தொண்டைமானாறு வெளிக்கள நிலையம் நடாத்தும்
ஆறாம் தவணைப் பரீட்சை - 2022

Conducted by Field Work Centre, Thondaimanaru.

6th Term Examination - 2022

FWC

பௌதிகவியல் - I
Physics - I

Two Hours

Gr -13 (2022)

01 | E | I

01) Quantities x, y, β of the physical equation $x = \frac{\alpha y}{\beta}$ are in $eV, m\,s^{-1}, nm$ respectively. SI unit of α is

(1) N (2) J (3) $J\,s$ (4) $N\,m^{-1}$ (5) $N\,s$

02) Which force combination cannot verify the parallelogram law using the Parallelogram of forces apparatus?

(1) $5\,N, 5\,N, 5\,N$ (2) $5\,N, 5\,N, 3\,N$ (3) $5\,N, 5\,N, 4\,N$ (4) $5\,N, 3\,N, 2\,N$ (5) $5\,N, 5\,N, 6\,N$

03) A uniform wire of length l and cross section A has resistance R. This wire is melted and converted into a wire of cross section $A/4$. Now, the resistance of the wire

(1) $4R$ (2) $8R$ (3) $12R$ (4) $16R$ (5) $\frac{1}{8}R$

04) Which of the following statements is/ are correct

A- While the momentum of a system remains constant, it's kinetic energy can change.

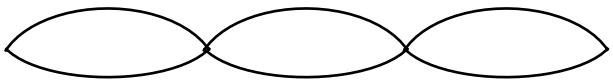
B- The center of gravity of the system may be constant while the particles in the system are moving.

C- When an external force acts on a system, it's angular momentum may not change

(1) Only A (2) Only B (3) Only C

(4) All A, B and C (5) All wrong

05) The figure shows a standing wave formed on a 3 m long stretched string. If the frequency of the string is 60 HZ what is the speed of the transverse wave in the string?



(1) 180 ms^{-1} (2) 120 ms^{-1} (3) 60 ms^{-1} (4) 30 ms^{-1} (5) 6 ms^{-1}

06) Which of the following statements about thermometer is/ are true?

A- Thermometric property must have a linear variation with the temperature

B- Thermal capacity of the thermometer must be negligible when compared to the thermal capacity of the environment of which the temperature is measured.

C- A thermometric property must have a constant value for a given temperature

(1) Only A (2) Only A, C (3) Only A, B

(4) Only B, C (5) All A, B and C

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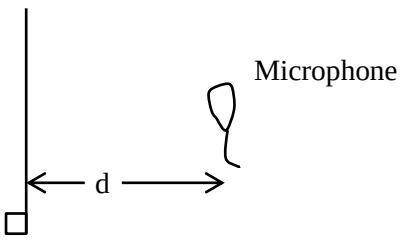
07)



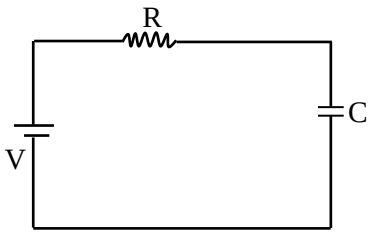
A sound source is placed in front of a large metal plate as shown in the figure. A microphone is placed at a distance d from the plate. In the case of $d = 12\ cm$ low sound intensity is observed in the microphone. As the metal plate is moved away from the microphone, the lowest intensity level is again observed at $d = 15\ cm$. If the speed of sound in air is $336\ m\ s^{-1}$, the frequency of this sound.

(1) $56\ Hz$ (2) $112\ Hz$ (3) $5600\ Hz$ (4) $11200\ Hz$ (5) $11400\ Hz$

08) The main scale of a travelling microscope is marked in half a millimeter. 50 vernier divisions coincide to 49 half-millimeter divisions. In this case the reading of the indicator is $12.57\ cm$. Which vernier scale should be coincided with a division on the main scale to obtain the above reading.

(1) 7th (2) 10th (3) 70th (4) 26th (5) 20th

09) A capacitor is charged by a battery in the circuit shown



A- The charge stored in the capacitor depends on the resistance R.
B- The current flowing through the resistor decreases with time.
C- The time taken for the capacitor to half-charge depends on the resistance R.

Of the above statements,

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

10) What is the work required to move an object of mass $m\ kg$ from the earth's surface to a height of $2R$ above the surface? (Earth's radius R, surface gravitational field intensity g)

(1) mgR (2) $\frac{mgR}{3}$ (3) $\frac{2mgR}{3}$ (4) $3mgR$ (5) $\frac{2}{5}\ mgR$

11) A metal cylinder at room temperature 25^oC is heated uniformly by a $15\ W$ heating coil and reaches steady state at 50^oC. The rate of heat loss to the surroundings at temperature of the metal cylinder is 30^oC

(1) $1.5\ W$ (2) $3\ W$ (3) $4.5\ W$ (4) $6\ W$ (5) $9\ W$

12) Consider the following statements about the equilibrium of a coplanar force system

A- As these forces stretch the lines of action they meet at a point.
B- This force can be represented by the dimensions and directions of the sides of a properly taken polygon.
C- The algebraic sum of moment of each force about any point is zero.

Of the above statements

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

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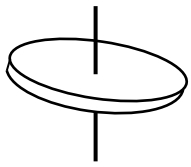
13) When a small piece of clay is slowly placed on the edge of a wheel rotating with constant angular velocity ω about a smooth vertical axis, it sticks to the wheel. which of the following statements is not true



(1) The angular velocity of the wheel decreases.
(2) The angular momentum of the system does not change.
(3) The moment of inertia of the system will increase.
(4) The rotational kinetic energy of the system will decrease.
(5) If the piece of clay slips and falls, the angular velocity of the plate will increase

14) Figure 1 shows the variation of electric potential with distance in an electric field region. Best represents the variation of electric field with distance is.

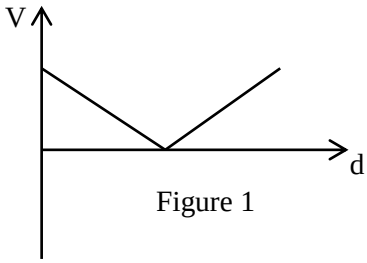
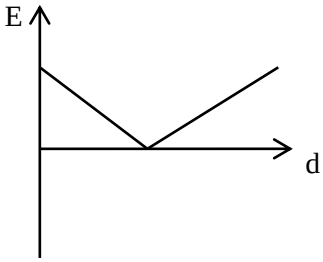
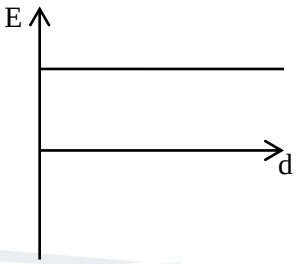
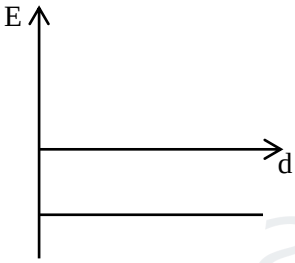


Figure 1

(1)


(2)


(3)


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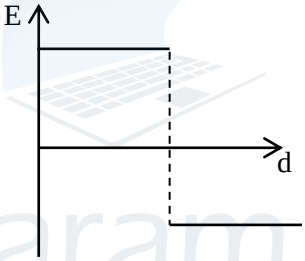
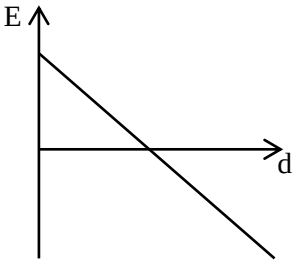
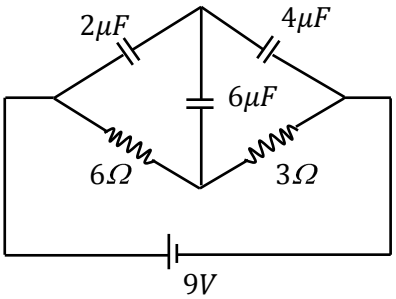


(5)


15) A metal container of volume $100\ cm^3$ is completely filled with liquid. What is the volume of liquid leaving when the temperature is increased by 100^oC ? (Volume expansivity of metal and liquid are $1.2 \times 10^{-4}C^{-1}$, $4.68 \times 10^{-4}C^{-1}$ respectively)

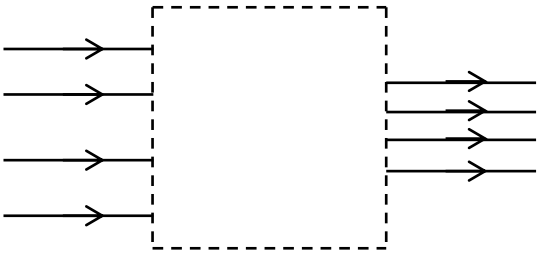
(1) $1.2\ cm^3$ (2) $12.0\ cm^3$ (3) $9.6\ cm^3$ (4) $10.8\ cm^3$ (5) $14.4\ cm^3$

16) The charge stored in the $6\mu F$ capacitor in the circuit shown is



(1) $3\ \mu C$
(2) $6\ \mu C$
(3) $12\ \mu C$
(4) $18\ \mu C$
(5) 0

17) In a system containing optical elements, parallel light rays entering and exiting as shown in the figure. Consider the three different combinations A, B, C given below.



