Revision practice

GRE Subject Test · GRE Physics

Apply the course version boundaries in notes.md; HSK tasks are transferable language practice, not a claimed HSK 3.0 mock.

■ Question 1

A reversible engine runs between 500 K and 200 K and absorbs 600 J. Find maximum work and rejected heat.

Worked answer

Carnot efficiency 0.6 gives work 360 J and rejected heat 240 J.

■ Question 2

An infinite well has levels $E_n=n^2E1$. Find the photon energy for $4\to2$.

Worked answer

$(16-4)E1=12E1$; emitted energy is positive.

■ Question 3

For isotropic emission, source distance increases by factor 3. What happens to flux and luminosity?

Worked answer

Flux becomes one ninth; intrinsic luminosity remains unchanged.

■ Question 4

A 1 kg cart at (6,0) m/s sticks to a 2 kg cart at (0,3) m/s. Find common velocity and kinetic-energy loss.

Worked answer

Momentum (6,6), final velocity (2,2) m/s. Initial $K=18+9=27$ J; final $K=12$ J, so loss 15 J.

■ Question 5

Spring B has four times spring A's stiffness. Compare stored energies first at equal force, then at equal extension.

Worked answer

At equal force $U_B/U_A=1/4$; at equal extension it is 4. State the fixed quantity before using U.

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■ Question 6

A rolling solid sphere has total kinetic energy 14 J. How much is rotational? Compare terminal speeds of identical-shape quadratic-drag balls with mass ratio 16, neglecting buoyancy.

Worked answer

Rotational fraction 2/7 gives 4 J. Terminal-speed ratio sqrt(16)=4.

■ Question 7

A uniform rod of length 2 m is pivoted at one end at angle 30° from vertical. With g=10 m/s^2, find angular-acceleration magnitude.

Worked answer

3g sinθ/(2L)=30 · 0.5/4=3.75 rad/s^2, using end-pivot inertia.

■ Question 8

A 6 kg table mass connects to a 2 kg hanging mass over an ideal pulley; g=10 m/s^2. Find acceleration and tension.

Worked answer

a=20/8=2.5 m/s^2 and T=6 · 2.5=15 N, below hanging weight 20 N.

■ Question 9

A level aircraft moves at 90 m/s and releases a load. With no drag and g=10 m/s^2, find ground velocity, aircraft-relative velocity and vertical drop after 5 s.

Worked answer

Ground velocity (90,−50) m/s; relative velocity (0,−50) m/s; drop ½ · 10 · 25=125 m.

■ Question 10

A centred charge +5Q lies inside a spherical conducting shell of net −2Q and outer radius b. Find induced surface charges and material potential, zero at infinity.

Worked answer

Inner surface −5Q; outer +3Q; V=3Q/(4$\pi\varepsilon$0b), constant in the material.

■ Question 11

Two attractive forces on an electron have magnitudes 5 N and 12 N at right angles. Find their resultant magnitude; explain why potential would be added differently.

Worked answer

Force magnitude sqrt(25+144)=13 N. Potential is a scalar sum, whereas force is a vector sum.

■ Question 12

A sinusoidal current has peak 4 A in a 5 Ω resistor. Find rms current and average power.

Worked answer

Irms=4/sqrt(2)=2sqrt(2) A; P=Irms^{2}R=8 · 5=40 W.

■ Question 13

A 200-turn coil of area 0.01 m^2 has perpendicular field decrease from 0.08 to 0.02 T in 0.30 s. Find average emf magnitude and state the Lenz condition.

Worked answer

Magnitude=200 · 0.01 · 0.06/0.30=0.4 V. Induced current opposes the decrease in original flux.

■ Question 14

A −x travelling wave has electric field along +z. Find magnetic and Poynting directions.

Worked answer

B is +y, since (−x)×z=+y. E×B=z×y=−x, matching propagation.

■ Question 15

A nonmagnetic lossless material has εr=36. Find v/c. At a zero-interior-B boundary, which exterior magnetic component is constrained to zero?

Worked answer

v/c=1/6. The component normal to the surface is zero; tangential field may remain.

■ Question 16

A 600 Hz moving source approaches a fixed reflecting wall at 20 m/s in still air of speed 320 m/s. Find the echo frequency heard at the source.

Worked answer

600 · 340/300=680 Hz; multiply the moving-source and moving-observer factors.

■ Question 17

An ideal both-open pipe has fundamental 90 Hz. Give the first three allowed frequencies after one end is closed; does 90 Hz remain?

