QB365

Model Question Paper 2

11th Standard CBSE

Physics

Reg.No. :

Time : 02:00:00 Hrs

Total Marks : 100

Section-A

1) If a cube is melted and is casted into a sphere, does moment of inertia about an axis through centre of mass increase or decrease. **1**

2) Two particles of masses m_1 and m_2 attract each other gravitationally and are set in motion under the influence of the gravitational force? Will the centre of mass move? **1**

3) Would we have more sugar to the kilogram at the pole or at the equator? **1**

4) Does it matter if one uses gauge instead of absolute pressures in applying Bernoulli's equation? Explain. **1**

5) On what factors does the critical speed of fluid flow depend? **1**

6) Why, water is used as an coolant in the radiator of cars? **1**

7) Can we boil water inside in the earth satellite? **1**

8) Which object will cool faster when kept in open air, the one at 300 ^{0} C or the one of 100 ^{0}C? Why? **1**

9) Which thermodynamic law put restrictions on the complete conversion of heat into work? **1**

10) What type of process is a Carnot cycle? **1**

Section-B

11) If ice on poles melts, then what is the change in duration of day? **2**

12) The speed of the whirl wind in a tornado is alarmingly high. Why? **2**

13) If earth contract to half its radius. What would be the length of the day? **2**

14) A plant moving along an elliptical orbit is closet to the Sun at a distance r_1 and farthest away at a distance of r_2 . If V_1 and V_2 are the linear velocities at these points respectively, then find the ratio v_1/v_2 **2**

15) The gravitational force between two spheres os x when the distance between their centre is y. What will be the new force, if the separation is made 3y? **2**

16) Which of the following symptoms is likely to affect an astronaut in space **2**

headache

17) The escape speed on the earth is 11.2 km/s.What is its value for a planet having double the radius and eight times the mass of the earth? **2**

18) A wire elongates by l mm when a load W is hanged from it. If the wire goes over a pulley and two weights W each are hung at the rwo ends, then what will be the elongation of the wire in mm? **2**

19) A solid sphere of radius R made of a material of bulk modulus B is surrounded by a liqiud in a cylindrical container. A massless piston of area A floats on the surface of the liqiud. When a mass M is placed on the piston on the piston to compress the liqiud, find fractiional change in the radius of the sphere? **2**

20) A liquid drop of radius 4mm breaks into 1000 identical drops. Find the change in surface energy. S=0.07Nm^{-1} **2**

21) The sap in trees, which consists mainly water in summer, rises in a system of capillaries of radius r=2.5 $\times$ 10^{-5}m. The surface tension of sap is S =7.28 $\times$ 10^{-2} N/m and angle of contact is 0^0 . Does surface tension alone account for the supply of water to the pot of all trees? **2**

22) A hydraulic automobile lift is designed to lift cars with a maximum mass of 300kg. The area of cross-section of the piston carrying the load is 425 cm^2.What maximum pressure would the smaller piston have to bear? **2**

23) A solid cylinder of mass 20 kg rotates about its axis with angular speed of (100 rad/s). The radius of cylinder is 0.25m. What is the kinetic energy of rotation of cylinder? What is the magnitude of angular momentum of the cylinder about its axis? **2**

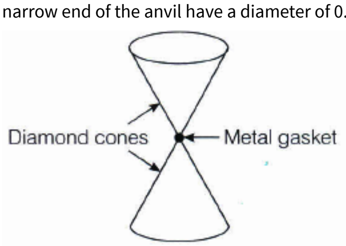
24) A particle on a rotating disc have initial and final angular position are -2rad, +6rad. In which case, particle undergoes a negative displacement. **2**

25) A particle on a rotating disc have initial and final angular position are -4rad, -8rad. In which case, particle undergoes a negative displacement. **2**

26) Define period of revolution.Derive an expression of the period of revolution or time period of satellite. **2**

27) Two strips of metal are riveted together at their ends by four rivets, each of diameter 6mm. What is the maximum tension that can be exerted by the riveted strip if the shearing stress on the rivet is not to exceed 6.9x10^7 Pa? Assume that each rivet is to carry onequarter of the load. **2**

28) Anvils made of single crystals of diamond, with the shape as shown in figure are used to investigate the behaviour of materials under very high pressure. Flat faces at the narrow end of the anvil have a diameter of 0.5 mm and the wide en are subjected to a compressional force of 50000 N. What is the pressure at the tip of the anvil? **2**



29) At what temperature, if any, do the following pairs of scales gives the same reading? **2**

Fahrenheit and Kelvin.

