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සියලු ම හිමිකම් ඇවිරිණි/முழுப் பதிப்புரிமையுடையது/All Rights Reserved]

නව නිර්දේශය/புதிய பாடத்திட்டம்/New Syllabus

NEW

Department of Examinations, Sri Lanka

අධ්‍යයන පොදු සහතික පත්‍ර (උසස් පෙළ) විභාගය, 2019 අගෝස්තු
கல்விப் பொதுத் தராதரப் பத்திர (உயர் தர)ப் பரீட்சை, 2019 ஓகஸ்ற்
General Certificate of Education (Adv. Level) Examination, August 2019

භෞතික විද්‍යාව I
பௌதிகவியல் I
Physics I

01 E I

09.08.2019 / 0830 - 1030

පැය දෙකයි
இரண்டு மணித்தியாலம்
Two hours

Instructions:

- *This question paper consists of* **50** *questions in* **12** *pages.*
- *Answer all the questions.*
- *Write your* ***Index Number*** *in the space provided in the answer sheet.*
- *Read the instructions given on the back of the answer sheet carefully.*
- *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 accordance with the instructions given on the back of the answer sheet.***

Use of calculators is not allowed.

(Consider that the acceleration due to gravity, $g = 10\,m\,s^{-2}$)

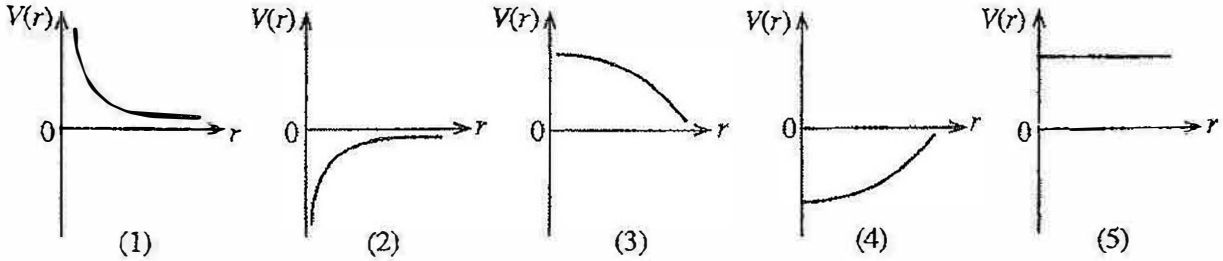
1. Which of the following is **not** a fundamental unit?
(1) m (2) J (3) cd (4) K (5) mol

2. The dimensions of the gravitational constant G are given by
(1) $L^2M^{-1}T^{-1}$ (2) L^2M^{-2} (3) $L^2M^{-2}T^{-1}$ (4) $L^3M^{-1}T^{-2}$ (5) $L^3M^{-2}T^{-2}$

3. When a bipolar junction transistor operates in saturation mode, a further increase in base current will
(1) turn on the transistor.
(2) turn off the transistor.
(3) increase the collector current.
(4) decrease the collector current.
(5) not change the collector current.

4. According to the evidences found in Particle Physics, matter is composed of
(1) 6 quarks.
(2) 6 leptons.
(3) 4 quarks and 4 leptons.
(4) 6 quarks and 4 leptons.
(5) 6 quarks and 6 leptons.

5. The variation of the gravitational potential $V(r)$ due to a point mass, with distance r is best represented by



6. Which of the following statements is **incorrect** regarding thermometry?
(1) There must be a measurable physical quantity that varies with temperature.
(2) Mercury-glass thermometers consist of thin-walled glass bulbs.
(3) By using a mercury-glass thermometer with a large mercury bulb, the range of measurements can be increased.
(4) Two different types of thermometers may give slightly different readings at the same temperature as all thermometric properties are not equally sensitive.
(5) Having a large contact angle between mercury and glass is an advantage for accurate readings in mercury-glass thermometer.

[*See page two*

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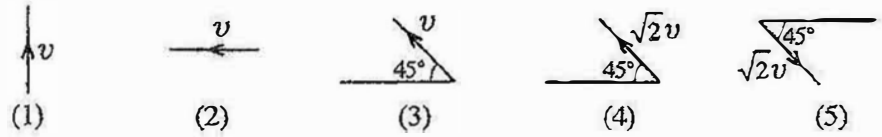
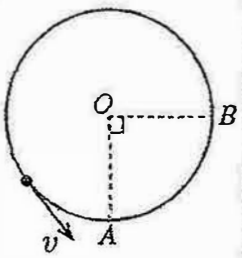
7. Consider the following statements regarding the physical properties of ultraviolet and ultrasound waves.
   (A) Energy of both waves depends on their frequencies.
   (B) Both waves have the ability of ionizing materials.
   (C) Both waves can be polarized.
   Which of the above statements is/are **incorrect**?
   (1) Only A (2) Only A and B (3) Only A and C
   (4) Only B and C (5) All A, B, and C

8. An object is moving in a circular path at a constant speed v as shown in the figure. The change in velocity of the object, when moving from A to B is



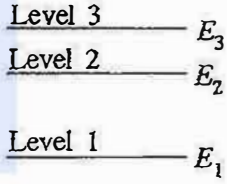
(1) (2) (3) (4) (5)



9. A weightlifter lifts a weight vertically up (positive direction) with his hands. The signs of the work done by
   (a) his hands on the weight,
   (b) gravity on the weight, and
   (c) the weight on his hands, respectively, are

	(a)	(b)	(c)
(1)	+	+	+
(2)	+	–	+
(3)	+	–	–
(4)	–	+	–
(5)	–	–	+

10. Consider the following statements regarding a three-level LASER system having energies E_1, E_2, and E_3 ($E_1 < E_2 < E_3$) as shown in the figure.



