F.Y. Diploma : Sem. II

[AE/FE/ME/MH/MI/PG/PT/PS]

Applied Physics

Time : 2 Hrs.] Prelim Question Paper Solution [Marks : 50

Q.1 Attempt any NINE of the following : [18]

Q.1(a) A car moving with an initial speed of 54 km/hr decelerates to 25 km/hr in 9 seconds. Calculate the SOL deceleration. [2]

(A) Formula.

Answer with unit.

Given u = 54 km/hr = $54 \times 1000/60 \times 60 = 15$ m/s,

v = 25 km/hr = $25 \times 1000/60 \times 60 = 6.94$ m/s, t=9 sec, a=?

We have, $v = u + a\,t$

$a = v - u / t$

$a = 6.94 - 15/9$

$a = 0.8955$ m/s^2

Q.1(b) State Netwton's first law of motion. Give one example. [2]

(A) (i) Newton's First Law of motion : It states that every body continues in its state of rest or of uniform motion in a straight line, unless it is acted upon by some external force.

(ii) examples (any one)

(1) When a bus suddenly starts, the passengers sitting or standing in the bus tend to fall backward.

(2) When a blanket is given a sudden jerk, the dust particles in it fall off due to inertia at rest.

Q.1(c) Define : [2]

(i) Angular displacement (ii) Angular acceleration

(A) (i) Angular displacement

It is the angle through which the radius vector turns when the particle in circular motion moves from one position to Other.

OR

It is defined as the angle subtended by the radius vector when a particle in circular motion moves from one position to other.

(ii) Angular acceleration

The rate of change of angular velocity with respect to time is called as angular acceleration.

Q.1(d) State any two properties of ultrasonic waves. [2]

(A) (i) Frequency of these sound waves is more than 20kHz.

(ii) It has shorter wavelength.

(iii) They carry high amount of sound energy.

(iv) The speed of propagation of ultrasonic waves increases with increase in frequency.

(v) They show negligible diffraction.

(vi) Ultrasonic waves travel over long distance without considerable loss.

(vii) Ultrasonic waves undergo reflection and refraction at the separation of two media.

(viii) If it passed through fluid, then temperature of the fluid increases.

(ix) They travel with constant speed through a homogeneous medium.

(x) They possess certain vibrations which are used as good massage action in case of muscular pain.

Q.1(e) State any two applications of ultrasonic testing. **[2]**

(A)
(i) To detect flaw: flaws in metal, rubber, tyre, concrete, wood composites, plastics components
(ii) Rail inspection: Rail tracks are tested on the spot which avoids service failure in track
(iii) Air-craft inspection: To detect crack
(iv) Tunnel inspection: To detect crack
(v) Bridge inspection
(vi) To detect subsurface discontinuities
(vii) To test plant component
(viii) Testing: It is used to test casting, forging, welding fabrication, rolling, heat treatment
(ix) Monitoring: Monitoring of thermal and atomic power plant, equipment pipe lines and structures
(x) On line tube testing: Channel ultrasonic flaw detection with thickness measurement of tube and hence corrosion

Q.1(f) Define : **[2]**
(i) Neutral temperature **(ii) Inversion temperature**

(A)
(i) Neutral temperature : The temperature at which the e.m.f is maximum is called neutral temperature.
(ii) Inversion temperature: The temperature at which the e.m.f becomes zero is called inversion temperature

Q.1(g) State any two applications of LDR. **[2]**

(A) Application of LDR
(i) It is used in camera exposure control.
(ii) It is used in photocopy (Xerox) machine to control density of toner.
(iii) It is used in security alarm.
(iv) It is used as flame, smoke and burglar detectors.
(v) It is used as automatic lighting control for street light.
(vi) It is used in colorimetric test equipment.
(vii) It is used as automatic rear view mirror.

Q.1(h) State any two factors affecting thermo emf. **[2]**

(A) Factors affecting thermo emf-
(i) Nature of metals forming thermo couple.
(ii) Temperature difference between two junctions.
(iii) Materials used for the terminals, contact and contact Connectors.

Q.1(i) State any two characteristics of thermocouple. **[2]**

(A)
(i) Measurement of thermoelectric e.m.f
(ii) The temperature difference between the two junctions.
(iii) Pair of metal used in thermocouple.
(iv) It is selected as per the requirement of the system whose temperature is to be determined.

