

D 11868

(Pages : 3)

Name.....

Reg. No.....

**THIRD SEMESTER (CUCBCSS—UG) DEGREE EXAMINATION  
NOVEMBER 2021**

Physics/Applied Physics

PHY 3B 03/APY 3B 03—MECHANICS

(2014—2018 Admissions)

Time : Three Hours

Maximum : 80 Marks

**Section A***Answer all questions.**Each question carries 1 mark.**Answer in a word or phrase.*

1. State law of inertia.
2. What is the work done by conservative forces ?
3. Define elastic collision.
4. Define inelastic collision.
5. Rocket works on the principle of \_\_\_\_\_.
6. Define angular momentum.
7. Give one example for central force.
8. Write down the expression for Newton's law of gravitation.
9. Write down the relation connecting angular momentum and torque.
10. Define holonomic constraint.

(10 × 1 = 10 marks)

**Section B***Answer all questions.**Each question carries 2 marks.**Answer in two or three sentences.*

11. What are fictitious forces ?
12. Define Potential energy.

**Turn over**

13. Define centre of mass.
14. What is the equation for the centre of mass of a solid hemisphere of radius  $R$  ?
15. Explain satellite motion.
16. What is two stage rocket ?
17. With equation define central force.

(7 × 2 = 14 marks)

### Section C

*Answer any **five** questions.  
Each question carries 4 marks.  
Answer in **one** paragraph.*

18. Define and obtain work-energy theorem.
19. Obtain the relation of force as the gradient of potential.
20. Derive an expression for the centre of mass of thin uniform rod.
21. Define areal velocity. Derive expression.
22. With figure explain scattering of protons by a heavy nucleus.
23. Define gravitational i) Field ; and ii) Potential.
24. Write down Lorentz transformation equations.

(5 × 4 = 20 marks)

### Section D

*Answer any **four** questions.  
Each question carries 4 marks.*

25. Calculate the effective weight of an astronaut ordinarily weighing 60 kg when his rocket moves vertically (1) upward ; and (ii) downward with 6g Acceleration.
26. A 1 kg stone at the end of a 2 metres long string makes 5 revolutions per second. Calculate the force on the stone as measured in an inertial frame and in a frame which is rotating with the string
27. Derive an expression for the P.E of a system of charges
28. An artificial satellite is revolving round the earth at a distance 620 km. Calculate the minimum velocity and the period of revolution.  $R_E = 6380 \text{ km}$  ;  $g = 9.8\text{m/s}^2$ .

29. Derive the equation of motion of a spherical pendulum using Lagrange equation.
30. Explain time dilation.
31. Explain the variation of mass with velocity.

(4 × 4 = 16 marks)

### Section E

*Answer any two questions.*

*Each question carries 10 marks.*

32. Explain i) Force ; ii) Conservative force ; iii) Work done ; and iv) Work done for a conservative force around any closed path.
33. Explain the deflection of a moving particle by a particle at rest.
34. With figure explain the principle and working of rocket propulsion.
35. With figure explain Michelson Morley experiment.

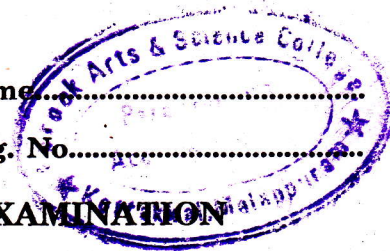
(2 × 10 = 20 marks)

D 91716

(Pages : 3)

Name.....

Reg. No.....



**THIRD SEMESTER (CUCBCSS—UG) DEGREE EXAMINATION  
NOVEMBER 2020**

Physics/Applied Physics

PHY 3B 03/APY 3B 03—MECHANICS

Time : Three Hours

Maximum : 80 Marks

**Section A**

*Answer all questions.*

*Each question carries 1 mark.*

*Answer in a word or phrase.*

1. A particle in uniform rectilinear motion corresponds to a straight world line. The relative position of one event with respect to another would be represented by \_\_\_\_\_.
2. A particle of \_\_\_\_\_ mass travels with the speed of light.
3. Work energy theorem is given by \_\_\_\_\_.
4. The configuration of the system of  $N$  particles, moving freely in space, may be represented by the position of a single point in  $3N$  dimensional space, which is called \_\_\_\_\_.
5. The relation represents variation of mass with velocity is \_\_\_\_\_.
6. An inertial frame attached with the centre of mass of an isolated system of particles is called the \_\_\_\_\_.
7. Constraints are always related to forces which restrict the motion of the system. These forces are called \_\_\_\_\_.

True or False :

8. Lagrangian equations are invariant under Galilean transformation.
9. It is impossible to perform an experiment which will measure the state of uniform velocity of a system by observations, confined to that system.
10. All the laws of physics have the same form in all non inertial systems.

(10 × 1 = 10 marks)

**Turn over**

**Section B**

*Answer all questions*  
*Each question carries 2 marks.*  
*Answer in two or three sentences.*

11. What are the assumptions of Galilean transformations ?
12. State D alembert's principle ?
13. State Newton's law of action and reaction.
14. What is the negative results of Michelson-Morley experiment.
15. Explain conservation of energy in a particle.
16. State postulates of special theory of relativity.
17. Explain length contraction.

(7 × 2 = 14 marks)

**Section C**

*Answer any five questions.*  
*Each question carries 4 marks.*  
*Answer in one paragraph.*

18. Explain the advantages of lagrangian dynamics over Newtonian approach.
19. Deduce an expression for escape velocity.
20. Explain validity of Newton's law.
21. State and deduce Kepler 's second law of planetary motion.
22. Explain inertial frames of reference with example.
23. What you mean by ether hypothesis in relativity.
24. Explain twin paradox phenomena.

