Olympiad Physics Questions 2010

1 An object has a mass of 2.64 x 10^{24} kg. The number of significant figures this is expressed in is:

A 10^{24}
B 7
C 5
D 3

Answer D

2 If $\vec{A} \cdot \vec{B} = 0$ then $|A \times B|$ will be:

A zero
B AB
C $\sqrt{AB}$
D none of the above

Answer B

If **A** and **B** are vectors, then if **A**·**B** = 0 means that the angle between them is 90°. The cross product **A** x **B** = AB sin θ. Since sin 90° = 1, the magnitude of the product **A** x **B** = AB.

3 The equation of state for a real gas is given by $\left(P + \frac{a}{V^2}\right)(V - b) = RT$ where P, v and T are pressure, volume and temperature respectively and R is the universal gas constant. The dimensions of the constant *a* in the above equation are:

A $[M^{-1}L^{-5}T^{-2}$
B $[ML^2T^{-2}]$
C $ML^5T^{-2}]$
D Unable to answer this unless the units of *R* are known.

Answer C

The term (a/V_2) has been added to the pressure, hence it should have the dimensions of pressure.

$$\left[\frac{a}{V^2}\right] = [P]$$

$$so\ [a] = \left[V^2\right][P]$$

$$and\ \left[L^6\right]\left[\frac{MLT^{-2}}{L^2}\right] = \left[ML^5T^{-2}\right]$$

4 The odometer of a car reads 31 299 km at the start of a trip and 31 733 km at the end. If the trip took 4 hours, what was the average speed of the car during the trip, in m·s^{-1}:

A. 30,14
B. 33,34
C. 108,5
D. 120

Answer A

Average speed = ΔDistance/Δ time

ΔDistance = 31733 – 31299 = 434 km

This is 434 x 1000 m = 434 000 m
Δ time = 4 hrs = 4 x 60 x 60 = 14 400 s

So average speed = $\frac{434000}{14400}$ = 30,14 m·s^{-1}

5 A truck starts from rest and moves at a constant acceleration of 2 m·s^{-2}. After 5 s the distance, in meters (m), travelled by the truck will be:

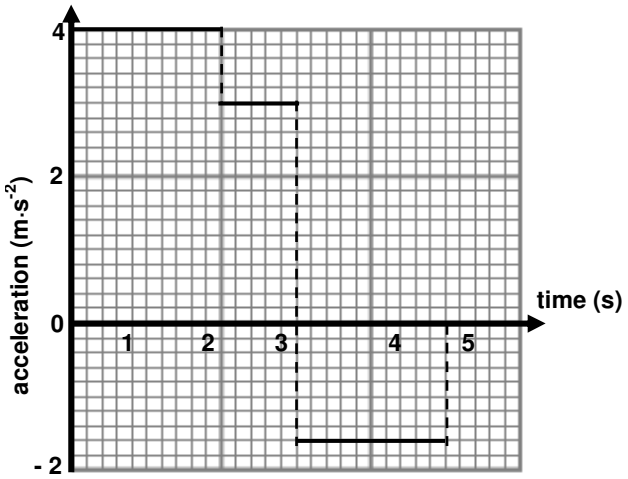
A. 5
B. 12,5
C. 25
D. 62,5

Answer C

Using $\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$

$\Delta x = 0 + ½ (2)(5)^2 = 25$ m

6 An object starts from rest and accelerates in a straight line. The change in acceleration of the object with time is shown in the graph below.



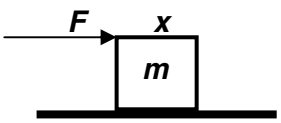
The speed (in $m \cdot s^{-1}$) of the object in the 5^{th} second is:

A. 0
B. 1,6
C. 7,8
D. 14,2

Answer C

In an acceleration – time graph the area between the graph and the time-axis is equal to the velocity.
Velocity = (4)(2) + (3)(1) – (1,6)(2) = 7,8 $m \cdot s^{-1}$
or
For first 2 s: $v_f = v_i + a\,\Delta t$ = 0 + (4)(2) = 8 $m \cdot s^{-1}$
For third second: $v_f = v_i + a\,\Delta t$ = 8 + (3)(1) = 11 $m \cdot s^{-1}$
Last two seconds: $v_f = v_i + a\,\Delta t$ = 11 + (- 1,6)(2) = 7,8 $m \cdot s^{-1}$