   (A) The LASER action occurs between energy levels 2 and 1.
   (B) The frequency of pumping radiation is $\frac{E_3 - E_2}{h}$.
   (C) Level 3 is known as the metastable energy level.
   Which of the above statements is/are correct?
   (1) Only A (2) Only B (3) Only C
   (4) Only A and C (5) Only B and C

11. Consider the following statements made regarding the velocity of sound in earth atmosphere.
   (A) It does not change with altitude at constant temperature.
   (B) It always increases with decreasing pressure.
   (C) It decreases with increasing altitude as a result of decreasing temperature.
   Which of the above statements is/are correct?
   (1) Only A (2) Only B (3) Only C
   (4) Only A and C (5) All A, B, and C

12. Which of the following statements regarding the X-ray production in common applications is **incorrect**?
   (1) Two circuits are used in the X-ray production system.
   (2) Anode could be damaged due to the bombardment of electrons.
   (3) Low voltage is sufficient to heat the cathode.
   (4) Energy of the X-rays emitted depends on the current through the filament.
   (5) X-ray tube must be evacuated to avoid the energy loss of electrons.

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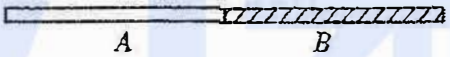
13. Consider the following statements regarding the dew point of air having water vapour in a closed container.
   (A) At dew point, unsaturated water vapour becomes saturated water vapour.
   (B) If the temperature is reduced below the dew point, some of the vapour will condense.
   (C) At dew point, if the volume of the container is reduced, the absolute humidity of the air will decrease.

   Which of the above statements is/are correct?
   (1) Only A (2) Only B (3) Only A and B
   (4) Only A and C (5) All A, B, and C

14. When the tension of a wire is slowly increased from T_1 to T_2 within the proportional limit, its length changes from l_1 to l_2. The energy stored in the wire during this process is
   (1) $(T_2+T_1)(l_2-l_1)$ (2) $\frac{1}{2}(T_2-T_1)(l_2+l_1)$
   (3) $\frac{1}{2}(T_2-T_1)(l_2-l_1)$ (4) $\frac{1}{2}(T_2+T_1)(l_2+l_1)$
   (5) $\frac{1}{2}(T_2+T_1)(l_2-l_1)$

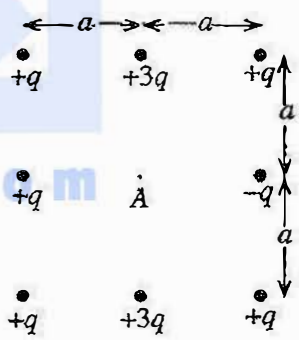
15. Hydrogen gas in a container is maintained at standard temperature (300 K) and pressure (1×10^5 N m^{-2}). If the root mean square speed of hydrogen molecules is 2 km s^{-1}, what is the density of hydrogen in the container?
   (1) 0·038 kg m^{-3} (2) 0·075 kg m^{-3} (3) 0·150 kg m^{-3} (4) 1·225 kg m^{-3} (5) 2·450 kg m^{-3}

16. A composite rod is formed by connecting two rods A and B as shown in the figure. Longitudinal wave velocities in rods A and B are 3210 m s^{-1} and 6420 m s^{-1}, respectively. A longitudinal pulse applied at the free end of the rod A propagates with a wavelength of 2 m. What is the wavelength of this wave when it propagates through rod B?



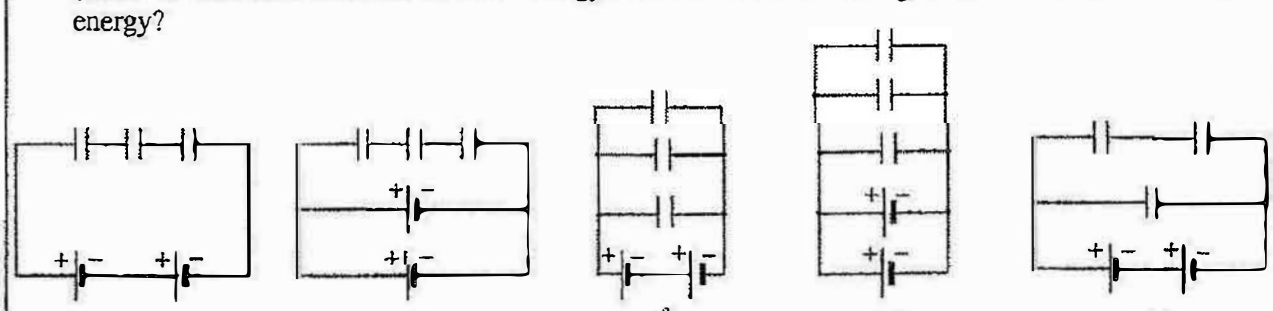
   (1) 1 m (2) 2 m (3) 3 m (4) 4 m (5) 5 m

17. The magnitude and the direction of the electric field at point A due to the point charge distribution shown in the figure are



   (1) $\frac{2q}{4\pi\varepsilon_0 a^2}\rightarrow$ (2) $\frac{q}{4\pi\varepsilon_0 a^2}\uparrow$
   (3) $\frac{2q}{4\pi\varepsilon_0 a^2}\leftarrow$ (4) $\frac{6q}{4\pi\varepsilon_0 a^2}\uparrow$
   (5) $\frac{6q}{4\pi\varepsilon_0 a^2}\downarrow$

18. Three capacitors with equal capacitance and two batteries with equal electromotive force (emf) are given to construct a circuit to store energy. Which of the following circuits stores the maximum energy?



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

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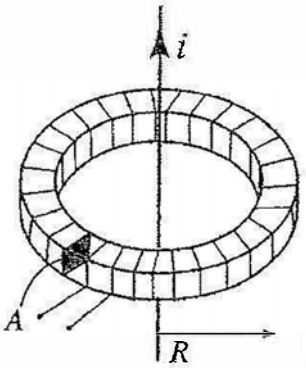
19. When a current of 6A is flowing through the primary coil of an ideal transformer having power of 60 W, output voltage is 12 V. Select the correct answer which gives the type of the transformer and the current ratio (Primary current : Secondary current).

(1) Step down and 6 : 5 (2) Step down and 5 : 6 (3) Step up and 1 : 2
(4) Step up and 5 : 6 (5) Step up and 6 : 5

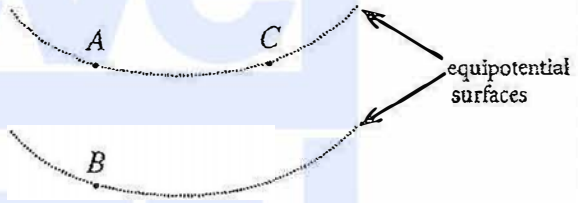
20. A coil is made by winding N number of turns around a plastic ring of mean radius R and cross sectional area A as shown in the figure. This coil is placed coaxially with a long straight wire carrying a current i. If the rate of change of current through the straight wire is $i_0 \cos \omega t$, which of the following expressions gives the electromotive force (emf) induced in the coil?



