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Raximova T.N

NAZARIY MEXANIKA

MUSTAQIL ISHLARNI BAJARISHGA OID USLUBIY O'QUV QO'LLANMA

$$\sum(\vec{F}_\nu + \vec{R}_\nu + \vec{\Phi}_\nu)\delta\vec{r}_\nu = 0$$

Qarshi - 2013

O’ZBEKISTON RESPUBLIKASI
OLIY VA O’RTA MAXSUS TA’LIM VAZIRLIGI

Qarshi davlat universiteti

Umumiy texnika fanlari kafedrasi

Raximov X.B., Batiyev R.G.,
Raximova T.N

Nazariy mexanikadan

Bakalavriat ta’lim yo’naishi talabalari uchun mustaqil ishlarini bajarishga doir o’quv uslubiy

Q O’L L A N M A

Qarshi - 2013

Tuzuvchilar : **Raximov X.B, Batiyev R.G**
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QDU dots. Bobojonov P

Ushbu uslubiy qo'llanmada 5520000 – « Muhandislik va muhandislik ishi» ta'lim yo'nalishlari bo'yicha Davlat ta'lim standartlariga muvofiq « Kasb ta'limi », «Matematika»,«Amaliy matematika», «Xizmat ko'rsatish texnikasi va texnologiyasi », «Gidrotexnik inshootlar va nasos stansiyalaridan foydalanish», «Qishloq xo'jalikni mexanizatsiyalashtirish »,«Elektr energetika» kabi yo'nalishi talabalari uchun nazariy mexanika fanidan o'quv dasturi asosida 8 ta mustaqil ish va topshiriqlar to'plami, berilgan. Har bir mustaqil ishda 3 ta nazariy savol, 3 ta masala, bitta hisob-grafik topshiriq variantlari berilgan. Har bir grafik topshiriqni bajarishga doir namunalar, nazorat savollari, testlar , adabiyotlar ro'yxati hamda ko'rsatma oxirida ilovalar berilgan.

Uslubiy ko'rsatma «Umumiy texnika fanlari» kafedrasida (Bayonnoma № _____ 2013 y), Kasbiy ta'lim fakulteti uslubiy komissiyasi (Bayonnoma № _____ 2013 y), universitet (Bayonnoma № _____ 2013 y) uslubiy kengashida muhokama qilingan va o'quv jarayonida qo'llashga tavsiya etilgan.

Qarshi davlat universiteti 2013 - y

K I R I SH

Ushbu uslubiy qollanmada 5520000–«Muhandislik va muhandislik ishi» ta’lim yo’nalishlari bo’yicha Davlat ta’lim standartlariga muvofiq « Kasb ta’limi », « Matematika »,« Amaliy matematika », « Xizmat ko’rsatish texnikasi va texnologiyasi », «Qishloq xo’jalik mashinalari», «Gidrotexnik inshootlar va nasos stansiyalaridan foydalanish»,«Elektr energitika» kabi yo’nalishi talabalari uchun nazariy mexanika fanidan o’quv dasturi asosida 8 ta mustaqil ish va topshiriqlar to’plami, berilgan. Har bir mustaqil ishda 3 ta nazariy savol, 3 ta masala, bitta hisob-grafik topshiriq variantlari berilgan. Har bir grafik topshiriqni bajarishga doir masalalar yechish namunalari, nazorat savollari, testlar, adabiyotlar ro’yxati hamda ko’rsatma oxirida ilovalar ham berilgan.

Ushbu uslubiy qo’llanma ilmiy – tadqiqot xarakteriga ega bo’lib, talabalardan ishni puxta bajarishni talab qiladi.

Nazariy mexanikadan mustaqil ish va topshiriqlarni bajarish talabalarning nazariy tushunchalarini texnikaga va turmushga tadbiq qilishga o’rgatadi. Yana talabalarni qunt bilan ishlashga, natijalarni tushungan holda to’g’ri baholashga o’rgatadi.

O’quv rejasida har bir yo’nalishlar bo’yicha « Nazariy mexanika» faniga ajratilgan soatlarning 40,63 % ni mustaqil ish va topshiriqlar tashkil etadi. Talabalar bilimlarini mustahkamlash uchun mustaqil ishlar asosiy rol o’ynaydi. Chunki o’tilgan mavzular va amaliy mashg’ulotlardan olgan bilimlarini adabiyotlar,internet tarmog’idan olgan ma’lumotlar bo’yicha mustahkamlaydilar. Fanning to’liq o’zlashtirish va uning qo’llanish sohalarini chuqur o’rganish uchun mustaqil ish bajariladi. Talaba mustaqil ishlarni bajarishda darslik, o’quv qo’llanmalar, tarqatma materiallar, elektron adabiyotlardan foydalanadi. Har bir mutaxassislik uchun mustaqil ish va topshiriqlar mavzusi quyida keltirilgan mavzularga asoslangan holda belgilanadi.

№	Mustaqil ish va topshiriqlarning nomi	Bajarish muddati	Ajratilgan vaqt	Tavsiya etilgan adab.
1	S-1 Hisob-grafik topshiriq. Qattiq jismning tayanch reaksiya kuchlarini aniqlash.			
2.	S-3 Hisob-grafik topshiriq. Yig’ma konstruksiyaning tayanch reaksiyalarini aniqlash.Hisob-grafik			

	topshiriq .			
3	K-1 Hisob-grafik topshiriq. Nuqtaning harakat tenglamalariga ko'ra ,uning tezligi va tezlanishini aniqlash.Hisob-grafik topshiriq.			
4.	K-3 Hisob-grafik topshiriq Yassi mexanizmning kinematik analizi.			
5.	K-7 Hisob-grafik topshiriq. Nuqtaning absolyut tezligi va tezlanishini aniqlash			
6.	D-2. Hisob-grafik topshiriq. O'zgaruvchi kuch ta'siri ostidagi moddiy nuqta harakat differensial tenglamasini integrallash.			
7.	D-10. Hisob-grafik topshiriq. Mexanik harakat jarayonlarni o'rganish uchun kinetik energiyani o'zgarish teoremasini qo'llash. Hisob-grafik topshiriq (D.10)			
8.	D-11. Hisob-grafik topshiriq. Qattiq jismning ilgarilanma va aylanma harakatlarini tekshirish.			
9	Fermalar haqida tushuncha a) Tugunlarni kesish usuli yordamida ferma sterjenlaridagi reaksiya kuchlarini aniqlash va masala yechish b)Ritter usuli yordamida ferma sterjenlaridagi reaksiya kuchlarini aniqlash va masala yechish			
10	Statik aniq va statik noaniq masalalar			
11	Tekis yoyilgan kuchlar va ularning teng ta`sir etuvchisini aniqlash			
12	Varinon teoremasi			
13	Ishqalanish kuchlarini hisobga olgan holda biriktirilgan balkalardagi reaksiya kuchlarini aniqlash			
14	Tezlanishlar oniy markazi yordamida tekis shakl nuqtasining tezlanishlarini aniqlash			
15	Murakkab harakatda tezlanishlarni qo`shish teoremasi			

16	Erkin qattiq jismning harakati va uning kinematik tenglamalari			
17	Kuchlar sistemasining invariantlari			
18	Erkin jism nuqtasining tezligi va tezlanishi			
19	Jismning ilgarilanma va aylanma harakatlarini qo`shish			
20	Nisbiy harakat dinamikasining asosiy tenglamalari			
21	Nisbiy muvozanat tenglamasi			
22	Matematik tebrangichning nisbiy harakati			
23	Differensial tenglamlarni integrallash (F=F(t); F=F(x); F=F(v) bo`lgan hollar uchun)			
24	Dinamikaning umumiy tenglamasini bir tomoni erkin harakatlanuvchi mexanik sistemani o'rganishda qo'llanishi. Hisob-grafik topshiriq (D.19) 2-sem.			
25	Muhit qarshilik kuchini hisobga olgan holda moddiy nuqtaning majburiy tebranma harakati			
26	Zarba naza riyasining asosiy tushunchalari va tenglamalari			
27	Zarba vaqtida sistema harakat miqdorining o`zgarishi haqidagi teorema			
28	Zarba ta'sirini aniqlovchi tenglamalar.			
29	Zarbali kuchlar uchun Dalamber prinsipi			
30	Qo`zg`almas o`q atrofida aylanuvchi jismga zarbaning ta`siri			
31	Tekis-parallel harakatdagi jismga zarbaning ta'siri.			
32	Umumlashgan koordinatalar,umumlashgan kuchlar. Sistemaning umumlashgan koordinatalardagi muvozanat shartlari.			
33.	Lagranjning 2 – tur tenglamalari.			
	Jami:			

Mustaqil ish va topshiriqlar mavzularining namunalari

1-mustaqil ish mavzusi

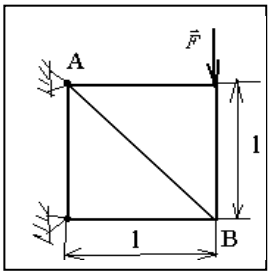
Tekislikdagi kuchlar sistemasi va fermalarni hisoblash usullari haqida tushuncha

Reja:

1.Fermalar haqida tushuncha

a) Tugunlarni kesish usuli yordamida ferma sterjenlaridagi reaksiya kuchlarini aniqlash va masala yechish

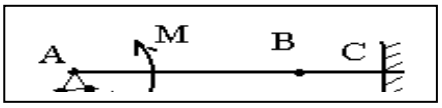
b) Ritter usuli yordamida ferma sterjenlaridagi reaksiya kuchlarini aniqlash va masala yechish.



2- masala(K.4.2.2). Agar fermaga F=600N kuch ta'sir etsa, AB sterjendagi zo'riqishni hisoblang. (849)

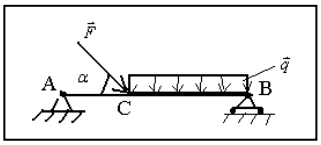
3 Statik aniq va statik noaniq masalalar.

4- masala(K.3.2.3). O'lchamlari AB=2m va BC =0,5m bo'lgan sterjendan iborat sistemaga momenti M=800 N*m li juft kuch ta'sir etsa, C tayanchdagi reaksiya momentini aniqlang. (200)



5. Tekis yoyilgan kuchlar va ularning teng ta`sir etuvchisini aniqlash.

6- masala(K.2.4.6). AB to'singa intensivligi q=2 N/m taqsimlangan kuchlar va $\alpha = 45^0$ burchak ostida yo'nalgan F=6 N kuch ta'sir etadi. Agar AC=AB/3 , AB=2 m bo'lsa, B tayanchdagi reaksiya kuchini aniqlang. (4,08)



7.S-1. Hisob-grafik topshiriq . Qattiq jismning tayanch reaksiya kuchlarini aniqlash.

Tayanch so'z va iboralar: 1) kuchlar sistemasi $(\vec{F}_1, \vec{F}_2, ...\vec{F}_n)$ 2) ekvivalent kuchlar sistemasi $(\vec{F}_1, \vec{F}_2, ...\vec{F}_n) \Leftrightarrow (\vec{Q}_1, \vec{Q}_2 ..., \vec{Q}_n)$; 3) bog'lanishdagi jism(harakati biror sabab bilan cheklangan jism bog'langan jism deyiladi); 4) bog'lanish va bog'lanish reaksiya kuchlari (Jism harakatini cheklovchi sababga bog'lanish deb ataladi.Bog'lanish ta'sirini almashtiruvchi kuch reaksiya kuchi deyiladi); 5) Ferma va tugun (Sharnrlar vositasida geometrik o'zgarmas qilib tutashtirilgan sterjenlardan hosil bo'lgan konstruksiyaga ferma deb ataladi. Sterjenlarning uchlarini tutashtiruvchi nuqtaga tugun deyiladi); 6) Yassi ferma (Sterjenlari bir tekislikda yotuvchi fermaga yassi ferma deyiladi); 7) statik aniq va statik noaniq fermalar(Ortiqcha sterjenga ega bo'lmagan ferma statik aniq ferma, ortiqcha sterjenga ega bo'lgan fermaga statik noaniq ferma deb ataladi); 8) tugunni kesish usuli; 9) Maksvell- Kremon diagrammasi; 10) Retter usuli; 11) statik aniq masala; (noma'lumlar soni muvozanat tenglamalari soniga teng bo'lsa, bunday masalaga statik aniq, masala deyiladi); 12) statik noaniq masala(noma'lumlar soni

muvozanat tenglamalari sonidan ortiq bo'lsa, bunday masalaga statik noaniq masala deyiladi); 13) Tekislikdagi kuchlar sistemasining bosh vektori($\sum \vec{F}_\nu = \vec{R}$ 14) Tekislikdagi kuchlar sistemasining bosh momenti($\vec{M} = \sum \vec{M}(F_\nu)$ 15) Varin'on teoremasi($M_0(\vec{R}) = \sum \vec{M}_0(\vec{F}_\nu)$; 16) Tekislikdagi kuchlar sistemasining muvozanatda bo'lishining zarur va yetarli sharti ($\sum X_\nu = 0; \sum Y_\nu = 0; \sum M_0(\vec{F}_\nu) = 0$

S-1. Qattiq jismning tayanch reaksiya kuchlaqrini aniqlash

1-4- rasmdagi sxemalarda brusning uch xil usulda o'q bo'yicha egallagan chizig'i ko'rsatilgan.

Berilgan kuchlar (1-jaqdvalga qarang) va o'lchamlar uch xil ulanishlarda ham bir xildir.

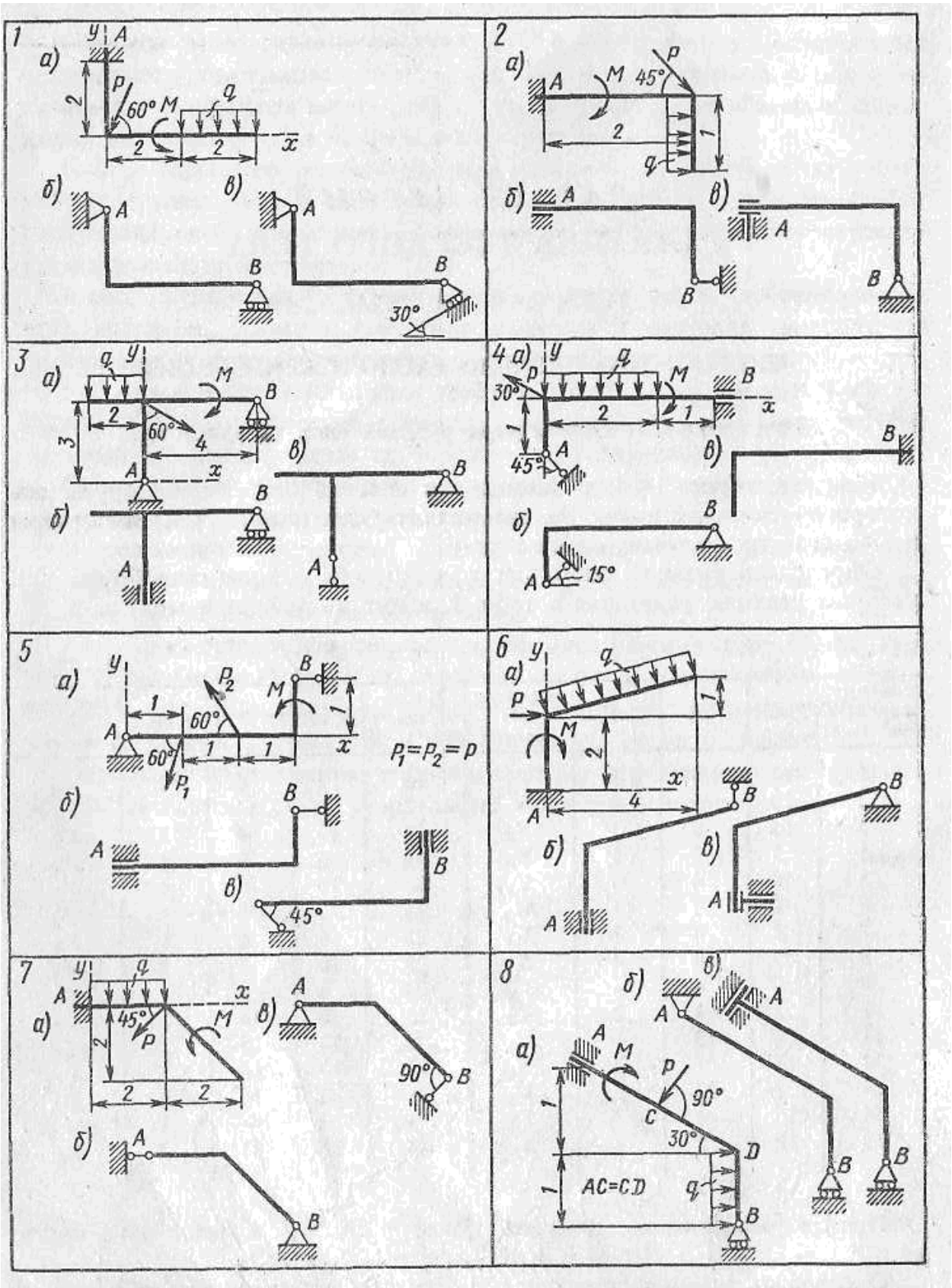
1-jadvalda ko'rsatilgan , aniqlanadigan reaksiya kuchining qiymati bruslar qanday usul bilan mahkamlanganda eng kichik qiymatga ega bo'lishini aniqlang?

