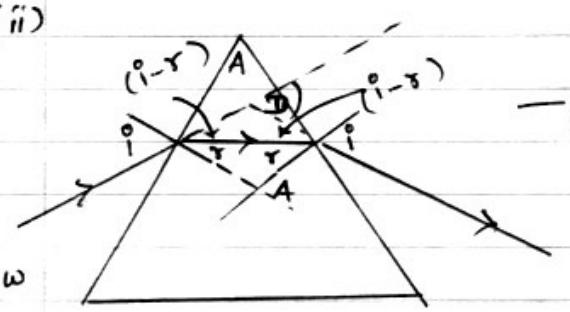
$c_B = 1.375 \times 10^8 ms^{-1}$ — (02)

(c) (i)



(03)

(ii)



— (03)

$i - r + i - r = D$

$2i - 2r = D$

$2i = A + D$

$i = \frac{A+D}{2}$ — (01)

n_ω

$r + r = A$ — (01)

$r = A/2$

Snell's law $n_\omega \sin i = n_g \sin r$

$\frac{n_g}{n_\omega} = \frac{\sin i}{\sin r} = \frac{\sin\left(\frac{A+D}{2}\right)}{\sin \frac{A}{2}}$

$$\sin\left(\frac{A+D}{2}\right) = \frac{n_g}{n_\omega} \cdot \sin\frac{A}{2}$$

$$\frac{A+D}{2} = \sin^{-1}\left(\frac{n_g}{n_\omega}\sin\frac{A}{2}\right)$$

$$D = 2\sin^{-1}\left(\frac{n_g}{n_\omega}\sin\frac{A}{2}\right) - A \qquad \text{—(03)}$$

$$D = 2\sin^{-1}\left(\frac{3/2}{4/3}\sin\frac{60}{2}\right] - 60 \qquad \text{—(02)}$$

$$= 2\sin^{-1}\left(\frac{9}{8}\times\frac{1}{2}\right] - 60^\circ$$

$$= 2\sin^{-1}(0.5625) - 60^\circ \qquad \text{—(02)}$$

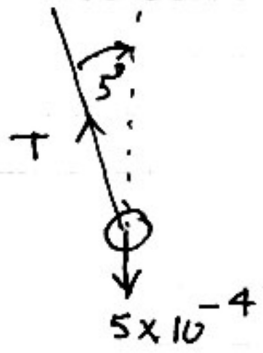
$$= 2\times 34^\circ 13' - 60^\circ$$

$$= 68^\circ 26' - 60^\circ = \underline{\underline{8^\circ 26'}} \qquad \text{—(03)}$$

විෂය 9A

09 A

(a) (i) $T\cos 5^\circ = 5\times 10^{-4}$



$$T = \frac{5\times 10^{-4}}{0.9961}$$

$$= 5.02\times 10^{-4}\ N$$

$(5.019 - 5.02)$

(ii) $E = -\frac{\Delta V}{d}$

$$= \frac{9\times 10^3}{1.2}$$

$$= 7.5\times 10^3\ V\,m^{-1}$$

(iii) $F = T \sin 5^\circ$

$= 5.02 \times 0.0871 \times 10^{-4}$

$= 0.437 \times 10^{-4}\,N$

(iv) $Eq = F$

$q = \dfrac{F}{E}$

$= \dfrac{0.437 \times 10^{-4}}{7.5 \times 10^{3}}$

$= 5.82 \times 10^{-9}\,C$

$(5.82 - 5.827)$

ආරෝපණය ~~[illegible]~~ ඍණාත්මක වේ. Charge is negative

$-5.82\,nC$

b (i). ක්ෂේත්‍රය ඉහළට යොමුකළවිට ගෝලය මත විද්‍යුත් බලය පහළට ක්‍රියාකරයි.

When the field is upwards, the electrostatic force on the ball is acting downwards.

$$T_1 = 2\pi \sqrt{\frac{l}{g + \frac{F}{m}}}$$

$$T_1 = 2 \times 3.14 \sqrt{\frac{1}{10 + \frac{0.437 \times 10^{-4}}{5.0 \times 10^{-5}}}}$$

(ii) ක්ෂේත්‍රය පහළට ක්‍රියාකරනවිට ගෝලයමත විද්‍යුත් බලය ඉහළට ක්‍රියාකරයි. When the field is downwards, the electrostatic force on the ball is acting upwards.

$$T_2 = 2\pi \sqrt{\frac{l}{g - \frac{F}{m}}}$$

$$= 2 \times 3.14 \sqrt{\frac{1}{10 - \frac{0.437 \times 10^{-4}}{5.0 \times 10^{-5}}}}$$

