FY 424
Date of Exam : 03.02.2022

IMPROVEMENT / SUPPLIMENTARY EXAMINATION, JANUARY - 2022

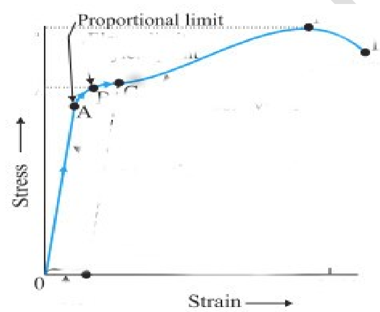
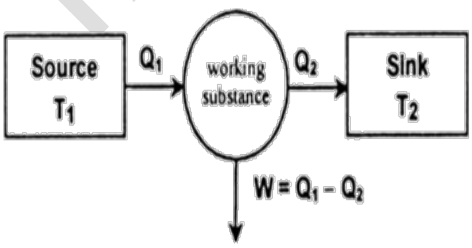
Part – III

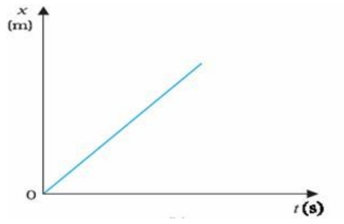
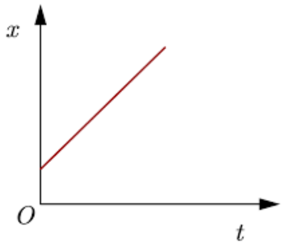
PHYSICS

Maximum : 60 Scores

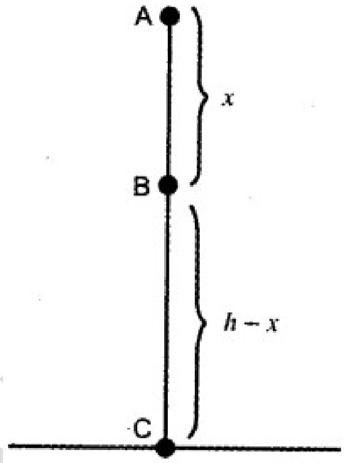
ANSWER KEY
(Unofficial)

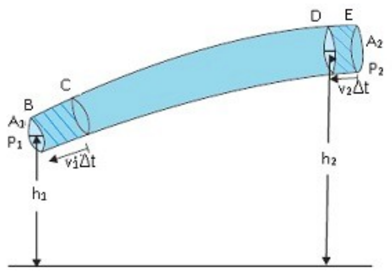
<table>
<tr><th>Qn No</th><th>Qn Sub No</th><th>Split Scores</th><th>Total Score</th></tr>
<tr><td>1</td><td></td><td>ii) Electrodynamics</td><td>1</td></tr>
<tr><td>2</td><td></td><td>iii) $\vec{v} = \vec{\omega} \times \vec{r}$</td><td>1</td></tr>
<tr><td>3</td><td></td><td>iv) Independent of Area of Contact</td><td>1</td></tr>
<tr><td>4</td><td></td><td>$P = \frac{1}{3} nm \bar{v}^2$</td><td>1</td></tr>
<tr><td>5</td><td></td><td>Gravitational force / Electromagnetic force / Strong nuclear force/ Weak nuclear force (any two)</td><td>1</td></tr>
<tr><td>6</td><td></td><td><table>
<tr><td>Time</td><td>second</td><td><u>s</u></td></tr>
<tr><td>Electric Current</td><td><u>ampere</u></td><td>A</td></tr>
<tr><td>Solid angle</td><td>steradian</td><td>Sr</td></tr>
<tr><td><u>Amount of Substance</u>
(Quantity of matter)</td><td>mole</td><td>mol</td></tr>
</table></td><td>2</td></tr>
<tr><td>7</td><td>i)
ii)</td><td>True — 1 Score
True — 1 Score</td><td>2</td></tr>
<tr><td>8</td><td>a)
b)</td><td>Power — 1 Score
magnitude — 1/2 Score
Direction — 1/2 Score</td><td>2</td></tr>
<tr><td>9</td><td></td><td>Distance d = 7 x 2πr = 14 x 3.14 x 0.12 = 5.28m — 1 Score
Speed $v = \frac{d}{t} = \frac{5.28}{100} = 0.0528$m/s — 1 Score</td><td>2</td></tr>
<tr><td>10</td><td>i)
ii)
iii)
iv)</td><td>Negative — 1/2 Score
Positive — 1/2 Score
Zero — 1/2 Score
Positive — 1/2 Score</td><td>2</td></tr>
<tr><td>11</td><td></td><td>Rate of Change of KE
$\frac{dK}{dt} = \frac{d(\frac{1}{2}mv^2)}{dt} = mv\frac{dv}{dt}$ = mva = Fv = F $\frac{dx}{dt}$
dK = F dx
Integrating,
$\int_{K_i}^{K_f} dK = \int_{x_1}^{x_2} F dx$
$K_f - K_i = W$</td><td>2</td></tr>
</table>