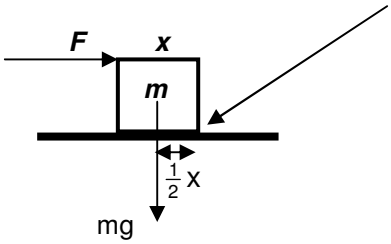
7 A cube of wood of mass *m* and side x, is placed on a rough horizontal surface. The friction between the block and the surface is sufficient so that the block can be toppled, without sliding, by applying a horizontal force, *F*, on the block as shown in the diagram below.



What is the minimum force *F* required for toppling the block?

A. mg
B. 2mg
C. $\frac{mg}{2}$
D. $\frac{mg}{\sqrt{2}}$

Answer C



When the torque (moment of the force) produced by the applied force *F* is just enough to topple the block, the toppling torque due to *F* is equal to the restoring torque due to mg about the edge shown:

$Fx = mg(\frac{1}{2}x)$ so $F = \frac{mg}{2}$

8 If the net work done on a car to increase its speed from 0 to *v,* is *W*. Which one of the following answers correctly shows the net work done to increase its speed from *v* to 3*v*?

A 2*W*
B 3*W*
C 8*W*
D 9*W*

Answer C

Work done = change of energy, in the case change of kinetic energy, ie:

$W = K_f - K_i = \frac{1}{2}mv^2 - 0 = \frac{1}{2}mv^2$

When the speed changes from v to 3v:

$W = K_f - K_i \quad \frac{1}{2}m(3v)^2 = -\frac{1}{2}mv^2$

$= 9(\frac{1}{2}mv^2) - \frac{1}{2}mv^2 = 8(\frac{1}{2}mv^2) = 8W$

9 The net work done on an object, moving on a horizontal rough surface in a straight line, is found to be zero. Which one of the following is true for this object?

A There is no frictional force acting on the object.
B The object has zero kinetic energy.
C The object moves at constant speed.
D The object moves at constant acceleration

Answer C

If the net work done in moving the object is 0, then the applied force is equal to the frictional force, so there is no net force on the object, and it therefore moves at constant speed.

10 Consider a planet whose mass and diameter were both half that of Earth. The weight of an object on its surface compared to that on Earth will be

A Same
B one-half
C Double
D One-fourth

Answer C

Using Newton's Law Universal of Gravitation, weight on Earth is:

$$W_E = \frac{GMm}{r^2}$$

On the planet, the weight is:

$$Wp = \frac{G\frac{M}{2}m}{\left(\frac{r}{2}\right)^2} = \frac{2GMm}{r^2} = 2W_E$$

11 Two objects, P and Q, have equal momentum. Object P has a mass of 1 kg and object Q has a mass of 4 kg. Which one of the following represents the ratio of their kinetic energies?

A. 2:1
B. 4:1
C. 8:1
D. 16:1

Answer B

Momentum is mass x velocity = mv
Kinetic energy K = ½ mv^2, so if

$m_Pv_P = m_Qv_Q$, then
$1v_P = 4v_Q \therefore v_P = 4v_Q$

$K_P = \frac{1}{2}mv^2 = \frac{1}{2}(1)(4v_Q)^2 = 8v_Q^2$

$K_Q = \frac{1}{2}(4)v_Q^2 = 2v_Q^2$

Ratio = 8:2 = 4:1

12 A spring which is initially in its natural condition , is first stretched by a length x and then again by a further length x. The work done in the first case is W_1 and in the second case is W_2 , then