(5 × 4 = 20 marks)

**Section D**

*Answer any four questions.  
Each question carries 4 marks.*

25. If  $F = (2xy + z^2)\mathbf{i} + x^2\mathbf{j} + 2xz\mathbf{k}$  newton, then show that it is conservative. Calculate the amount of work done by this force in moving a particle from (0, 1, 2) to (5, 2, 7) m.
26. A clock keeps correct time. With what speed should it be moved relative to an observer so that it may seem to lose 2 minutes in 24 hours ?
27. Obtain the equation of motion of a simple pendulum by using Lagrangian method and hence deduce the formula for its time period for small amplitude oscillations
28. Calculate the speed of an electron which has kinetic energy 2 MeV.
29. The eccentricity of the earth's orbit is 0.0167. Calculate the ratio of maximum and minimum speeds of the earth in its orbit.
30. Write the Hamiltonian for a simple pendulum and deduce its equations of motion.
31. Determine the length and the orientation of a rod of length 10 metres in a frame of reference which is moving with  $0.6c$  velocity in a direction making  $30^\circ$  angle with the rod.

(4 × 4 = 16 marks)

**Section E**

*Answer any two questions.  
Each question carries 10 marks.*

32. Explain and deduce Hamilton's equations.
33. Briefly explain and deduce Inverse square law of planetary motion.
34. Explain conservation theorems and symmetry laws.
35. Explain Galilean transformation and deduce Galilean transformation equations.

(2 × 10 = 20 marks)

D 71658

(Pages : 3)

Name.....

Reg. No.....

**THIRD SEMESTER B.A./B.Sc. DEGREE EXAMINATION, NOVEMBER 2019**

(CUCBCSS—UG)

Physics/Applied Physics

PHY 3B 03/APY 3B 03—MECHANICS

Time : Three Hours

Maximum : 80 Marks

**Section A**

*Answer all questions.  
Each question carries 1 mark.  
Answer in a word or phrase.*

1. Newton's laws of motion are valid in reference systems, known as \_\_\_\_\_.
2. C-frame is also known as \_\_\_\_\_.
3. The simplest frame of reference is a \_\_\_\_\_ coordinate system.
4. Expression for an areal velocity of a particle gives \_\_\_\_\_.
5. The limitations on the motion of a system are called \_\_\_\_\_.
6. The equations which provide the relationship between the coordinates of two reference systems are called \_\_\_\_\_.
7. A vector in four dimensional \_\_\_\_\_ space is called a four vector.

True or False :

8. The constraint of a particle moving on an ellipsoid under the influence of gravity is holonomic
9. The angular momentum of a particle is constant of motion in presence of external torque. This is the conservation theorem of angular momentum of a particle.
10. Results of Michelson Morley experiment suggests that the speed of light in vaccum must be the same in all inertial frames.

(10 × 1 = 10 marks)

**Section B**

*Answer all questions.  
Each question carries 2 marks.  
Answer in two or three sentences.*

11. Explain work energy theorem.
12. Define Newton's law of force.

Turn over

13. What you mean by degrees of Freedom ?
14. Define Central force.
15. Write the expression for galilean transformation equations.
16. What is principle of equivalence ?
17. Explain time dilation.

(7 × 2 = 14 marks)

### Section C

*Answer any five questions.  
Each question carries 4 marks.  
Answer in one paragraph.*

18. Explain different type of constraints.
19. Explain conservation of linear momentum.
20. Define Centre of mass.
21. State and deduce Kepler's second law of planetary motion.
22. Briefly explain covariance of the physical laws.
23. What you mean by ether hypothesis in relativity.
24. Deduce a expression of Mass energy relation in relativity.

(5 × 4 = 20 marks)

### Section D

*Answer any four questions.  
Each question carries 4 marks.*

25. Express for the momentum of a photon in terms of wavelength  $\lambda$ . How much is the rest mass of the photon ? Calculate the relativistic mass of the photon of wavelength  $5000\text{\AA}$ .
26. A particle, moving in a central force field located at  $r = 0$ , describes a spiral  $r = e^{-\theta}$ . Prove that the magnitude of force is inversely proportional to  $r^3$ .
27. A meson has a speed  $0.8c$  relative to the ground. Find how far the meson travels relative to the ground. If its speed remains constant and the time of its flight, relative to the system, in which it is at rest, is  $2 \times 10^{-8}$  sec.
28. Consider the motion of a particle of mass  $m$ . using Cartesian coordinates as generalized coordinates, deduce Newton's equation of motion from Lagrange's equations.
29. An electron and a positron practically at rest come together and annihilate each other. Calculate the energy released.

30. Obtain equations of motion for a projectile near the surface of the earth.
31. Two objects of masses  $m_1 = 200$  gm and  $m_2 = 500$  gm possess velocities  $V_1 = 10i$  m/sec and  $V_2 = 3i + 5j$  m/sec just prior to a collision during which they become permanently attached to each other. Calculate (a) the velocity of the centre of mass, (b) the final momentum of the combination in the laboratory frame.

(4 × 4 = 16 marks)

### Section E

*Answer any two questions.*

*Each question carries 10 marks.*

32. Explain principle of virtual work and derive Lagrangian's equation from D'Alembert's Principle.
33. Briefly explain Kepler's planetary motion and deduce Kepler's third law of motion.
34. Explain Michelson Morley experiment and explain what are the results obtained from the experiment.
35. Explain Minkowski space and Lorentz transformations and deduce Lorentz transformations.

(2 × 10 = 20 marks)

**D 51244**

(Pages : 3)

Name.....

Reg. No.....

**THIRD SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2018**

(CUCBCSS—UG)

Core Course

PHY 3B 03/APY 3B 03—MECHANICS

Time : Three Hours

Maximum : 80 Marks

I. Answer *all* questions, each question carries 1 mark (in a word or phrase) :

1. Give an example of non-inertial frame of reference.
2. What is centrifugal force ?
3. Write down the relation between angular momentum and torque.
4. Give an example of motion under central force.
5. Give the significance of principle of virtual work.
6. Write down the expression for escape velocity.
7. What is gravitational potential ?
8. What are constraints ?
9. Write down Lagrange's equation of motion.
10. Give the significance of mass - energy equation.

