D.S. Senanayake College - Colombo 07
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01 E I

First Term Test, November 2018
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Physics	I
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Grade 13
13 වන ශ්‍රේණිය

Two hours
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NOTE :

* Answer **all the** question.
* Answer questions from **1 to 50** using (1), (2), (3), (4), (5) answer by selecting the **correct or most appropriate** answer. **Indicate the answer in the given answer script using a cross.**

01. In the expression $P = \left(\frac{\alpha^2}{\beta}\right) e^{\frac{-\alpha Z}{K\theta}}$ P is the pressure, Z is distance, K is Boltzmann constant and θ is the temperature.

The dimensional formula for β is,

1) ML^3T^{-2} 2) ML^2T^{-2} 3) MLT^{-2} 4) $M^0L^2T^{-1}$ 5) M^2L^2T

02. A Vernier caliper has 1 mm marks on the main scale. It has 20 equal divisions on the Vernier scale which match with 16 main scale divisions. For this Vernier calipers, the least count is,

1) 0.02 mm 2) 0.05 mm 3) 0.1 mm 4) 0.2 mm 5) 0.01 mm

03. The diameter of a cylinder is measured using a Vernier calipers with no zero error. It is found that the zero of the Vernier scale lies between 5.10 cm and 5.15 cm of the main scale. The Vernier scale has 50 divisions equivalent to 2.45 cm. The 24th division of the Vernier scale exactly coincides with one of the main scale divisions. The diameter of the cylinder is,

1) 5.112 cm 2) 5.124 cm 3) 5.136 cm 4) 5.148 cm 5) 5.115 cm

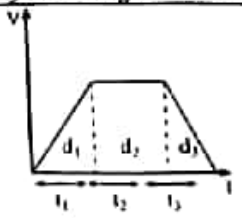
04. A body moving in a straight line covers a distance of 14 m in the 5th second and 20 m in the 8th second. How much distance will it cover in the 15th second?

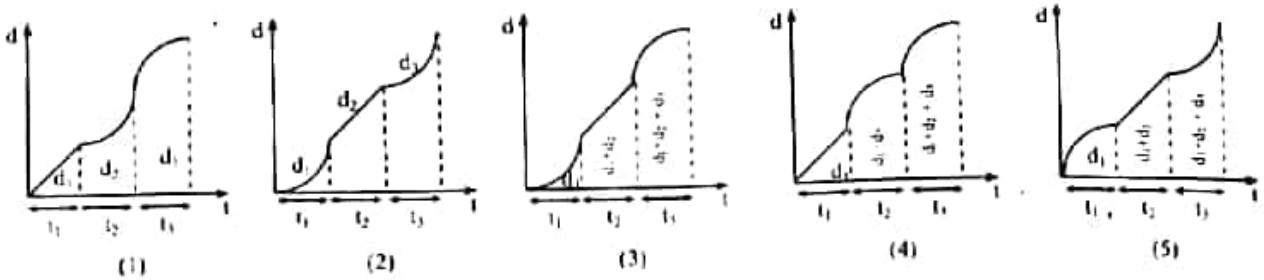
1) 18 m 2) 25 m 3) 34 m 4) 30 m 5) 35 m

05. A balloon is rising vertically upwards at a velocity of 10 ms^{-1}. When it is at a height of 45 m from the ground, a parachutist bails out from it. After 3 s he opens his parachute and decelerates at a constant rate of 5 ms^{-2}. What was the height of the parachutist above the ground when he opened his parachute? (Take g = 10 ms^{-2})

1) 15 m 2) 30 m 3) 45 m 4) 60 m 5) 50 m

06. Following graph shows the variation of the velocity of a particle (V) with time (t). d_1, d_2, d_3 are distances traveled during time intervals t_1, t_2, t_3 respectively. Which of the following distance - time (d) - (t) graphs represents this motion.





07. Figure shows displacement (s) versus time (t) curve for a motion of a particle. Consider the following statements made about its motion.

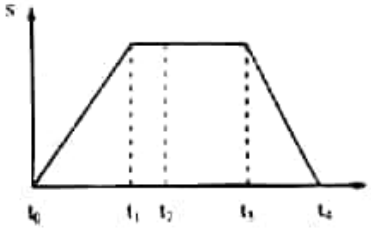
(A) During the time period t_0 - t_1 the particle moves at a constant acceleration and during t_2 - t_3, it moves at a constant velocity.