1-jadval

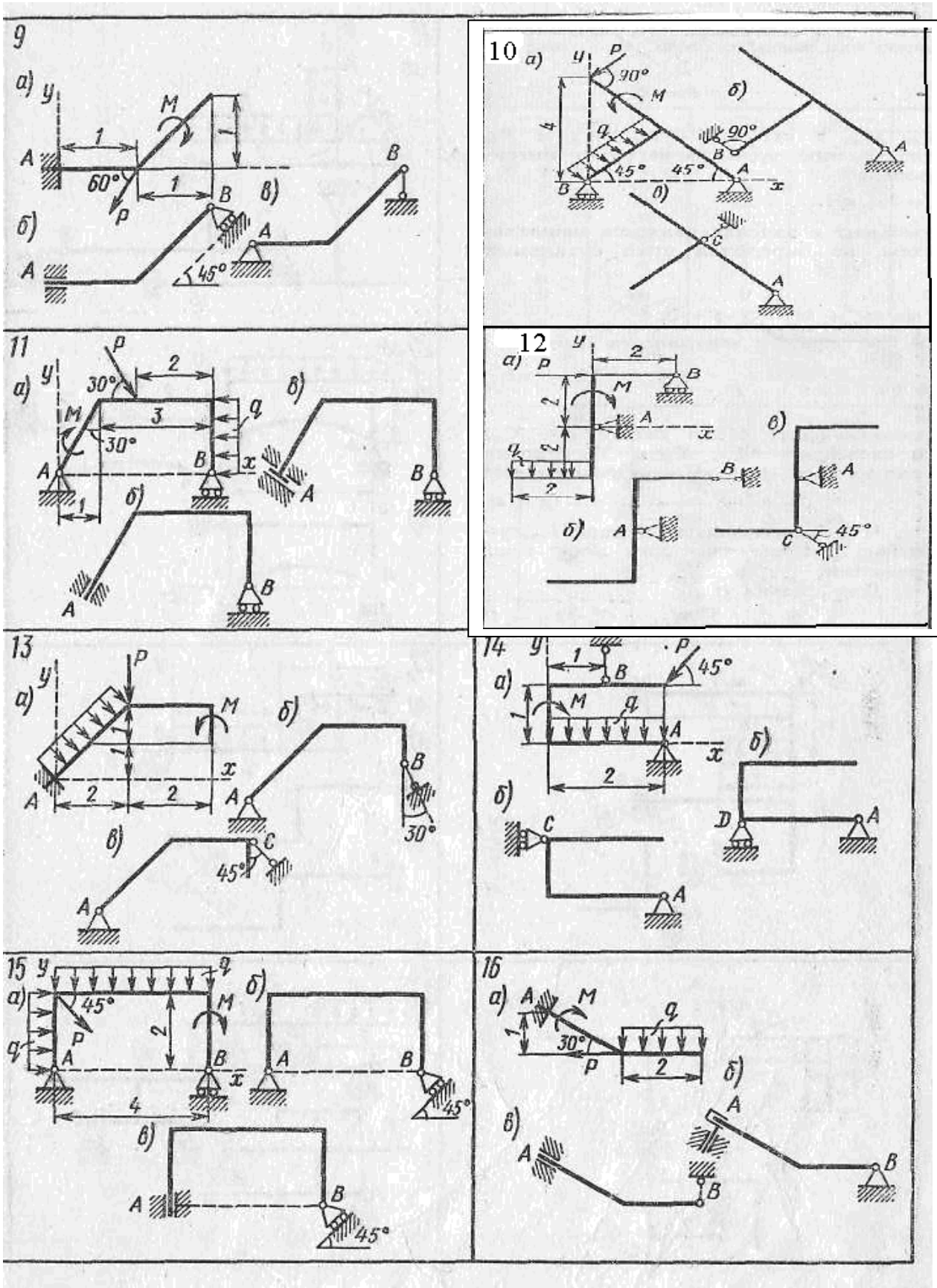
n.v(1-4 rasm)	P,kN	M,kN*m	Q,kN/m	Tek.rea.	n.v.(1-4 rasm)	P,kN	M,kN*m	Q,kN/m	Tek.rea
1	10	6	2	y_A	16	12	6	2	M_A
2	20	5	4	M_A	17	20	4	3	y_A
3	15	8	1	y_B	18	14	4	2	x_A
4	5	2	1	y_B	19	16	6	1	R_B
5	10	4	-	x_B	20	10	-	4	y_A
6	6	2	1	M_A	21	20	10	2	M_A
7	2	4	2	x_A	22	6	6	1	y_a
8	20	10	4	R_B	23	10	4	2	M_A
9	10	6	-	y_a	24	4	3	1	y_A
10	2	4	2	x_A	25	10	10	2	x_a
11	4	10	1	R_B	26	20	5	2	M_A
12	10	5	2	y_A	27	10	6	1	x_A
13	20	12	2	y_A	28	20	10	2	y_a
14	15	4	3	y_A	29	25	-	1	M_A
15	10	5	2	x_A	30	20	10	2	R_B

1-masala (S-1). Bruslarning mahkamlanishi va ularga ta'sir etuvchi $P = 5kN, M = 8kN*m, q = 1,2kN/m$ kuchlarning quyilishi 1-rasm a,b,s larda ko'rsatilgan.M_A momentning qiymati qaysi ulanishda eng kichik bo'lishini va shu ulanishdagi tayanch reaksiya kuchlarini aniqlang.

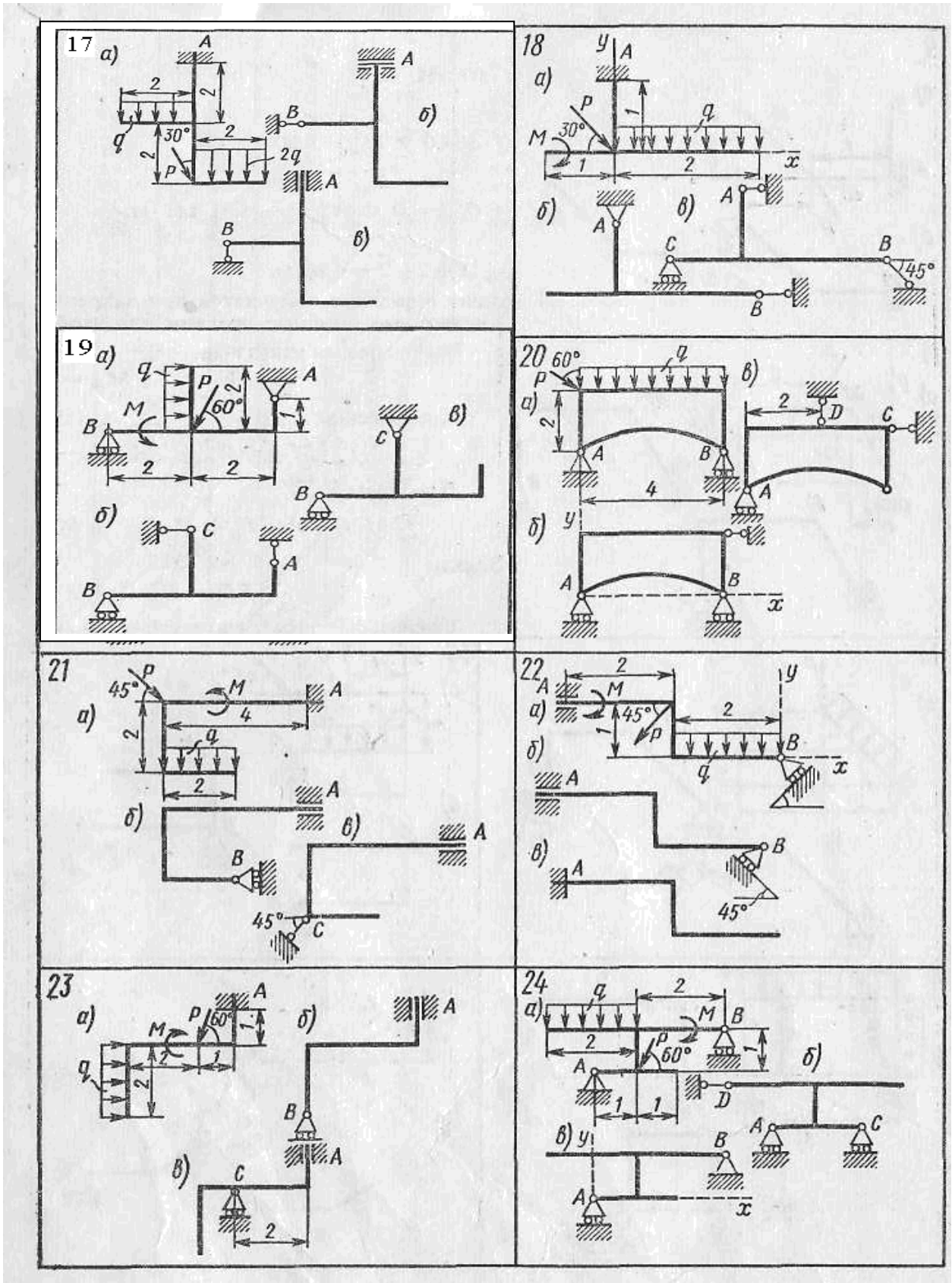
Yechish. Konstruksiyaga qo'yilgan muvozanatlashtiruvchi kuchlar sistemasini tekshiraylik



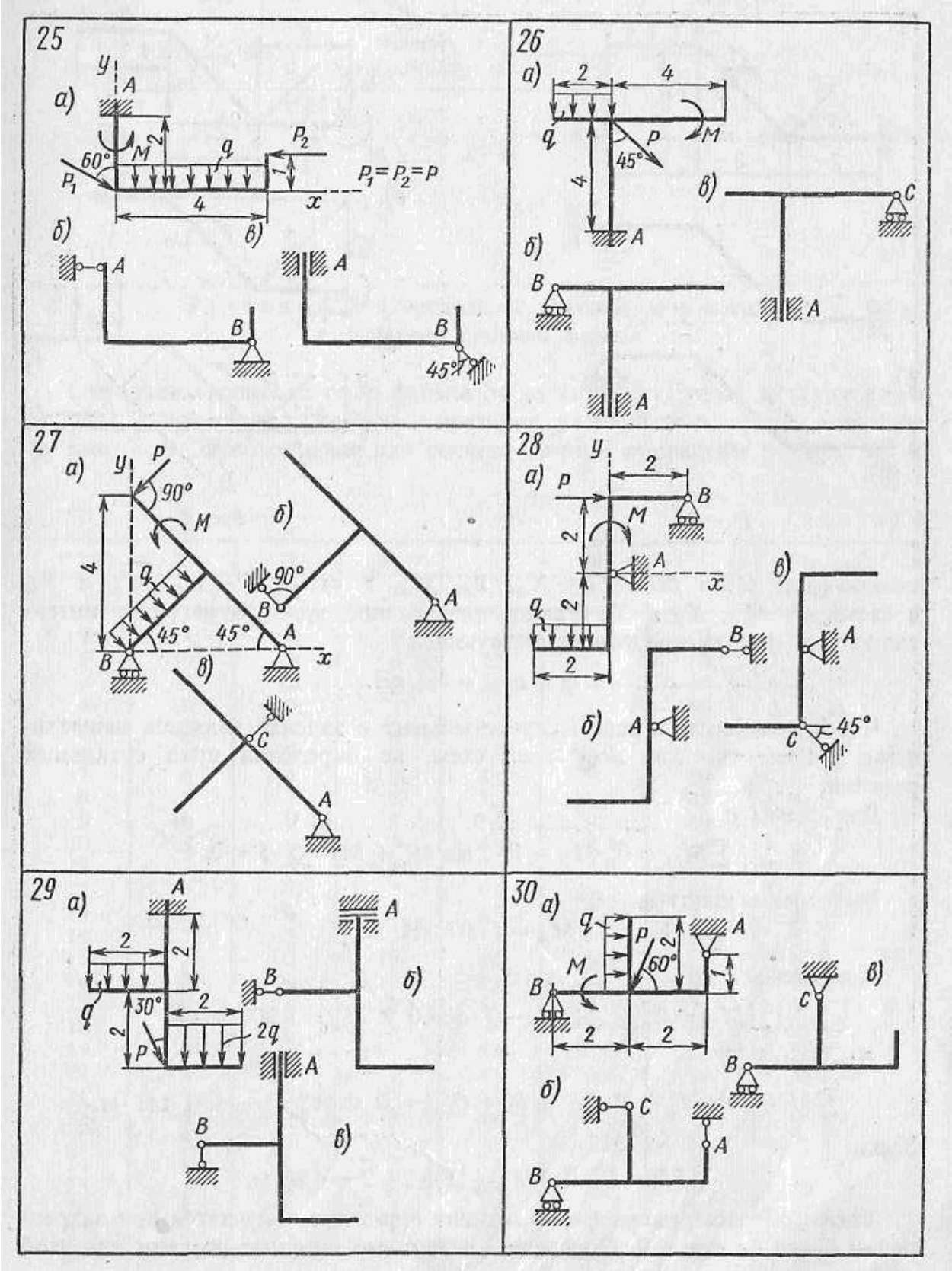
1-rasm(S-1)



2-rasm(S-1)



3-rasm(S-1)



4-rasm(S-1)

Konstruksiyadagi bog'lanishlarni, ularning reaksiya kuchlarini 2-rasmdagi a) sxemada- x_A, y_A, z_A; b) sxemada $y_A^{'}, M_A^{'}, R_B$; s) sxemada $M_A^{''}, x_B, y_B$ lar bilan

almashtiramiz. Tekis taqsimlangan kuchlar intensivligi q ni teng ta'sir etuvchi Q kuch bilan almashtiramiz, uning qiymati:. Q=2q=2,4 kN. ga teng bo'ladi.

Uchta sxemadan qaysi birining mahkamlangan A nuqtasidagi M_A momentning qiymati eng kichik bo'lishini , boshqa reaksiya kuchlarini hisoblamasdan aniqlaymiz 2-rasm a sxema uchun A nuqtaga nisbatan barcha kuchlarning momentlarining yig'indisi nolga teng bo'lgan muvozanat tenglamasini yozamiz:

$$\sum M_{iA} = 0; M_A - 2P\sin 45^0 + M - 5Q = 0. \quad (1)$$

Berilganlarni qo'yib M_A ning qiymatini hisoblaymiz: M_A =11,07 kN*m.

2-rasm b sxema uchun: $\sum M_{iC} = 0; M_A^{'} + M - 5Q = 0, M_A^{'} = 4kN*m$ (2)

2-rasm sxema uchun:

$$\sum M_{iB}^{''} = 0; M_A^{''} + P*BD + M + Q*1 = 0, M_A^{''} = -31kN*m \quad (3)$$

Bu yerda BD=BE+ED= $BD = BE + ED = \sqrt{2} + 2\sqrt{2} = 4{,}24m$

Shunday qilib, mahkamlangan qismning eng kichik momenti 2-rasm b sxemada hosil bo'lar ekan. Bu sxemadagi qolgan reaksiya kuchlarini ham hisoblaymiz:

$$\sum x_i = 0; \; P\cos 45^0 - R_B = 0 \quad (4)$$

bundan R_B =3,54kN

$\sum y_i = 0; \; y_A^{'} - P\sin 45^0 - Q = 0$ bundan $y_A^{'} = 5{,}94kN$. (5)

Hisoblash natijalari 2-jadvalda keltirilgan.

2-jadval

1-rasmdagi sxemalar	Moment $M_A(M_A^{'}, M_A^{''}), kN*m$	Kuchlar, kN	
		$y_A^{'}$	R_B
a	11,07	-	-
b	4,00	5,04	3,54
s	-31,61	-	-

2-masala(S-1. V-28). *Berilganlar: P=20 kN, M=10 kN, q=2kN/m, t.k; $y_{A-?}$*

a)1- rasm a uchun Q=2q=2*2=4kN. A nuqta uchun muvozanat tenglamalarini tuzamiz;

$$\sum M_{iA} = 0; \quad -M - 2P + 2R_B + !*Q = 0 \quad (1)$$

$$\sum X_i = 0; \; P + X_A = 0 \quad (2)$$

$$\sum Y_i = 0; \; R_B + Y_A - Q = 0 \quad (3)$$

(1)ifodadan R_B ni aniqlaymiz:

$$R_B = \frac{M + 2P - Q}{2} = \frac{10 + 2*20 - 4}{2} = \frac{46}{2} = 23kN$$

(3)dan Y_A ni aniqlaymiz:

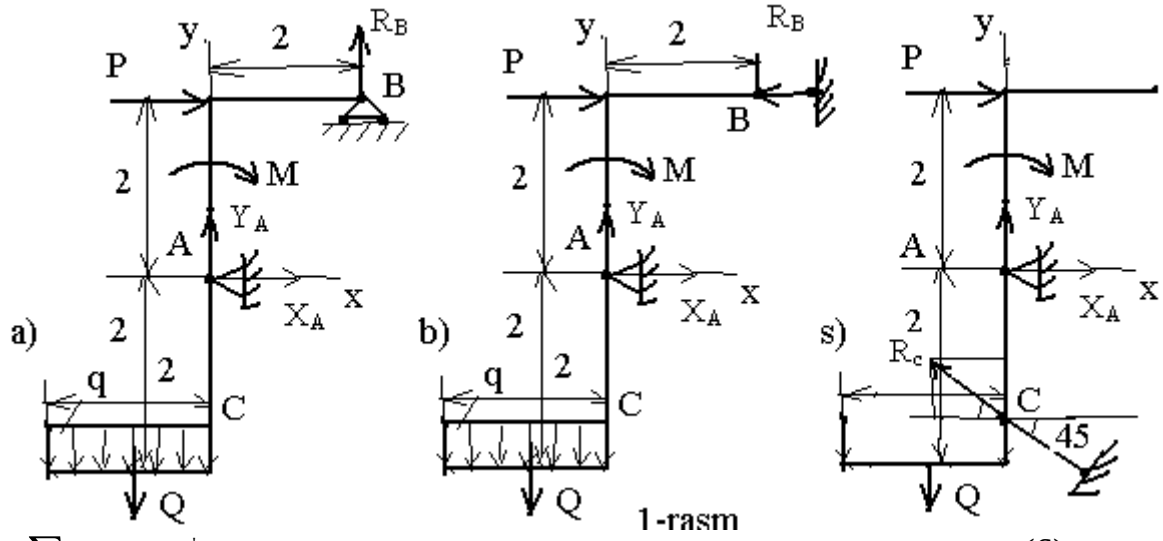
$Y_A = Q - R_B = 4 - 23 = -19kN$,

(2)dan X_A ni aniqlaymiz: $X_A = -P = -20kN$.

b) sxemadagi A nuqtaga nisbatan moment olamiz:

$$\sum M_{iA} = 0; \quad -M - 2P + 2R_B + 1*Q = 0 \quad (4)$$

$$\sum X_i = 0; \; P - R_B + X_A = 0 \quad (5)$$



1-rasm

$$\sum Y_i = 0;\ \ Y_A^{'} - Q = 0 \qquad (6)$$

(6) ifodadan $Y_A^{'} = Q = 4kN$

s) sxemadagi A nuqtaga nisbatan moment olamiz.

$$\sum M_{iA} = 0;\ \ -M - 2P + 1*Q - R_{cx}*2 = 0; R_{cx} = R_c\cos 45^0; R_{cy} = R_c \sin 45 \qquad (7)$$

$$\sum X_l = 0;\ \ -P + X_A - R_c\cos 45^0 = 0 \qquad (8)$$

$$\sum Y_i = 0;\ \ Y_A^{''} + R_c \sin 45^0 - Q = 0 \qquad)9)$$

(7) dan

$$R_c = \frac{Q - M - 2P}{2\cos 45} = \frac{4 - 10 - 2*20}{2*0{,}705} = -\frac{46}{1{,}41} = -32.16kN.$$

(9)dan $Y_A^{''} = Q - R_c \sin 45 = 4 - 32*0{,}705 = -18{,}56kN$

Demak a,b,s sxemalardan b sxemadagi Y_A=4kN eng kichik bo'ladi.

