Assiut University
Faculty of Science
Department of Physics

Vibration and Waves
(212 P)

May 2018
Time Allow: Three hours

Answer all questions [Ten marks for each question]

1- a) Explain the characteristics of simple harmonic motion using the simple pendulum as a model.

b) A physical pendulum is displaced by 3 cm then left from rest. If the period is 3 s, calculate the time at which the rod is at 2 cm from the equilibrium.

2-a) The energy of a damped harmonic oscillator is observed to reduce by a factor 3 after 12 complete cycles. By what factor will it reduce after 36 complete cycles. Draw the results.

b) Deduce the amplitude of the charge for the undamped forced oscillation in an electric circuit.

3-a) A spring of constant 150 N/m and mass of 2 kg oscillates in a damping medium of constant 0.05 Ns/m and affected by a force $F = 2 \cos 30\ t$. Calculate:

the amplitude – the phase angle – the approximate maximum amplitude.

b) Deduce the average power absorbed during a damped forced oscillation.

4-a) Two simple pendulums, each of length 0.8 m and mass of 4 kg are coupled by a horizontal spring of constant 30 N/m. One of the masses is moved to 6 mm and the other mass is moved to 3 mm, then the masses released from rest. (i) Calculate the normal modes of vibrations.

(ii) Calculates the displacements as functions of time.

b) If $T(x,t)$ represent the temperature wave along a metal rod. Prove that

$T(x,t) = A \sin(2\pi/\lambda)(x+vt)$ is a solution of the wave equation.

5-a) Calculate the transmission and reflection coefficients of amplitude for a wave travels from a medium to another if the mass of the unit length of the second medium is 4 times that of the first medium.

b) A radar moves with a speed of 20m/s behind a car of speed 15m/s and voice of frequency 400 Hz. Calculate the frequency recorded by the radar in the two cases of the radar: behind and ahead of the car.

Best wishes,

Prof. Dr. Mostafa Buody

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olem 5

ries ***RLC*** circuit has components with following values:

200 mH, $C = 10\ \mu F$, $R = 20\ \Omega$, and $\Delta V_{max} = 100\ V$, with $\Delta v = \Delta V_{max} \sin 377\,t$.

l:

Determine the inductive reactance, the capacitive reactance, and the impedance of the circuit.

Find the maximum current in the circuit.

Find the phase angle between the current and voltage.

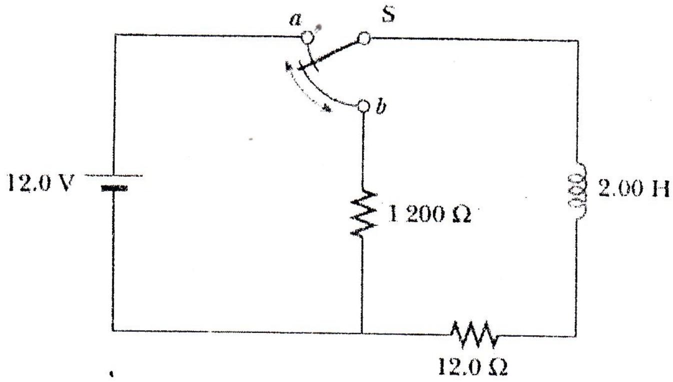
he Exam...Good Luck

Problem 4

Draw to scale a phasor diagram showing Z, X_L, X_C, and Φ for an AC series circuit for which R =3
$C = 11\ \mu F$, $L = 0.2\ H$, and $f = (500/\pi)\ Hz$.

blem 3

ne application of an *RL* circuit is the generation of timevarying high voltage from a low-voltage source, as own in the figure.



) What is the current in the circuit a long time after e switch has been in position ***a***?

) Now the switch is thrown quickly from ***a*** to ***b***. ompute the initial voltage across each resistor and ross the inductor.

) How much time elapses before the voltage across e inductor drops to ***12.0 V***?

Problem 2

An air-core solenoid with **120 turns** is *9 cm* long and has a diameter of *10 mm.*

(a) Calculate the inductance of the solenoid.
(b) How much energy is stored in its magnetic field when it carries a current of *0.770 A*?
(a) What If? The air-core is replaced with a soft iron rod that has the same dimensions, but a magnetic permeability $\mu_m = 800\,\mu_0$. What is the new inductance?

stion II: **(30 Marks, 7.5 per each)**

ve only FOUR of the following FIVE problems.

blem 1

nF capacitor with an initial charge of **5.1** μC is discharged through a **1.3** $k\Omega$ resistor.