A $W_2 = W_1$
B $W_2 = 2W_1$
C $W_2 = 3W_1$
D $W_2 = 4W_1$

If k is the force constant of the spring potential energy of the spring after first stretching

$$E_1 = \frac{1}{2}kx^2$$

Potential energy of the spring after second stretching

$$E_2 = \frac{1}{2}k(2x)^2 = \frac{1}{2}4kx^2 = 2kx^2$$

But $E_1 = W_1$ then

$$W_2 = E_2 - E_1 = 2kx^2 - \frac{1}{2}kx^2 = \frac{3}{2}kx^2 = 3W_1$$

13 The temperature of an ideal gas in increased from 120 K to 480 K. If the rms velocity of the gas molecules at 120 K is v, then at 480 K it becomes:

A 4v
B 2v
C v/2
D v/4

Answer C

The velocity of a gas molecule is given by:

$$v = \sqrt{\frac{3RT}{M}}$$

where v is the rms velocity. So at two different temperatures T_1 and T_2 the ratio of the two velocities is given by:

$$\frac{v_1}{v_2} = \sqrt{\frac{\frac{3RT_1}{M}}{\frac{3RT_2}{M}}} = \sqrt{\frac{T_1}{T_2}} = \sqrt{\frac{120}{480}} = \frac{1}{2}$$

so $2v_1 = v_2$ ie answer is $2v$

14 A machine gun fires bullets onto a wall at a rate of 100 bullets per minute. Each bullet has a mass of 4 g and is fired at a speed of 450 m·s^{-1}. Assume that all the momentum of the bullets is transferred to the wall The average force exerted by the bullets on the wall, in newtons, is:

A 1,8
B 3
C 30
D 1 800

Answer B

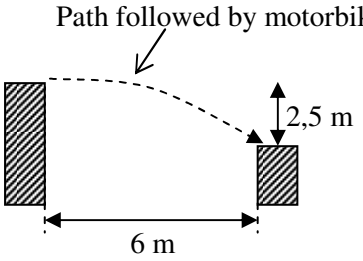
Force = rate of change of momentum, or

$$\boldsymbol{F} = \Delta \boldsymbol{P}/\Delta \boldsymbol{t}$$

so $\boldsymbol{F}\Delta t = \Delta \boldsymbol{P} = mv_f - mv_i$

$\therefore$ $\boldsymbol{F}$ (60) = (100)(0,004)(450 – 0)
$\therefore$ $\boldsymbol{F}$ = 3 N

15 A daredevil on a motorbike jumps a river 6m wide. He lands on the edge of the far bank, which is 2,5 m lower than the bank from which he takes off.



His minimum horizontal speed, in m·s^{-1}, at take off is:

A. 7,0
B. 8,4
C. 9,8
D. 10,8

Answer B

Vertically: using $\Delta y = v_i \Delta t + \frac{1}{2} a \Delta t^2$ it takes him:

2.5 = 0 + ½ x 9.8 x t^2 or 0.714 s to fall the 2.5 m between one side and the other.

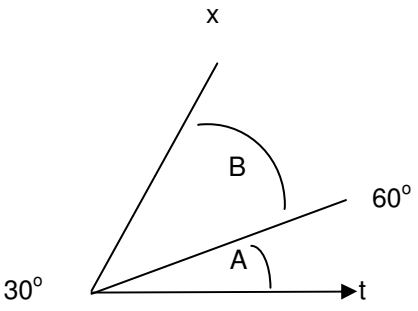
$\Delta x = v_i \Delta t + \frac{1}{2} a \Delta t^2$ Horizontally: using the minimum speed to get across is: (a = 0)

6 = v_i x 0.714 + 0 = 8.14

16 The displacement time graph for two particles A and B are straight lines Inclined at angles of 30^o and 60^0 with the time axis. The ratio of velocities v_A:v_B is:

A 1:2
B 1:√3
C √3:1
D 1:3

Answer D



$$v_B = \frac{\Delta x_B}{\Delta t} = Tan60 \quad \text{and} \quad v_A = \frac{\Delta x_A}{\Delta t} = Tan30$$

$$\frac{v_A}{v_B} = \frac{Tan60}{Tan30} = \frac{\frac{1}{\sqrt{3}}}{\sqrt{3}} = \frac{1}{3}$$

