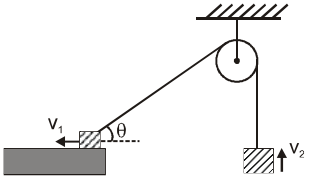
DPP No. : B13 (JEE-ADVANCED)

Total Marks : 43		**Max. Time : 27 min.**
Single choice Objective ('–1' negative marking) Q.1	**(3 marks 2 min.)**	**[03, 02]**
One or more than one options correct type ('–1' negative marking) Q.2 to Q.8	**(4 marks 2 min.)**	**[28, 14]**
Subjective Questions ('–1' negative marking) Q.9	**(4 marks 5 min.)**	**[04, 05]**
Match the Following (no negative marking) Q.10	**(8 marks 6 min.)**	**[08, 06]**

1. The relation between v_1 and v_2 is :



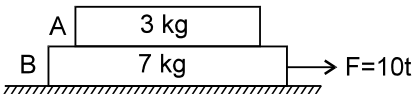
(A) $v_1 \sin\theta = v_2$

(B) $v_1 \cos\theta = v_2$

(C) $v_2 \cos\theta = v_1$

(D) $v_2 \sin\theta = v_1$

2. A variable force F = 10 t is applied to block B placed on a smooth surface. The coefficient of friction between A & B is 0.5. (t is time in seconds. Initial velocities are zero)



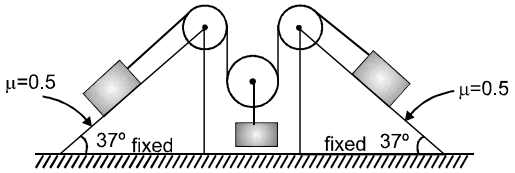
(A) block A starts sliding on B at t = 5 seconds

(B) the heat produced due to friction in first 5 seconds is 312.5J

(C) the heat produced due to friction in 5 seconds is (625/8) J

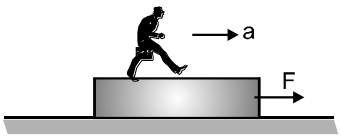
(D) acceleration of A at 10 seconds is 5 m/s^2.

3. In given arrangement, 10 kg and 20 kg blocks are at rest on two fixed inclined. All strings and pulleys are ideal. value(s) of m for which system remain in equilibrium are: ($g = 10\ m/s^2$)



(A) m = 6 kg (B) m = 3 kg (C) m = 8 kg (D) m = 20 kg

4. A plank of mass M is placed on a rough horizontal surface. A man of mass m walks on the plank with an acceleration 'a' while the plank is also acted upon by a horizontal force F whose magnitude and direction can be adjusted to keep the plank at rest :



The coefficient of friction between plank and surface is μ. Choose the correct options.

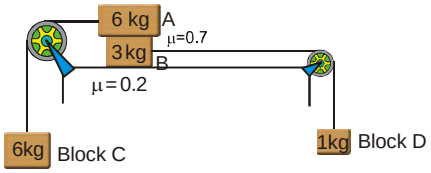
(A) The maximum value of F to keep plank at rest is $ma + \mu(M + m)g$

(B) The minimum value of F to keep the plank at rest is $ma - \mu(M + m)g$

(C) The direction of friction on ground due to plank will always be forward

(D) If F = ma then friction on man due to plank is also F and friction between plank and ground will be zero

5. An arrangement of the masses and pulleys is shown in the figure. Strings connecting masses A and B with pulleys are horizontal and all pulleys and strings are light. Friction coefficient between the surface and the block B is 0.2 and between blocks A and B is 0.7. The system is released from rest. (use $g = 10\ m/s^2$)



(A) The magnitude of acceleration of the system is $2\ m/s^2$ and there is no slipping between block A and block B.

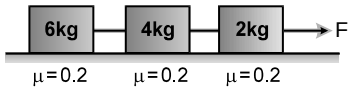
(B) The magnitude of friction force between block A and block B is 42 N.

(C) Acceleration of block C is $1\ m/s^2$ downwards.

(D) Tension in the string connecting block B and block D is 12 N.

COMPREHENSION

Three blocks of masses 6 kg, 4kg & 2 kg are pulled on a rough surface by applying a constant force F. The values of cofficient of friction between blocks & surface are shown in the figure.