Q.1(j) State any four methods of non-destructive testing. **[2]**

(A) N.D.T: Non-Destructive Testing Methods.
(i) Liquid penetrant testing (LPT)
(ii) Ultrasonic testing (UT)
(iii) Magnetic particle testing (MT)
(iv) Radiograph testing (RT)
(v) Leak testing (LT)
(vi) Visual testing (VA)
(vii) Holographic testing (HT)
(viii) Thermal infra radiography (TR)

Q.1(k) A car moving with an initial velocity 90 km/hr comes to rest in 10 seconds when brakes are applied. Find the retardation value. **[2]**

(A) Formula and substitution

Given :

Initial velocity of a car (u) = 90 km/hr = (90×1000) / 3600

u = 25 m/sec.

Final velocity of a car (v) = 0 m/sec.

Time (t) =10 sec, a =?

Formula :

Retardation (a) = (v- u) / t

Retardation (a) = (0-25) /10

Retardation (a) = - 2.5 m/sec2

Q.1(l) The energy of a photoelectron is 2.8 eV. Calculate its wavelength (Planck's constant, h = 6.625 × 10^{-34} J-sec; speed of light, c = 3 × 10^{8} m/sec) **[2]**

(A) Given : h = 6.625×10^{-34} J-sec, c = 3×10^{8} m/s,

$E = 2.8 \text{ eV} = 2.8 \times 1.6 \times 10^{-19} = 4.48 \times 10^{-19}$ J

$E = h \upsilon$ But, $\upsilon = c / \lambda$

$E = h c / \lambda$

$\lambda = h c / E$

$\lambda = 6.625 \times 10^{-34} \times 3 \times 10^{8} / 4.48 \times 10^{-19}$

$\lambda = 4.436 \times 10^{-7}$

$\lambda = 4436 \times 10^{-10m}$ OR $\lambda = 4436\ A^{0}$

Q.2 Attempt any FOUR of the following : **[16]**

Q.2(a) Define the terms : (i) Projectile (ii) Trajectory (iii) Angle of projection (iv) Time of flight **[4]**

(A) **(i) Projectile:** The object which moves in air by making an angle θ (less than 900) with the horizontal.

(ii) Trajectory: The path along which projectile moves is called trajectory.

OR

It is also defined as the path traced by an object in projectile motion.

(iii) Angle of projection: It is defined as angle made by the velocity of projection with the horizontal at the original point.

(iv) Time of flight: The total time in which projectile covers the entire trajectory is called as time of flight.

Q.2(b) Explain the terms : **[4]**

(i) Spontaneous emission and

(ii) Stimulated emission with reference to lasers.

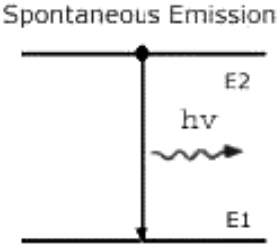
(A) **(i) Spontaneous emission:** When the electron jumps from higher energy state to lower energy state on its own accord, the emission is known as spontaneous emission.

Radiations are in random direction, phase and wavelength.

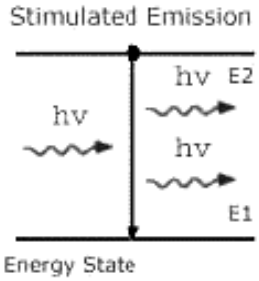
Independent of outside circumstances.

No metastable state exist (ordinary exited state).

Number of photons emitted is less.



(ii) Stimulated emission: When the electron jumps from higher energy state to lower energy state by triggering, (supplying external energy) the emission is known as spontaneous emission.
Radiations are coherent, monochromatic and in same direction. Dependent of outside circumstances.
Metastable state exists.
Number of photons emitted is more.



Q.2(c) Explain production of ultrasonic waves by piezoelectric method. **[4]**

(A) Principle: When the electric field is applied across the crystal its dimensions changes and when alternating PD is applied across crystal then the crystal sets into elastic vibrations

Working: A chip of piezo-electric crystal like quartz is placed between two plates as shown in figure. A suitable oscillator is connected across it. The electric oscillations along the electric axis produce mechanical vibrations along the mechanical axis. The frequency of oscillator is increased. At a particular frequency of oscillator, the oscillator frequency becomes equal to natural frequency of vibration of crystal. Then the crystal sets into resonance vibration and ultrasonic waves are produced.