(B) Particle comes to rest at time t_2

(C) During the time period t_0 - t_4, the total distance travelled by the particle is equal to the area under the s - t curve.

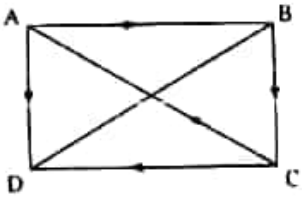
Of the above statement,

1) Only (A) is true
2) Only (A) and (B) are true
3) Only (B) and (C) are true
4) Only (A) and (C) are true
5) All (A), (B) and (C) are true



08. ABCD is a rectangle. It's sides AB, BC, CD, AD and CA represent five vectors with magnitudes and directions. The resultant of this system of vectors is,

1) $\overrightarrow{AC}$
2) $\overrightarrow{BD}$
3) $\overrightarrow{AB}$
4) $\overrightarrow{CA}$
5) $\overrightarrow{DB}$



09. Co-liner system of forces is acted on a rigid object. If the resultant moment of force is zero around a particular point on the object, consider the following statements.

(A) Object should be in equilibrium

(B) Resultant force on the object must be zero.

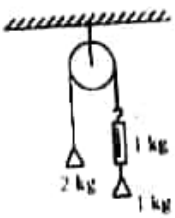
(C) Resultant moment of force around any other point on the object is always zero.

Of the above statements,

1) All (A), (B) and (C) are false
2) Only (A) is true
3) Only (B) is true
4) Only (C) is true
5) Only (A) and (B) are true

10. A light string passing over a smooth pulley carries a spring balance of mass 1 kg and two weights of masses 1 kg and 2 kg as shown in the figure. The reading on the balance will be,

1) zero
2) 1 kg
3) 2 kg
4) 3 kg
5) 4 kg.



11. A light string passing over a smooth pulley. If a man standing on a platform is moving up with an acceleration 2 ms^{-2}, Reaction between the man and the platform is, (mass of the man is 70 kg, mass of the platform is 30 kg)

1) 300 N 2) 600 N 3) 240 N 4) 200 N 5) 400 N

12. A person throws two balls vertically upward with the same velocity, one after the other. He throws the second ball at time when the first ball is at the highest point. If he throws the balls in an interval of one second, what is the maximum height attained by each ball? ($g = 10\ ms^{-2}$)

1) 4.0 m 2) 5.0 m 3) 10 m 4) 20 m 5) 15 m

13. A balloon of mass M is rising up with an acceleration a. If a mass m is removed from the balloon its acceleration becomes,

1) $\frac{Ma+mg}{(M-m)}$ 2) $\frac{Ma+mg}{(M+m)}$ 3) $\frac{ma+Mg}{(M-m)}$

4) $\frac{ma+Mg}{(M+m)}$ 5) $\frac{Mg+ma}{(2M-m)}$

14. Horizontal platform mass 10 g is kept floated in the air in allowing to collide particles of mass 5 g with a rate of 10 per second perpendicularly upward on the lower surface of the platform. If the particles rebound with the same velocity at the time of collision, the magnitude of the velocity of particle at the time of collision is.

1) 1 ms^{-1} 2) 2 ms^{-1} 3) 3 ms^{-1} 4) 0.5 ms^{-1} 5) 4 ms^{-1}

15. A force F hits a block of mass m = 35 g initially at rest. The duration of the impact is 5 ms. If the force varies with time as shown in figure. The speed of the block immediately after impact is,