A- A – Convex lens and concave lens.
B- Two equilateral triangle prisms.

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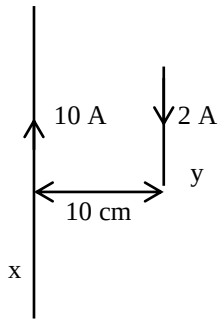
C- Two right equilateral triangular prisms.
A possible combination to this system

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

18) A radioactive element was observed to decay to $7/8$ of its initial amount in 12 days. What is the fraction that has not decayed after 20 days

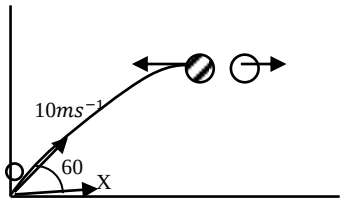
(1) 0 (2) $\frac{1}{128}$ (3) $\frac{1}{64}$ (4) $\frac{1}{32}$ (5) $\frac{1}{6}$

19) A current of $10\,A$ and $2\,A$ flows through two parallel wires x, y in opposite directions. Wire x is infinitely long, wire y is $2\,cm$ long. If the distance between them is $10\,cm$, the magnitude of the magnetic force acting on y $(\mu_0 = 4\pi \times 10^{-7})$



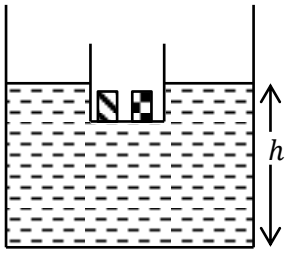
(1) $2 \times 10^{-5} N$ (2) $4 \times 10^{-5} N$ (3) $8 \times 10^{-7} N$
(4) $8 \times 10^{-6}\,N$ (5) $4 \times 10^{-6} N$

20) A 2 kg object is thrown at an angle of 60° with a velocity of $10\,ms^{-1}$. At the maximum point it explodes into two equal pieces, one piece returning to its initial state. What is the velocity change of another piece?



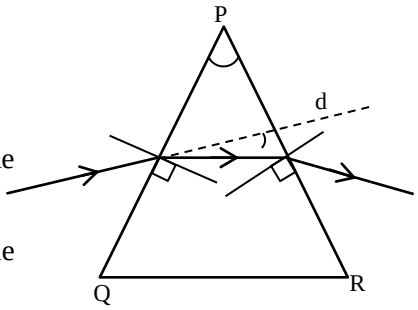
(1) $15\,ms^{-1}$ (2) $20\,ms^{-1}$ (3) $10\,ms^{-1}$
(4) $0\,ms^{-1}$ (5) $5\,ms^{-1}$

21) As seen in the figure, a small vessel consisting of a piece of wood and a stone float in the water within the vessel. The density of stone is greater than the density of water. The density of wood is less than the density of water. Which of the following statements about the height h of the water level inside the large vessel is true



1) When the stone is taken out and placed in water, h increases.
2) When a piece of wood is taken and placed in water, h decreases.
3) When a piece of wood is taken out and placed in water, h decreases
4) When a stone and a piece of wood are taken out and placed in water, h will decrease.
5) When stones and pieces of wood are taken out and tied together and placed in water, h does not change as they go down to the surface

22) The figure shows a ray of light passing through a prism. The prism angle of the prism is A and the angle of deviation is d. Consider the following statements.



A- when the incident angle i is increased from a given value the deflection angle d always increases after taking a minimum value.
B- The deflection angle d does not depend on A for the given value of i.
C- The angle of refraction r of minimum deviation depends only on A.

Of the above statements

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

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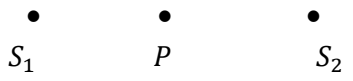
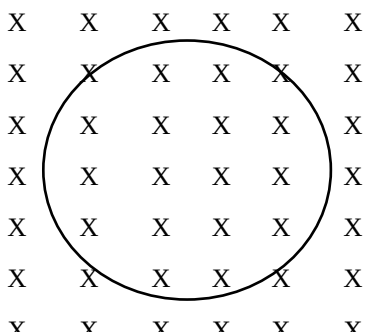
23) Both S_1 and S_2 are identical point sources. P is the midpoint of S_1 and S_2. The sound intensity level at point P is $50\,dB$. When the power of the sound emitted by both sources S_1 and S_2 are doubled and the distances of each source from p are doubled, the new sound intensity level at p is. ($\log_{10}2 = 0.3$)



(1) $25\,dB$ (2) $47\,dB$ (3) $48\,dB$ (4) $50\,dB$ (5) $53\,dB$

24) A wire loop of area $2\,m^2$ is placed perpendicular to a magnetic field increasing at a constant rate of $0.8\,T\,s^{-1}$ in the inward direction. What is the magnitude and direction of the current if the resistance of the wire is $20\,\Omega$

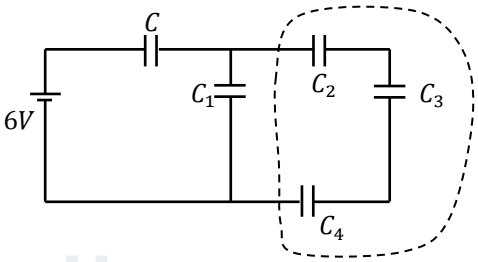


(1) $0.08\,mA$, clockwise (2) $0.08\,mA$, anticlockwise

(3) $80\,mA$, clockwise (4) $80\,mA$, anticlockwise

(5) $160\,mA$, anticlockwise

25) The capacitor shown is connected to a $6\,V$ source. If the potential difference across the capacitor C is $4\,V$, what is the resultant capacitance of the area shown in dotted line



(1) $2C$ (2) C_1 (3) $2C - C_1$

(4) $\frac{2CC_1}{2C+C_1}$ (5) $C + 2C_1$

26) Two spheres (one is solid, other one is hollow) made of different materials have equal mass and outer radius. Both are slowly released to the surface of a deep reservoir. These move downwards. Consider the following statements.

A- The terminal velocities of both the spheres are equal.

B- The terminal velocity of a solid sphere is greater than the terminal velocity of a hollow sphere.

C- Initially both accelerations are equal.

Of the above statements

(1) Only A is true.

(2) Only B is true.

(3) Only A and C are true.

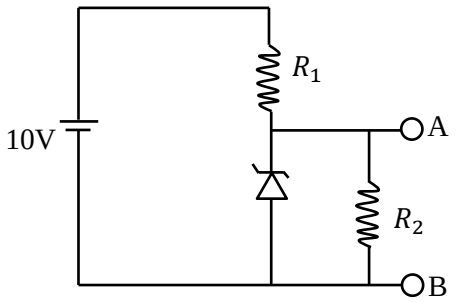
(4) Only B and C are true.

(5) All A, B and C are true.

27) A radio wave of wavelength λ is transmitted with power P from a radio broadcasting station. If Planck's constant is h and the speed of light in air is C, what is the emission rate of photons

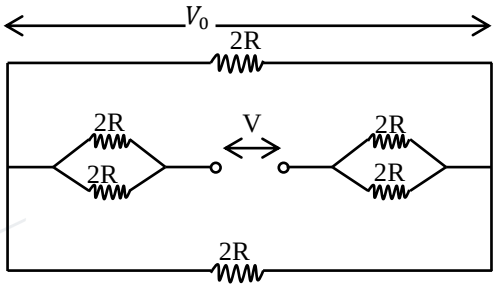
(1) $\frac{P\lambda}{hc}$ (2) $\frac{\lambda C}{Ph}$ (3) $\frac{hc}{P\lambda}$ (4) $\frac{Ph}{C\lambda}$ (5) $\frac{PC}{h\lambda}$

28) The breakdown voltage of the Zener diode shown in the figure is 5 V. A true statement about this circuit is



(1) when the load resistor R_2 decreases, the current through R_1 increases.
(2) when the resistor R_1 decreases, the current through R_2 decreases.
(3) As the load resistor R_2 decreases, the voltage across AB decreases.
(4) when the resistor R_1 decreases, the current through the circuit decreases.
(5) when the resistor R_1 decreases, the current through the Zener diode increases

29) What gives the potential differences $\frac{V}{V_0}$ in Figure

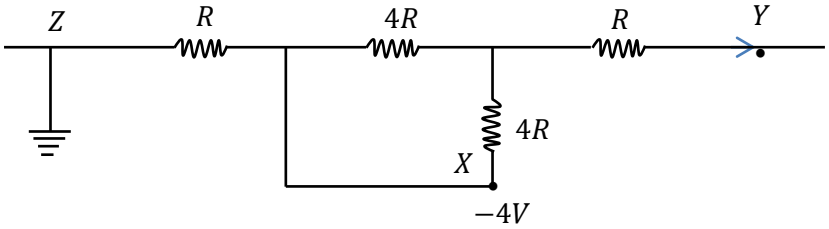


(1) 3
(2) $\frac{2}{3}$
(3) 1
(4) 2
(5) $\frac{1}{3}$

30) A thermometer with a mass of 0.05 kg and a specific heat capacity of 840 $Jkg^{-1}\,{}^{o}C^{-1}$ shows a reading of $15^{o}C$ in air. It shows a reading of $45^{o}C$ when it is immersed in 0.3 kg of water. If the heat loss to the environment is negligible and the specific heat capacity of water is 4200 $Jkg^{-1}\,{}^{o}C^{-1}$, what is the temperature of the water before the thermometer is immersed in the water

(1) $44°C$ (2) $45.5°C$ (3) $45°C$ (4) $46°C$ (5) $46.5°C$

31)



The voltage at point X in the circuit shown in figure is $-4\,V$. Point Z is connected to earth. What is the voltage at point Y?