(10 × 1 = 10 marks)

II. Answer *all* questions, each question carries 2 marks (Answer in two or three sentence) :

11. A light and heavy body have equal kinetic energies of translation. Which one has the larger momentum ? Why ?
12. What is the principle of rocket ?
13. What is Kepler's law of orbits ?
14. Give examples for non-holonomic constraints.
15. State any one conservation law.
16. What is the importance of geometrical interpretation of Lorentz transformation ?
17. Explain what is meant by simultaneity ?

(7 × 2 = 14 marks)

**Turn over**

III. Answer any *five* questions, each question carries 4 marks (Answer in a *paragraph*):

18. What is a fictitious force? Why is it so called? Under what condition will an accelerated frame of reference serve as an inertial frame?
19. Obtain an expression for restoring force as a function of position for a particle moving in a potential energy field  $U = A - Bx + Cx^2$ . At what point does the force vanish? Is this a point of stable equilibrium? If so find the value of the force constant.
20. What is gravitational potential energy? Derive an expression for escape velocity.
21. State and explain Kepler's laws of planetary motion.
22. State the principle of virtual work and hence to derive D'Alembert's principle.
23. State and explain the three conservation laws.
24. Briefly explain the concept of four vectors and give its importance.

(5 × 4 = 20 marks)

IV. Answer any *four* questions, each question carries 4 marks:

25. What will be the period of rotation of the plane of oscillation of Foucault's pendulum (i) in latitudes  $30^\circ$  and  $45^\circ$  (ii) at the equator.
26. The position of a moving particle is at any instant given by  $r = A \cos \theta i + A \sin \theta j$ . Calculate the total energy of the particle.
27. What is the momentum of an electron of kinetic energy 100 electron volts?
28. 20 gram of cane sugar is dissolved in water to make  $50 \text{ cm}^3$  solution. A 20 cm length of this solution causes a rotation of  $53^\circ 30'$  optical rotation. Calculate the specific rotation.
29. Show from Lorentz transformation that two events simultaneous at different positions in a reference frame S are not in general simultaneous in another reference frame S'.
30. A proton of rest mass  $1.67 \times 10^{-24} \text{ gm}$  is moving with velocity  $0.9c$ . Find its mass and momentum.
31. Determine the time (as measured by a clock at rest on a rocket) taken by a rocket to reach a distant star and return to earth with a constant velocity  $v = (0.9999)^{1/2} c$  if the distance of the star is 4 light years.

(4 × 4 = 16 marks)

V. Answer any *two* questions, each question carries 10 marks :

32. What is an inertial frame of reference ? Show that all other frames of reference, with constant velocity relative to it, are also inertial frames. What are the characteristic properties and importance of such frames ? Can the earth be regarded as one such frame ?
33. A satellite of mass  $M$  is going round the earth in a circular orbit of radius  $R$ . Obtain an expression for its angular momentum about the centre of its orbit. Also express the total energy of the satellite in terms of its angular momentum.
34. Derive Lorentz's transformation equation.
35. Explain Hamilton's principle and hence deduce Lagrange's equation of motion. Give any one of its application.

(2 × 10 = 20 marks)

**THIRD SEMESTER B.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION  
NOVEMBER 2017**

(UG—CCSS)

PH 3B 05/AP 3B 05—MECHANICS

(Common for Applied Physics)

[2009 Admissions]

Time : Three Hours

Maximum : 30 Weightage

**Part A**

*Answer all questions.*

*Each question carries  $\frac{1}{4}$  weightage.*

1. Absolute motion is :
  - (a) Real.
  - (b) Imaginary.
  - (c) Complex.
  - (d) Sometimes real and sometimes imaginary.
2. Freely falling bodies deviate from their true vertical path due to the effect of Absolute motion is :
  - (a) Newton's force.
  - (b) Coriolis force.
  - (c) Galilean force.
  - (d) Centripetal force.
3. The instantaneous Power acting on a particle is :
  - (a)  $F \cdot P$ .
  - (b)  $F \times r$ .
  - (c)  $F \cdot v$ .
  - (d)  $F \cdot ax$ .
4. A force which is constant and uniform is always :
  - (a) Zero.
  - (b) Conservative.
  - (c) Non Conservative.
  - (d) Infinite.
5. In the absence of external forces the velocity of the center of mass is \_\_\_\_\_.
6. The maximum height attained by a rocket is :
  - (a) R.
  - (b) 2R.
  - (c) 3R.
  - (d) 4.3R.

**Turn over**

7. The angular momentum of a particle moving under the action of a central force is :
- (a)  $J = r \times p$ . (b)  $lw = p$ .  
(c) Zero. (d)  $J = \frac{dv}{dt}$ .
8. When a particle moves under the action of a central force, its angular momentum is :
- (a) Not conserved. (b) Conserved.  
(c) Zero. (d) Infinite.
9. The escape velocity of a body projected in the upward direction from the earth is :
- (a) 7.98km/sec. (b) 11.2 km/sec.  
(c) 11.2km/hr. (d) 9.8m/sec.
10. The null result of the Michelson Morley experiment :
- (a) Confirms the existence of ether  
(b) Confirms a privileged frame of reference.  
(c) Discards the existence of ether.  
(d) Confirms the necessity of a medium for electromagnetic waves propagation
11. The source of solar energy is :
- (a) Fission of Protons. (b) Fusion of hydrogen atoms.  
(c) Fusion of neutrons. (d) None of the above.
12. Constraints which can be written in the form of inequality are called :
- (a) Holonomic. (b) Lagrangian.  
(c) Hamiltonian. (d) Holonomic.

(12 × ¼ = 3 weightage)

### Part B

*Answer all questions.*

*Each question carries 1 weightage.*

13. Explain the concept of inertial frame of reference.
14. What is Pseudo force ?
15. Give the features of conservation laws.
16. What is a non conservative force ? Give one example.
17. Explain Centre of Mass.
18. What is areal velocity ? Express it mathematically.

19. Explain Superposition principle.
20. Why is it that atmosphere is not present at moon's surface ?
21. What is meant by length contraction ?

