Department of Physics

UNIVERSITY OF CALICUT

M.Sc Physics Entrance Examination, 2018

Model Question Paper

Instructions

This question booklet contains 50 multiple choice questions. Each correct answer carries 2 marks and each wrong answer carries 2/3 as negative marks. The OMR answer sheet should be marked with BLACK or BLUE ball point pen.

Time: 2 hours   **Maximum marks: 100**

1) The Lagrangian of a particle is given by $L = \dot{q}^2 - q\dot{q}$. Which of the following statements is true?

   a) This is a free particle.
   b) The particle is experiencing velocity dependent damping.
   c) The particle is executing simple harmonic motion.
   d) The particle is under constant acceleration.

2) An ideal gas has a specific heat ratio c_p/c_v = 2. Starting at a temperature T1, the gas undergoes an isothermal compression to increase its density by a factor 2. After this an adiabatic compression increases its pressure by 2. The temperature of the gas at the end of the second process is :

   a) T1/2
   b) $\sqrt{2T1}$.
   c) $2T1$.
   d) $T1/\sqrt{2}$.

3) The equation of a surface of revolution is $z = \sqrt{(\frac{3}{2}x^2 - \frac{3}{2}y^2)}$. The unit vector normal to the surface at the point $A\left[\sqrt{\frac{2}{3}}, 0, 1\right]$ is

   a) $\sqrt{\frac{3}{5}}\hat{\imath} + \frac{2}{\sqrt{10}}\hat{k}$
   b) $\sqrt{\frac{3}{5}}\hat{\imath} - \frac{2}{\sqrt{10}}\hat{k}$
   c) $\sqrt{\frac{3}{5}}\hat{\imath} + \frac{2}{\sqrt{5}}\hat{k}$
   d) $\sqrt{\frac{3}{10}}\hat{\imath} + \frac{2}{\sqrt{10}}\hat{k}$

4) A blackbody at a temperature of 6000 K emits a radiation which peaks at 600 nm. If the temperature falls to 300 K , the spectrum will peak at
   a) 120 µm.
   b) 12 µm
   c) 12 mm
   d) 120 mm

5) A metal bullet comes to rest after hitting its target with a velocity of 80 m/s. If 50% of the heat generated remains in the bullet, what is the increase in temperature of the bullet. Given the specific heat of the bullet is equal to 160 joules/kg/^{0}C.
   a) 14^0C
   b) 12.5^0C
   c) 10^0C
   d) 8.2^0C

6) A mono atomic ideal gas of volume v1 and temperature T expands to another enclosure of volume v2 through a porous plug. What is the change in temperature of the gas,
   a) 0
   b) $T\ln\frac{v1}{v2}$

c) $T \ln \frac{v2}{v1}$

d) $Tln \frac{v2-v1}{v2}$.

7) Efficiency of a perfectly reversible heat engine operating between absolute temperature T and zero is equal to

a) 0

b) 0.5

c) 0.75

d) 1

8) A satellite around a planet in a circular orbit is at a distance R from its centre. The time period of revolution of the satellite is T. if the same satellite is taken to an orbit of 4R around the same planet, the time period would be,

a) 8T   b) 4T   c) T/4   d)T/8

9) Lorentz transformation coincide with the Galilean transformations when

a) V=C

b) V>C

c) V<<C

d) None of the above.

10) A square of length a is moving with a speed C/2 parallel to one of its sides. What is its area in motion?

a) $0.86\ a^2$

b) $0.75\ a^2$

c) $0.34\ a^2$

d) $0.25\ a^2$

11) Two particles A and B of mass m each and C of mass M are placed on x axis in the order ABC. Particle A is given with a velocity v along x axis and consequently there will be two collisions both of which are inelastic. If the final loss of energy is 7/8 of the initial energy , the value of M will be

a) 8 m

b) 6 m

c) 4 m

d) 2 m.