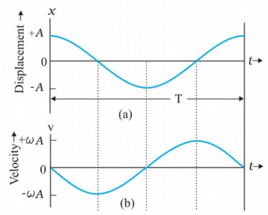
12		Every body in this universe attracts every other body with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them. $F = \frac{G m_1 m_2}{r^2}$	2
13		If a wire is stretched then the restoring force per unit area is called tensile stress (1 Score) Longitudinal Strain is the ratio of change in length to original length Or, Longitudinal Strain = $\frac{\Delta l}{l}$ (1 Score)	2
14			2
15			2
16		Workdone $W = \int_{V_1}^{V_2} PdV = \int_{V_1}^{V_2} \frac{\mu RT\, dV}{V} = \mu RT \int_{V_1}^{V_2} \frac{dV}{V}$ $= \mu RT \ln \frac{V_2}{V_1}$	2
17	a)	It is ratio of total displacement of the particle to the time taken. 1 Score	3

	b)	 or  2 Scores	
18	a)	The rate of change of linear momentum is equal to applied external force 1 Score $F \,\alpha\, \frac{\Delta P}{\Delta t}$ 1/2 score $F \,\alpha\, \frac{\Delta mv}{\Delta t}$ 1/2 score F = kma 1/2 score k=1 F = ma 1/2 score	3
19		$\vec{l}=\vec{r}\,x\,\vec{p}$ $\frac{d\vec{l}}{dt}=\frac{d\vec{r}\,x\,\vec{p}}{dt} = \frac{d\vec{r}}{dt}\ x\ \vec{p} + \vec{r}\ x\ \frac{d\vec{p}}{dt}$ 1 score $= \vec{v}\,X\,\vec{p}+\vec{r}\,X\,\vec{F}$ 1 score $= 0 + \vec{\tau} = \vec{\tau}$ 1 score	3
20	a)	Let $F=km^a v^b r^c$ $[M^1L^1T^{-2}]=M^a[L^1T^{-1}]^bL^c$ $[M^1L^1T^{-2}]=M^aL^bT^{-b}L^c$ $[M^1L^1T^{-2}]= M^aL^{b+c}T^{-b}$ Applying principle of homogeneity of dimensions a=1 b+c=1 -b = -2 b=2 c =1-2 = -1 putting these values $F=km^1v^2r^{-1}$ $F = \frac{km\,v^2}{r}$	3
21		$X = \frac{m_1 x_1+m_2 x_2}{M} = \frac{1\,m\,x\,0+35.5\,m\,x\,1.27}{36.5\,m}$ = 1.23 A^0 away from H atom	3
22		$P = \frac{1}{3}\ nm\ \bar{v}^2$ $= \frac{1}{3}\ \frac{N}{V}\ m\ \bar{v}^2$ $PV = \frac{1}{3}\ Nm\ \bar{v}^2$ $Nk_BT = \frac{1}{3}\ Nm\ \bar{v}^2$, $\frac{1}{2}\ m\ \bar{v}^2 = \frac{3}{2}\ k_BT$, $\overline{KE} = \frac{3}{2}k_BT$	3

23		On the surface g = $\frac{GM}{R^2} = \frac{G\frac{4}{3}\pi R^3\rho}{R^2} = \frac{4}{3}\pi G R\rho$ 1 Score At depth d , g' = $\frac{4}{3}\pi G(R-d)\rho$ 1 Score $\frac{g'}{g} = \frac{R-d}{R} = 1-\frac{d}{R}$ g' = g ($1-\frac{d}{R}$) 1 Score	3
24		N=Normal force F=Frictional force 2 Score N sinθ and f cos θ 1 Score	3
25	a) b)	Parabola 1 score $v^2 = v_0^2 + 2as$ 1 Score $0^2 = (u\sin\Theta)^2 + 2x\ -g\ xH$ $0 = u^2\sin^2\Theta - 2gH$ $2gH = u^2\sin^2\Theta$ 1 Score H = $\frac{u^2\sin^2\Theta}{2g}$ 1 Score	4
26	a) b)	T= $\frac{2V_0\times\sin(\Theta)}{g}$ 1 Score T= $\frac{2x28\times\sin(30^0)}{9.8}$ = 2.86 s 1 Score R = $\frac{V_0^2\times\sin(2\Theta)}{g}$ 1 Score = $\frac{28^2\times\sin(2x30^0)}{9.8}$ = 69.28m 1 Score	4