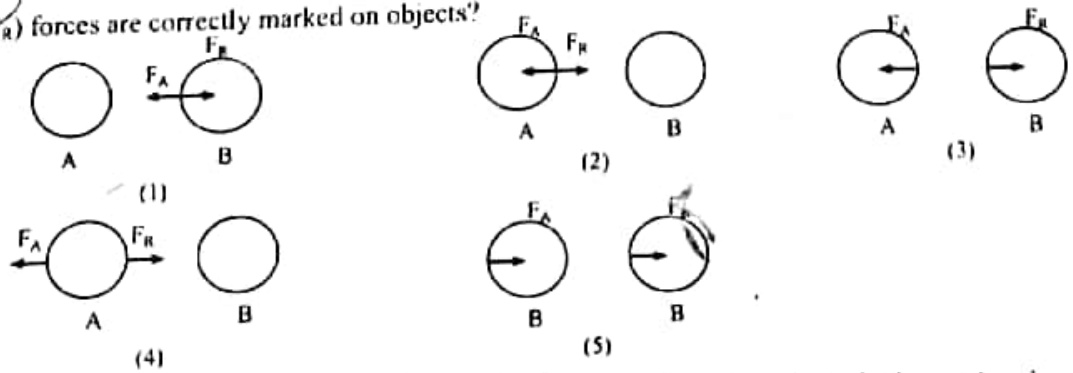
1) 1 ms^{-1} 2) 2 ms^{-1} 3) 3 ms^{-1}

4) 4 ms^{-1} 5) 5 ms^{-1}

16. The blocks A and B of masses 2m and m are connected as shown in the figure. The spring has negligible mass. The string is suddenly cut. The magnitudes of accelerations of masses 2m and m at that instant are,

1) g, g 2) g, $\frac{g}{2}$ 3) $\frac{g}{2}$, g 4) $\frac{g}{2}$, $\frac{g}{2}$ 5) 0, g

17. When two objects A and B collide with each other, in which of the following figures, the action (F_A) and reaction (F_R) forces are correctly marked on objects?



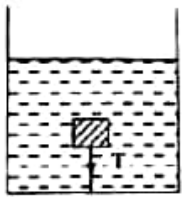
18. A gramophone record of mass M and radius R is rotating at an angular velocity ω. A coin of mass m is gently placed on the record at a distance $r = \frac{R}{2}$ from its centre. The new angular velocity of the system is,

1) $\frac{2\omega M}{(2M + m)}$ 2) $\frac{2\omega M}{(M + 2m)}$

3) ω

4) $\frac{\omega M}{(M + m)}$ 5) $\frac{M}{(2M + m)}$

19. A solid block of density ρ_1 is held inside a liquid of density ρ_2 (with $\rho_1 < \rho_2$) by means of a string fixed to the bottom of the beaker as shown in figure. The system is placed at the floor of a lift. If the lift is at rest, the tension in the string is T. The tension in the string when the lift moves upwards with an acceleration "a" will be,



1) T 2) $\frac{Tg}{a}$ 3) $T\left(1 + \frac{a}{g}\right)$

4) $T\left(1 - \frac{a}{g}\right)$ 5) $\frac{Ta}{g}$

20. A transverse wave of wave length 20 cm travels in a medium with a speed 10 cm s^{-1}. If the amplitude of the wave is 2 cm the highest speed of particles in the medium is,

1) 0.1 cms^{-1} 2) 0.2 cms^{-1} 3) 0.4 cms^{-1} 4) 6.3 cms^{-1} 5) 10 cms^{-1}

21. The percentage increase of the tension of a string to increase the frequency of transverse vibration by 50% is,

1) 25 % 2) 50 % 3) 100 % 4) 125 % 5) 150 %

22. In which temperature the speed of sound in the air at 0°C becomes twice?

1) 1092 °C 2) 819 K 3) 819 °C 4) 546 °C 5) 546 K

23. A tuning fork and a sonometer wire when sounded together produce 4 beats / s when the length of the wire is 95 cm and 100 cm. The frequency of the tuning fork is,

1) 148 Hz 2) 150 Hz 3) 152 Hz 4) 156 Hz 5) 160 Hz

24. Which of the following statements is incorrect from among the statements related to stationary waves.

1) Wave structure of stationary wave does not move.
2) No energy propagation along with the wave
3) Two waves are inneed for superposition of waves and those can move along the same direction or opposite direction
4) There is always zero displacement points in superposition of waves.
5) The point where the displacement is maximum is always situated in the middle of zero displacement point.

25. Consider of the following statements related to a transverse wave of a string

(A) Those consist of compressions and rarefactions

(B) Those consist of crest and troughs.

(C) The shortest distance between two particles with exactly similar nature of movements is one wave length.

Of the above statements.

1) Only (A) is true 2) Only (B) is true 3) Only (C) is true
4) Only (A) and (B) are true 5) Only (B) and (C) are true.

