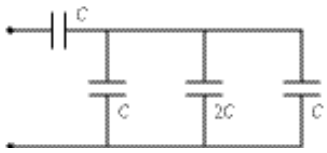
1. A rod (length = 80 cm) with a rectangular cross section (1.5 mm × 2.0 mm) has a resistance of 0.20 Ω. What is the resistivity of the material used to make the rod?

a) $6.0 \times 10^{-7}$ Ω·m b) $3.8 \times 10^{-7}$ Ω · m c) $7.5 \times 10^{-7}$ Ω · m

d) $3.0 \times 10^{-7}$ Ω·m e) $4.8 \times 10^{-7}$ Ω · m

2. Determine the equivalent capacitance of the combination shown when $C$ = 15 mF.

a) 20 mF
b) 16 mF
c) 12 mF
d) 24 mF
e) 75 mF

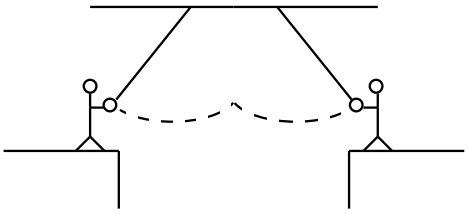



3. An electric heater is constructed by applying a potential difference of 110 V across a wire with a resistance of 5.0 Ω. What is the power rating of the heater?

a) 2.0 kW b) 2.4 kW c) 1.7 kW d) 1.5 kW e) none of the above

4. Two circus clowns (each having a mass of 50 kg) swing on two flying trapezes (negligible mass, length 25 m) shown in the figure. At the peak of the swing, one grabs the other, and the two swing back to one platform. The time for the forward and return motion in *s* is

a) 10 b) 5
c) 15 e) 20
e) 25

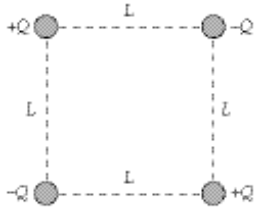


5. A flute player holding a tone with a frequency of 520 Hz approaches a wall at 2 m/s on a day when the speed of sound in air is 340 m/s. The frequency in Hz he hears coming back to him from the wall is

a) 260 b) 517 c) 520 d) 523 e) 526

6 D If $Q$ = 20 $\mu$C and $L$ = 60 cm, what is the magnitude of the electrostatic force on any one of the charges shown?

a) 25 N
b) 19 N
c) 15 N
d) 9.1 N
e) none of the above



**7** [D] In an *RC* circuit, how many time constants must elapse if an initially uncharged capacitor is to reach 80% of its final potential difference?

a) 2.2 b) 1.9 c) 1.6 d) 3.0 e) 5.0

8 A jet plane has a sound level of 150 dB. What is the intensity in $W/m^2$?

a) 1 b) 10 c) 100 d) 1000 e) none of the above

9 A uniform rod of mass m and length L is freely pivoted at one end. What is the period of its oscillations. $I_{CM}$ for uniform rod rotating about its centre of mass is $\frac{1}{12}mL^2$.

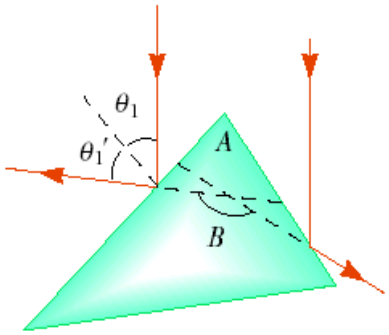
a) $\sqrt{\frac{3g}{2L}}$ b) $2\pi\sqrt{\frac{3L}{2g}}$ c) $2\pi\sqrt{\frac{2L}{3g}}$ d) $2\pi\sqrt{\frac{L}{g}}$ e) none of the above

10 The inhabitants of a planet in another galaxy have their eyes at the exact center of their 2.0-m long bodies. How long must a plane mirror be for such a creature to be able to see all of its body in the mirror?

a) 1.0 m b) 2.0 m c) 2.5 m d) 4.0 m
e) it depends on how far from the mirror are they.