(4) dan R_B ni topamiz.

$$R_B = \frac{M + 2P - Q}{2} = \frac{10 + 2*20 - 4}{2} = \frac{46}{2} = 23kN.$$

(5) dan X_A ni topamiz. $X_A = R_B - P = 23 - 20 = 3kN$

Hisob natijalari 2-jadvalda keltirilgan:

1-rasmdagi sxemalar	K u ch l a r , kN			
	X_A	$Y_A, Y_A^{'}, Y^{''}_A$	R_B	
a		-19		
b	3	4	23	
s		-18,56		

Nazorat savollari

1. Kuchlar sistemasi deb nimaga aytiladi ?
2. Qanday kuchlar sistemasi ekvivalent sistema deyiladi?
3. Qanday kuch berilgan kuch sistemasining teng ta'sir etuvchisi deyiladi?
4. Bog'lanishdagi jism deb nimaga aytiladi?
5. Bog'lanish reaksiya kuchi deb nimaga aytiladi?

6. Tarmoqlangan kuchlarning qanday turlari bor va ular qanday aniqlanadi?
7. Ferma va tugun deb nimaga aytiladi ?
8. Yassi ferma deb nimaga aytilad?
9. Statik aniq va statik noaniq fermalarlar deb nimaga aytiladi?
10. Tugunni kesish usulini tushuntiring.
11. Maksvell- Kremon diagrammasi tushuntiring.
12.Retter usulini tushuntiring.
13. Statik aniq masala deb nimaga aytiladi ?
14. Statik noaniq masala deb nimaga aytiladi
13.Tekislikdagi kuchlar sistemasining bosh vektori formulasini yozib tushuntiring?
14. Tekislikdagi kuchlar sistemasining bosh momenti formulasini yozib ma'nosini tushuntiring?
15. Varin'on teoremasi ifodasini yozib ma'nosini tushuntiring?

16. Tekislikdagi kuchlar sistemasining muvozanatda bo'lishini zarur va etarli sharti ifodalarini yozib ma'nosini tushuntiring?

1-test. Quyidagi ifodalardan tekislikdagi kuchlar sistemasining bosh vektori formulasini, kesishuvchi kuchlar ta'siridagi jismning muvozanat sharti, Varinon teoremasi ifodalarini ko'rsating?

1. $\sum \vec{F}_\nu = \vec{R}$; 2. $R = \sqrt{F_1^2 + F_2^2 - 2F_1F_2\cos(\pi - \alpha)}$ 3. $R = \sqrt{R_x^2 + R_y^2 + R_z^2} = 0;$

4. $\vec{M} = \sum \vec{M}(F_\nu)$; 5. $M_0(\vec{R}) = \sum \vec{M}_0(\vec{F}_\nu)$; 6. $\sum X_\nu = 0; \sum Y_\nu = 0; \sum M_0(\vec{F}_\nu) = 0$;

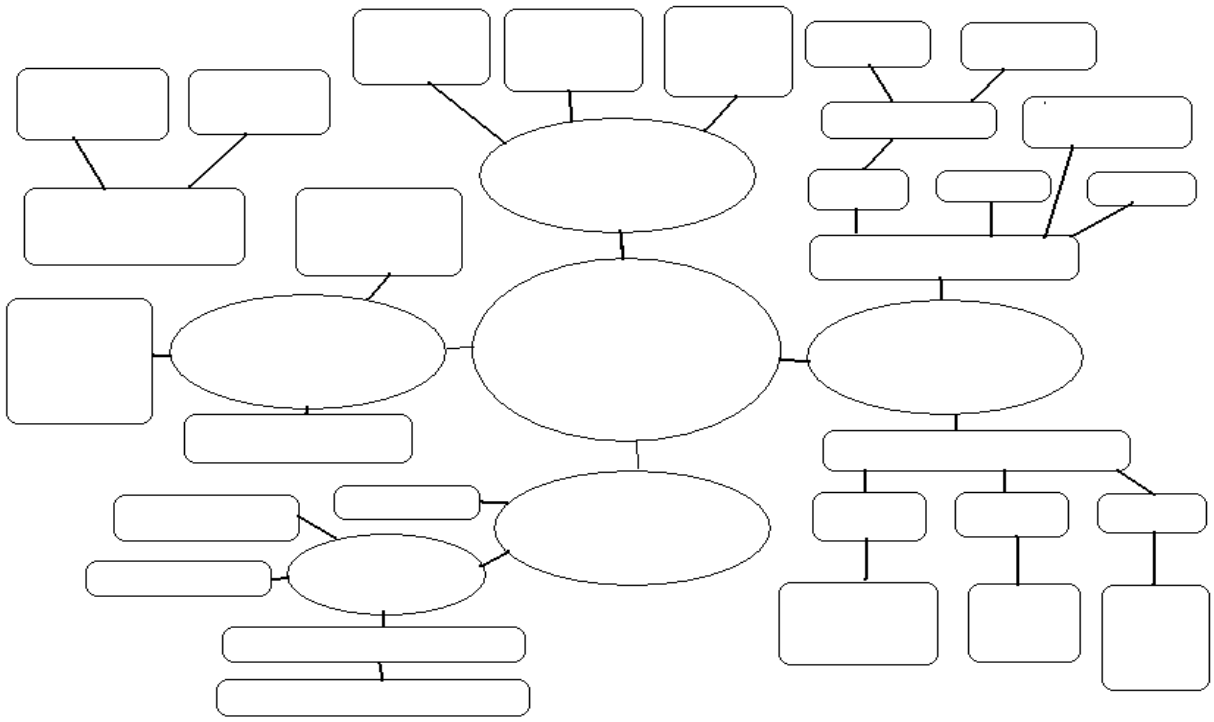
2-test. Quyidagi ifodalardan teng ta'sir etuvchi kuchning modulini, tekislikdagi kuchlar sistemasining bosh momenti, tekislikdagi kuchlar sistemasining muvozanatda bo'lishini zarur va yetarli sharti ifodalarini ko'rsating?

1. $\sum \vec{F}_\nu = \vec{R}$; 2. $R = \sqrt{F_1^2 + F_2^2 - 2F_1F_2\cos(\pi - \alpha)}$ 3. $R = \sqrt{R_x^2 + R_y^2 + R_z^2} = 0;$

4. $\vec{M} = \sum \vec{M}(F_\nu)$; 5. $M_0(\vec{R}) = \sum \vec{M}_0(\vec{F}_\nu)$; 6. $\sum X_\nu = 0; \sum Y_\nu = 0; \sum M_0(\vec{F}_\nu) = 0$;

Klasterni tuzish qoidalari **13-ilova**

1. Topshiriqni diqqat bilan o'qib chiqing.
2. Fikrlarni tarmoqlantirish jarayonida paydo bo'lgan har bir fikrni yozing.
3. Imlo xatolar va boshqa jihatlarga e'tibor bermang.
4.Belgilangan vaqt tugamaguncha yozishni to'xtatmang, fikringizni jamlashga harakat qiling.
5.Fikrlarni chegaralamang, ular o'rtasida o'zaro aloqadorlikka e'tibor qarating.



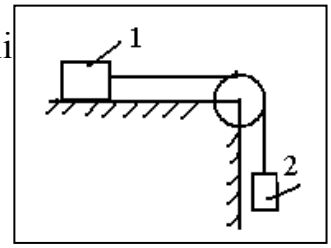
Foydalanilgan adabiyotlar

1. **Rashidov T.R. va boshqalar. «Nazariy mexanika asoslari», T, «O'qituvchi»,1991 y.**
2. **M.M.Mirsaidov va boshqalar. «Nazariy mexanika», T, «Ilm ziyo» , 2009 y.**
3. **O.E.Kere va boshqalar. «Nazariy mexanika fanidan qisqa masalalar to'plami», T, «Yangi asr avlodi», 2008 y.**

2-mustaqil ish mavzusi
Jismning sirpanish va dumalanishdagi ishqalanishini va bir tekislikda yotuvchi bir necha jismdan tashkil topgan sistemaning muvozanatini o'rganish

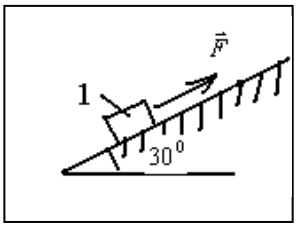
Reja:

1.Ishqalanish kuchlarini hisobga olgan holda biriktirilgan balkalardagi reaksiya kuchlarni aniqlash.



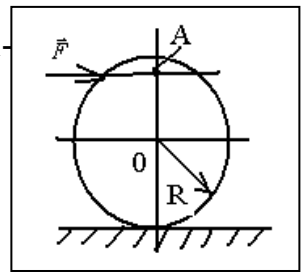
2-masala(K.2.5.2). Og'irligi 200N bo'lgan 1 yuk blok orqali ip yordamida 2 yukka bog'langan. Agar 1 yuk va tekislik orasidagi ishqalanish koeffisenti f=0,2 bo'lsa,1 yuk o'rnidan qo'zg'alishi uchun 2 yukning eng kam miqdorini toping. (40)

3.Tekis yoyilgan kuchlar va ularning teng ta`sir etuvchisini aniqlash.



4-masala(K.2.5.7). Qiya tekislikdagi 1 jismga F=90 N kuch ta'sir etadi. Agar jism va tekislik orasidagi ishqalanish koeffisenti f=0,3 bo'lsa, yuk o'z o'rnidan yuqoriga qo'zg'alishi uchun uning og'irligi qancha bo'lishi lozim? (118)

5.Tekislikda joylashgan kuchlar sistemasi ta'siridagi tekis mexanizmning muvozanati.



6-masala(K. K.2.6.4. Og'irligi 2 kN bir jinsli g'ildirakka gorizontal F kuchi ta'sir etib, g'ildirak sirpanmay va dumalamay turishi uchun kuchning eng katta qiymatini toping. Bunda g'ildirakning radiusi R=0,6m va o'lchamlari OA =0,4m . Sirpanib va dumalab ishqalanish koeffisentlari f=0,2 va $\delta = 0{,}006m$ deb oling. (12).

7. S-3 Hisob-grafik topshiriq. Yig'ma konstruksiyaning tayanch reaksiyalarini aniqlash.

Tayanch so'z va iboralar: 1) to'g'ri chiziq kesmasi bo'yicha tekis taqsimlangan kuchlar ($Q = aq$); 2) To'g'ri chiziq kesmasi, bo'yicha chiziqli qonun bo'yicha taqsimlangan kuchlar ($Q = \frac{1}{2}aq_m$) ; 3) devorga qisib mahkamlangan balkaga ta'sir etuvchi taqsimlangan kuchlar; 4) Tekislikda joylashgan kuchlar sistemasining muvozanati ($\sum X_\nu = 0; \sum Y_\nu = 0, \sum M_0(\vec{F}_0) = 0$

5) tekislikda joylashgan kuchlar sistemasi ta'siridagi tekis mexanizmning muvozanati; 6) Birlashtirilgan ikkita jismdan tashkil topgan konstruksiyaning reaksiya kuchlarini aniqlash.

S-3 Hisob-grafik topshiriq. Yig’ma konstruksiyaning tayanch reaksiyalarini aniqlash

Ikkita jismdan tashkil topgan tutash balkalarning muvozanat holatini tekshirish.Ikki qismli balka bog’lanish reaktsiya kuchlarini va oraliq sharnirlardagi bosim kuchini aniqlash.

Konstruksiya (sistema) ikki qismdan tashkil topgan. Konstruksiya qismlarini qanday usul bilan ulaganda 1 jadvalda ko’rsatilgan reaksiya kuchining miqdori eng kichik bo’ladi, bu variant uchun tayanch reaksiya kuchlarini hamda C birlashgan nuqtaning reaksiya kuchlarini aniqlang.

1-jadval.

Variant raqami	P_1 кН	P_2 кН	M, кН м	q, кН/м
1	5,0	-	24,0	0,8
2	6,0	10,0	22,0	1,0
3	7,0	9,0	20,0	1,2
4	8,0	-	18,0	1,4
5	9,0	-	16,0	1,6
6	10,0	8,0	25,0	1,8
7	11,0	7,0	20,0	2,0
8	12,0	6,0	15,0	2,2
9	13,0	-	10,0	2,4
10	14,0	-	12,0	2,6
11	15,0	5,0	14,0	2,8
12	12,0	4,0	16,0	3,0
13	9,0	6,0	18,0	3,2
14	6,0	-	20,0	3,4
15	5,0	8,0	22,0	3,6
16	7,0	10,0	14,0	3,8
17	9,0	12,0	26,0	4,0
18	11,0	10,0	18,0	3,5
19	13,0	9,0	30,0	3,0
20	15,0	8,0	25,0	2,5
21	10,0	7,0	20,0	2,0
22	5,0	6,0	15,0	1,5
23	8,0	5,0	10,0	1,4
24	11,0	4,0	5,0	1,3
25	14,0	6,0	7,0	1,2

26	12,0	8,0	9,0	1,1
27	10,0	7,0	11,0	1,0
28	8,0	9,0	13,0	1,2
29	6,0	10,0	15,0	1,4
30	10,0	12,0	17,0	1,6

S-3. Hisob-grafik topshiriqqa doir 1-masalalarni yechish namunasi

1-masala (S-3). Tutash balkalarning muvozanat holatini tekshirish. Ikki qismli balka bog'lanish reaksiya kuchlarini va oraliq sharnirlardagi bosim kuchini aniqlash.

Berilgan: P1=5kN; P2=6kN ; M=34kN*m ; g =1,5kN/m;

Berilgan shaklni chizib olamiz va bog'lanishlarni reaksiya kuchlari bilan almashtirib, balkaning har bir qismi uchun muvozanat tenglamasini yozamiz. Qo'zg'almas A tayanchning reaktsiya kuchi R_A , qo'zg'aluvchi B va S sharnirning reaksiya kuchlari mos ravishda R_C va R_B – lar bo'lsin, u vektorlar tekisliklarga perpendikulyar ravishda bo'ladi. DC- balkaning DC- qismida q tekis taqsimlangan kuchlarni Q- teng ta'sir etuvchisi bilan almashtiramiz, ya'ni Q=gl =1,5*3=4,5kN

Endi balkaning AD va DS qismlari uchun muvozanat tenglamalarini yozamiz.