Questions 17 and 18 refer to the following extract: *In 2006 it was announced that a group of South African scientists from the University of Johannesburg made a breakthrough in developing affordable and highly efficient solar power technology. A 60 W solar panel could finally have a price of roughly around R 500, or R 8 to R 10 per watt, compared to imported panels entering South Africa at about R 30 to R 40 per watt.*

17 The leader of this group of scientists is:

A Diane Hildebrandt
B Vivian Alberts
C Phillip Tobias
D Hulda Swai

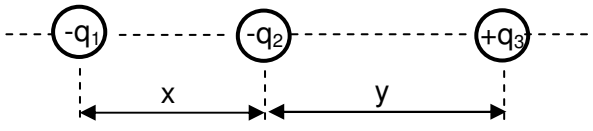
Answer B

18 The newly developed solar panel Makes use of … to absorb heat.

A silicon as semi-conductor
B gallium and selenium between two normal window glasses as semi-conductor
C a compound semi-conductor comprising five different elements
D Germanium and silicon as semi-conductors

Answer C

19 The diagram below shows three insulated conductors carrying charges of $-q_1$, $-q_2$ and $+q_3$.They are situated on the same straight line as shown in the diagram (not drawn to scale).



The magnitude of the net electrostatic force experienced by charge q_2 due to the presence of the other two charges can be expressed as:

A $kq_2(\frac{q_1 - q_3}{x^2 y^2})$

B $kq_2(\frac{q_1 + q_3}{x^2 y^2})$

C $kq_2(\frac{q_1 y^2 - q_3 x^2}{x^2 y^2})$

D $kq_2(\frac{q_1 y^2 + q_3 x^2}{x^2 y^2})$

Answer D

It is clear that Q_2 will experience a force to the right of magnitude:

$$F = \frac{kq_1 q_2}{x^2} + \frac{kq_2 q_3}{y^2}$$

$$= kq_2\left(\frac{q_1}{x^2} + \frac{q_3}{y^2}\right)$$

$$= kq_2\left(\frac{q_1 y^2 + q_3 x^2}{x^2 y^2}\right)$$

20 An electrostatic force of attraction exists between two small conducting spheres. This force of attraction can occur for a variety of reasons. Which of the following statements MUST be true?

A At least one sphere is charged.
B Both spheres must be charged.
C Neither of the spheres is charged.
D Both spheres must have the same charge.

Answer A

If only one sphere is charged it can induce a charge in the other and so there will be a force between them. For B and D the conditions do not HAVE to be so, and for C there is no force.

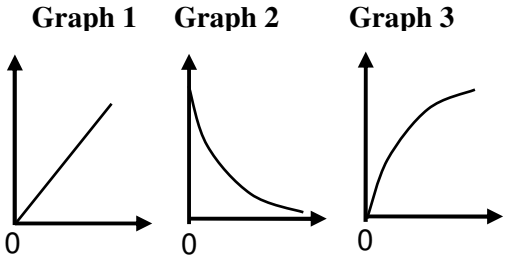
21 The method of detecting the presence, position and direction of motion of distant objects by reflecting a beam of sound waves is known as:

A RADAR
B SONAR
C NMR
D MI

Answer B

SONAR is an acronym for SOund Navigation And Ranging.

22 During a practical investigation a DC source is used to charge a capacitor. The three graphs shown below were obtained from the results of the investigation.



Which one of the following correctly describes the labels of the three graphs?

	Graph 1	Graph 2	Graph 3
A.	Charge vs time	Current vs time	Potential difference vs time
B.	Charge vs potential difference	Potential difference vs time	Current vs time
C.	Potential difference vs time	Current vs time	Charge vs potential difference
D.	Charge vs potential difference	Current vs time	Potential difference vs time

Answer A

1 Charge accumulates proportional to time
2 Initial current is high and then decreases: inversely proportional to charge accumulation with time.
3 Potential Difference increases rapidly initially and then levels off to a maximum

Answer A has the order correct.

23 A charge Q is divided in to two parts *q* and (*Q*-*q*). What will the ratio q:Q for the force between them to become the maximum?

