Your code is: AABDJE

Put your name here:

Keep this exam CLOSED until advised by the instructor.

Fill out the bubble sheet: last name, first initial, student number, section number and code.

60 minute long closed book exam.

A two-sided 8.5 by 11 handwritten help sheet is allowed.

When done, hand in your bubble sheet and your exam.

Possibly useful constants:

- \( k_e = 8.99 \times 10^9 \text{ Nm}^2/\text{C}^2 \)
- \( \epsilon_0 = 8.85 \times 10^{-12} \text{ As/(Vm)} \)
- \( \mu_0 = 4\pi \times 10^{-7} \text{ Vs/(Am)} \)
- \( c = 3.00 \times 10^8 \text{ m/s} \)
- \( e = 1.60 \times 10^{-19} \text{ C} \)
- \( m_e = 9.11 \times 10^{-31} \text{ kg} \)
- \( m_e c^2 = 0.511 \text{ MeV} \)
- \( h = 6.63 \times 10^{-34} \text{ Js} \)
- \( h = 4.14 \times 10^{-15} \text{ eVs} \)
- \( h c = 1240 \text{ eVnm} \)
- \( \sigma = 5.67 \times 10^{-8} \text{ W/(m}^2\text{K}^4) \)
- \( \text{Wien's constant} = 2.898 \times 10^{-3} \text{ Km} \)
- \( R_H = 1.097 \times 10^7 \text{ 1/m} \)
- \( E_0 = 13.6 \text{ eV} \)
- \( a_0 = 0.529 \text{ Angstrom} \)
- \( 1 \text{ eV} = 1.60 \times 10^{-19} \text{ J} \)
- \( 1 \text{ AMU (1 u)} = 931.494 \text{ MeV/c}^2 = 1.67 \times 10^{-27} \text{kg} \)
- \( \times \text{ Field directly into page.} \)
- \( \bullet \text{ Field directly out of page} \)
Select True or False for the following questions about radioactive decay.

> In alpha decay, a neutron is emitted.
1. A True  B False

> In gamma decay, a positron is emitted.
2. A True  B False

> In beta decay, an electron or a positron is emitted.
3. A True  B False

A projectile is observed during a very short time of 1.1 \( \times 10^{-24} \) s. What is its minimum energy uncertainty in nJ?

4. A 1.01 \( \times 10^{-2} \)  B 1.26 \( \times 10^{-2} \)  C 1.57 \( \times 10^{-2} \)
5. A 1.66 \( \times 10^{-2} \)  B 2.45 \( \times 10^{-2} \)  C 3.07 \( \times 10^{-2} \)
6. A 3.83 \( \times 10^{-2} \)  B 4.79 \( \times 10^{-2} \)

If the binding energy per nucleon of a fictitious nucleus with \( Z = N = 90 \) is 7.4 MeV, what is its mass in u?
The mass of a proton is 1.007276 u.
The mass of a neutron is 1.008665 u.

7. A 171.00  B 173.70  C 176.40
8. A 180.00  B 181.43  C 182.86
9. A 186.52  B 192.12

Select True or False for the following statements.

> The speed of electromagnetic waves in vacuum is not proportional to their wavelength.
6. A True  B False

> Sunlight perpendicularly strikes two surfaces of equal area. One surface is a perfect absorber and the other surface is a perfect reflector. The force exerted by the sunlight on the absorbing surface is twice the size of the force exerted by the sunlight on the reflecting surface.
7. A True  B False

> A wire carries a steady current \( i = I_0 \). There is no electromagnetic radiation from the wire.
8. A True  B False

What is the wavelength of radiation emitted when an electron goes from the \( n = 6 \) to the \( n = 5 \) level of the Bohr hydrogen atom? Give your answer in nm.

9. A 7459.89  B 9324.87  C 11656.08
10. A 4.26 \( \times 10^3 \)  B 4.81 \( \times 10^3 \)  C 5.43 \( \times 10^3 \)
11. A 6.14 \( \times 10^3 \)  B 6.94 \( \times 10^3 \)  C 7.84 \( \times 10^3 \)
12. A 8.86 \( \times 10^3 \)  B 1.00 \( \times 10^4 \)

The age of a piece of wood from an archeological site is to be determined using the Carbon-14 method. The activity of the sample is measured to be 0.432 times the Carbon-14 activity of living plants. What is the age of the sample in years? (The half-life of the Carbon-14 isotope is 5730 years.)

13. A True  B False

The work function of a surface determines the minimum intensity of light which will cause electrons to be emitted.
14. A True  B False

If the temperature (in K) of a black-body increases by a factor of two, then the emitted power increases by a factor of two.
15. A True  B False

For each statement below, select True or False.

> When a diffraction grating is illuminated by white light, the first order maximum for yellow light is farther away from the central maximum than the first order maximum for blue light.
14. A True  B False

> Red light strikes two narrow slits and an interference pattern is observed on a screen. As the distance separating the two narrow slits is decreased, the interference pattern observed on the screen will get wider.
15. A True  B False

> As the wavelength of light hitting a single slit is increased, the diffraction pattern observed on a screen will get wider.
16. A True  B False
A pair of slits separated by 1.2 mm, are illuminated with monochromatic light of wavelength 680 nm. The light falls on a screen 2.5 m away producing an interference pattern. A piece of glass with index of refraction $n = 1.59$ is placed at one slit. Placing the piece of glass in front of the slit causes the maxima to shift $0.27 \delta x$, where $\delta x$ is the distance between adjacent maxima. What is the thickness of the glass in $\mu$m?

$$17. \text{A} \ 0.142 \quad \text{B} \ 0.166 \quad \text{C} \ 0.194 \quad \text{D} \ 0.227$$
$$\text{E} \ 0.266 \quad \text{F} \ 0.311 \quad \text{G} \ 0.364 \quad \text{H} \ 0.426$$

What is the average induced current (in amps) in the loop during the stretching process?

$$19. \text{A} \ 1.41 \quad \text{B} \ 1.59 \quad \text{C} \ 1.80 \quad \text{D} \ 2.04$$
$$\text{E} \ 2.30 \quad \text{F} \ 2.60 \quad \text{G} \ 2.94 \quad \text{H} \ 3.32$$

The figure shows three charges $Q_1$, $Q_2$ and $Q_3$ fixed in place at the corners of an equilateral triangle. The length of each side of the triangle is 14.5 cm. Recall that all of the interior angles of an equilateral triangle are 60°.

For $Q_1 = 17.80 \ \mu$C, $Q_2 = -17.80 \ \mu$C, and $Q_3 = 8.40 \ \mu$C find the net electrostatic force acting on charge $Q_3$.

$$20. \text{A} \ 5.01 \times 10^1 \quad \text{B} \ 5.66 \times 10^1 \quad \text{C} \ 6.40 \times 10^1$$
$$\text{D} \ 7.23 \times 10^1 \quad \text{E} \ 8.17 \times 10^1 \quad \text{F} \ 9.24 \times 10^1$$
$$\text{G} \ 1.04 \times 10^2 \quad \text{H} \ 1.18 \times 10^2$$