(1) $\mu_0 AN i_0 \cos \omega t$ (2) $\mu_0 AN^2 i_0 \sin \omega t$
(3) $\frac{\mu_0 AN}{\omega} i_0 \sin \omega t$ (4) $\frac{\mu_0 AN}{2\pi R} i_0 \cos \omega t$
(5) $\frac{\mu_0 AN}{4\pi^2 R^2} i_0 \cos \omega t$

21. Consider the points A, B, and C on two equipotential surfaces as shown in the figure. When a proton moves from A to B, the electric field does a work of $3{\cdot}2 \times 10^{-19}$ J on it. Charge of an electron is $-1{\cdot}6 \times 10^{-19}$ C. The electric potential differences V_{AB}, V_{BC}, and V_{CA}, respectively, are

(1) 2 V, –2 V, and 0 V
(2) 2 V, –2 V, and 2 V
(3) –2 V, 2 V, and 0 V
(4) 0·5 V, –0·5 V, and 0 V
(5) –0·5 V, 0·5 V, and 0 V



22. A celestial object is located at the mid point of the line joining the centres of the earth and the moon at a certain time. The mass of the moon is 0·0123 times the mass of the earth. Assume that the distance between the centres of the moon and the earth is 60 times the radius of the earth. The acceleration of the object due to the gravity of both the earth and the moon in terms of g is approximately,

(1) $1{\cdot}1 \times 10^{-6} g$ (2) $1{\cdot}1 \times 10^{-3} g$ (3) $3{\cdot}3 \times 10^{-2} g$ (4) $0{\cdot}5\, g$ (5) $1{\cdot}0\, g$

23. The gap of 2 cm between two horizontal plates of surface area 500 cm^2 is filled with an oil having the coefficient of viscosity $0{\cdot}2$ N s m^{-2}. A horizontal force of 5 N is applied to the upper plate while keeping the lower plate at rest. What is the velocity of the middle layer of the oil, if the velocities of the oil layers vary linearly across the gap between the plates?

(1) 2·5 m s^{-1} (2) 5 m s^{-1} (3) 10 m s^{-1} (4) 25 m s^{-1} (5) 50 m s^{-1}

24. A diode and a resistor are connected in such a way that only two terminals are available for external connections. When a voltage of 1 V is applied across the external terminals, the current through the circuit is 50 mA. When the applied voltage is reversed, the current doubles. What are the forward bias resistance of the diode, and the value of the resistor?

	Resistance (Ω)	
	Diode	Resistor
(1)	0	20
(2)	10	10
(3)	10	20
(4)	20	10
(5)	20	20

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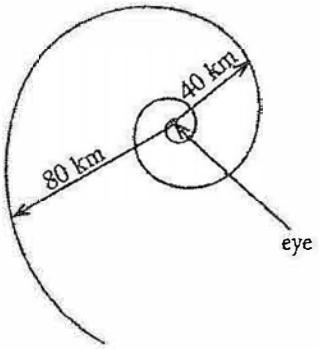
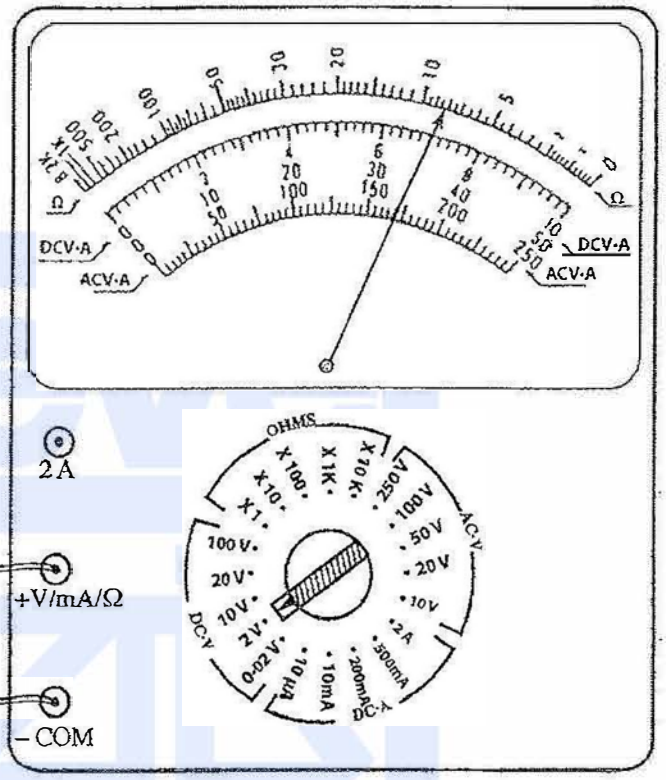
25. An air mass in a cyclone moves around its eye in a spiral path as shown in the figure. The velocity of the air mass at a radial distance of 80 km from the centre of the eye is 150 km h^{-1}. What could be the velocity of the same air mass at a radial distance of 40 km from the centre of the eye?



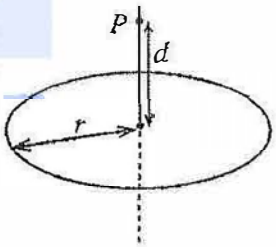
(1) 75 km h^{-1}
(2) 150 km h^{-1}
(3) $150\sqrt{2}$ km h^{-1}
(4) 300 km h^{-1}
(5) 450 km h^{-1}

26. An analogue multimeter connected to a circuit is shown in the figure. The reading of the multimeter is



(1) 8 Ω
(2) 7 mA
(3) 1·4 V
(4) 7 V
(5) 14 V

27. A large number of point charges are uniformly spread out over a non-conducting ring of radius r. If the total charge on the ring is Q, what is the electrostatic potential at point P on the axis of the ring, as shown in the figure?