6. If F = 20N, then

(A) the tension in the string connecting 4 kg & 2 kg is 16 N

(B) the tension in the string connecting 6 kg & 4 kg is 8 N

(C) the frictional force on 6 kg block is 8 N

(D) If force is increased slightly above 20N, the 2kg block starts sliding

7. If F = 36 N, then

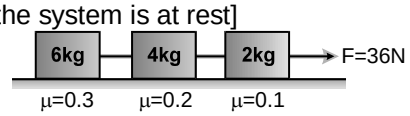
(A) the acceleration of 4 kg block will be $3\ m/s^2$

(B) the acceleration of 4 kg block will be $1\ m/s^2$

(C) the frictional force on 6 kg block will be 12 N

(D) the tension in the string connecting 6kg and 4kg blocks will be 18 N

8. Now consider the following situation with blocks having different coefficients of friction as shown in figure. Blocks are pulled by applying F= 36N force for t = 0 to t = 15 seconds and then the force is removed at t = 15sec. [Initially the system is at rest]



Choose the correct option(s) [for time $t = 15$ sec to $t = t_0$ (when all blocks stop)]

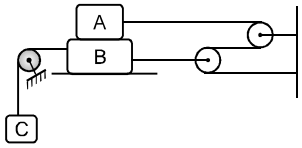
(A) Blocks move with different accelerations and at least one of the strings get slacked before all blocks stop.

(B) magnituded of acceleration of 4kg block is $7/3\ m/s^2$

(C) The tension in the string connecting 6kg and 4kg blocks is 32 N

(D) all the blocks will stop in $\frac{30}{7}$ seconds after removing the force

9. Block A of weight 500 N and block B of weight 700 N are connected by rope pulley system as shown. The largest weight C that can be suspended without moving block A and B is W. The coefficient of friction for all plane surfaces of contact is 0.3. The pulleys are ideal. Find $\frac{W}{90}$.



10. A particle is performing rectilinear motion on x axis, such that its x- coordinate varies with time as $x = \frac{t^3}{3} - 2t^2 + 3t + 5$ (m) where t is in second. In Column-I time instant is given and Column-II describes the motion of particle at particular instant. Match the proper entry from Column-II to Column-I.

Column-I		**Column-II**	
(A)	$t = \frac{1}{2}$ sec	(p)	Particle is moving in positive x-direction and speeding up.
(B)	$t = \frac{3}{2}$ sec	(q)	Particle is moving in negative x-direction and slowing down.
(C)	$t = \frac{5}{2}$ sec	(r)	Particle is moving in negative x-direction and speeding up.
(D)	t = 4 sec	(s)	Particle is moving in positive x-direction and slowing down.
		(t)	Acceleration and velocity of particle have same direction

2. DPP Syllabus :

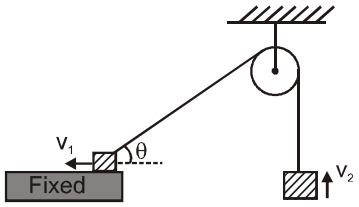
DPP No. : B13 (JEE-ADVANCED)

Total Marks : 43	**Max. Time : 27 min.**
Single choice Objective ('–1' negative marking) Q.1	**(3 marks 2 min.) [03, 02]**
One or more than one options correct type ('–1' negative marking) Q.2 to Q.8	**(4 marks 2 min.) [28, 14]**
Subjective Questions ('–1' negative marking) Q.9	**(4 marks 5 min.) [04, 05]**
Match the Following (no negative marking) Q.10	**(8 marks 10 min.) [08, 06]**

ANSWER KEY OF DPP No. : B13

1.	(B)	**2.**	(A,D)	**3.**	(C,D)	**4.**	(A,B,D)	**5.**	(A,D)	**6.**	(A,B,C)
7.	(B,C,D)	**8.**	(B, D)	**9.**	9	**10.**	A-s ; B-r, t ; C-q ; D-p, t				

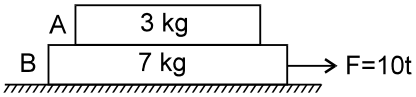
1. The relation between v_1 and v_2 is :
वेग v_1 तथा v_2 के मध्य सम्बंध है :