What is the maximum current in the resistor?

Calculate the current in the resistor **9** μs after the resistor is connected across the terminals of the icitor.

Vhat charge remains on the capacitor after **8** μs?

Calculate the maximum energy stored in the electric field of the capacitor.

5. A charged capacitor and an inductor are connected in series. At time $t = 0$ the current is zero, capacitor is charged. If T is the period of the resulting oscillations, the next time after $t = 0$ that the e stored in the magnetic field of the inductor is a **maximum** is:

(a) T (b) $2T$ (c) $T/2$ (d) $T/4$

6. At time $t = 0$ the charge on the $50\ \mu F$ capacitor in an **LC** circuit is $15\ \mu C$ and there is no current. If the inductance is $20\ mH$ the maximum current is:

(a) $15\ nA$ (b) $15\ \mu A$ (c) $15\ mA$ (d) $15\ A$

7. The quantity B^2/μ_0 has units of:

(a) J (b) J/H (c) J/m (d) J/m^3

8. In a **purely capacitive** circuit the current:

(a) leads the voltage by one-fourth of a cycle
(b) leads the voltage by one-half of a cycle
(c) lags the voltage by one-fourth of a cycle
(d) lags the voltage by one-half of a cycle

9. The impedance of an RLC series circuit is **definitely increased** if:

(a) C **decreases** (b) **L increases** (c) **R increases** (d) **R decreases**

10. An **ac** generator produces $10V$ *(rms)* at $400\ rad/s$. It is connected to a series **RL** circuit ($R = 17.3\ \Omega$, $L = 0.025\ H$). The **rms current** is:

(a) $0.50A$ and leads the emf by 30°
(b) $0.71A$ and lags the emf by 30°
(c) $1.40A$ and lags the emf by 60°
(d) $0.50A$ and lags the emf by 30°

Assiut University
Faculty of Science
Physics Department
Final Exam: 50 Marks

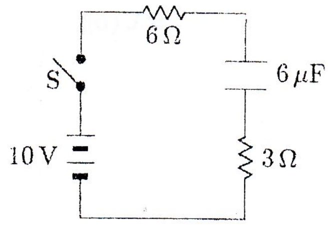
Semester: Spring 2018
Date: 10/5/2018
Course: Electricity & AC current (P226)
Time Allowed: 2 hours

Constants: $\mu_0 = 4\pi\times10^{-7}$ T.m/A

Question I: (20 Marks, 2 per each)

Circle the correct answer for all of the following TEN multiple-choice questions.

1. In the circuit shown, the capacitor is initially uncharged. At time t = 0, switch **S** is closed. If τ denotes the time constant, the approximate current through the **3 Ω** resistor when $t = \tau/3$ is:



(a) 0.38 A
(b) 0.8 A
(c) 1.0 A
(d) 1.5 A

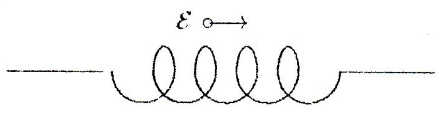
2. A certain capacitor, in series with a **1 kΩ** resistor, is being charged. At the end of **10 ms**, its charge is half the final value. The capacitance is about:

(a) 9.6 μF (b) 20 μF (c) 14 μF (d) 10 F

3. A long narrow solenoid has length ℓ and a total of N turns, each of which has cross-sectional area A. Its inductance is:

(a) $\mu_0 N^2 A\,\ell$ (b) $\mu_0 N^2 A/\ell$ (c) $\mu_0 NA/\ell$ (d) $\mu_0 N^2 \ell/A$

4. The diagram shows an inductor that is part of a circuit. The direction of the emf induced in the inductor is indicated. Which of the following is possible?



(a) The current is constant and rightward
(b) The current is constant and leftward
(c) The current is increasing and rightward
(d) The current is increasing and leftward

Question IV: **(15 marks)**

1. Compare BRIEFLY between the simultaneity in the Newtonian relativity and in the special theory of relativity. Use the space-time diagram for the case of the special theory of relativity. (6 Marks)
2. An electron in a hydrogen atom makes a transition from the n=3 to the n=1 energy state. Determine the wavelength of the emitted photon. (3 Marks)
3. Using plank's radiation law, find the power radiated by a unit area of a blackbody within narrow wavelength interval $d\lambda = 10^{-9}$ m close to the maximum of spectral radiation intensity at a temperature $T = 3000$ K. (3 Marks)
4. An electron and an alpha particle moving in opposite direction. The speed of the electron is 0.850c and the speed of the alpha particle is 0.750c, both measured by a stationary observer in the laboratory frame. What is the speed of the electron as observed from the alpha particle in units of the speed of light? (3 Marks)

Question V: **(15 marks)**

1.

