FIRST YEAR HIGHER SECONDARY MODEL EXAMINATION, JUNE 2022

Part III

PHYSICS

Maximum: 60 Score

ANSWER KEY (unofficial)

ME 624
Date: 06.06.2022
HSPTA KANNUR

Qn No.	Qn Sub No.	Scoring Indicators	Split score	Total
Answer any 5 questions from 1 to 7. Each carries 1 score				**[5 x 1 = 5]**
1		c) Strong Nuclear Force	1	1
2		b) 10^{-10} m	1	1
3		b) Zero	1	1
4		c) Law of inertia	1	1
5		a) Young's modulus	1	1
6		a) Pascal's law	1	1
7		b) sublimation	1	1
Answer any 5 questions from 8 to 14. Each carries 2 scores [5 x 2 = 10]				
8		According to Newton's second law, $F = \frac{dp}{dt}$ $\Rightarrow F\,dt = dp$ i.e., $\boxed{I=dp}$ i.e., Impulse = change in momentum	1 1	2
9		S_1 = Yield Strength S_2 = Ultimate tensile strength	1 1	2
10	i)	a) Weight of the body(F_g) , acting in the downward direction. b) Buoyant force (F_b), acting in the upward direction. c) Viscous force(F_v) acting in the upward direction.	1	2
	ii)	Terminal Velocity (V_t)	1	

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11		$T_F = 9/5\ T_C + 32$ $T_F = 9/5 \times -56.6 + 32$ OR $(\frac{Tc}{100} = \frac{Tf-32}{180})$ $T_F = -69.88$ F	1 1	2
12		The law of equipartition of energy states that "If a system is in equilibrium at absolute temperature T, the total energy is distributed equally in different degrees of freedom, the energy in each degree of freedom being equal to $\frac{1}{2}k_BT$.	2	2
13		$a = \frac{dv}{dt}$ $a = \frac{d}{dt} - \omega A \sin(\omega t + \phi)$ $a = -\omega A \cos(\omega t + \phi) \times \omega$ $a = -\omega^2 A \cos(\omega t + \phi)$ $a = -\omega^2 x$	1 1	2
14		When two waves of same amplitude and frequency travelling in opposite directions superimpose , the resulting wave pattern does not move to either sides. This pattern is called standing waves.	2	2

Answer any 6 questions from 15 to 22. Each carries 3 scores **[6 x 3= 18]**

15	i) ii)	Principle of Homogeneity states that "The dimensions of fundamental physical quantities on both sides of an equation should be the same". Dimension of $[mv^2] = M^1(L^1T^{-1})^2$ $= [M^1L^2T^{-2}]$ Dimension of $[mgh] = [M^1L^1T^{-2}\ L^1]$ $= [M^1L^2T^{-2}]$ Both the terms have the same dimension. Therefore by the principle of homogeneity the equation is correct.	1 1 1	3

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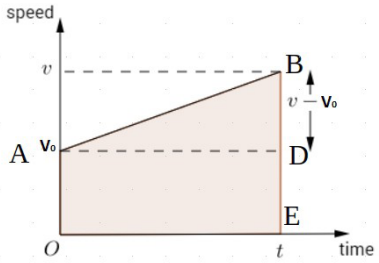
16	i)		1	3
	ii)	Displacement S = Area under the graph AB = Area of rectangle OADE + Area of triangle ADB = $OA \times OE + \frac{1}{2} DB \times AD$ = $u \times t + \frac{1}{2}(v - v_0) \times t$ = $v_0 t + \frac{1}{2} at \times t$ $S = v_0 t + \frac{1}{2} at^2$ This is the displacement – time relation.	2	