AD- balka uchun

$$\sum X_i = 0; \qquad X_A - P_1 \cos 45^0 - X_D = 0 \qquad (1)$$

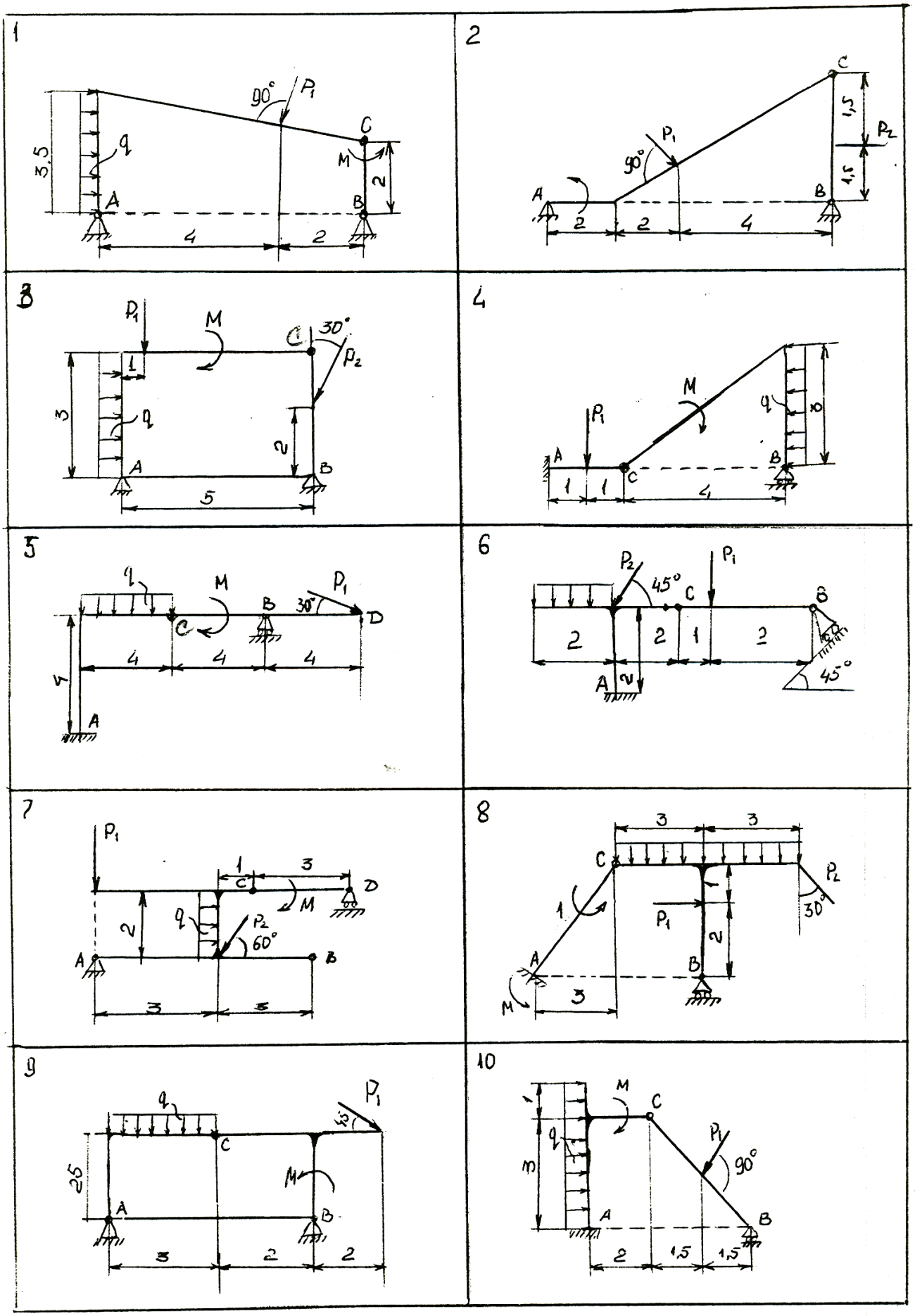
$$\sum Yi = 0; \qquad Y_A - P_1 \sin 45^0 + Y_D = 0 \qquad (2)$$

$$\sum M_A(\overrightarrow{F_i}) = 0; \qquad Y_D 3 - M - P_1 \sin 45^0 1 = 0 \qquad (3)$$

DC-balka uchun

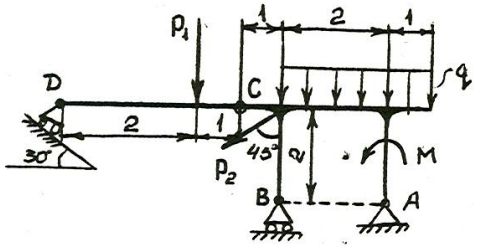
$$\left.\begin{array}{l} \sum X_i = 0; \\ \sum Yi = 0; \\ \sum Mc(\overrightarrow{F_i}) = 0; \end{array}\right\} \quad (4) \qquad \left\{\begin{array}{l} X_D - N_C \sin 30^0 = 0 \\ N_B - Y'_D - P_2 - Q + N_C \cos 30^0 = 0 \end{array}\right. \quad (5)$$

$$1{,}5Q - 3N_B + 4P_2 + 5Y_D^{'} = 0 \qquad (6)$$


1
90°
P1
C
M
q
3,5
A
B
4
2
2
C
1,5
P2
P1
90°
1,5
A
B
2
2
4
3
P1
M
C
30°
P2
q
3
2
A
B
5
4
P1
M
q
10
A
B
C
1
1
4
5
q
M
B
30°
P1
C
D
4
4
4
4
A
6
P2
45°
P1
C
B
2
2
1
2
A
2
45°
7
P1
1
3
C
D
M
2
q
P2
60°
A
B
3
3
8
3
3
C
P2
1
P1
30°
2
A
B
M
3
9
q
P1
45°
C
2,5
M
A
B
3
2
2
10
M
C
1
q
P1
90°
3
A
B
2
1,5
1,5

1-rasm(S-3)

11



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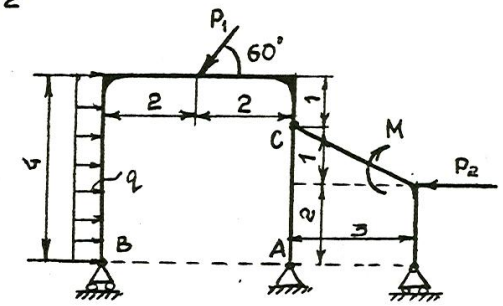

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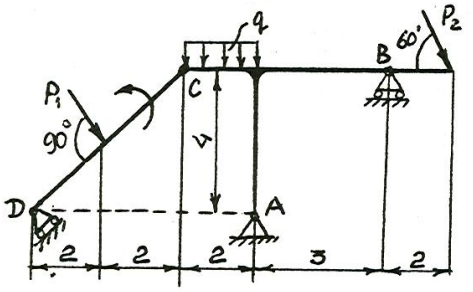

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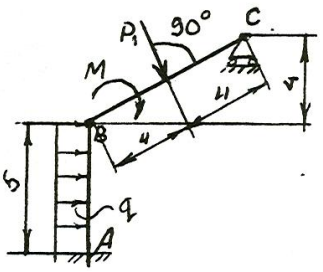

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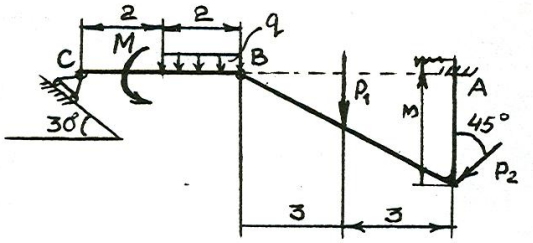

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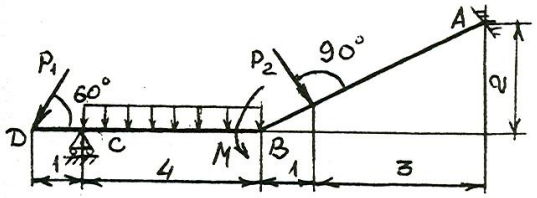
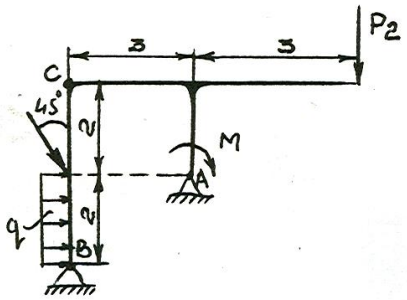


17



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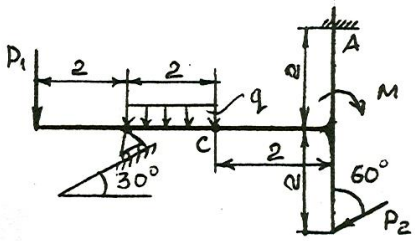

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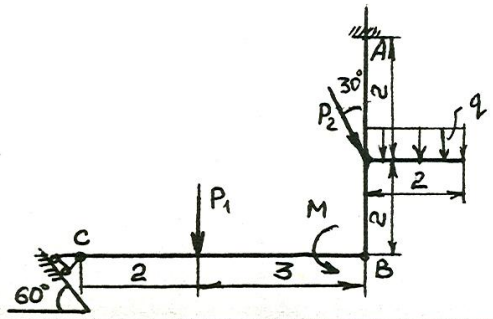

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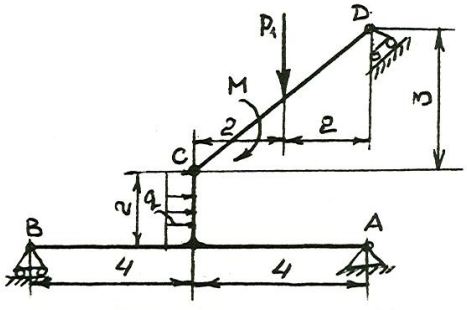
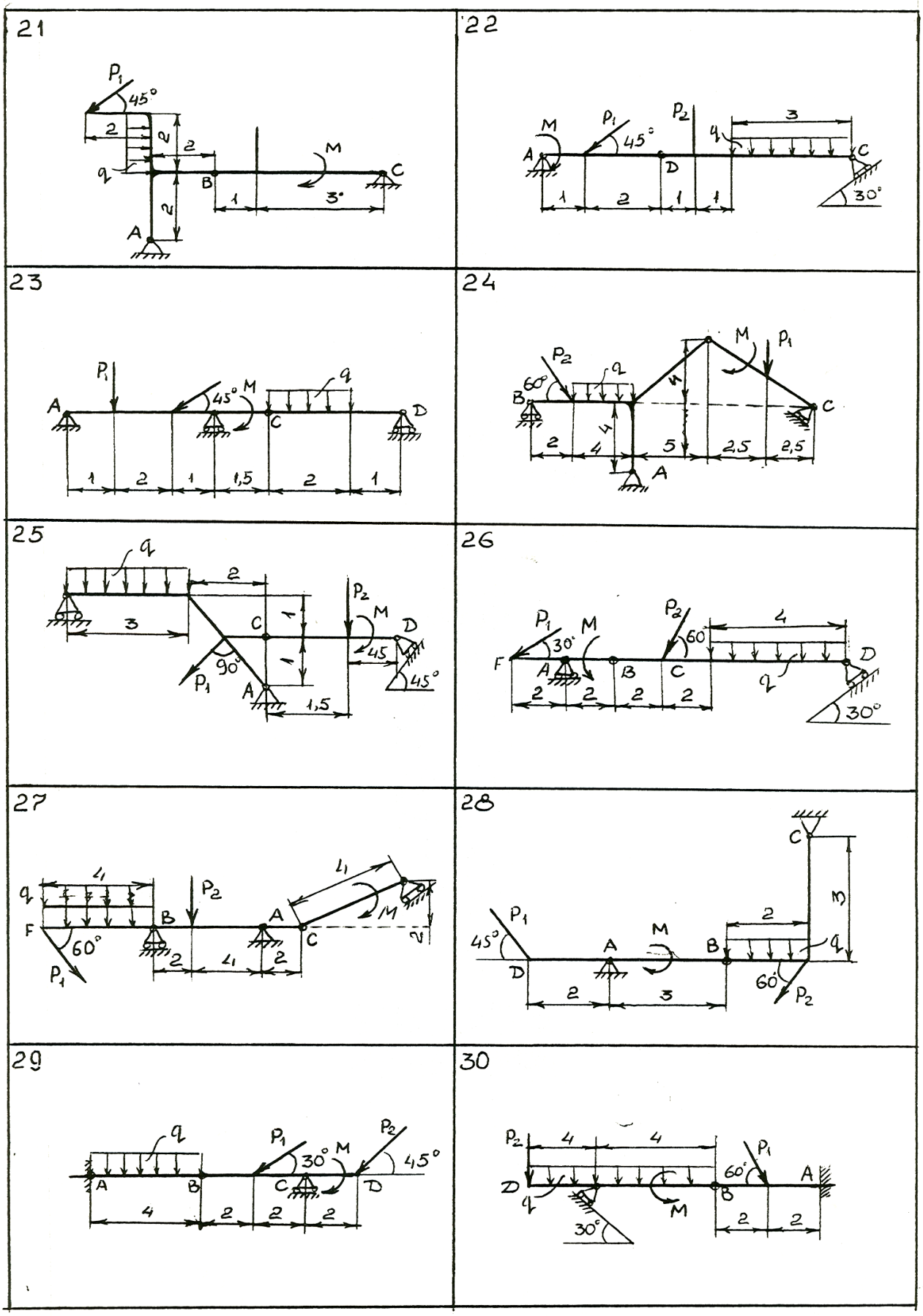
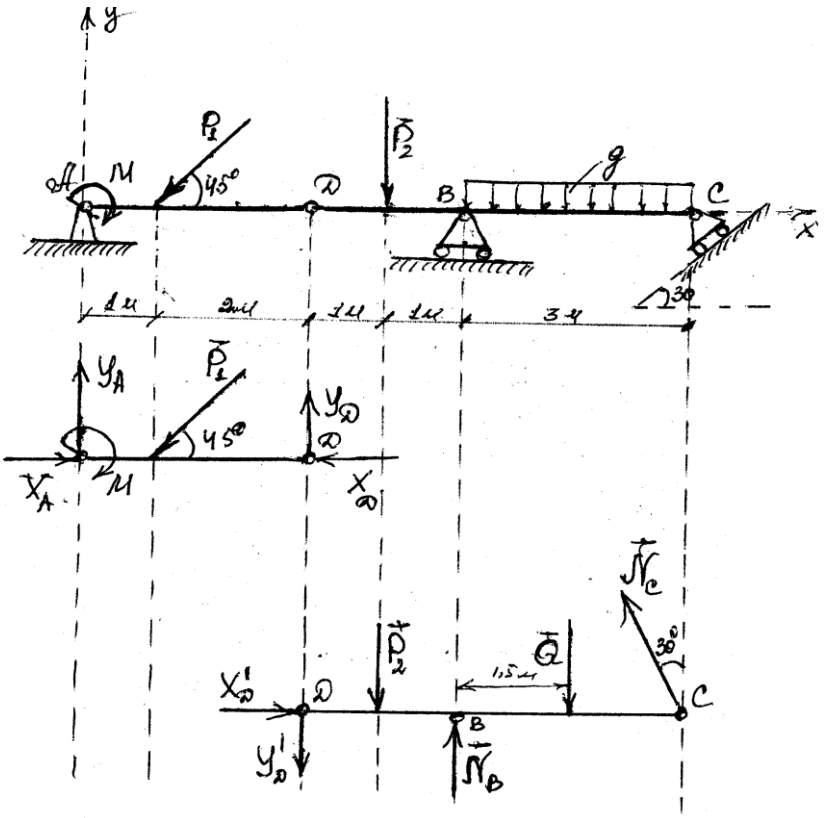



21
P1
45°
2
q
2
q
M
B
C
1
3
2
A
22
M
P1
45°
P2
q
3
A
D
C
1
2
1
1
30°
23
P1
45°
M
q
A
C
D
1
2
1
1,5
2
1
24
M
P1
P2
q
60°
B
C
4
4
2
4
5
2,5
2,5
A
25
q
2
3
C
P2
M
D
45
90°
P1
A
1,5
45°
26
P1
M
P2
4
30°
60°
F
A
B
C
D
q
2
2
2
2
30°
27
4
q
P2
4
B
A
M
F
60°
C
2
4
2
P1
28
C
P1
M
2
45°
A
B
D
q
2
3
60°
P2
29
q
P1
P2
30°
M
45°
A
B
C
D
4
2
2
2
30
P2
4
4
P1
60°
D
A
q
M
B
30°
2
2

3-rasm(S-3)



AD- balka uchun

$$\sum X_i = 0; \qquad X_A - P_1 \cos 45^0 - X_D = 0 \qquad (1)$$

$$\sum Yi = 0; \qquad Y_A - P_1 \sin 45^0 + Y_D = 0 \qquad (2)$$

$$\sum M_A(\overrightarrow{F_i}) = 0; \qquad Y_D 3 - M - P_1 \sin 45^0 1 = 0 \qquad (3)$$

DC-balka uchun

$$\left.\begin{aligned} &\sum X_i = 0; \\ &\sum Yi = 0; \\ &\sum Mc(\overrightarrow{F_i}) = 0; \end{aligned}\right\} \qquad (4)$$

$$\begin{cases} X_D - N_C \sin 30^0 = 0 \\ N_B - Y'_D - P_2 - Q + N_C \cos 30^0 = 0 \\ Q1{,}5 - N_B 3 + P_2 4 + Y'_D 5 = 0 \end{cases} \qquad (5)$$

(6)

Ta‘sir va aks ta‘sir aksiomasiga asosan

$$\begin{cases} X_D = X'_D \\ Y_D = Y'_D \end{cases} \qquad (7)$$

(8)

Hosil bo’lgan tenglamalardan, ya‘ni:

(3) dan $YD = \dfrac{M + P_1 \dfrac{\sqrt{2}}{2}}{3} = \dfrac{34 + 5\dfrac{\sqrt{2}}{2}}{3} \approx 12{,}5kH$

(8) dan $Y'_D = Y_D = 12{,}5kH$

(6) dan $N_B = \dfrac{Q \times 1{,}5 + P_2 4 + Y'_D 5}{3} = \dfrac{4{,}5 \times 1{,}5 + 6 \times 4 + 12{,}5 \times 5}{3} \approx 31{,}08 \approx 31{,}1kH$

(5) dan $N_C = \dfrac{Y'_D + P_2 + Q - N_B}{\cos 30^0} = \dfrac{12{,}5 + 6 + 6{,}75 - 31{,}1}{0{,}866} \approx -6{,}75kH$

(4) dan $X'_D = N_C \sin 30^0 = -6{,}75 \times 0{,}5 = -3{,}37kH$

(2) dan $Y_A = P_1 \sin 45^0 - Y_D = 5\dfrac{\sqrt{2}}{2} - 12{,}5 = -8{,}96kH$

(1) dan $X_A = P_1 \cos 45^0 + X_D = 0{,}16kH$

(7) dan $X_D = X'_D = -3{,}37kH;$ larni hosil qilamiz.

S-3. Hisob-grafik topshiriqqa doir 2-masalani yechish namunasi

2-masala(S-3). Ikkita jismdan tashkil topgan sistemaning tayanchlarda hosil bo’ladigan reaksiya kuchlarini aniqlash**.**

Konustruksiya (sistema) ikki qismdan tashkil topgan. Konstruksiya qismlarini qanday usul bilan ulaganda 1- jadvalda ko’rsatilgan reaksiya kuchining miqdori eng kichik bo’ladi, bu variant uchun tayanch reaksiya kuchlarini hamda C birlashgan nuqtaning reaksiya kuchlarini aniqlang.

1-rasmdagi konstruksiya sxemasida quyidagi $P_1 = 5kN, P_2 = 7kN; M = 22kN/m; q = 2kN/m; \alpha = 60^0$ kuch momenti va kuchlar quyilgan bo’lsin. Konstruksiyaning C nuqtasi sharnirli yoki sirpanib harakat qiladigan moslama bilan birlashtirilganda A tayanchning reaksiya kuchi eng kichik bo’lishi va tayanchlardagi reaksiya kuchlari aniqlansin (1-rasm).