(a) Using Bohr's general assumptions, derive the smallest orbit radius in hydrogen atom (Bohr's radius). (3 Marks)

(b) Compare between the stationary states and classical stable states in the Bohr and Rutherford atomic models showing the failure of the Rutherford model. (3 Marks)

2. Space-time coordinates of two events 1 and 2 in a frame S are $x_1 = 20$ m, $t_1 = 6\times10^{-8}$ s and $x_2 = 40$ m, $t_2 = 3\times10^{-8}$ s. Find the velocity of the frame S' in which both events occur simultaneously. (3 Marks)
3. Unstable particles are created in a nuclear reaction with a proper half-life time $t_{1/2} = 10^{-10}$ s. If the speed of these particles is v=0.6c on average, how far will they travel before half of them decay? (3 Marks)
4. An astronaut takes a trip to a star system, which is located a distance of 8 light-years from the earth. If the spaceship moves at a constant speed of 0.8c, prove that the time of journey as measured by the astronaut is 6 years. (3 Marks)

Constants:

The electron charge $e = 1.60217662\times10^{-19}\ C$; the electron rest mass $m_0 = 9.10938356\times10^{-31}\ kg$; the proton rest mass $m_p = 1.672\times10^{-27}\ kg$; the speed of light $c = 2.99\ 792\ 458\times10^{8}\ m/s$; Plank's constant $h = 6.62607004\times10^{-34}\ m^2\ kg/s$; Rydberg constant $R_\infty = 1.097373\times10^{7}\ m^{-1}$; the permittivity of free space $\varepsilon_0 = 8.85418782\times10^{-12}\ m^{-3}kg^{-1}s^4A^2$.

End of the Exam...**Good Luck!**

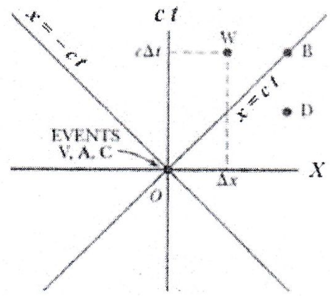
Dr. Hesham Fares

Assiut University	**Course: Modern Physics (P215)**
Faculty of Science	**Date: May 11, 2108**
Physics Department	**Time Allowed: 3 hours**
Final Exam: 50 Marks	**Semester: Spring 2018**

Answer the following TWO questions:

Question I: True or false and COMMENT why **(12 marks, 1 mark per each)**

1. According to the Galilean transformations, the speed of light is constant in all frames.
2. In the special theory of relativity, accelerations in the rest and moving frames are equal.
3. In the special theory of relativity, the velocity of a particle with rest mass m_0 can exceed the speed of light.
4. The proper time is longest time and can ONLY be measured in the rest frame.
5. In the front space-time diagram, the motion between the two events A and B is not real.
6. In the front space-time diagram, the two events C and D can be casually connected.
7. For a fixed relative velocity between sound source and observer, the sound frequency measured by the observer is always same.
8. For a nonzero mass object with rest mass m_0, if the total energy is $E = \gamma m_0 c^2$, then $E = pc$ where p is the relativistic momentum.



Space time diagram

9. Plank assumed that the cavity wall of a black body consists of microscopic oscillators where the average energy of oscillator is hf where h is the plank's constant and f is the oscillator frequency.
10. In the Compton scattering, the wavelength of the scattered photon is always longer than the wavelength of the incident photon.
11. In the Bohr's model, the separation between the energy levels decreases with increasing the principle quantum number.
12. De Broglie's wave is an electromagnetic wave whose wavelength approaches to zero for the particle at rest.

Question II: **(8 marks, 2 marks per each)**

1. In the relativistic Doppler effect, derive the relation between the light frequency as measured by an observe and the source frequency when the observer and source are approaching to each other.
2. The total energy of a proton is nine times its rest energy. Find the momentum of the proton.
3. Calculate the energy of electron in excited states of hydrogen atom at the principle quantum number n=2,3,4,5 where the electron energy at n=1 is $E_1 = -13.6$ eV. Draw schematically the energy states and discuss your answer.
4. A photon with a wavelength $\lambda = 5\times10^{-11}$ m is scattered straight backward. What is the wavelength of the scattered wave? What is the kinetic energy of the scattered electron?