A 1:8
B 1:4
C 1:2
D 1:1

Answer C

If the distance between the two charges stays constant, then Coulomb's Law can be written as:

$$F = Cq(Q-q) = CQq - q^2$$

Now $\frac{dF}{dq} = 0$ for a maximum

$\frac{dF}{dq} = Q - 2q = 0$ so q/Q = 1/2

24 Seven capacitors each of capacitance 2 μF are to be connected to obtain a capacitance of (10/11) μF. Which one of the following combinations is possible?

A 5 in parallel with 2 in series
B 4 in parallel with 3 in series
C 3 in parallel with 4 in series
D 2 in parallel with 5 in series

Answer A

For capacitors in parallel they simply add up, whereas for those in series they add up as fractions, ie

$$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$$

Five 2μF capacitors in parallel gives 10 μF and then two in series gives:

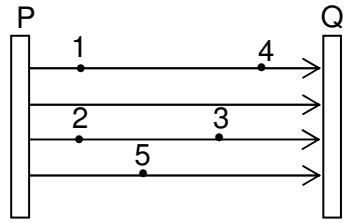
$\frac{1}{C} = \frac{1}{2} + \frac{1}{2} = 1$ so C = 1

Then connecting this in series with the others:

$$\frac{1}{C_F} = \frac{1}{10} + \frac{1}{1} = \frac{1+10}{10} = \frac{11}{10}$$

$$\therefore C_F = \frac{10}{11}\mu F$$

25 The diagram below shows different points in an electric field between two parallel plates, P and Q.



Which one of the following statements is correct?

A The charge on plate P is positive and point 2 is at a higher potential than 3
B The charge on plate P is negative and point 5 is at a higher potential than 4
C The charge on plate P is negative and point 3 is at a lower potential than 1
D The charge on plate P is positive and all points are at the same potential.

Answer A

The diagram indicates that the field is such that P is positive (or at a higher potential than Q), so point 2 is at a higher potential than 3.

26 In a transformer, the secondary coil has twice as many turns as the primary. If the alternating current in the primary coil is 2 amperes, what is the current in the secondary coil, in amperes?

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

Answer C

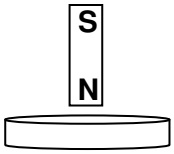
$\frac{V_s}{V_p}=\frac{N_s}{N_p}$ so $\frac{V_s}{V_p}=\frac{2}{1}$ and $V_s = 2V_p$

Now Power in = Power out, so if the PD is doubled, the current is halved, = 1A. ie

$V_pI_p = V_sI_s$ so $V_pI_p = 2V_pI_s$

$\therefore$ $I_p = 2I_s$ substituting $2 = 2I_s$ and $I_s = 1$ A

27 A bar magnet falls through a copper ring as shown below.



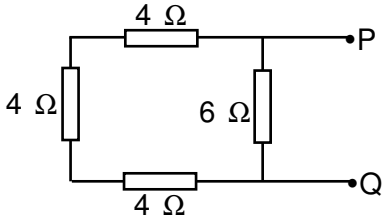
Which one of the following correctly describes the magnitude of the acceleration of the magnet while it falls through the ring?

A Equal to 9,8 $m{\cdot}s^{-2}$
B Larger than 9,8 $m{\cdot}s^{-2}$
C Smaller than 9,8 $m{\cdot}s^{-2}$
D Zero

Answer C

As the magnet falls towards the circular conductor (copper ring) it will induce a current in the conductor. According to Lenz's Law, this current will flow in such a direction that the magnetic field produced will oppose the motion of the falling magnet. There is therefore a force acting upwards on the magnet and so decreasing the net downward force on it and so the magnet's acceleration will be less than before.

28 Four resistors are connected as shown below.



The total resistance, in ohm, between P And Q is:

A 4
B 6,4
C 10,4
D 18

Answer A

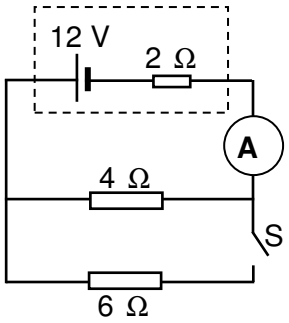
The circuit effectively has three resistors in series joined in parallel with another.