12) Seven uniform disks of radius r and mass m are inscribed in a regular hexagon. The moment of inertia of this system of seven disks about the axis of the central disk and perpendicular to the plane of the disk is

a) $\frac{7}{2}\ mr^2$

b) $\frac{13}{2}\ mr^2$

c) $\frac{55}{2}\ mr^2$

d) $\frac{17}{2}\ mr^2$

13) Thermal neutrons incident on a sodium chloride crystal of inter atomic spacing of $2.81A^0$ undergoes a first order diffraction from the Bragg planes at an angle of $2\Theta^0$. What is the energy of the thermal neutrons?

a) 2.21 eV   b)   1.73 eV   c) 0.0221 eV   d) 0.0173 eV

14) The energy required to remove the least tightly bound neutron from $_{20}Ca^{40}$ is

a)   13.6 Mev   b)   12.5 Mev   c)   15.6 MeV   d)   16.2 MeV

15) The molar specific heat of a diatomic molecule is

a) 5/2 R   b) 7/2 R   c) 3/2 R   c) ½ R

16) How much time is required for 5mg of Na^{22} ($T_{1/2}$ = 2.60 YEARS) to disintegrate to 1 mg?

a) 5.04 years b) 6.04 years c) 3.04 years d) 2.04 years.

17) The width of a spectral line of wavelength $4000A^0$ is measured as 10^{-4} A^0. What is the average lifetime that the atomic system remains in the corresponding energy state?

a) 4.24 x 10^{-9} s   b) 6.23 x10^{-9}s   c) 4.24 x10^{-6} s   d) 6.23 x 10^{-6} s

18) The lowest quantum mechanical energy of a particle confined in a one-dimensional box of size L is 2 eV. The energy of the quantum mechanical ground state for a system of three non-interacting spin ½ particles is
a)   6 eV   b) 10 eV   c) 12 eV   d) 16 eV

19) Light takes approximately 8 minutes to travel from the Sun to the Earth. Suppose in the frame of the Sun, an event occurs at $t=0$ at the Sun and another event occurs on Earth at t =1 minute. The velocity of the inertial frame in which both these events are simultaneous is:

a) $\frac{c}{8}$ with the velocity vector pointing from Earth to Sun.

b) $\frac{c}{8}$ with the velocity vector pointing from Sun to Earth.
c)   The events can never be simultaneous - no such frame exists.

d) $\sqrt{\left(1 - (\frac{1}{8})^2\right)}$ with velocity vector Pointing from Sun to Earth.

20) For mercury, the critical temperature at which superconductivity ensured with zero applied magnetic field is 4.15 K. The critical applied magnetic field at which superconductivity will not take place at any temperature is 0.041 T. The applied magnetic field that will stop superconductivity at 2.2 K is
a)   0.27 T   b) 0.45 T   c) 4.5 T   d) 2.7 T

21) An electric dipole of dipole moment P is placed in a uniform external electric field E. Then

a) torque experienced by the dipole is PE

b) torque is zero if is P perpendicular to E

c) torque is maximum if P is perpendicular to E

d) potential energy is maximum if P is parallel to E

22) Two pith balls carrying equal charges e are suspended from a common point by strings of equal length, the equilibrium separation between them is r. Now the strings are rigidly clamped at half the height. The equilibrium separation between the balls now becomes
a)$2e/\epsilon_0$ b) e/ϵ_0 c) $e/4\epsilon_0$ d) $2e/3\epsilon_0$

23) Three identical charges each of which are placed at the vertices of a triangle ABC as shown in the figure. If AB+AC= 12 cm and AB.AC= 32 cm^2, the potential energy of the charge at A is
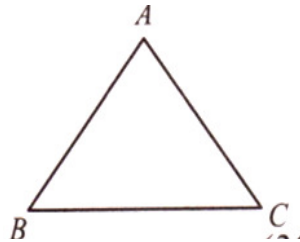

a) 1.53J   b) 1.35 J   c) 5.31 J   d) 3.51 J

24) A charged particle q is shot towards another charged particle Q which is fixed, with a speed v. It approaches Q upto the closest distance r and then returns. It q is shot with speed 2v, the closest distance of approach would be

a) $\frac{r}{4}$ b) $\frac{r}{2}$ c) $\frac{3r}{2}$ d) r   e) 2r

25) A conductor having a cavity is given a positive charge. Then field strengths EA, EB and EC at point A (within cavity) B (within conductor but outside cavity) and C(near conductor) respectively will be
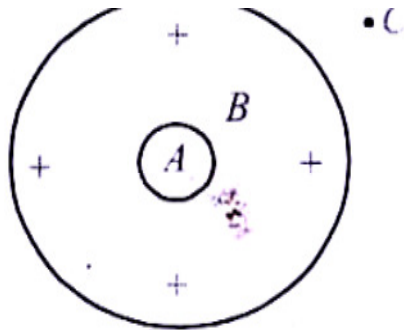
a) EA=0, EB=0, EC=0

b) EA=0, EB=0, EC≠0
c) EA ≠ 0, EB=0, EC=0
d) EA=0, EB≠0, EC=0

26) A spherical conductor of radius 2 m is charged to a potential of 120 V. It is now placed inside another hollow spherical conductor of radius 6 m. Calculate the potential to which the bigger sphere would be raised, if the smaller sphere is made to touch the bigger sphere

a) 40V   b) 60V   c) 20V   d) 80V.

