Question Review

All

A source of light emits a continuous stream of light energy which falls on a given area.
Luminous intensity is defined as

- ○ Luminous energy emitted by the source per second
- ◉ Luminous flux emitted by source per unit solid angle
- ○ Luminous flux falling per unit area of a given surface
- ○ Luminous flux coming per unit area of an illuminated surface

EXPLANATIONS

Report

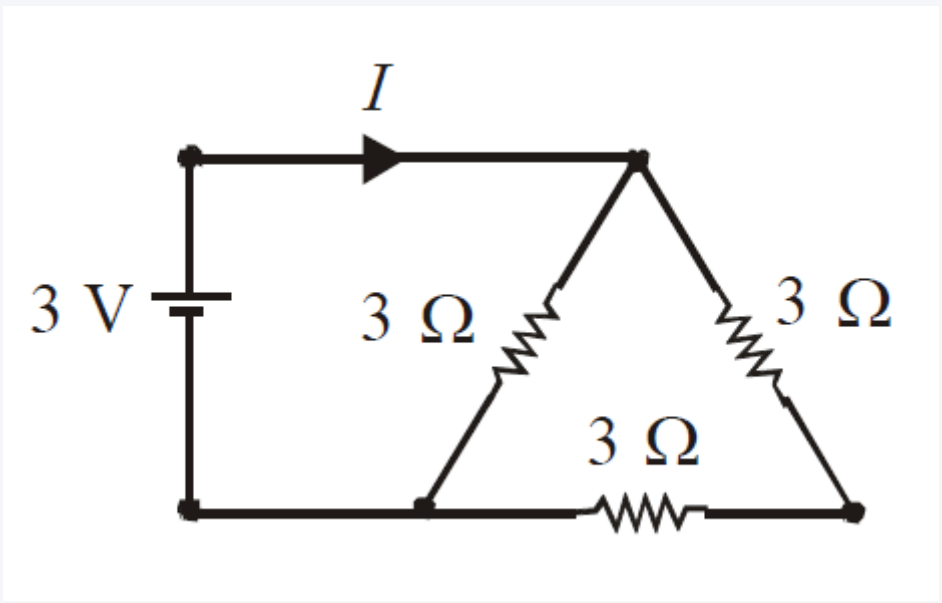
37 % were correct!

Luminous intensity is defined as luminous flux per unit solid angle.

$$L = \frac{\phi}{\Omega}$$

Its SI unit is candela (Cd).

A 3 volt battery with negligible internal resistance is connected in a circuit as shown in figure.
The current I, in the circuit will be



- ○ 1 A
- ◉ 1.5 A
- ○ 2 A
- ○ 1/3 A

EXPLANATIONS

Report

77 % were correct!

Equivalent resistance $= \dfrac{(3+3)\times 3}{(3+3)+3} = \dfrac{18}{9} = 2\Omega$

$\therefore$ Current $I = \dfrac{V}{R} = \dfrac{3}{2} = 1.5\text{A}$

From a stationary tank of mass 125000 *pound* a small shell of mass 25 *pound* is fired with a muzzle velocity of 1000 *ft/sec*. The tank recoils with a velocity of

- 0.1 ft/sec
- 0.2 ft/sec
- 0.4 ft/sec
- 0.8 ft/sec

EXPLANATIONS Report

According to conservation of momentum

Momentum of tank = Momentum of shell

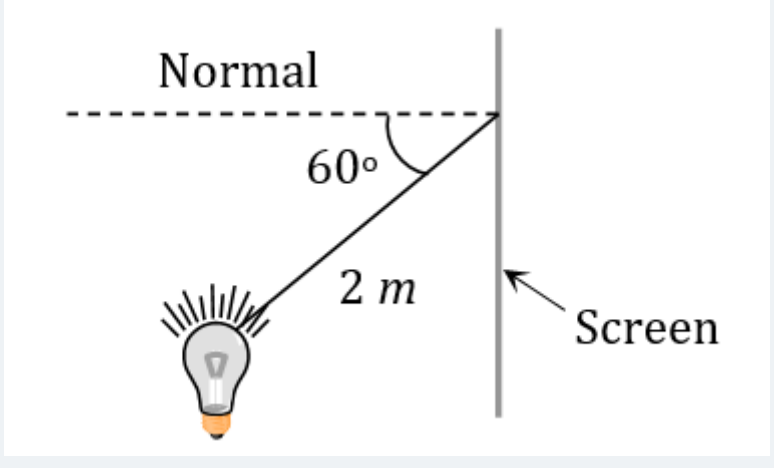
$125000 \times v_{\text{tank}} = 25 \times 1000 \Rightarrow v_{\text{tank}} = 0.2 ft/sec$

