PHYSICS

1. The blue colour of the sky is the result of the scattering of light by the molecules of the atmosphere. This scattering is known as:

   A Mie scattering
   B Rayleigh scattering
   C Raman scattering
   D Brillouin scattering

2. The splitting up of a beam of white light by refraction into its components is called

   A. Reflection
   B. Refraction
   C. Dispersion
   D. Secular reflection

3. Who carried out a precise measurement of the elementary charge in 1909:

   A. Rutherford,
   B. Millikan
   C. Newton
   D. Bohr

4. Barrier penetration is a wavelike spreading of a quantum particle into a region of space that would be inaccessible to a classical particle. Numerous electronic devices depends on barrier penetration. One such application of barrier penetration is:

   A. Raman spectroscopy
   B. Electron paramagnetic spectroscopy
   C. Scanning Tunnelling electron microscope (STM)
   D. Diffuse Reflectance Infrared Fourier Transform Spectroscopy (DRIFTS)

5. A resonance technique involving the absorption of microwave radiation by a chemical species which has an unpaired electron(s) is called:

   A. X-ray photoelectron spectroscopy
   B. Electron spin resonance spectroscopy
   C. Diffuse Reflectance Infrared Fourier Transform Spectroscopy DRIFTs
   D. Scanning tunnelling electron spectroscopy

Answers

1- B 2-C 3-B 4-C 5-B

6. Volume of a given object is 16 cm^3. What is its volume in m^3?

   A. 1.6×10^{-1} m^3
   B. 1.6×10^{-3} m^3
   C. 1.6×10^{-5} m^3
   D. 1.6×10^{-8} m^3

Answer C

$1\ m^3 = 10^6\ cm^3$ so $1\ cm^3 = 10^{-6}\ m^3$

So $16\ cm^3 = 16 \times 10^{-6} = 1.6 \times 10^{-5}\ m^3$

7. Identify this main component of a DC (direct current) circuits as used in circuit diagrams:

   A. light bulb,
   B. capacitor,
   C. resistor,
   D. inductor

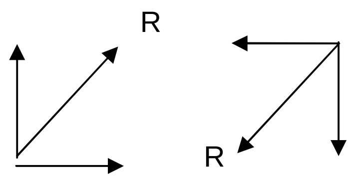
Answer D

Such a symbol represents an **inductor**

8. If all of a components of a vector are reversed in direction, the vector itself

A. Will stay the same in direction and magnitude
B. Will be reversed in direction
C. Will be doubled
D. Will be halved

Answer B

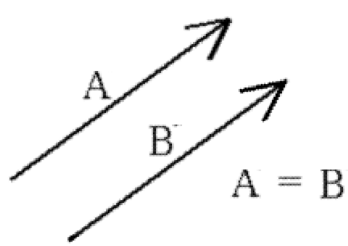


It is clear that reversing each component is equivalent of reversing the resultant.

9. Two vectors **A** and **B** are equal if

A. They have the same magnitude only
B. They have the same magnitude and direction
C. Only if they have the same magnitude and direction **and** have the same initial point
D. None of the above

Answer B

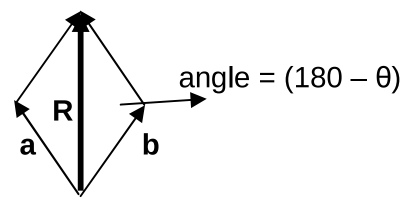


The two vectors are equal if they have the same magnitude and direction, regardless of whether they have the same initial points.

10. If two vectors of magnitude a and b are placed tail to tail and are making an angle of θ with each other, the magnitude of their resultant is

A. $\sqrt{a^2+b^2}$
B. $\sqrt{a^2+b^2}+2ab\cos\theta$
C. $\sqrt{a^2+b^2+2ab\cos\theta}$
D. $\sqrt{a^2+b^2+2ab\sin\theta}$

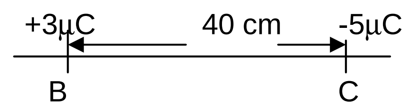
Answer C



Using the cosine rule:

$R^2 = a^2 + b^2 - 2ab\cos(180 - \theta)$

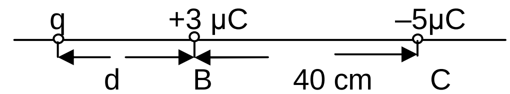
So $R = \sqrt{a^2 + b^2 + 2ab\cos\theta}$

11. 