Worked answer

45,135,225 Hz. The old 90 Hz is twice the new fundamental, an absent even harmonic.

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■ Question 18

A relaxed-view telescope has 100 cm lens separation and 20 cm eyepiece focal length. Find objective focal length and magnification magnitude.

Worked answer

Objective 80 cm; magnification 4.

■ Question 19

Evacuating a 4.5 cm Michelson gas cell gives 60 fringes at 450 nm. Find n before evacuation.

Worked answer

$n-1=60\cdot 450\times10^{-9}/0.09=0.0003$, so $n=1.0003$.

■ Question 20

For $f(x)=1+2\cos x+4\cos(3x)$, identify a_0, a_1, a_3 and all b_n under the standard Fourier convention.

Worked answer

$a_0=2$, $a_1=2$, $a_3=4$; all $b_n=0$. The mean is 1.

■ Question 21

Two equal coherent waves have individual intensity I_0 and phase difference $2\pi/3$. Find combined intensity. Compare the incoherent average.

Worked answer

Coherent intensity $2I_0(1-1/2)=I_0$; incoherent average $2I_0$.

■ Question 22

A clockwise triangular P–V cycle has pressure span 6000 Pa and volume span 0.004 m^3. Find net work and heat.

Worked answer

Work$=\tfrac{1}{2}\cdot 6000\cdot 0.004=12$ J; net entering heat is also 12 J.

■ Question 23

A Carnot refrigerator absorbs 1800 J at 240 K and rejects heat at 300 K. Find COP, work input and rejected heat.

Worked answer

COP$=240/60=4$; work 450 J; rejected heat 2250 J.

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■ Question 24

A speed-count density has trapezoid area 3av0, N=180 and v0=5 m/s. Find a and explain its units.

Worked answer

a=12 particles per unit speed; integrating the density over speed gives a particle count.

■ Question 25

Two levels have ground degeneracy 1, excited degeneracy 4 and gap kBT ln4. Find probabilities of the excited level and one specified excited state.

Worked answer

Each level has total weight 1, so excited level probability 1/2; one excited state has probability 1/8.

■ Question 26

For N=250 independent detector trials and p=0.20, find mean, variance and standard deviation.

Worked answer

Mean 50; variance 40; standard deviation sqrt(40)≈6.32.

■ Question 27

A kinetic-energy estimate has independent mass uncertainty 8% and speed uncertainty 3%. Find approximate fractional standard uncertainty. Explain why dimensional analysis alone cannot determine a coefficient.

Worked answer

sqrt(8^2+6^2)%=10%. A dimensionless coefficient does not affect unit powers, so it is undetermined by dimensions.

■ Question 28

A particle moves at 0.8c. Find γ and kinetic energy as a fraction of rest energy. For a longitudinal wavelength ratio 5, find recession speed.

Worked answer

γ=5/3 and K/(mc^2)=2/3. β=(25−1)/(25+1)=12/13.

■ Question 29

A particle has total energy 17 GeV and pc=15 GeV. Find rest energy and explain why E−pc is not the answer.

Worked answer

Rest energy sqrt(289−225)=8 GeV. The invariant is quadratic; direct subtraction would give 2 GeV incorrectly.

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■ Question 30

A two-body one-electron model has nuclear mass 4m_e. Find μ/m_e. A photon has energy 5 eV and work function is 3 eV: find stopping magnitude.

Worked answer

Reduced-mass ratio 4/5; maximum electron energy 2 eV, stopping magnitude 2 V.

■ Question 31

Franck–Hertz current features are spaced by 6 V. Find the excitation energy and corresponding single-photon wavelength using hc=1240 eV · nm.

Worked answer

Energy 6 eV; wavelength 1240/6≈206.7 nm. Repeated features can reflect repeated losses of this same energy.

■ Question 32

A step has k2=5k1. Find reflection/transmission probabilities and verify their sum.

Worked answer

r=−2/3 gives R=4/9; T=5 · $(1/3)^2$=5/9; sum one.

■ Question 33

Count spin-zero isotropic oscillator states for N=5, and compute σ_yσ_x.

Worked answer

Degeneracy 6 · 7/2=21; σ_yσ_x=−iσ_z.

■ Question 34

Compare B/A for (A,B)=(5,30 MeV) and (15,120 MeV). Is total binding alone the correct comparison?