30) A monoatomic ideal gas($\gamma = \frac{5}{3}$)initialy at 17^{0}C is suddenly compressed to one-eight of its original volume. **2**
Find the final temperature after compression.

Section-C

31) In a hydrogen atom, electron revolves in a circular orbit of radius $0.53A^\circ$ with a velocity of $2.2 \times 10^6 m/s$ with an angle 30°. If the mass of electron is $9 \times 10^{-31}kg$. Find its angular momentum. **5**

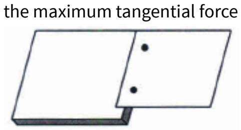
32) **An Elongated Wire** **5**
If a wire of length 4 m and crosssectional area of 2m^2 is stretched by a force of 3KN, then determine the change in length due to this force. Given Young's modulus of material of wire 110x10^9 N/m^2.

33) In given pulley mass system, mass m_1 = 500 g, m_2 = 460 g and the pulley has a radius of 5 cm. When released from rest, heavier mass falls through 7.50 cm in 5 s. There is no slippage between pulley and string. **5**
What is magnitude of pulley's angular acceleration?

34) A man stands on a rotating platform with his arms stretched horizontally holding a 5 kg weight in each hand. The angular speed of the platform in 30 rpm. The man then brings his arms close to his body with the distance of each weight from the axis changing from 90 cm to 20 cm. The moment of inertia of the man together with the platform may be taken to be constant and equal to 7.6 kg-m^2. **5**
What is his new angular speed? (Neglect friction)

35) A silica glass rod has a diameter of 1 cm and is 10 cm long. The ultimate strength of glass is 50x10^6 Nm^{-2} . Estimate the largest mass that can be hung from it without breaking it. Take g=10Nkg^{-1} **5**

36) Two long metallic strips are joined together by two rivets each of radius 0.1cm (see Fig.).Each rivet can withstand a maximum shearing stress of 3.0x 108Nm^{-2}.Calculate the maximum tangential force a strip can exert. **5**



37) Glycerine flows steadily trough a horizontal tube of length 1.5 m and radius 1.0 cm. If the amount of glycerine flowing per second at one end is 4.0x10^{-3} kg/m^3 and viscosity of glycerine =0.83 Pa-s). (You may also like to check , if the assumption of laminar flow in tube is correct). **5**

38) A circular disc made by iron is rotating about its axis of rotation with a uniform angular speed ω **5**
Determine the change in the linear speed of particle at the rim in percentage. The disc of rim is slowly heated from 20^o C to 50^o C keeping the angular speed uniform. Give that coefficient of linear expansion for the material of iron is 1.2×10^{-5} ^{0}C^{-1}

39) A Carnot cycle is performed by 1 mole of air (r = 1.4) initially at 327^o C. Each stage represents a compression or expansion in the ratio 1:6 Calculate the lowest temperature **5**
Take R = 8.31 J/ mol^{-K}

40) The efficiency of a Carnot engine is 1/2. If the sink temperature is reduced by 100o C, then engine efficiency becomes 2/3. Find **5**
Explain, why a Carnot engine cannot have 100% efficiency?

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Section-A

1) Moment of inertia of a sphere is less than that of a cube of same mass. **1**

2) Since, gravitational force is an internal force, therefore the centre of mass would not move. **1**

3) $mg_p = m' g_e$since, $g_p > g_e \therefore m' > m$. So, we shall have greater mass of sugar at the equator. **1**

4) **1**
No, it does not matter if one uses gauge instead of absolute pressures in applying Bernoulli's equation unless the atmospheric pressure at the two points where, Bernoulli's equation is applied are significantly different.

5) The critical speed of a fluid depends on (a) diameter of tube, (b) density of fluid, (c) coefficient of viscosity of the fluid. **1**

6) Because, specific heat of water is very high due to this it absorbs, a large amount of heat. This helps in maintaining the temperature of the engine low. **1**

7) **1**
No, the process of transfer of heat by convection is based on the fact that a liquid becomes lighter .on becoming hot and rise up. In condition of weightlessness, this is not possible. So, transfer of heat by convection is not possible in the earth satellite.

8) **1**
The object at 300 ^{0}C will cool faster than the object at 100 ^{0}C. This is in accordance with Newton's law of cooling. As we know, rate cooling of an object α temperature between the object and its surroundings.

