Question Review

All

The ionisation potential of hydrogen atom is 13.6 eV. The energy required to remove an electron in the n = 2 state of the hydrogen atom is

- 27.2 eV
- 13.6 eV
- 6.8 eV
- 3.4 eV ✓

EXPLANATIONS

Report

62 % were correct!

Energy required to remove electron in the n = 2 state$= +\frac{13.6}{2^2} = +3.4\,eV$

A point object is placed at a distance of 30 *cm* from a convex mirror of focal length 30. The image will form at

- Infinity
- Focus
- Pole
- 15 cm behind the mirror ✓

EXPLANATIONS

Report

$u = -30\mathrm{cm}, \quad f = +30\mathrm{cm}$, by using mirror formula

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u} \Rightarrow \frac{1}{+30} = \frac{1}{v} + \frac{1}{(-30)}$$

v = 15 cm, behind the mirror

When a body moves in a circular path, no work is done by the force since,

- There is no displacement

- ○ There is no net force
- ● Force and displacement are perpendicular to each other
- ○ The force is always away from the centre

EXPLANATIONS Report

76 % were correct!

Throughout the circular motion, centripetal force is perpendicular to the velocity of the particle.

In an explosion a body breaks up into two pieces of unequal masses. In this

- ● Both parts will have numerically equal momentum
- ○ Lighter part will have more momentum
- ○ Heavier part will have more momentum
- ○ Both parts will have equal kinetic energy

EXPLANATIONS Report

58 % were correct!

Both part will have numerically equal momentum and lighter part will have more velocity.

A 60 *kg* man runs up a staircase in 12 seconds while a 50 *kg* man runs up the same staircase in 11, seconds, the ratio of the rate of doing their work is

- ○ 6:5
- ○ 12:11
- ● 11:10
- ○ 10:11

EXPLANATIONS Report

63 % were correct!

$P = \frac{mgh}{t} \Rightarrow \frac{P_1}{P_2} = \frac{m_1}{m_2} \times \frac{t_2}{t_1}$ (As h = constant)

$\therefore \frac{P_1}{P_2} = \frac{60}{50} \times \frac{11}{12} = \frac{11}{10}$

A ball of radius r and density ρ falls freely under gravity through a distance h before entering water. Velocity of ball does not change even on entering water. If viscosity of water is η, the value of h is given by

- $\frac{2}{9}r^2(\frac{1-\rho}{\eta})g$
- $\frac{2}{81}r^2(\frac{\rho-1}{\eta})g$
- ✓ $\frac{2}{81}r^4(\frac{\rho-1}{\eta})^2 g$
- $\frac{2}{9}r^4(\frac{\rho-1}{\eta})^2 g$

EXPLANATIONS Report

42 % were correct!

Velocity of ball when it strikes the water surface

$v = \sqrt{2gh}$ ... (i)

Terminal velocity of ball inside the water

$$v = \frac{2}{9}r^2 g\frac{(\rho-1)}{\eta} \quad \ldots \text{(ii)}$$

Equating (i) and (ii) we get $\sqrt{2gh} = \frac{2}{9}\frac{r^2 g}{\eta}(\rho-1)$

$$\Rightarrow h = \frac{2}{81}r^4\left(\frac{\rho-1}{\eta}\right)^2 g$$

At what temperature will the rms speed of oxygen molecules become just sufficient for escaping from the Earth's atmosphere?

[Mass of oxygen molecule (m) = 2.76×10^{-26} kg]

[Boltzmann's constant $k_B = 1.38 \times 10^{-23}$ JK^{-1}]

- 5.016×10^4 K
- ✓ 8.360×10^4 K
- 2.508×10^4 K
- 1.254×10^4 K

EXPLANATIONS Report

54 % were correct!

$\mathrm{V}_{\text{escape}} = \sqrt{\dfrac{GM}{R}} = 11200\mathrm{m/s}$

Say at temperature T, it attains $\mathrm{V}_{\text{escape}}$

Kinetic energy of a molecule based on translational motion $\dfrac{1}{2}mv^2 = \dfrac{3}{2}k_BT$

$\Rightarrow v = \sqrt{\dfrac{3\mathrm{k_B\,T}}{\mathrm{m_{O_2}}}} = 11200\mathrm{m/s}$

On solving,

$\mathrm{T} = 8.360 \times 10^4\mathrm{K}$

A voltmeter has a resistance of $R\,\Omega$ and range of V volts. The value of resistance used in series to convert it into a voltmeter of range nV volts is

- nG
- (n - 1)G
- $\frac{G}{n}$
- $\frac{G}{(n-1)}$

EXPLANATIONS Report

63 % were correct!

Suppose resistance R is connected in series with voltmeter. By Ohm's law

$I_g(R+G) = nV$

$\Rightarrow I_gR = nV - I_gG$

$\Rightarrow \dfrac{V}{G}R = nV - V = (n-1)V$

$\therefore R = (n-1)G\left(\text{where } I_g = \dfrac{V}{G}\right)$

In Millikan's oil drop experiment, an oil drop of mass $16 \times 10^{-6}kg$ is balanced by an electric field of $10^6V/m$. The charge in coulomb on the drop, assuming $g = 10m/s^2$ is

- 12×10^{-9}
- 16×10^{-9}
- 12×10^{-11}
- 16×10^{-11}

EXPLANATIONS Report

55 % were correct!

Electric force = Weight of the oil drop

$$eE = mg \Rightarrow e = \frac{mg}{E} = \frac{16 \times 10^{-6} \times 10}{10^6} = 16 \times 10^{-11} C$$

If two mirrors are kept at 60° to each other, then the number of images formed by them is

- (●) 5
- ( ) 6
- ( ) 7
- ( ) 8

EXPLANATIONS Report

55 % were correct!