Worked answer

Values 6 and 8 MeV per nucleon. Total binding alone confounds different nucleon counts.

■ Question 35

Classify neutrino, kaon and neutron as lepton/meson/baryon in the ordinary constituent model. Explain the sign of R_H for one-carrier holes.

Worked answer

Neutrino lepton, kaon meson, neutron baryon. Hole charge +e gives positive R_H under R_H=1/(nq).

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■ Question 36

Identical satellites have circular orbit-radius ratio 16 around the same dominant mass. Compare angular momentum and period ratios.

Worked answer

Angular momentum ratio sqrt(16)=4; period ratio 16^(3/2)=64.

■ Question 37

A central-force particle conserves pθ. Radius changes from 4 m to 2 m. Compare angular speeds. For a 1 m pendulum with g=10, give the linear angular frequency and the approximation needed.

Worked answer

Angular speed quadruples because mr$^2\theta$dot is fixed. The pendulum has ω=sqrt(10) rad/s only for small angles in radians.

■ Question 38

For L=2(xdot^2+ydot^2)/2−3x^2, identify cyclic coordinates, a conserved momentum and the x equation.

Worked answer

y is cyclic and p_y=2ydot is conserved. Euler–Lagrange gives 2xddot+6x=0; x is not cyclic.

■ Question 39

At r=(3,0,0), Ω=(0,0,2), m=1 and v′=(0,0,0), find apparent forces for constant rotation and the real force required to stay fixed.

Worked answer

Centrifugal=(12,0,0) N; Coriolis=Euler=0. Real force=(−12,0,0) N, inward.

■ Question 40

An 8 kg passenger accelerates upward at 1.5 m/s^2 with g=10. Then evaluate Coriolis direction for Ω along +z and relative motion along −x.

Worked answer

Scale force 8(10+1.5)=92 N. z×(−x)=−y, so Coriolis is along +y.

■ Question 41

An ideal horizontal incompressible flow speeds up from 2 to 5 m/s with density 800. Find pressure drop. If a laminar tube radius halves at fixed Δp, compare Q.

Worked answer

Ideal pressure drop=800(25−4)/2=8400 Pa. At fixed Δp, laminar Q becomes 1/16; this is distinct from fixed-Q continuity.

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Question 42

A liquid has density 900 and viscosity 0.003 Pa · s; mean pipe speed is 0.1 m/s and diameter 0.01 m. Find Re and explain why a steady uniform pipe can still have a pressure drop.

Worked answer

Re=900 · 0.1 · 0.01/0.003=300. Viscous momentum transfer can dissipate energy at unchanged mean speed; loss-free Bernoulli alone misses it.

Question 43

A capacitor stays connected to an ideal battery while a dielectric of ε_r=6 completely fills its gap. Compare free charge, E and stored energy with the vacuum case. Contrast the isolated fixed-Q case.

Worked answer

At fixed V: free charge and U are six times larger; E=V/d is unchanged. At fixed Q: E, V and U are one sixth. The connected source exchanges energy.

Question 44

For a uniform linear dielectric with ε_r=2 and free plate density σ, find P/σ. A long solenoid has nI=250 A/m and χ_m=0.2. Find H, M and B/μ_0.

Worked answer

P=(ε_r−1)σ/ε_r=σ/2. H=250 A/m, M=50 A/m and B/μ_0=300 A/m under the long-solenoid linear-response assumptions.

Question 45

An RC discharge has τ=3 s and initial voltage 10 V. Find voltage at 6 s and the time to halve. An RL circuit has L=0.3 H and R=6 Ω; find its time constant.

Worked answer

Voltage=10e^(−2)=1.353 V; half-time=3 ln2=2.079 s. RL τ=L/R=0.05 s.

Question 46

In series RLC, R=10 Ω, L=0.1 H, C=0.001 F, V_rms=20 V and ω=200 rad/s. Find X, impedance magnitude, current, phase direction and mean power.

Worked answer

X=20−5=15 Ω; |Z|=sqrt(325)=18.028 Ω; I_rms=1.1094 A. Current lags voltage. P=400 · 10/325=12.308 W. This is off resonance; ω_0=100 rad/s.

Question 47

A linear beam of intensity 64 W/m^2 passes ideal analyser axes at 45° and then 75° relative to its initial direction. Find the two outputs. What would a circular input of the same intensity transmit through one analyser?