9) According to second law of thermodynamics, heat energy cannot converted into work completely. **1**

10) Carnot cycle is a reversible cyclic process through which heat is converted into mechanical work. **1**

Section-B

11) **2**
Molten ice from poles into ocean and so mass is going away from axis of rotation. So, moment of inertia of earth increases and to conserve angular momentum, angular velocity (ω) decreases. So, time period of rotation increases ($T = 2\pi/\omega$). So, net effect of global warming is increasing in the duration of day.

12) 2

In a whirl wind, the air from nearby region gets concentrated in a small space thereby decreasing the value moment of inertia considerably. Since $I\omega$= constant, due to decrease in moment of inertia, the angular speed becomes quite high.

13) 2

The moment of inertia $\left(I = \frac{1}{2}MR^2\right)$ of the earth about its own axis will become one-fourth and so its angular velocity will become four times $(L = I\omega = constant)$.

Hence, the time period will reduce to one-fourth ($T = 2\pi/\omega$), i.e. 6 hours.

14) From the law of conservation of angular momentum 2

$mr_1v_1 = mr_2v_2 \quad \Rightarrow \quad r_1v_1 = r_2v_2 \quad or \quad \frac{v_1}{v_2} = \frac{r_2}{r_1}$

15) $F\alpha\frac{1}{r^2}$ So, if r is increased by a factor of 3, F will be reduced by a factor of 9. Thus, the new force will be x/9. 2

16) 2

Headache is due to mental strain.It will persist whether a person in an astronaut in space or he is on earth.It means headache will have the same effect on the astronaut in space as on a person on earth.

17) v_p (escape speed on a planet) = $\sqrt{\frac{GM_p}{R_p}}$ 2

v_e (escape speed on the earth) = $\sqrt{\frac{GM_e}{R_e}}$

Clearly , $\frac{v_p}{v_e} = \sqrt{\frac{M_p}{M_e} \times \frac{R_e}{R_p}} = \sqrt{8 \times \frac{1}{2}} = 2v_p = 2v_e = 22.4km/s$

18) According to Hooke's law 2

Modulus of elasticity, $E = \frac{W}{A} \times \frac{L}{l}$

where, L = original length of the wire

A = crosssectional area of the wire

Elongation $\Delta l = \frac{WL}{E}$

On either side of the wire, tension s W and length is l/2

$\Delta l = \frac{WL/2}{AE} = \frac{WL}{2AE} = \frac{1}{2}$

Total elongation in the wire $= \frac{1}{2} + \frac{1}{2} = 1$

19) 2

When mass M is placed on the piston, the excess pressure, p=Mg/A. As the pressure is equally applicable from all the direction on the sphere, hence there will be decrease in volume due to decrease in raius sphere. Volume of the sphere, $V = \frac{3}{4}\pi R^3$

Differentiating it , we get,

$\Delta V = \frac{4}{3}\pi(3R^2)\Delta R = 4\pi R^2\Delta R \frac{\Delta V}{V} = \frac{4\pi R^2\Delta R}{\frac{4}{3}\pi R^3} = \frac{3\Delta R}{R}$

We know that, $B = \frac{P}{dV/V} = \frac{Mg}{A} / \frac{3\Delta R}{R}$

$or \qquad \frac{\Delta R}{R} = \frac{Mg}{3BA}$

20) Volume of 1000 small drops = volume of a large drop $1000 \times \frac{4}{3}\pi r^3 = \frac{4}{3}\pi R^3$ 2

r=$\frac{R}{10}$

Surface area of large drop =$\frac{4}{3}\pi R^2$

Surface area of 1000 drop = $4\pi \times 1000r^2$=$40\pi R^2$

Increase in surface area = (40-4)πR^2=36πR^2

The increase in surface energy

=Surface tension $\times$ increase in surface area

=36$\pi R^2 \times$ 0.07=36 $\times$ 3.14(4 $\times$ 10^{-3})^2 $\times$ 0.07

=1.26 $\times$ 10^{-4} J

21) 2

$Given, \quad radius \quad (r) = 2.5 \times 10^{-5}m Surface \quad t6ension(S) = 7.28 \times 10^{-2}N/m Angle \quad of \quad contact \quad (\theta) = 0^0 density \quad of \quad water \quad (\rho) = 10^3 kg/m^3 The \quad maximum \quad height \quad which \quad sa$

But, the height of many trees are more than 0.59m, therefore, the rise of sap in all trees is not possible through capillarity action alone.