Two charges are placed on an x-axis, +3μC at x=0, and -5μC at x=40 cm. where must a third charge, q, be placed if the force it experiences is to be zero?

A Within the interval BC
B To the right of C
C To the left of B
D None of the above

Answer C

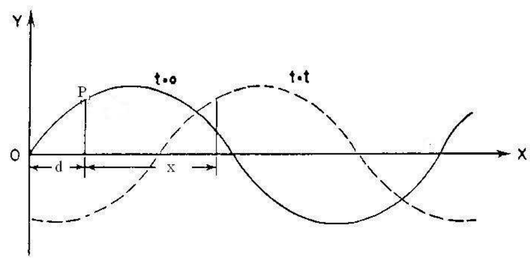


The situation is depicted above. Suppose that q is positive. When it is placed in the interval BC, the two forces (due to the two charges) are in the same direction and thus cannot cancel. When it is placed to the right of C, the attractive force due to -5μC will be larger than the repulsive force due to +3μC and therefore the force on q cannot be zero. Only in the region to the left of B can cancellation occur

12. A wave has the equation,

$y = 4 \sin(3\pi t - 6\pi x)$

This wave is travelling in the

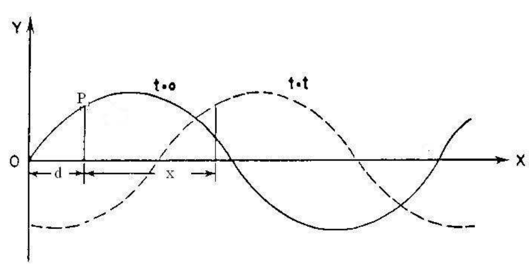


A. -x direction
B. +x direction
C. Cannot be answered unless the amplitude is given,
D. No direction, it is a standing wave

Answer

The general wave equation can be given by:

$$y = A \sin 2\pi vt$$



Where A = amplitude, v is the velocity at time t = 0. Some time later, say t, the wave will have moved as shown by the broken line and the point P will have moved a distance of x. If the broken curve is now moved back a distance of – x it will coincide with the curve at time t = 0 and this can be written as:

$$y = A \sin 2\pi (vt - x)$$

This can be re-written as used in the question, since v, π etc are constants.:

$$y = 4 \sin(3\pi t - 6\pi x)$$

and represents a wave moving in the positive x-direction.

13. For many purposes it is convenient to compare substances with one another. Pure water at 4^oC is often used as a standard substance and we define the relative density as

$$\text{relative density} = \frac{\text{density of substance}}{\text{density of water}}$$

The dimensions of relative density are

A. $[ML^{-3}]$
B. $[M^2L^{-3}]$
C. Dimensionless
D. $[ML^{-2}]$

Answer C

Relative density is the **ratio** of two densities and is therefore dimensionless.

14. A body of mass m has kinetic energy E, its momentum is

A. $\frac{4E^2}{m}$
B. $\frac{2E}{\sqrt{m}}$
C. $2mE$
D. $\sqrt{2mE}$

Answer D

Momentum, P = mv and Kinetic Energy,

$E_K = \frac{1}{2} mv^2$ or E as in the question.

Now $P^2 = m^2v^2$ and so $\frac{1}{2} P^2 = \frac{1}{2} m^2v^2$.

Dividing by m:

$\frac{1}{2} P^2/m = \frac{1}{2} mv^2 = E$. Rearranging this:

$P^2 = 2mE$, so $P = \sqrt{2mE}$

15. Light passes through a thick, parallel sided slab of glass with a refractive index 1.5. The angle of incidence of the light onto the glass is 30^0. With what angle does the light emerge on the other side of the slab?

A. 20^0
B. 30^0
C. 45^0
D. 60^0

Answer B

The incident ray and the exiting ray are parallel. The refracted ray deviates in the slab, and on emerging, continues in a parallel direction.

