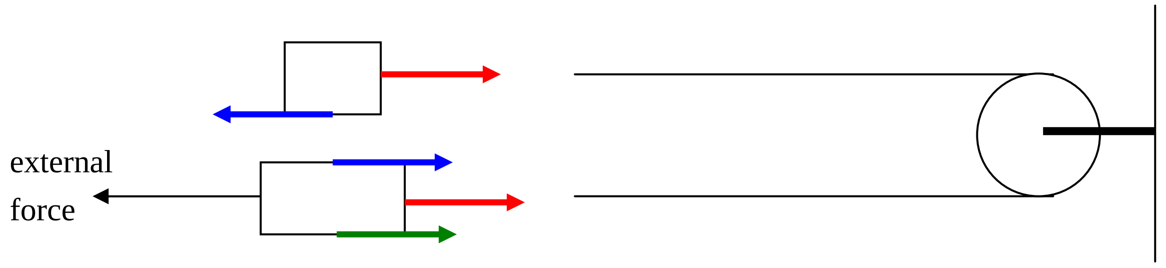
AL Physics MC Answers

Year:1997

Question Number: 1,2,3,4,5,6,9,12,14,15,16,17,18,19,20,21,24,25,26,27,33,40,41,42,43

1997MC(1)



Red force: tension = T (along the same string, tension is unchanged)

Blue force = friction between the two blocks = fr

- the upper block tends to move to the right, so the friction on it is to the left
- by action and reaction, the friction on the lower block is to the right

Green force = friction between the lower block and the floor = fr'

The upper block is stationary, so T= fr

The lower block is stationary, so the external force =T + fr +fr' = 2fr + fr'

The frictional forces increase with the external force, keeping the blocks stationary, until they reach their maximum value, i.e. 2 N.

Therefore, the lower block starts to move when external force = $(2fr + fr')_{maximum} = 2 \times 2 + 2 = 6$ N

1997MC (2)

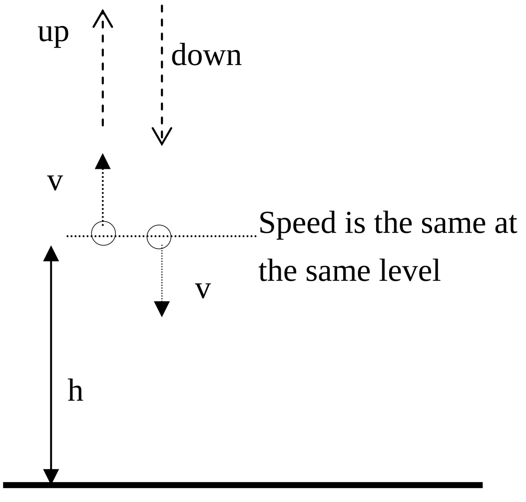
Total energy before reaching the ground = $mgh + mv^2/2$ ....(1)

Total energy after rebound = mgh ...(2)

(1) Correct, because there is energy loss during the rebound

(2) Correct. Energy loss = (1) – (2)

(3) Incorrect,



1997MC(3)

Let h be the height of the table

By conservation of energy

$\frac{1}{2}mu^2 + mgh = \frac{1}{2}mv^2$, so

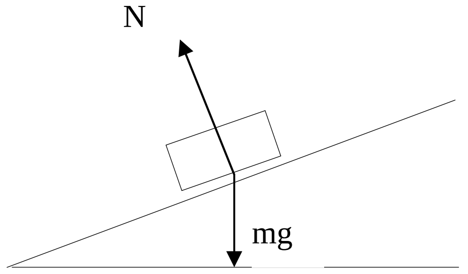
h = $\frac{v^2 - u^2}{2g}$ ……………..(1)

Vertical motion h = $\frac{1}{2}gt^2$

t = $\sqrt{\frac{2h}{g}}$ ……………………(2)

Putting (1) into (2), we will get the answer.

1997MC (4).



The acceleration is horizontal, so upward force = downward force

Ncosθ = mg …………(1)

The centripetal force is provided by Nsinθ, so Nsinθ = mv^2/R …………(2)

From (1) and (2), tanθ = mv^2/Rg

$$v = \sqrt{Rg\tan\theta} = 5.4ms^{-1}$$

[Remark: We do not say N = mg cosθ and a = gsinθ, because NOW, **THE ACCELERATION IS HORIZONTAL, NOT PARALLEL TO THE PLANE**]

1997MC (5)

Let r be the radius of the loop.

KE at the top of the loop is mg(h-2r), so the speed at the top of the loop $v = \sqrt{2g(h-2r)}$

Net force at the top F = mg +R, which is the centripetal force required.

$mg + R = mv^2/r = 2mg(h - 2r)/r$

So R increases linearly with h.