(1) $+4\,V$ (2) $+6\,V$ (3) $(-8)\,V$ (4) $(-12)\,V$ (5) $(-16)\,V$

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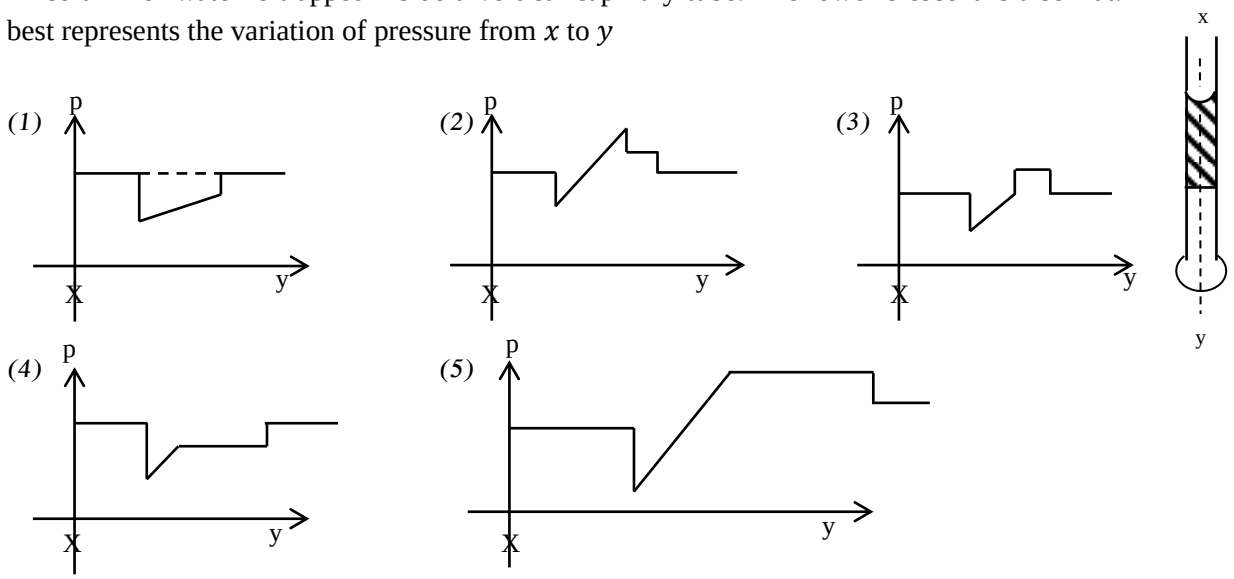
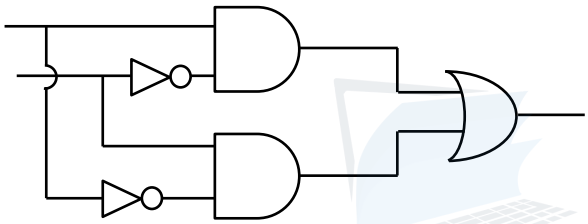
32) A column of water is trapped inside a vertical capillary tube. The lower crescent is also flat. best represents the variation of pressure from x to y



33) Which is equivalent to the combination of the logic gates given in the figure



(1) AND (2) OR (3) X – OR (4) X – NOR (5) NAND

34) A $8\ cm \times 4\ cm$ dimensional rectangular metal plate emits energy at a rate of $E\ J/s$ at $127\ ^oC$ If its dimension is halved and the temperature of the plate is increased to $327\ ^oC$, what is the rate at which the plate emits energy

(1) $\frac{27}{8}\ E$ (2) $\frac{81}{64}\ E$ (3) $\frac{10}{9}\ E$ (4) $\frac{9}{4}\ E$ (5) E

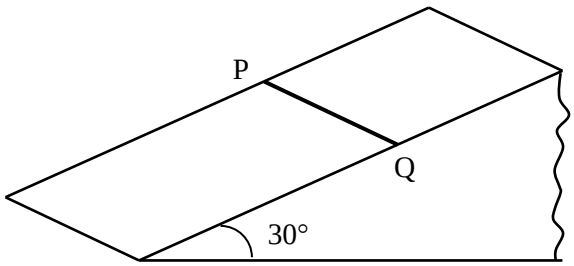
35) Both the wires X and Y are made of the same material. X has three times the diameter of Y and Y has twice the length of X. What is the ratio of the extension of Y to the extension of X if each of these wires does not reach its elastic limit when pulled by the same tensio

(1) $\frac{2}{9}$ (2) $\frac{9}{2}$ (3) $\frac{1}{18}$ (4) 18 (5) 6

36) A compound microscope consists of an objective of focal length 1.5 cm and an eyepiece of focal length 2.5 cm. The separation between these lenses is 25 cm. The final image is adjusted to infinity by a person with a minimum distance of distinct vision of 25cm. Angular magnification during this adjustment.

(1) 25 (2) 75 (3) 110 (4) 140 (5) 150

37) A current-carrying conductor PQ is placed in an inclined plane at an angle of inclination of 30° in a vertically downward magnetic field of 0.1 T. If the unit length is 0.3 kg, what is the direction and magnitude of the current through the conductor for equilibrium of the conductor

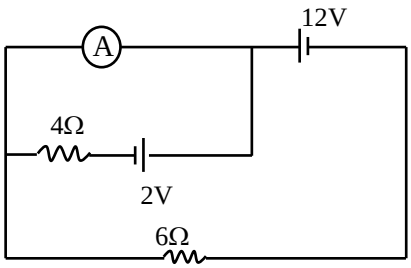


(1) PQ direction, $10\ A$ (2) PQ direction, $15\ A$ (3) PQ direction, $10\sqrt{3}A$
(4) QP direction, $15\sqrt{3}\ A$ (5) QP direction, $15\ A$

38) Car A of mass 500 kg is traveling at a speed of 100 $km\,h^{-1}$ and car B of mass 1000 kg is traveling at a speed of 50 $km\,h^{-1}$ on a given road. If the drivers hit the brakes hard enough to stop at that moment, both cars slide to rest. What are the ratios of the times $(t_A : t_B)$ and distances $(d_A : d_B)$ taken by cars A and B to come to rest? (Assume that both cars are traveling in a straight line, that the coefficient of friction between the tires and the road surface is equal for both, and that air resistance is negligible.)

(1) 1:1, 2:1 (2) 2:1, 2:1 (3) 1:1, 4:1 (4) 4: 1, 4:1 (5) 2 : 1, 4:1

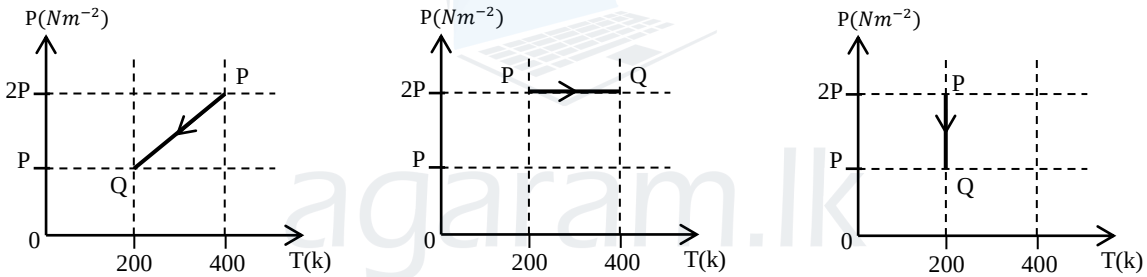
39)



An ideal ammeter is connected to the circuit shown above. What is current through the ammeter

(1) 1 A (2) 2 A (3) 2.5 A (4) 3 A (5) 4 A

40) Graphs of pressure P versus absolute temperature T of an ideal gas of given mass are shown below.



