Topic : Gravitation and current electricity

1. A body weighs $49\ \mathrm{N}$ on a spring balance at the North Pole. What will be its weight recorded on the same weighing machine, if it is shifted to the equator?

   [Use, $g = \dfrac{GM}{R^2} = 9.8\ \mathrm{m/s^2}$ and radius of earth, $R = 6400\ \mathrm{km}$]

   A. $49\ \mathrm{N}$

   B. $49.83\ \mathrm{N}$

   C. $49.17\ \mathrm{N}$

   D. $48.83\ \mathrm{N}$

2. Four identical particles of equal masses $1\ \mathrm{kg}$ are made to move along the circumference of a circle of radius $1\ \mathrm{m}$ under the action of their own mutual gravitational attraction. The speed of each particle will be :
   [Assume particles are at the vertices of a square, also G is Gravitational Constant]

   A. $\dfrac{\sqrt{(1+2\sqrt{2})G}}{2}$

   B. $\sqrt{G(1+2\sqrt{2})}$

   C. $\sqrt{\dfrac{G}{2}(2\sqrt{2}-1)}$

   D. $\sqrt{\dfrac{G}{2}(1+2\sqrt{2})}$

3. Consider two satellites, S_1 and S_2 with periods of revolution, $1\ \text{hr}$ and $8\ \text{hr}$ respectively revolving around a planet in circular orbits. The ratio of angular velocity of satellite S_1 to the angular velocity of satellite S_2 is

A. $8:1$

B. $1:8$

C. $2:1$

D. $1:2$

4. Two stars of masses m and $2m$ at a distance d rotate about their common centre of mass in free space. The period of revolution is

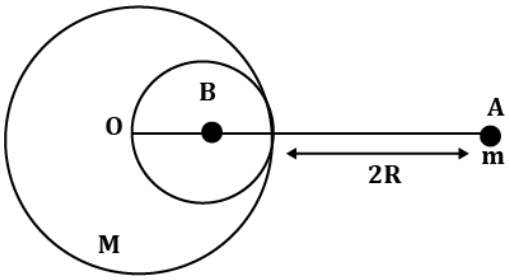
A. $2\pi\sqrt{\frac{d^3}{3Gm}}$

B. $\frac{1}{2\pi}\sqrt{\frac{3Gm}{d^3}}$

C. $\frac{1}{2\pi}\sqrt{\frac{d^3}{3Gm}}$

D. $2\pi\sqrt{\frac{3Gm}{d^3}}$

5. A solid sphere of radius R gravitationally attracts a particle placed at $3R$ from its centre with a force F_1. Now, a spherical cavity of radius $R/2$ is made in the sphere as shown in the figure and the force becomes F_2. The value of $F_1 : F_2$ is -



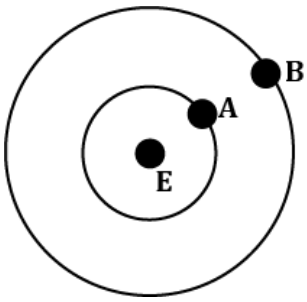
A. $41:50$

B. $36:25$

C. $50:41$

D. $25:36$

6. Two satellites A and B of masses $200\ \text{kg}$ and $400\ \text{kg}$ are revolving round the earth at height of $600\ \text{km}$ and $1600\ \text{km}$ respectively. If T_A and T_B are the time periods of A and B respectively then the value of $T_B - T_A$ is:
[Given : Radius of earth$= 6400\ \text{km}$, Mass of earth$= 6 \times 10^{24}\ \text{kg}$]



A. $4.24 \times 10^2\ \text{s}$

B. $3.33 \times 10^2\ \text{s}$

C. $1.33 \times 10^3\ \text{s}$

D. $4.24 \times 10^3\ \text{s}$

7. Given below are two statements : one is labelled as Assertion A and the other is labelled as Reason R.

Assertion A : The escape velocities of planets A and B are the same, but A and B are of unequal masses.

