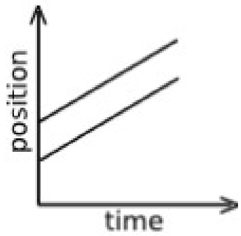
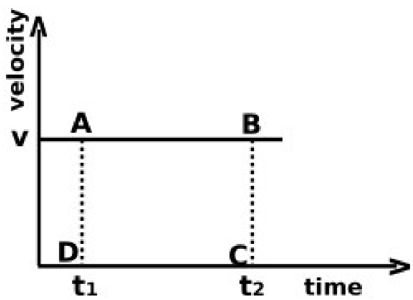
FIRST YEAR HIGHER SECONDARY
SECOND TERMINAL EVALUATION:2019(Key)
PHYSICS

Maximum mark:60 **Time:2 hr**

	Answer **any THREE** questions from 1 to 4. Each carry **1** score	
1.	Which of the following is not a conservative force. a. Gravitational force b. Frictional force. c. Electrostatic force. d. Magnetic force. **Ans**. b. Frictional force.	2
2.	When a ballet dancer draws her arms closer to her body, her angular velocity will ...... **Ans**. Remains constant. (No change)	2
3.	Is fuel necessary for an artificial satellite to revolve around the earth? **An**s. No	2
4.	State TRUE or FALSE : “The viscosity of gases decreases with an increase in temperature” **Ans.** False.	2
	Answer **any SIX** questions from 5 to 12. Each question carry **2** scores	
5.	a. Define relative velocity. b. Draw position – time graph of two objects moving with equal velocities. **Ans**. a. The velocity of one body with respect another is called relative velocity. b.  	2
6.	Fill in the blanks: a. kWh is the unit of .... b. Power = Force x .... c. 1 Horse power = ... W d. 1kWh = ... joules. **Ans**.a. Energy b. Velocity c. 746 W d. 3600000 J	2
7.	Show that the area under velocity – time graph gives displacement. **Ans**. Consider an object moves with uniform velocity v. Its velocity time graph will be as shown.  A and B are the two points on the graph and the corresponding time are t_1 and t_2 . From the graph, area below AB = Area of rectangle ABCD = DCxAD = $(t_2 - t_1)$xv = vt = displacement. That is, area under velocity – time graph is numerically equal to displacement.	2
8.	Two satellites of equal masses are orbiting the earth at different height. a. Will their moment of inertia be same or different? b. Write the unit and dimension of moment of inertia. **Ans**.a. Different (Because $I = mr^2$, here r is different) b. unit: kgm^2 Dimension: ML^2	2
9.	Which one do you prefer ‘steel or copper’ to make spring? Why? **Ans**. Steel. Because steel is more elastic than that of copper. (Rigidity modulus of steel is greater than that of copper)	2

10.	The escape velocity of earth is 11.2 km/s. Find orbital velocity of the smallest possible orbit. **Ans**.We have $V_e = \sqrt{(2GM/R)} = 11.2$ km/s .... (1) and orbital velocity of a satellite = $\sqrt{[GM/(R+h)^2]}$ When the orbit is smallest, h<<R and hence R+h ≈ R Then $V_o = \sqrt{[(GM/R]}$ .... (2) From (1) and (2):- $V_o = V_e/\sqrt{2} = 11.2/\sqrt{2} = 7.92$ km/s	2
11.	Define completely inelastic collision and head on collision. **Ans**.i. Completely inelastic collision: A collision in which the two particles move together after the collision is called completely inelastic collision. ii. Head on collision: If the initial velocities and final velocities of both the objects are along the same straight line, the collision is called head on collision.	2
12.	Water exhibits an anomalous behaviour. a. Write the temperature at which water has maximum density. b. Below the above temperature, the volume of water .... (increases/decreases) **Ans**.a. 4°C b. Increases.	2
	Answer **any SIX** questions from 13 to 20. Each question carries **3** score	
13.	Fill in the blanks:	3

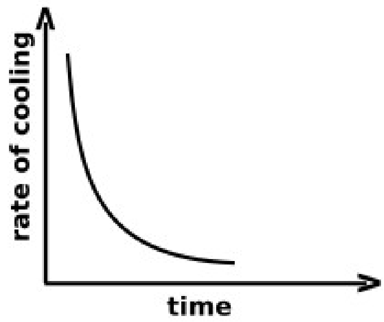
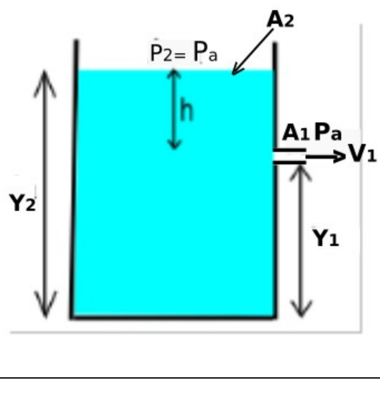
Physical Quantity	**Unit**	**Dimension**
Pressure	--------	--------
--------	--------	ML^{-3}
--------	Nm^{-1}	--------

Ans.