16. An impulse is equal to:

A. The product of a force and a time interval during which the force acts
B. The final linear momentum of a body on which it acts
C. A scalar quantity depicting change in kinetic energy
D. The ability of an object to do work

Answer A

An impulse is defined as the product of force and time. However the time interval is usually very small for an impulsive force, making the force very large. Mathematically this can be written as:

$$I = \int_0^{\Delta t} \vec{F}\, dt$$

17. When a motor turns through an integral number of revolutions, the angle in radians is an even multiple of

A. $\frac{\pi}{2}$
B. π
C. 2π
D. none of the above

Answer B

One revolution is 2π radians, so πn radians will always give a complete revolution if n is even, say n = 2m with m = 1, 2, 3, 4, . . giving n = 2, 4, 6, 8, . .

18. The potential energy of a stretched spring is proportional to

A. the square of the force constant
B. the square of the amount of stretch
C. both of these
D. Third power of the force constant.

Answer B

When a spring is stretched by an amount x, the potential energy, E_P, gained is:

$$E_P = \frac{1}{2}kx^2$$

19. Longitudinal waves cannot

A. have frequency
B. transit energy
C. be polarized
D. be reflected

Answer C

All the particles in a longitudinal wave move backwards and forwards in the direction of travel. Polarization requires transverse motion.

20. During a tornado, air pressure 8×10^4 Pa inside a house and 1×10^5 Pa out side the house. The net force on a window of area 0.5 m^2 is

A. 1.0×10^4 N
B. 4.0×10^4 N
C. 5.0×10^4 N
D. 3.0×10^4 N

Answer A

The pressure difference is ($10 \times 10^4 - 8 \times 10^4$) Pa, or 2×10^4 Pa. A pascal is the number of newtons per square metre. So on ½ a square metre the force will be:

$$1 \times 10^4 \text{ Pa}$$

21. Which one of the following statements is correct?

    A. The incident ray, reflected ray and the normal at the point of incident all lie in the same plane.
    B. The incident ray, reflected ray and the normal lie in different planes
    C. The incident ray lies in different plane to the reflected ray
    D. The normal to the reflecting plane does not bisect the angle of incident and reflected rays.

Answer A

This is straight bookwork, straight recall

22. A body that is in equilibrium could have

    A. uniform velocity
    B. motion in a circular path at uniform speed
    C. a uniform acceleration
    D. a constant net force applied to it

Answer A

A body in equilibrium has no resultant or net force acting on it, and as a result will move with uniform **velocity** or remain at rest. A body moving at constant speed in a circular path is experiencing an inward force: the centripetal force.

23. Sound waves travels faster in water than in air because water has a greater

    A. density
    B. bulk modulus
    C. shear modulus
    D. Viscosity

Answer B

$$\text{velocity of sound} = \sqrt{\frac{C}{\rho}}$$

where C = coefficient of stiffness and ρ is the density. In general speed of sound in fluid is

$$v_{fluid} = \sqrt{\frac{K}{\rho}}$$

Where K = is the bulk modulus of the fluid. Thus the speed of sound increases with the stiffness of the material, and decreases with the density

24. For what physical quantity must a consumer pay when the electricity bill is received or bought Pre-paid?

    A Power
    B Energy
    C Current
    D Voltage

Answer B

The consumer is buying energy.

25. The amount of work you have to do against gravity to push your car on a level road

    A depends on the local value of the acceleration due to gravity
    B is zero
    C depends on the mass of the car
    D depends on the force you apply

Answer B

If the car is pushed along a level road, the only work that can be done is against friction! No work is done against **gravity** as the car does not go up!

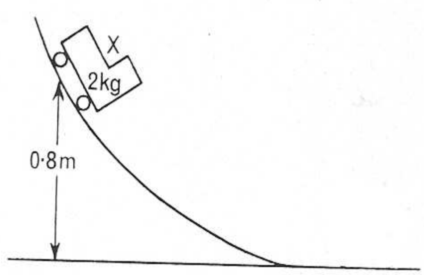
26. An astronaut travels from the Earth to the Moon

    A His mass will remain the same but his weight will be decreased
    B His mass will increase
    C His weight will increase
    D His mass and weight will remain the same.