Reason R : The product of their mass and radius must be the same
$i.e.\ M_A R_A = M_B R_B$.

In the light of the above statements, choose the most appropriate answer from the options given below.

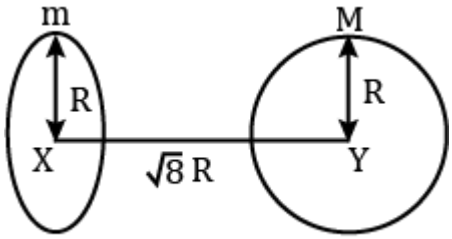
A. Both A and R are correct, but R is **NOT** the correct explanation of A.

B. A is correct, but R is not correct.

C. Both A and R are correct, and R is the correct explanation of A.

D. A is not correct, but R is correct.

8. Find the gravitational force of attraction between the ring and sphere as shown in the diagram, where the plane of the ring is perpendicular to the line joining the centres. If $\sqrt{8}R$ is the distance between the centres of a ring (of mass m) and a sphere (of mass M) where both have equal radius R.



A. $\frac{\sqrt{8}\,GmM}{9 \quad R}$

B. $\frac{\sqrt{8}\,GmM}{27 \quad R^2}$

C. $\sqrt{2}\,\frac{GmM}{R^2}$

D. $\frac{1 \quad GmM}{3\sqrt{8} \quad R^2}$

9. Assume that a tunnel is dug along a chord of the earth, at a perpendicular distance $\left(\frac{R}{2}\right)$ from the earth's centre, where R is the radius of the Earth. The wall of the tunnel is frictionless. If a particle is released in this tunnel, it will execute a simple harmonic motion with a time period:

A. $2\pi\sqrt{\frac{R}{g}}$

B. $\frac{1}{2\pi}\sqrt{\frac{g}{R}}$

C. $\frac{2\pi R}{g}$

D. $\frac{g}{2\pi R}$

10. A planet revolving in an elliptical orbit has :

A). a constant velocity of revolution.

B). the least velocity when it is nearest to the sun.

C). its areal velocity directly proportional to its velocity.

D). its areal velocity inversely proportional to its velocity.

E). a trajectory such that the areal velocity is constant.

Choose the correct statement from the options given below :

A. A only

B. E only

C. D only

D. C only

11. A geostationary satellite is orbiting around an arbitrary planet P at a height of $11R$ above the surface of P, R being the radius of P. The time period of another satellite in hours at a height of $2R$ from the surface of P is ___. P has the time period of rotation of 24 hours.

A. $\frac{6}{\sqrt{2}}$

B. 3

C. $6\sqrt{2}$

D. 5

12. The time period of a satellite in a circular orbit of radius R is T. The period of another satellite in a circular orbit of radius $9R$ is:

A. $3T$

B. $9T$

C. $27T$

D. $12T$

13. The angular momentum of a planet of mass M moving around the sun in an elliptical orbit is $\overrightarrow{L}$. The magnitude of the areal velocity of the planet is :

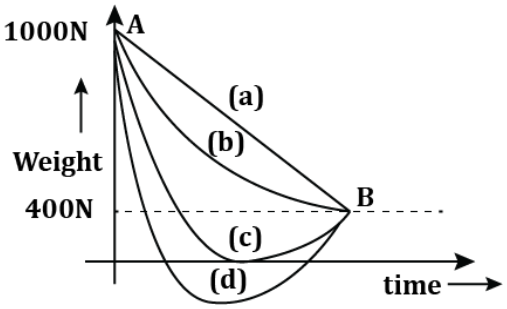
A. $\frac{L}{M}$

B. $\frac{2L}{M}$

C. $\frac{L}{2M}$

D. $\frac{4L}{M}$

14. A person whose mass is $100\ \mathrm{kg}$ travels from Earth to Mars in a spaceship. Neglect all other objects in sky and take acceleration due to gravity on the surface of the Earth and Mars as $10\ \mathrm{m/s^2}$ and $4\ \mathrm{m/s^2}$ respectively. Identify from the below figure, the curve that fits best for the weight of the passenger as a function of time.