An electric bulb illuminates a plane surface. The intensity of illumination on the surface at a point $2m$ away from the bulb is 5×10^{-4} phot (*lumen/cm*^{2}). The line joining the bulb to the point makes an angle of 60^o with the normal to the surface. The intensity of the bulb in *candela* is

- $40\sqrt{3}$
- 40
- 20
- 40×10^{-4}

EXPLANATIONS Report

35 % were correct!



$$I = \frac{L\cos\theta}{r^2}$$

$$\Rightarrow \quad L = \frac{I \times r^2}{\cos\theta} = \frac{5 \times 10^{-4} \times 10^4 \times 2^2}{\cos 60^\circ} \; = \; 40 \; Candela$$

A Carnot engine takes 3×10^6 *cal* of heat from a reservoir at $627^\circ C$, and gives it to a sink at $27^\circ C$. The work done by the engine is

- 4.2 × 10^6J
- 8.4 × 10^6J
- 16.8 × 10^6J
- zero

EXPLANATIONS Report

51 % were correct!

Efficiency $\eta = 1 - \frac{T_2}{T_1} = 1 - \frac{300}{900} = 1 - \frac{1}{3} = \frac{2}{3}$

Given heat energy $Q = 3 \times 10^6 \text{cal} = 3 \times 10^6 \times 4.2\text{J}$

Work done by Carnot engine $= \eta \times Q$

$\therefore W = \frac{2}{3} \times \left(3 \times 10^6 \times 4.2\right)\ \text{J} = 8.4 \times 10^6\text{J}$

If L, C and R denote the inductance, capacitance and resistance respectively, the dimensional formula for C^2LR is

- [$M^{-1}L^{-2}T^{-1}A^0$]
- [$M^0L^0T^3A^0$]
- [$M^{-1}L^{-2}T^6A^2$]
- [$M^0L^0T^2A^0$]

EXPLANATIONS Report

50 % were correct!

$$C^2LR = \left[C^2L^2\right] \times \left[\frac{R}{L}\right] = \left[T^4\right] \times \left[\frac{1}{T}\right] = \left[T^3\right]$$

As $\left[\frac{L}{R}\right] = T$ and $\sqrt{LC} = T$

Maximum density of H_2O is at the temperature

- 32°*F*
- 39.2°*F*
- 42.8°*F*
- 40.6°*F*

EXPLANATIONS Report

70 % were correct!

Maximum density of water is at 4°*C*,

$$\frac{C}{5} = \frac{F-32}{9} \Rightarrow \frac{4}{5} = \frac{F-32}{9} \Rightarrow F = 39.2^{\circ}F$$

A charge Q is divided into two parts of q and $Q-q$. If the coulomb repulsion between them when they are separated is to be maximum, the ratio of $\frac{Q}{q}$ should be

- 1/4
- 1/2
- 2
- 4

EXPLANATIONS Report

45 % were correct!

Let separation between two parts be r.

Force between the charges,

$$F = k.\, q\frac{(Q-q)}{r^2}$$

For F to be maximum $\frac{dF}{dq} = 0 \Rightarrow \frac{Q}{q} = \frac{2}{1}$

Calculate the amount of heat (in calories) required to convert 5 *gm* of ice at 0°*C* to steam at 100°*C*.

