AL Physics MC Answers

Year:1989

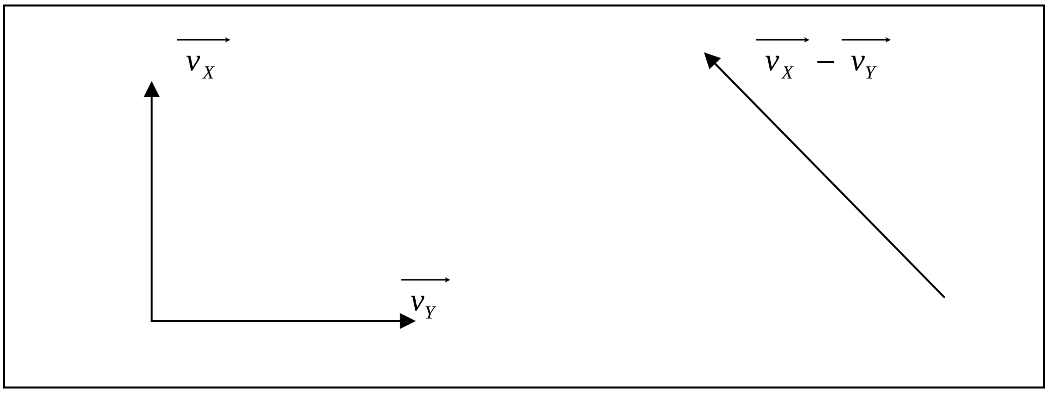
Question Number: 3,20,22,24,26,29,30,31,36,40,42

1989MC (3)

If velocity of A relative to ground = $\vec{v_A}$ and

velocity of B relative to ground = $\vec{v_B}$, then

the velocity of A relative to B = $\vec{v_A} - \vec{v_B}$



Suppose that X is stationary and Y moves to the right. So relative to Y, X appears to move to the left. In addition, X moves upwards, so X's velocity is to the "left and up", as seen by Y.

1989MC (20)

A rotating disc is ***seen to be stationary*** when

Flashing rate = freq of the rotating disc (one revolution between two flashes)

Flashing rate = (freq of rotating disc)/2 (two revolutions between two flashes)

Flashing rate = (freq of rotating disc)/3 (three revolutions between two flashes)

so on.

A rotating disc appears to move backward slowly when the **rotating freq of the disc is slightly lower than one of the freezing frequencies**, e.g.

First flash 0^0

Second flash 358^0 (not complete a full revolution)

Third flash 716^0

First sight is at 0^0, second sight is at -2^0, third sight is at -4^0. so it appears to move backwards.

Now, the flashing rate is 50 Hz.

Disc rotating at 50 Hz, 100 Hz, 150 Hz, ………..can be “frozen” by the flash.

The answer in 1989(2) is 98 Hz, because it is slightly lower than 100 Hz.

1989 MC (22)

$$d\sin\theta = m\lambda$$

p lines per mm, θ is the angle when m = 2, so $\frac{10^{-3}}{p}\sin\theta = 2\lambda$ …………(1)

3p lines per mm, ϕ when m=1 and the avelength is 5λ/4, so

$$\frac{10^{-3}}{3p}\sin\phi = 1(\frac{5\lambda}{4}) \qquad \text{……………(2)}$$

Divide (1) by (2)

3sinθ/sinϕ = 8/5 or sinϕ = (15sinθ)/8

1989MC (24)

The moving object receive wave of freq $f' = \frac{c+u}{c}f$

The wave is reflected, the wall now acts a moving source.

A stationary observer detect $f'' = \frac{c}{c-u}f' = \frac{c+u}{c-u}f$

The above formulae are not strictly correct for EM waves (radar - microwaves)

Because u << c

The apparent wavelength c/f'' = $\frac{c-u}{c+u}\frac{c}{f} = \frac{1-\frac{u}{c}}{1+\frac{u}{c}}\lambda$

$$= \left(1-\frac{u}{c}\right)\left(1+\frac{u}{c}\right)^{-1}\lambda \approx \left(1-\frac{u}{c}\right)\left(1-\frac{u}{c}\right)\lambda = \left(1-2\frac{u}{c}\right)\lambda$$

$$= \lambda - 2u(\frac{\lambda}{c}) = \lambda - \frac{2u}{f}$$

1989MC (26)

A spherical conductor (essentially any type of conductor) can be regarded as a capacitor.

A capacitor consists of two conductors, but a sphere doesn’t. How come?

No wonder. The "other conductor" is infinity.

To any system, Q is proportional to V and hence the proportionality constant is defined as the capacitance (Q = CV).