Answer ONLY TWO questions from the following questions (III, IV, and V).

Question III: **(15 marks)**

1. Describe BRIEFLY the Rutherford-Geiger-Marsden experiment discussing BRIEFLY the Rutherford explanations of the results. (6 Marks)
2. Derive the Compton shift $\Delta\lambda$ when a photon scatters with an electron. (3 Marks)
3. If the kinetic energy of an electron is 99 times its rest energy, what is the de Broglie wavelength of the electron? (3 Marks)
4. An electron has a speed of u=0.9c. Find its total energy (in eV), kinetic energy (in eV), and its momentum. (3 Marks)

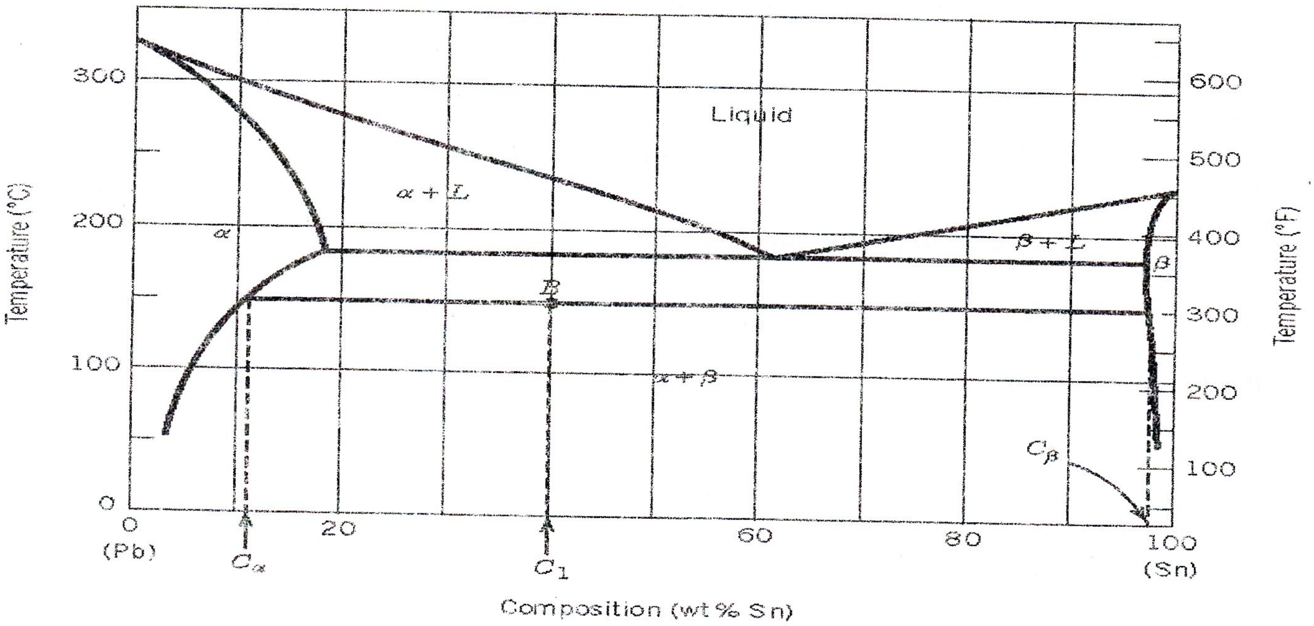
Q.6: **(10 Marks)**

Q.6(a): **(5 Marks)**

Discuss briefly the steps generally used for preparing metallic polycryatalline samples for optical microscopy examination (OM). How you can use the obtained OM photographs to determine the average grain size.

Q.6(b): **(5 Marks)**

As shown in this figure below at the point B, For a 40 wt% Sn -60 wt% pb alloy at 150 °C, a)- what phase (s) is (are) present? B)- what is (are) the composition(s) , c) calculate the relative amount of each phase present in terms of mass fraction. D)- Apply the Gibbs phase rule at this point to find the number of degrees of freedom.



With my best wishes

Prof. Dr. Atta . Y. Abdel-latief

Q.5: (Marks10)

Q.5(a): (5 Marks)

Write a short account on two only from the following:

i)- diffusion mechanism in solids and factors affect diffusion.

ii)- different classes of volume defects in solids.

ii)- Homogenous nucleation and the critical nucleus radius during solidification of pure metals.