22) Given, maximum mass that can be lifted (m)=3000 kg **2**

Area of cross-section (A)=425cm^2=4.25 × $10^{-2}m^2$

∴ Maximum pressure on the bigger piston

$p = \frac{F}{A} = \frac{mg}{A} = \frac{3000 \times 9.8}{4.25 \times 10^{-2}} = 6.92 \times 10^5 Pa$

According to Pascal's law, the pressure applied on an enclosed liquid is transmitted equally in all directions.

∴ Maximum pressure on smaller piston = maximum pressure on bigger piston

$p' = p = 6.92 \times 10^5 Pa$

23) Moment of inertia of cylinder about its own axis = $= \frac{1}{2}MR^2$ **2**

$= \frac{1}{2} \times 20 \times (0.25)^2 kg - m^2$

= 0.625 kg-m^2

Kinetic energy of rotating cylinder

$= \frac{1}{2}I\omega^2 = \frac{1}{2}(0.625)(100)^2 J = 3125J\cdot$

Angular momentum of cylinder about its own axis

$= I\omega = 0.625 \times 100 = 62.5 \quad kg - m^2/s$

24) Angular displacement is **2**

$\Delta\theta = \theta_f - \theta_i = 6 - (-2) = 8rad$

25) Angular displacement is **2**

$\Delta\theta = \theta_f - \theta_i = -8rad - (-4rad) = -4rad$

26) Period of a revolution of a satellite is the time taken by the satellite to complete one revolution round the earth.It is denoted by T. **2**

$\therefore T = \frac{Circumference \quad of \quad circular \quad orbit}{Orbital \quad velocity}$

or $T = \frac{2\pi r}{v_o}$

or $T = \frac{2\pi(R+h)}{v_o}$ $[\therefore r = R + H]$

or

$T = 2\pi(R+h)\sqrt{\frac{R+h}{GM}}\left[\because \quad v_o = \sqrt{\frac{GM}{R+h}}\right]$

or $T = 2\pi\sqrt{\frac{(R+h)^2}{GM}}$

Also, $T = 2\pi\sqrt{\frac{(R+h)^2(R+h)}{GM}}$

or $T = 2\pi\sqrt{\frac{(R+h)^3}{gR^2}}$

$\because \quad gR^2 = GM$

$\therefore T = 2\pi\sqrt{\frac{(R+h)^2}{gR^2}}$

27) Diameter of each rivet D=6mm **2**

Radius r = $\frac{D}{2} = 3mm = 3 \times 10^{-3}m$

Maximum shearing stress on eac river = 6.9x10^7 Pa

Let w be the maximum load that can be subjected to the riveted strip. As each rivet carry one-quarter of the load.

Therefore, load on each rivet = $\frac{w}{4}$

$\therefore \quad 6.9 \times 10^7 = \frac{w/4}{\pi r^2} or \quad w = 6.9 \times 10^7 \times 4\pi r^2 or \quad w = 6.9 \times 10^7 \times 4 \times 3.14 \times (3 \times 10^{-3})^2 \quad = 6.9 \times 4 \times 3.14 \times 9 \times 10 = 7.8 \times 10^3 \quad N$

28) Given, compressional force, F=50000 N **2**

Diameter, D=0.5 mm = 5 × 10^{-4} m

Radius, r=$\frac{D}{2}$ = 2.5 × 10-4m

Pressure at the tip of the anvil (p) = $\frac{Force}{Area}$

$p = \frac{F}{\pi r^2} = \frac{50000}{\left(2.5 \times 10^{-4}\right)^2}$ = 2.5 × 10^{11} Pa

29) 574.6^o **2**

30) 887^{0}C **2**

Section-C

31) $Given, \quad r = 0.53A° = 0.53 \times 10^{-10}m\theta = 30°, L = ?L = mvrsin\theta = 9 \times 10^{-31}kg \times 2.2 \times 10^6 \times 0.53 \times 10^{-10} \times sin30° = 5.247 \times 10^{-3}kg - m^2/s$ **5**

32) Given area of cross section A=2m^2 **5**

Force F=3kN=3x10^3 N

Length L=4m

Young's modulus Y=110x10^{9}N/m^2

Change in length, $\Delta L = ?$

Apply, $Y = \frac{FL}{A\Delta L}$

$\Rightarrow \quad \Delta L = \frac{Fl}{AY} = \frac{3 \times 10^3 \times 4}{2 \times 110 \times 10^9} = 0.0545 \times 10^{-6} m \qquad \Delta L = 54.5 \times 10^{-3} mm$