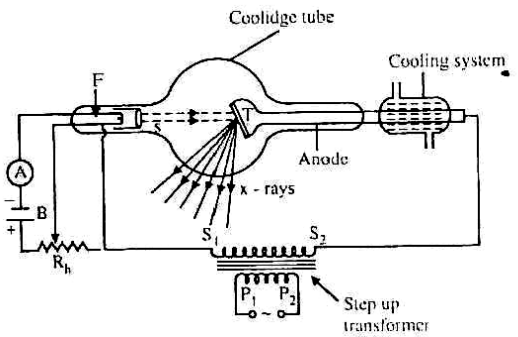
Q.2(d) An object projected upwards making an angle of 38° with the horizontal moves with an initial speed of 60 m/sec. Calculate : **[4]**
(i) The distance from the point of projection at which the object strikes.
(ii) The time taken by the object to reach ground.

(A) Given: V = 60 m/s, θ = 380, R =? ,T =?
We have,
(i) R = v2 sin 2θ / g
R = (60)2sin 2 × 38/ 9.8
R = 356.43 m

(ii) T = 2 v sin θ/ g
T = 2 × 60sin 38/9.8
T = 7.53 sec

Q.2(e) Describe how X-rays are produced by using modern Coolidge tube. **[4]**

(A)



T – Target
F – Metal filament
S – Cylinder
A – Ammeter
B – Battery
R_h – Rheostat
P_1 P_2 – Primary of transformer
S_1, S_2 – Seconday of transformer

Principle:
When fast moving electrons are suddenly stopped then X- rays are produced.

Working:
When the cathode is heated by electric current it produce electrons due to thermionic emission. The beam of electrons is then focused on the anode (target). The electrons from cathode are accelerated by applying high voltage between cathode & anode using step up transformer. When these fast moving electrons are suddenly stopped by tungsten anode, they lose their kinetic energy and x rays are produced from the target. Some amount of Kinetic energy is converted to large amount of heat. By controlling the filament current, the thermionic emission of electron hence intensity of X- rays can be controlled.

Q.2(f) State the necessary criteria for selecting a NDT method in practice (any four points). [4]

(A) (i) Codes or standard requirement.
(ii) Specification of material to be tested, for example, nature of material, its size and shape.
(iii)Type of disorders to be detected, also depend on nature of disorders.
(iv)Testing also depends on manufacturing process of material to be tested.
(v) It is also depending on the equipments available for testing.
(vi) Total cost required to test the material.

Q.3 Attempt any FOUR of the following : [16]

Q.3(a) Find minimum wavelength and maximum frequency of X-rays produced by an X-ray tube working of 50 kV. [4]

(A) **Given :** V= 50 kV $= 50 \times 10^3$ V

Find: λ_{min} =? υ_{max}=?

$\lambda_{min} = 12400 \times 10^{-10}/V$
$\lambda_{min} = 12400 \times 10^{-10}/ 50 \times 10^3$
$\lambda_{min} = 2.48 \times 10^{-11}$ m $= 0.248 \times 10^{-10}$m
$\lambda_{min} = 0.2480 A^0$

$\upsilon_{max} = c / \lambda_{min}$
$\upsilon_{max} = 3 \times 10^8 / 0.248 \times 10^{-10}$
$\upsilon_{max} = 1.2 \times 10^{19}$ Hz

Q.3(b) State the three equations of motion of a body performing angular motion - along with the meaning of all symbols involved. [4]

(A) (i) $\omega_1 = \omega_0 + \alpha t$ (ii) $\theta = \omega_0 t + \frac{1}{2}(\alpha t^2)$ (iii) $\omega_2^1 = \omega_0^2 + 2\alpha\theta$

ω_0 = initial angular velocity.
ω_1 = final angular velocity.
α = angular acceleration.
θ = angular displacement.
t = time

Q.3(c) A vehicle covers 68 m in 6^{th} second and 92 m in 9^{th} second of its motion. Calculate the acceleration and the distance covered by it in 16^{th} second of its motion. [4]

(A) **Given:** S^{6th} = 68 m, S^{9th} =92 m, a=? , S^{16th} =?