$R_S = 4 + 4 + 4 = 12\Omega$

$$\frac{1}{R_T} = \frac{1}{12} + \frac{1}{6} = \frac{3}{12} = \frac{1}{4}$$

So $R_T = 4\Omega$

29 A battery of emf 12 V and internal resistance of 2 Ω is connected in a circuit as shown below.



When switch S is closed, the ammeter reading changes from:

A 2 A to 1 A
B 2 A to 2,7 A
C 3 A to 1,2 A
D 3 A to 5 A

Answer B

With S open, total resistance = 6Ω, so current I = 2A.

With S closed total resistance is:

$$\frac{1}{R_P} = \frac{1}{6} + \frac{1}{4} = \frac{2+3}{12} = \frac{5}{12}$$

so $R_P = 2.4\Omega$. Total resistance is now

2.4 + 2 = 4.4Ω so current is now

12/4.4 = 2.7A.

30 When the cells are connected in parallel:

A net emf increases,
B net emf decreases
C current capacity increases,
D current capacity decreases.

Answer C

With resistors in parallel, the current has more paths available, so capacity increases. Alternatively, each resistor carries a current, and all the currents are added

Questions 31 & 32 refer to the following extract: *South Africa made history when it successfully launched its second satellite into space on 17 September 2009 from Kazakhstan, on the back of a Russian rocket and carries a high-resolution camera*

31 The satellite is called:

A NalediSat
B SumbandilaSat
C SUNSAT
D MapungubweSat

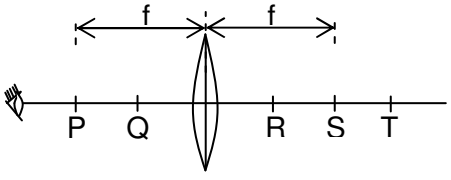
Answer B

32 The high-resolution camera will produce images that will be used for:

A Mapping infrastructure and land use, as well as tracking population in Russia
B Improvement of the quality of television transmissions only
C Monitoring agriculture, tracking population movement, measuring water levels of dams and mapping infrastructure and land use
D Improvement of radio-communication only.

Answer C

33 An artist uses a magnifying glass to draw a picture on a grain of rice. *f* is the focal length of the magnifying glass. At which one of the points, in the diagram shown below, must he place the rice?



A. Q
B. R
C. S
D. T

Obviously the rice grain needs to be placed on the opposite side of the lens to the eye. The image also needs to be upright and enlarged, and so it must be placed between the focal point, S, and the lens, ie at R.

34 Optical fibres are used to transmit pulses of light and in telecommunications to transmit telephone conversations and data. This is possible due to:

A total internal refraction,
B the diffraction of light
C total internal refraction,
D the interference of light

Answer C

Recall. Total internal reflection

35 An astronomer observes electromagnetic waves emitted by oxygen atoms in a distant galaxy and found that these waves have a frequency of 5,7 x 10^{14} Hz. In the laboratory on Earth, oxygen atoms emit waves with a frequency of 5,8 x 10^{14} Hz. The speed of light is 3 x 10^{8} m·s^{-1}. The velocity of the galaxy relative to the Earth is:

A 5,17 x 10^{6} m·s^{-1} away from the Earth
B 5,17 x 10^{6} m·s^{-1} towards the Earth
C 3,33 x 10^{4} m·s^{-1} away from the Earth
D 3,33 x 10^{4} m·s^{-1} towards the Earth

Answer A

The light from the galaxy has a lower frequency that the laboratory sample, and so a longer wavelength, and is therefore moving away from Earth: it is exhibiting redshift.

$$f_L = \frac{v \pm v_L}{v \pm v_s} f_s$$

so 5,7 x 10^{14} = 5,8 x 10^{14}($\frac{3\times10^{8} - v_L}{3\times10^{8}}$)

and v_L = 5,17 x 10^{6} m·s^{-1}

36 A sound wave of frequency 500 Hz Covers a distance of 1000 m in 5 seconds between two points X and Y. the number of waves between X and Y are:

A 500
B 1 000
C 2 500
D 5 000

Answer C

Speed = distance/time and
Speed = frequency/wavelength
So distance/time = frequency/wavelength, ie

1000/5 = 500/λ, so λ = 0.4 m and so in 1000 m there are 2 500 waves.