(1) $\frac{Q}{4\pi\varepsilon_0 d}$
(2) $\frac{Q}{4\pi\varepsilon_0 r}$
(3) $\frac{Q}{8\pi^2\varepsilon_0 rd}$
(4) $\frac{Q}{4\pi\varepsilon_0\sqrt{r^2+d^2}}$
(5) $\frac{rQ}{4\pi\varepsilon_0 d\sqrt{r^2+d^2}}$

28. The human blood circulatory system consists of about one billion (10^9) capillary vessels each with an average diameter of 8 μm. If the blood is pumped from the heart at a rate of 5 litres per minute, what is the average speed of blood flowing through the capillary vessels in cm per minute?

(1) $\frac{1}{32\pi}$ (2) $\frac{25}{16\pi}$ (3) $\frac{25}{4\pi}$ (4) $\frac{125}{16\pi}$ (5) $\frac{125}{4\pi}$

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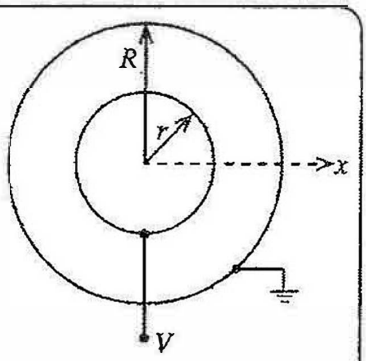
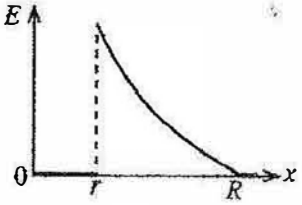
29. Two thin spherical metallic shells are placed concentrically as shown in the figure. Inner shell is kept at a potential V while the outer shell is grounded. The variation of the electric field E with distance x from the centre is best represented by





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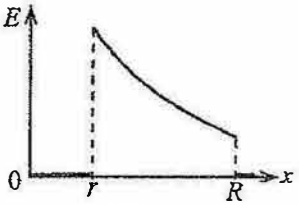
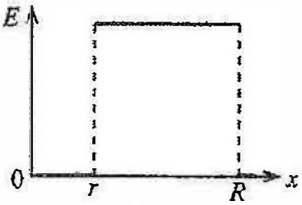
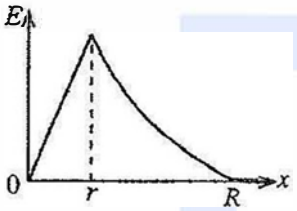


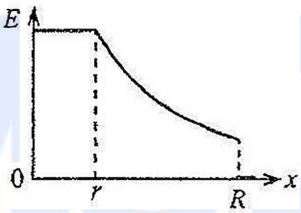
(2)



(3)



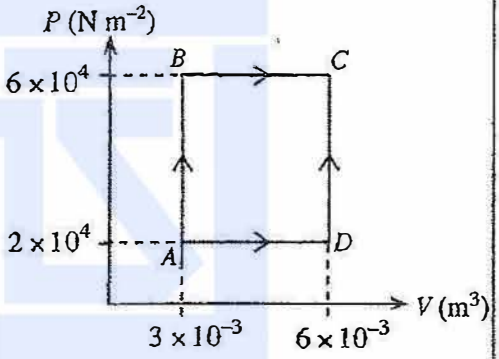
(4)



(5)

30. An ideal gas expands from state A to state C along two different paths, ABC and ADC, as shown in the P-V diagram. The heat absorbed by the gas during the processes AB and BC are 200 J and 700 J, respectively. What is the change in internal energy, when the gas expands along the path ADC?

(1) 380 J (2) 520 J
(3) 720 J (4) 880 J
(5) 1080 J



31. A ball is dropped freely to a floor from a height of 1 m. If its speed is reduced by 25% at each bounce, what would be the height the ball reaches after three bounces?

(1) $\frac{3}{4}$ m (2) $\left(\frac{3}{4}\right)^2$ m (3) $\left(\frac{3}{4}\right)^3$ m (4) $\left(\frac{3}{4}\right)^6$ m (5) $\left(\frac{3}{4}\right)^9$ m

32. Part of an orbiting satellite is coated with a metal that has a work function of 5 eV. The Planck constant is $4{\cdot}1 \times 10^{-15}$ eV s and the speed of light is 3×10^8 m s^{-1}. What could be the longest wavelength of incident sunlight that can eject an electron from the metal coating?

(1) 12·3 nm (2) 246 nm (3) 683 nm (4) 800 nm (5) 1230 nm

33. A standard photographic slide has a picture size of 30 mm × 40 mm. An enlarged image of the slide is projected onto a screen 4·0 m away from the projection lens of a 'single-lens slide projector'. If the size of the image on the screen is 1·2 m × 1·6 m, what should be the focal length of the projection lens?

(1) 4·9 cm (2) 9·8 cm (3) 10·2 cm (4) 49 cm (5) 98 cm

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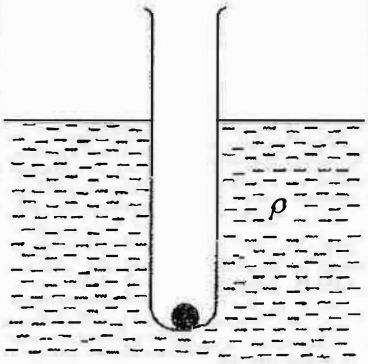
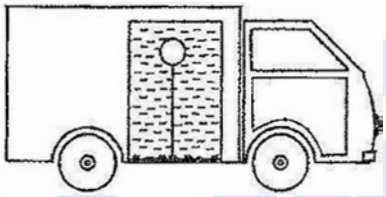
34. A test tube is made to float upright in a fluid by placing a metal ball at the bottom of the tube as shown in the figure. Total mass of the tube and the ball is m, density of the fluid is ρ, and the cross-sectional area of the tube is A. Effect of surface tension and the viscosity of the fluid can be neglected. If the tube is given a small vertical displacement, what is the period of oscillations of the subsequent motion of the tube?