27	a) b)	For every action there is equal and opposite reaction 1 Score For first ball, $v_1=-u_1$ Then change in momentum(impulse)=$m_1v_1-m_1u_1= -2m_1u_1 = -0.6\ kgms^{-1}$ 2 Score	4
28		Principle of conservation of energy states that energy can neither be created nor be distroyed At point A  K.E = 0 P.E = mgh Total Energy=mgh At point B, $K.E = \frac{1}{2} mv^2$ $2gx = V^2-0^2$ $V^2 = 2gx$ $K.E= \frac{1}{2} mv^2 = \frac{1}{2} mX\ 2gx = mgx$ P.E = m.g.(h−x) Total Energy = K.E+P.E = mgx+mg(h−x)= mgh At point C, P.E =0 $2gh = v^2-0^2 = v^2$ $K.E = \frac{1}{2} m.v^2 = mX\ 2gh = mgh$ Total Energy = K.E+P.E = mgh+0= mgh Thus, at all the points the energy is same.	4
29	a) b) c)	P=Fv 1 Score iii) kilowatt hour 1 Score m=5000kg, a=3/20 ms^{-2} from $v^2=u^2+2as$, s=1320m then find work W then power P=W/t=8.25 kilowatt 2 Score	4

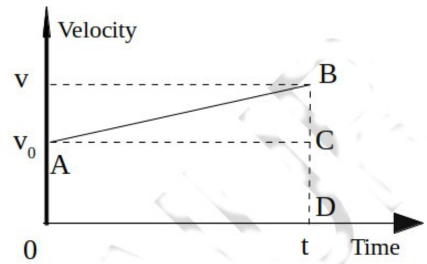
30	a) b)	The minimum vertical velocity that has to be imparted to a body on the earth's surface , so that it escapes from the earth's gravitational field is called escape velocity. 1 Score on the Ground Total Energy = KE + PE = $\frac{1}{2}$ mv_e^2 - $\frac{GM_E m}{R_E}$ At infinity Total Energy = 0 By Conservation of energy $\frac{1}{2}$ mv_e^2 - $\frac{GM_E m}{R_E}$ = 0 $\quad$ $\frac{1}{2}$ mv_e^2 = $\frac{GM_E m}{R_E}$ ve = $\sqrt{\frac{2GM_E}{R^2}}$ $\quad$ 3 Score	4
31		Bernoulli's Theorem: According to Bernoulli's theorem, the sum of the energies possessed by a flowing ideal liquid at a point is constant provided that the liquid is incompressible and non-viscous and flow in streamline. Consider the flow of liquid. Let at any time, the liquid lies between two areas of flowing liquid A_1 and A_2. In time interval Δt, the liquid displaces from A_1 by $\Delta x_1 = v_1 \Delta t$ and displaces from A_2 by $\Delta x_2 = v_2 \Delta t$. Here v_1 and v_2 are the velocities of the liquid at A_1 and A_2.  The work done on the liquid is $P_1A_1\Delta x_1$ by the force and $P_2A_2\Delta x_2$ against the force respectively. Net work done, $W = P_1A_1\Delta x_1 - P_2A_2\Delta x_2 = (P_1 - P_2)\Delta V$ ....(1) Here, $\Delta V \rightarrow$ the volume of liquid that flows through a cross-section is same (from equation of continuity). But, the work done is equal to net change in energy (K.E. + P.E.) of the liquid, and $\Delta K = \frac{1}{2} \rho \Delta V(v_1^2 - v_2^2)$ and $\Delta U = \rho \Delta V(h_2 - h_1)$ $\therefore (P_1 - P_2)\Delta V = \rho \Delta V(v_1^2 - v_2^2) + \rho g \Delta V(h_2 - h_1)$ $P_1 + \frac{1}{2} v_1^2 + \rho g h_1 = P_2 + \frac{1}{2} v_2^2 + \rho g h_2$ or $P + \frac{1}{2} \rho v2 + \rho g h = constant$	4