27) A piece of iron is heated in a flame. It first becomes dull red then becomes reddish yellow and finally turns to white hot. The correct explanation for the above observation is possible by using

a) Kirchhoff's Law
b) Newton's Law of cooling
c) Stefan's Law
d) Wien's displacement Law

28) A negatively charged oil drop is prevented from falling under gravity by applying a vertical electric field 1000 V/m. If the mass of the drop is 1.6×10^{-3}g , the number of electrons carried by the drop is
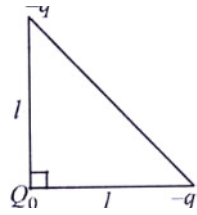
a) 10^{14} b) 10^{18} c) 10^{12} d) 10^{9}

29) Which one of the following graph represents the variation of electric field with distance r from the centre of a spherical charged conductor of radius R.?
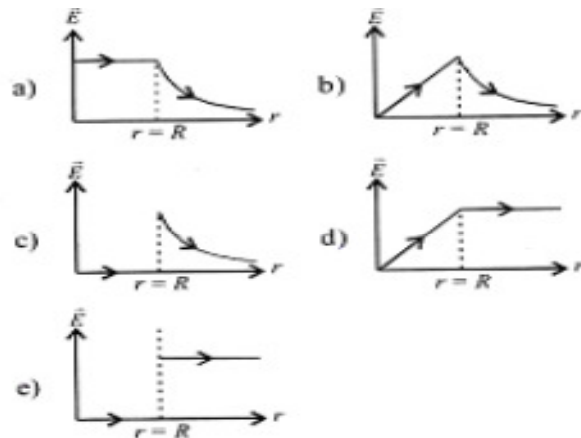
30) Three charge Q_O, −q and −q are placed at the vertices of an isosceles right angled triangle as in the figure. The net electrostatic potential energy is zero if Q_O is equal to

-q

a) $\frac{q}{4}$ b) $\frac{2q}{\sqrt{32}}$ c) $\sqrt{2}q$ d) $\frac{q}{\sqrt{2}}$

31) An electron enters uniform electric field maintained by parallel plates and of value E Vm^{-1} with a velocity v ms^{-1}. The plates are separated by distance d metre, the acceleration of the electrons in the field is

a) E/m   b) eE/m   c) eE/md   d) Ed/m

32) An arc lamp requires a direct current of 10 A at 80 V to function. If it is connected to a 220 V (rms), 50 Hz AC supply, the series inductor needed for it to work is close to :

a) 80 H   b) 0.08 H   c) 0.044 H   d) 0.068H

33) A chain of mass M and length L is suspended vertically with its lower end touching a weighing scale. The chain is released and falls freely onto the scale. Neglecting the size of the individual links, what is the reading of the scale when a length x of the chain has fallen?

a) Mgx/L b) $3Mgx/L$ c) $Mgx/2L$ d) $2Mgx/L$

34) A spring of force constant k is stretched by x. It takes twice as much work to stretch a second spring by $x/2$. The force constant of the second spring is,

a) 2k   b) 4k   c) 8k   d) k

35) A K meson (with a rest mass of 494 MeV) at rest decays into a muon (with a rest mass of 106 MeV) and a neutrino. The energy of the neutrino, which can be massless, is approximately

a) 388 MeV   b) 236 MeV   c) 120 MeV   d) 134 MeV

36) The period of a simple pendulum inside a stationary lift is T. If the lift accelerates downwards with an acceleration $g/4$, the period of the pendulum will be

a) T   b) $T/4$ c) $2T/\sqrt{5}$ d) $2T/\sqrt{3}$

37) A small mass M hangs from a thin string and can swing like a pendulum. It is attached above the window of a car. When the car is at rest, the string hangs vertically. The angle made by the string with the vertical when the car has a constant acceleration $a = 1.2 m/s^2$

is approximately

a) 1^0 b) 7^0 c) 15^0 d) 11^0

38) Which one of the following axis of rotational symmetry is not possible for single crystals

a) Two fold axis   b) three fold axis
b) Four fold axis   c) five fold axis

39) The trace of a 3x3 matrix is 2 and two of its eigen values are 1 and 2. The third eigen value
is
a) -1   b) 0   c) 1   d) 2