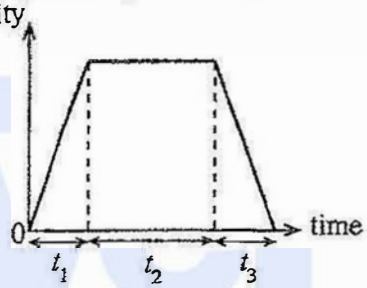


(1) $2\pi\sqrt{\frac{A\rho g}{m}}$ (2) $2\pi\sqrt{\frac{m}{A\rho g}}$ (3) $2\pi\sqrt{\frac{2m}{A\rho g}}$

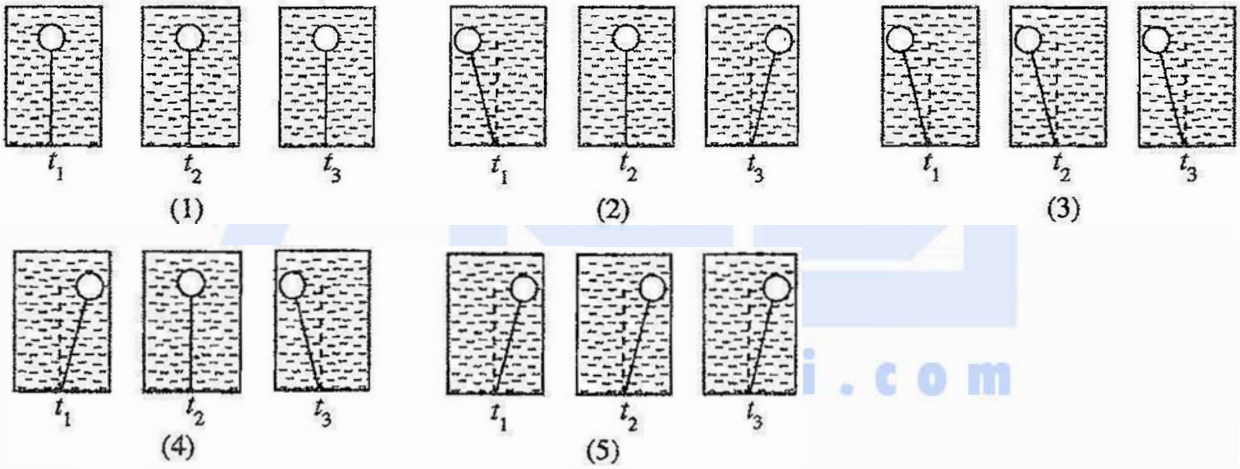
(4) $2\pi\sqrt{\frac{m}{2A\rho g}}$ (5) $2\pi\sqrt{\frac{mg}{A^2\rho}}$

35. Consider a massless balloon attached to one end of a light string. The other end of the string is attached to the bottom of a water tank which is fixed in a truck as shown in the figure. The balloon is completely submerged in water. The velocity-time graph shows the motion of the truck.

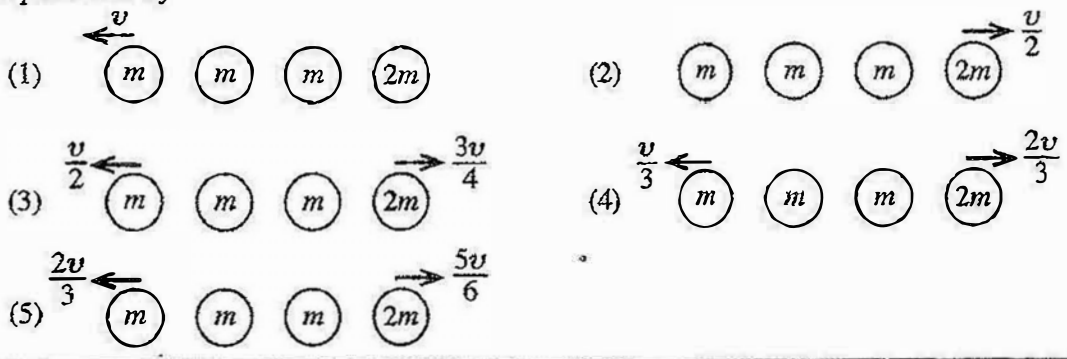




The positions of the balloon and the string inside the water tank during the time intervals t_1, t_2, and t_3 are best represented by



36. Consider four metal balls of same volume placed on a smooth horizontal surface. Mass of each of the first three balls is m while the mass of the fourth ball is $2m$. They are equally separated on a straight line. The first ball moves with speed v and collides with the second ball resulting a series of linear elastic collisions among the balls. After all the collisions, the motion of each ball is best represented by



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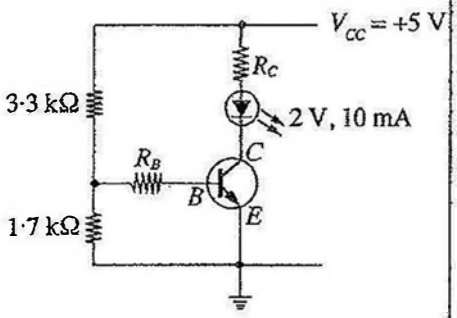
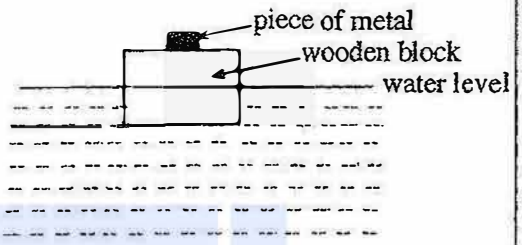
37. For optimum operation of a light emitting diode (LED), forward voltage and current should be 2V and 10mA, respectively. Transistor is having $V_{BE} = 0{\cdot}7\,V$, current gain $\beta = 100$, and $V_{CE(sat)} = 0{\cdot}1\,V$. For the circuit shown in the figure, what are the values of R_B and R_C for the optimum operation of the LED?