26. A closed organ pipe and an open organ pipe of same length produce 2 beats when they are set in to vibration simultaneously in their fundamental mode. The length of the open organ pipe is now halved and of the closed organ pipe is doubled. The number of beats produced will be,

1) 8 2) 7 3) 4 4) 2 5) 3

27. A person speaking normally produces a sound of intensity 40 dB at a distance of 1m. If the threshold intensity for reasonable audibility is 20 dB, the maximum distance at which he can be heared clearly is,

1) 20 m 2) 10 m 3) 5 m 4) 4 m 5) 2 m

28. The apartment frequency of the whistle of an engine changes in the ratio of 6 : 5 as the engine passes a stationary observer. If the velocity of sound is 330 ms^{-1}, then the velocity of the engine is,

1) 10 ms^{-1} 2) 15 ms^{-1} 3) 20 ms^{-1} 4) 25 ms^{-1} 5) 30 ms^{-1}

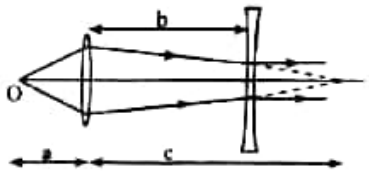
29. The type of wave in a sonometer wire is,

1) Propagative, longitudinal 2) Propagative, transverse 3) Stationary, longitudinal
4) Stationary, transverse 5) Stationary, transverse or longitudinal

30. Convex and a concave lens are placed coaxial with a gap of 10 cm. The focal length of the concave lens is 10 cm. The parallel rays which are incident on concave lens emits as parallel rays from the convex lens after refraction through the lenses. The focal length of convex lens is,

1) 10 cm 2) 15 cm 3) 20 cm 4) 25 cm 5) 30 cm

31. Image of O can be seen through concave lens at the infinity. It's focal length is,



1) a 2) b 3) c
4) a + b 5) c - b

32. An object is placed in front of a convex lens with focal length f. so that a real image can see. If the distance of the object from the closest focus point is x, the magnification of the image is,

1) $\frac{f}{x}$ 2) $\frac{x}{f}$ 3) $\frac{f+x}{f}$ 4) $\frac{f}{f+x}$ 5) $\frac{f}{f-x}$

33. Magnifying power of an astronomical telescope when it is in normal adjustment is 5. The distance between two lenses is 36 cm. The focal lengths of eye piece and objective are respectively,

1) 4 cm, 9 cm 2) 50 cm, 10 cm 3) 20 cm, 16 cm
4) 6 cm, 30 cm 5) 30 cm, 6 cm

34. In an experiment to find the angle of minimum deviation of a prism in using a spectrometer,

(A) Collimator is adjusted to give a parallel set of rays.
(B) Telescope is adjusted to receive a parallel set of rays
(C) Prism is adjusted always so that refracted angle of the prism is on the center of the prism table

Of the above statements

1) Only (A) is true 2) Only (B) is true 3) Only (C) is true
4) Only (A) and (B) are true 5) Only (A) and (C) are true.

35. A person cannot see clearly the objects beyond a distance of 50 cm from his eyes. In order to see distant objects he must wear.
1) Concave lenses of focal length 10 cm
2) Convex lenses of focal length 50 cm
3) Concave lenses of focal length 50 cm
4) Convex lenses of focal length 100 cm
5) Concave lenses of focal length 100 cm

36. If the mass of the earth is M and the universal constant of gravitation is G, the acceleration due to gravity at a distance R from the center of the earth is,
1) $\frac{GM}{R}$ 2) $\frac{GM}{R^2}$ 3) $\frac{GM^2}{R}$ 4) $\frac{G^2M}{R}$ 5) $\frac{GM}{R^3}$

37. The weight of an object on the earth surface is 600 N. At a height of one earth radius above the earth surface the weight of the object will be,
1) 150 N 2) 240 N 3) 300 N 4) 600 N 5) 2400 N

38. A geostationary satellite A moves in an orbit of radius R_A. Another geostationary satellite B has twice the mass of A. The orbital radius of the satellite B is,
1) R_A 2) $2R_A$ 3) $\frac{1}{2}R_A$ 4) $\sqrt{2}R_A$ 5) $\frac{1}{\sqrt{2}}R_A$