9(B) (a) Doppler effect —(02)

(b) (i) $u\cos\phi$ —(02) (ii) $v\cos\phi$ —(02) (iii) $c+u\cos\phi$ —(02)

(iv) $c+v\cos\phi$ —(02) (v) spherical —(02) (vi) $\lambda = \frac{c}{f}$ —(02)

(vii) $\lambda' = \frac{c+v\cos\phi}{f}$ —(03) (viii) $f' = \left(\frac{c+u\cos\phi}{c+v\cos\phi}\right) f$ —(03)

(ix) $f' = \left[\frac{c+ux/(d^2+x^2)^{1/2}}{c+vx/(d^2+x^2)^{1/2}}\right] f$ —(04)

(x) $f' = f$ —(02)

(xi) if $d >> x$, $(d^2+x^2)^{1/2} \approx d$

$$\frac{f'}{f} = \frac{cd+ux}{cd+vx} \quad —(04)$$

10(A)

Answers

(a) (i) $Q = It$

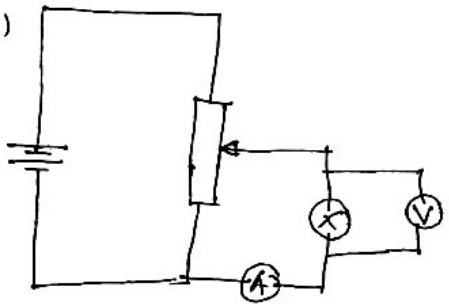
$Q = 200 \times 6 = \underline{1200\,C}$

(ii) $Q = ne$

$1200 = n \times 1.6 \times 10^{-19}$

$n = \frac{1200}{1.6 \times 10^{-19}} = \underline{7.5 \times 10^{21}}$

(b)(i)



(ii) when $V = 12\,V$, $I = 3\,A$

$V = IR$

$12 = 3 \times R$

$\underline{R = 4\,\Omega}$

(iii) $P = VI$

$P = 12 \times 3 = \underline{36\,W}$

(B) when $V = 6V$, $I = 2.5A$

using

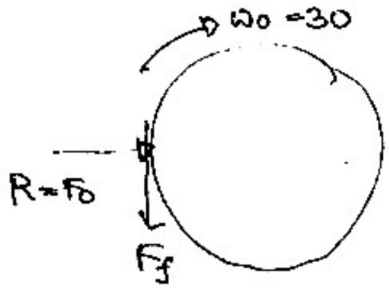
$$V = IR$$

$$6 = 2.5 \times R$$

$$R = \frac{6}{2.5} = 2.4\,\Omega$$

10 (B)

(a) (i)



In this process Fo act as a perpendicular Force. the build up a frictional Force. Due to this Frictional Force, opposite torque acts on the wheel. Due to this frictional Force wheel can be stopped.

(ii) $\theta = 2\pi \times 10$, $\omega_0 = 30$,

$\omega^2 = \omega_0^2 + 2\alpha\theta$

$0 = 30^2 - 2 \times \alpha \times 60$

$2\alpha 60 = 30 \times 30$

$\alpha = 2.5 \text{ rad s}^{-2}$

(iii) For wheel $I = \frac{1}{2} MR^2$

$= 0.5 \times 2 \times 0.4^2$

$= 0.16$

$\tau = I\alpha$

$= 0.16 \times 2.5$

Using $\tau = F_f r$

$0.16 \times 2.5 = F_f \times 0.4$

$F_f = 1N$

$F_f = \mu F_0$

$1 = 0.5 \times F_0$

$F_0 = 2N$

(b) (i) $K.E = \frac{1}{2} MV^2$

$= \frac{1}{2} \times 2 \times 10^3 \times 20^2$

$= 400 \times 10^3 = 4 \times 10^5 J$

(ii) $V = u + at$

$0 = 20 - 4a$

$4a = 20$

$a = 5 \text{ ms}^{-2}$

(iii) $S = ut + \frac{1}{2} at^2$

$S = 20 \times 4 - \frac{1}{2} \times 5 \times 4^2$

$S = 40m$

(iv) Work against frictional Force on one wheel $= \frac{4 \times 10^5}{4} = 1 \times 10^5 J$

(v) work against friction force $= \tau\theta$

$1 \times 10^5 = \tau\theta$

$1 \times 10^5 = F r \theta$

$1 \times 10^5 = F \times \frac{1}{2} \times 60$

$F = 5000N$

(vi) Force act on the plate $\Rightarrow F = \mu_K F_1$

$5000 = 0.5 \times F_1$

$F = 10000 N$

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