Physical Quantity	**Unit**	**Dimension**
Pressure	Nm^{-2}	$ML^{-1}T^{-2}$
Density	kgm^{-3}	$ML^{-3}T^{0}$
Surface tension	Nm^{-1}	$ML^{0}T^{-2}$

14.	What is meant by positive, negative and zero work. i. If the object has displacement component along the direction of force work is positive. Example: Work done on the freely falling body by the gravity. ii. If the object is displaced opposite to the direction of force, work is negative. Example: Work done by frictional force. iii. If there is no displacement along the direction of applied force, work is negative. Example: Work done by centripetal force. OR Work = F.d Cosθ If θ > 90, work is positive If θ < 90 , work is negative. If θ = 90 , work is zero.	3
15.	The reading taken by a student in measuring diameter of a wire using a screw gauge is given below.	3

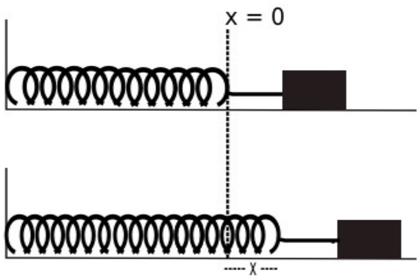
Sl.No.	**PSR(mm)**	**HSR(div)**	**Total(mm)**
1	0	42	0.42
2	0	41	0.41
3	0	40	0.40
4	0	41	0.41

	Ans.a. Mean diameter = (0.42 + 0.41+0.40+0.41)/4 = 1.64/4 = 0.41 mm b. Δd1 = 0.41 – 0.42 = 0.01 Δd2 = 0.41 – 0.41 = 0.00 Δd3 = 0.40 – 0.41 = 0.01 Δd4 = 0.41 – 0.41 = 0.00 Mean absolute error = (0.01+0.00 + 0.001+ 0.00)/4 = 0.005 c. Percentage error = (0.005/0.41)x100 = 1.2%	
16.	The acceleration due to gravity (g) is maximum on the surface of the earth. a. Write the relation between acceleration due to gravity and gravitational constant. b. If the earth stops rotation, what will happen to the weight of a body at the poles. c. What is the value of 'g' at the centre of the earth? **Ans**. a. $g = GM/R^2$ b. No change. [$mg^1 = mg - ,mR\omega^2 Cos^2\lambda$. At pole λ = 90] c. Zero.	3
17.	Calculate the force required to produce an elongation of 0.1 cm in a steel wire of radius 1 mm and length 2m. (Young's modulus of the wire = $20x10^{10}$ N/m^2) **Ans**. We have $Y = FL/\pi r^2 \Delta L$ Or $F = Y x \pi r^2 \Delta L/L$ $= 20x10^{10}x3.14x(1x10^{-3})^2x0.1x10^{-2}/2 = 3.14x10^2$ N = 314 N	3
18.	Hot water left on a table begin to cool gradually. a. State the law behind it. b. Write the mathematical expression relating the above law. c. Draw a graph which shows the cooling of hot water with time. **Ans**.a. Newton's law of cooling: The rate of loss of heat from a hot body is proportional to temperature difference between the body and surroundings. b. $dQ/dt = -k(T_2 - T_1)$ c. 	3
19.	Two syringes of different cross section (without needles) filled with water are connected with a tightly fitted rubber tube filled with water. Diameter of the smaller piston and larger piston are 1 cm and 3 cm respectively. Find the force exerted on the larger piston when a force of 10 N is applied to the smaller piston. **Ans**. We have F/A = f/a Or $F/\pi R^2 = f/\pi r^2$ Here f = 10N, r = 0.5 cm R = 1.5 cm F = ? Then $F = fx R^2/r^2$ = 10x1.5x1.5/0.5x0.5 = 90 N OR We have F:f = A: a F:10 = 9:1 Then F = 10x9/1 = 90N	3
20.	Derive an expression for speed of efflux using Bernoulli's equation. Consider an open tank containing fluid of density ρ with small hole at height y_1. Let A_1& A_2 are cross sectional area of the hole (outlet) and tank respectively. Since A_2 is much greater than A_1, fluid at the top remains rest.(ie v_2= 0). It is also noted that the outlet and top of the fluid are open to atmosphere and the pressure there is equal to atmospheric pressure P_a. 	3