11[D] A parallel beam of light is directed on the prism at such angle, that parts of the beam reflect from opposite sides as shown. If A= 55°, what is the value of B?

a) 105°
b) 110°
c) 115°
d) 125°
e) none of the above




**12.** If a convex lens were made out of very thin clear plastic filled with air, and if it were then placed underwater where *n* = 1.33, where the lens would have an effective index of refraction *n* = 1, the lens would act in the same way

**a)** as a concave mirror in air.
**b)** as a concave lens in air.
**c)** as a convex lens in air.
**d)** as a flat refracting surface between water and air as seen from the water side.
**e)** as the glasses worn by a farsighted person.

13 The polarizing angle in air for diamond is 67.4°. Calculate the critical angle inside the diamond for total internal reflection.

a) 32.6° b) 22.6° c) 24.6° d) 28.6° e) 48.8°

14 What, approximately, are the dimensions of the smallest object on Earth that the astronauts can resolve by eye at 200 km height from the space shuttle? Assume $\lambda$ = 500 nm light and a pupil diameter $D$ = 0.50 cm. Assume eye fluid has an average $n$ = 1.33.

a) 150 m b) 100 m c) 250 m d) 25 m e) 18 m

15 D In a Newton's rings apparatus, find the phase difference (in radians) when an air wedge of 500 nm thickness is illuminated with red light ($\lambda$ = 640 nm).

a) 13 b) 11 c) 9 d) 7 e) 3

16 Monochromatic light is beamed into a Michelson interferometer. The movable mirror is displaced 0.292 mm, causing the interferometer pattern to reproduce itself 1000 times. Determine the wavelength of the light.

a) 292nm b) 448nm c) 523nm d) 584nm e) none of the above

17 D In a double slit experiment, the distance between the slits is 0.2 mm and the distance to the screen is 150 cm. What is the phase difference (in degrees) between the waves from the two slits arriving at a point P when the angular distance of P is 10° relative to the central peak, and the wavelength is 500 nm? (Convert your result so the angle is between 0 and 360°.)

a) 145° b) 155° c) 165° d) 135° e) none of the above

18 D The space station orbiting a distant star ($r_{star}$= 1x10$^6$ km, $R_{orbit}$ =800x10$^6$ km) uses a spherical dish (hemisphere of 40m diameter) as an antenna to power its operations. The opto-electrical module converts ALL of the EM energy received by the antenna into the electrical power with 20% efficiency. Find the wavelength for which the unknown star has the maximum in blackbody radiation profile. The station is fully powered at 20kW.

a) 890nm b) 750nm c) 630nm d) 530nm e) none of these answers

19. A photon whose wavelength is = $5.0 \times 10^{-11}$ m is scattered straight backward. What is the wavelength of the scattered wave?

a) $5.0 \times 10^{-11}$m b) $4.5 \times 10^{-11}$m c) $5.5 \times 10^{-11}$ m
d) $6.0 \times 10^{-11}$m e) $6.5 \times 10^{-11}$m

20. A stopping potential of 3.2 V is needed for radiation whose wavelength is 200 nm. What is the work function (in eV) of the material?

a) 4.0 b) 3.0 c)5.0 d)6.0 e)2.0

21. An electron in a hydrogen atom makes a transition from the $n$ = 4 to the $n$ = 3 energy state. Determine the energy (in eV) of the emitted photon.

a) 0.54 b) 0.66 c) 0.85 d) 1.51 e) 10.2

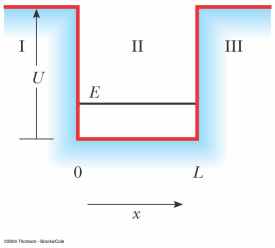
22 The radius of a nucleus of $^{165}_{67}$Ho (in fm) is:

a. 15.4 b. 5.5 c. 12.8 d. 6.6 e. none of the above

23 D 29 g of petrified wood was found in a petrified forest. A sample showed a $^{14}$C activity of 98 decays/minute. How long has the tree been dead (in years)? Round your answers to the nearest hundred of years) (The half-life of carbon-14 is 5730 years, and freshly cut wood contains $6.5 \times 10^{10}$ atoms of $^{14}$C per gram.)