Worked answer

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Outputs 64 $\cos^2 45°$=32 and 32 $\cos^2 30°$=24 W/m^2; the second relative angle is 30°, not 75°. Circular input gives 32 W/m^2 through one ideal analyser.

■ Question 48

At a fixed point E_x=5 cosωt and E_y=5 cosωt. Classify the field. For ideal incidence from n_1=1.2 into n_2=1.6 find θ_B and the complementary refracted angle.

Worked answer

The field is linear at 45°, not circular: the components have equal phase. θ_B=atan(4/3)=53.13°; refracted angle 36.87°.

■ Question 49

Two equal finite slits have λ=400 nm, L=2 m, a=0.20 mm and d=1.0 mm. Find fringe spacing, central-envelope width, first missing orders and nominal centres inside the central envelope.

Worked answer

Spacing 0.8 mm, width 8 mm, missing $\pm$5 and nine nominal centres -4 through $+4$. Boundary orders $\pm$5 are dark.

■ Question 50

For a uniform far-field single slit, calculate I/I_c at $\beta=\pi/3$. If slit width triples while λ and L remain fixed, compare small-angle central widths.

Worked answer

$(\sin(\pi/3)/(\pi/3))^2=27/(4\pi^2)\approx 0.6839$. Central width becomes one third. Amplitude and intensity ratios are different.

■ Question 51

A diverging lens has f=$-$20 cm and a real object 60 cm away. Find signed image distance and magnification. Contrast a concave mirror f=20 cm with the same object distance.

Worked answer

Lens s′=$-$15 cm and M=+1/4, virtual upright reduced. Concave mirror s′=30 cm and M=$-$1/2, real inverted in front.

■ Question 52

A converging lens at x=0 has f=10 cm and real object x=$-$30 cm. A second f=10 cm lens is at x=10 cm, before the first predicted image. Find its signed object distance and final image coordinate.

Worked answer

First predicted image x=15 cm. At the second lens incoming rays converge toward a point 5 cm beyond it, so s_2=$-$5 cm. $1/s_2'=1/10+1/5=3/10$, giving $s_2'=10/3$ cm and final x=40/3 cm. $M_1=-1/2$, $M_2=+2/3$ and total $-1/3$.

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■ Question 53

Two parallel heat paths have resistances 0.5 and 1.5 K/W between 50°C and 20°C. Find each rate, total rate and equivalent resistance.

Worked answer

Rates 60 W and 20 W; total 80 W; equivalent R=30/80=0.375 K/W. They share the temperature difference rather than the heat rate.

■ Question 54

Ice already at its melting point has mass 0.04 kg and specified latent heat 3×10^5 J/kg. It receives 9000 J with no losses. Find melted mass and explain why mcΔT is insufficient.

Worked answer

Melted mass=Q/ℓ=0.03 kg; 0.01 kg ice remains. Temperature stays at the melting point during this ideal phase conversion; latent energy is not a temperature rise.

■ Question 55

A two-state fixed spectrum has energies 0 and Δ with $\Delta/(kBT)=\ln 4$. Calculate U/Δ, $\mathrm{Var}(E)/\Delta^2$ and C/kB.

Worked answer

p_exc=1/5, so $U/\Delta=1/5$, variance=1/5−1/25=4/25; $C/kB=4(\ln 4)^2/25\approx 0.307490$. Differentiate at fixed Δ.

■ Question 56

A canonical two-level model has a unique ground state. Describe U, S and C at low temperature and at arbitrarily high temperature; then shift both levels by fixed ε.

Worked answer

Low T: $U\to 0$, $S\to 0$, $C\to 0$ for energies $0,\Delta$. High T: $U\to\Delta/2$, $S\to kB\ln 2$, $C\to 0$. Offset ε shifts U/F by ε but leaves S, variance and C unchanged.

■ Question 57

At $(\varepsilon-\mu)/(kBT)=\ln 9$, compute single-state Fermi, Bose and Maxwell–Boltzmann means. Count two identical bosons in four complete states and two identical fermions in the same states.

Worked answer

Fermi 1/10, Bose 1/8, dilute approximation 1/9. Bosonic patterns choose(5,2)=10; fermionic choose(4,2)=6.

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■ Question 58

An oscillator has fixed spacing ε and $\varepsilon/(\mathrm{kBT})=\ln 4$. Find thermal energy above zero point divided by ε and C/kB. State the classical high-T and frozen low-T heat-capacity limits.

