

Year:1986

Question Number:1,21,25,26,31,34,37,42,46

1986MC (1)

Let T be the tension

Motion of the 2 kg mass: $mg - T = ma$

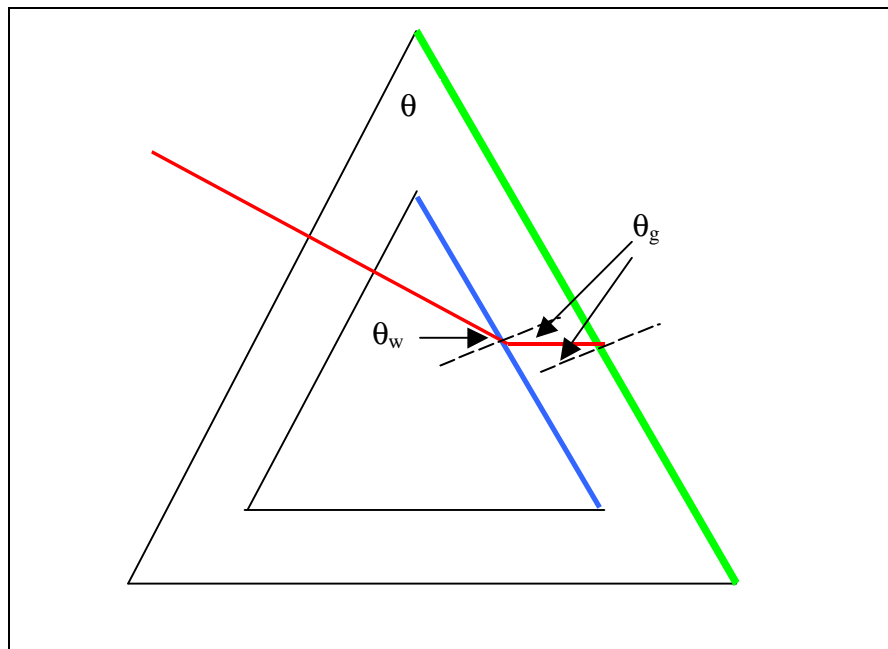
Motion of the 3 kg mass : $T - Mg\sin\theta = Ma$

Find T and a from the above equations

If acceleration a found is positive, the 2 kg mass is really falling down.

If acceleration a is negative, the motion is opposite to that we assumed

1986MC(21)



Refraction at the blue interface

$$n_w \sin \theta_w = n_g \sin \theta_g$$
$$(4/3) \sin \theta_w = (3/2) \sin \theta_g$$

Since $\theta = \theta_w$,

$$\sin \theta_g = (8/9) \sin \theta$$

Refraction at the green interface

The green surface is parallel to the blue surface, so the angle of incidence at the green interface = θ_g

Total internal reflection occurs when

$$\begin{aligned}\sin\theta_g &= 1/n_g \\ (8/9)\sin\theta &= 2/3 \\ \sin\theta &= 3/4\end{aligned}$$

1986MC(25)

Speed of transverse wave in a stretched string $\propto \sqrt{\text{tension in the string}}$

When the tension is increased by 1 %. The new speed is therefore $\sqrt{1.01} = 1.005$ times the old speed (we talk about the waves in string, not the sounds in air).

In string, wavelength of fundamental is fixed
 speed is 1.005 times higher,
 freq is 1.005 times higher.

In air, freq of the sound generated = freq of vibration of string
 So freq of sound heard is 1.005 higher.

Beat frequency = difference in frequency = 0.005 (old freq) = 0.005(1200) = 6 Hz.

1986MC (26)

Doppler effect

When the aeroplane is approaching $f_1 = \frac{c}{c-v} f$

When the aeroplane is leaving, $f_2 = \frac{c}{c+v} f$

Their difference $f_1 - f_2 = \frac{2vc}{c^2 - v^2} f \approx \frac{2v}{c} f = \frac{2(300)}{3 \times 10^8} 30 \times 10^6 = 60 \text{ Hz}$

[Radio waves travel at the speed of light]

1986MC (31)

Use “ $\frac{1}{2}mv^2 = eV$ ”.

However, we need to treat the signs carefully. $\frac{1}{2}mv^2$ is the gain in kinetic energy and eV is the loss in electrical potential energy. For simplicity, we may take the absolute values of both sides.

Another good approach to write the principle of conservation of energy is

$$\frac{1}{2}mv_A^2 + eV_A = \frac{1}{2}mv_B^2 + eV_B$$

A is the point of $r = 1\text{ m}$ and B is a point on the surface.