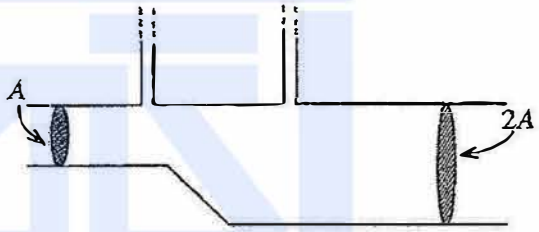
(1) $R_B = 100\,\Omega$ and $R_C = 1\,k\Omega$
(2) $R_B = 1\,k\Omega$ and $R_C = 1\,k\Omega$
(3) $R_B = 1\,k\Omega$ and $R_C = 290\,\Omega$
(4) $R_B = 10\,k\Omega$ and $R_C = 1\,k\Omega$
(5) $R_B = 10\,k\Omega$ and $R_C = 290\,\Omega$

38. A piece of metal is attached to the top of a rectangular wooden block that floats in water. As shown in the figure, 50% of the volume of the wooden block is submerged in water. **The metal piece and the wooden block have the same mass.** If the wooden block with the metal piece is flipped up side down, what could be the percentage of the volume of the wooden block submerged in water?



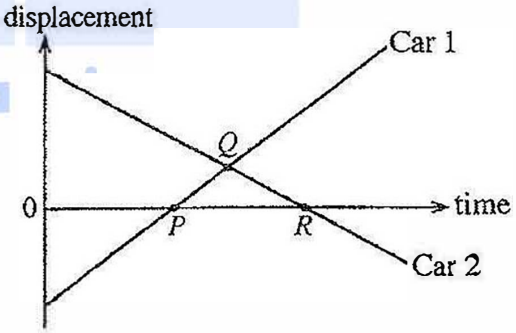
(1) Slightly smaller than 50% (2) Much smaller than 50% (3) 50%
(4) Slightly larger than 50% (5) Much larger than 50%

39. As shown in the figure, an incompressible liquid flows steadily through a horizontal pipe. Two narrow vertical tubes are fixed at two places on the horizontal pipe where the cross-sectional areas are A and $2A$. If the height difference of the liquid columns in the two vertical tubes is h, flow rate of the liquid through the pipe is



(1) $A\sqrt{2gh}$ (2) $A\sqrt{6gh}$
(3) $A\sqrt{\frac{3gh}{2}}$ (4) $2A\sqrt{\frac{gh}{3}}$
(5) $2A\sqrt{\frac{2gh}{3}}$

40. The figure shows the displacement-time graphs for the motion of two cars with respect to a lamp post aside the road. Consider the displacement to the right side of the lamp post as positive. A student has made the following statements regarding the motion of cars relevant to the points P, Q, and R marked on the graph.



(A) Relevant to P: Car 1 coming from left crosses Car 2.
(B) Relevant to Q: Both cars are moving towards the lamp post and cross each other.
(C) Relevant to R: Car 2 coming from right passes the lamp post.

Which of the above statements is/are correct?

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

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41. A whistling firecracker having a constant whistling frequency is fired vertically upward. It travels initially with an acceleration, then with a deceleration, and finally **blasts before coming to the rest.** An observer at ground directly below the firecracker listens to the whistling sound of the firecracker.

Consider the following statements regarding the frequency of the sound heard by the observer.

(A) During the acceleration, it is higher than the whistling frequency and is decreasing with time.

(B) During the deceleration, it is lower than the whistling frequency and is increasing with time.

(C) Just before the blast, it becomes equal to the whistling frequency.

Which of the above statements is/are correct?

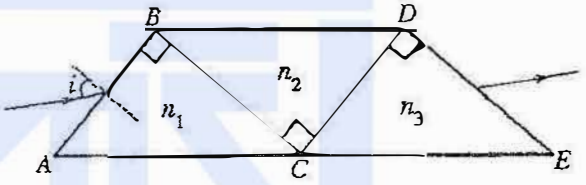
(1) Only A (2) Only B (3) Only C
(4) Only A and B (5) Only B and C

42. A metal bowl of mass 700 g contains 1 litre of water at 27 °C. When a steel ball of mass 300 g at 120 °C is dropped into the water in the bowl, the final temperature of water is measured to be 30 °C. Specific heat capacities of steel and water are 500 J kg^{-1} K^{-1} and 4200 J kg^{-1} K^{-1}, respectively. Out of the metals given in the table, what could be the metal that the bowl is made of?

Metal	Specific Heat Capacity (J kg^{-1} K^{-1})
Aluminium	900
Iron	450
Copper	385
Silver	230
Lead	128

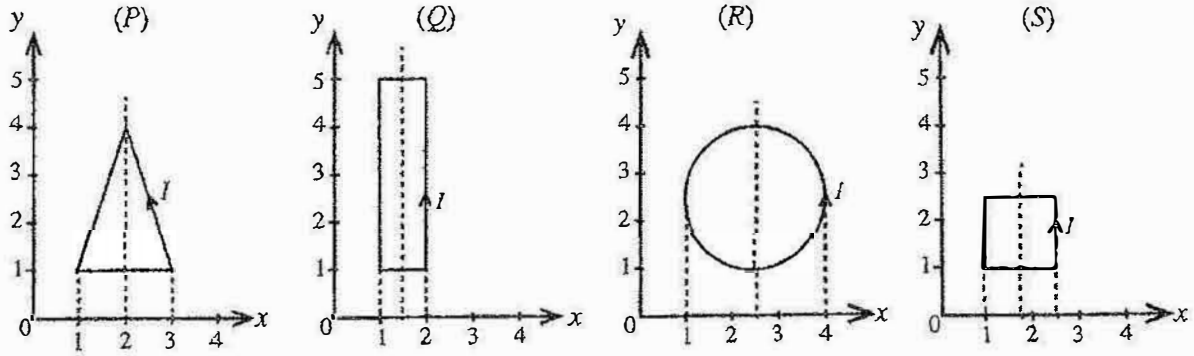
(1) Aluminium (2) Copper
(3) Lead (4) Iron
(5) Silver

43. Three right angled prisms of refractive indices n_1, n_2, and n_3 ($n_2 > n_1, n_3$) are arranged very close to each other on a table as shown in the figure. There are no gaps between the contact surfaces of the prisms. A ray entering through the face AB with an incident angle i, refracts at faces AB, BC, CD, and DE, and emerges from the face DE without deviation. The angles of refraction at the faces AB, BC, and CD are r_1, r_2, and r_3, respectively. Which of the following expressions is **incorrect**?