Answer A

An astronaut moving between the Earth and Moon will experience different gravitational fields, and as a result his weight will change, but his mass remains constant

27. A trolley X of mass 2.0 kg rolls down a frictionless track from a vertical height of 0.8 m, as shown below. What is the velocity of X in ms^{-1} when it reaches the bottom?



    A 16.0
    B 8.0
    C 4.0
    D 1.6

Answer C

Assuming the trolley is also frictionless, the loss of potential energy equals the gain in kinetic energy ie.

$E_P = E_K$ or $mgh = ½ mv^2$ . . . . (1)

so $2 \times 10 \times 0.8 = ½ \times 2 \times v^2$ so,

$v^2 = 16$ and $v = 4\ m.s^{-1}$

Alternatively from 1:

$V = \sqrt{2gh} = \sqrt{2 \times 10 \times 0.8} = 4\ m.s^{-1}$

28. A given mass undergoes a uniform acceleration when the resultant force acting on it

    A is zero
    B is constant but not zero
    C increases uniformly with respect to time
    D is proportional to the displacement from fixed point

Answer B

If a body's acceleration is uniform, then the force acting on it is greater then zero (> 0) but constant.

29. Two projectiles are launched simultaneously with the same initial speed and position. One is launched at 70^o to the horizontal direction, and the other at 20^o to the horizontal. If the air resistance is neglected then both will land at the same point on a horizontal plane

    A The projectiles will land at the same time.
    B The projectiles will collide above the ground.
    C The projectile launched at 70^o to the horizontal will land first.
    D The projectile launched at 20^o to the horizontal will land first.

Answer D

The flight time of a projectile is given by

$$t_{flight} = \frac{2v_o \sin\theta}{g}$$

For this question for both the projectiles, v_o and g are constant,

$$t_{flight} \propto \sin\theta \quad \text{or} \quad t_{flight} \propto \theta$$

therefore the projectiles fired at 20° will take shorter time than projectile fired at 70°.

30. A 1000 kg car collides head-on with a 2500 kg bus. They stop instantly on collision. If before the impact the car was travelling at 20 ms^{-1}, the bus's speed was

A 5.7 ms^{-1}
B 8.0 ms^{-1}
C 20.0 ms^{-1}
D 25 ms^{-1}.

Answer B

Momentum, P, is mass x velocity = mv

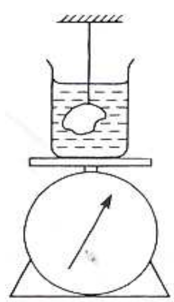
During a collision linear momentum is conserved, so $P_{BEFORE} = P_{AFTER}$ so

1 000 x 20 = 2 500 x v,

So v = 20 000/2 500 = 8 $m.s^{-1}$

31 When a beaker of water rests on a balance, the weight indicated is X. A solid object of weight W in air displaces weight Z of water when completely immersed What will be the balance reading when the object is suspended in the beaker of water so that it is totally immersed (but does not touch the beaker) as shown

A X
B X+Z
C X+Y-Z
D X+Y

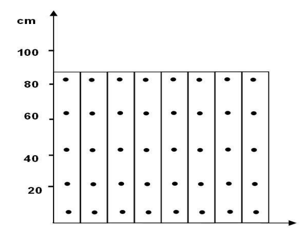


Answer B

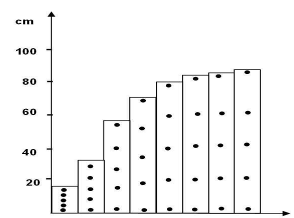
When an object is submerged in water it experiences an *up-thrust* equal to the mass (or weight) of the water displaced by that object. According to Newton's third law this *up-thrust* will have an equal *down-thrust* increasing the scale reading by the weight of water displaced. Therefore the scale will show X + Z.

32 You have performed four different experiments using a trolley and ticker timer etc. For each experiment you have obtained a chart from the ticker tape by cutting it into five tick lengths. Which one of the charts represents the motion with uniform acceleration?