(9 × 1 = 9 weightage)

### Part C

*Answer any five questions.*

*Each question carries 2 weightage.*

22. Explain Einstein's mass energy relationship using an example.
23. What is Galilean transformation ? Show that the distance between two points is invariant under Galilean transformation.
24. Prove that the Plane of oscillation of Foucault's pendulum rotates  $15^\circ \sin \phi$  per hour where  $\phi$  is the latitude of the place.
25. A body of mass 5kg is suspended from a spring which comes to rest after a downward displacement of 0.5 metre. Calculate the force constant and elastic potential energy gained.
26. The maximum and minimum distance of a Comet from the sun are  $1.4 \times 10^9$ km and  $7.0 \times 10^7$ km. If the velocity closest to the sun is  $6 \times 10^4$ m/s, what is its velocity when farthest ?
27. A rod of length 1m is moving along its length with a velocity of 0.8C. Calculate the length as it appears to an observer a) On the earth b) moving with the rod itself.
28. State and explain D' Alembert's Principle. Is D' Alembert's equation true for real or virtual displacement.

(5 × 2 = 10 weightage)

### Part D

*Answer any two questions.*

*Each question carries 4 weightage.*

29. What is Potential energy curve? Explain. What are the positions of stable and unstable equilibrium and why? Explain Neutral equilibrium.
30. State and derive Kepler's laws of Planetary motion from Newton's law of gravitation.
31. Describe the Michelson Morley experiment. Discuss the importance of negative results.

(2 × 4 = 8 weightage)

**D 72364-A**

(Pages : 3)

Name.....

Reg. No.....

**THIRD SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2014**

(U.G.—CCSS)

Core Course—Physics

PH 3B 05—MECHANICS

(2013 Admissions)

Time : Three Hours

Maximum : 30 Weightage

**Part A**

*Answer all questions.*

*Each question carries  $\frac{1}{4}$  weightage.*

1. (i) Foucault's Pendulum have freedom of oscillation in : (a) only one direction ; (b) only in two direction ; (c) only in three direction ; and (d) in any direction.  
(ii) Earth is rotating uniformly about its axis from : (a) East to West ; (b) West to East ; (c) North to south ; and (d) South to North.  
(iii) \_\_\_\_\_ Frame is also called zero —momentum frame .  
(iv) The escape velocity from the earth is  $11 \text{ kms}^{-1}$ . The escape velocity from a planet having twice the radius and the same mean density as that of the earth is ? (a)  $5.5 \text{ kms}^{-1}$  ; (b)  $11 \text{ km/s}$  ; (c)  $22 \text{ km/s}$  ; and (d) None of these.
2. (i) An earth satellite is moved from one circular orbit to another higher circular orbit. Which of the following quantities will increase for the satellite : (a) potential energy ; (b) Kinetic energy ; (c) angular velocity ; and (d) acceleration.  
(ii) An object entering the earth atmosphere at high velocity catches fire due to : (a) Viscosity of air ; (b) due to pressure of the air ; (c) Due to temperature of the air ; and (d) none of the above.  
(iii) For the Lagrangian  $L = \frac{1}{2} \dot{q}^2 - qq + q^2$ , Find  $p$  conjugate to  $q$  (a)  $p \times q$  ; (b)  $p + q$  ; (c)  $p - q$  ; (d)  $p'q$ .  
(iv) A wire is bent in the form of a parabola  $z = ar^2$  and a bead slides of the wire without friction. The wire is rotated by means of a shaft with a constant angular acceleration. The Hamiltonian is (a) a constant of motion ; (b) increasing with time ; (c) decreasing with time linearly ; and (d) decreasing with time quadratically.

**Turn over**

3. (i) At what velocity along its length will a rod contract 50 % ? (a)  $c/2$  ;(b)  $\sqrt{3}c/2$ . (c)  $2c/3$ .  
 (d)  $5c/9$
- (ii) \_\_\_\_\_ is the relativistic mass formula.
- (iii) Energy equivalent to one a.m.u is \_\_\_\_\_ MeV (a) 937.5 ; (b) 827.5 ; (c) 746 ; and (d) 556.2.
- (iv) Einstein got Nobel Prize for \_\_\_\_\_.

(12 × ¼ = 3 weightage)

### Section B

*Answer all nine questions.*

*Each question carries a weightage of 1.*

- 4 What is a fictitious force ?
- 5 What is the potential energy curve of a particle ?
- 6 Explain the law of conservation of mechanical energy.
- 7 What is Galilean Invariance ?
- 8 A light and heavy body have equal KE, which one will have greater momentum ? Explain.
- 9 State Keplers laws.
- 10 What are generalized co-ordinate system ?
- 11 What are constraints ? Distinguish between holonomic and non-holonomic constraints.
- 12 What do you meant by Hamiltonian of a system ?

(9 × 1 = 9 weightage)

### Section C

*Answer any five questions.*

*Each question carries a weightage of 2.*

- 13 What is meant by a non — inertial frame of reference ?
- 14 Assuming the law of gravitation, find an expression for the period of revolution of a satellite.
- 15 Show that the following force is conservative.  $F = (y^2 - x^2) I + 2xyj$
- 16 Explain the basic postulates of special theory of relativity.
- 17 State and explain D' Alembert's principle.
- 18 A rod of 1 metre length is moving along its length with a velocity 0.6 c. Calculate its length as it appears to an observer on the earth.
- 19 Calculate the speed of electron which has kinetic energy 1.02 MeV.

(5 × 2 = 10 weightage)

**Section D**

*Answer any two questions.*

*Each question carries a weightage of 4.*

- 20 What is a Foucault pendulum? How does it enable us to demonstrate the rotation of the earth about its own axis?
- 21 Obtain the Lagrange's equation for a conservative system. Show that if a coordinate  $q$ , is absent in the Lagrangian of a conservative system then  $\frac{dl}{dq}$  is conserved.
- 22 Describe the Michelson-Morley experiment and explain the physical significance of the negative results.