a) 12300 b) 15600 c) 8500 d) 4700 e) none of the above

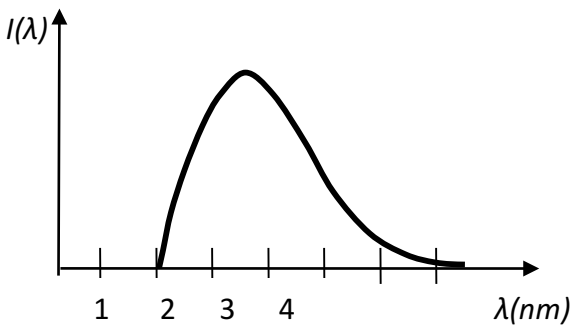
24. Given is the potential well (V=const. <0 for 0<X<L and V=0 for X>L and X<0 )
Which of the following sentences is true.
a) there is large probability of finding the particle with E<0 at X>L .
b) the oscillatory solutions to the Schrodinger Equation exist for 0<x<L.
c) particle is trapped by this potential if its energy E >0.
d) the exponential solutions to the Schrodinger Equation exist for 0<X<L.
e) none of the above is true.




25. A proton with a kinetic energy of 0.20 keV follows a circular path in a region where the magnetic field is uniform and has a magnitude of 60 mT. What is the radius of this path?

a) 4.1 cm b) 2.9 cm c) 3.4 cm d) 5.1 cm e) 2.4 cm

26. The X ray intensity distribution function for X ray lamp is given on the figure. Based on this profile one could say that the X-ray lamp was operating under the following potential difference:
a) 0.62kV
b) 0.98kV
c) 0.124kV
d) not enough information to answer
e) none of the above



27. The results of COBE mission confirmed which of the following hypotheses:
a) that Big Bang left behind the isotropic relic radiation.
b) that relic radiation corresponds to a blackbody radiation of T=2.7K.
c) that the multiverse hypothesis is a good model for the universe .
d) <u>that there were density fluctuations in very young universe.</u>
e) all of the above.

28 If the star main energy source is the set of fusion reactions that may be summed up as: $3\,^{28}Si \rightarrow {}^{84}Kr$, what type of star is it?
a) proto-star
b) main sequence star
c) red giant or red supergiant
d) neutron star
e) <u>none of the above, this process is not possible in any of the stellar cores.</u>

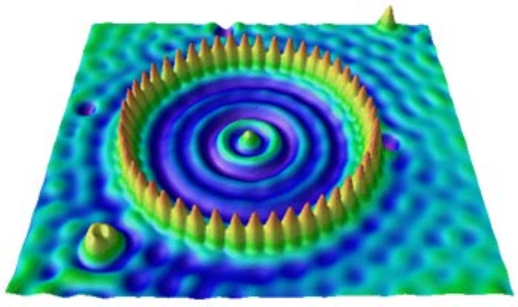
29 Which of the following classification schemes of the fundamental particles is <u>not valid</u>:

a) Fundamental particles are either fermions or bosons.
b) Fundamental particles are: leptons, quarks, intermediate bosons.
c) Based on their mass the elementary particles were originally grouped as leptons mesons and baryons.
d) <u>Fundamental particles may be divided into: fermions, leptons and baryons</u>
e) Majorana particles are their own anti-particles, while Dirac particles have distinct (separate) antiparticles.

30 Which of the following is <u>not true</u> about the Oklo Reactors:

a) <u>these natural reactors operated “on and off” for less than hundredths of years at a time about 500 million years ago.</u>
b) their existence provides an upper limit for the possible changes of the fundamental constants in nature.
c) they provide the evidence of existence of liquid water on Earth at the time of their operation.
d) they provide the evidence that radioactive waste can be stored safely for millions of years in the deep mines in the tectonically stable terrain.
e) none of the above (all of the above statements are true.)

31 The mage below was produced using which of the following:
a) Light Amplification of Stimulated Emission of Radiation (LASER)
b) <u>Scanning Tunneling Microscope (STM)</u>
c) Positron Emission Tomography (PET)
d) Nuclear Magnetic Resonance (NMR)
e) Computer Aided Tomography (CAT)



32 Electronic frequency synthesizer capable of imitating variety of different music instruments utilizes which of which of the following principles:

a) Superposition Principle.
b) Taylor Theorem.
c) Fourier Theorem.
d) Gödel Theorem.
e) none of the above

33 D A compound microscope is made with an objective lens ($f_0$ = 0.900 cm) and an eyepiece ($f_e$ = 1.10 cm). The lenses are separated by a distance of 10.0 cm. What is the angular magnification? (Assume the near point is 25.0 cm.)

a) –253 b) –450 c) –770 d) –980 e) –635