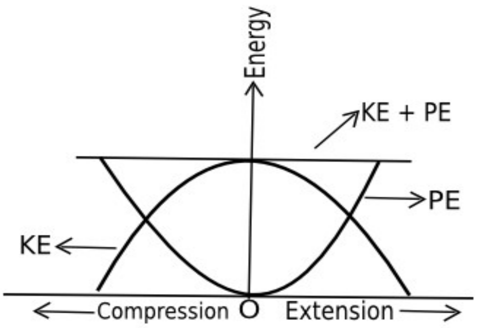
According to Bernoulli's equation,
$P_a + ½ \rho v_1^2 + \rho g y_1 = P_a + ½ \rho v_2^2 + \rho g y_2$
$½ v_1^2 = g(y_2 – y_1) = gh$ Since $v_2 = 0$ and $(y_2 – y_1) = h$
Or **$v_1 = \sqrt{(2gh)}$** which is same as that of the speed of freely falling body.

Answer **any THREE** questions from 21 to 24. Each question carries **4** score

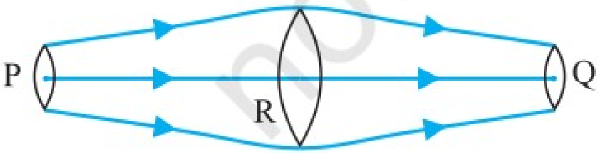
21. Spring force is an example of a variable force which is conservative. 4
a. Obtain an expression for potential energy of a spring.
b. Show graphically the variation of kinetic energy and potential energy in a spring.



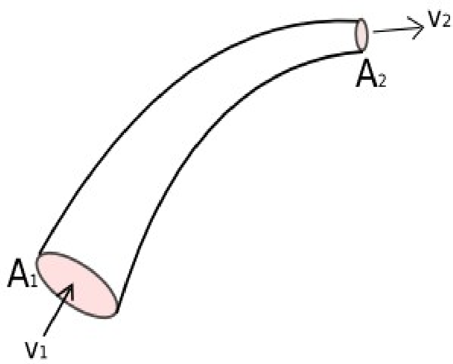
Ans.a. Consider a spring which one end is fixed to a wall and a block is attached to other end . The block is resting on a smooth horizontal surface. Let the spring is too light and hence it is treated as massless. The spring force is proportional to the displacement x of the block.
Then $F_s = -kx$ Where k is spring constant.
Since this force is a variable force, the work done by the spring when it stretches from 0 to x,
$W = \int F_s.dx = \int -kx.dx = -k\int x.dx = - ½ kx^2$
This work is stored in the stretched spring as potential energy.
Hence potential Energy $U = - ½ kx^2$
b. The variation of KE & PE against extension or compression of the spring is shown as in fig.



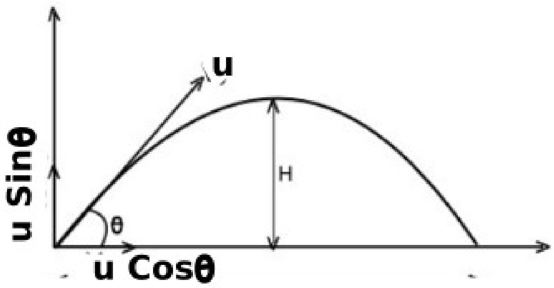
22. A region of streamline flow of an incompressible fluid is shown in the figure. 4
a. As the fluid flows from R to Q, fluid velocity .... (increases/decreases)
b. By considering mass conservation in the fluid flow, arrive at the equation of continuity.



Ans.a. Increases. (According to equation of continuity, speed is inversely proportional to area of cross section)
b. If an incompressible liquid (fluid) flowing through a tube of non uniform cross section, the velocity of flow at any section is inversely proportional to the area of cross section. That is, $A_1v_1 = A_2v_2$
Consider a flow of fluid through a tube of non uniform cross section as shjown.
Let A_1 be the area of cross section and v_1 be velocity of flow at one face and A_2 & v_2 are corresponding values at other face.
Then mass of fluid enter into the first face during time Δt is $\rho[A_1(v_1\Delta t)]$ (Since *mass = density x volume*)
Similarly mass of liquid flowing through the second face during the same time is $\rho.[A_2(v_2\Delta t)]$
Since there is only one entry and exit, these two masses will be equal.



That is, $\rho.[A_1(v_1\Delta t)] = \rho.[A_2(v_2\Delta t)]$ Or $A_1v_1 = A_2v_2$ Hence the proof.