37 Solid P has a bigger refractive index than solid Q. What happens to the speed, wavelength and frequency of light passing from solid P to solid Q?

	speed	**wavelength**	**frequency**
A.	decreases	decreases	stays constant
B.	increases	increases	decreases
C.	increases	stays constant	increases
D.	increases	increases	stays constant

Answer D

The light is going from a high to a low RI medium, example, from say glass to air. In all refractions frequency is constant, the speed in the higher optical density medium is lower, so on leaving the speed of light increases, and so the wavelength must also increase

38 A light of wavelength 600 nm in air enters a medium with refractive index 1.5. Inside the medium its wavelength will be:

A 900 nm
B 600 nm
C 400 nm
D 300 nm

Answer C

The refractive index, n, is the ration of the speed in air to that in the medium, ie

$$n = \frac{C_{AIR}}{C_{MEDIUM}} = \frac{f\lambda_{AIR}}{f\lambda_{MEDIUM}} = \frac{\lambda_{AIR}}{\lambda_{MEDIUM}}$$

$$\therefore \lambda_{MEDIUM} = \frac{\lambda_{AIR}}{1.5} = 400nm$$

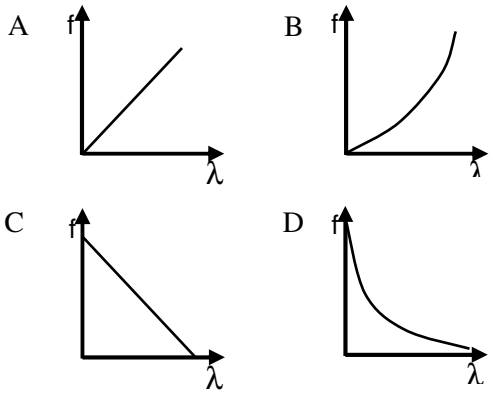
39 A single slit diffraction pattern is obtained on a screen using blue light. If the blue light is replaced by yellow light without making any other changes in the experimental setup, what will happen to the diffraction bands?

A Bands will become broader and farther apart
B Bands will become broader and crowded together
C Bands will become narrower and farther apart
D Bands will become narrower and crowded together

Answer A

Yellow light has a longer wavelength than blue light, and so there is more diffraction

40 Which one of the following graphs correctly represents the relationship between frequency and wavelength of photons of electromagnetic radiation?



Answer D

$v = f\lambda$ and f = $\frac{v}{\lambda}$, so f $\alpha \frac{1}{\lambda}$

If the speed remains constant.

41 An X-ray tube produces a continuous spectrum of radiation with its short wavelength end at 0.45Å. What is the maximum energy of a photon in the radiation?
(1eV = 1.6x10^{-19}J)

A 2,76 keV
B 2,76 MeV
C 27,6 eV
D 27,6 keV

Answer D

0.45Å= 0.45 x 10^{-10} m

$$E = \frac{hc}{\lambda} = \frac{6.6x10^{-34}\ x\ 3x10^{8}}{0.45x10^{-10}} J$$

$$= \frac{44.2x10^{-16}}{1.6x10^{-19}} eV = 27.6keV$$

42 A source of light is placed 1 m from a photo cell and cutoff potential is found to be V_0. If the distance is doubled, the cutoff potential will be:

A $2V_0$
B $V_0/2$
C V_0
D $V_0/4$

Answer C

The change in distance only affects the intensity of the radiation, not the energy of the incident photons. The cutoff potential is a property on the photoelectric material and so is unaffected by the energy of the incident photons.