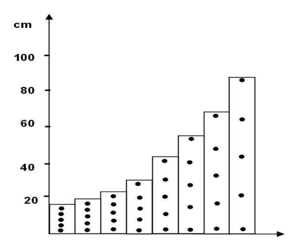
A



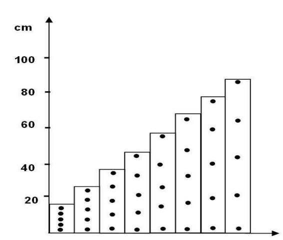
B



C



D



Answer C

All the graphs show displacement vs time. Using these axes, acceleration is shown by an upward curve as shown in C

33 If a runner doubles her speed, the ratio of her new kinetic energy to her original kinetic energy will be

A $\frac{1}{4}$
B $\frac{1}{2}$
C 2
D 4

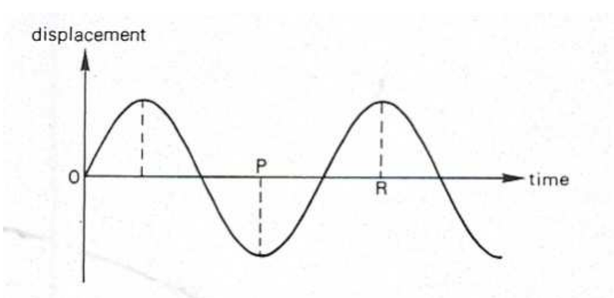
Answer D

Kinetic energy, E_K is ½ mv^2.

This means the $E_K \propto v^2$

So if her speed doubles her kinetic energy will be 4 x greater.

34 In the diagram below, the ***displacement*** of oscillating particle is plotted against ***time***. What does the length PR on the *x*-axis represent?



A Half the period.
B Twice the frequency.
C Twice the period.
D Half the wavelength.

Answer A

Since the *x*-axis represents **time**, the distance PR (which is half a cycle) is half periodic time, or is half a period!

35. In order for a convex (converging) lens, of focal length f, to form a real image of the same size as the object is, the object must be placed at

A 2*f*
B $\frac{f}{2}$
C $\frac{3f}{2}$
D *f*

Answer A

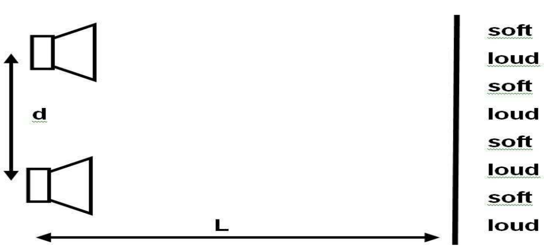
A simple line drawing of an object placed at 2f will produce an image at 2f on the other side of the lens. Mathematically:

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v}$$

where: f = focal length, u is the object distance and v is the image distance. If the size image is the same size as the object then u = v, so

$$\frac{1}{f} = \frac{1}{u} + \frac{1}{v} \quad \text{so} \quad \frac{1}{f} = \frac{1}{u} + \frac{1}{u} = \frac{2}{u}$$
$$\text{or} \quad u = 2f$$

36. Two loudspeakers are arranged as shown in the diagram below, are emitting sound waves of frequency 1000 Hz, in phase and of the same amplitude. The sound heard along XY alternates between loud and soft.
The distance between loud and soft regions may be decreased by



A using only one loud speaker
B decreasing the distance d
C increasing distance L
D using sound of higher frequency

Answer D

The distance between successive loud and

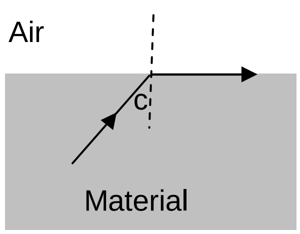
$$\Delta y = \frac{\lambda L}{2d}$$

soft sound is given by . In this case if we decrease λ (thus increasing *f*) the distance between successive loud and soft sound will decrease.

37. The sine of 30^o is 0.5000. What is the index of refraction of a material with critical angle of 30^o?

A 0.50
B 1.00
C 1.50
D 2.00

Answer D



Sin c = 1/n where n is the critical angle, so

$$n = \frac{1}{\sin c} = \frac{1}{\sin 30^o} = \frac{1}{0.5000} = 2.00$$

38. Visible light has wavelength between 400 nm and 700 nm and its speed is 3.0×10^8 ms^{-1}. What is the maximum frequency of visible light?