33) α = 1.20 rad/s^2 **5**

34) Moment of inertia of man and platform system **5**

I_i = 7.6 kg-m^2

Change in moment of inertia of man and platform system when he stretches his hands to a distance of 90 cm = $2 \times mr^2 = 2 \times 5 \times (0.9)^2$

= 8.1 kg-m^2

I_i = I + 8.1 = 7.6 + 8.1 = 15.7 kg-m^2

Initial angular velocity,$\omega_i = 30 rpm$

Initial angular momentum of system,

$L_i = I_i \omega_i = 15.7 kg - m^2 \times 30 rpm$

When man folds his hands to a distance of 20 cm,

Moment of inertia of man=$2 \times mr^2 = 2 \times 5 \times (0.2)^2$

$= 0.4 kg - m^2$

So, final moment of inertia of man and platform system

= 7.6 + 0.4 = 8 kg-m^2

Final angular momentum of system

$L_f = I_f \omega_f = 8 \times \omega_f$

Equating initial and final values

$L_i = L_f$

$\Rightarrow \quad \omega_f = \frac{15.7 \times 30}{8}$

= 58.88 rpm.

35) 392.5kg **5**

36) Let F be the tensile force applied. Since, each rivet shares the stretching force equally, so the shearing force on each rivet = F/2. **5**

If A is the area of each rivet, then shearing stress on each rivet=$\frac{F}{2A}$.Now, maximum shearing stress on each strip = 3.0 $\times$ 10^8 Nm^{-2}

i.e. $\frac{F_{max}}{2A}$ = 3.0 $\times$ 10^8 Nm^{-2}

where, F_{max} is maximum tangential force.

or F_{max} = 3.0 $\times$ 10^8 $\times$ 2A = 6.0 $\times$ 10^8 $\times$ πr^2

$\therefore$ r = 0.1 cm

$\Rightarrow$ 0.1 $\times$ 10^{-2}

r=1 $\times$ 10^{-3} m

$\Rightarrow$ F_{max} = 6.0 $\times$ 10^8 $\times$ $\frac{22}{7}$ $\times$ (1 $\times$ 10^{-3})^2

=1885 N

37) Given, length of the tube (l)=1.5 m 5

Radius of the tube(r) = 1.0 cm = 1x 10^{-2} cm

Mass of glycerine flowing per second = 4x 10^{-3} kg/s

Density of glycerine, ρ = 1.3 x 10^3 Kg/ m^3

Viscosity of glycerine , $\eta = 0.83 \quad Pa - s$

Volume of glycerine flowing per second, $V = \frac{m}{\rho}$

$$\left[\because density = \frac{Mass}{Volume} \right]$$

$$= \frac{4 \times 10^{-3}}{1.3 \times 10^3} m^3/s = \frac{4}{1.3} \times 10^{-6} m^3/s$$

According to Poiseuille's formula, the rate of flow of liquid through a tube

$$V = \frac{\pi}{8} \frac{pr^4}{\eta l}$$

Where, p is the pressure difference between the two ends of the tube.

or $p = \frac{8\eta l V}{\pi r^4} = \frac{8 \times 0.83 \times 1.5 \times 4 \times 10^{-6}}{3.14 \times (1 \times 10^{-2})^4 \times 1.3} = 976 \quad Pa$

To check the laminar flow in tube, the value of Reynold's number should be less than 2000.

Reynold's number, $R_e = \frac{\rho D v_c}{\eta}$

where, v_c is the critical velocity and D is the diameter of the tube.

Critical velocity, $v_c = \frac{Volume \quad flowing \quad out \quad per \quad second}{Area \quad of \quad cross-section}$

$$= \frac{m/\rho}{A} = \frac{m}{\rho \pi r^2} \quad [\because A = \pi r^2]$$

$\therefore$ Reynold's number, $R_e = \frac{\rho D}{\eta} \times \frac{m}{\rho \pi r^2}$

$$= \frac{2r \times m}{\eta \pi r^2} = \frac{2m}{\pi r \eta} = \frac{2 \times 4 \times 10^{-3}}{3.14 \times 10^{-2} \times 0.83} = 0.31$$

As R_e < 2000, therefore. flow of glycerine is laminar.

38) 3.6 x 10^{-2} 5

39) 20^o C 5

40) As efficiency, $\eta_2 \Rightarrow 1 - \frac{T_2}{T_1}$ 5

It equals to 1 only when $\frac{T_2}{T_1} = 0 \quad or \quad T_2 = 0K$

But absolute zero is not possible.