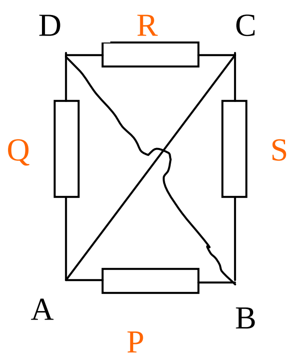
If the potential at infinity is zero, then the potential at the spherical surface is V = $\frac{Q}{4\pi\varepsilon\ a}$, where a is its radius. V is in fact the p.d. between the conducting sphere and infinity. Therefore the capacitance of a conducting sphere is C = $\frac{Q}{V} = 4\pi\varepsilon_0 a$

The energy stored in a capacitor is $\frac{1}{2}QV = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$.

So the energy stored in a charged sphere is $\frac{1}{2}(4\pi\varepsilon_0 a)V^2 = (2\pi\varepsilon_0 a)V^2$

This is the total work in bringing all the charges from infinity to the surface of the sphere.

1989MC (29)



Current enters A ------pass through P (A to B)------exit at B, or
current enters A------pass through Q (A to D)------path DB -----exit at B, or
current enters A -----path AC -----pass through S (C to B)------exit at B, or
Current enters A-----path AC ----pass through R (C to D)------exits at B.

In other words, a current entering at A will be divided into four parts and each will pass through P, Q, R or S, they join and leave at B.

So, the four resistors are effectively joined in PARALLEL.

1989MC (30)

F= qE. q is negative, so F is opposite to E . F is upward, so acceleration is also upwards.

.

Path III and IV are impossible. At their "highest points", the vertical velocity is zero. An upward acceleration will not produce a downward velocity at a later time!

1989MC(31)

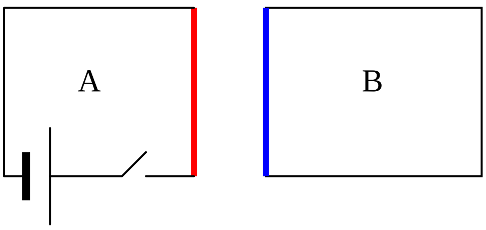
X is situated at the mid-point of AB, $R_{AX} = 5\ \Omega$,

Total resistance between AX is 10/3 Ω and the resistance between XB is 5 Ω.

AX and XB are is series, the "10V" is divided into two parts in the ratio 10/3 : 5

Final p.d. across AX = 10 (3.3333333/8.333333) = 4V

1989MC (36)



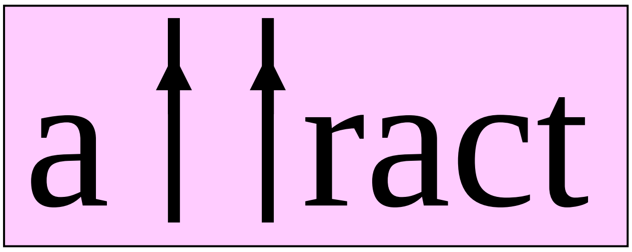
Without going into details, we will say immediately that the force acting on B at the moment when the switch is closed must be **repulsive**. **Why?**

Before the switch is closed; no flux passing through B.

The flux now floods into B, what is the response of B ?

It "runs away" in order to restore the "zero field" state ------Lenz's law.

The force is repulsive when the currents in two neighboring straight wires are opposite in direction. The current in the red wire is upward, so the current in the blue wire must be downwards. So the current in B is anticlockwise.

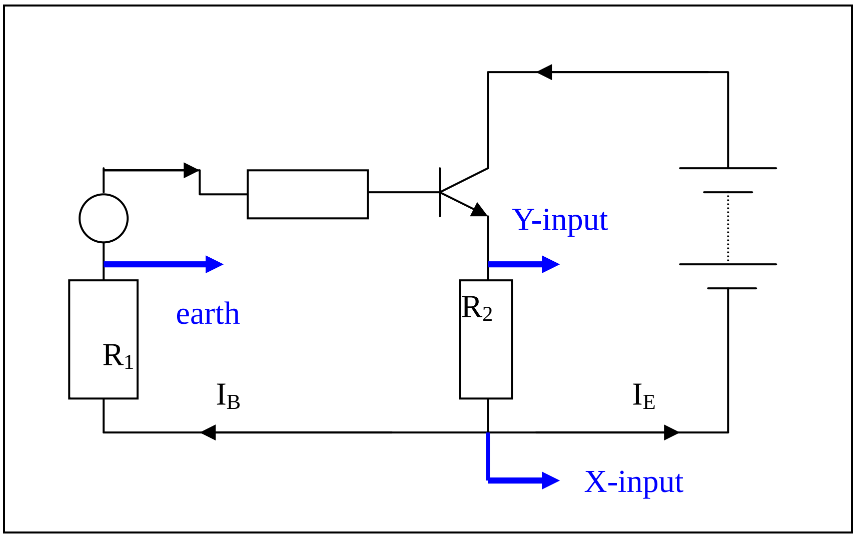


[The field at B produced by the rising current in A is downward So the field produced by the induced current is upwards. Such a current must be anticlockwise]

1989MC (40)

It is a very difficult question.