A. (c)

B. (a)

C. (d)

D. (b)

15. A satellite is launched into a circular orbit of radius R around earth, while a second satellite is launched into a circular orbit of radius $1.02\ R$. The percentage difference in the time periods of the two satellites is :

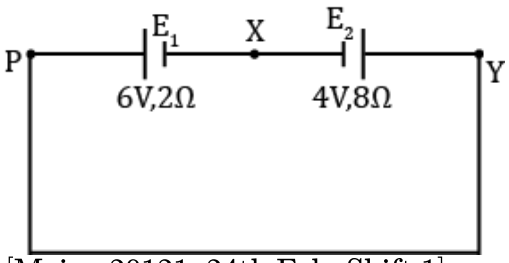
A. 1.5

B. 2.0

C. 0.7

D. 3.0

16. A cell E_1 of emf $6\ \text{V}$ and internal resistance $2\ \Omega$ is connected with another cell E_2 of emf $4\ \text{V}$ and internal resistance $8\ \Omega$ as shown in the figure. The potential difference across points X and Y is



[Mains-20121, 24th Feb, Shift 1]

A. $3.6\ \text{V}$

B. $10.0\ \text{V}$

C. $5.6\ \text{V}$

D. $2.0\ \text{V}$

17. A current through a wire depends on time as $i = \alpha_o t + \beta t^2$ where $\alpha_o = 20\ \text{A/s}$ and $\beta = 8\ \text{As}^{-2}$. Find the charge crossed through a section of the wire in $15\ \text{s}$.

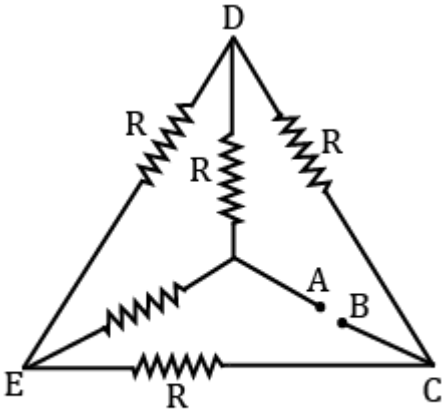
A. $2100\ \text{C}$

B. $260\ \text{C}$

C. $2250\ \text{C}$

D. $11250\ \text{C}$

18. Five equal resistances are connected in a network as shown in figure. The net resistance between the points A and B is



A. $\frac{3R}{2}$

B. $\frac{R}{2}$

C. R

D. $2R$

19. A resistor develops $500\ \text{J}$ of thermal energy in $20\ \text{s}$ when a current of $1.5\ \text{A}$ is passed through it. If the current is increased from $1.5\ \text{A}$ to $3\ \text{A}$, what will be the energy developed in $20\ \text{s}$.

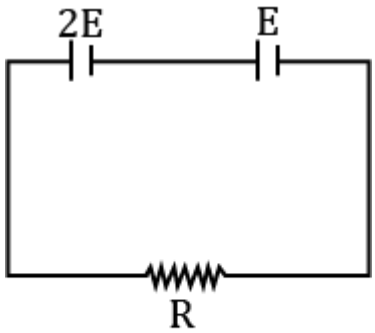
A. $500\ \text{J}$

B. $1000\ \text{J}$

C. $2000\ \text{J}$

D. $1500\ \text{J}$

20. Two cells of emf $2E$ and E with internal resistance r_1 and r_2 respectively are connected in series to an external resistor R (see figure). The value of R, at which the potential difference across the terminals of the first cell becomes zero is



[Mains-2021, March 21st, Shift 2]

