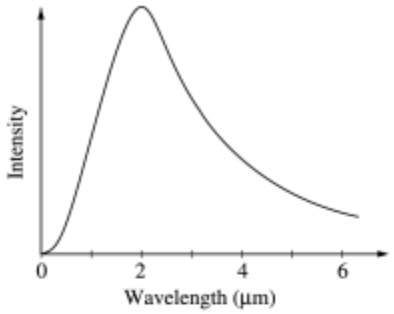
GRE Physics Practice Test 6



63. The distribution of relative intensity $I(\lambda)$ of blackbody radiation from a solid object *versus* the wavelength λ is shown in the figure above. If the Wien displacement law constant is 2.9×10^{-3} m·K, what is the approximate temperature of the object?

(A) 10 K
(B) 50 K
(C) 250 K
(D) 1,500 K
(E) 6,250 K

64. Electromagnetic radiation provides a means to probe aspects of the physical universe. Which of the following statements regarding radiation spectra is NOT correct?

(A) Lines in the infrared, visible, and ultraviolet regions of the spectrum reveal primarily the nuclear structure of the sample.
(B) The wavelengths identified in an absorption spectrum of an element are among those in its emission spectrum.
(C) Absorption spectra can be used to determine which elements are present in distant stars.
(D) Spectral analysis can be used to identify the composition of galactic dust.
(E) Band spectra are due to molecules.

$$C = 3kN_A\left(\frac{h\nu}{kT}\right)^2 \frac{e^{h\nu/kT}}{(e^{h\nu/kT} - 1)^2}$$

65. Einstein's formula for the molar heat capacity C of solids is given above. At high temperatures, C approaches which of the following?

(A) 0
(B) $3kN_A\left(\frac{h\nu}{kT}\right)$
(C) $3kN_A h\nu$
(D) $3kN_A$
(E) $N_A h\nu$

66. A sample of radioactive nuclei of a certain element can decay only by γ-emission and β-emission. If the half-life for γ-emission is 24 minutes and that for β-emission is 36 minutes, the half-life for the sample is

(A) 30 minutes
(B) 24 minutes
(C) 20.8 minutes
(D) 14.4 minutes
(E) 6 minutes

67. The ^{238}U nucleus has a binding energy of about 7.6 MeV per nucleon. If the nucleus were to fission into two equal fragments, each would have a kinetic energy of just over 100 MeV. From this, it can be concluded that

(A) ^{238}U cannot fission spontaneously
(B) ^{238}U has a large neutron excess
(C) nuclei near $A = 120$ have masses greater than half that of ^{238}U
(D) nuclei near $A = 120$ must be bound by about 6.7 MeV/nucleon
(E) nuclei near $A = 120$ must be bound by about 8.5 MeV/nucleon

68. When $^{7}_{4}\mathrm{Be}$ transforms into $^{7}_{3}\mathrm{Li}$, it does so by

(A) emitting an alpha particle only
(B) emitting an electron only
(C) emitting a neutron only
(D) emitting a positron only
(E) electron capture by the nucleus with emission of a neutrino

69. Blue light of wavelength 480 nanometers is most strongly reflected off a thin film of oil on a glass slide when viewed near normal incidence. Assuming that the index of refraction of the oil is 1.2 and that of the glass is 1.6, what is the minimum thickness of the oil film (other than zero) ?

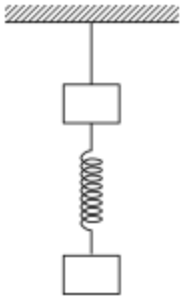
(A) 150 nm
(B) 200 nm
(C) 300 nm
(D) 400 nm
(E) 480 nm

70. Light from a laser falls on a pair of very narrow slits separated by 0.5 micrometer, and bright fringes separated by 1.0 millimeter are observed on a distant screen. If the frequency of the laser light is doubled, what will be the separation of the bright fringes?