39. If the distance between two masses is doubled the gravitational force between them will decrease by a factor of,
1) 2 2) 4 3) 6 4) 8 5) 12

40. The radius of a spherical asteroid is 60 km. The acceleration due to gravity on its surface is 3 ms^{-2}. The escape velocity at the surface of the asteroid is,
1) 400 ms^{-1} 2) 600 ms^{-1} 3) 800 ms^{-1} 4) 1200 ms^{-1} 5) 3600 ms^{-1}

41. When a thermometer is in use,
1) Thermometric substance must be a liquid through out the total range of temperature to be measure.
2) Thermometric substance must have a property which is changing linear with the temperature
3) Thermometric substance must have a property which is changing with the temperature.
4) Thermometric substance must follow boil's law
5) Thermometric substance must have the constant expansivity.

42. The work done by a thermodynamic system is W. The amount of increasing energy of that system is given by ΔU which of the following statement is true
1) $\Delta U = -W$ is for a isothermal process
2) $\Delta U = -W$ is for a adiabatic process
3) $\Delta U = W$ is for a isothermal process
4) $\Delta U = W$ is for a adiabatic process
5) None of above relations is true.

43. In a particular space the partial pressure of the water vapour in air in room temperature is P. Saturated vapour pressure of the air in the same temperature is P_0 and saturated vapour pressure at dew point in the same space is P_d. Consider the following equations for relative humidity R of the same space.

a) $R = \frac{P}{P_0} \times 100\%$ b) $R = \frac{P}{P_d} \times 100\%$ c) $R = \frac{P_d}{P_0} \times 100\%$ d) $R = \frac{P_d}{P} \times 100\%$

Which of the above are correct
1) Only (a) 2) Only (c) 3) Only (a) and (c)
4) Only (b) 5) Only (d)

44. Two equal vessels have been made with two totally different materials. Equal amount of ice is put in each of the vessels. If the time taken for the ice to be totally melted are 20 minutes and 35 minutes respectively, the ratio between heat conductivity of materials is,

1) 5 : 6 2) 6 : 5 3) 3 : 1 4) 7 : 4 5) 3 : 2

45. The temperature that a flask should be heated to remove half of the mass of air, which is filled at 27°C is (flask is not expansive)

1) 54 °C 2) 108 °C 3) 227 °C 4) 277 °C 5) 327 °C

46. Volume of the cavity of a hollow sphere is $\frac{3}{4}$ of its external volume. This sphere submerges in a liquid of relative density 1.5, so that half of its volume is in the liquid. Relative density of the material of the sphere is,

1) 1.0 2) 1.5 3) 2.0 4) 3.0 5) 4.0

47. Equal amounts of heat was given to two liquids A and B of mass m and $\frac{m}{2}$ respectively. The liquid A has one half the specific heat capacity of the liquid B. If the increase in the temperature of liquid A and B are θ_A and θ_B respectively, then

1) $\theta_A = \theta_B$ 2) $\theta_A = \frac{\theta_B}{2}$ 3) $\theta_A = 2\,\theta_B$

4) $\theta_A = \frac{\theta_B}{4}$ 5) $\theta_A = 4\,\theta_B$

48. Long metal rod is insulated other than its ends. Keeping one end at 100 °C, the other end is exposed to the environment at 25°C. At the steady state temperature at that end was 30°C. If the environmental temperature was dropped by 5 °C, new steady temperature at the end of the rod which was exposed to the environment is,

1) 23.6 °C 2) 24.0 °C 3) 25.0 °C 4) 25.3 °C 5) 26.0 °C

49. Volume of an ideal gas of mass m kg is increase by V m^3. When its temperature is increase from 30 °C to 40 °C in constant pressure. In the same pressure the density of this air at 0 °C in kg m^{-3} is given by,

1) $\frac{m}{V}\left(\frac{10}{283}\right)$ 2) $\frac{m}{V}\left(\frac{10}{273}\right)$ 3) $\frac{m}{V}\left(\frac{313}{303}\right)$

4) $\frac{m}{V}(10)$ 5) $\frac{273m}{V}\left(\frac{1}{313}-\frac{1}{303}\right)$

50. The molecular weights of two ideal gases A and B in a mixture are M_1 and M_2 respectively. The ratio $\frac{\text{r.m.s speed of gas A}}{\text{r.m.s speed of gas B}}$ is equal to,

1) $\sqrt{\frac{M_1}{M_2}}$ 2) $\frac{M_1}{M_2}$ 3) $\sqrt{\frac{M_2}{M_1}}$ 4) $\frac{M_2}{M_1}$ 5) $\sqrt{M_1 M_2}$

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Part - B

Essay

Answer all questions.