A. $r_1 - r_2$

B. $r_1 + r_2$

C. $\frac{r_1}{2} + r_2$

D. $\frac{r_1}{2} - r_2$

21. A wire of $1\ \Omega$ has a length of $1\ \mathrm{m}$. It is stretched till its length increases by 25 %. The percentage change in the resistance to the nearest integer is -

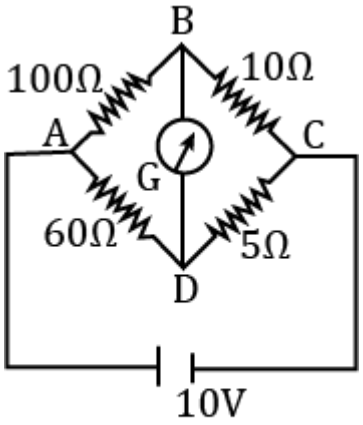
A. 25%

B. 12.5%

C. 76%

D. 56%

22. The four arms of a wheatstone bridge have resistances as shown in the figure. A galvanometer of $15\ \Omega$ resistance is connected across BD. Calculate the current through the galvanometer when a potential difference of $10\ \mathrm{V}$ is maintained across AC.



A. $4.87\ \mathrm{mA}$

B. $4.87\ \mu\mathrm{A}$

C. $2.44\ \mu\mathrm{A}$

D. $2.44\ \mathrm{mA}$

23. A current of $10\ \mathrm{A}$ exists in a wire of cross-sectional area $5\ \mathrm{mm}^2$. The drift velocity of the electrons is $2 \times 10^{-3}\ \mathrm{m/s}$. The number of free electrons in each cubic meter of the wire are :

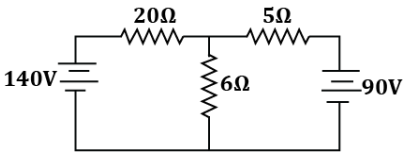
A. 1×10^{23}

B. 2×10^{6}

C. 2×10^{25}

D. 625×10^{25}

24. The value of current in the $6\ \Omega$ resistor is :



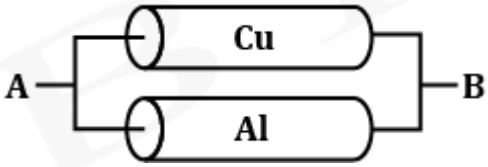
A. $4\ \text{A}$

B. $8\ \text{A}$

C. $10\ \text{A}$

D. $6\ \text{A}$

25. A Copper (Cu) rod of length $25\ \text{cm}$ and cross-sectional area $3\ \text{mm}^2$ is joined with a similar Aluminium (Al) rod as shown in figure. Find the resistance of the combination between the ends A and B.
$(\text{Resistivity of Copper} = 1.7 \times 10^{-8}\ \Omega\text{m}$
$\text{Resistivity of Aluminium} = 2.6 \times 10^{-8}\ \Omega\text{m})$



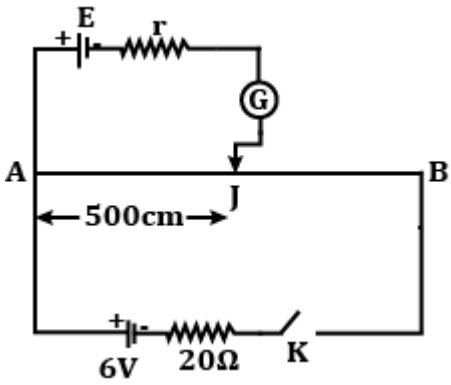
A. $2.170\ \text{m}\Omega$

B. $1.429\ \text{m}\Omega$

C. $0.0858\ \text{m}\Omega$

D. $0.858\ \text{m}\Omega$

26. In the given figure, there is a circuit of potentiometer of length $AB = 10\ \mathrm{m}$. The resistance per unit length is $0.1\ \Omega/\mathrm{cm}$. Across AB, a battery of emf E and internal resistance r is connected. The maximum value of emf, that can be measured, using this potentiometer is,