(A) 0.25 mm
(B) 0.5 mm
(C) 1.0 mm
(D) 2.0 mm
(E) 2.5 mm

71. The ultraviolet Lyman alpha line of hydrogen with wavelength 121.5 nanometers is emitted by an astronomical object. An observer on Earth measures the wavelength of the light received from the object to be 607.5 nanometers. The observer can conclude that the object is moving with a radial velocity of

(A) 2.4×10^{8} m/s toward Earth
(B) 2.8×10^{8} m/s toward Earth
(C) 2.4×10^{8} m/s away from Earth
(D) 2.8×10^{8} m/s away from Earth
(E) 12×10^{8} m/s away from Earth



72. Two identical blocks are connected by a spring. The combination is suspended, at rest, from a string attached to the ceiling, as shown in the figure above. The string breaks suddenly. Immediately after the string breaks, what is the downward acceleration of the upper block?

(A) 0
(B) $g/2$
(C) g
(D) $\sqrt{2}\,g$
(E) $2g$

73. For the system consisting of the two blocks shown in the figure above, the minimum horizontal force F is applied so that block B does not fall under the influence of gravity. The masses of A and B are 16.0 kilograms and 4.00 kilograms, respectively. The horizontal surface is frictionless and the coefficient of friction between the two blocks is 0.50. The magnitude of F is most nearly

(A) 50 N
(B) 100 N
(C) 200 N
(D) 400 N
(E) 1,600 N

74. The Lagrangian for a mechanical system is

$$L = a\dot{q}^2 + bq^4,$$

where q is a generalized coordinate and a and b are constants. The equation of motion for this system is

(A) $\dot{q} = \sqrt{\frac{b}{a}}\, q^2$

(B) $\dot{q} = \frac{2b}{a}\, q^3$

(C) $\ddot{q} = -\frac{2b}{a}\, q^3$

(D) $\ddot{q} = +\frac{2b}{a}\, q^3$

(E) $\ddot{q} = \frac{b}{a}\, q^3$

$$\begin{pmatrix} a'_x \\ a'_y \\ a'_z \end{pmatrix} = \begin{bmatrix} 1/2 & \sqrt{3}/2 & 0 \\ -\sqrt{3}/2 & 1/2 & 0 \\ 0 & 0 & 1 \end{bmatrix} \begin{pmatrix} a_x \\ a_y \\ a_z \end{pmatrix}$$

75. The matrix shown above transforms the components of a vector in one coordinate frame S to the components of the same vector in a second coordinate frame S'. This matrix represents a rotation of the reference frame S by

(A) 30° clockwise about the x-axis
(B) 30° counterclockwise about the z-axis
(C) 45° clockwise about the z-axis
(D) 60° clockwise about the y-axis
(E) 60° counterclockwise about the z-axis

76. The mean kinetic energy of the conduction electrons in metals is ordinarily much higher than kT because

(A) electrons have many more degrees of freedom than atoms do
(B) the electrons and the lattice are not in thermal equilibrium
(C) the electrons form a degenerate Fermi gas
(D) electrons in metals are highly relativistic
(E) electrons interact strongly with phonons

77. An ensemble of systems is in thermal equilibrium with a reservoir for which $kT = 0.025$ eV. State A has an energy that is 0.1 eV above that of state B. If it is assumed the systems obey Maxwell-Boltzmann statistics and that the degeneracies of the two states are the same, then the ratio of the number of systems in state A to the number in state B is

(A) e^{+4}
(B) $e^{+0.25}$
(C) 1
(D) $e^{-0.25}$
(E) e^{-4}

78. The muon decays with a characteristic lifetime of about 10^{-6} second into an electron, a muon neutrino, and an electron antineutrino. The muon is forbidden from decaying into an electron and just a single neutrino by the law of conservation of

(A) charge
(B) mass
(C) energy and momentum
(D) baryon number
(E) lepton number

79. A particle leaving a cyclotron has a total relativistic energy of 10 GeV and a relativistic momentum of 8 GeV/c. What is the rest mass of this particle?

(A) 0.25 GeV/c^2
(B) 1.20 GeV/c^2
(C) 2.00 GeV/c^2
(D) 6.00 GeV/c^2
(E) 16.0 GeV/c^2