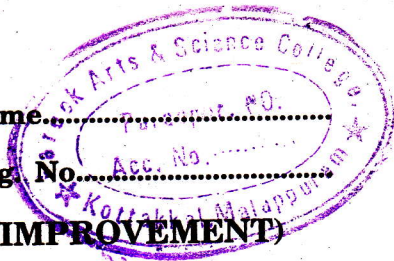
(2 × 4 = 8 weightage)

D 92582

(Pages 3)

Name.....

Reg. No.....



**THIRD SEMESTER B.Sc. DEGREE (SUPPLEMENTARY/IMPROVEMENT)  
EXAMINATION, NOVEMBER 2015**

(UG-CCSS)

Core Course

Physics/Applied Physics

PH 3B 05/AP 3B 05—MECHANICS

(2009-2012 Admissions)

Time : Three Hours

Maximum : 30 Weightage

**Part A**

*Answer all twelve questions.  
Each question carries  $\frac{1}{4}$  weightage.*

1. Absolute rest is :
  - (a) Imaginary.
  - (b) Real.
  - (c) Complex.
  - (d) Sometimes real and sometimes imaginary.
2. The motion of a projectile as seen from another is :
  - (a) Circular motion.
  - (b) Elliptical.
  - (c) Parabolic.
  - (d) Straight line motion.
3. A force which is constant and uniform is always :
  - (a) Zero.
  - (b) Conservative.
  - (c) Non-Conservative.
  - (d) Infinite.
4. The graph plotted between potential energy and distance has :
  - (a) Parabolic shape.
  - (b) Straight line.
  - (c) Elliptical shape.
  - (d) Hyperbolic shape.
5. The maximum height attained by a rocket is :
  - (a) R.
  - (b) 2R.
  - (c) 3R.
  - (d) 4.3R.
6. The shape of galaxy is :
  - (a) Spherical.
  - (b) Elliptical.
  - (c) Convex.
  - (d) Concave.

Turn over

7. The angular momentum of a particle moving under the action of a central force is :
- (a)  $\mathbf{J} = \mathbf{r} \times \boldsymbol{\rho}$ . (b)  $i\omega = \rho$ .
- (c) Zero. (d)  $\mathbf{J} = \frac{d\mathbf{v}}{dt}$ .
8. When a particle moves under the action of a central force, its angular momentum is :
- (a) Not conserved. (b) Conserved.
- (c) Zero. (d) Infinite.
9. The force on a point mass at the centre of a sphere of radius R is :
- (a) Proportional to  $R^2$ . (b) Proportional to  $\sqrt{R}$ .
- (c) Inversely proportional to  $R^2$ . (d) Zero.
10. The null result of the Michelson Morley experiment :
- (a) Confirms the existance of ether.
- (b) Confirms a privileged frame of reference.
- (c) Discards the existance of ether.
- (d) Confirms the necessity of a medium for e.m.w. propagation
11. The source of solar energy is :
- (a) Fission of Protons. (b) Fusion of hydrogen atoms.
- (c) Fusion of neutrons. (d) None of the above.
12. Constraints which can be absorbed is generalized co-ordinates are known as :
- (a) Holonomic. (b) Non holonomic.
- (c) Lagrangian. (d) Hamiltonian.

(12 × ¼ = 3 weightage)

### Part B

*Answer all questions.*

*Each question carries 1 weightage.*

13. What is Pseudo force ?
14. What is Coriolis acceleration ?
15. Define force constant.
16. What is a non conservative force ? Give *one* example.
17. What is areal velocity ? Express it mathematically.
18. Explain how anguiar momentum is conserved using an example.

19. Why is it that atmosphere is not present at moon's surface ?
20. What is Virtual work ?
21. What is meant by time dilation ?

(9 × 1 = 9 weightage)

**Part C**

*Answer any five questions.  
Each question carries 2 weightage.*

22. Prove that the Plane of oscillation of Foucault's pendulum rotates  $15^\circ \sin \phi$  per hour where  $\phi$  is the latitude of the place.
23. Prove that the work done around a closed path is zero for conservative forces.
24. The maximum and minimum distance of a Comet from the sun are  $1.4 \times 10^9$  m and  $7.0 \times 10^7$  km. If the velocity closest to the sun is  $6 \times 10^4$  m/s, what is its velocity when farthest ?
25. Calculate the earth's gravitational potential Density of earth =  $5,500 \text{ kg/m}^3$  and radius of the earth = 6,400 km.  $G = 6.67 \times 10^{-11}$  MKS units
26. A rod of length 1m is moving along its length with a velocity of 0.8 C. Calculate the length as it appears to an observer : (a) On the earth ; (b) moving with the rod itself.
27. A  $\pi$  meson has a mean life time of  $2 \times 10^{-8}$ s when measure at rest. How far does it go before decaying into another particle if its speed is 0.98 C.
28. What is a Hamiltonian ? Obtain the canonical equations of Hamiltonian.

(5 × 2 = 10 weightage)

**Part D**

*Answer any two questions.  
Each question carries 4 weightage.*

29. Explain the working principle of a rocket. Derive the differential equation representing rate of gain of speed by a rocket. What is the advantage of a two stage rocket ?
30. What are Kepler's laws of Planetary motion ? Derive the Newton's law of gravitation from Kepler's laws of Planetary motion.
31. Derive the relationship  $H = \sum_j q_j \frac{\partial L}{\partial q} - L$  from the properties of Lagrangian.

(2 × 4 = 8 weightage)

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(Pages : 2)

Name.....

Reg. No.....

**THIRD SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2015**

(CUCBCSS-UG)

Core Course—Physics/Applied Physics

PH 3B 03/AP 3B 03—MECHANICS

Time : Three Hours

Maximum : 80 Marks

I. Answer *all* questions, each question carries 1 marks (in a word or phrase) :

- 1 Give an example of inertial frame of reference.
- 2 What is Coriolis force ?
- 3 Give an example of conservative force.
- 4 Why frictional force is non-conservative ?
- 5 What is the significance of principle of virtual work ?
- 6 What is generalized co-ordinates ?
- 7 What is generalized momentum ?
- 8 What is frame of reference ?
- 9 What is proper time ?
- 10 Do we have one absolute reference system ?