32	a) b)	Hydraulic Lift 1 Score m=3000kg, F=mg= 3000 x 9.8=29400N & $A=425cm^2$ pressure on the smaller piston =f/a =F/A= $691764.7 N/m^2$ 3 Score	4
33	a) b) c)	Melting Point 1 Score True 1 Score m=0.3kg, Q= 10^5 J here L=Q/m= $3.34\times10^5\ J\ kg^{-1}$ 2 Score	4
34	a) b)	 2 Scores $T = 2\pi\sqrt{\frac{l}{g}}$ 1 Score $T^2 = 4\pi^2 \frac{l}{g}$ $l = \frac{T^2 g}{4\pi^2} = \frac{2^2 x 9.8}{4 x 3.14^2}$ = 0.994m = 1m 1 Score	4
35	a) b)	y = a sin (kx – ωt + φ) (1 Score) for a point with fixed phase (kx – ωt + φ) = Constant (1 Score) $k \frac{dx}{dt} - \omega + 0 = 0$ (1 Score) k v - ω = 0 kv = ω $v = \frac{\omega}{k}$ (1 Score)	4
36	a) b) c)	Homogeneity (1 Score) Distance and Displacement or Velocity and Speed or Torque and Work or Any other correct pair (1 Score) $\left[\frac{1}{2} m v^2\right] = M (LT^{-1})^2 = ML^2T^{-2}$ (1 Score) $[mgh] = M LT^{-2} L = ML^2T^{-2}$ (1 Score) So the equation is dimensionally correct (1Score)	5

37 (5)

a) $v = u + at$ (1 Score)

b) In the graph, (Figure 1 Score)



AC = t, CD = v_0 , BD = v

BC = BD – CD = $v - v_0$ = αt

x = Area OABD (1 Score)

= Area OACD + ABC = CD x AC + $\frac{1}{2} AC\,x BC$ (1Score)

= $v_0t + \frac{1}{2} t\,x at$ = $v_0t + \frac{1}{2} a t^2$ (1 Score)

38 (5)

a) *Centripetal force ≤ Frictional force*

$\frac{mv^2}{R} \leq \mu mg$ 1 Score

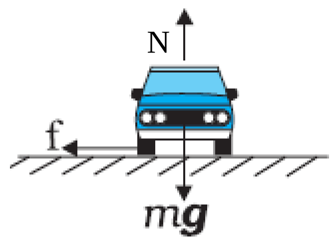
$v^2 \leq \mu Rg$ 1 Score

$v \leq \sqrt{\mu Rg}$, $v_{max} = \sqrt{\mu Rg}$ 1 Score

b) $v_{max} = \sqrt{\mu Rg}$ 1/2 Score

$= \sqrt{0.1 x 20 x 9.8}$

= 4.48 m/s



1 Score

Since the speed of the car is more than this safe speed it will slip while taking the turn 1/2 Score

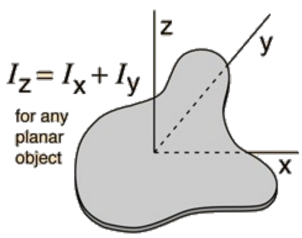
39 (5)

a) ML^2 (1 Score)

b) The perpendicular axis theorem states that the moment of inertia of a planar lamina about an axis perpendicular to the plane of the lamina is equal to the sum of the moments of inertia of the lamina about the two axes at right angles to each other, in its own plane intersecting each other at the point where the perpendicular axis passes through it.

$I_z = I_x + I_y$

or



(2 Score)

	c)	$I_z = I_x + I_y$ 1/2 Score $\frac{MR^2}{2} = I + I = 2I$ 1/2 Score $I = \frac{MR^2}{4}$ 1 Score	
40	a) b)	$g = \frac{GM}{R^2}$ 1 Score $g^1 = \frac{gR^2}{(R+h)^2}$ 1 Score $mg^1 = \frac{mgR^2}{(R+h)^2}$ 1 Score $W^1 = \frac{WR^2}{(R+h)^2} = \frac{63\,xR^2}{(R+\frac{R}{2})^2} = \frac{63\,xR^2}{(\frac{3}{2}R)^2} = 28N$ 2 Score	5

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