Angle between the mirrors $\theta = 60^\circ$

We have $\frac{360^\circ}{\theta} = \frac{360^\circ}{60^\circ} = 6$ which is even.

$\therefore$ No. of images formed when it is kept between the mirrors $= \frac{360^\circ}{\theta^\circ} - 1 = \frac{360^\circ}{60^\circ} - 1 = 5$

Hailstone at 0°*C* falls from a height of 1 *km* on an insulating surface converting whole of its kinetic energy into heat. What part of it will melt $\left(g = 10 m/s^2\right)$?

- (●) $\frac{1}{33}$
- ( ) $\frac{1}{8}$
- ( ) $\frac{1}{33} \times 10^{-4}$
- ( ) All of it will melt

EXPLANATIONS Report

29 % were correct!

Suppose *m' kg* ice melts out of *m kg* then by using $W = JQ \Rightarrow mgh = J\left(m'L\right)$.

Hence fraction of ice melts $= \frac{m'}{m} = \frac{gh}{JL} = \frac{9.8 \times 1000}{4.18 \times 80} = \frac{1}{33}$

For a colour of light the wavelength for air is 6000 Å and in water the wavelength is 4500 Å.
Then the speed of light in water will be

- ○ $5. \times 10^{14} m/s$
- ● 2.25×10^{8} m/s
- ○ 4.0×10^{8} m/s
- ○ Zero

EXPLANATIONS Report

80 % were correct!

$$v \propto \lambda \Rightarrow \frac{v_1}{v_2} = \frac{\lambda_1}{\lambda_2} \therefore v_2 = \frac{v_1}{\lambda_1} \times \lambda_2 = 3 \times 10^8 \times \frac{4500}{6000} = 2.25 \times 10^8 m/s$$

The angle between two vectors is:

- ○ always acute
- ○ never obtuse
- ● is between 0° and 180°
- ○ is between 0° and 360°

EXPLANATIONS Report

72 % were correct!

This is obvious.

For a function $f(x)$ to be invertible, it should be:

- ○ surjective
- ○ injective
- ● bijective
- ○ none of these

EXPLANATIONS Report

61 % were correct!

- surjective : onto
- injective : one-to-one
- bijective : both one-to-one and onto

If $a = 2i + 2j - k$ and $b = 6i - 3j + 2k$, then the value of $a \times b$ is

- 2i + 2j - k
- 6i - 3j + 2k
- **i - 10j - 18k**
- i + j + k

EXPLANATIONS Report

80 % were correct!

$$\begin{vmatrix} i & j & k \\ 2 & 2 & -1 \\ 6 & -3 & 2 \end{vmatrix} = i - 10j - 18k.$$

$\frac{d^2x}{dy^2}$ is equal to

- $\frac{1}{(dy/dx)^2}$
- $\frac{(d^2y/dx^2)}{(dy/dx)^2}$
- $\frac{d^2y}{dx^2}$
- **$\frac{(-d^2y/dx^2)}{(dy/dx)^3}$**

EXPLANATIONS Report

32 % were correct!

$$\frac{d^2x}{dy^2} = \frac{d}{dy}\left(\frac{dx}{dy}\right) = \frac{d}{dy}\left(\frac{1}{\frac{dy}{dx}}\right) = \frac{d}{dx}\left(\frac{1}{\frac{dy}{dx}}\right) \cdot \frac{dx}{dy} = \frac{-1}{\left(\frac{dy}{dx}\right)^3} \cdot \frac{d^2y}{dx^2}.$$

If $\vec{a}, \vec{b}, \vec{c}$ represent three sides of a triangle in order, then, $\vec{a} \cdot \vec{b} + \vec{b} \cdot \vec{c} + \vec{c} \cdot \vec{a} =$

- ○ 0
- ○ $\frac{1}{2}(a^2+b^2+c^2)$
- ● $-\frac{1}{2}(a^2+b^2+c^2)$
- ○ can't be determined

EXPLANATIONS Report

33 % were correct!

For the vectors to represent sides of a triangle in order,

$\vec{a}+\vec{b}+\vec{c}=0$

Squaring,

$a^2+b^2+c^2+2(\vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a})=0$

This implies,

$\vec{a}\cdot\vec{b}+\vec{b}\cdot\vec{c}+\vec{c}\cdot\vec{a}=-\frac{1}{2}(a^2+b^2+c^2)$

The range of $f(x)=\sin^2 e^x+\cos^2 e^x$ is:

- ○ {0,1}
- ○ [0,1]
- ● {1}
- ○ {-1,1}

EXPLANATIONS Report

52 % were correct!

Since $\sin^2 e^x+\cos^2 e^x=1$ the range is {1}.

Given that, $P=\begin{bmatrix}2&0&0\\3&4&0\\4&5&6\end{bmatrix}$, then P is:

- ○ A null matrix
- ● A lower triangular matrix
- ○ An upper triangular matrix

- ○ none of these

EXPLANATIONS Report

68 % were correct!

P is a lower triangular matrix since all elements above main diagonal are zero.

If $\sin 2\theta = \sin\theta$ then $\theta =$

- ○ 0
- ○ $\frac{\pi}{6}$
- ○ $\frac{\pi}{3}$
- ● both (a) and (c)

EXPLANATIONS Report

60 % were correct!

Checking options, both (a) and (c) satisfy. So, (d) is correct.

OR

$$\sin 2\theta = \sin\theta$$
$$\Rightarrow \sin\theta(2\cos\theta - 1) = 0$$
$$\Rightarrow \sin\theta = 0 \quad \text{OR} \quad \cos\theta = 1/2$$

So for acute angles, $\theta = 0$ or $\frac{\pi}{3}$

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