Q.5(b): (5 Marks)

The NaCl is ionic ceramic material have NaCl crystal structure. Calculate the theoretical density (ρ) for this ceramic, consider the following parameters:

The number of formula unit n =4 , $\sum A_c = A_{Na} = 22.99\ g/mole$

$\sum A_A = A_{Cl} = 35.45\ g/mole$ r_{Na}=0.102x10^{-7} cm

r_{Cl}=0.181x10^{-7} cm N_A=6.022x10^{23} formula unit/ mole

Q.4: (Marks10)

Q.4(a): (5 Marks)

Give an expression for the following:

i)- average theoretical density (ρ_{aver}) and the average atomic weight (A_{aver}) for a binary alloy of the elements A and B with wt% concentrations C_1, C_2 and density ρ_1, ρ_2 respectively.

ρ_{aver} =......................................., ... A_{aver} =.......................................

ii)-The Chvorinov,s Rule for the total solidification time during casting

TST=..

Q.4(b):

Calculate the activation energy for vacancy formation in aluminum given that the equilibrium number of vacancies at 500C^0 is $7.57 \times 10^{23}/m^3$. The atomic weight and density of (at 500 C^0) for aluminum are respectively 26.98 g/mole and 2.62g/cm^3.

Q.3: **(10 Marks)**

Q.3(a): **(5 Marks)**

Using the sketch diagram to compare between the following:

i)- Cooling curve for a pure metal (e.g Ni) and that for 50%Ni-50% Cu alloy during casting.

ii)- Vacancy and interstitial diffusion mechanism

Q.3(b): **(5 Marks)**

A tensile stress is to be applied along the long axis of a cylindrical brass alloy rod that has a diameter of 5 mm. Determine the magnitude of the load required to produce a $5x10^{-3}$ mm change in diameter if the deformation is entirely elastic. [consider for brass alloy the following: the young Modulus $E=97x10^{3}$ MPa, The value of the Poisson's ratio is - 0.34].

Q.2: **(10 Marks)**

Q.2(a): **(5 Mark)**

Prove that the atomic packing factor (APF) for the BCC and hcp unit cells have different values.

Q.2(b):

For which set of crystallographic planes will a first-order diffraction peak occur at a diffraction angle of 46.21^0 for BCC iron when a monochromatic radiation having a wavelength of 0.0711nm is used.[consider the atomic radius for BCC iron R=0.1241nm].

جامعة أسيوط

كلية العلوم

قسم الفيزياء

الفرقة : المستوى الثانى

المادة : 223 ف ديناميكا حرارية

الزمن : 3 ساعات

امتحان الفصل الدراسى الثانى 2018م

أجب عن خمسة أسئلة فقط مما يأتى: **(السؤال 10 درجات)**

السؤال الأول :

أ – إذا كانت C_p هى السعة الحرارية عند ضغط ثابت، C_v هى السعة الحرارية عند حجم ثابت فاثبت أن: $C_p - C_v = R$ و أن $C_p/C_v = const.$ للغاز المثالى.

ب – عرف المحتوى الحرارى H ثم اثبت أن $C_p = (\frac{\partial H}{\partial T})_P$

السؤال الثانى :

أ – اثبت أن التغير فى الانتروبى الناشئ عن تغير كل من الحجم و درجة الحرارة يعطى من العلاقة :

$$T\,ds = C_v\,dT + T\left(\frac{dP}{dT}\right)_V dV$$

ب – اشرح باختصار فكرة الالة الحرارية المثالية موضحا متى تكون كفاءتها η 100 % .

السؤال الثالث:

أ – عرف القانون الأول و الثانى و الثالث للديناميكا الحرارية ثم أذكر قيمة كل من التمدد الحرارى α_p و السعة الحرارية عند حجم ثابت C_v و الطاقة الحرة A عند الصفر المطلق.

ب- من تجربة جول و كلفن اثبت أن الانثالبى H مقدار ثابت أى أن:

$$H_1 = H_2$$

السؤال الرابع :

فسر نموذج اينشتين للسعة الحرارية ثم قارن بينه و بين نموذج ديباى للسعة الحرارية عند درجات الحرارة المرتفعة و المنخفضة موضحا مدى التوافق مع النتائج العملية .

السؤال الخامس:

أ – اثبت أن $\epsilon = b\,T^4$

حيث ϵ كثافة الطاقة الإشعاعية ، **T** درجة الحرارة المطلقة ، **b** مقدار ثابت

ب – اثبت أن الجهد الديناميكى الحرارى G يساوى صفر نتيجة الإشعاع الحرارى عند ثبوت الضغط أى أن $G = 0$.