1997MC(6)

(1) Incorrect. The two fragments should have the same magnitude of momentum

$M_1V_1 + M_2V_2 = 0$

(2) Correct. Speed = P/m, so smaller mass, larger speed

(4) Correct. By writing $KE = P^2/2m$, where p is the momentum. Smaller mass, larger KE

1997MC (9)

Basic facts about SHM:

a leads v by $\pi/2$

v leads by x by $\pi/2$

(1) correct (2) correct (3) incorrect, because a and x are in anti-phase

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1997MC (12)

Refection of a transverse wave from a denser medium : π change, that means the wave is inverted

Reflection of a transverse wave from a less dense medium: no change in shape

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1997MC (14)

(1) Doppler effect, so the frequency will change.

(2) Longer distance, intensity is reduced, so amplitude is smaller

(3) If "speed" refers to the speed of propagation of wave in air, O.K., it doesn't change, but if "speed " refers to the speed of sound relative to the men on the ship, it is changed

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1997 MC(15)

(1) Incorrect. Path difference 3000 nm/400 nm = 7.5 = 7 + 1/2

It is the 8th dark fringe.

m = 0 → 1st dark fringe

m = 1→ 2nd dark fringe

so on

(2) Incorrect. The fringe pattern is independent of the separation between the light source and the slits.

. (3) Correct. 3000/500 = 6 (so P becomes a bright fringe)

1997MC (16)

Pipe A: wavelength of fundamental note = $4L_A$

Pipe B; wavelength of fundamental note = $2L_B$

Same fundamental note, so same wavelength, $4L_A = 2L_B$ $L_A:L_B = 1:2$

1997MC (17)

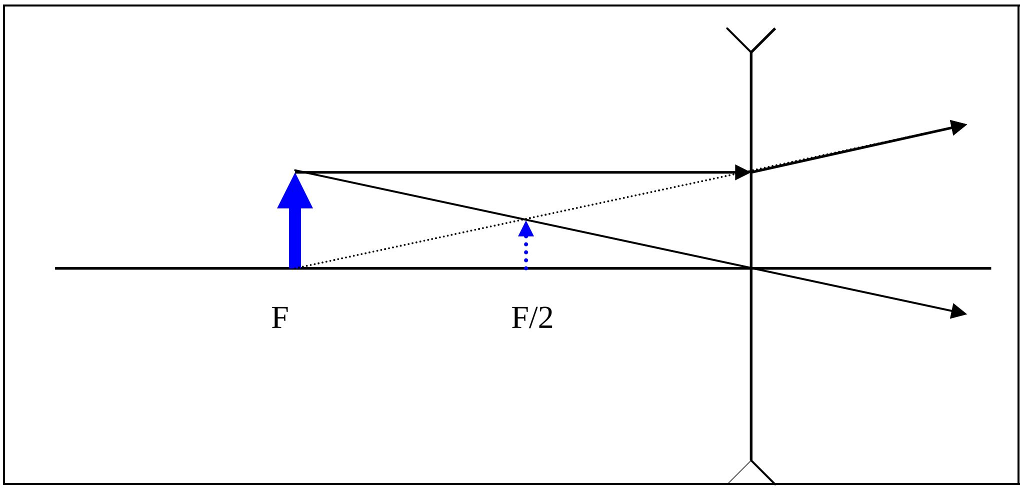
Optical path difference is increased if water is introduced (because wavelength is shorter in water).

For a particular order of fringe m, $2d = m\lambda$. After water is introduced, the condition becomes $2nd' = m\lambda$. Because $n > 1$, so $d' < d$. The same order now appears at a smaller thickness of film (i.e. at a smaller radius).

1997MC (18)

To a convex lens, object at 2F, object is formed at 2F, so to L1, 2f = 10 cm, f = 5 cm

To a concave lens, object at F, image is formed at F/2



To L_2, f = 20 cm > 10 cm

The best answer is D.

1997MC(19)

$d \sin\theta = m\lambda$

$d \sin(90^0 - 65^0) = \lambda$ ....(1)

[Note: θ is the angle measured from the zeroth order, which is 90^0 as measured by the protractor]

$d\sin\theta = 2\lambda$ ....(2)

Divide (2) by (1) $\sin\theta = 2\sin 25^0$

$\theta = 58^0$

The **protractor reads** $90^0 - 58^0$ or $90^0 + 58^0$

1997 MC(20)

Some facts about material

Stiffness (stiff/soft): slope of the elastic (linear) part

P is stiffer because it has a larger slope

Strength (strong/weak): highest point of the curve

Q has a greater strength because it has a higher ultimate tensile stress

Ductility (ductile/brittle): length of the plastic region

Q is more ductile because it has a longer plastic region

1997MC(21)

(2) The number of conduction electrons per unit volume solely depends on the type of material.