43 The difference of kinetic energies of photo electron emitted from a surface by light of wavelength 2500Å and 5000Å will be:

A 1,6 x 10^{-19} J
B 3,96 x 10^{-20} J
C 3,96 x 10^{-19} J
D 1,6 x 10^{-30} J

Answer C

The energy of a photo-electron is given by:

$E_{RADIATION} = E_{ELECTRON} + \varphi$,

where φ = work function of the metal.
So E = hf = E_K + φ,
and E_K = hf – φ = (hc/λ) – φ. This means that:

$$\Delta E = E_2 - E_1 = hc\left(\frac{\lambda_2 - \lambda_1}{\lambda_1 \lambda_2}\right)$$

$$= 6.6\,x10^{-34}\ x\,3\,x10^{8}\left(\frac{2500\,x10^{-10}}{2500\,x\,5000\,x10^{-20}}\right)$$

$$= 3.96\,x10^{-19}\,J$$

44 Ultraviolet radiation is incident on the surface of a certain metal. Photoelectrons are ejected with a maximum velocity *v* and kinetic energy E_K. Light of the same frequency, but twice the intensity, is now shone onto the same metallic surface. Which of the following statements is (are) true?

I The maximum speed of ejected photo-electrons will increase from *v* to *2v*.
II Twice the amount of electrons will now be emitted per second.
III The maximum kinetic energy of ejected photoelectrons will increase from E_K to *2* E_K .

A Only I and III
B Only I and II
C I, II and III
D Only II

Answer D

The E_K of the photoelectrons depends on the energy of the incident photons, or the **frequency** of the incident radiation. The number of emitted photons depends on the **intensity** of the incident radiation. So by increasing the intensity of the incident radiation only the number of electrons ejected is affected.

45 The maximum kinetic energy of photo-electrons emitted from a surface when photons of 6 eV fall on it is 4 eV. The stopping voltage, in volts, is:

A 2
B 4
C 6
D 10

Answer A
$E_{RADIATION}$ = $E_{ELECTRON}$ + work function of metal

So E_R = E_E – φ or 6eV = E_E – 4eV

So E_E = (6 – 4) eV = 2 eV which converts to 2V

46 The production of an electron beam in a television tube is based on the phenomenon of

A photoelectric effect
B ionization
C thermionic emission
D screening

Answer C

47 Electrons are accelerated from rest through a small potential difference *V* and reach a speed *u*. The ratio of the charge of the electron to its mass (*e/m*) is:

A u/V
B V/u
C $u^2/2V$
D $2u^2/V$

Answer C

Potential Difference, PD = work done per unit charge, ie V = E/e so E = Ve, where e is the charge on an electron.

E is also equal the gain in kinetic energy, or

E = ½ mu^2 so ½ mu^2 = Ve

or $\frac{e}{m} = \frac{u^2}{2V}$

48 When high speed electrons strike a target:

A only heat is produced,
B only continuous X-rays are emitted,
C only continuous and characteristic X-rays are emitted,
D heat is produced and simultaneously continuous and characteristic X-rays are emitted.

Answer D

99% of the energy of striking electrons is used up in heating the target and hardly 1% is converted in the form of continuous and characteristic X-ray radiation.

49 For the following nuclear fusion reaction to occur:

$$^{1}_{1}\mathrm{H} + ^{1}_{1}\mathrm{H} + ^{2}_{1}\mathrm{H} \rightarrow ^{4}_{2}\mathrm{He} + ^{0}_{1}\mathrm{e} + \text{energy}$$

A only very high temperature is required
B a normal temperature and very high pressure is required
C a very high temperature and very high pressure is required
D a very high temperature and very low pressure is required

Answer C

When positively charged nuclei come very close to fusion, electrical repulsive force between them becomes very strong. For fusion to occur against this force they require very high energy. To impart very high energy to them very high temperatures and very high pressures are required.

50 Radon is a radioactive gas, Rn^{222}_{86}, and decays by emitting α (He^{4}_{2}) and β (e^{0}_{-1}) particles to produce Polonium, Po^{214}_{84}. Which one of the following decay processes correctly describes:

$$\mathrm{Rn}^{222}_{86} \rightarrow \mathrm{Po}^{214}_{84}$$

A α α β β
B α β β β β
C α β α α β β
D β β α

Answer A

The relative mass change from Radon to Polonium is 8 units. Electrons have zero mass, so this means that 2 α-particles are emitted. This means a charge change of 4 units. The change is 2 units, so two β-particles or electrons are emitted.