During the process from P to Q, consider the following statements in terms of graphs

A- At curve A, the density of the gas decreases.

B- At curve B, the density of the gas decreases.

At curve C, the density of the gas decreases

Of the above statements.

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

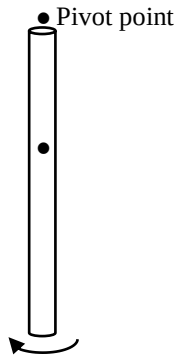
(4) Only A and B are true (5) All A, B and C are true

41) A glass tube of radius 0.02 cm is immersed vertically to a depth of 3 cm in water having a surface tension of $75 \times 10^{-3}\ N\,m^{-1}$. What is the excess pressure from the atmosphere required to blow a bubble from the lower end of the tube?

(1) 7300 Nm^{-2} (2) 1050 Nm^{-2} (3) 750 Nm^{-2}

(4) 300 Nm^{-2} (5) 450 Nm^{-2}

42) A point mass is attached to a point inside a massless narrow hollow tube of length L. The pipe is fixed at one end on a frictionless horizontal axis and oscillates with a small oscillation with a period of T. Thus, the tube oscillates with period $3\,T$ when the tube is fixed at the other end and allowed to oscillate. How far is the point mass from the center.

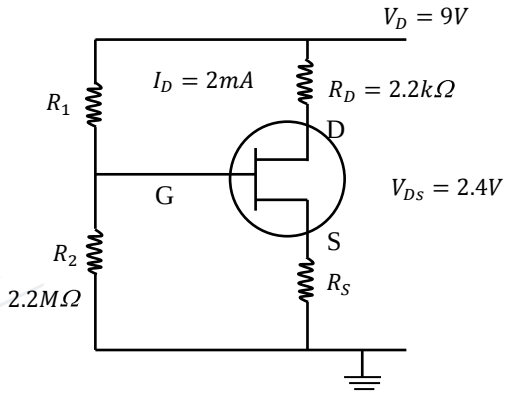


(1) $\frac{L}{10}$ (2) $\frac{9L}{10}$ (3) $\frac{2L}{5}$
(4) $\frac{L}{2}$ (5) $\frac{3L}{10}$

43) Volume ratio of two closed rooms separated by a door is $1:2$. Both rooms are at the same temperature. Relative humidity (R.H) of these rooms is 70 %. The R.H of the small room is maintained at 70 % and the R.H is reduced to 40 % to remove water vapor to keep the temperature from the other room unchanged. Now if the door is opened the common R.H is,

(1) 40 % (2) 50 % (3) 55 % (4) 60 % (5) 65 %

44) Consider the statements regarding the field effect transistor (FET) given in Figure.

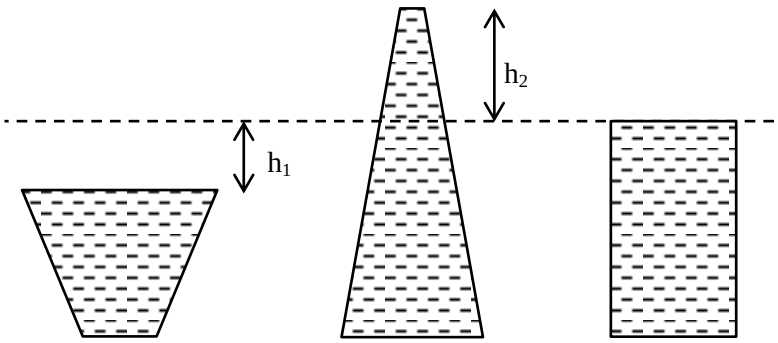


A- The drain terminal voltage is $4.6\,V$.
B- Magnitude of R_S is $1.1\,k\Omega$.
C- Magnitude of R_1 is $11\,M\Omega$ when $V_{GS} = (-0.7\,V)$.

Of the above statements

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

45) The vessels shown in the figure have equal surface area A and equal volume V. Each of these is completely filled with water of density ρ_W. Correctly give the magnitude and direction of the resultant force of water on the surface of the vessels.



	(a) a	(b) b	(c) c
(1)	$Ah_1\rho_w g \downarrow$	$Ah_2\rho_w g \uparrow$	0
(2)	$(V - Ah_1)\rho_w g \downarrow$	$(Ah_2 - V)\rho_w g \uparrow$	0
(3)	$(V + Ah_1)\rho_w g \downarrow$	$(V + Ah_1)\rho_w g \uparrow$	0
(4)	$Ah_2\rho_w g \uparrow$	$Ah_2\rho_w g \downarrow$	0
(5)	$(V - 2h_1)\rho_w g \uparrow$	$(Ah_2 - V)\rho_w g \downarrow$	0

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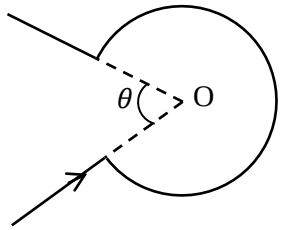
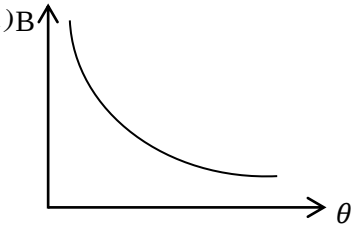
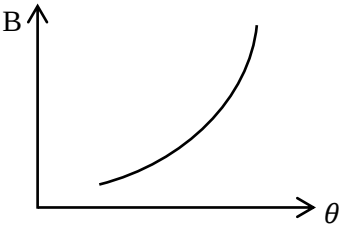
46) A 40-year-old man reads a book at a distance of 25 cm using a $2D$ power lens. At the age of 50 he was able to read letters at a distance of 40 cm from his eye using the same power lens. At the age of 50, what is the power of the lens required by him to read letters at a distance of 25 cm?

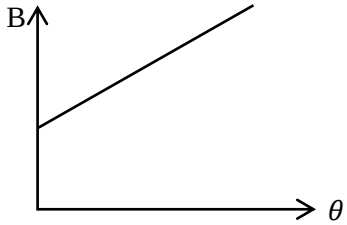
(1) $2.5D$ (2) $3D$ (3) $3.5D$ (4) $4D$ (5) $5D$

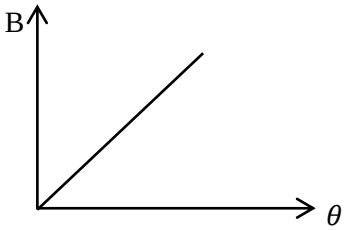
47) 

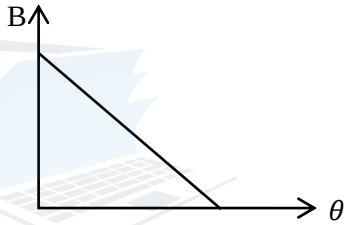
A current carrying conductor of radius R is bent in a circular curve. If θ is varied uniformly without changing R and I, which is the best represent to the change of magnetic field B at its center O.

(1) 

(2) 

(3) 

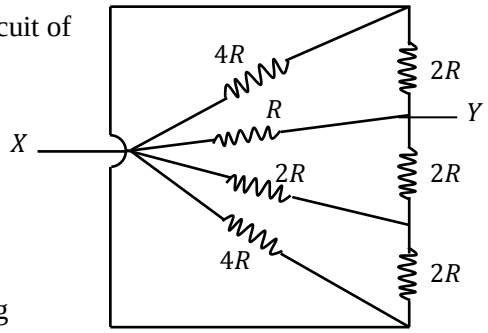
(4) 

(5) 

48) When the distance between the wooden bridges of a sonometer wire is 75 cm, two successive frequencies of this wire are found to be 360 Hz and 480 Hz. What is the velocity of the wave through this wire and fundamental frequency respectively.

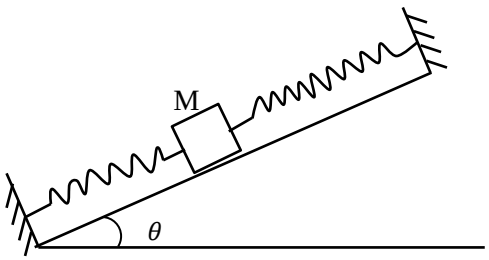
(1) $180\ ms^{-1},\ 60\ Hz$ (2) $90\ ms^{-1}, 120\ Hz$ (3) $90\ ms^{-1}, 60\ Hz$
(4) $60\ ms^{-1}, 120\ Hz$ (5) $180\ ms^{-1}, 120\ Hz$

49) What is the equivalent resistance between X and Y of the circuit of the given resistance combination?



