AL Physics MC Answers

Year:1987

Question Number:4,18,24,26,30,33,35,37,38,39,42,43,44

1987MC(4)

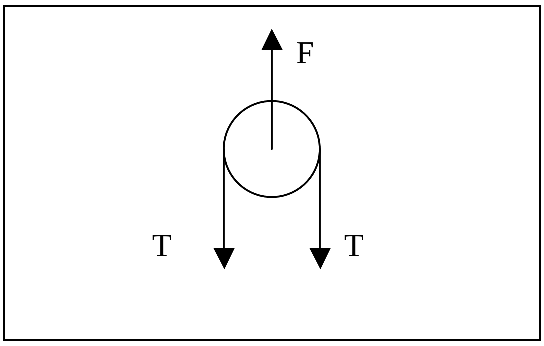
Let T be the tension

The heavier mass falls down

Solve T by **30 – T = 3a** and **T – 20 = 2a**

The pulley is stationary, so all the forces acting on it are balance.

So force acting on the axle, F = 2T



1987MC (18)

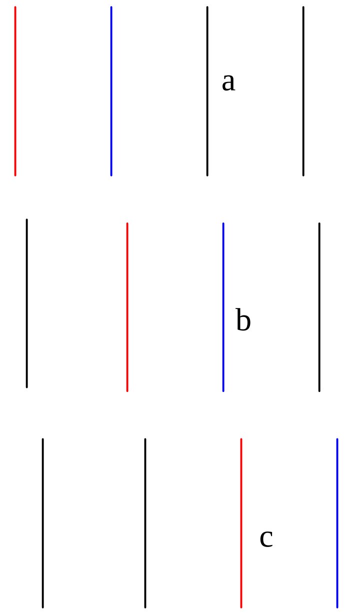
The flashing frequency is slightly lower than the wave frequency.

Between two flashes, the wave has moved slightly more than one wavelength.

First flash
(first sight)

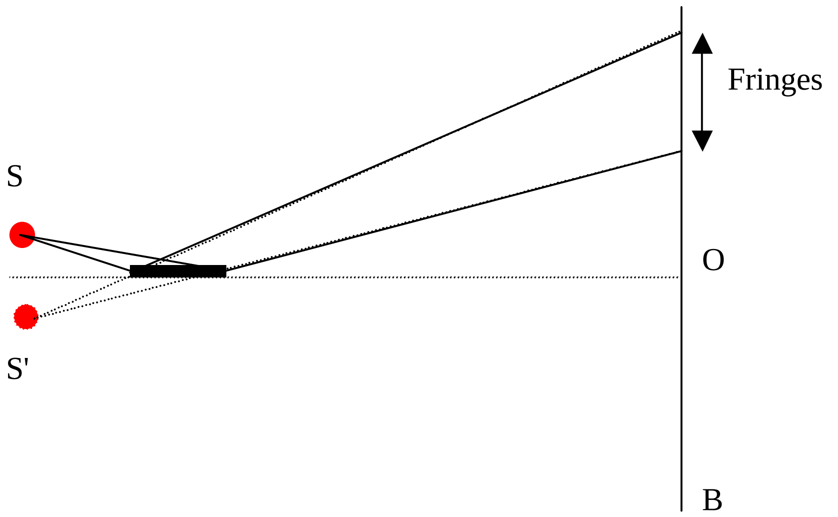
Second flash
(second sight)

Third flash
(third sight)



It seems that a, b and c are three consecutive positions of the same wavefront (a moves to b, b moves to c). So the wave pattern appears to move forward slightly.

1987 MC (24)



S' is the optical image of S.

S and S' act as two coherent sources.

The interference is produced by S and S'.

(1) The reflected light cannot reach OB, so interference is not formed there.

(2) When the mirror is moved downwards, the image S' also shift downwards

Distance between object and mirror = Distance between image and mirror

In other words, the separation between the two sources increases. The fringes shrinks.

$d \sin\theta = m\lambda$ When d increases, θ for the same order decreases.

(3) S' is still there if the mirror is moved forward. No change.

1987MC(26)

Doppler effect and beat formation.