(10 × 1 = 10 marks)

II. Answer *all* questions, each question carries 2 marks (Answer in two or three sentence) :

- 11 State and explain the law of conservation of momentum.
- 12 What is potential energy curve ?
- 13 State work energy principle.
- 14 Explain whether a body have kinetic energy without momentum.
- 15 Explain Lorentz transformation.
- 16 What was the aim of Michelson - Morley experiment ?
- 17 What is twin paradox ?

(7 × 2 = 14 marks)

III. Answer any *five* questions, each question carries 4 marks (Answer in a paragraph) :

- 18 Show that Lorentz force is a conservative force.
- 19 Write a short note on the law of conservation of momentum and its importance in Physics. Does the law also hold good in nuclear and relativistic physics ?

Turn over

- 20 Briefly explain conservation laws and symmetry properties.
- 21 Using Lagrange's equation, derive Newton's second law.
- 22 Describe an experiment in support of time dilation.
- 23 Explain the principle of Michelson - Morley experiment and discuss its importance.
- 24 Derive the equation  $E = mc^2$ .

(5 × 4 = 20 marks)

IV. Answer any *four* questions, each question carries 4 marks :

- 25 Calculate the fictitious force and the observed force on a body of mass 5 kg in a frame of reference moving vertically upwards with an acceleration of  $4 \text{ m/s}^2$ .
- 26 The position of a moving particle is at any instant given by  $r = A \cos \theta \mathbf{i} + A \sin \theta \mathbf{j}$ . Show that the force acting on it is a conservative one.
- 27 A hunter has a rifle that can fire 0.06 kg bullets with a muzzle velocity of 900 m/sec. A 40 kg leopard springs at him at a speed of 10 m/s. How many bullets must the hunter fire into the leopard in order to stop it in its tracks ?
- 28 Derive Lagrange's equation from Hamilton's principle.
- 29 In the Michelson-Morley experiment, the wavelength of the monochromatic light used is 5000 Angstrom unit. What will be the expected fringe shift on the basis of stationary ether hypothesis if the effective length of each path be 5 meters? Given velocity of earth is  $3 \times 10^4 \text{ m/s}$ .
- 30 A rod of 1 meter long is moving along its length with a velocity  $0.6c$ . Calculate its length as it appears to an observer on the earth.
- 31 Deduce the minimum energy of a gamma ray photon which can cause electron-positron pair productions.

(4 × 4 = 16 marks)

V. Answer any *two* questions, each question carries 10 marks.

- 32 What is collision ? Briefly explain different types of collision. Derive an expression for the final velocities of colliding particles in elastic one dimensional collision. Discuss the different cases.
- 33 Show that the conservation of the angular momentum of a system is a consequence of the rotational invariance of its potential energy. Derive the expression for the distance of closest approach of a proton projected into the Coulomb field of a heavy nucleus.
- 34 Derive Galilean transformation equations. Show that acceleration is invariant under this transformation.
- 35 Explain Hamilton's principle and hence deduce Lagrange's equations of motion.

(2 × 10 = 20 marks)

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(Pages : 3)

Name.....

Reg. No.....

**THIRD SEMESTER B.Sc. DEGREE (SUPPLEMENTARY/IMPROVEMENT)  
EXAMINATION, NOVEMBER 2015**

(UG—CCSS)

Core Course—Physics

PH 3B 05—MECHANICS

(2013 Admissions)

Time : Three Hours

Maximum : 30 Weightage

**Section A**

*Answer all questions.*

*Each question carries  $\frac{1}{4}$  weightage.*

1. If a co-ordinate corresponding to a rotation is cyclic, rotation of the system about given axis remains invariant then the following quantity is conserved.
  - (a) Linear momentum.
  - (b) Angular momentum.
  - (c) Kinetic energy.
  - (d) Potential energy.
2. In the case of elliptic orbits, the energy is proportional to :
  - (a) A.
  - (b)  $1/a$ .
  - (c)  $1/a^2$ .
  - (d)  $1/a^3$ .
3. Lorentz transformations assume :
  - (a) Space and time are both relative.
  - (b) Space is relative.
  - (c) Space is absolute but time is relative.
  - (d) Space and time are both absolute.
4. Freely falling bodies deviate from their true vertical path due to the effect of :
  - (a) Gravitational force.
  - (b) Centripetal force.
  - (c) Centrifugal force.
  - (d) Coriolis force.
5. For a system of particles when the P.E. is translationally invariant then the momentum is :
  - (a) Conserved.
  - (b) Not conserved.
  - (c) Zero.
  - (d) Infinite.
6. The shape of the galaxy is :
  - (a) Elliptical.
  - (b) Convex.
  - (c) Concave.
  - (d) Spherical.

Turn over

7. The escape velocity of a body projected in the upward direction on the earth is :
- (a) 9.8 km/hr. (b) 11.2 km/hr.  
(c) 11.2 km/sec. (d) 7.98 km/sec.
8. The force on a point mass  $m$  placed at the centre of a sphere is :
- (a) Infinity. (b)  $4/3$  Newtons.  
(c) Zero. (d) 9.8 Newtons.
9. Absolute motion is :
- (a) Imaginary.  
(b) Real.  
(c) Sometimes imaginary and sometimes real.  
(d) None of these.
10. The maximum height attained by a rocket is :
- (a)  $R$ . (b)  $2R$ .  
(c)  $3R$ . (d)  $4.3R$ .
11. When a particle moves under the action of a central force, its angular momentum is :
- (a) Not conserved. (b) Conserved.  
(c) Zero. (d) Infinite.
12. Constraints which can be written in the form of inequality are called :
- (a) Holonomic. (b) Lagrangian.  
(c) Hamiltonian. (d) Non-holonomic.

(12  $\times$   $\frac{1}{4}$  = 3 weightage)

### Section B

*Answer all questions.  
Each question carries 1 weightage.*

13. What is frame of reference ? Give example.
14. Give two important properties of conservation laws.
15. What is energy function? Give its property.
16. Define areal velocity.
17. Explain superposition principle.
18. Is the Lagrangian formulation more advantageous than the Newtonian formulation. Why ?
19. Give the postulates of a special theory of relativity.
20. What is Coriolis acceleration ?
21. What is virtual work ?