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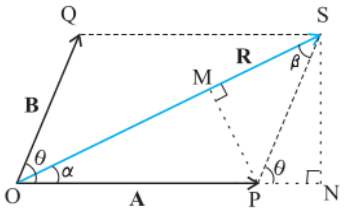
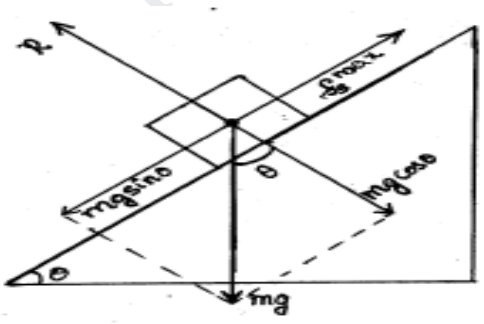
Qn No.	Qn Sub No.	Scoring Indicators	Split score	Total
17		 From figure, From Δ PNS, $\cos\theta = \frac{PN}{PS}$ $\Rightarrow PN = PS\cos\theta$ and $\sin\theta = \frac{SN}{PS}$ $\Rightarrow SN = PS\sin\theta$ Magnitude of R $R^2 = ON^2 + NS^2$ $R^2 = (OP + PN)^2 + NS^2$ $= OP^2 + PN^2 + 2OP.PN + NS^2$ $= OP^2 + 2OP.PN + (PN^2 + NS^2)$ $= OP^2 + 2OP.PN + PS^2$ $= OP^2 + 2OP.PS\cos\theta + PS^2$ $= A^2 + 2AB\cos\theta + B^2$ $\therefore \boxed{R = \sqrt{A^2 + B^2 + 2AB\cos\theta}}$	1 1 1	3
18		 Here, $mg\sin\theta = f_s^{max}$ ----------(1) $mg\cos\theta = R$ ----------(2) $\frac{(1)}{(2)} \rightarrow \tan\theta = \frac{f_s^{max}}{R} = \frac{\mu_s R}{R} = \mu_s$ $\boxed{\tan\theta = \mu_s}$	1 1 1	3

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19		$\vec{F}.\vec{d} = Fd\cos\theta$ $\cos\theta = \frac{\vec{F}.\vec{d}}{Fd}$ ----------(1) $\vec{F}.\vec{d} = F_x d_x + F_y d_y + F_z d_z$ $= (3 \times 5) + (4 \times 4) + (-5 \times 3)$ $\vec{F}.\vec{d} = 16$ unit $F = \sqrt{F_x^2 + F_y^2 + F_z^2} = \sqrt{3^2 + 4^2 + (-5)^2}$ $= \sqrt{9 + 16 + 25}$ $F = \sqrt{50}$ unit $d = \sqrt{d_x^2 + d_y^2 + d_z^2} = \sqrt{5^2 + 4^2 + 3^2}$ $= \sqrt{25 + 16 + 9}$ $d = \sqrt{50}$unit Substituting the values in eq(1) $\cos\theta = \frac{16}{\sqrt{50}\sqrt{50}} = \frac{16}{50} = 0.32$ $\theta = \cos^{-1} 0.32$ $= 71.33^{\circ}$	1 ½ ½ ½ ½	3
20		$\vec{l} = \vec{r} \times \vec{p}$ $\frac{d\vec{l}}{dt} = \frac{d}{dt}(\vec{r} \times \vec{p})$ $\frac{d\vec{l}}{dt} = \frac{d\vec{r}}{dt} \times \vec{p} + \vec{r} \times \frac{d\vec{p}}{dt}$ $\vec{p} = m\vec{v}$, $\frac{d\vec{r}}{dt} = \vec{v}$, $\frac{d\vec{p}}{dt} = \vec{F}$ $\frac{d\vec{l}}{dt} = \vec{v} \times m\vec{v} + \vec{r} \times \vec{F}$ $\vec{v} \times \vec{v} = 0$, $(\vec{r} \times \vec{F} = \vec{\tau})$ $\frac{d\vec{l}}{dt} = 0 + \vec{\tau}$ $\frac{d\vec{l}}{dt} = \vec{\tau}$ $\vec{\tau} = \frac{d\vec{l}}{dt}$	1 ½ ½ ½ ½	3