For instance, someone asks you: "There is a copper block of 1 m^3, how many free electrons does it contain?" What will you do? You will use the molar mass of copper, Avogadro's constant, etc to calculate, rather than saying:"I can't calculate because I don't know what voltage is applying to the copper block"

Yes, I = nqAv, but it tells us nothing about what the quantity n really depends on. Which of the four quantities n, q, A, and v is/are constant? We cannot tell from the equation itself. Only from the given information and other physics, we know n, q and A (auume same wire) are unchanged, so I is proportional to v.

Everybody knows density $\rho = \frac{M}{V}$, but would you say ρ is proportional to M?

Another example is wave speed v = fλ. Would we say v is proportional to f? NO ! "v=fλ" is always true, but v may or may not depends on f (c.f. light in vacuum and light in glass)

"y = kx" means y is proportional to x only when k is a constant

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1997MC (24)

Volume control is usually a variable resistor

1997MC (25)

Mass is proportional to volume.

Length of X = 3(Length of Y)

Cross-sectional area of x = (Cross-sectional area of Y)/3 (because of same mass)

$\text{Resistance } R \propto \frac{l}{A}$ $R_X:R_Y = 9:1$

Power P = I^2R $P_X:P_Y = 9(1^2):1(2^2) = 9 : 4$

1997MC (26)

Basic facts about motor

Battery voltage = V, induced emf = ε, internal resistance = R

V - ε = IR

$$\varepsilon \propto angular\ \ speed$$

Power delivered by the battery = VI

Power loss in armature coil = I^2R

Mechanical power developed = VI – I^2R = εI

1997MC (27)

(1) Time constant of an RC circuit = RC, so the unit of RC is second.

(2) Time constant of an LR circuit = L/R, so the unit of L/R is second.

(3) Resonant frequency = $\frac{1}{\sqrt{LC}}$, so the unit of $\sqrt{LC}$ is second (so LC is not)

1997MC (33)

(1) The glass wall is in thermal equilibrium. Its temperature does not rise after reaching the equilibrium. Then, the glass wall does not gain a net energy.

(2) No, if the resistance is high, the power of the lamp will be very small. This is irrelevant to the low efficiency of the lamp bulb.

(3) Most of the energy is dissipated as thermal energy. The thermal energy is radiated to outside in the form of infra-red

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1997MC (40)

Total impedance $Z = \sqrt{R^2 + (\frac{1}{\varpi C})^2}$

RMS current (ammeter reading) $I_{rms} = V_{rms}/Z$

As freq increases, Z decreases, so RMS current increases.

RMS voltage across C (voltmeter reading) = $I_{rms}\ X_C$

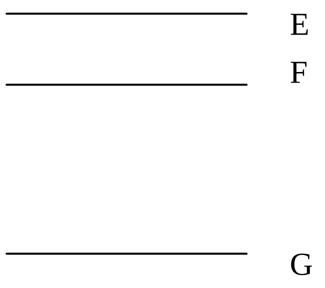
$$= \frac{V_{rms}}{\varpi C\sqrt{R^2 + (\frac{1}{\varpi C})^2}} = \frac{V_{rms}}{\sqrt{(\varpi CR)^2 + 1}}$$

When frequency increases, RMS voltage across C decreases.

[Quick thinking: a cap behaves as a "perfect conducting wire" at high frequencies, so as frequency increases, total current rises and the p.d. across C drops]

1997MC (41)

Suppose the three levels are E, F and G.



Longest wavelength of photon comes from the transition from E to F

$$h\frac{c}{\lambda_2} = E - F \quad \ldots\ldots\ldots\ldots\ldots(1)$$

Shortest wavelength of photon comes from the transition E to G

$$h\frac{c}{\lambda_1} = E - G \ldots\ldots\ldots\ldots\ldots\ldots(2)$$

Let the wavelength of the photon originating from the transition is F to G be λ

$$h\frac{c}{\lambda} = F - G \ldots\ldots\ldots\ldots\ldots\ldots.(3)$$

Since $(3) = (2) - (1)$

$$\frac{1}{\lambda} = \frac{1}{\lambda_1} - \frac{1}{\lambda_2} \quad \text{or} \quad \lambda = \left(\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right)^{-1}$$

[If F is closer to G, the longest wavelength comes from F to G.. Nevertheless, the result is the same]

1997MC (42)

It is a summing amplifier

R_f = 20kΩ.

Two input voltages to V_-

One input voltage: $V_1 = 30(\frac{2}{3}) - 15 = 5V$ R_{i1} = 10 kΩ

The other input voltage: $V_2 = 30(\frac{1}{3}) - 15 = -5V$ R_{i2} = 20 kΩ

$V_{out} = -R_f(\frac{V_1}{R_{i1}} + \frac{V_2}{R_{i2}})$ = -5V

1997MC (43)

Let m α–particles and n β–particles are emitted

One α particle will decrease the mass number by 4.

226 – 206 = 4m m = 5

One α particle decreases the atomic number by 2 and one β particle increases the atomic number by 1.

88 – 82 = m(2) – n n = 4