(A) $v_1 \sin = v_2$ (B*) $v_1 \cos\theta = v_2$ (C) $v_2 \cos\theta = v_1$ (D) $v_2 \sin\theta = v_1$

Sol. $v_1\cos\theta - v_2 = 0$

2. A variable force F = 10 t is applied to block B placed on a smooth surface. The coefficient of friction between A & B is 0.5. (t is time in seconds. Initial velocities are zero)
एक चिकने तल पर रखे ब्लॉक B पर एक परिवर्ती बल F = 10 t लगाया जाता है। । A व B के बीच घर्षण गुणांक 0.5 है। (t सेकण्ड़ में समय है व प्रारम्भिक वेग शून्य है)



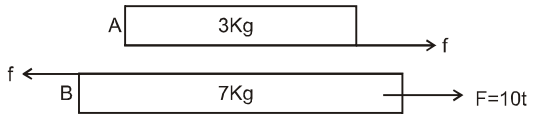
(A*) block A starts sliding on B at t = 5 seconds
ब्लॉक A, ब्लॉक B पर t = 5 सेकण्ड़ पर फिसलना प्रारम्भ करता है।

(B) the heat produced due to friction in first 5 seconds is 312.5J
घर्षण द्वारा 5 सेकण्ड़ में उत्पन्न ऊष्मा 312.5J है।

(C) the heat produced due to friction in 5 seconds is (625/8) J
घर्षण द्वारा 5 सेकण्ड़ में उत्पन्न ऊष्मा (625/8) J है।

(D*) acceleration of A at 10 seconds is 5 m/s^2.
10 वें सेकण्ड़ में A का त्वरण 5 m/s^2 है।

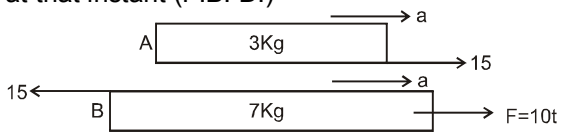
Sol.



$f_{max} = \mu \times 3g = 0.5 \times 30 = 15$ N

block A starts sliding when friction force becomes max. i.e. $f_{max} = 15$

at that instant (F.B. D.)



both will move with same acceleration

So $15 = 3a \Rightarrow a = 5m/s^2$

$F - 15 = 7a$

$10t - 15 = 7 \times 5$

$10t = 50 \Rightarrow t = 5$ sec

Work done by friction in 5 seconds

$W = \int F.ds$

$= \int 10t.ds \qquad \left(a = \frac{F}{m} = \frac{10t}{10} = t\right)$

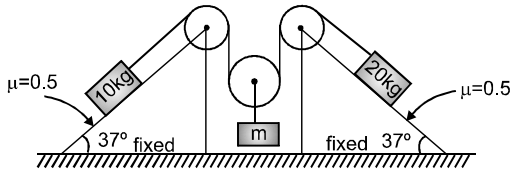
$= \int_0^5 10t.Vdt \qquad (ds = vdt)$

$= \int_0^5 10t.\frac{t^2}{2}dt \qquad \left(V = \int adt = \int tdt = \frac{t^2}{2}\right)$

$= \int_0^5 5t^3 dt = 5\left[\frac{t^4}{4}\right]_0^5 = \frac{5}{4}[625 - 0] = \frac{625 \times 5}{4}$

3. In given arrangement, 10 kg and 20 kg blocks are at rest on two fixed inclined. All strings and pulleys are ideal. value(s) of m for which system remain in equilibrium are: ($g = 10\ m/s^2$)

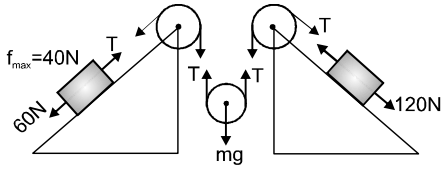
दिये गये विन्यास में, 10 kg तथा 20 kg के ब्लॉक दो स्थिर नततल पर विरामवस्था में है। सभी डोरीयाँ व घिरनियां आदर्श है। m का मान क्या होगा जिसके लिए निकाय साम्यावस्था में ही रहता है। ($g = 10\ m/s^2$)