(1) R (2) $\frac{R}{4}$
(3) $\frac{R}{3}$ (4) 2R
(5) $\frac{2R}{3}$

50) A mass M is attached by two springs each of spring constant k and is placed along an inclined plane of slope θ with the horizontal. The other ends of the spring are attached to fixed points. What is the period of oscillation of the mass when it is released with a small displacement



(1) $2\pi\sqrt{\frac{m}{k}}$ (2) $2\pi\sqrt{\frac{m}{2k}}$ (3) $2\pi\sqrt{\frac{m\sin\theta}{2k}}$

(4) $2\pi\sqrt{\frac{m}{2k\sin\theta}}$ (5) $2\pi\sqrt{\frac{2m}{k}}$

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ஆறாம் தவணைப் பரீட்சை - 2022
Conducted by Field Work Centre, Thondaimanaru.
6th Term Examination - 2022

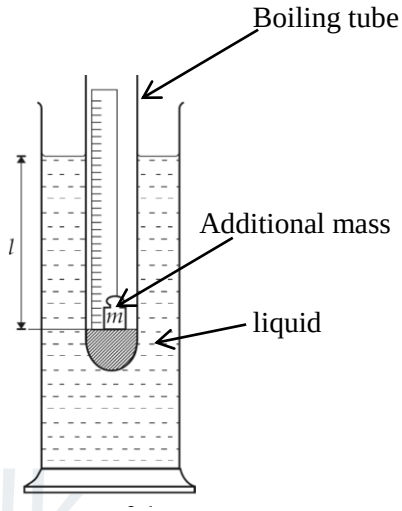
FWC

பௌதிகவியல் - II A Physics - II A	Three Hours 10 min Gr -13 (2022)	01	E	II

Part – II A
Structured Essay Questions

(g = 10 Nkg^{-1})

01) A thin-walled and weighed down boiling tube is used to measure the density of a liquid ρ in a laboratory as shown in the figure. Lead shots are placed at the bottom of the tube and then some wax is poured into the lead shots. The mass of lead shots and wax is M and the volume of the tube filled with wax is V. The rest of the outer cylindrical part of the cross-section of the tube is A. The length (above the wax level) of the cylindrical part immersed in the liquid when the tube floats in the liquid is l. The mass of the additional weights in the tube is m



a) When a prepared boiling tube is partially floating in liquids of densities $800\ kg\ m^{-3}, 1000\ kg\ m^{-3}$, if the upthrusts on the tube are U_1, U_2 respectively, compare U_1 and U_2. Give the reason.

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b) Consider the equilibrium of the boiling tube and obtain an expression in terms of M, m, V, A, l, ρ and g.

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c) Write the law used to derive the expression in part (b) above.

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d) Rearrange the expression obtained in part (b) to draw the linear graph, indicating the dependent and independent variables.

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e) Give the experimental steps to obtain the range of points at uniform intervals for drawing the graph..

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a) What other measurement is needed to determine the density of a liquid after determining the gradient from the drawn graph? What instrument should be used to measure this? Which part of the instrument will you use?

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f) Figure (1) shows the reading obtained when the object is not placed (zero error) and Figure(2) the reading obtained when the object is placed, by the instrument referred to in part (f).

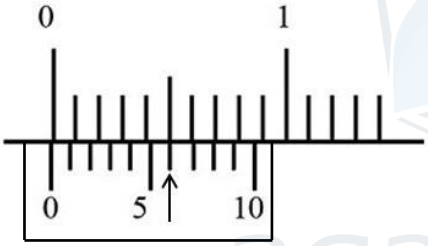

Figure *(1)*

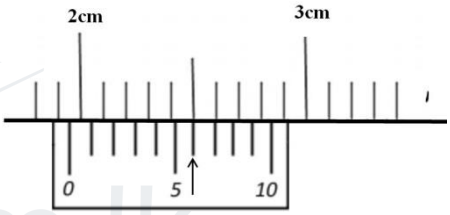

Figure *(2)*

i) What is the zero error of the instrument?

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ii) What is the reading of figure (2)?

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iii) What is the actual reading of the object?

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b) Determine the density of the liquid using the result obtained in part (g), (iii) above. The gradient of the graph is $1000\ cm\ kg^{-1}$.

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g) An experimental setup is placed on a lift moving upward with acceleration a.

i) What happens to the upthrust acting on the boiling tube?

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ii) What happens to the immersion the depth of the boiling tube?

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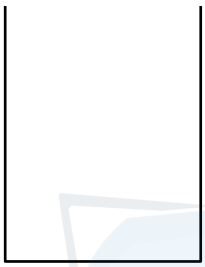
02) A student has to find the specific heat capacity of a liquid by using cooling method. For this, he plans to obtain the cooling curves for water and liquid. Metal calorimeter with insulated gap, starrier, thermometer, triple beam balance and stop watch are provided.



a)

i) Indicate the level of water or liquid you need to take in the calorimeter in the figure above.

ii) Why take the volume mentioned in part (a), (1).

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iii) Should take a volume of liquid equal to a volume of water or a volume of water equal to a volume of liquid (more accurate)? Why?

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iv) Is it necessary for the calorimeter to be metallic and thin wall?

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b) What experimental procedure should the student follow to ensure that a thermometer immersed in water or a liquid measure the surface temperature of a calorimeter?

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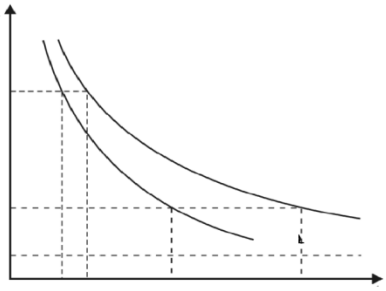
c) Two cooling curves obtained by the student are shown in figure.



i) Name the axis with unit.

ii) Name the curves.

d) Other details of the experiment are given below.

Heat capacity of calorimeter and starrier $= 112\ J\ K^{-1}$

Mass of the water $= 0.2\ kg$

Mass of the liquid $= 0.172\ kg$

Specific heat capacity of water $4 \times 10^3\ J\ kg^{-1}\ K^{-1}$

Calorimeter containing water and calorimeter containing liquid took 4 minutes and 2 minutes respectively to cool from $55°C$ to $45°C$.

i) What is the average rate of heat loss of a calorimeter containing water when it is cool from $55°C$ to $45°C$?

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ii) Determine the specific heat capacity of liquid.

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iii) In this experiment how the same heat loss condition is maintained for water and liquid?

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03) An experimental setup is designed by a student for determine the speed of sound in air and end correction of a given tube using a resonance tube and a tuning fork.

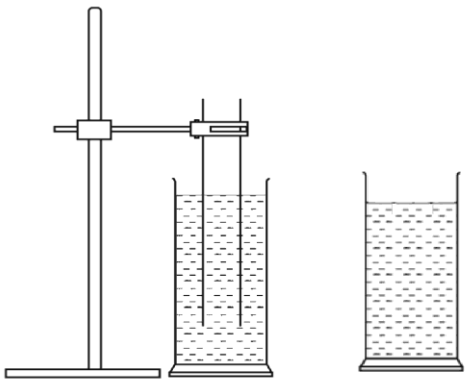

figure (1) figure (2)

a) What is the purpose of using a two-ended open tube immersed in a tube containing water in this experiment?

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b) If you were given two tuning forks of frequencies $512\ Hz$ and $256\ Hz$, which tuning fork would you choose.

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c) Draw in figure (1) the method of holding the tuning fork in order to obtain the resonance.

d) i) Draw the standing wave pattern for the fundamental resonance in figure (1) and indicate the tube length l_1 and end correction e.

ii) Write an expression in terms of l_1, e for the wavelength obtained in figure (1).

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iii) Give an expression for speed of sound in air in terms frequency of tuning fork f, l_1 and e from part (d), (ii) above.

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e) i) Draw the standing wave pattern for the second resonance situation in figure (2) and indicate the tube length l_2 and end correction e.

ii) Write an expression in terms of l_2, e for the wavelength obtained in figure (2).

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iii) Give an expression for speed of sound in air in terms frequency of tuning fork f, l_2 and e from part (e), (ii) above

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f) i) Using part (d), (iii) and part (e), (iii) derive the expression for the end correction e in terms of l_1 and l_2.

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ii) Determine the end correction e if $l_1 = 16\ cm$ and $l_2 = 49.8\ cm$.

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iii) Determine the speed of sound in air v.

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g) The student says that the speed of sound in air obtained in this experiment was slightly higher than its actual value. Justify this statement.

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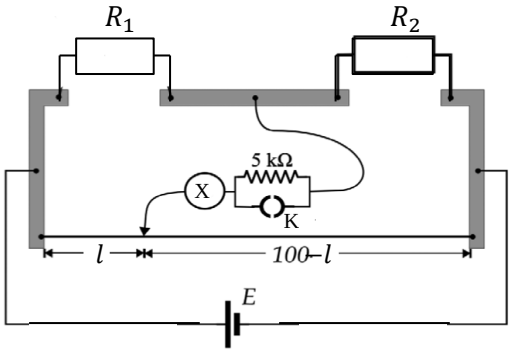
04) The circuit shown in figure can be used to find the unknown resistance. All resistors and resistor wires are connected using wide copper strips. The length of the resistance wire is 1 m.



a)

i) High resistances can be compared with a meter bridge, although low resistances are not suitable for comparison. Do you agree with this statement? Explain it.