I just explain why "D" is the correct answer.



We are going to plot I_C against I_B.

CRO measures voltage, not current, so we need to find voltages which are proportional to I_C and I_B.

The major difficulty is to find a suitable common ground

The transistor conducts only when the currents flows as shown in the above figure.

- X-input measure the p.d. across R_1, which is proportional to I_B. "X-input" is positive relative to "earth", so the trace appears on the right of the center of the screen (positive x).
- Y-input measures the p.d. across R_1 and R_2. Since $I_E >> I_B$, so the p.d. across R_1 can be neglected, as compared with that across R_2.
  Y-input essentially measures the p.d. across R_2, which is proportional to I_E. I_E is approximately equal to I_C. So the signal fed into Y-input is basically the same waveform as I_C. Y -input is positive with respect to earth, so the signal is displayed on the side of positive y.

Why are there so many approximations?

The answer is that we cannot find a common ground better than that.

1989MC(42)

Absorption spectrum

An atom can absorb a photon of energy whose value is just the right amount to raise the atom to a higher energy level. When white light, which contains all wavelengths, is passed through a cooler gas or vapour, photons of those energy that correspond to transitions between energy levels are absorbed. The resulting excited atoms re-radiate their excitation energy almost at once, but these photons come off in random directions with only a few in the same direction as the original beam of white light. This causes dark lines in the spectrum of the original beam. The dark lines are not completely dark. They appear dark by contrast with the bright background. The absorption spectrum of any element is identical with its emission spectrum

(1) (3) Iodine vapour absorbs the light whose frequencies will be emitted by it.

(2) All the absorbed energy will be emitted (in all directions)

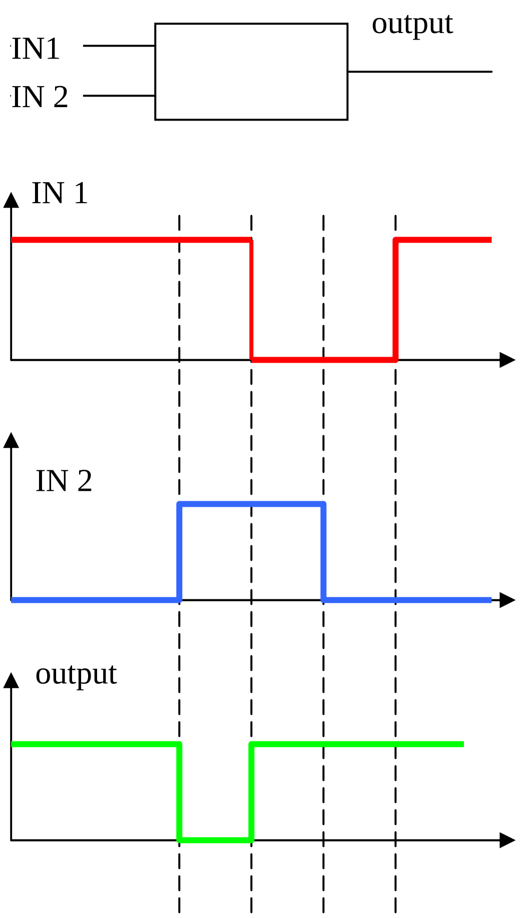
1989MC (44)

6V = state “1”

0V = state ‘0”

From the voltage graphs, the truth table of the logic gate is obtained:

Input 1	Input 2	Output
1	0	1
1	1	0
0	1	1
0	0	1



As compared with the standard logic gates:

OR gate

Input 1	Input 2	Output
0	0	0
0	1	1
1	0	1
1	1	1

NOR gate

Input 1	Input 2	Output
0	0	1
0	1	0
1	0	0
1	1	0

AND

Input 1	Input 2	Output
0	0	0
0	1	0
1	0	0
1	1	1

NAND

Input 1	Input 2	Output
0	0	1
0	1	1
1	0	1
1	1	0

Obviously, the logic gate is a NAND gate. (Answer E)