(A) m = 6 kg (B) m = 3 kg (C*) m = 8 kg (D*) m = 20 kg

Sol. $T = \frac{mg}{2}$ for minimum T, by F.B.D. of 20 kg block

$T = \frac{mg}{2}$ 20 kg ब्लॉक के F.B.D. से F का न्यूनतम मान



$\Rightarrow$ $T + 80 = 120 \Rightarrow T = 40$ N

$\Rightarrow$ $m = 8$ kg

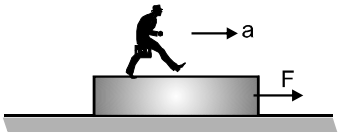
For maximum T, by F.B.D. of 10 kg block $T = 40 + 60 \Rightarrow T = 100$ N

10 kg ब्लॉक के FBD से T के अधिकतम मान के लिए $T = 40 + 60 \Rightarrow T = 100$ N

m = 20 kg.

4. A plank of mass M is placed on a rough horizontal surface. A man of mass m walks on the plank with an acceleration 'a' while the plank is also acted upon by a horizontal force F whose magnitude and direction can be adjusted to keep the plank at rest :

द्रव्यमान M का एक प्लांक (पट्टा) एक खुरदरी क्षैतिज सतह पर रखा है। द्रव्यमान m का एक व्यक्ति प्लांक पर त्वरण 'a' से चलता है। जबकि प्लांक पर एक क्षैतिज बल F भी लगता है। जिसका परिमाण व दिशा इस प्रकार रखी जाती है ताकि प्लांक विराम पर रहे। प्लांक व सतह के मध्य घर्षण गुणांक μ है। सही विकल्प छांटिए :



The coefficient of friction between plank and surface is μ. Choose the correct options.

(A*) The maximum value of F to keep plank at rest is $ma + \mu(M + m)g$

(B*) The minimum value of F to keep the plank at rest is $ma - \mu(M + m)g$

(C) The direction of friction on ground due to plank will always be forward

(D*) If $F = ma$ then friction on man due to plank is also F and friction between plank and ground will be zero

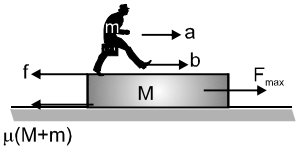
(A*) प्लांक को विराम पर रखने के लिए F का अधिकतम मान $ma + \mu(M + m)g$ है।

(B*) प्लांक को विराम पर रखने के लिए F का न्यूनतम मान $ma - \mu(M + m)g$ है।

(C) धरातल पर प्लांक के कारण घर्षण की दिशा सदैव आगे की ओर होगी।

(D*) यदि $F = ma$ हो तो प्लांक के कारण व्यक्ति पर घर्षण भी F होगा एवं प्लांक व धरातल के मध्य घर्षण शून्य होगा।

Sol.



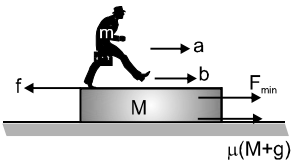
If $F > f$ then friction due to gravity will be left

यदि $F > f$ तो गुरूत्व के कारण घर्षण बायीं ओर होगा।

$F_{max} = f + \mu(M + m)g = ma + \mu(M + m)g$

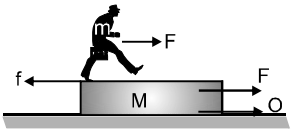
If $F < f$ then friction due to gravity will be right

यदि $F < f$ तो गुरूत्व के कारण घर्षण दायीं ओर होगा।

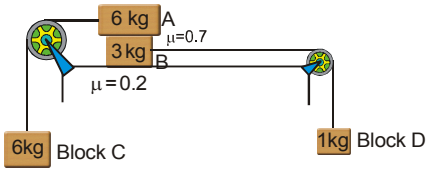


$F_{min} = Ma - m(m + M)g$

If यदि $F = ma \quad \Rightarrow \quad f = ma = f$



5. An arrangement of the masses and pulleys is shown in the figure. Strings connecting masses A and B with pulleys are horizontal and all pulleys and strings are light. Friction coefficient between the surface and the block B is 0.2 and between blocks A and B is 0.7. The system is released from rest. (use g = 10 m/s^2)
प्रदर्शित व्यवस्था में द्रव्यमान तथा घिरनियाँ दर्शाई गई है। A व B से जुड़ी तथा घिरनीयों से पारित रस्सियाँ क्षैतिज तथा सभी घिरनीयाँ व सभी रस्सियाँ हल्की है। ब्लॉक B तथा सतह के मध्य घर्षण गुणांक 0.2 तथा ब्लॉक A व B के मध्य 0.7 है। निकाय को विरामावस्था से छोड़ा जाता है। (g = 10 m/s^2 का प्रयोग करो)