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ii) What is the advantage of wide copper strips in the above experimental setup?

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iii) Identify the item X in the circuit.

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b)

i) Is it necessary for the cell to be constant emf in the circuit? Why?

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ii) What are the purposes for which a switch is used in a given meter bridge circuit?

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c) The unknown R_2 value can be found by drawing a graph. A resistance box should be used for this.

i) What will happen to the deflection of the galvanometer if a student makes contact with the meter bridge wire without taking any plug in the resistor box? What is the reason for your answer?

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ii) Can the equilibrium point be obtained if the resistance of the resistance box R_1 is infinite? Explain it?.

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iii) Even if the student removes the plugs in the resistance box, the deflection of the galvanometer shows the same direction when any point is contacted with the sliding key. Which plug should he remove?

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iv) How to choose resistance of resistance box R_1 during experiment? Give two reasons for this.

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d)

i) Derive an expression relating the balance length l , R_1 and R_2

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ii) Rearrange the variables obtained expression (e), (1) above, for inverse $1/R_1$ of independent variable R_1 is as the X axis on the graph.

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iii) How do you find R_2 from the graph?

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iv) A student says that there is not an equipment in the circuit that affects the accuracy of the test result. Do you agree with this statement? If you agree, what is that equipment? How to connect to the circuit?

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ஆறாம் தவணைப் பரீட்சை - 2022

Conducted by Field Work Centre, Thondaimanaru.
6th Term Examination - 2022

FWC

பௌதிகவியல் - II B Physics - II B	Gr -13 (2022)	01	E	II

Part – II B Essay

Answer four questions only

$g = 10\ N\ kg^{-1}$

5. a) Figure 1 shows a force F acting tangentially to a circular disc of radius r.

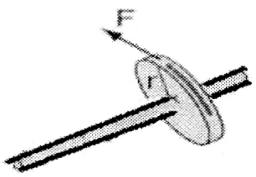

Figure 1

i) Define torque.

ii) Copy the given figure in your answer sheet and draw the direction of the torque.

iii) Write an expression for torque τ in terms of F, r.

b) A weightless handle $0.8\,m$ long is attached to the axis of a cylinder of radius $0.1\,m$ placed horizontally. A string is wrapped around the cylinder and the other end of the string is attached to the wall so that the string is horizontal. A rectangular force of 250 N is applied at the end of the handle as shown in figure 2.

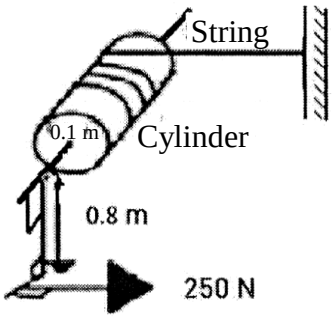

Figure 2

i) Find the tension on the string if the cylinder is at rest without rotating, assuming the axis is smooth.

ii) Find the extension of the string if the force constant of the string is $4 \times 10^4\ N\ m^{-1}$.

iii) State the law you used to find the extension.

iv) Find the energy stored in the string during extension.

c)

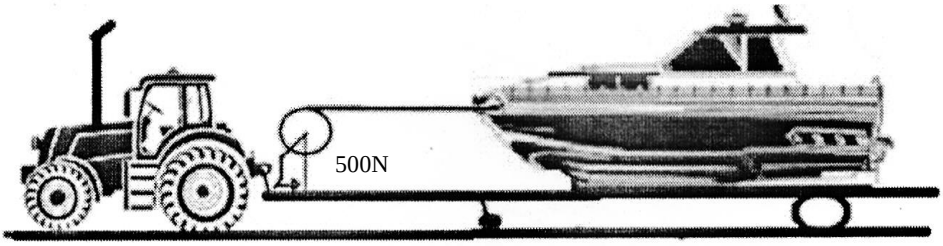

figure 3

Above mechanism is connected to a tractor is used to pull the boat by a trailer. String is wrapped around the cylinder and the other end of the string is attached to the boat. A man applies $500\ N$ force on the handle for pull the boat on the trailer as shown in the figure 3. Torque in the axis of the cylinder is $5\ N\ m$. Find the tension on the boat by the string if the trailer does not move.

d) The boat moves towards the trailer at a constant speed of $0.25\ m\ s^{-1}$ when the man applies the above force.

i) Find the frictional force acting on the boat, assuming the string is maintained horizontally.

ii) Find the rate of energy lost due to friction.

iii) Find the mass of the boat if the friction between boat and ground is 0.2.

e) The string breaks when the man removes the force on the handle.

i) Find the angular deceleration of the cylinder after the string breaks, if the moment of inertia of the cylinder about the axis is $2\ kg\ m^2$.

ii) Find the number of rotations during this time (assume $\pi = 3$)

f) A mechanism is a Massless 100% efficient pulley system used to fill a hole in the boat. Figure 04 shows that the boat is lifted up $0.5\ m$ vertically. The string attached to the boat is passed through smooth pulleys and wrapped on the cylinder. Neglect the friction of axis of cylinder and mass of the board supporting the boat

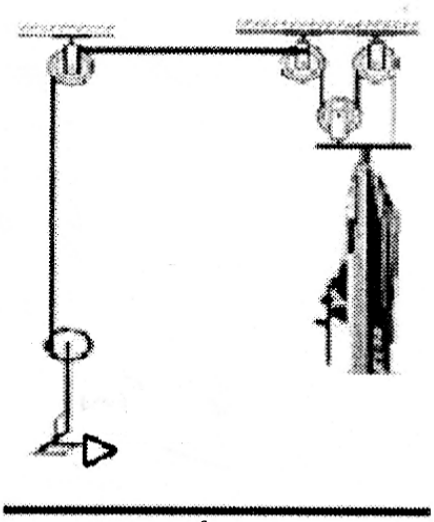

figure 4

i) Find the tension in the string wrapped around handle.

ii) Find the force F to be applied to the handle in this stage.

iii) Find the minimum work done by the man on the handle to cause this.

6. Fiber optical cable is used to transmit electromagnetic waves including LASER beam with low energy loss.

a. Energy levels of a 3 – level LASER is shown in figure 01. E_1, E_2 and E_3 are energies of the first, second and third energy levels. P, Q, R are the three processes. Figure 02 shows the system of LASER generation. (Planck's constant is h)

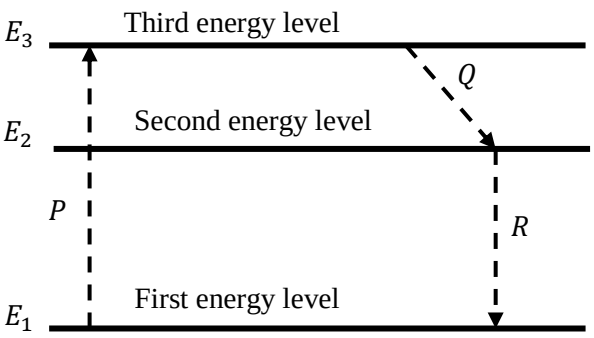

figure 01

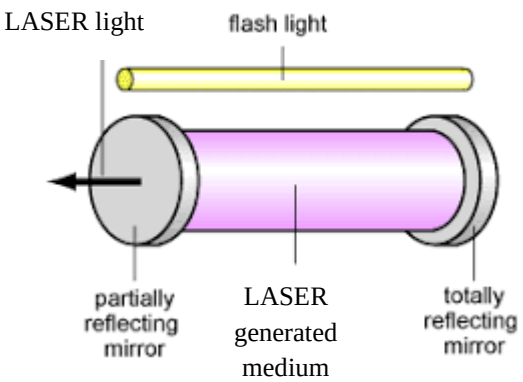

figure 02

i) LASER light is how to differ from ordinary light?
ii) Which is called "Metastable level"?
iii) State what are denoted by P, Q and R.
iv) What type of emission is a LASER produced by?
v) What is the purpose of using flash light in figure 02
vi) State the pumping photon energy and frequency in figure 01.
vii) State that the energy and frequency of the LASER generated in figure 01.
viii) A student says that the frequency of a monochromatic LASER beam is higher than a frequency of ordinary light which is same color. Do you agree with this statement? Explain it.

b) Figure 3 shows that a fiber cable with refractive index n is placed in air and a LASER beam incident at point X with incident angle θ.