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21	i. Ii.	Poles At a height 'h' $g_h = g\left[\frac{R}{R+h}\right]^2$ When $g_h = \frac{g}{2}$ $\frac{g}{2} = g\left[\frac{R}{R+h}\right]^2$ $\frac{1}{2} = \left[\frac{R}{R+h}\right]^2$ $\frac{1}{\sqrt{2}} = \frac{R}{R+h}$ $R+h = \sqrt{2}\,R$ $h = (\sqrt{2}-1)R$ Therefore $h = (1.44-1)\,x\,6400 = 2650\,km.$	1 2	3
22	i. ii.	The type of flow in which each particle passing through a point has the same velocity and direction as its predecessor is called streamline flow or steady flow. If the speed increases beyond a certain value the flow becomes irregular and is called turbulent flow . In turbulent flow each particle crossing a certain point may have different velocity and direction. The velocity beyond which streamline flow changes in to turbulent flow is called critical velocity.	2 1	3

Answer any 3 questions from 23 to 27. Each carries 4 scores **[3 x 4 = 12]**

23	i) ii)	Since the body is released, u=0 For an object accelerating downward under gravity a = g, v = gt $v^2 = 2gh$ h= ½ gt^2  	 1 1 1 1	4
24	i)	Work done is the scalar product of the force vector and displacement vector. $W = \vec{F} \cdot \vec{S}$	1	

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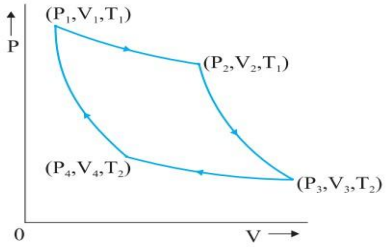
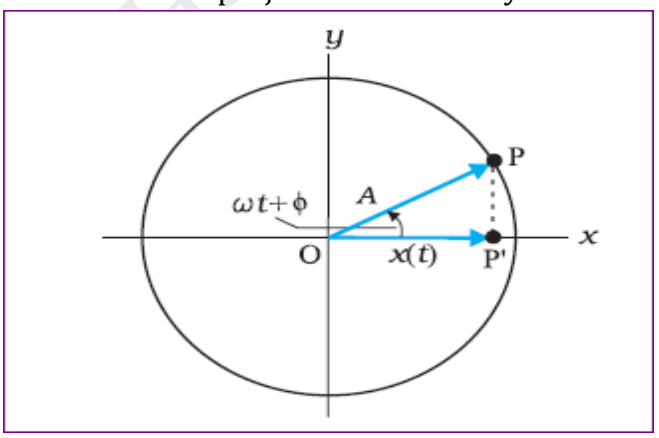
	ii)	a) When F and S are perpendicular to each other, b) When the displacement is zero	2	4
	iii)	Work done by frictional force, work done by a man lowering a body or other relevant examples.	1	
25		Explain the functions of source, working substance and sink.	1	
		Mention the four processes-isothermal expansion, adiabatic expansion, isothermal compression and adiabatic compression.	2	
			1	4
26	i)	A particle is said to have SHM if it moves to and fro under the action of a restoring force which is directly proportional to the displacement and is directed towards the equilibrium position.	1	
	ii)	$F \propto -x$ OR $\mathbf{F = -kx}$ the projection of a body in circular motion  As p moves along circumference of the circle, the projection point P' (along x axis) moves along the diameter, gives an SHM $OP' = x(t) = A\cos(\omega t + \phi)$ - shows an SHM	3	4

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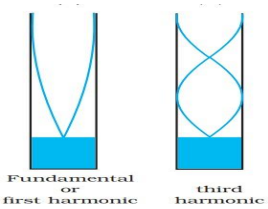
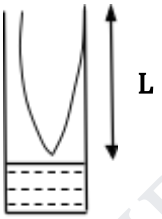
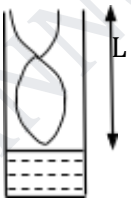
27	i)	3  	1+1	4
	ii)	1. First mode of vibration (n =0) $L=\frac{1}{4}\lambda_1$ R $\lambda_1=4L$ $\nu_1=\frac{V}{\lambda_1}$ OR $\nu_1=\frac{V}{4L}$  2. Second mode of vibration (n =1) $L=\frac{3\lambda_2}{4}$ R $\lambda_2=\frac{4}{3}L$ $\nu_2=\frac{V}{\lambda_2}$ OR $\nu_2=\frac{3V}{4L}$  $\nu_2=3\nu_1$ $\nu_1 : \nu_2 :: 1 : 3$	1 1	