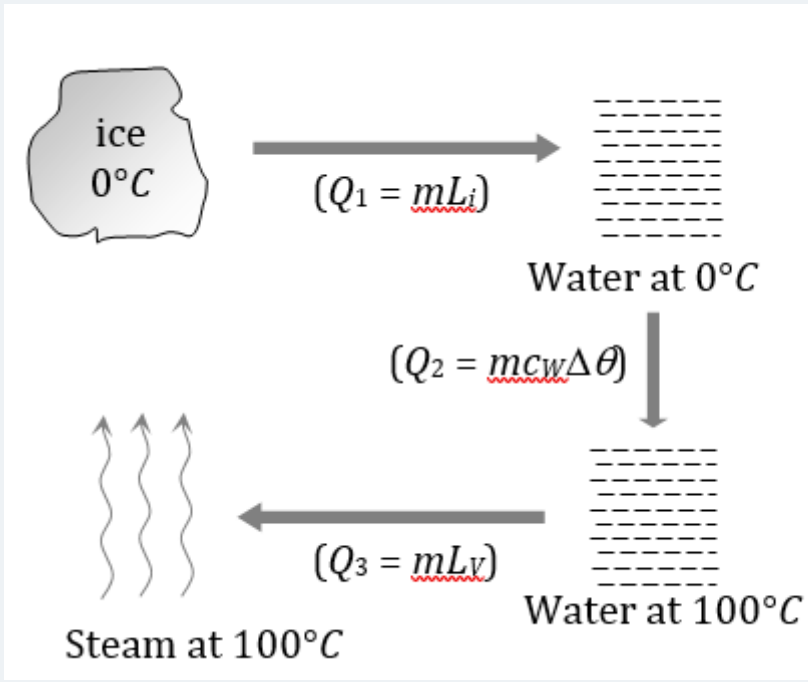
- 3100

- 3200
- 3600
- 4200

EXPLANATIONS Report

63 % were correct!

Ice ($0°C$) converts into steam ($100°C$) in following three steps.



Total heat required $Q = Q_1 + Q_2 + Q_3$
$= 5 \times 80 + 5 \times 1 \times (100 - 0) + 5 \times 540 = 3600\text{cal}$

If the radius and acceleration due to gravity both are doubled, escape velocity of earth will become

- 11.2 km/s
- 22.4 km/s
- 5.6 km/s
- 44.8 km/s

EXPLANATIONS Report

72 % were correct!

Escape velocity is given as $v_e = \sqrt{2gR} = 11.2\, km/s$.

If g and R both are doubled, then

$v_e = \sqrt{2 \times (2g) \times (2R)} = 2\sqrt{2gR} = 2 \times 11.2\, km/s = 22.4\, km/s$

$\therefore$ Escape velocity becomes double.

Two wires *A* and *B* are of same materials. Their lengths are in the ratio 1 : 2 and diameters are in the ratio 2 : 1 when stretched by force F_A and F_B respectively they get equal increase in their lengths. Then the ratio F_A/F_B should be

- 1 : 2
- 2 : 1
- 4 : 1
- 8 : 1 ✓

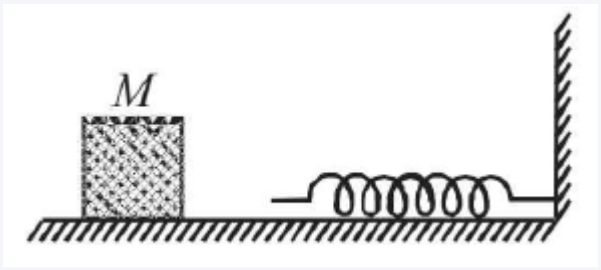
EXPLANATIONS Report

47 % were correct!

$$F = Y \times A \times \frac{e}{L} \Rightarrow F \propto \frac{r^2}{L} \left[Y \text{ (Young's modulus) and } e \text{ (increase in length) are constant } \right]$$

$$\frac{F_A}{F_B} = \left(\frac{r_A}{r_B}\right)^2 \times \left(\frac{L_B}{L_A}\right) = \left(\frac{2}{1}\right)^2 \times \left(\frac{2}{1}\right) = \frac{8}{1}$$

The block of mass M moving on the frictionless horizontal surface collides with the spring of spring constant k and compresses it by length L. The maximum momentum of the block before collision is



- $\frac{kL^2}{2M}$
- $\sqrt{MkL}$ ✓
- $\frac{ML^2}{k}$
- 0

EXPLANATIONS Report

50 % were correct!

From conservation of energy,

KE of mass M = PE stored in string

$$\frac{1}{2}Mv^2 = \frac{1}{2}kL^2$$

$$\Rightarrow v = \sqrt{\frac{k}{M}} \cdot L$$

$\therefore$ Initial Momentum of the block $= M \times v = M \times \sqrt{\frac{k}{M}} \cdot L = \sqrt{kM}.L$

The least integer k which makes the roots of the equation $x^2 + 5x + k = 0$ imaginary is:

- 4
- 5
- 6
- 7 ✓

EXPLANATIONS Report

58 % were correct!