23.	A particle is projected with an initial velocity u in a direction making an angle θ with the horizontal. a. Derive an expression for time of flight of the projectile. b. A player kicks a football with an initial velocity of 20 m/s. Find the time of flight of the football. **Ans**.a. Consider a projectile projected with initial velocity 'u' making an angle θ with the horizontal as in figure. The velocity u can be resolved into two components u cosθ along horizontal direction and usinθ along vertical direction. Expression for T can derived as follows. Initial vertical velocity = usinθ Acceleration a = -g Time of flight = T After time t=T,total vertical displacement = 0 We have the eqn. $x = u.t + ½ at^2$ Substitute the above values in this eqn. We get, $0 = usinθ T – ½ gT^2$ Or $usinθ. T = ½ gT^2$  Therefore time of flight **T = 2usinθ/g** **b.** u = 20 m/s θ = 30° T = 2usinθ/g = 2x20xSin30/9.8 = 2 s	4
24.	Fill in the blanks by finding the moment of inertia using suitable theorems (let M and R are the mass and radius of the body)	4

Body	**Axis**	**Moment of inertia**	**Axis**	**Moment of inertia**	**Name of theorem used.**
Circular disc	Perpendicular to the plane through the centre	$½ MR^2$	Diameter	---------	---------
Solid sphere	Diameter	$2/5. MR^2$	tangent	---------	---------

Ans.

Body	**Axis**	**Moment of inertia**	**Axis**	**Moment of inertia**	**Name of theorem used.**
Circular disc	Perpendicular to the plane through the centre	$½ MR^2$	Diameter	$¼MR^2$	Perpendicular axes theorem
Solid sphere	Diameter	$2/5. MR^2$	tangent	$7/5. MR^2$	Parallel axes theorem

Answer **any THREE** questions from 25 to 28. Each carry **5** scores

25.	Escape speed of moon is less than that of earth. a. what is meant by escape speed? b. Derive an expression for the escape speed from the earth. c. Is there any difference in escape speed of a heavy body and a light body? **Ans**.a. Escape speed: It is the minimum speed with which a body should be projected away from a planet so that it may escapes from the gravitational attraction of the planet permanently. b. Consider a body of mass m projected with speed V_e. Suppose this speed reduces to zero only after it reaches the point where gravitational potential zero. Total energy of the body when it is projected $E_i = KE + PE = ½ mV_e^2 + –GMm/R_e$. Total energy when it reaches the point beyond the gravitational field, $E_f = 0$ According to conservation of energy, $E_i = E_f$ $½ mv_e^2 –GMm/R_e. = 0$ Escape speed **$V_e = \sqrt{(2GM/R_e)}$**	5

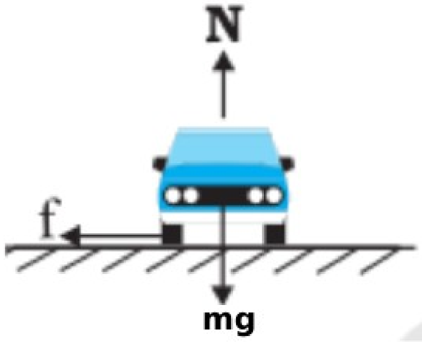
c. Since escape speed is independent of the mass of projecting body, escape speed of heavy body and light body will be the same.

26. The motion of a car on a circular level road is shown below: 5

a. Name the forces acting on the car.

b. Derive an expression for the maximum safe speed of the car.

c. A cyclist speeding at 18 km/hour on a level road takes a sharp circular turn of radius 3 m without reducing the speed. The coefficient of static friction between the tyres and the road is 0.1. Will the cyclist slip while taking the turn?



Ans.a. i. Weight 'mg' of the car .

ii. Normal reaction N on the car by the road

b.When a car takes a turn along a level road, the force acting on the car are 1. Weight 'mg' of the car acting vertically downward

2.Normal reaction N on the car by the road

3. Frictional force f.

Since there is no acceleration in the vertical direction, N–mg = 0 Or N = mg

The required centripetal force is provided by friction.

$mv^2/R \le \mu_s N$, where 'v' the speed of the car, R radius of curvature of the road.

But N = mg.

Then $= mv^2/R \le \mu_s mg$ Or $v \le \sqrt{(\mu_s Rg)}$.

The maximum speed that a car can acquire without skidding $v_{max} = \sqrt{(\mu_s Rg)}$.

c. Here maximum permissible speed without slipping = $\sqrt{(\mu_s Rg)}$.