We have,

$S^{nth} = u + a / 2 (2n - 1)$ … (1)
$S^{6th} = u + a / 2(2 \times 6 - 1)$
But S^{6th} = 68 m
$68 = u + a /2 (12 - 1)$
$68 = u + 11 a /2$ … (2)

Putting n =9 in equation (1)

$S^{9th} = u + a / 2(2 \times 9 - 1)$

But $S^{9th} = 92$ m

$92 = u + a / 2 (18 - 1)$

$92 = u + 17\ a/2$ … (3)

Now, Substrating equation (3) from equation (2) we get

$92 - 68 = 0 + (17\ a /2) - (11\ a /2)$

$24 = a(17/2 - 11/2)$

$24 = a(6/2)$

$24 = 3a$

$a = 24/3$

$a = 8$ m/s^2.

Putting the value of a in equation(2)

$68 = u + 11\ a /2$

$68 = u + (11 \times 8) /2$

$68 = u + 44$

$u = 68 - 44$

$u = 24$ m/s.

Now, For S^{16th} putting n = 16 in equation (1)

$S^{16th} = u + a / 2 (2n - 1)$

$S^{16th} = 24 + 8 / 2(2 \times 16 - 1)$

$S^{16th} = 24 + 124$

$S^{16th} = 148$ m.

Q.3(d) (i) State Joule's law and write its mathematical form. **[4]**

(ii) Calculate the amount of heat generated when a current of 2 Amp flows through a resistance of 6.4 Ω for 10 minutes.

(A) (i) Statement of Joule's Law:

"The amount of heat generated (H) due to flow of electric current through a resistance is directly proportional to square of the current (I2), the resistance(R), the time for which current flow(t)".

Hence, H α I2 R t

H = Constant × I2 R t

H = (1/J) I2 R t

H = I2 R t / J

Where, J = Joule's Constant or Mechanical equivalent of heat.

I = Current

R = Resistance

t = Time

H = Heat generated

(ii) Given : $h = 6.63 \times 10^{-34}$ J-Sec, $e = 1.6 \times 10^{-19}C$, $c = 3 \times 10^8$ m/sec

$V = 60$ kV $= 60 \times 10^3$ v, $\lambda_{min} = ?$ $f_{max} = ?$

We have, $\lambda_{min} = \dfrac{hc}{eV}$ OR $\lambda_{min} = \dfrac{12400}{V}$

$$\lambda_{min} = \frac{6.63 \times 10^{-34} \times 3 \times 10^8}{1.6 \times 10^{-19} \times 60 \times 10^3}$$

$\lambda_{min} = 0.206\ A^0$

$\lambda_{min} = 0.206 \times 10^{-10}$ m

Now, $f_{max} = \frac{C}{\lambda_{min}}$

$f_{max} = \frac{3 \times 10^8}{0.206 \times 10^{-10}}$

$f_{max} = 14.563 \times 10^{18}$ Hz

OR

$f_{max} = 145.63 \times 10^{17}$ Hz

Q.3(e) State any two engineering applications and any two medical applications of laser. [4]

(A) Engineering applications :

(i) Lasers are used for engraving and embossing of printing plates. For example – number plate, name plate etc.
(ii) Lasers are used in cutting, drilling and welding metals.
(iii) Lasers are used in holography.
(iv) Lasers are used in computer printers.
(v) Lasers are used for 3D, Laser scanners.
(vi) Lasers are used in controlled heat treatment.
(vii) Lasers are used for data transfer through optical fiber from one computer to other.
(viii) Lasers are used to find laws flaws or defect in material.

Mechanical applications :

(i) Surgeryless eye treatment.
(ii) Surgeryless treatments of different body parts.
(iii) Scanning of different body parts.

Q.3(f) State any four characteristics of photoelectric effect. [4]

(A) (i) A metal emits electrons only when the incident (light) radiation has frequency greater than critical frequency (v_0) called threshold frequency. Threshold frequency different for different metals.
(ii) Photoelectric current is directly proportional to intensity of light and independent of frequency.
(iii) The velocity of photoelectron is directly proportional to the frequency of light.
(iv) For a given metal surface, stopping potential is directly proportional to the frequency and is not dependent on intensity light.
(v) The rate of emission of photoelectrons from the photocathode is independent of its temperature i.e. photoelectric emission is different from thermionic emission.
(vi) The process is instantaneous.

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