(9  $\times$  1 = 9 weightage)

## Section C

*Answer any five questions.  
Each question carries 2 weightage.*

22. What is a Foucault's Pendulum? Prove that the plane of oscillation of Foucault's pendulum rotate  $15^\circ \sin Q$  per hour where  $Q$  is the latitude of the place.
23. Prove that the work done around a closed path is zero for conservative force.
24. State and explain D' Alembert's principle. Is D' Alembert's equation true for real or virtual displacement.
25. What is gravitational potential? Calculate the change in PE if a mass of 500 kg is raised through a height twice the radius of the earth.
26. Calculate the mass and momentum of a proton of mass  $1.6 \times 10^{-27}$  kg moving with a speed of  $2 \times 10^8$  m/s. If the proton coalesces with a stationary nucleus of mass  $2.5 \times 10^{-25}$  kg. Calculate the velocity the combined particle.
27. Prove that the work done around a closed path is zero for conservative forces.
28. The maximum and minimum distance of a comet from the sun are  $1.4 \times 10^9$  km and  $7.0 \times 10^7$  km. If its velocity closest to the sun is  $6.0 \times 10^4$  m/s what is its velocity when farthest?

(5 × 2 = 10 weightage)

## Section D

*Answer any two questions.  
Each question carries 4 weightage.*

29. Deduce the Lorentz transformation equations. How is it superior to Galilean transformations?
30. Prove that the velocity of escape of the body from the earth's surface is times the velocity for a circular orbit is just above the earth's surface. Explain why the atmosphere is rare at the moon's surface.
31. State and derive Kepler's laws of planetary motion from Newton's law of gravitation.
32. Derive the relationship  $H = \sum_j q_j \frac{\partial L}{\partial q_j} - L$  from the properties of Lagrangian.

(2 × 4 = 8 weightage)

**D 12390**

(Pages : 3)

Name.....

Reg. No.....

**THIRD SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2016**

(CUCBCSS-UG)

Physics/Applied Physics

PHY 3B 03/APY 3B 03—MECHANICS

Time : Three Hours

Maximum : 80 Marks

**Section A**

*Answer all questions.*

*Each question carries 1 mark.*

*Answer in a word or phrase.*

1. The force that does not really act on the particle but appears due to the acceleration of the frame is \_\_\_\_\_.
2. Freely falling body deviates from their vertical path. This is due to the effect of \_\_\_\_\_.
3. The geometrical restrictions on the motion of a particle are known as \_\_\_\_\_.
4. For conservative forces, the sum of potential and kinetic energies is \_\_\_\_\_.
5. The essential requirement of a frame of reference is that it should be \_\_\_\_\_.
6. Frictional and viscous forces are examples of \_\_\_\_\_ force.
7. The work done in moving a unit mass from one point to another on an equipotential surface is \_\_\_\_\_.

Write *True* or *False* :

8. Newton's law or motion are also known as laws of mechanics.
9. Torque is the rate of change in linear momentum.
10. In an inelastic collision the momentum is not conserved.

(10 × 1 = 10 marks)

**Section B**

*Answer all questions.*

*Each question carries 2 marks.*

*Answer in two or three sentences.*

11. What are inertial frames of references ?
12. Give the postulates of special theory of relativity.
13. Explain conservative and non-conservative forces with examples.
14. What is the difference between the pseudo force and the real force appearing in inertial frames ?
15. State the principle of virtual work.

**Turn over**

16. What is time dilation hence explain twin paradox ?  
 17. What does the term "rotational invariance" imply ?

(7 × 2 = 14 marks)

**Section C**

*Answer any five questions.  
 Each question carries 4 marks.  
 Answer in one paragraph.*

18. Use Galilean transformation to show that the distance between two points  $(x_1, y_1, z_1)$  and  $(x_2, y_2, z_2)$  is invariant in two inertial frames.  
 19. State the postulates of special theory of relativity, and deduce from them the Lorentz transformations.  
 20. Prove work energy theorem.  
 21. Define angular momentum of a particle. Show that the time rate of change of angular momentum of a particle is equal to the torque acting on it.  
 22. Show that the intensity of the field can be expressed as  $E = -\text{grad } V$ , where  $V$  is the potential.  
 23. Establish the relations (i)  $m = m_0 \sqrt{1 - \frac{v^2}{c^2}}$  and (ii)  $E = mc^2$ .  
 24. Derive an expression for the potential energy of a system of masses.

(5 × 4 = 20 marks)

**Section D**

*Answer any four questions.  
 Each question carries 4 marks.*

25. Prove that the plane of oscillation of Foucault's pendulum rotates  $15^\circ \sin \phi$  per hour, where  $\phi$  is the latitude of the place.  
 26. Calculate the fictitious force and the total force acting on a freely falling body of mass 20 kg. with reference to a frame moving with a downward acceleration of 6 m/s.  
 27. If  $F = (2xy + z^2)\hat{i} + x^2\hat{j} + 2xz\hat{k}$ , then show that it is conservative. Calculate the amount of work done by this force in moving a particle from (0, 1, 2) to (5, 2, 7).  
 28. Two particles, having the positions  $r_1 = (3\hat{i} + 5\hat{j}) m$  and  $r_2 = -(5\hat{i} + 3\hat{j}) m$  move with velocities  $v_1 = (4\hat{i} + 3\hat{j}) m/s$  and  $v_2 = (a\hat{i} + 7\hat{j}) m/s$ . Find (i) the value of  $a$ , they collide, (ii) when and where the collision will take place ?  
 29. Period of Saturn is 29.5 years. Calculate the average distance of the Saturn from the sun. (The radius of the earth's orbit is  $1.5 \times 10^8$  km.).  
 30. Calculate the length and acceleration of a rod of length 5 m. in a frame of reference which is moving with 0.6  $c$  velocity in a direction making  $30^\circ$  angle with the rod.  
 31. Calculate the energy in electron volts released when a neutron decays into a proton and electron, ( $m_n = 1.6747 \times 10^{-27}$  kg.,  $m_p = 1.6725 \times 10^{-27}$  kg.,  $m_e = 0.9 \times 10^{-31}$  kg.).