السؤال السادس:

احسب الشغل المبذول على مادة ممغنطة لزيادة مغنطتها ثم اكتب القانون الأول للديناميكا الحرارية فى الحالة المغناطيسية.

مع تمنياتى بالتوفيق و النجاح

Question Two: Perform the indicated calculations (6 points each)

(i) An electron e with kinetic energy 1.000 MeV makes a head-on collision with a positron e+ at rest. In the collision the two particles annihilate each other and are replaced by two photons of equal energy, each traveling at angles with the electron's direction of motion. (A photon is a massless particle of electromagnetic radiation having energy E = pc.) The reaction is

$$e^- + e^+ \rightarrow 2\gamma$$

Determine the energy E, momentum p and angle of emission of each photon.

(ii) The stopping potential for electrons emitted from a surface illuminated by light of wavelength 491 nm is 0.710 V. When the incident wavelength is changed to a new value, the stopping potential is 1.43 V. (a) What is this new wavelength? (b) What is the work function for the surface?

(iii) X-rays having energy of 250 keV undergo Compton scattering from a target. The scattered rays are detected at 41.0° relative to the incident rays. (a) Find the Compton wavelength shift at this angle. (b) Find the energy of the scattered x-ray. (c) Find the kinetic energy of the recoiling electron.

(iv) Hydrogen's 656 nm red spectral line is the result of a transition between quantum states of the electron in the hydrogen atom. Such transitions occur within approximately 10^{-8} s. Using the uncertainty principle $\Delta E.\Delta t \geq \hbar/2$, find the range of wavelengths observed.

(v) The ^{16}O atom has 8 protons, 8 neutrons, and 8 electrons. Its mass is 15.994 914 6 u. Find the mass defect, the binding energy and the binding energy per nucleon?

Best Wishes

Assiut University **Faculty of Science** **Physics Department** **Final Exam**		**Level: two** **Date:22.05.2018** **Allowed time: Two hours** **Course code: P225**

Some possibly useful constants can be found in the table below

$e = 1.6\times10^{-19}$ C	$m_e = 9.1\times10^{-31}$ Kg	$c = 3\times10^{8}$ m.s^{-1}	$R_h = 1.097\times10^{-13}$ m^{-1}	$m_H = 1.007825$ u
$h = 6.62\times10^{-34}$ J.s	$m_p = 1.67\times10^{-27}$ Kg	1 eV $= 1.6\times10^{-19}$ J	$m_H = 1.007825\,u$	$m_n = 1.008665$ u

<u>Question one</u>: choose the correct answer [2 points each]

1) The total energy of a proton is nine times its rest energy. Then, the momentum of the proton in MeV/c units

A. 8392 MeV/c. B. 6425 MeV/c. C. 0.58 MeV/c. D. 88.6 MeV/c.

2) Which of the following was a fundamental problem of the Thompson model of the atom?

A. Electron orbits were unstable.
B. The atom was too large.
C. The atom was too small.
D. The distribution of charge was wrong.

3) Which of the following formulas describes the longest wavelength in the Lyman series (n = 1)?

A. $5hc/36R_H$ B. $36hc/5R_H$ C. $3hc/4R_H$ D. $4hc/3R_H$

4) Suppose a spacecraft is moving relative to us, and is emitting electromagnetic radiation with frequency f_0. In which circumstances will the detected frequency f be

A. lower than f_0? If it is moving directly away from us (only)
B. If it is moving directly towards us (only)
C. If it is moving perpendicular to our line of sight (only)
D. A and C are true, but not B

5) In nuclear fusion, as compared to masses of original nuclei, final nucleus is always

A. equal B. more C. less D. zero.

6) For large-mass-number nuclei which are stable, the ratio of protons to neutrons is almost

A. 2 to 1 B. 1 to 1 C. 1 to 2 D. Not related.

7) Bremsstrahlung consists of .... wavelength of radiation.

A. Single. B. double C. triple. D. Multiple.

8) Series that lie in infrared region of electromagnetic spectrum is .... series

A. Lyman. B. Ballmer. C. bracket. D. both a and b.

9) A train at rest has a length of 100 m. At what speed must it approach a tunnel of length 80 m so that an observer at rest with respect to the tunnel will see that the entire train is in the tunnel at one time?

A. 1.25c B. 0.8c C. 0.64c D. 0.6c.

10) The intensity of the X-rays depends on ________ of materials.

A. atomic weight. B. atomic number. C. volume electron. D. number of neutron.

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