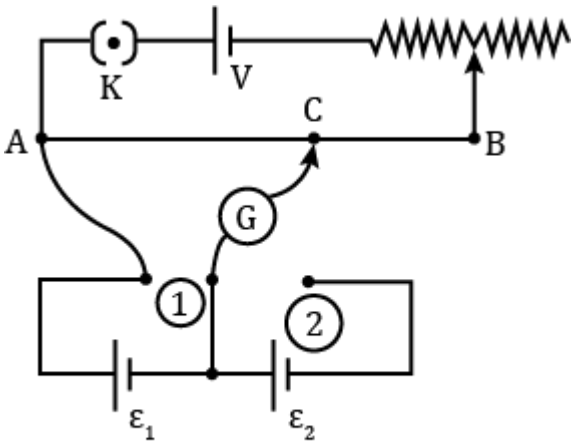
A. $5\ \mathrm{V}$

B. $2.25\ \mathrm{V}$

C. $6\ \mathrm{V}$

D. $2.75\ \mathrm{V}$

27. In the given potentiometer circuit arrangement, the balancing length AC is measured to be $250\ \mathrm{cm}$. When the galvanometer connection is shifted from point (1) to point (2) in the given diagram, the balancing length becomes $400\ \mathrm{cm}$. The ratio of the emf of two cells, $\frac{\mathcal{E}_1}{\mathcal{E}_2}$ is:



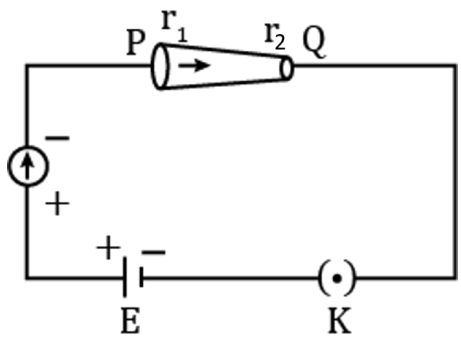
A. $\frac{5}{3}$

B. $\frac{8}{5}$

C. $\frac{4}{3}$

D. $\frac{3}{2}$

28. In the given figure, a battery of emf E is connected across a conductor PQ of length $'l'$ and different area of cross-sections having radii r_1 and r_2 $(r_2 < r_1)$.



Choose the correct option as one moves from P to Q :

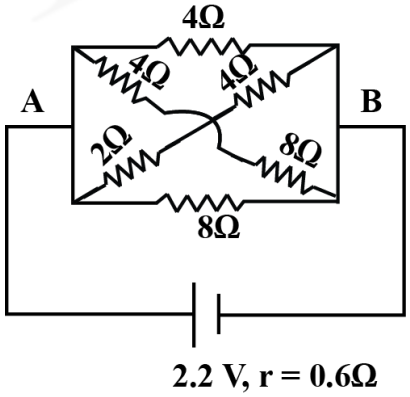
A. Drift velocity of electron increases.

B. Electric field decreases.

C. Electron current decreases

D. All of these

29. In the given figure, the emf of the cell is $2.2\ V$ and if internal resistance is $0.6\ \Omega$. Calculate the power dissipated in the whole circuit.



A. $2.2\ \mathrm{W}$

B. $4.4\ \mathrm{W}$

C. $0.65\ \mathrm{W}$

D. $1.32\ \mathrm{W}$

30. What equal length of an iron wire and a copper-nickel alloy wire, each of $2\ \mathrm{mm}$ diameter connected parallel to give an equivalent resistance of $3\ \Omega$? (Given resistivities of iron and copper-nickel alloy wire are $12\ \mu\Omega\ \mathrm{cm}$ and $51\ \mu\Omega\ \mathrm{cm}$ respectively)

A. $110\ \mathrm{m}$

B. $97\ \mathrm{m}$

C. $90\ \mathrm{m}$

D. $82\ \mathrm{m}$