(4 × 4 = 16 marks)

**Section E**

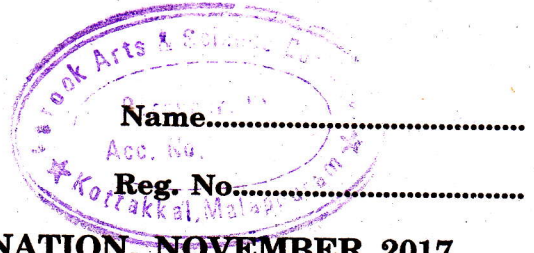
*Answer any two questions.  
Each question carries 10 marks.*

32. Explain inertial frame of reference, frame of reference 'r' rotates about its origin fixed in an inertial frame of reference 'T'. Find how velocities and accelerations in the two reference frames are related to each other.
33. State Kepler's laws of planetary motion. Show how the universal law of gravitation of Newton has been derived from these laws.
34. State the postulates of special theory of relativity, and deduce from them the Lorentz transformations.
35. What is relativistic energy? Prove the relation  $E^2 - P^2C^2 = m_0^2C^4$ . Derive an expression for the velocity of a particle in terms of the relativistic momentum and energy.

(2 × 10 = 20 marks)

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(Pages : 3)



**THIRD SEMESTER B.Sc. DEGREE EXAMINATION, NOVEMBER 2017**

(CUCBCSS—UG)

Physics/Applied Physics

PHY 3B 03/APY 3B 03—MECHANICS

Time : Three Hours

Maximum : 80 Marks

I. Answer *all* questions. Each question carries 1 marks (in a word or phrase) :

- 1 What is rotating frame of reference ?
- 2 Give an example of fictitious force.
- 3 A light and heavy body has equal kinetic energies of translation. Which one has the larger momentum ?
- 4 What do you mean by areal velocity ? Name the law behind it.
- 5 Give any *one* example of conservation of angular momentum.
- 6 What is proper length ?
- 7 Write down the expression for Kinetic energy in generalized coordinates.
- 8 What is ether hypothesis ?
- 9 What is holonomic constraints ?
- 10 Give the significance of space – time diagram.

(10 × 1 = 10 marks)

II. Answer *all* questions. Each question carries 2 marks (Answer in two or three sentence) :

- 11 What is Keplers laws of periods ?
- 12 What is the principle of the law of conservation of angular momentum ?
- 13 What is collision ?
- 14 What is proper mass ?
- 15 What is meant by simultaneity ?
- 16 What is Hamilton's principle ?
- 17 What do you mean by cyclic co-ordinates ?

(7 × 2 = 14 marks)

Turn over

III. Answer any *five* questions. Each question carries 4 marks (Answer in a *paragraph*):

- 18 What is potential energy curve of a particle? What significant information does it give about the behavior of the particle?
- 19 The distance between the centers of the carbon and oxygen atoms in the carbon monoxide gas molecule is  $1.130 \times 10^{-10}$  meters. Locate the centre of mass of the molecule relative to the carbon atom.
- 20 A particle of mass  $m$  moves under the action of a central force whose potential is  $V(r) = Kmr^3$ . For what Kinetic energy and angular momentum will the orbit be a circle of radius  $R$  about the origin.
- 21 Show that the shortest distance between two points in a plane is a straight line.
- 22 Using Lagrange's equation derive time period of oscillation of a simple pendulum.
- 23 Show that a particle with zero rest mass travels with the speed of light.
- 24 Derive the relativistic expression for the kinetic energy of a particle. Show that it reduces to the classical expression when  $v \ll c$ .

(5 × 4 = 20 marks)

IV. Answer any *four* questions. Each question carries 4 marks:

- 25 Considering the earth to be a homogeneous sphere of mass density. Show that the period of revolution of a satellite in an orbit lying just outside the equator depends only upon the density.
- 26 Show that the force  $F = (2xy + z^2)i + x^2j + 2xz k$  is conservative.
- 27 A rocket, set for vertical firing weighs 50 kg and contains 450 kg of fuel. It can have a maximum exhaust velocity of 2 km/s. What should be its minimum rate of fuel consumption to lift it off the launching pad?
- 28 A red hot sphere of iron has a mass of 1 kg. If the temperature of the sphere is reduced by 1200 K, what is the loss of mass? Given specific heat capacity of iron is 462 J/Kg/K.
- 29 In the laboratory two particles are observed to travel in opposite directions with speed  $2.8 \times 10^{10}$  cm/s. Deduce the relative speed of the particles.
- 30 A particle in a stationary frame  $S$  lies in the  $X - Y$  plane and has a velocity  $0.8c$  inclined at  $60^\circ$  to the axis of  $x$ . What will be the velocity of the particle as observed by a person in a frame  $S'$  moving relative to  $S$  with a velocity  $0.4c$  metres/sec.
- 31 A muon is travelling through the laboratory at  $3/5$  th the speed of light. How long does it last if its life time is  $2 \times 10^{-4}$  s.

(4 × 4 = 16 marks)

V. Answer any *two* questions. Each question carries 10 marks :

- 32 What is Foucault's pendulum? How does it enable us to demonstrate the rotation of the Earth about its own axis?
- 33 (a) State the law of conservation of angular momentum. Give *one* example of its application.  
(b) Show that for a central force, the angular momentum is conserved.
- 34 Explain the principle of Michelson-Morley experiment and describe it to prove that there is no absolute frame of reference. How was the negative result explained?
- 35 (a) What are constraints? Distinguish between holonomic and non-holonomic constraints.  
(b) State the principle of virtual work and hence derive D'Alembert's principle. List some of its applications in Physics.

(2 × 10 = 20 marks)