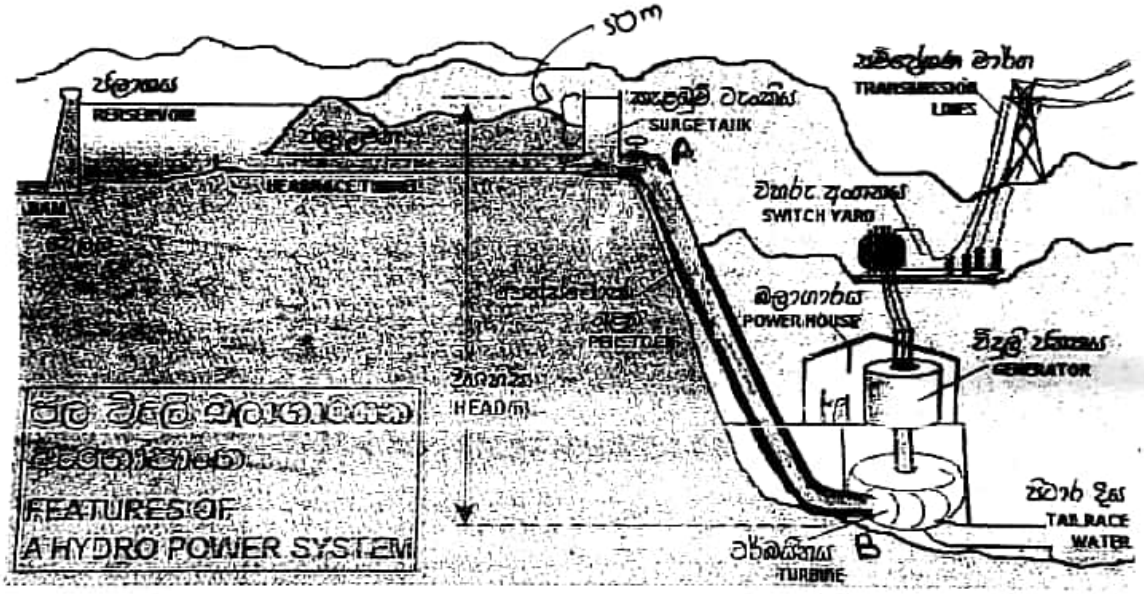
05. (a) State Bernoulli's theorem

(b) A student says that the Bernoulli's equation of a liquid of mass m and volume V is given by $PV + \frac{1}{2}\frac{M}{m}V^2 + mgh = K$. Check whether the equation is dimensionally correct.

In the process of generating hydro electricity vertical height from the surface of the reservoir to the water level of the turbine is called 'head' and it is considered as a very important measurement in calculating hydro electric power.

Water that is coming through the tunnel reaches the surge tank.

The purpose of this tank is to avoid pressure perturbation of the water and assure proper stream line to the turbine. Consequently the water that enters to penstock tube flows to the turbine. The diameter of penstock tube at the top end the bottom end is 1.0 m and 0.5 m respectively. The thickness of the wall of penstock tube increases toward downward. Consider that the water behavior according to the above theorem, water head of the power station is 190 m, capacity of the reservoir 720×10^6 m^3, density of water 10^1 kg m^{-3}



(i) Give two reasons for sending water through an open tank which is situated at higher point without sending directly to the penstock tube through the tunnel. (One of the reasons is mentions in the paragraph)

(ii) What is the reason to make the penstock tube narrower downward?

(iii) What is the reason to mark the walls of the tube more thick downward?

(iv) Calculate the speed of water entering to the turbine in considering that speed of water entering to the penstock tube is 2 ms^{-1} and water level of reservoir keep constant.

(v) Find the pressure at points A and B where atmosphere pressure 1×10^5 Pa.

(vi) Find the expected electric energy in GWh considering that the efficiency of the turbine is 80 %.

