

KATHMANDU UNIVERSITY  
End Semester Examination  
August, 2018

Marks scored:

Level : B. Sc.  
Year : III

Course : PHYS 312  
Semester : II

Exam Roll No. :

Time: 30 mins.

F. M. : 20

Registration No.:

Date **AUG 12 2018**

SECTION "A"

[20 Q × 1 = 20 marks]

Choose and tick (✓) the most appropriate answer. The symbols, unless mentioned otherwise, have their usual meanings.

1. A spacecraft is moving relative to the earth. An observer on the earth finds that, between 1 pm and 2 pm according to her clock, 3601 sec. elapse on the spacecraft's clock. Then the spacecraft's speed relative to earth is equal to  
[a]  $6 \times 10^6$  m/s      [b]  $9 \times 10^6$  m/s      [c]  $2 \times 10^6$  m/s      [d]  $7.1 \times 10^6$  m/s
2. How fast must a spacecraft travel relative to earth for each day on the spacecraft to correspond to 2 day on the earth?  
[a]  $6.6 \times 10^8$  m/s      [b]  $4.6 \times 10^8$  m/s      [c]  $2.6 \times 10^8$  m/s      [d]  $2 \times 10^8$  m/s
3. How much work (in MeV) must be done to increase the speed of an electron from  $1.2 \times 10^8$  m/s to  $2.4 \times 10^8$  m/s?  
[a] 0.294 MeV      [b] 0.594 MeV      [c] 0.794 MeV      [d] 0.994 MeV
4. A particle has a kinetic energy 20 times its rest energy. Then speed of the particle in terms of c is equal to  
[a] 0.552 c      [b] 0.9989 c      [c] 0.902 c      [d] 0.752 c
5. An observer detects two explosions, one that occurs near her at a certain time and another that occurs 2 ms later 100 km away. Another observer finds that the two explosions occur at the same place. What time interval separates the explosions to the second observer?  
[a] 6.97 ms      [b] 3.97 ms      [c] 2.97 ms      [d] 1.97 ms
6. At what speed does the relativistic value for length differ from the classical value by 1 %?  
[a] 0.941 c      [b] 0.541 c      [c] 0.141 c      [d] 0.241 c
7. How fast must an unstable particle move to travel 20 m before it decays? The mean lifetime at rest =  $2.6 \times 10^{-8}$  sec  
[a]  $1.8 \times 10^8$  m/s      [b]  $2.8 \times 10^8$  m/s      [c]  $6.8 \times 10^8$  m/s      [d]  $9.8 \times 10^8$  m/s
8. A beam of particles travels at a speed of 0.9c. At this speed, the mean lifetime as measured in the laboratory frame is  $5 \times 10^{-6}$  sec. What is the proper lifetime of the particles?  
[a]  $2.18 \times 10^{-6}$  sec      [b]  $5.18 \times 10^{-6}$  sec      [c]  $7.18 \times 10^{-6}$  sec      [d]  $9.18 \times 10^{-6}$  sec

9. If the sun radiates energy at the rate of  $4 \times 10^{26}$  J/s. Then the rate at which its mass is decreasing is equal to  
 [a]  $4.44 \times 10^{31}$  kg    [b]  $4.44 \times 10^{19}$  kg    [c]  $4.44 \times 10^{11}$  kg    [d]  $4.44 \times 10^9$  kg
10. What is the velocity of an electron having a kinetic energy 10 MeV? The rest energy of the electron is 0.512 MeV.  
 [a] 0.5588 c    [b] 0.7788 c    [c] 0.9988 c    [d] 0.9588 c

Fill in the blanks.

11. In inertial frame S, two events occur at the same instant in time and  $3c$  minutes apart in space. In inertial frame S', the same events occur at  $5c$  minutes apart. Then the time interval between the events in S' is equal to.....
12. An atom moving at speed of  $0.3c$  emits an electron along the same direction with speed  $0.6c$  in the internal rest frame of the atom. The speed of the electron in the laboratory frame is equal to .....
13. Real intervals are known as .....
14. In Michelson-Morley experiment, they used .....to measure the velocity of light.
15. The four momentum is like.....
16. If  $a_0^3$  is the rest volume of a cube, then the volume viewed from a reference frame moving with uniform velocity  $v$  parallel to one edge of the cube will be.....
17. A cube moving along one of its faces at a very high speed will look like.....
18. A man moves on the ground with a speed of 2 m/s towards a train moving towards him with 40 m/s on the ground. Their relative speed will be .....
19. A meter long rod when moving with speed  $0.8c$ , appears to a stationary observer to be of length .....
20. A body of mass  $m$  falls through height of  $h$  meters. The decrease in its mass is equivalent to.....

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SECTION "B"

[5Q. × 4 = 20 marks]

1. Discuss the Galilean transformations of velocity and acceleration of a particle. Also derive an expression for invariance of momentum under Galilean transformation.
2. Deduce an expression for transformation of momentum and energy.  
OR  
Derive an expression for transformation of acceleration.
3. Develop Hamilton's equations from modified Hamilton's principle.
4. Establish the relativistic formulation of equation of motion and also express the classical limit of such equation of motion.
5. Prove that  $m = m_0\gamma$  and  $E = mc^2$  and discuss the equivalence of mass and energy.  
OR  
Establish the Hamilton's principle in relativity. Derive an expression for relativistic Lagrange's equation

SECTION "C"

[5Q. × 7 = 35 marks]

6. Explain the phenomenon of aberration? Deduce the formulae for aberration by using Lorentz transformation equations. Compare it with the classical formula.
7. Describe in details about space like and time like intervals in Minkowski space with necessary diagrams.  
OR  
What do you mean by four vectors? Express scalar and vector product of two world vectors, gradient, divergence and curl of four vectors. Obtain the conditions and difference for space like and time like components of four vectors.
8. Describe the consequences of Lorentz transformation equations.  
OR  
What are the postulates of special theory of relativity? Establish the Lorentz transformation and inverse Lorentz transformation equations and discuss it for low velocity of particle.
9. Find the relation between energy and momentum in relativistic mechanics. Derive the expression for Lorentz transformation of force.
10. Obtain the modified Hamilton's principle. Establish an expression for Hamilton's canonical equations in covariant form.