We will get the correct answer whenever the correct formulae is used [note: e and V must bear correct signs]..

$$0 + (-10^{-10})\left[\frac{10^{-4}}{4\pi\epsilon_0(1)}\right] = \frac{1}{2}(2 \times 10^{-5})v^2 + (-10^{-10})\left[\frac{10^{-4}}{4\pi\epsilon_0(0.1)}\right]$$

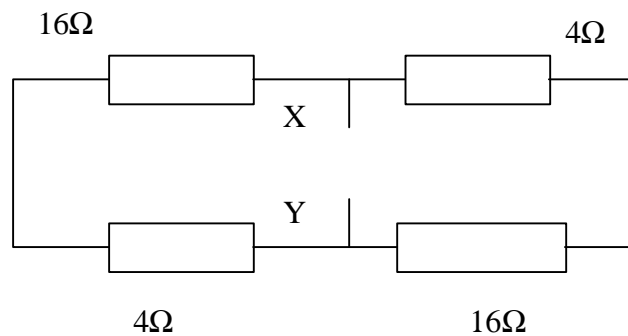
where

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9$$

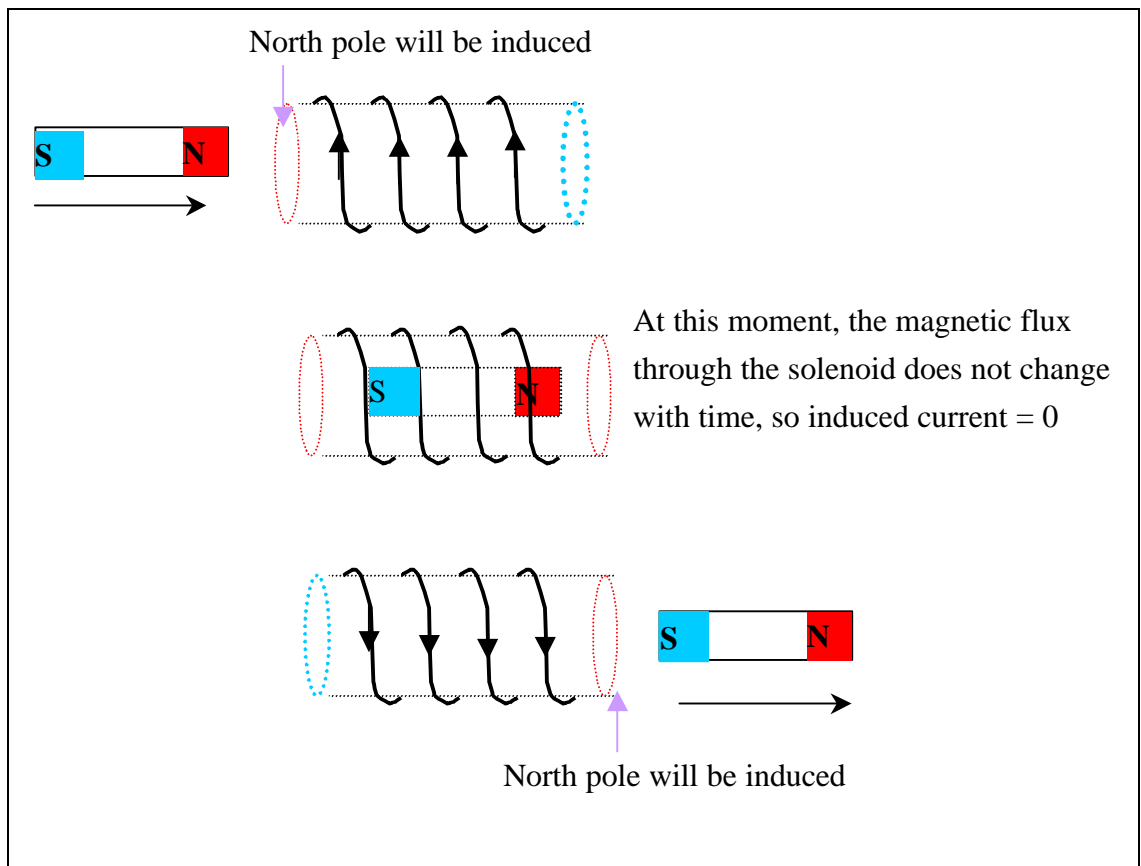
Finally, we get $v = 9\text{ ms}^{-1}$.

1986MC (34)

The original circuit can be changed to



The total resistance is $\left(\frac{1}{16+4} + \frac{1}{16+4}\right)^{-1} = 10\Omega$



More about the middle figure: To the right end of the solenoid, the "N" of the bar magnet is approaching, so a north pole is induced there.
To the left end of the solenoid, the "S" of the bar magnet is leaving, so also a north pole is induced there.
Cancellation occurs, no net current is flowing

The induced current flows in one direction first, it rises and drops to zero and then flows in the opposite direction.

- A. R, diode and CRO are in series, the voltage will drop across that of the largest resistance.
In forward bias, the CRO unquestionably displays the waveform of the input source.
But in reverse bias, the result is unknown because we do not exactly know which one, the diode or the CRO, has a larger internal resistance (both have assumed infinite, but which one is "more infinite"?). Nevertheless, (A) is not the best answer.
- B. The CRO always connects to the source, so the CRO displays the waveform of the input a.c. signal.
- C. The current passing through the resistor is rectified, but the CRO is not connected across the resistor. As in (B), it is connected to the terminals of the source.
- D. The upper diode blocks the current when the upper terminal is positive.
The lower diode blocks the current when the lower terminal is positive.
No current flows at all times !
- E. Yes, the CRO displays a half-rectified waveform
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1986 MC (46)

For convenience, let $E_{\infty} = 0$, so the energy level of a hydrogen atom is $E_n = \frac{E_1}{n^2}$ because

$E_n = E_1$ when $n = 1$. From the graph, E_1 is below "0" by 8 units, so $E_1 = -8$ units. When $n = 2$ (first excitation), $E_2 = -8/2^2 = -2$ units, so E_2 is below "0" by 2 units.