Frequency of sound when the source is moving away at the speed v = 0.1 c

$$f' = \frac{c}{c+v} f = \frac{c}{c+0.1c} f = \frac{1}{1.1} f = 0.909 f$$

Beat frequency f – f' = 0.0909f

"Loud signals are detected whenever the source moves through a distance of 0.50 m"

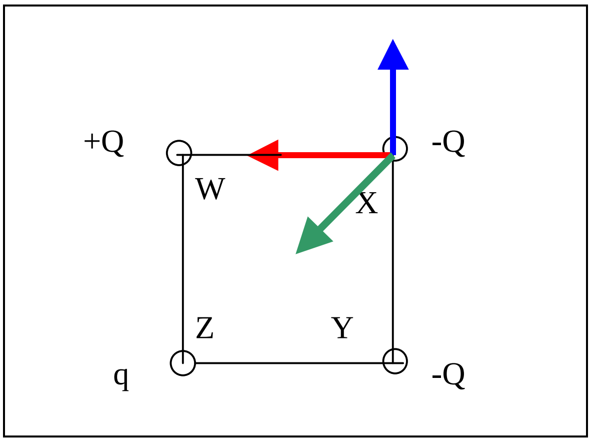
→ v x beat period = 0.5 m

→ 0.1 c x $(0.0909f)^{-1} = 0.5$

→ 1.1 λ = 0.5

→ λ = 0.45 m

1987MC (30)



Blue arrow: electrostatic force acting on X by Y

Red arrow: electrostatic force acting on X by W

Green arrow: electrostatic force acting on X by Z.

[q must be positive]

The resultant force is X to W, so the downward component of the green force is cancelled by the blue force [this explains why q must be positive].

Suppose WX=YX = 1, so ZX = $\sqrt{2}$

$$\frac{qQ}{4\pi\varepsilon_0(\sqrt{2})^2}\cos 45^0 = \frac{QQ}{4\pi\varepsilon_0(1)^2}$$

Hence, we get $q = +2\sqrt{2}Q$

1987MC (33)

P.d. across XB = 75 cm x 0.02 V cm^{-1} = 1.5 V

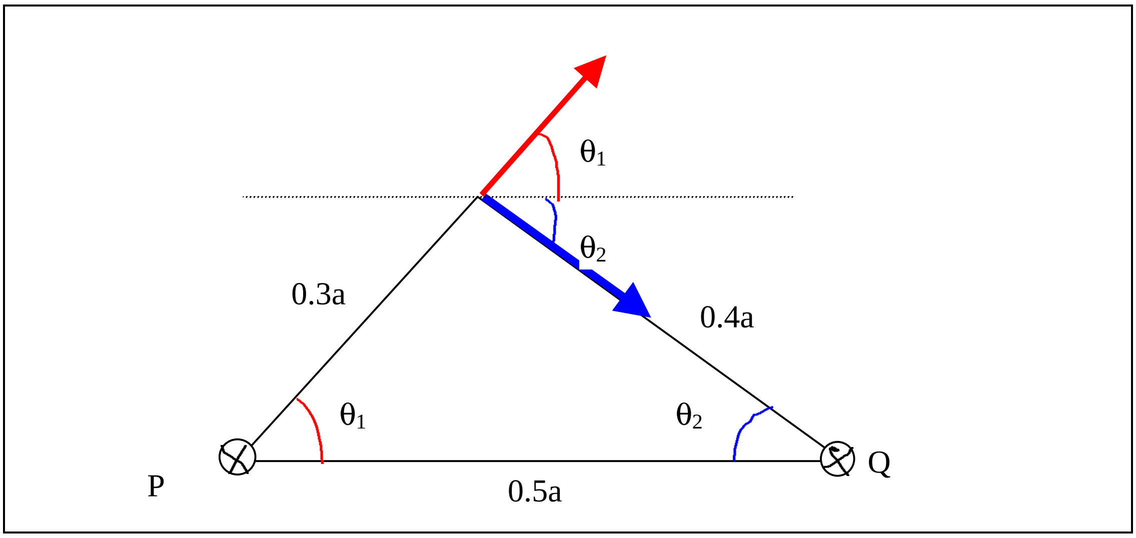
The galvanometer is balance, so in the lower circuit

P.d. across the 2 Ω resistor = 1.5 V

Current in the 2 Ω resistor = 1.5V/2 Ω = 0.75 A

Therefore, the current in the ammeter = 0.75 A

1987MC (35)



Blue arrow – magnetic field due to wire at P

$$B_P = \frac{\mu_0 I}{2\pi(0.3a)}$$

$$\text{Horizontal component of } B_P = \frac{\mu_o I}{2\pi(0.3a)}\cos\theta_2 = \frac{\mu_o I}{2\pi(0.3a)}\frac{0.4a}{0.5a}$$

Red arrow – magnetic field due to wire at Q

$$B_Q = \frac{\mu_o I}{2\pi(0.4a)}$$

$$\text{Horizontal component of } B_P = \frac{\mu_o I}{2\pi(0.4a)}\cos\theta_1 = \frac{\mu_o I}{2\pi(0.4a)}\frac{0.3a}{0.5a}$$