$= \sqrt{(0.1x3x9.8)}$ = 1.71 m/s = 1.71x18/5 = 6.2 km/s

Since 18 km/hr is greater than permissible speed, he will slip.

27. To determine the the motion of the centre of mass of a system no knowledge of internal forces of the system is not required. 5

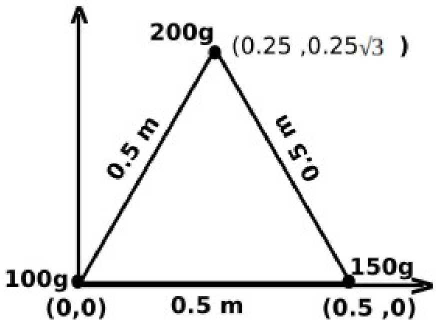
a. Define centre of mass of a system of particles.

b. Find the centre of mass three particles at the vertices of an equilateral triangle. The masses of the particles are 100g, 150 g ang 200 g respectively. Each side of the equilateral triangle is 0.5 m long.

c. Discuss the motion of centre of mass during the explosion of a shell thrown into air.

Ans.a.It is a point which behaves as though the entire mass of the body or system concentrated there.

b. Suppose the particles are placed in a coordinate system as shown and the respective coordinates are given.



Then $X = (m_1x_1+m_2x_2+m_3x_3)/(m_1+m_2+m_3)$

= 100x0 +150x0.5+200x0.25)/(100+150+200)

=125/450 = 0.28 m

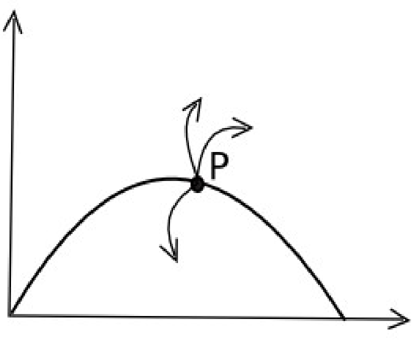
$Y = (m_1y_1+m_2y_2+m_3y_3)/(m_1+m_2+m_3)$

= 100x0 +150x0+200x0.25√3)/(100+150+200)

=86.6/450 = 0.19 m

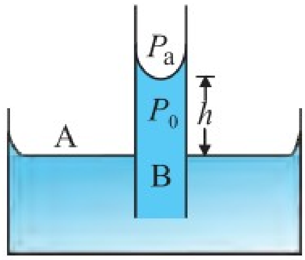
The co ordinate of the centre of mass of the system is (0.28,0.19)

c. Consider a shell which is in projectile motion as in fig. While in flight, if it explodes at P and different fragments travel along their own parabolic path. But the centre of mass of the system follow the same path as it would have followed as if there was no explosion, since the explosion is not due to external force.



28. Schematic picture of a capillary tube immersed in water is shown below. **5**

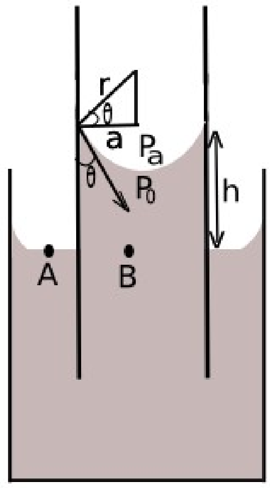
a. Name the phenomenon.
b. Name the expression for ‘h’ shown in the above figure.
c. The pressure of water inside the tube just at the meniscus is .... (less/greater) than the atmospheric pressure.



Ans.a. Capillary rise.
b.

Consider a capillary tube of radius 'a' dipped in a liquid of surface tension 'S' and density ρ. Let the angle of contact of water and glass tube is θ and concave meniscus radius is 'r' and 'h' is the capillary rise.

Since the surface is concave, there is some excess pressure in the concave side.



Excess pressure $P_i – P_o = P_a – P_o = 2S/r$ ------- (1)

Where P_i is the pressure just above the meniscus and is equal to atmospheric pressure P_a.

And P_o is the pressure just below the surface.

But from the right angled triangle in the fig. $\cos\theta = a/r$ Or $r = a/\cos\theta$.

Substitute this value of 'r' in eqn.(1),

then $P_a – P_o = 2S\cos\theta /a$. --------- (2)

Consider two points A and B on same level. According to Pascal's law, the pressure at A&B will be same.

Pressure at B, $P_B = P_o + h\rho g = P_A = P_a$

Or $P_a – P_o = h\rho g$ -------- (3).

from (2) & (3), $h\rho g = 2S\cos\theta/a$

Capillary rise, $\mathbf{h = 2S\cos\theta/a\rho g}$.

c. greater.

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