Yechish: 1. C nuqta sharnirli ulanganda A tayanchning reaksiya kuchini aniqlaymiz Konistruksiyaning barcha qismlariga muvozanatlashuvchi kuchlar ta’sir etsin. B nuqtaga nisbatan kuchlar momentlarining tenglamasini tuzamiz. P_1 kuchning momentini hisoblashni soddalashtirish uchun uni vertikal va gorizontal tashkil etuvchilarga ajratamiz:

$P_1^{'} = P_{1x} = P_1 \cos 60^0 = 2{,}5kN, P_1^{''} = P_{1y} = P_1 \sin 60^0 = 4{,}33kN.$

$\sum M_{iB} = 0;\ P_1^{'} * 3 + 8 * P_1^{''} - 1 * Q - 5 * y_A + 1 * x_A - M + P_2\sqrt{17^2 + 1{,}5^2} = 0, \qquad (1)$

Bu yerda Q=4*q=2*4=8kN ekanligini hisobga olamiz.

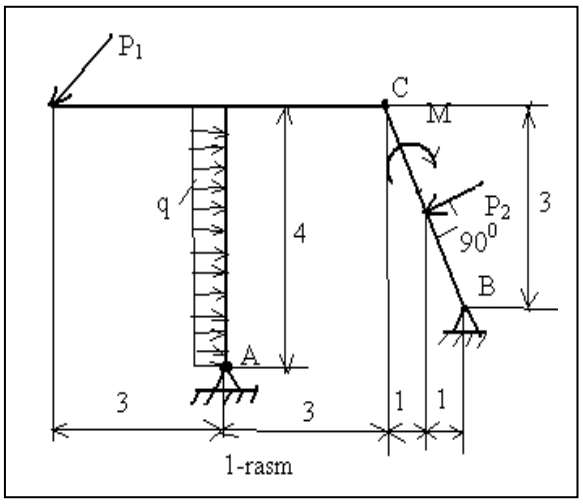
Berilgan kattaliklarni (1) ga quyib hisoblaymiz:

$x_A + 5y_A = -24{,}74kN$ $(1^{'})$

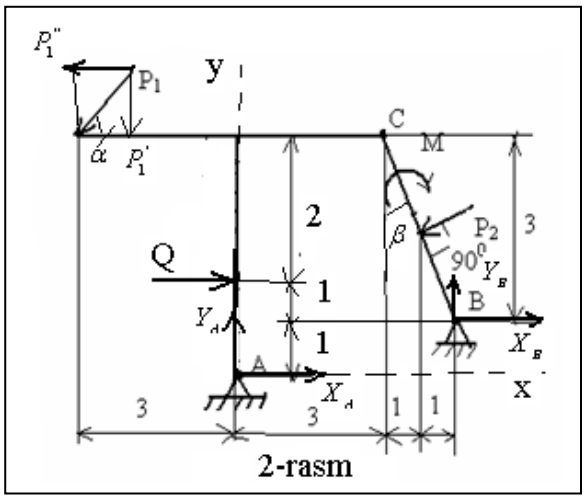
$(1^{'})$ dagi x_A va y_A noma'lumlarni aniqlash uchun C sharnirni chap qismidagi muvozanatlovchi kuchlarni C nuqtaga nisbatan momentini tenglamasini yozamiz.

$M_{iC} = 0;\ P_1^{''} * 6 + 2Q + 4x_A - 3y_A = 0$ yoki hisoblashdan keyin

$4x_A + 3y_A = 41{,}98kN$ (2)



1-rasm



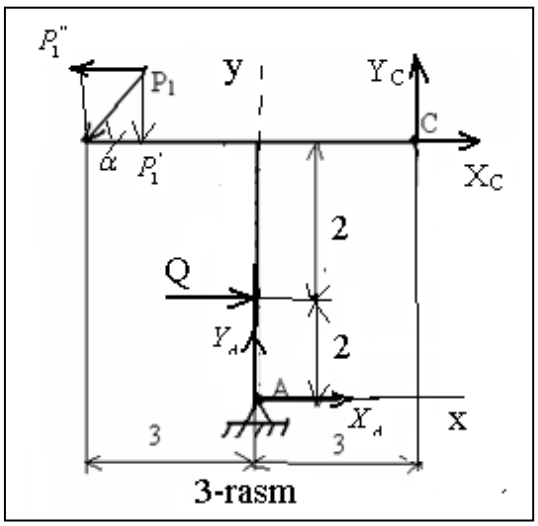
2-rasm

Tenglamani hosil qilamiz. $(1^{'})$ va (2) tenglamalarni birgalikda yechib X_A=-7,97kN, y_A=3,36kN larni aniqlaymiz.

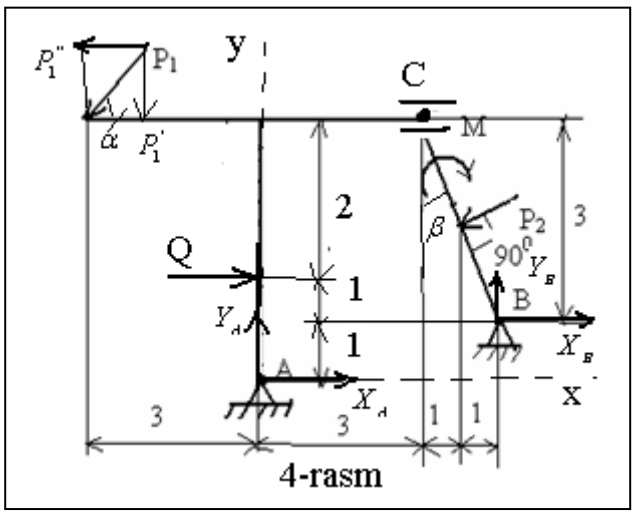
C nuqta sharnirli ulangandagi A tayanchning reaksiyasini miqdorini hisoblaymiz:

$$R_A^{'} = \sqrt{x_A^2 + y_A^2} = \sqrt{7{,}97^2 + 3{,}36^2} = \sqrt{74{,}81} = 8{,}65kN$$

2. Konsturuksiyaning C nuqtasi sirpanuvchi moslama bilan ulangandagi hisoblash sxemasi 4 - rasmda ko'rsatilgan. 2- va 4- rasmlarda ko'rsatilgan kuchlar sistemalari bir-biridan hech qanday farq qilmaydi. Shuning uchun $(1^{'})$ tenglama o'zgarishsiz qoladi. C sirpanuvchi moslamaning chap qismidagi muvozanatlashuvchi kuchlarning x va y o'qlaridagi muvozanat tenglamalarini yozamiz.



3-rasm



4-rasm

$\sum X_i = 0;\ X_A + Q - P_1^{'} = 0$ (3)

bundan X_A=-5,5kN va ($1^{'}$) dan Y_A=3,85 kN ni aniqlaymiz.

C sirpanuvchi moslama bilan ulanganda A tayanchning reaksiyasini miqdori:

$R_A^{"} = \sqrt{X_A^2 + Y_A^2} = \sqrt{5{,}5^2 + 3{,}85^2} = 6{,}71kN$ ga teng bo'ladi.

Shunday qilib C nuqta tayanch reaksiya kuchi sharnerli ulangandagiga nisbatan, sirpanuvchi moslama bilan ulanganda (~20 %) kam bo'lar ekan.

B tayanchdagi va sirpanuvchi moslamadagi reaksiya kuchlarini aniqlaymiz.

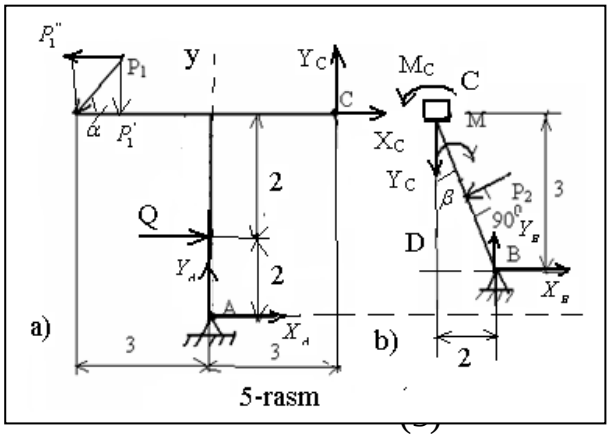
C nuqtaning chap qismi uchun (5-rasm,a)quyidagi

$$\sum Y_i = 0; \quad -P_1^{"} + Y_A + Y_C = 0 \qquad (4)$$

Tenglamani tuzamiz , bundan

$Y_C = P_1^{'} - Y_A = 0{,}48kN$ ni aniqlaymiz.

B tayanchning reaksiya kuchini va sirpanuvchi moslamaning momentini C nuqtaning o'ng qismidagi muvoza-natlashuvchi kuchlarning muvozanat tenglamalaridan aniqlaymiz (5-rasm,b).



5-rasm

$$M_{iB} = 0; \quad M_C + Y_C 2 - M + 1{,}8P_2 = 0$$

$$\sum X_i = 0; \quad -P_2 \cos\beta + X_B = 0 \qquad (6)$$

$$\sum Y_i = 0; \quad -Y_C + Y_B - P_2 \sin\beta = 0 \qquad (7)$$

ΔBCD to'g'ri burchakli uchburchakdan

$$\sin\beta = \frac{BD}{BC} = 2/\sqrt{2^2 + 3^2} = \frac{2}{3{,}61} = 0{,}56; \cos\beta = \frac{CD}{BC} = \frac{3}{3{,}61} = 0{,}832$$

(5)-(7) tenglamalarni birgalikda yechib, M_C, X_B, Y_B larni aniqlaymiz;

$M_C = 8{,}44kN * m; \quad X_B = 5{,}82kN; \quad Y_B = 4{,}37kN$

Reaksiya kuchlarini to'g'ri topilganligini aniqlash uchun konstruksiyaning barcha qismiga quyilgan kuchlarning oldin foydalanilmagan muvozanat tenglamasidan foydalaniladi (2-rasmga qarang),masalan,

$$\sum M_{iA} = P_1^{'} 4 + 3P_1^{"} - 2Q - M - 4P_2 \sin\beta + P_2 \cos\beta * 2{,}5 - X_B * 1 + 5Y_B = 2{,}5 * 4 + 3 * 4{,}33 - 8 * 2 -$$

$$- 22 - 7 * 0{,}555 * 4 + 7 * 0{,}832 * 2{,}5 - 5{,}82 * 1 + 4{,}37 * 5 = 59{,}4 - 59{,}36 \approx 0$$

Hisoblash natijalarini - jadvalga yozing.

	K u ch l a l a r, kN						Moment,kn*m
	X_A	Y_A	R_A	Y_C	X_B	Y_B	
1-rasmdagi sxema uchun	-7,97	3,36	8,65	-	-	-	
4-rasmdagi sxema uchun	-5,5	3,85	6,71	0,48	5,82	4,37	8,44

Nazorat savollari

1. To’g’ri chiziq kesmasi bo’yicha tekis taqsimlangan kuchlar deb nimaga aytiladi?
2. To’g’ri chiziq kesmasi, bo’yicha chiziqli qonun bo’yicha taqsimlangan kuchlar ni tushuntiring.
3. Kuchning nuqtaga nisbatan momenti deb nimaga aytiladi?
4. Kuchning o’qqa nisbatan momenti deb nimaga aytiladi?
5. Fazodagi juft kuchlar muvozanat sharti qanday?
6. Devorga qisib mahkamlangan balkaga ta’sir etuvchi taqsimlangan kuchlarni tushuntiring;
7. Tekislikda joylashgan kuchlar sistemasining muvozanatini tushuntiring.
8. Tekislikda joylashgan kuchlar sistemasi ta’siridagi tekis mexanizmning muvozanati qanday bo’ladi?
9. Birlashtirilgan ikkita jismdan tashkil topgan konstruksiyaning reaksiya kuchlarini aniqlashni tushuntiring?

1-test. Quyidagi ifodalardan to’g’ri chiziq kesmasi bo’yicha tekis taqsimlangan kuchlarni, tekislikda joylashgan kuchlar sistemasining muvozan shartini , kuchning o’qqa nisbatan momenti ifodalarini ko’rsating?

1. $Q = aq$; 2. $Q = \frac{1}{2} aq_m$; 3. $\sum X_\nu = 0; \sum Y_\nu = 0, \sum M_0(\vec{F}_0) = 0$; 4. $\vec{M}_0 = \vec{m}_0(\vec{F}) = \vec{r} x \vec{F}$;

5. $m_z(\vec{F}) = \pm F_{xy} h$; 6. $\vec{M} = \sum \vec{M}_\nu = 0; \sum M_{\nu x} = 0, \sum M_{\nu y} = 0, \sum M_{\alpha z} = 0$

2-test. Quyidagi ifodalardan to’g’ri chiziq kesmasi, bo’yicha chiziqli qonun bo’yicha taqsimlangan kuchlarni, kuchning nuqtaga nisbatan momentini, fazodagi juft kuchlar muvozanatini ifodalarini ko’rsating?

1. $Q = aq$; 2. $Q = \frac{1}{2} aq_m$; 3. $\sum X_\nu = 0; \sum Y_\nu = 0, \sum M_0(\vec{F}_0) = 0$; 4. $\vec{M}_0 = \vec{m}_0(\vec{F}) = \vec{r} x \vec{F}$;

5. $m_z(\vec{F}) = \pm F_{xy} h$; 6. $\vec{M} = \sum \vec{M}_\nu = 0; \sum M_{\nu x} = 0, \sum M_{\nu y} = 0, \sum M_{\alpha z} = 0$

Munozara ishtirokchisiga eslatma

1.Munozara shaxsiy munosabatlarni hal qilish emas, balki muammoni yechish uslubi hisoblanadi.

2.Judayam uzoq gapirma, boshqalarga ham fikr bildirish imkonini ber.

3.So’zlarni o’ylab, hissiyotlaringni jilovlab gapir, shunda sening aqlli fikrlaring maqsadga yetaklaydi.

4.Boshqalarning tutgan yo’lini o’rgan va ularga hurmat bilan qara.

5.Faqatgina munozara mavzusi bo’yicha gapirishga harakat qil.

6.O’z nutqing bilan boshqalarni behurmat qilishdan cheklan.

Foydalanilgan adabiyotlar

1 Rashidov T.R. va boshqalar. «Nazariy mexanika asoslari», T, «O’qituvchi»,1991 y.

2. O.E.Kere va boshqalar. «Nazariy mexanika fanidan qisqa masalalar to’plami», T, «Yangi asr avlodi»,2008 y.

3- mustaqil ish mavzusi
Nuqta kinematikasi va nuqtaning berilgan harakat tenglamasiga ko'ra tezligi, tezlanishini aniqlash

Reja:

1. Burchakli koordinatalar sistemasida nuqtaning traektoriyasi va tezligi.
2-masala. (K7.1.3). Nuqtaning harakati koordinatalar ko'rinishida: $x = 3t,\ y = t^2$ berilgan bo'lsa, t=2s paytida nuqta koordinata boshidan qancha masofaga uzoqlashadi? (7,21)
3.Nuqtaning urinma va normal tezlanishlari.
4- masala (K.7.2.5). Nuqtaning tezligi $\vec{\vartheta} = 2t\vec{i} + 3\vec{j}$ berilgan bo'lsa, t=4s paytda tezlik vektori va Ox o'qi orasidagi burchakni graduslarda toping. (20,6)
5. Harakat qonuni tabiiy usulda berilgan nuqtaning tezlanishi.
6- masala (K.7.4.6). Nuqtaning tezlik vektori $\vec{\vartheta} = 0{,}9t\vec{i} + t^2\vec{j}$ bo'lsa,t=1,5s vaqtdagi tezlanishni aniqlaqng. (3,13)
7. K-1. Hisob-grafik topshiriq. Nuqtaning berilgan harakat tenglamasiga ko'ra tezligini va tezlanishini aniqlash.

Tayanch so'z va iboralar: 1) nuqtaning traektoriyasi (nuqta harakatlanganda uning berilgan sanoq sistemasiga nisbatan chizgan uzluksiz chizig'i nuqtaning traektoriyasi deyiladi) ; 2) to'g'ri chiziqli harakat (agar nuqta traektoriyasi to'g'ri chiziqdan iborat bo'lsa,uning harakati to'g'ri chiziqli harakar deyiladi; 3) nuqta harakatining vektori usuli()($\vec{r} = \vec{r}(t)$); 5) tabiiy usuli (s=s(t)); 7) nuqta harakatini koordinatalar usulida ifodalash($x = x(t); y = y(t); z = z(t)$); 8) harakati koordinatalar usulida berilgan nuqta tezligi $\vec{\vartheta} = \vartheta_x\vec{i} + \vartheta_y\vec{j} + \vartheta_z\vec{k}$ 9) harakati vertor usulida berilgan nuqtaning tezlanishi $\vec{a} = \frac{d\vec{\vartheta}}{dt} = \frac{d^2\vec{r}}{dt^2}$ 10) harakati koordinatalar usulida berilgan nuqtaning tezlanishi $\vec{a} = a_x\vec{i} + a_y\vec{j} + a_z\vec{k}$ 11) Egri chiziqli harakatda nuqtaning urinma va normal tezlanishlari $\vec{a}_\tau = \frac{d\vec{\vartheta}_\tau}{dt}, \vec{a}_n = \frac{\vec{\vartheta}^2}{\rho}$ 12) harakat qonuni tabiiy usulda berilgan nuqtaning tezlanishi. $\vec{a}_\tau = \frac{d\vec{\vartheta}_\tau}{dt}, \vec{a}_n = \frac{\vec{\vartheta}^2}{\rho}, \vec{a}_b = 0$

.

K – 1. (Grafik topshiriq). Nuqta harakatining berilgan tenglamasiga ko'ra tezlik va tezlanishini aniqlash.

M nuqta harakatining berilgan tenglamasiga asosan uning traektoriya tenglamasini va vaqtning $t=t_1$ paytida nuqtaning traektoriyasidagi o'rni (koordinatasi)ni,uning tezligini,urinma,normal va to'la tezlanishini, hamda traektoriyasining egrilik radiusini aniqlang. Yechish uchun zarur bo'lgan kattaliklarni 1-jadvaldan oling.