Answer any 3 questions from 28 to 32. Each carries 5 scores **[3 x 5 = 15]**

28	(i) (ii)	c) Parabola We have from the equation of motion $t=\frac{x}{(v_0\cos\theta)}$ Substituting this in the equation $y=(v_0\sin\theta)t-\frac{1}{2}gt^2$ We get $y=(v_0\sin\theta)\frac{x}{(v_0\cos\theta)}-\frac{1}{2}g\left(\frac{x}{(v_0\cos\theta)}\right)^2$ $y=(\tan\theta)x-\frac{g}{2(v_0\cos\theta)^2}x^2$	1 2	5
	iii	$H=\frac{v_0^2\sin^2\theta}{2g}=\frac{28^2(\sin 30)^2}{2\times 9.8}=10m$	2	

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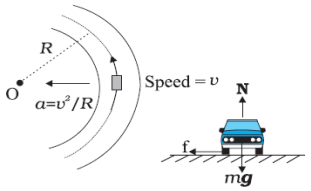
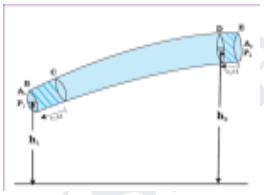
29	i)	Weight ,mg Normal force Frictional force Centripetal force 	1	5
	ii)	$N = mg$; $f_s = \frac{mv^2}{r}$; $\mu_s N = \frac{mv^2}{r}$	1+1	
		$\mu_s mg = \frac{mv^2}{r}$; $v^2 = \mu_s rg$	1	
		$v = \sqrt{\mu_s rg}$	1	
30		Statement The total energy of an incompressible non viscous fluid in a steady flow from one point to another is a constant. **It is a statement of conservation of energy.**	1 1	5
				
		Work done for small displacements Δx at both ends are $W_1=P_1A_1v\Delta t$ & $W_2=P_2A_2v\Delta t$ Total work done $W=(P_1-P_2)\Delta V$. This work done increases the KE and PE of the fluids. This are $\Delta U=\rho\Delta V\, g(h_2-h_1)$ & $\Delta K=(1/2)\rho\Delta V(v_2^2-v_1^2)$ Then by conservation of energy $W=\Delta U+\Delta K$ ie $(P_1-P_2)\Delta V= \rho\Delta V\, g(h_2-h_1)+(1/2)\rho\Delta V(v_2^2-v_1^2)$ Divide through out by ΔV, gives $P_1-P_2= \rho\, g(h_2-h_1)+(1/2)\rho(v_2^2-v_1^2)$ $P_1+(1/2)\rho v_1^2+\rho\, gh_1=P_2+ (1/2)\rho v_2^2+\rho\, gh_2$ ie $P+(1/2)\rho v^2+\rho\, gh$ = constant This is the Bernouli's equation	3	

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31	i)	The speed with which a satellite revolves around a planet.	1	5
	ii)	The centripetal force required for the orbital motion of the satellite is provided by the gravitational force between satellite and the planet. $\frac{mv^2}{R+h} = \frac{GMm}{(R+h)^2}$	1	
		Where m- mass of the satellite, v –velocity • Therefore the orbital velocity is given by $v = \sqrt{\frac{GM}{R+h}}$	1	
		For a satellite very close to earth h = 0 $v_o = \sqrt{\frac{GM}{R}}$		
		We have $GM = gR^2$, thus $v_o = \sqrt{gR}$	1	
	iii)	$v_e = \sqrt{2}v_o$	1	
32	i)	Moment of Inertia and Torque	2	5
	ii)	Cosider a particle of mass m rotating about an axis of radius r with angular velocity ω The kinetic energy of motion of this particle is $kE = \frac{1}{2}mv^2$	1	
		But v = r ω $kE = \frac{1}{2}mr^2\omega^2$	1	
		$I = mr^2$ Rotational kE $= \frac{1}{2}I\omega^2$	1	

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