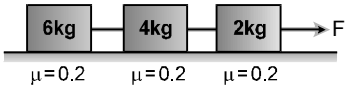


(A*) The magnitude of acceleration of the system is 2 m/s^2 and there is no slipping between block A and block B.
(B) The magnitude of friction force between block A and block B is 42 N.
(C) Acceleration of block C is 1 m/s^2 downwards.
(D*) Tension in the string connecting block B and block D is 12 N.
(A*) निकाय के त्वरण का परिमाण 2 m/s^2 तथा ब्लॉक A व B के मध्य कोई फिसलन नहीं है।
(B) ब्लॉक A व B के मध्य घर्षण बल का परिमाण 42 N है।
(C) ब्लॉक C का त्वरण 1 m/s^2 नीचे की तरफ है।
(D*) ब्लॉक B तथा D से जुड़ी रस्सी में तनाव 12 N है।

Sol. Suppose blocks A and B move together. Applying NLM on C, A + B, and D
माना ब्लॉक A व B साथ–साथ चलते हैं। C, A + B तथा D ब्लॉकों पर न्यूटन के नियम से
60 – T = 6a
T – 18 – T' = 9a
T' – 10 = 1a
Solving हल करने पर a = 2 m/s^2
To check slipping between A and B, we have to find friction force in this case. If it is less than limiting static friction, then there will be no slipping between A and B.
A व B के बीच फिसलन का जाँचने के लिए हम इस स्थिति में घर्षण बल ज्ञात करते हैं। यदि यह घर्षण बल। सीमान्त घर्षण से कम हो तो A व B के बीच कोई भी फिसलन नहीं होगी
Applying NLM on A. A पर न्यूटन के नियम के प्रयोग से
T – f = 6.2
चूंकि as T = 48 N
f = 36 N
and f_s = 42 N hence A and B move together.
तथा f_s = 42 N अतः A व B साथ–साथ चलेंगे
and तथा T' = 12 N.

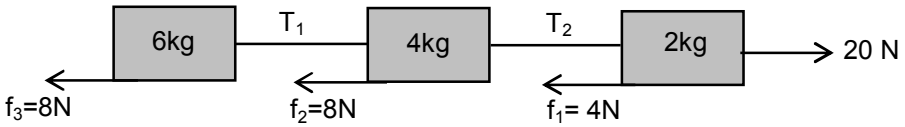
COMPREHENSION
अनुच्छेद

Three blocks of masses 6 kg, 4kg & 2 kg are pulled on a rough surface by applying a constant force F. The values of cofficient of friction between blocks & surface are shown in the figure.
6 kg, 4kg तथा 2 kg द्रव्यमान के तीन ब्लॉक खुरदरे तल पर 20N के नियत बल द्वारा खींच जाते है। ब्लॉकों तथा सतह के बीच घर्षण गुणांक का मान चित्र में दिखाया गया है।



6. If F = 20N, then
यदि F = 20N है, तब
(A*) the tension in the string connecting 4 kg & 2 kg is 16 N
(B*) the tension in the string connecting 6 kg & 4 kg is 8 N
(C*) the frictional force on 6 kg block is 8 N
(D) If force is increased slightly above 20N, the 2kg block starts sliding
(A*) 4 kg व 2 kg के मध्य जुड़ी डोरी में तनाव 16 N है।
(B*) 6 kg व 4 kg के मध्य जुड़ी डोरी में तनाव 8 N है।
(C*) 6 kg ब्लॉक पर घर्षण बल 8 N है।
(D) यदि बल 20N से अधिक हल्का सा बढ़ाया जाता है, 2kg का ब्लॉक फिसलना प्रारम्भ कर देता है।

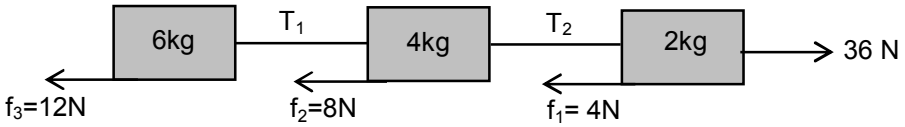
Sol.