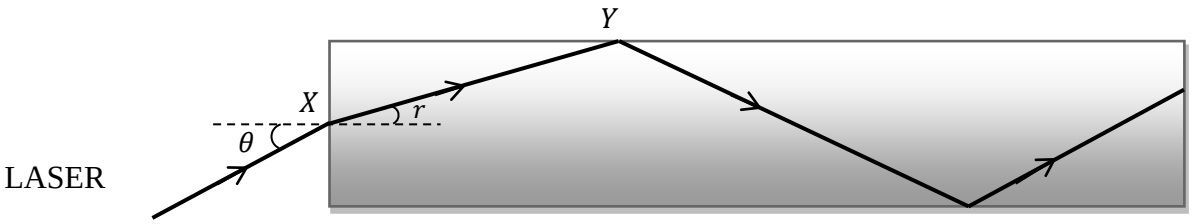

Figure 03

i) Find the minimum incident angle C at point Y in terms of n for the beam go through the cable by total internal reflection as shown in the figure 3.
ii) At the stage of question (b), (i) above,
1. Obtain a relationship between C and r. r is the angle of refraction at point X.
2. Obtain the incident angle θ at point X in term of n.

$(\sin(90 - C) = \cos C)$

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c) Now, the fiber cable specified in question (b) above is covered by a cladding as shown in the figure 04. Refractive index of the fiber cable is 1.4. Critical angle between the fiber cable and the cladding is 76^0

i) Find the refractive index of cladding material.

ii) Find the range of θ' for the beam go through the cable by the total internal reflection.

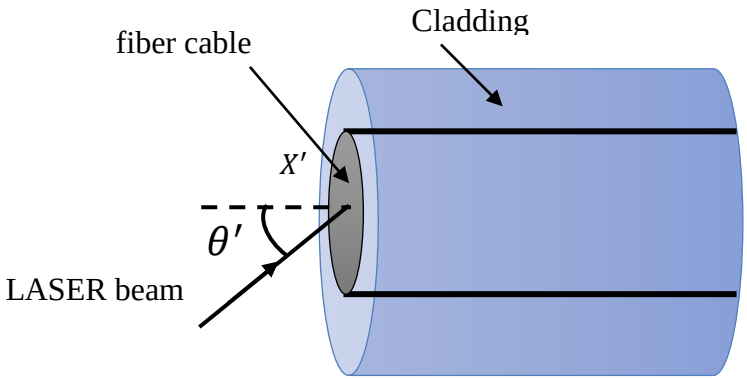


Figure 04

7. a) Define the surface.

A liquid has the density ρ, surface tension T is contained in a clean capillary tube at height h as shown in figure 1. The radius of upper meniscus is r and atmospheric pressure is P

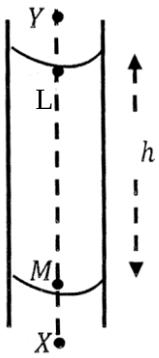


Figure 1

i) Write expressions for pressure at points L and M in terms of given quantities.

ii) Find the radius of the lower crescent in terms of given quantities.

iii) Draw the variation of pressure with distance from X to Y.

b) Two soap bubbles A and B are formed at the end of the narrow tube as shown in Fig. 02. Radius of bubbles A and B are r and R $(r < R)$ respectively. The surface tension of the soap liquid is T and the atmospheric pressure is P.

i) Write the pressure inside the soap bubbles P_1 and P_2 in terms of P, T, r, R when the tap is closed.

ii) State what happens to the bubbles up to equilibrium when the tap is opened and draw the shape of the bubbles at this point. (Assuming the bubbles are not broken.)

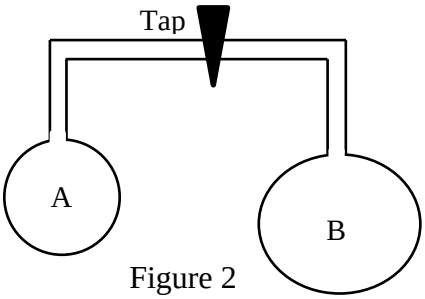


Figure 2

iii) Find the radius of the common surface in terms of r, R when the two bubbles are removed from the tube and touch each other with the tap closed as mentioned in question (b) above.

c) n number of mercury droplets of radius r at 30^0C combined together to form a single drop. The surface tension of mercury is T.

i) Give the expression for the initial surface energy of a drop of mercury in terms of r, T.

ii) Derive an expression for the radius of the mercury droplet formed in terms of r, n.

iii) Derive an expression for the release energy when mercury droplets combined together in terms of n, r and T.

iv) Find the temperature of the final drop if all the released energy is absorbed by the mercury. $T = 476\ mN\ m^{-1}, r = 0.2\ mm, n = 64$, density and specific heat capacity of mercury are $13600\ kg\ m^{-3}$ and $144\ J\ kg^{-1}K^{-1}$ respectively. (Neglect the variation of surface tension with temperature)

8. a) i) Define gravitational field intensity

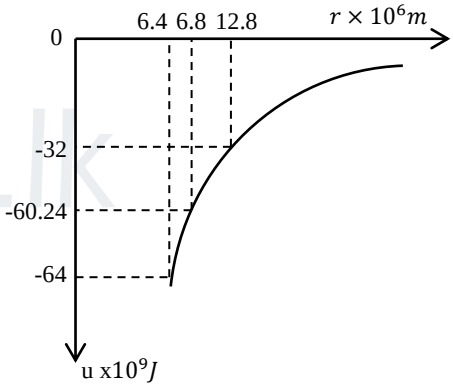
ii) State the law used to find the gravitational field intensity (g) on the earth surface and show that the magnitude of the $g = \frac{GM}{R^2}$ Where M, R and G are mass of the earth, radius of the earth and universal gravitational constant respectively

iii) Find the intensity of the gravitational field in terms of g at a point r from the center of the earth $(r > R)$.

iv) Plot the variation in the intensity of the gravitational field with distance r from the Earth's surface.

Write an expression for the gravitational potential energy of a mass m under the Earth's gravitational force and identify the factors.

b) The variation of gravitational potential energy (u) with distance (r) of a mass of $1000\ kg$ object in Earth's gravitational field is shown in Fig. Find the following using this diagram.



i) What is the minimum energy required for this object to escape from the Earth's surface?

ii) Find the escape velocity of the object at the Earth's surface.

iii) What is the minimum energy required to move this object $400\ km$ above the earth's surface?

iv) Find the gravitational acceleration at the Earth's surface by considering an expression for the gravitational potential energy of a mass in the Earth's gravitational field.

v) A satellite of mass m rotates around the earth of radius R_0. Find the angular velocity of the satellite ω in terms of $g -$ the gravitational acceleration at the earth's surface, $R -$ the radius of the earth, and R_0.

vi) A satellite is $1.7 \times 10^7\ m$ above the Earth's surface above a point on Earth's equator. Find the angular velocity of the satellite.

vii) If the mass of this satellite is $1000\ kg$ then what is the total energy of the satellite?

viii) What will happen to radius and speed of the satellite if its total energy of the satellite is lost?

9.A) a) Two ideal ammeters A_1, A_2 are connected to a battery and bulbs R, S as shown in figure 1.

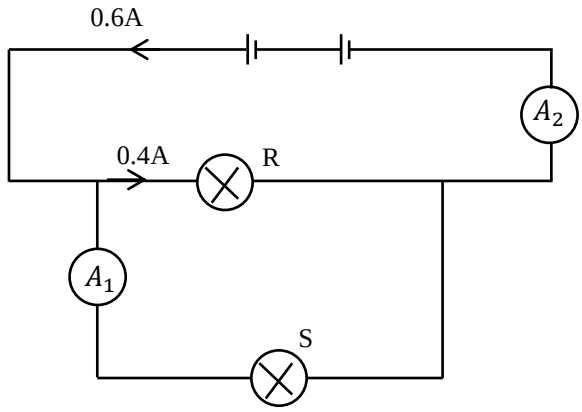


Figure 1

i) Find the readings of Ammeters A_1 and A_2.

ii) Find the resistance of bulb S if the resistance of bulb R is 12 $ohms$?

iii) If four identical cells of emf 1.5 V are arranged in a battery stack, find the internal resistance of the cell?

iv) When the cells have an emf of 6 V and an internal resistance of 3 $ohms$,

a) What is the minimum number of cells to be connected in parallel so that the reading of ammeter A_2 does not fall below 0.6 A?

b) When using the number of cells in part (iv), (a) above, what change must be made in the circuit to keep the A_2 reading constant? Specify an object that requires it.

b)

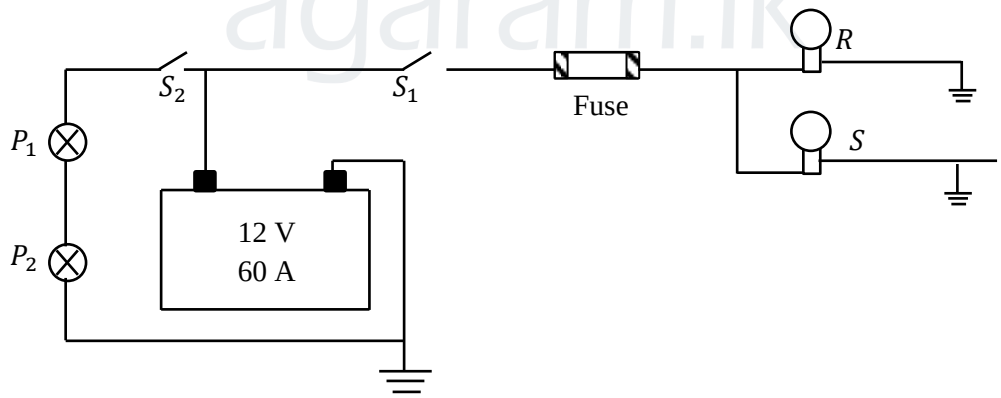


Figure 2 shows a circuit developed by a student to demonstrate the working of the lights of a toy car using a 12 V lead charging battery. P_1 and P_2 are signal lights and R and S are head lights. The identical headlights are rated at 12 V, 36 W each and the signal lamps are each rated at 12 V, 36 W.

i) Do the headlights light up when switch S_1 is closed in the position shown by the student?

ii) If the headlight is light up at the given rate, what is the current through a headlight?

iii) The student has used a fuse in the circuit. What is the reason for that?