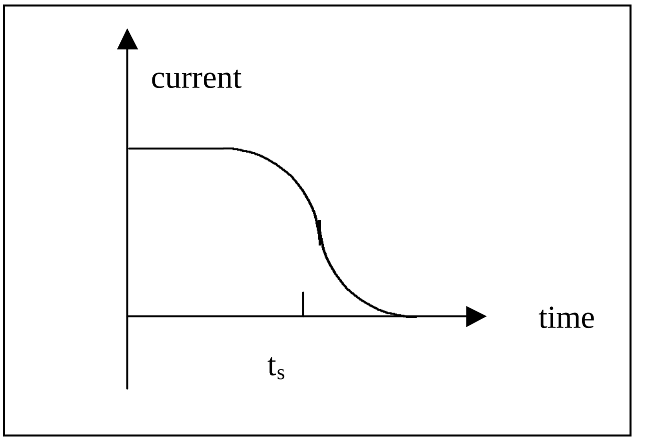
The total horizontal component

$$= \frac{\mu_o I}{2\pi(0.3a)}\frac{0.4a}{0.5a} + \frac{\mu_o I}{2\pi(0.4a)}\frac{0.3a}{0.5a} = \frac{\mu_o}{2\pi a}(2.67+1.5)$$

1987MC (37)

The cut off of the current will last for a short time interval. The induced emf is proportional to the rate of change of current (slope of the graph).

The induced emf hence rises and falls sharply.

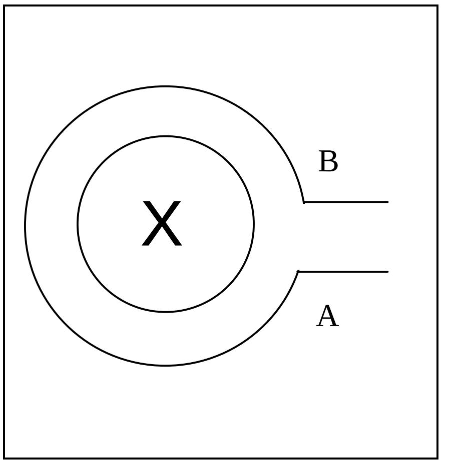


1987MC(38)

Magnitude of induced emf $V = \frac{dBA}{dt}$, where A is the area of the field region.

$= p(0.08)^2(0.01)$

$= 2.0 \times 10^{=4}$ V



Direction of induced emf

Suppose the circuit is complete, so there is an induced current.. The external field is pointing into page and decreasing, so the field produced by the induced current points into page too (in order to "refill" the losing part and hence restore the field to the original level ---- Lenz's law).

By the right hand grab rule, **the induced current flows from A to B via the loop.**

Hence, B is positive and A is negative.

The E-field inside the wire is also A to B (the E-field exists no matter the circuit is complete or not), which is defined as the direction of emf.

1987MC (39)

After squaring, the graph becomes a horizontal line of V^2.

Mean of V^2 is also V^2. Root of mean of V^2 is V

1987MC (42)

Referring to the standard explanation of smoothing circuit, (1) and (2) are correct because time constant = RC. A large RC means the voltage doesn't drop significantly during the discharging period (p.d. across the diode is larger than the applied a.c., the diode does not conduct. The capacitor discharges through the load and thus maintains a comparatively smoother voltage. To be smooth, the discharge should be as slow as possible).

(3) is correct because a higher frequency means a shorter period. The voltage drop is small when the discharging period is short

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1987MC(43)

- Consider the output loop:

  $6V = I_C R_L + V_{out}$

  When R_L is increased, V_{out} will decrease.

- The a.c. amplification gain $G = -b\dfrac{R_L}{R_b}$

When R_L is increased, G, and hence V_{pp} will increase.

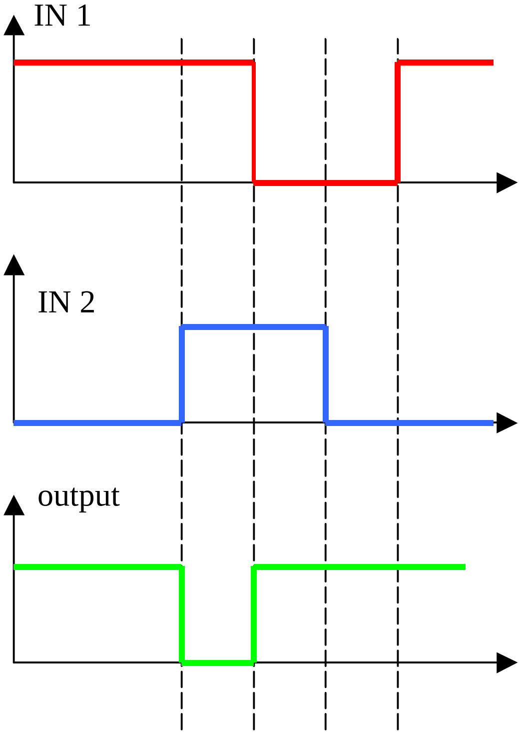
1987MC (44)

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)