Roots are non real if discriminant < 0 i.e, if $5^2 - 4.1\,k < 0$ i.e, if $4k > 25$ i.e, if $k > \frac{25}{4}$

Hence, the required least integer$k$ is 7. (25/4 = 6.25)

$$\begin{vmatrix} 19 & 17 & 15 \\ 9 & 8 & 7 \\ 1 & 1 & 1 \end{vmatrix} =$$

- 0 ✓
- 187
- 354
- 54

EXPLANATIONS Report

87 % were correct!

$$\begin{vmatrix} 19 & 17 & 15 \\ 9 & 8 & 7 \\ 1 & 1 & 1 \end{vmatrix} = 19 - 34 + 15 = 0$$

$$\lim_{x \to 0} \frac{\sin mx}{\tan nx} =$$

- $\frac{n}{m}$

- [x] $\frac{m}{n}$
- [ ] mn
- [ ] none of these

EXPLANATIONS Report

76 % were correct!

$$\lim_{x\to 0}\frac{\sin mx}{\tan nx}=\lim_{x\to 0}\frac{(\sin mx/mx)}{(\tan nx/nx)}\frac{m}{n}=\frac{m}{n}$$

The principal value of $\sin^{-1}\left(-\frac{\sqrt{3}}{2}\right)$ is

- [ ] $\frac{-2\pi}{3}$
- [x] $\frac{-\pi}{3}$
- [ ] $\frac{-2\pi}{3}$
- [ ] $\frac{5\pi}{3}$

EXPLANATIONS Report

55 % were correct!

$$\sin^{-1}\left(\frac{-\sqrt{3}}{2}\right)=-\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)=-\frac{\pi}{3}.$$

[The range of $\sin^{-1}x$ is $[-\pi/2,\pi/2]$]

If A and B are disjoint, then $n(A\cup B)$ is equal to

- [ ] n(A)
- [ ] n(B)
- [x] n(A) + n(B)
- [ ] n(A) . n(B)

EXPLANATIONS Report

93 % were correct!

Since A and B are disjoint,

$\therefore A \cap B = \phi$

$n(A \cap B) = 0$

Now,

$$\begin{aligned} n(A \cup B) &= n(A) + n(B) - n(A \cap B) \\ &= n(A) + n(B) - 0 \\ &= n(A) + n(B) \end{aligned}$$

If $\vec{a} = i + 2j + 2k$ and $\vec{b} = 3i + 6j + 2k$, then, the vector of magnitude of $\vec{b}$ along $\vec{a}$ is:

- 7 (i + j + k)
- $\frac{7}{3}$ (i + 2j + 2k)
- $\frac{7}{9}$ (i + 2j + 2 k)
- None of these

EXPLANATIONS Report

62 % were correct!

$$|b|\hat{a} = \sqrt{9+36+4}\left(\frac{i+2j+2k}{\sqrt{1+4+4}}\right) = \frac{7}{3}(i+2j+2k).$$

$$\lim_{x \to \sqrt{2}} \frac{\sec^{-1}x - \pi/4}{x^2 - 2} =$$

- 1/8
- 4
- 1/4
- doesn't exist

EXPLANATIONS Report

65 % were correct!

Given limit is:

$$\lim_{x \to \sqrt{2}} \frac{\sec^{-1}x - \pi/4}{x^2 - 2} = L \quad (\text{say})$$

It is obviously $0/0$ form. Using L-Hopital's rule:

$$L = \lim_{x \to \sqrt{2}} \frac{1}{2x^2\sqrt{x^2-1}}$$

So,

$$L = \frac{1}{2 \times 2 \times 1} = 1/4$$

If $|a+b| > |a-b|$, then the angle between a and b is

- Acute
- Obtuse
- $\frac{\pi}{2}$
- π

EXPLANATIONS

Report

51 % were correct!

$|a+b| > |a-b|$

Squaring both sides, we get

$$a^2 + b^2 + 2a\,.\,b > a^2 + b^2 - 2a\,.\,b$$

$\Rightarrow 4a.b > 0 \Rightarrow \cos\theta > 0.$

Hence $\theta < 90^\circ$, (acute).

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