For 4kg block,
$20 = T_2 + 4$
$T_2 = 16$ N
For 6 kg block
$T_1 = f_3 = 8$ N

7. If F = 36 N, then
यदि F = 36N है, तब
(A) the acceleration of 4 kg block will be 3 m/s^2
(B*) the acceleration of 4 kg block will be 1 m/s^2
(C*) the frictional force on 6 kg block will be 12 N
(D*) the tension in the string connecting 6kg and 4kg blocks will be 18 N
(A*) 4 kg ब्लॉक का त्वरण 3 m/s^2 है।
(B*) 4 kg ब्लॉक का त्वरण 1 m/s^2 है।
(C*) 6 kg ब्लॉक पर घर्षण बल 12 N है।
(D) 6 kg व 4 kg के मध्य जुड़ी डोरी में तनाव 18 N है।

Sol.



$a = \frac{36-24}{12}$ = 1 m/s^2
$T_1 - 12 = 6 \times 1$
$T_1 = 18$ N

8. Now consider the following situation with blocks having different coefficients of friction as shown in figure. Blocks are pulled by applying F= 36N force for t = 0 to t = 15 seconds and then the force is removed at t = 15sec. [Initially the system is at rest]
अब नीचे चित्र में दी गई स्थिति को लेते हैं जिसमें ब्लॉक भिन्न–भिन्न घर्षण गुणांक रखते हैं। ब्लॉकों को F= 36N बल आरोपित करके t = 0 से t = 15 सेकण्ड तक खींचा जाता है तब t = 15सेकण्ड पर बल हटा लिया जाता है [निकाय प्रारम्भ में विराम अवस्था में है।]

Choose the correct option(s) [for time t = 15 sec to t = t_0 (when all blocks stop)]
सही विकल्प/विकल्पों का चयन कीजिये। [t = 15 सेकण्ड से t = t_0 (जब तक सभी ब्लॉक रूक जाते हैं)]

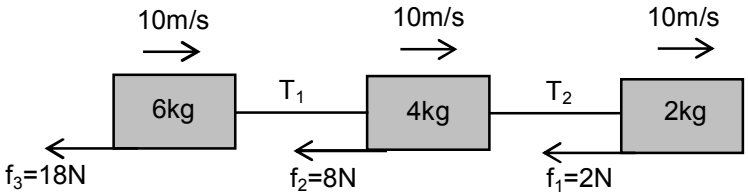
(A) Blocks move with different accelerations and at least one of the strings get slacked before all blocks stop.
(B*) magnituded of acceleration of 4kg block is 7/3 m/s^2
(C) The tension in the string connecting 6kg and 4kg blocks is 32 N
(D*) all the blocks will stop in $\frac{30}{7}$ seconds after removing the force

(A) ब्लॉक भिन्न–भिन्न चाल से त्वरित गति करते हैं तथा सभी ब्लॉकों के रूकने के पहले कम से कम एक डोरी ढ़ीली हो जाती है।
(B*) 4kg ब्लॉक के त्वरण का परिमाण 7/3 m/s^2 है।
(C) 6kg व 4kg ब्लॉक से जुड़ी डोरी में तनाव 32 N है।
(D*) बल हटाने के $\frac{30}{7}$ सेकण्ड पश्चात् सभी ब्लॉक रूक जायेंगे।

Sol. acceleration of all blocks (t < 15) = $\frac{36-28}{12}=\frac{2}{3}$ m/s

Velocity attained by all blocks in 15 sec = $\frac{2}{3}\times 15 = 10 m/s$

t = 15 :



All blocks move together since $f_1 < f_2 < f_3$

common retardation = $\frac{28}{12}=\frac{7}{3}$ m/s^2

$T_1 - 18 = 6\times\frac{7}{3}$

$T_1 = 32N$

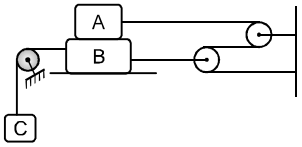
V = 0, u = 10m/s, a = $-\frac{7}{3}$ m/s^2