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iv) If $0-5\ A$, $0-10\ A$ and $0-60\ A$ fuses are provided to the student, which fuse should the student use here. Give the reason.

v) What is the resistance of a headlight?

vi) If the cell can deliver a high current of $60\ A$, what can you say about the lighting of the lamps (light or not) when switch S_1 is closed? Give the reason?

vii) Do the signal lamps light up at their rated value when switch S_2 is closed in the pupil connecting circuit?

viii) What is the current through the signal lamp when switch S_2 is closed?

ix) Another student looking at the circuit suggests another method as a better way to connect the signal lights. Draw a circuit with signal lights only for the other student's proposed method.

B).

a) A lamp in a room should be operated by two switches, which are located on the front and back doors. The light will illuminate if switch A on the front door is ON (1) and switch B on the back door is OFF (0) or switch A on the front door is OFF (0) and switch B on the back door is ON (1). If switches A and B are both ON (1) or OFF (0), the lamp does not light.

i) Write a truth table where the maximum output state (light on state) is 1 and the minimum output state (light off state) is 0.

ii) Write a Boolean expression for output (F) in terms of A and B using the truth table written above.

iii) Name the logic gate used to operate this system and draw the circuit symbol of the gate.

iv) Draw a logic gate using only AND, OR and NOT gates for the gate drawn above.

b)

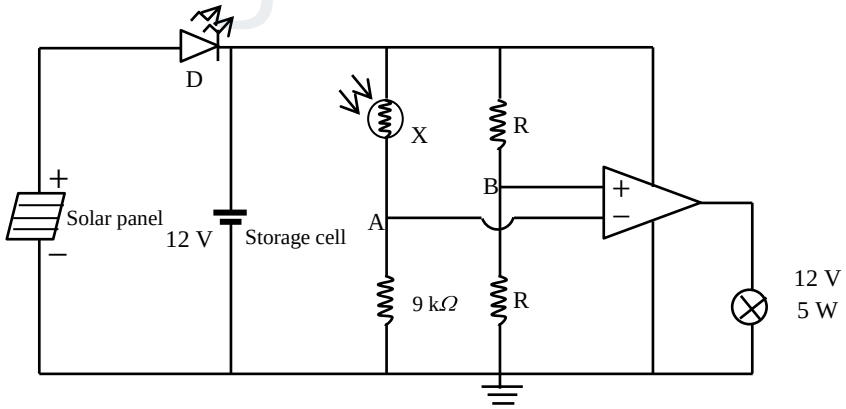

Figure shows a circuit diagram with symbols constructed by a student to design an automatic solar cell circuit.

i) Give an expression in terms of V_O, V_A and V_B for the open loop gain of the operational amplifier used above. (V_A and V_B are the voltages at points A and B respectively and V_O is the output voltage)

ii) LED (D) is connected to solar cell, give two reasons why it is connected.

iii) When light falls on device X the resistance of X is $1000\ \Omega$ and when device X is in dark the resistance of device is $91\ k\Omega$.

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a) When no light falls on the device X
   1) Find the voltage at point B.
   2) Find the voltage at point A
   3) Find the output voltage V_O
   4) What can you say about luminance of the LED?

b) When light falls on the device X
   1) Find the voltage at point B.
   2) Find the voltage at point A.
   3) Find the output voltage V_O..
   4) What can you say about luminance of LED

iv) State a problem when using small values for resistance R.

10) A)

a) i) State any three processes for converting unsaturated water vapor into saturated water vapor.

ii) What is known as dew point?

iii) State the definition of relative humidity in terms of dew point.

b)

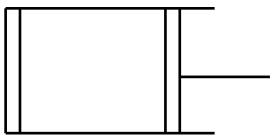

Figure 1

Temperature $(\theta)°C$	10	11	12	13	14	15	16	17	18	19	20
Saturated pressure $(Hg\ mm)$	5.5	6.3	7.2	8.2	9.3	10.5	12.8	14.0	15.1	16.2	17.5

Figure 2

Figure 1 shows a cylinder containing $1m^3$ of air at 20^0C and 60% humidity. Table 2 shows the variation of saturated pressure with temperature. Molar mass of water is $18\ g$, gas constant is $8.31\ Jmol^{-1}K^{-1}$ and density of mercury $13000\ kg\ m^{-3}$.

Answer the following questions

1) i) What is the dew point of the air inside the cylinder?

   ii) What is the Absolut humidity of the air inside the cylinder?

2) Find the new values of absolute humidity and relative humidity when the volume of air inside the cylinder is changed to $0.6\ m^3$ without changing the temperature. (When this volume changes, the air inside the cylinder is not saturated)

3) If the condensed water vapor is now removed and the air volume is returned to its initial state without changing the temperature, find the present absolute humidity and relative humidity.

c) Explain by molecular theory of gases how the pressure and temperature change when the volume of air in a well-insulated cylinder is reduced by pushing the piston inwards

d) If the cylinder is not insulated, explain how the temperature of the gas will change by thermodynamics in the following situations.

i. Slowly
ii. Very rapidly.

B) Nuclear fission is the splitting of an unstable heavy nucleus into two or more lighter nuclei in order to reach a stable state. Nuclear fission can be created by colliding heavy nuclei with lighter neutrons. The formation of a heavy nucleus by the fusion of two or more lighter atoms is called a nuclear fusion. During nuclear fission, nuclear fusion the difference in masses (mass deficit) of reactors and reactants is released as energy. The energy released ΔE is given by, $\Delta E = \Delta m\, C^2$, Where M is mass defect and C is speed of light.

(a) State one advantage of using neutrons rather than protons to formation of nuclear fission.

The reaction in which a neutron hits a ${}^{235}_{92}U$ nucleus causing nuclear fission is given below.

$${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{96}_{37}Rb + {}^{138}_{55}Cs + x\,{}^{1}_{0}n$$

${}^{235}_{92}U$ Mass of U Nucleus $= 235.04\,393\ u$

${}^{96}_{37}Rb$ Mass of Rb Nucleus $= 95.93431\ u$

${}^{138}_{55}Cs$ Mass of Cs Nucleus $= 137.91101\ u$

Mass of neutron $= 1.00866\ u$

u is the atomic mass unit equal to $1.660 \times 10^{-27}\ kg$.

Charge of electron $e = 1.6 \times 10^{-19}\ C$

i) What is the value of x?

ii) Give the magnitude of u in MeV.

(1 MeV = $1.6 \times 10^{-13} J$, $\frac{166 \times 9}{16} = 93.375$.)

iii) Find the release energy in MeV during nuclear fission of ${}^{235}_{92}U$.

iv) If a $200\ MW$ nuclear power plant uses ${}^{235}_{92}U$ as fuel, find the rate of nuclear fission.

v) Another possible reaction in which a neutron hits a uranium nucleus causing nuclear fission is given below.

$${}^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{139}_{54}Xe + {}^{95}_{38}Sr + 2\,{}^{1}_{0}n$$

The energy release during this reaction is known to be $210\ MW$.

Is this reaction more or less likely than the reaction in part A? Give reasons.

(b) A nuclear fusion reaction usually requires very high temperatures. Four hydrogen nuclei combine to form helium nuclei and positrons and neutrinos. Fusion reaction takes place in our Sun. The reaction is written as follows.

$4H \rightarrow He + 2e^{+} +$ Neutrinos + Energy

i) Why is high temperature required for fusion to occur?

ii) Find the release energy in J during the above nuclear fusion reaction. The mass of hydrogen nuclei and helium nuclei are $1.67 \times 10^{-27}\ kg\ and\ 6.65 \times 10^{-27}\ kg$ respectively

iii) Energy is known to be released at the surface of the Sun at a rate of $4.8 \times 10^{26}\ W$. What is the number of hydrogen atoms converted into helium in question (b), (ii) above?

iv) What can happen in nuclear fusion after all the hydrogen atoms in the sun are converted into helium?