1-jadval

Variant nomeri	Harakat tenglamasi		Vaqt, s
	X=x(t) , sm	Y= y(t) , sm	t_1
1	$-2t^2+3$	-5t	1/2
2	$4\cos^2((\pi t/3)+2$	$4\sin^2(\pi t/3)$	1
3	$-\cos(\pi t^2/3)+3$	$\sin(\pi t^2/3)-1$	1
4	4t +4	-4/(t+1)	2
5	$2\sin(\pi t/3)$	$-3\cos(\pi t/3)+4$	1
6	$3t^2+2$	-4t	1/2
7	$3t^2$-t+1	$5t^2$-5t/3-2	1
8	$7\sin(\pi t^2/6)+3$	$2-7\cos(\pi t^2/6)$	1
9	-3/(t+2)	3t+6	2
10	$-4\cos(\pi t/3)$	$-2\sin(\pi t/3)-3$	1
11	$-4t^2$+1	-2t	1/2
12	$5\sin^2(\pi t/6)$	$-5\cos^2(\pi t/6)-3$	1
13	$5\cos(\pi t^2/3)$	$-5\sin(\pi t^2/3)$	1
14	-2t-2	-2/(t_+1)	2
15	$4\cos(\pi t/3)$	$-3\sin(\pi t/3)$	1
16	3t	$4t^2+1$	1/2
17	$7\sin^2(\pi t/6)-5$	$-7\cos^2(\pi t/6)$	1
18	$1+3\cos(\pi t^2/3)$	$3\sin(\pi t^2/3+3$	1
19	$-5t^2$-4	3t	1
20	2-3t-$6t^2$	3-3t/2-$3t^2$	0
21	$6\sin(\pi t^2/6)-2$	$6\cos(\pi t^2/6)+3$	1
22	$7t^2-3$	5t	1/4
23	3-$3t^2$+t	4-$5t^2$ +5t/3	1
24	$-4\cos(\pi t/3)-1$	$-4\sin(\pi t/3)$	1
25	-6t	$-2t^2$ -4	1
26	$8\cos^2(\pi t/6)+2$	$-8\sin^2(\pi t/6)-7$	1
27	$-3-9\sin(\pi t^2/6)$	$-9\cos(\pi t^2/6)+5$	1
28	$-4t^2$ +1	-3t	1
29	$5t^2$ +5t/3-3	$3t^2$ +t+3	1

K1.topshiriqqa doir masalalar yechish namunalari (Variant-28) .

Berilganlar: $X=-4t^2+1$, y==-3t, t_1=1 s (1)

V_x-?, v_y-?, v- ?, a_x -?, a_y -?,a -?, a_τ -?, a_n= ?, $\rho-?$

(1)dan vaqtni yo'qotish uchun mazkur tenglamaning birinchisidan t ni topib, uni (1) ning ikkinchisiga qo'ysak,traektoriya tenglamasi kelib chiqadi.

$$4tx-1; t=\sqrt{\frac{x-4}{4}}=\frac{\sqrt{x-4}}{2} \quad , \quad y=-3*\frac{\sqrt{x-1}}{2}=-\frac{3}{2}\sqrt{x-1} \qquad (2)$$

(2)dan ko'rinadiki, nuqta traektoriyasi to'g'ri chiziqdan iborat ekan.

t=1 sekundda nuqta koordinatalari: x=-3 sm , y=-3 sm

(1) dan vaqt bo'yicha hosila olib, tezlik proeksiyalari va tezlik modulini topamiz: $\vartheta_x = \dot{x} = -8t : \vartheta_y = \dot{y} = -3$ (3)

t=1 s da $\vartheta_x = -8sm/s; \vartheta_y = -3sm/s$

$$\vartheta = \sqrt{\vartheta_x^2 + \vartheta_y^2} = \sqrt{(-8)^2 + (-3)^2} = \sqrt{73} = 8{,}54sm/s \quad (4)$$

(3) dan hosila olsak:

$$a_x = \dot{\vartheta}_x = -8\frac{sm}{s}; a_y = \dot{\vartheta}_y = 0 \quad (5)$$

$$a = \sqrt{a_x^2 + a_y^2} = \sqrt{64 + 0^2} = 8\frac{sm}{s^2}$$

Urinma tezlanishni aniqlaymiz:

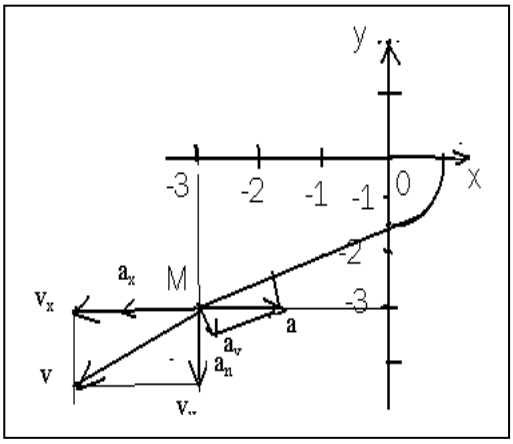
$$a_\tau = \frac{\vartheta_x a_x + \vartheta_y a_y}{\vartheta} = \frac{(-8)*(-8)+0}{8{,}54} = 7{,}82\frac{sm}{s^2} \quad (6)$$

Normal tezlanish quyidagicha bo'ladi

$$a_n = \sqrt{a^2 - a_\tau^2} = \sqrt{8^2 - (7{,}8)^2} = 1{,}73\frac{sm}{s^2} \quad (7)$$

Egrilik radiusi esa :

$$\rho = \frac{\vartheta^2}{a_n} = \frac{(8{,}54)^2}{1{,}73} = 42sm \quad (8)$$



1-rasm

(2) dan ko'ramizki, nuqta traektoriyasi to'g'ri chiziqdan iborat. t=1s sekunddagi barcha kinematik parametrlar yo'nalishini rasmda ko'rsatamiz (1 -rasm). t=1 s da nuqta koordinatalari x=-3 sm, y=-3 sm.

Vaqtning t=1s da (3)- (8) ifodalar bilan hisoblanadigan kattaliklarning qiymatlari 2-jadvalda keltirilgan.

2-jadval.

Koor-talar,sm		**Tezliklar,sm/s**			**Tezlanishlar, sm/s^2**					**Egrilik radiusi,sm**
x	y	v_x	v_y	v	a_x	a_y	a	a_τ	a_n	ρ
-3	-3	-8	-3	8,5	-8	0	8	7,82	1,73	42

K-1. V-26. Berilganlar:

$x = 8\cos^2(\frac{\pi t}{6}) + 2 = 6 + 4\cos\frac{\pi t}{3}$; $y = -8\sin^2(\frac{\pi t}{6}) - 7 = -11 + 4\cos\frac{\pi t}{3}$, t_1=1 s. (1)

Yechish. Harakatning izini koordinata ko'rinishdagi tenglamasidan vaqt t ni yo'qoptib,

$x - y = 17;\ y = x - 17$ (2)

Nuqtaning izi to'g'ri 1 chiziqdan iborat bo'ladi (1-rasm).

Nuqtaning tezlik vektori; $\vec{\vartheta} = \vartheta_x\vec{i} + \vartheta_y\vec{i}$ (3)

Nuqtaning tezlanish vektori: $\vec{a} = a_x\vec{i} + a_y\vec{j}$ (4)

Bu yerda $\vec{i}, \vec{j}$ - x,y o'qlarning ortlari (birlik vektorlari); $\vartheta_u, \vartheta_y, a_x, a_y$ - nuqtaning tezlik va tezlanishini koordinata o'qlardagi proeksiyalari.

(1) dan vaqt bo'yicha hosila olib, quyidagi harakat tenglamasini hosil qilamiz.

$$\vartheta_x = \dot{x} = -\frac{4\pi}{3}\sin\frac{\pi t}{3} \quad , \vartheta_y = \dot{y} = -\frac{4\pi}{3}\sin\frac{\pi t}{3} \qquad (5)$$

t=1 s da $\vartheta_x = -3{,}63 sm/s; \vartheta_y = -3{,}63 sm/s$

$$\vartheta = \sqrt{\vartheta_x^2 + \vartheta_y^2} = \sqrt{(-3{,}63)^2 + (-3{,}63)^2} = 5{,}62 sm/s$$

(5) dan hosila olsak:

$$a_x = \dot{\vartheta}_x = -\frac{4\pi^2}{9}\cos\frac{\pi t}{3} = -2{,}2\frac{sm}{s^2}; a_y = \dot{\vartheta}_y = -\frac{4\pi^2}{9}\cos\frac{\pi t}{3} = -2{,}2\frac{sm}{s^2}$$

$$a = \sqrt{a_x^2 + a_y^2} = \sqrt{(\ 2{,}22)^2 + (\ 2{,}22)^2} = 3{,}15\frac{sm}{s^2}$$

Urinma tezlanishni aniqlaymiz:

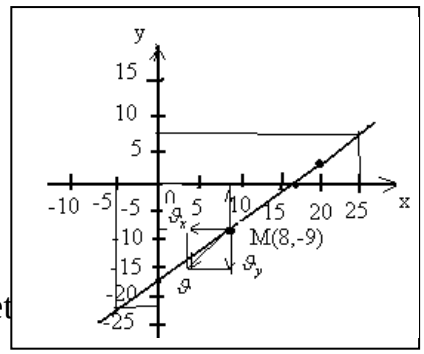
$$a_\tau = \frac{\vartheta_x a_x + \vartheta_y a_y}{\vartheta} = \frac{(-3{,}63)*(-2{,}2) + (-3{,}63)(-2{,}2)}{5{,}62} = 3{,}12\frac{sm}{s^2} \qquad (6)$$

Normal tezlanish quyidagicha bo'ladi.

$$a_n = \sqrt{a^2 - a_2} = \sqrt{3{,}15^2 - (3{,}12)^2} = 0 \qquad (7)$$

Egrilik radiusi esa :

$$\rho = \frac{\vartheta^2}{a_n} = \frac{(5{,}62)^2}{0} = \infty \qquad (8)$$



2-rasm

(2)dan ko'ramizki, nuqta traektoriyasi to'g'ri chiziq-dan iborat. t=1s sekunddagi barcha kinematik paramet yo'nalishini rasmda ko'rsatamiz (1 -rasm). t=1 s da nuqta koordinatalari x=8 sm, y=-9 sm.

Vaqtning t=1s da (3)- (8) ifodalar bilan hisoblanadigan kattaliklarning qiymatlari 2-jadvalda keltirilgan.

2-jadval.

Koor-talar,sm		**Tezliklar,sm/s**			**Tezlanishlar, sm/s^2**					**Egrilik radiusi,sm**
x	y	v_x	v_y	v	a_x	a_y	a	a_τ	a_n	ρ
8	-9	-3,63	-3,63	5,64	-2,2	-2,2	3,15	3,15	0	∞

Nazorat savollari.

1. Nuqtaning traektoriyasi deb nimaga aytiladi?
2. To'g'ri chiqli harakat deb qanday harakatga aytiladi?
3. Nuqta harakatining vektorli , tabiiy , koordinata usullarini tushuntiring.
4. Nuqta harakatining vektor ko'rinishining kinematik tenglamasini yozib tushuntiring.
5. Harakati koordinatalar usulida berilgan nuqta tezligi ifodasini yozib tushuntiring.
6. Harakati vektor usulida berilgan nuqtaning tezlanishini yozing.
7. Harakati koordinatalar usulida berilgan nuqtaning tezlanishini yozing.
8. Nuqtaning urinma va normal tezlanishlari ifodalarini yozib tushuntiring.
9. Harakat qonuni tabiiy usulda berilgan nuqtaning tezlanishi ifodasini yozing.

1-test. Quyidagi ifodalardan nuqta harakatining vektorli ifodasini, harakati vektor usulida berilgan nuqtaning tezlanishi ifodasini va egri chiziqli harakatda nuqtaning urinma va normal tezlanishlari ifodalarini ko'rsating?

1. $\vec{r} = \vec{r}(t)$; 2. $x = x(t); y = y(t); z = z(t)$; 3. (s=s(t); 4. $\vec{\vartheta} = \vartheta_x \vec{i} + \vartheta_y \vec{j} + \vartheta_z \vec{k}$; 5.

$\vec{a} = \frac{d\vec{\vartheta}}{dt} = \frac{d^2\vec{r}}{dt^2}$;6. $\vec{a} = a_x \vec{i} + a_y \vec{j} + a_z \vec{k}$;7. $\vec{a}_\tau = \frac{d\vec{\vartheta}_\tau}{dt}, \vec{a}_n = \frac{\vec{\vartheta}^2}{\rho}$; 8. $\vec{a}_\tau = \frac{d\vec{\vartheta}_\tau}{dt}, \vec{a}_n = \frac{\vec{\vartheta}^2}{\rho}, \vec{a}_b = 0$

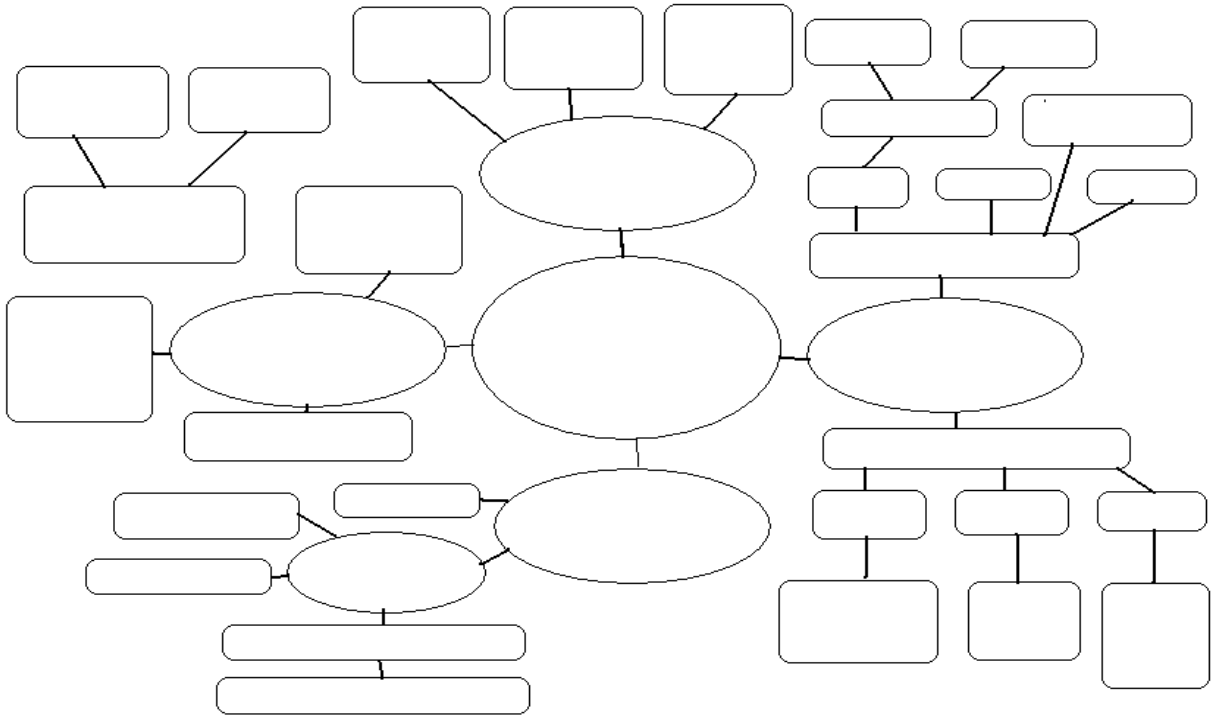
2-test. Quyidagi ifodalardan nuqta harakatini koordinatalar usulidagi ifodasi, harakati koordinatalar usulida berilgan nuqta tezligi, harakati koordinatalar usulida berilgan nuqtaning tezlanishi ifodalarini ko'rsating?

1. $\vec{r} = \vec{r}(t)$; 2. $x = x(t); y = y(t); z = z(t)$; 3. (s=s(t); 4. $\vec{\vartheta} = \vartheta_x \vec{i} + \vartheta_y \vec{j} + \vartheta_z \vec{k}$; 5.

$\vec{a} = \frac{d\vec{\vartheta}}{dt} = \frac{d^2\vec{r}}{dt^2}$;6. $\vec{a} = a_x \vec{i} + a_y \vec{j} + a_z \vec{k}$;7. $\vec{a}_\tau = \frac{d\vec{\vartheta}_\tau}{dt}, \vec{a}_n = \frac{\vec{\vartheta}^2}{\rho}$; 8. $\vec{a}_\tau = \frac{d\vec{\vartheta}_\tau}{dt}, \vec{a}_n = \frac{\vec{\vartheta}^2}{\rho}, \vec{a}_b = 0$

Klasterni tuzish qoidalari **13-ilova**

1. Topshiriqni diqqat bilan o'qib chiqing.
2. Fikrlarni tarmoqlantirish jarayonida paydo bo'lgan har bir fikrni yozing.
3. Imlo xatolar va boshqa jihatlarga e'tibor bermang.
4. Belgilangan vaqt tugamaguncha yozishni to'xtatmang, fikringizni jamlashga harakat qiling.
5. Fikrlarni chegaralamang, ular o'rtasida o'zaro aloqadorlikka e'tibor qarating.



Foydalanilgan adabiyotlar

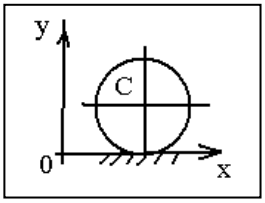
1. **Rashidov T.R. va boshqalar. «Nazariy mexanika asoslari», T, «O'qituvchi»,1991 y.**
2. **O.E.Kere va boshqalar. «Nazariy mexanika fanidan qisqa masalalar to'plami», T, «Yangi asr avlodi»,2008 y.**

4- mustaqil ish mavzusi
Qattiq jismning tekis parallel harakati va yassi jismning kinematik analizi.

Reja:

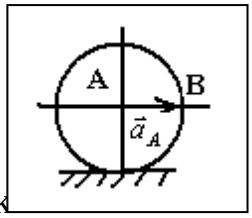
1. Tekis shaklning burchak tezligi va burchak tezlanishi.

2. m.(K.9.2.2). Qattiq jism $x_A = 2t^2, y_A = 0{,}2m, \varphi = 10t^2$ tenglamaga asosan tekis parallel harakat qiladi. t_1= 1s paytdagi jismning burchak tezligini toping. (20)



3.Tekis shakl nuqtasining tezligi va tezlanishi.