A 1.2×10^{11} Hz
B 4.3×10^{11} Hz
C 4.3×10^{14} Hz
D 7.5×10^{14} Hz

Answer D

The maximum frequency is obtained when the wavelength of the visible light is minimum ie. 400 nm Therefore, since v = c = 3.10^8 $m.s^{-1}$

$$f = \frac{v}{\lambda} = \frac{3.0 \times 10^8 \, ms^{-1}}{400 \times 10^{-9} \, m} = 7.5 \times 10^{14} \, Hz$$

39. In an electromagnetic wave, the electric field and magnetic field vectors are

A opposed to each other at every instant and along or against the direction of propagation of the waves
B perpendicular to each other and to the direction of propagation of the wave
C perpendicular to each other with the magnetic field vector parallel to the propagation of the wave
D opposed to each other and each perpendicular to the direction of the propagation

Answer B

For an electromagnetic wave all the three quantities are perpendicular to each other.

40. The electric field intensity at the midpoint between two spheres of the same size and identical charge is

A zero
B directed perpendicular to the line joining the centres of the spheres
C directed along the line connecting the spheres
D twice as large as if only one sphere was present

Answer A

Since the electric charges are identical they each will produce an electric field which will be opposing each other between the spheres, so the electric field intensity at the mid-point will be zero.

41. A charged rod is brought near an electroscope and the leaf deflects. The cap of the electroscope is touched with a finger keeping the rod near the cap. The finger and then the rod are removed and the electroscope is seen to be charged. The charge on the electroscope is

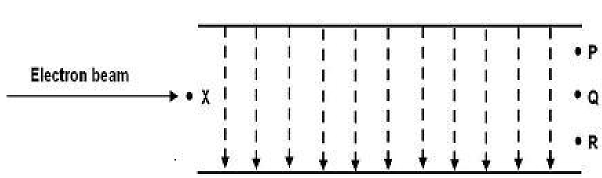
    A positive
    B negative
    C the same as that of the rod
    D opposite that of the rod

Answer D

When a charged rod is brought near the cap (of an uncharged) electroscope it attracts opposite charge near the cap and the same type of charge on the leaf. Now the cap is earthed (by touching) so the charge which is on the leaf is neutralised by this process while the charge which was attracted by the rod is still on the cap. When finally the charged rod is removed the charge which was on the cap is distributed all over making the electroscope oppositely charged than that of the road.

42. An electron beam enters in an evacuated tube in which there is a uniform electric field directed as shown in the diagram.
    Which of the following is a possible path of the beam?

    A a curved line from X to P
    B a curved line from X to R
    C a straight line XQ
    D a line curving out of the plane of the diagram



Answer A

Since the direction of the electric filed is directed from positive to negative and, since the electron beam carries a negative charge, the beam will be attracted towards the positive plate (upper plate), thus deflecting the beam upwards and so making curved path XP.

43. If the voltage applied across the ends of a conductor is unchanged but the resistance of the conductor is doubled, the current is

    A cut in half
    B cut into one-quarter
    C unchanged
    D doubled

Answer A

From Ohm's Law: $I_1 = \frac{V}{R}$

Since V is constant and R is doubled, then, .

$$I_2 = \frac{V}{2R}$$

Therefore the current is halved.

44. A charged capacitor of 1 μF holds 10μC charge. What is the energy stored by this capacitor?

    A $50 \text{ X } 10^{-12}$ J
    B $50 \text{ X } 10^{-9}$ J
    C $50 \text{ X } 10^{-6}$ J
    D $50 \text{ X } 10^{-3}$ J

Answer C

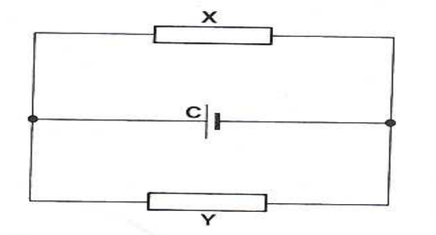
Energy stored in a capacitor, $E = \frac{1}{2} CV^2$

But since $V = Q/C$, then by substituting:

$$\text{Energy} = \frac{Q^2}{2C} = \frac{(10\times10^{-6}\text{ C})^2}{2(1.0\times10^{-6}\text{ F})} = 50\times10^{-6}\text{ J}$$

45. In the circuit shown, each of the resistors X and Y has resistance of 6 Ω. The cell C has an emf of 12 V and internal resistance of 3 Ω. What is the current in Y?