40) The high input impedance of a field effect transistor is due to

a) The pinch off voltage
b) It's very low gate current
c) The source and drain being far apart
d) The geometry of FET

41) Which one of the following electronic transition in neon is not responsible for the LASER
action in helium neon laser?

a) 6s $\longrightarrow$ 5p   b) 5s $\longrightarrow$ 4p   c) 5s $\longrightarrow$ 3p   d) 4s $\longrightarrow$ 3p

42) Three point charges q, q, and -2q are located at (0, -a, a), (0, a, a) and (0, 0 –a)
respectively. The net dipole moment of this charge distribution is

a) $4qa\hat{k}$ b) $2qa\hat{k}$ c) $-4qa\hat{i}$ d) $-2qa\hat{i}$

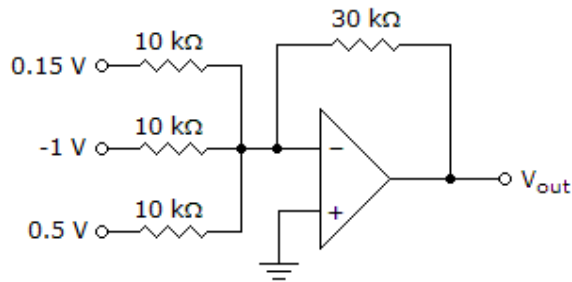43) In a Raman scattering experiment, the light of frequency v from a laser is scattered by a
diatomic molecule of moment of inertia I. The typical Raman shifted frequency depends
on
a) I and v b) only v c) only I   d) neither I nor v

44) In a CE amplifier the voltage gain =………………………..x R_{ac}/R_{in}

a) β   b) 1+β   c) 1+α   d) α

45)

The output of this circuit is
a) 1.05 V b) -0.35 V c) 0.35 V d) -1.05V

46)

V_{in}
2 V_{p-p}
V_{out}
R_1
68 kΩ
R_2
$V_{(out)max} = \pm 11$ V 10 kΩ
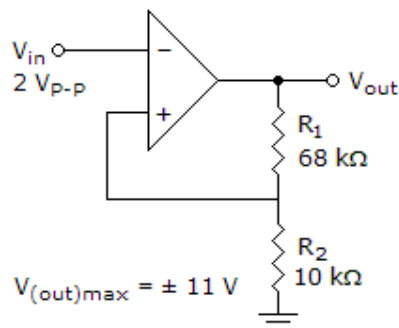
Determine the upper trigger point.
a) $V_{out\,max}$ b) $-V_{out\,max}$ c) -1.41 V d) 1.41 V

47) The cut-off frequencies of a band pass filter with R1 = R2 = 5 kΩ and C1 = C2 = 0.1µ F are

a) f_{OL} = 318.3 Hz, f_{OH} = 318.3 Hz
b) f_{OL} = 636.6 Hz, f_{OH} = 636.6 Hz
c) f_{OL} = 318.3 Hz, f_{OH} = 636.6 Hz
d) f_{OL} = 636.6 Hz, f_{OH} = 318.3 Hz

48) The output of the circuit when a square wave input is given to the circuit shown below.

C
0.22 µF
R
15 kΩ
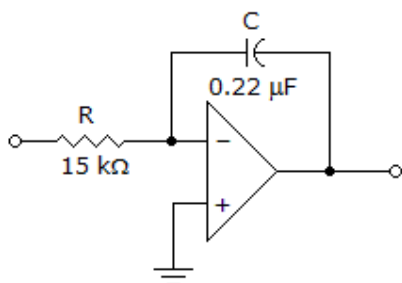
a) A square wave
b) A triangle wave

c) A sine wave
d) No output

49) In H_2O, which of the following modes of vibration are IR active:
   a. Symmetric stretching   b. Symmetric bending   c. Both a and b
   d. None of the above.

50) If a proton were ten times massive than electron, the ground state energy of the electron in a hydrogen atom would be

   a) Less   b) more   c) same   d) depends on electronic mass.