4. 2.masala (K.9.3.3). Sirpanmasdan dumalayotgan g'ildirak $x_C = 2t^2, y_C = 0{,}5m$ qonun bo'yicha harakat qilsa, uning burchak tezlanishi ε qancha bo'ladi? (8).



5. Erkin jism nuqtasining tezligi va tezlanishi.

6. 3.masala (K.9.7.5). G'ildirak sirpanmasdan dumalaydi. Uning B nuqtasining tezlanishini A nuqtaning tezligi va tezlanishi: $\vartheta_A = 0$ va $a_A = 2m/s^2$ holat uchun hisoblang. (2.83).

7. K-3. Hisob-grafik topshiriq. Yassi mexanizmning kinematik analizi.

Tayanch so'z va iboralar: **1)** Jismning tekis parallel harakati; 2) tekis shaklning harakat tekisligi; 3) tekis shakl harakatining kinematik tenglamalari $x_0 = f_1(t), y_0 = f_2(t), \varphi_0 = f_3(t)$ 4) tekis shaklning burchak tezligi $\omega_z = \frac{d\varphi}{dt}$ 5) tekis shaklning burchak tezlanishi $\varepsilon_z = \frac{d\omega_z}{dt} = \frac{d^2\varphi}{dt^2}$ 6) tekis shakl nuqtasining tezligi $\vec{\vartheta}_M = \vec{\vartheta}_0 + \vec{\vartheta}_{MO}$ 7)M nuqta tezligining miqdori $\vartheta_M = \sqrt{\vartheta_0^2 + \vartheta_{MO}^2 + 2\vartheta_0\vartheta_{MO}\cos\alpha}$ 8) tekis shakl nuqtasining tezlanishini qutb usulida aniqlash $\vec{a}_M = \vec{a}_0 + \vec{a}_{MO}^{\tau} + \vec{a}_{MO}^{n}$ 9) tezlanishlar oniy markazi.

.

K-3. Hisob-grafik topshiriq

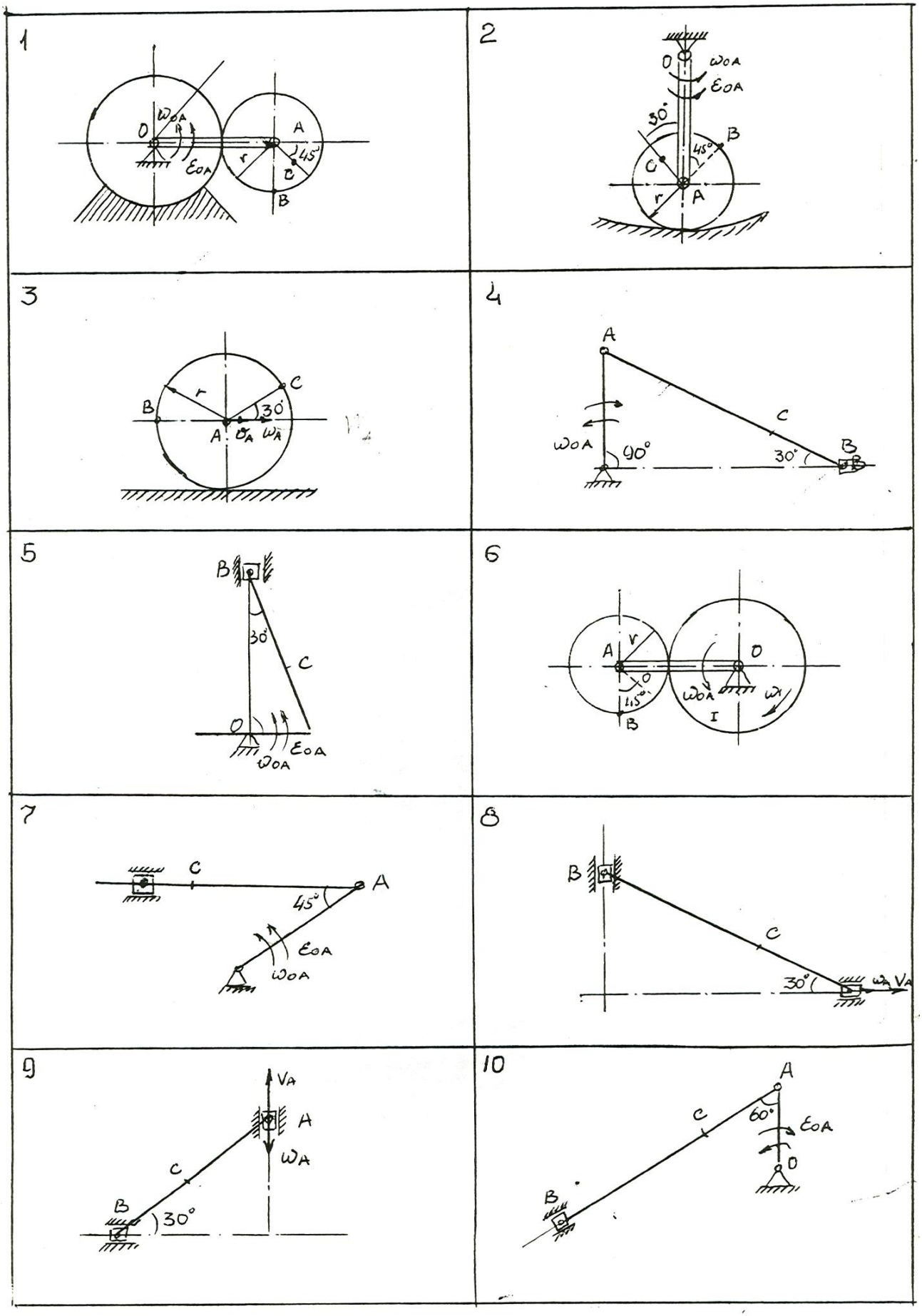
Tekis parallel harakatdagi qattiq jism nuqtalarining tezlik va tezlanishlarini aniqlash.

Mexanizmning berilgan holati uchun V va S nuqtalarining tezlik va tezlanishlari , hamda shu nuqtalari yotgan zvenolarining burchak tezligi va burchak tezlanishlari aniqlansin**.** Mexanizmlarning sxemasi 1,2,3-rasm(K-3)larda ko'rsatilgan, hisoblash uchun zarur bo'lgan kattaliklar 1-jadvalda keltirilgan.

1-jadval.

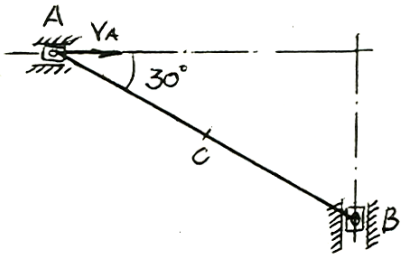
Variant raqami	O'lchamlari, sm				ω_{0A}, $rad/.s$	ω_1, ras/s	ε_{0A}, rad/s^2	$\vartheta_A, sm/s$	a_A, sm/s^2
	OA	r	AB	AC					
1	2	3	4	5	6	7	8	9	10
1	40	15	-	8	2	-	2	-	-
2	30	15	-	8	3	-	2	-	-
3	-	50	-	-	-	-	-	50	100
4	35	-	-	45	4	-	8	-	-
5	25	-	-	20	1	-	1	-	-
6	40	15	-	6	1	1	0	-	-
7	35	-	75	60	5	-	10	-	-
8	-	-	20	10	-	-	-	40	20
9	-	-	45	30	-	-	-	20	10
10	25	-	80	20	1	-	2	-	-
11	-	-	30	15	-	-	-	10	0
12	-	-	30	20	-	-	-	20	20
13	25	-	55	40	2	-	4	-	-
14	45	15	-	8	3	12	0	-	-
15	40	15	-	8	1	-	1	-	-
16	55	20	-	-	2	-	5	-	-
17	-	30	-	10	-	-	-	80	50
18	10	-	10	5	2	-	6	-	-
19	20	15	-	10	1	2,5	0	-	-
20	-	-	20	6	-	-	-	10	15
21	30	-	60	15	3	-	8	-	-
22	35	-	60	40	4	-	10	-	-
23	-	-	60	20	-	-	-	5	10
24	25	-	35	15	2	-	3	-	-
25	20	-	70	20	1	-	2	-	-
26	20	15	-	10	2	1,2	0	-	-
27	-	15	-	5	-	-	-	60	30
28	20	-	50	25	1	-	1	-	-
29	12	-	35	15	4	-	6	-	-
30	40	-	-	20	5	-	10	-	-

Eslatma. ω_{0A} $vva\varepsilon_{0A}$ - mexanizmning berilgan holatida krivoship OA ning burchak tezligi va burchak tezlanishi; ω_1 - 1 g'ildirakning burchak tezligi(o'zgarmas); ϑ_A va a_A - A nuqtaning tezlik va tezlanishi. G'ildiraklarning aylanishi ishqalanishsiz bo'ladi.


1
O
ωOA
εOA
r
A
45°
C
B
2
O
ωOA
εOA
30°
B
45°
C
r
A
3
B
r
C
30°
A
εA
ωA
4
A
C
ωOA
90°
30°
B
5
B
30°
C
O
εOA
ωOA
6
A
r
O
ωOA
ω1
45°
B
I
7
C
A
45°
εOA
ωOA
8
B
C
30°
ωA
VA
9
VA
A
ωA
C
B
30°
10
A
C
60°
εOA
O
B

1-rasm (k-3)

11



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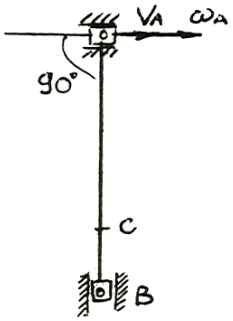

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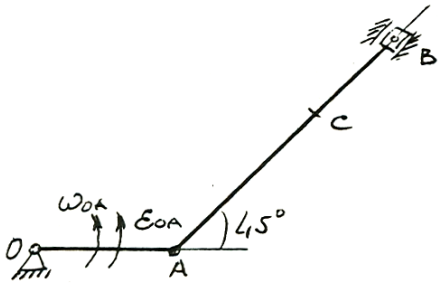

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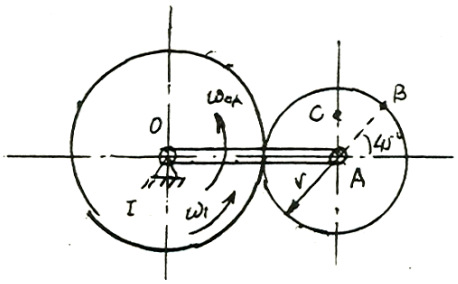

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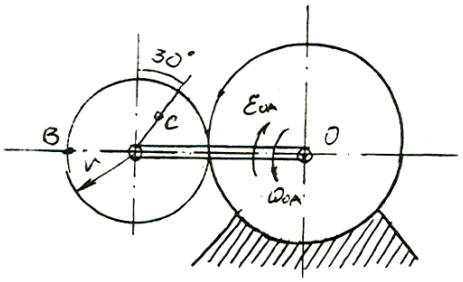

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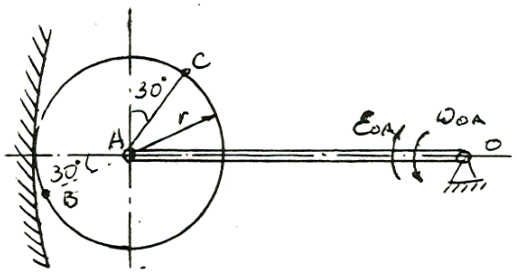

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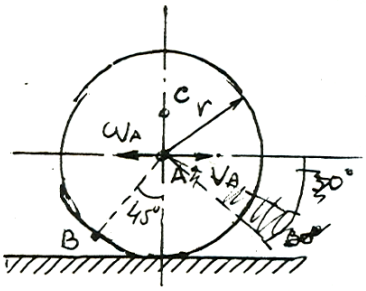

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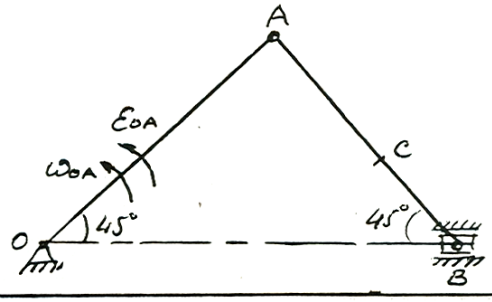

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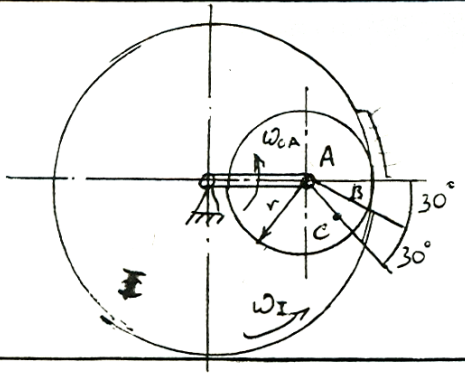

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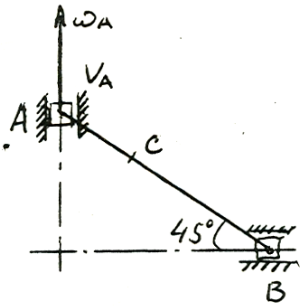
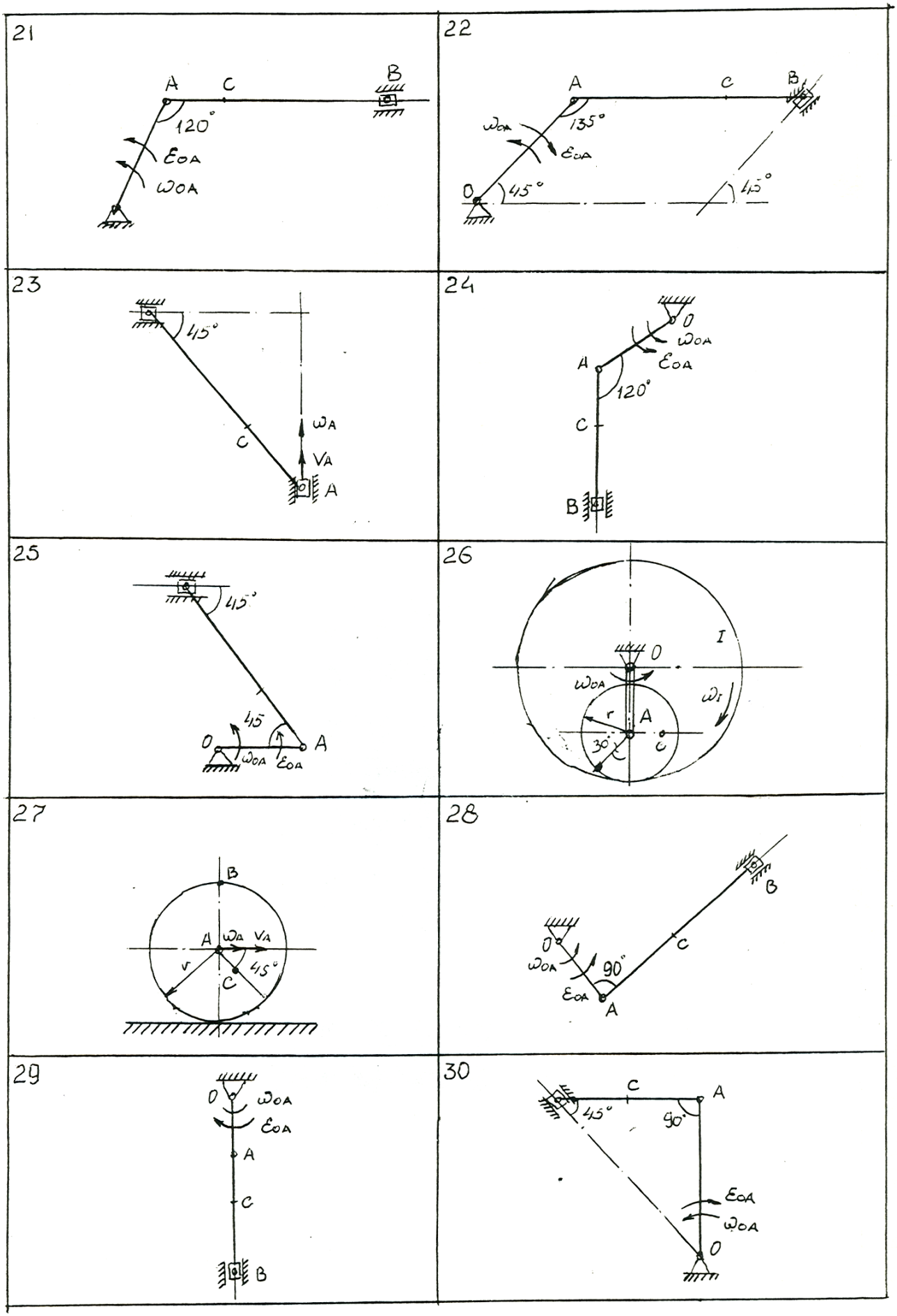



21
A
C
B
120°
εOA
ωOA
22
A
C
B
ωOA
135°
εOA
O
45°
45°
23
45°
C
ωA
VA
A
24
O
ωOA
εOA
A
120°
C
B
25
45°
45
O
A
ωOA
εOA
26
I
O
ωOA
ωI
r
A
30°
C
27
B
A
ωA
VA
r
45°
C
28
B
O
ωOA
C
90°
εOA
A
29
O
ωOA
εOA
A
C
B
30
C
A
45°
90°
εOA
ωOA
O

3-rasm (K-3)

K-3. Topshirig'iga doir masalalar yechish namunalari.

1-masala. Mexanizmning berilgan holati uchun B va C nuqtalarining tezlik va tezlanishlari , hamda shu nuqtalari yotgan zvenolarining burchak tezligi va burchak tezlanishlari aniqlansin.