$0 = 10 - \frac{7}{3} \times t$

$t = \frac{30}{7}$ sec

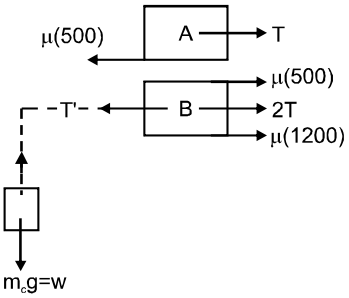
9. Block A of weight 500 N and block B of weight 700 N are connected by rope pulley system as shown. The largest weight C that can be suspended without moving block A and B is W. The coefficient of friction for all plane surfaces of contact is 0.3. The pulleys are ideal. Find $\frac{W}{90}$.

ब्लॉक A का भार 500 N तथा B का भार 700 N है। दोनो ब्लॉक घिरनियो से गुजरती रस्सी से चित्रानुसार जुडे है। A तथा B गति नही करे इसके लिए लटकाए गए ब्लॉक C का अधिकतम भार W है। सभी समतल सतहो के मध्य घर्षण गुणांक 0.3 है। तो $\frac{W}{90}$ का मान ज्ञात करो। (घिरनियाँ आदर्श है)



Ans. 9

Sol.



$3T + 0.3 \times 1200 = m_c g = w$

and तथा $T = \mu(500)$

$= 0.3 \times 500$

$w = m_0 g = 810$ N.

10. A particle is performing rectilinear motion on x axis , such that its x- coordinate varies with time as $x = \frac{t^3}{3} - 2t^2 + 3t + 5$ (m) where t is in second. In Column-I time instant is given and Column-II describes the motion of particle at particular instant. Match the proper entry from Column-II to Column-I.

एक कण x अक्ष के अनुदिश सरल रेखिय गति कर रहा है इसका x निर्देशांक समय के साथ $x = \frac{t^3}{3} - 2t^2 + 3t + 5$ (m) के अनुसार परिवर्तित होता है, जहाँ t सेकण्ड में है। कॉलम–I में समय तथा कॉलम–II में किसी क्षण कण की गति के बारे में सुचना प्रदर्शित है। कॉलम–I में दिये गये प्रविष्टियों को कॉलम–II से सुमेंलित किजिये।

	Column-I		**Column-II**
(A)	$t = \frac{1}{2}$ sec	(P)	Particle is moving in positive x-direction and speeding up.
(B)	$t = \frac{3}{2}$ sec	(Q)	Particle is moving in negative x-direction and slowing down.
(C)	$t = \frac{5}{2}$ sec	(R)	Particle is moving in negative x-direction and speeding up.
(D)	t = 4 sec	(S)	Particle is moving in positive x-direction and slowing down.
		(T)	Acceleration and velocity of particle have same direction

	कॉलम-I		**कॉलम-II**
(A)	$t = \frac{1}{2}$ sec	(P)	कण धनात्मक x-दिशा में गतिशील है, तथा इसकी चाल बढ़ रही है।
(B)	$t = \frac{3}{2}$ sec	(Q)	कण ऋणात्मक x-दिशा में गतिशील है, तथा इसकी चाल घट रही है।
(C)	$t = \frac{5}{2}$ sec	(R)	कण ऋणात्मक x-दिशा में गतिशील है, तथा इसकी चाल बढ़ रही है।
(D)	t = 4 sec	(S)	कण धनात्मक x-दिशा में गतिशील है, तथा इसकी चाल घट रही है।
		(T)	कण का त्वरण तथा वेग समान दिशा में है।

Ans. A-s ; B-r, t ; C-q ; D-p, t

Sol. $x = \frac{t^3}{3} - 2\,t^2 + 3 + 5$

$v = t^2 - 4t + 3 = t^2 - 3t - t + 3 = (t - 1)\,(t - 3)$

$a = 2t - 4 = 2\,(t - 2)$

	t=1	t=2	t=3
V > 0	V < 0	V< 0	V > 0
a < 0	a < 0	a > 0	a > 0