A 0.5 A
B 1.0 A
C 2.0 A
D 4.0 A

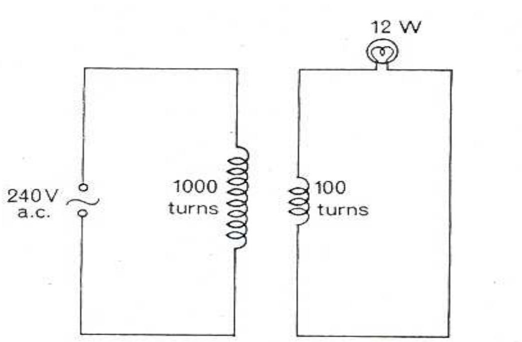


Answer B

Using E = I(R + r) where
R = external resistance,
E = emf,
r = resistance and
I = current.

X and Y are in parallel, so their effective resistance is = 3Ω and the total resistance is then 6Ω. The current I the is 2A, so, since the external resistors are equal and in parallel, each will carry a current of 1A.

46. A lamp marked 12 W is connected to a step-down transformer as shown in the diagram. Assuming that no energy is lost in the transformer, the current passing through lamp is



A 0.5 A
B 2.0 A
C 2.4 A
D 10 A

Answer A

It is a 10:1 (1 000:100) step down transformer, so the PD across the secondary is 24V.

Power = V x A,

so the current I = Power/V 12/24 = 0.5A

47. A high-voltage power line operates at 500 kV-rms and carries an rms current of 500 A. If the resistance of the cable is 0.5 Ω km^{-1}, what is the resistive power loss in 200 km of the power line?

A 250 kW
B 500 W
C 2.5 MW
D 25 MW

Answer D

If the resistance = 0.5Ω/km then the resistance of 200 km = 100Ω.

Power = $(current)^2$ x R

$I^2R = (500)^2 \times 100 = 250\,000 \times 100$

= 25 000 000 watts = 25 MW.

48. For ac circuits in which the source voltage varies sinusoidally and has an amplitude of V_o, the effective voltage

A is equal to 0.707 V_o
B depends on the circuit resistance
C is equal to the product of the current amplitude and resistance
D varies sinusoidally with time for a given frequency

Answer A

$$V = V_O/\sqrt{2} = V_O/1.414 = 0.707\ V_O$$

49. What is the maximum kinetic energy (in eV) of a photoelectron emitted from a surface whose work function is 5 eV when illuminated by a light whose wavelength is 200 nm?

A 1.90
B 1.21
C 3.10
D zero

Answer B

The kinetic energy, E_K, of the photoelectron is given by the equation:

$E_K = E_{PHOTON}$ –Work function, φ, or

$E_K = hf - \varphi$. From the wave equation $c = f\lambda$, so

$$f = \frac{v}{\lambda} = \frac{3.0 \times 10^{8}\ ms^{-1}}{200 \times 10^{-9}\ m} = 1.5 \times 10^{15}\ Hz$$

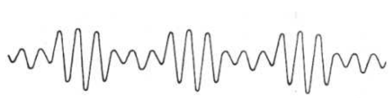
ie. $E_K = hf - \varphi$

$$= \frac{(6.63 \times 10^{-34}\ Js)(1.5 \times 10^{-15}\ Hz)}{1.6 \times 10^{-19}\ J\ eV^{-1}} - 5eV$$

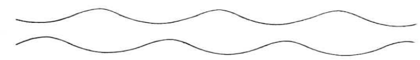
$$= 6.21eV - 5eV = 1.21eV$$

The value 1.6×10^{-19} is used to convert from joules to eV.

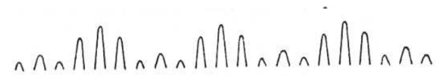
50. A signal is applied to a cathode ray oscilloscope and gives pattern shown in the figure.



When a p-n junction diode is connected in series with the signal, which one of the following patterns will be observed?

A


B


C


D

Answer C

The *p-n* junction diode will act as a *half-wave rectifier*. So the wave displayed will appear as if it has been shown in answer C.