(1) $\sin i = n_1 \sin r_1$ (2) $n_2 \sin r_2 = n_1 \cos r_1$ (3) $\sin i = n_3 \cos r_3$
(4) $n_2 \cos r_2 = n_3 \sin r_3$ (5) $\cos i = n_3 \cos r_3$

44. Each of the single turn wire loops placed on xy plane as shown in figures, carries the same current I. A uniform magnetic field is applied along the positive direction of the x-axis. Assume that each wire loop can rotate freely about its symmetric axis perpendicular to the magnetic field. Which choice represents the order of loops that the initial torque acting on them are in descending order?



(1) P, Q, R, S (2) R, Q, P, S (3) Q, P, R, S (4) S, R, Q, P (5) R, Q, S, P

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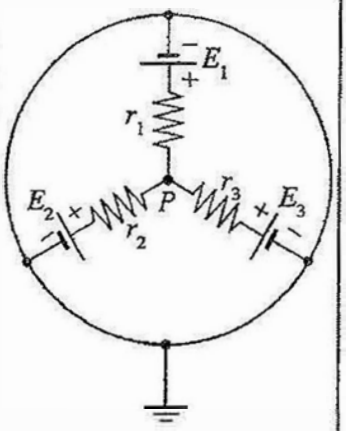
45. Three cells with electromotive force (emf) E_1, E_2, and E_3, and internal resistances r_1, r_2, and r_3, respectively, are connected as shown in the figure. Which of the following expressions gives the potential at point P of the circuit?



(1) $\dfrac{E_1 + E_2 + E_3}{3}$

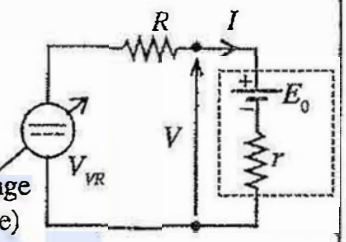
(2) $\dfrac{E_1E_2E_3}{E_1E_2 + E_2E_3 + E_3E_1}$

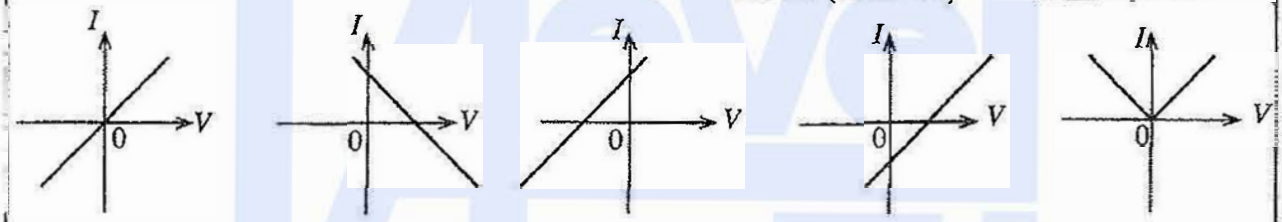
(3) $\dfrac{E_1r_1^2 + E_2r_2^2 + E_3r_3^2}{r_1r_2 + r_2r_3 + r_1r_3}$

(4) $\dfrac{E_1r_2r_3 + E_2r_1r_3 + E_3r_1r_2}{r_1r_2 + r_2r_3 + r_1r_3}$

(5) $\dfrac{E_1r_2r_3 + E_2r_1r_3 + E_3r_1r_2}{r_1r_2r_3}$

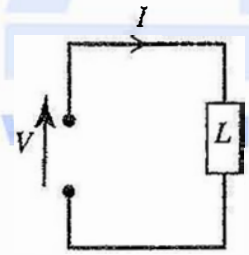
46. Consider a battery of electromotive force (emf) E_0 and internal resistance r. As shown in the figure, it is connected in series with a resistor R and a variable dc voltage source which can be reversible. When the voltage of the variable source V_{VR} is varied, the graph of I *vs* V is best represented by

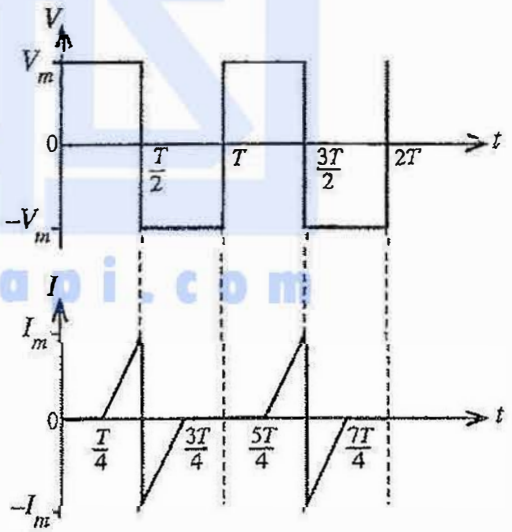




(1) (2) (3) (4) (5)

47. Consider the circuit shown in the figure. The graphs show the waveforms of the applied voltage and the current through the load L.





The average power dissipation of the load is

(1) 0 (2) $\dfrac{V_mI_m}{4}$ (3) $\dfrac{V_m}{\sqrt{2}}\dfrac{I_m}{\sqrt{2}}$ (4) V_mI_m (5) $2V_mI_m$