06. (a) Draw the ray diagram for a compound microscope in its normal adjustment and show that angular magnification M is given by $M = \left(\frac{V_0}{f_0} - 1\right)\left(1 - \frac{D}{f_e}\right)$

Where f_0 and f_e are focal lengths of the objective and eyepiece respectively. V_o is distance of image of objective and D is least distance of distinct vision of the observer

(b) The distance between lenses is 19 cm the focal length of objective is 3 cm. The magnification of objective and eyepiece are 3 and 8 respectively of a compound microscope. When it is made normal adjustment by observer with farsightedness.

(i) What is the distance between objective and object

(ii) Considering that the eye is placed near the eyepiece, find the distance to the near point of the observer

(iii) Find the lens power of the spectacles that should be use by the observer to make, least distance in distinct vision 25 cm.

(iv) Calculate the range of vision of the observer once the lens found in (iii) were worn considering that observers far point is at a distance 10 m from the eye.

07. (A) (i) When a string is tied between two stationary walls and disturbed it doesn't produce a sound with a considerable intensity. But when the string is mounted on a wooden box with holes, a sound with high intensity can be heard. Explain this.

(ii) A string of which both ends are fixed stationary is set in to a transverse simple harmonic motion. Its length is 0.5 m. The variation of the acceleration of the particle on the string 'a' with its vertical displacement y is given by $a = -64 \times 10^4 \pi^2 y$.

(a) How much is the frequency of vibration?

(b) Find the wave length of the wave along the string and velocity of the wave.

(c) If the mass of the string is 5×10^{-3} kg m^{-1}, how much is the tension of the string.

(iii) There is another similar string is placed close to that string. Find the percentage increase of tension in the second string to produce beat frequency of 2 Hz if both strings were disturbed by fundamental mode.

(B) A metal wire of diameter 1 mm is held on two knife edges by a distance 50 cm. The tension in the wire is 100 N. The wire vibrating with its fundamental frequency and a vibrating tuning fork together produce 5 beats / s. The tension in the wire is then reduced to 81 N. When the two are excited, beats are heard at the same rate. Calculate,

(i) The frequency of the fork

(ii) The density of material of wire.

08. (a) Mention the Newton's law of gravitation.

(b) Consider a satellite of mass m moving along a circular orbit at a height h from the earths surface where radius and gravitational acceleration at surface of the earth are R and g respectively.

(i) Derive an expression for the speed of the satellite in terms of g, R and h

(ii) Derive an expression for the total mechanical energy for the system "Earth + satellite" considering that earth is stable relative to the satellite, in terms of g, R, h and m

(c) People believe that the speed of an object always reduces due to the air resistance on it. But there are situations where the speed of an object even increases with air resistance. Consider a satellite of man 100 kg which is situated at 200 km height from the earth surface. Consider the radius of the earth is 6400 km and gravitational acceleration on the earth surface is 10 ms^{-2}. The satellite enters to an orbit which is at 100 km height from the surface of the earth due to air resistance.

(i) Calculate the initial speed of this satellite.

(ii) Calculate the final speed of this satellite.

(iii) Calculate the initial total mechanical energy of the "E + S" system

(iv) Calculate the final total mechanical energy of the "E + S" system

(v) What is the energy loss due to air resistance

(vi) What is the force that leads to increase the speed of the satellite

09. The environment temperature of a country drops to -20 C at the beginning of the winter. It was seen a layer of ice of thickness 5 cm was found on the surface of a deep pond one week after the beginning of the winter.

(a) Draw a rough graph for the variation of temperature with the depth of the pond from a point of air just above the ice layer of the pond in this situation.

(b) Find the rate of conduction of heat through a unit area of the ice layer towards the air just above the ice layer in this situation. (Heat conduction of ice is 2.5 $W K^{-1}$

(c) What is the loss of heat [redacted] of unit area of water if the thickness of the ice layer was increased by another 5 cm. Specific latent heat of fusion of ice is 3.25×10^5 $J K^{-1}$, density of ice is 920 kg m^{-3}.

(d) Find the time that will be taken to increase the thickness of ice by another 5 cm.

(e) Calculate a mean value for the thickness of the ice layer at the end of the winter considering the period of winter is 90 days