Worked answer

Energy/ε=1/3; C/kB=$4(\ln 4)^2/9\approx 0.854139$. High T C→kB; low T C→0. The fixed zero-point $\varepsilon/2$ does not change these derivatives.

■ Question 59

A normalised well state in $0<x<5$ nm receives weak γx with γ=0.012 eV/nm. Find its first-order shift. Explain what changes if the perturbation is $\gamma(x-2.5\ \mathrm{nm})$.

Worked answer

The first shift is $\gamma L/2$=0.03 eV. The centred odd perturbation has zero first-order diagonal expectation; off-diagonal mixing and higher-order shifts can remain.

■ Question 60

Within a two-state exact degeneracy, a perturbation is $\varepsilon[[3,-1],[-1,3]]$, $\varepsilon>0$. Find first-order shifts and the symmetric/antisymmetric combinations.

Worked answer

Symmetric $(1,1)/\sqrt{2}$ gives 2ε; antisymmetric $(1,-1)/\sqrt{2}$ gives 4ε. The two diagonal entries 3ε are not the first-order energy shifts.

■ Question 61

Two electrons can access four spatial orbitals with two spin states each. Count complete-state occupations for two electrons. Which spin sector can put both in one spatial orbital?

Worked answer

Eight complete states give choose(8,2)=28 patterns. Same-orbital double occupation needs antisymmetric spin, the singlet.

■ Question 62

For distinct orthonormal orbitals a,b, classify the exchange symmetry of $\Psi_+\chi_$triplet and $\Psi_-\chi_$singlet. Are either allowed two-electron total states?

Worked answer

Both products are symmetric overall: (+)(+) and (−)(−). Neither is allowed for two identical electrons. Allowed pairings are Ψ_+ with singlet or Ψ_- with triplet.

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■ Question 63

A finite-well ground root is ρ=2, z=1.02986653. Find E/V_0 and κa. Why should the well-edge amplitude not be set to zero?

Worked answer

$E/V_0=z^2/4-1\approx-0.734844$; $\kappa a\approx1.714461$. Finite boundaries match the nonzero oscillatory interior to decaying tails; zero-edge conditions belong to infinite walls.

■ Question 64

For a one-electron Z=2 ion at n=4, find approximate bound energy and spatial degeneracy. For l=3,m_l=−2, give L magnitude and L_z.

Worked answer

$E\approx-13.6\cdot4/16=-3.4$ eV; spatial degeneracy 16. $L=\sqrt{12}\hbar$ and $L_z=-2\hbar$. Spin/fine structure and reduced mass have been excluded.

■ Question 65

An electron in the uncoupled magnetic regime has m_l=−1,m_s=+1/2. Find its linear shift. A weak LS-coupled L=1,S=1/2,J=3/2,m_J=−3/2 level is instead placed in 0.5 T: find its shift using $\mu_B=5.788\times10^{-5}$ eV/T.

Worked answer

Uncoupled shift is zero. In the other regime g_J=4/3, so g_J m_J=−2 and the shift is -5.788×10^{-5} eV. Regime-specific labels cannot be interchanged.

■ Question 66

A degenerate opposite-parity pair has supplied real dipole matrix [[0,d],[d,0]], d=1.5 e · nm. For $F=2\times10^5$ V/m find the level shifts and splitting. What would a nondegenerate parity-state diagonal expectation alone predict at first order?

Worked answer

Shifts ±0.0003 eV, separation 0.0006 eV. A nondegenerate parity-state expectation is zero at first order; it cannot describe the off-diagonal splitting in this degenerate model.

■ Question 67

For a 5000 K grey surface with ε=0.4,$A=3\times10^{-5}$ m^2 and T_env=1000 K, find wavelength peak using $b=2.898\times10^{-3}$ m · K and net power with $\sigma=5.670\times10^{-8}$. State the wavelength-independent-emissivity assumption.

Worked answer

Peak 579.6 nm under the grey spectral model. Net power $0.4\cdot3\times10^{-5}\cdot5.670\times10^{-8}(5000^4-1000^4)=424.5696$ W. Emissivity is independent of wavelength and the large surroundings fill the relevant view.

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■ Question 68

A heavy-nucleus one-electron Z=2 ion emits n=4→2. Find photon energy/wavelength, n=4 Bohr radius, and ionisation energy from n=4, using 13.6 eV and 1240 eV · nm constants. Distinguish the Bohr $n\hbar$ from wave angular momentum.