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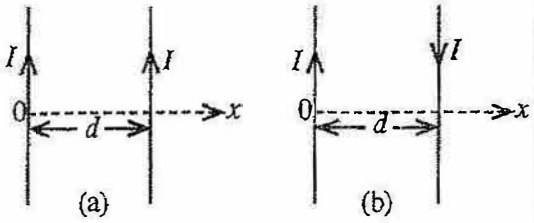
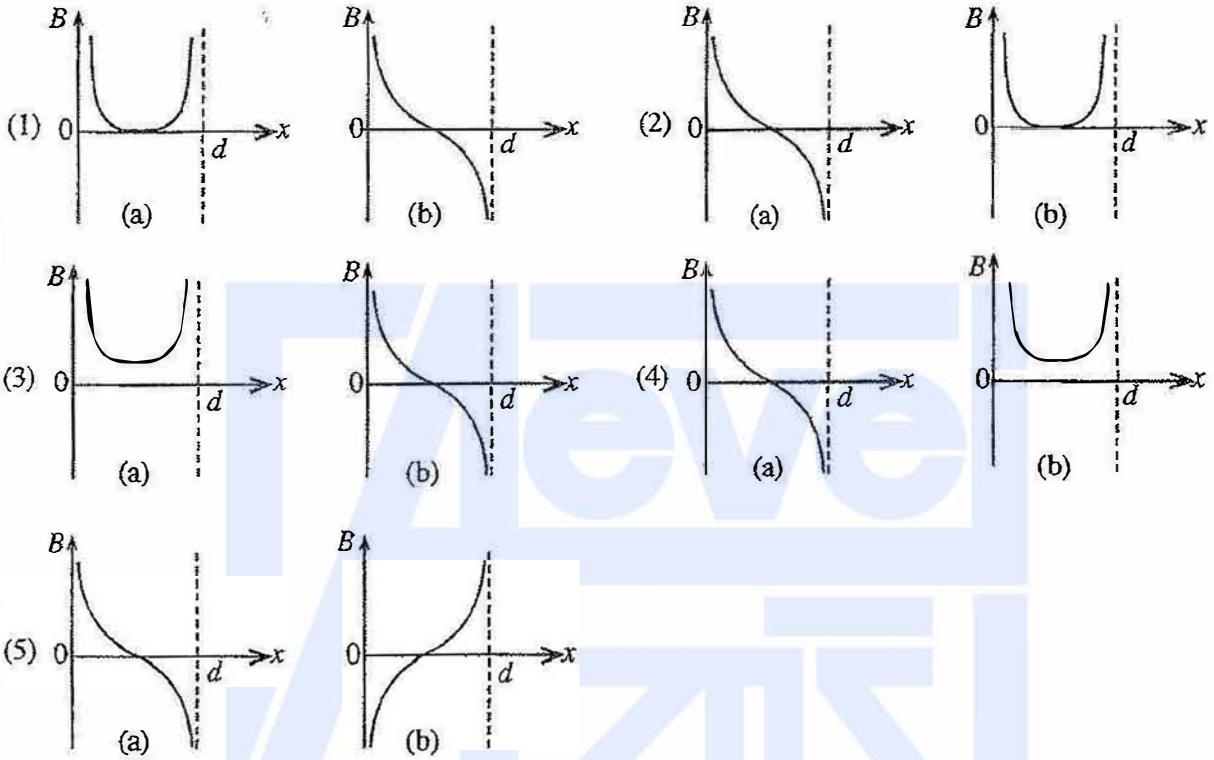
48. Two long, straight, and parallel wires are placed in free space. Consider the following two cases as shown in the figures.

(a) Wires carry the same current I in the same direction.

(b) Wires carry the same current I in opposite directions.



Consider the direction of the magnetic flux density into the paper as positive. Which pair of graphs best represents, the variation of the magnetic flux density B between the two wires?



49. What is the current through the battery of the circuit shown in the figure?

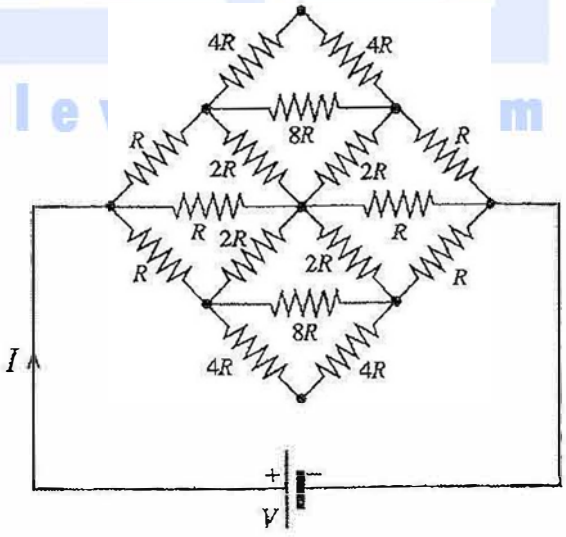
(1) $\frac{V}{8R}$

(2) $\frac{V}{4R}$

(3) $\frac{V}{2R}$

(4) $\frac{V}{R}$

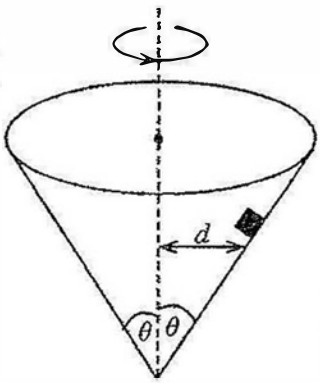
(5) $\frac{2V}{R}$



[See page twelve

උසස් පෙළ විද්‍යා/ගණිත/කලා/වාණිජ හා තාක්ෂණ විෂය ධාරාවන්ට අදාළ සියලුම ප්‍රශ්න පත්‍ර/සටහන් හා තවත් බොහෝ දෑ ලබා ගැනීමට පිවිසෙන්න www.alevelapi.com වෙත.

50. A small object is placed inside a right circular cone with axis vertical and vertex down as shown in the figure. The coefficient of static friction between the inner surface of the cone and the object is μ. What is the maximum angular velocity of rotation of the cone about its axis for the object to be on the inner surface of the cone without slipping at a distance d away from the axis?



(1) $\sqrt{\frac{g(\cos\theta - \mu\sin\theta)}{d(\sin\theta + \mu\cos\theta)}}$

(2) $\sqrt{\frac{g(\sin\theta - \mu\cos\theta)}{d(\cos\theta + \mu\sin\theta)}}$

(3) $\sqrt{\frac{g(\cos\theta + \mu\sin\theta)}{d(\sin\theta - \mu\cos\theta)}}$

(4) $\sqrt{\frac{g(\sin\theta + \mu\cos\theta)}{d(\cos\theta - \mu\sin\theta)}}$

(5) $\sqrt{\frac{g}{d\tan\theta}}$

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උසස් පෙළ විද්‍යා/ගණිත/කලා/වාණිජ හා තාක්ෂණ විෂය ධාරාවන්ට අදාළ සියලුම ප්‍රශ්න පත්‍ර/සටහන් හා තවත් බොහෝ දෑ ලබා ගැනීමට පිවිසෙන්න www.alevelapi.com වෙත.