Worked answer

Photon 10.2 eV; $\lambda\approx$121.5686 nm; Bohr radius $8a_0$; n=4 ionisation 3.4 eV. Wave orbital $L=\sqrt{[l(l+1)]}\hbar$ with l=0,…,3; it is not fixed to $4\hbar$ for every n=4 orbital.

■ Question 69

Two lab events are separated by Δx=1200 m and Δt=3 μs. Using c=3×10^8 m/s, classify the interval and find the simultaneity-frame speed and the proper distance.

Worked answer

$c\Delta t=900$ m<1200 m, so the separation is spacelike. $v=c^2\Delta t/\Delta x=(900/1200)c=0.75c$. Proper distance $\text{sqrt}(1200^2-900^2)=\text{sqrt}(630000)\approx$793.7 m.

■ Question 70

A rocket moving at 0.6c launches a probe forward at 0.75c relative to itself. Find the probe lab speed and its Lorentz factor.

Worked answer

$u=(0.6+0.75)c/(1+0.45)=1.35c/1.45=(27/29)c\approx0.931c$.
$\gamma=1/\text{sqrt}(1-(27/29)^2)=29/\text{sqrt}(112)\approx2.740$.

■ Question 71

A 5 V source with internal resistance 25 kΩ is read by a 100 kΩ meter. Find the reading, and the cutoff of a first-order RC low-pass with R=2 kΩ, C=50 nF.

Worked answer

Reading $5\times100/125=4.0$ V. $f_c=1/(2\pi RC)=1/(2\pi\times10^{-4})\approx$1591.5 Hz.

■ Question 72

A non-paralyzable counter with τ=50 μs records 15000 counts/s. Find the true rate and the fraction of true events lost.

Worked answer

$n=m/(1-m\tau)=15000/(1-0.75)=60000$ /s. Lost fraction $1-m/n=3/4$ (75%), because $m\tau=0.75$.

■ Question 73

A narrow photon beam with μ=0.4 /cm must be reduced to 1/16 of its initial intensity. Find the thickness and the number of half-value layers.

Worked answer

$1/16=(1/2)^4$, so four half-value layers give $x=4\times\ln2/0.4\approx$6.93 cm.

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■ Question 74

Explain why a three-level laser can sustain inversion while a two-level equilibrium system cannot, and find the mode spacing of a 75 cm linear cavity.

Worked answer

Pumping into a fast-decaying third level accumulates population in a metastable upper laser level while the lower level empties, so N2>N1; equilibrium Boltzmann populations always give N2<N1 in a two-level system. Spacing c/(2L)=3×10^{8}/1.5=200 MHz.

■ Question 75

X-rays of λ=0.20 nm reflect from crystal planes with d=0.50 nm. Find the first- and second-order Bragg angles.

Worked answer

sinθ_1=0.20/(2×0.50)=0.2, $\theta_1\approx11.54°$; second order sinθ_2=0.4, $\theta_2\approx23.58°$.

■ Question 76

A metal has Fermi energy 5 eV. Estimate its Fermi temperature and the order of the thermally excited electron fraction at 300 K.

Worked answer

T_F=E_F/k_B=$5\times1.602\times10^{-19}/1.381\times10^{-23}\approx5.8\times10^{4}$ K; excited fraction of order T/T_F≈0.005, about 0.5%.

■ Question 77

Find the Q value of D+T fusion from masses 2.0141 u (D), 3.0161 u (T), 4.0026 u (He) and 1.0087 u (n), and state the two conserved quantities checked.

Worked answer

Q=(2.0141+3.0161−4.0026−1.0087)×931.5=0.0189×931.5≈17.6 MeV. Charge 1+1=2=2+0 and nucleons 2+3=5=4+1.

■ Question 78

A radioactive sample has T½=30 min and 1.2×10^{10} atoms. Find the decay constant and the activity.

Worked answer

λ=ln2/1800≈3.85×10^{-4} /s; A=λN≈4.62×10^{6} Bq.

■ Question 79

For $y'=-25y$, state the explicit-Euler stability limit and classify the step h=0.1 s.

Worked answer

Stable needs h≤2/λ=0.08 s. h=0.1 gives factor 1−2.5=−1.5, |factor|>1, so the run diverges with alternating sign.

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■ **Question 80**

A fixed-fixed string has L=0.8 m and wave speed 240 m/s. Find its first three mode frequencies.

Worked answer

f_n=nc/(2L)=n×150 Hz, giving 150, 300 and 450 Hz.