Berilganlar. OA=10 sm,AB=60 sm,AC=20 sm, $\omega_{OA}=1{,}5rad/s, \varepsilon_{OA}=2rad/s^2$, $\vartheta_B-?, a_B-?, \vartheta_C-?, a_C-?$

Yechish. 1. Zvenoning burchak tezligini va nuqtaning tezligini aniqlang. Zevenoning berilgan holatida OA krivoshipni A barmog'ini tezligini modulini hisoblaymiz.OA krivoshipga A nuqtasining tezligi perpendikulyar bo'ladi.

$$\vartheta_A=\omega_{OA}OA=1{,}5*10=15\frac{sm}{s} \qquad (1)$$

Shatun AB dagi A va B nuqtalarining tezligiga o'tkazilgan perpendikulyar chiziqning kesishish nuqtasi P_{AB} ga tezliklar oniy markazi deyiladi (1-rasm).

AB zvenoning burchak tezligi

$$\omega_{AB}=\frac{\vartheta_A}{AP_{AB}} \qquad (2)$$

B va C nuqtalar tezligining miqdori

$$\vartheta_B=\omega_{AB}BP_{AB}\ ,\vartheta_C=\omega_{AB}CP_{AB} \qquad (3)$$

Uchburchak ABP_{AB} va ACP_{AB} lardan AP_{AB},BP_{AB} va CP_{AB} masofalar aniqlanadi.

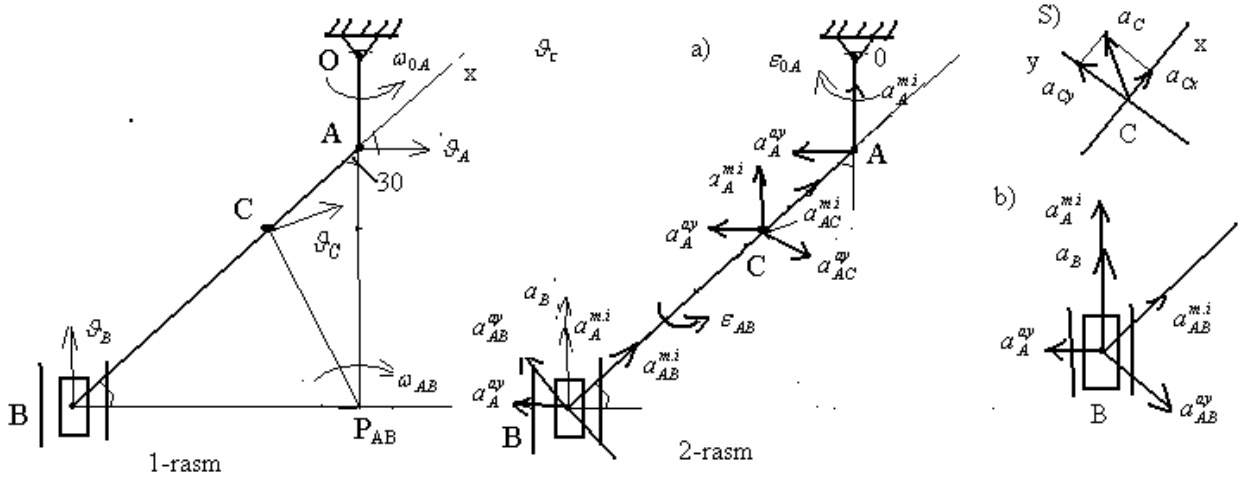
$$SSi60^0=\frac{AP_{AB}}{AB}; AP_{AB}=AB\sin 60^0=60*0{,}86=52sm$$

$$Cos60^0=\frac{BP_{AB}}{AB}; BP_{AB}=AB\cos 60^0=60*0{,}5=30sm$$

ΔACP_{AB} $ddanC_{AB}=\sqrt{AC^2+AP_{AB}^2-2BC*AP_{AB}*\cos 30^0}=36{,}1sm$ ni hisobladik. Bularni hisobga olib (3) ga asosan:

$$\omega_{AB}=\frac{\vartheta_A}{AP_{AB}}=\frac{15}{52}=0{,}29\frac{rad}{s}, \vartheta_B=0{,}29*30=8{,}7\frac{m}{s}, \vartheta_C=0{,}29*36{,}1=10{,}5\frac{sm}{s}$$

$\overline{\vartheta}_C$ vector CP_{AB} ga perpendikulyar bo'lib,AB zvenoning yo'nalishi tomonga yo'nalgan bo'ladi.



1-rasm 2-rasm

Tekshirish uchun B nuqtaning tezligini boshqa usul bilan aniqlaylik. Nuqta tezliklarini ulardan o'tuvchi o'qlarni proeksiyalari tengligi haqidagi teoremaga asosan aniqlaymiz. AB shatunni B uchidan A o'qiga qarab x o'qini o'tkazamiz . 1-rasmdan quyidagini aniqlaymiz;

$$\vartheta_A \cos(\vec{\vartheta}_A; x) = \vartheta_B \cos(\vec{\vartheta}_B, x) \qquad (4)$$

Yoki $\vartheta_A \cos 60^0 = \vartheta_B \cos 30^0$

Bundan $\vartheta_B = \dfrac{\vartheta_A \cos 60^0}{\cos 30^0} = 8{,}7sm.$

3. Zvenoning burchak tezlanishi va nuqtalari tezlanishini aniqlash (2-rasm).

A nuqtaning tezlanishi aylanma va markazga intelma tezlanishlarining yig'indisiga teng bo'ladi.

$$\vec{a}_A = \vec{a}_A^{ay} + \vec{a}_A^{m.i}; a_A^{ay} = \varepsilon_{OA} * OA; a_A^{m.i} = \omega_{OA}^2 * OA \qquad (5)$$

Yassi figuralar nuqtalarining tezlanishi haqidagi teoremaga asosan

$$\vec{a} = \vec{a}_A + \vec{a}_{AB}^{ay} + \vec{a}_{AB}^{m.i}$$

Yoki $\vec{a} = \vec{a}_A^{ay} + \vec{a}_A^{m.i} + \vec{a}_{AB}^{ay} + \vec{a}_{AB}^{m.i}$ (6)

AB shatunning B nuqtasi markazga intelma tezlanishi

$$a_{AB}^{m.i} = \omega_{AB}^2 * AB \qquad (7)$$

Keltirilgan formulalarni hisoblaymiz;

$$a_A^{ay} = \varepsilon_{OA} OA = 2 * 10 = 20 \frac{sm}{s^2}; a_A^{m.i} = \omega_{OA}^2 * OA = 1{,}5^2 * 10 = 22{,}5 \frac{sm}{s^2}$$

$$a_{AB}^{m.i} = \omega_{AB}^2 * AB = 0{,}29^2 * 60 = 5 \frac{sm}{s^2}$$

Vektor $a_A^{m.i}$ A dan O ga qarab yo'nalgan a_A^{ay} vektor $a_A^{m.i}$ ga perpendikulyar $\varepsilon_{\Phi II}$ yo'nalishida yo'nalgan bo'ladi. $\vec{a}_B$ polzundan yuqoriga vertikal yo'nalgan, a_{AB}^{ay} tezligi esa AB ga perpendikulyar yo'nalgan bo'ladi.

X va Y o'qining tanlangan yo'nalishda (6)ning proeksiyasi quyidagicha bo'ladi (2-rasm,a).

$$a_B \cos 30^0 = -a_A^{ay} \cos 60^0 + a_A^{m.i} \cos 30^0 + a_{AB}^{m.i} \qquad (8)$$

$$a_B \cos 60^0 = a_A^{ay} \cos 30 + a_A^{m.i} \cos 60^0 + a_{ab}^{ay} \qquad (9)$$

(8) dan $a_B = 16{,}7 \dfrac{sm}{s^2}$,(9) dan $a_{AB}^{ay} = -20{,}2 \dfrac{sm}{s^2}$ larni aniqladik.

AB shatunning burchak tezligini $\varepsilon_{AB} = \left|a_{AB}^{ay}\right| / ab = 0{,}34 \dfrac{rad}{s}$

C nuqtaning tezlanishini aniqlaymiz

$$\vec{a}_C = \vec{a}_A^{ay} + \vec{a}_A^{m.i} + \vec{a}_{AC}^{ay} + \vec{a}_{AC}^{m.i} \qquad (11)$$

$$a_{AC}^{ay} = \varepsilon_{AB} AC = 6{,}8sm/s; a_{AC}^{m.i} = \omega_{AB}^2 AC = 1{,}7sm/s$$

C nuqtaning tezlanishini proeksiya usuli bilan aniqlaymiz (2-rasm,S)

$$a_{Cx} = a_{AC}^{m.i} + a_A^{m.i} \cos 30^0 - a_A^{ay} \cos 60^0, a_{Cy} = a_A^{m.i} \cos 60^0 + a_A^{ay} \cos 30 - a_{AC}^{ay}$$

Tezlanishning modulini hisoblaymiz;

$a_C = \sqrt{(a_{Cx})^2 + (a_{Cy})^2} = 24{,}5sm/s^2$, a_{Cx}=11,9 sm/s^2 ,a_{Cy}=21,8 sm/s^2 .

2-masala. Mexanizmning berilgan holati uchun B va C nuqtalarining tezlik va tezlanishlari , hamda shu nuqtalari yotgan zvenolarining burchak tezligi va burchak tezlanishlari aniqlansin.

Berilgan: OA= 35 sm; AC= 40 sm; AB= 60 sm; $\omega_{oA} = 4rad/s;$ $\varepsilon_{oA} = 10rad/s^2$

Topish kerak: $\bar{v}_A, \bar{W}_A, \bar{v}_B, \bar{W}_B, \bar{v}_c va \bar{W}_c$

Yechish:

1. Mexanizm A nuqtasining tezligini aniqlash $v_A = \omega_{oA} OA = 4 \cdot 35 = 140sm/s$
2. $\vec{v}_A$- vektor A nuqtadan AO- ga perpendikulyar, ω_{oa}- ga mos ravishda yo'nalgan.
3. Mexanizm A nuqtasining tezlanishini $\vec{W}_A = \vec{W}_A^{\,n} + W_A^{\,\tau}$ ifoda yordamida topamiz:
4. $W_A^{\,n} = \omega_{OA}^{\,2} \cdot OA = 4^2 \cdot 35 = 560sm/s^2$ normal tezlanish A dan O ga yo'nalgan. $w_A^{\,n} = \omega_{OA}^{\,2} \cdot OA = 4^2 \cdot 35 = 560sm/s^2$, urinma tezlanish $\vec{v}_A \uparrow\downarrow \vec{W}_A^{\,\tau}$ kabi yo'nalgan

AB- shatunning P- oniy tezlik markaz A va B nuqtalardan $\vec{v}_A$ va $\vec{v}_B$ larga o'tkazilgan to'g'ri chiziqlar kesishgan nuqtasida bo'ladi.

ΔAPB da $\angle PAB = \angle PBA = 45^\circ$ bo'lganligi uchun $AP = BP = AB\cos 45^\circ = 60 \cdot \sqrt{2}/2 = 30 \cdot \sqrt{2} \approx 42{,}3sm$

ΔAPC dan esa

PC= $\sqrt{(AP)^2 + (AC)^2 - 2 \cdot AP \cdot AC \cos 45^\circ} = \sqrt{(30\sqrt{2})^2 + 40^2 - 2 \cdot 30\sqrt{2} \cdot 40 \cdot \sqrt{2}/2} =$
$\sqrt{900 \cdot 2 + 1600 - 2400} = \sqrt{1000} \approx 31{,}62sm$

5. $v_B = \omega_P \cdot PB = \frac{v_A}{AP} \cdot BP = \frac{140 \cdot 30\sqrt{2}}{30\sqrt{2}} = 140sm/s$

bunda $\omega_P = \frac{v_A}{AP} = \frac{140}{30\sqrt{2}} = \frac{14\sqrt{2}}{6} = \frac{7\sqrt{2}}{3} \approx 3{,}3sm$

$v_c = \omega_P \cdot PC = \frac{v_A}{AP} \cdot PC = 3{,}3 \cdot 31{,}62 \approx 105sm/s$

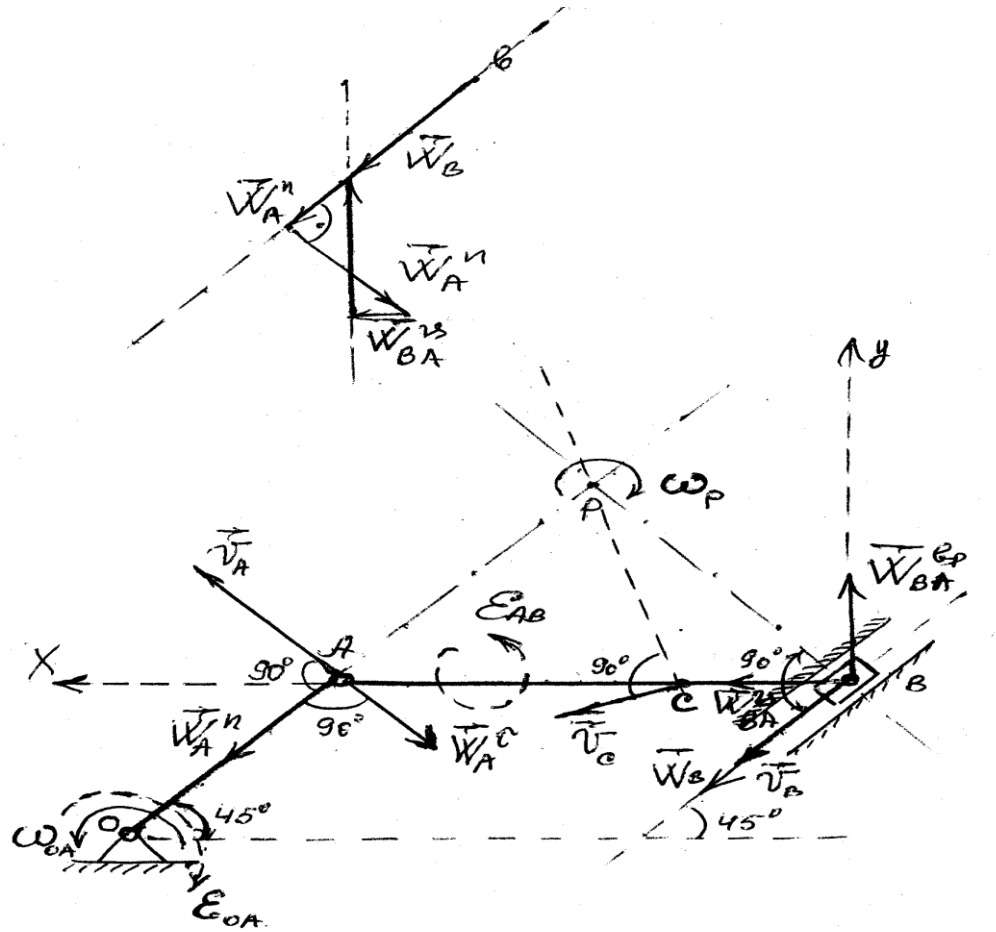
6. $\bar{v}_B$-Yo'naltiruvchi bo'ylab yo'naladi, $\bar{v}_c$ esa C nuqtadan ω_P ga mos ravishda CP-ga perpendikulyar yo'nalishda
7. AB- shatun B nuqtasining tezlanishini (3-rasm).

$\vec{w}_B = \vec{w}_A^{\,n} + \vec{w}_A^{\,\tau} + \vec{w}_{BA}^{\,m.i} + \vec{w}_{BA}^{\,ay}$ (2) ifoda yordamida aniqlaymiz. Bunda

$W_{BA}^{\,m.i} = \omega_p^{\,2} \cdot AB = (\frac{7\sqrt{2}}{3})^2 \cdot 60 = \frac{49 \cdot 2}{9} \cdot 60 \approx 53{,}4sm/s^2$

$\vec{W}_{BA}{}^{u}$ – vektor B da A nuqtaga yo'nalgan $\vec{W}_B$ va $\vec{W}_{BA}{}^{ep}$-larning yo'nalishlarini topish uchun B nuqta tezlanishlar planini yasaymiz. Endi bu vektorlar miqdorini aniqlash uchun (2) ifodani X va U o'qlariga proeksiyalaymiz.

$\vec{W}_A^n \perp \vec{W}_{BA}^{\tau}$ $\quad$ $\vec{W}^{m.i}{}_{BA} \perp W^{ay}{}_{BA}$,



3-rasm

$W_{BX} = W_B \cos 45°;$ $\quad W_B \cos 45° = W_A \cos 45° + W^{II}{}_{BA} - W^{\tau}{}_A \sin 45°$

$W_{BY} = -W_B \sin 45°;$ $\quad -W_B \sin 45° = W^{ep}{}_{BA} - W^{n}{}_A \sin 45° - W^{\tau}{}_A \cos 45°$

(3) dan $w^{m.i}{}_{BA} = w_A / \cos 45 + \dfrac{W^{II}{}_{BA}}{cos 45°} - W^{\tau}{}_A \dfrac{\sin 45°}{\cos 45°} = 560 + \dfrac{653{,}4}{\frac{\sqrt{2}}{2}} - 350 = 1134 \ ss \ / s^{\ 2}$

(4) dan $W_{BA}{}^{ep} = (W_A{}^{n} + W_A{}^{\tau} - W_B)\dfrac{\sqrt{2}}{2} = (560 + 350 - 303)\dfrac{\sqrt{2}}{2} = 429 sm/s^2$

8. Markazdan qochma $W_{BA}{}^{ep}$- tezlanish ikkinchi tomondan $W_{BA}{}^{ep} = \varepsilon_{AB} \cdot AB$ bo'lgani uchun $\varepsilon_{AB} = \dfrac{W_{BA}{}^{ep}}{AB} = \dfrac{429}{60} = 7{,}15 s^{-2}$

9. Endi C- nuqta tezlanishini

$$\vec{W}_c = \vec{W}_A{}^n + W_A{}^\tau + \vec{W}_{CA}{}^{Ц} + \vec{W}_{CA}{}^{вр}$$

Ifoda yordamida topamiz

$$W_{CA}{}^{Ц} = \omega_P{}^2 \cdot CA = (\frac{7\sqrt{2}}{3})^2 \cdot 40 = \frac{49 \cdot 2}{9} \cdot 40 = 435{,}56 sm/s^2;$$

$$W_{CA}{}^{вр} = \varepsilon_{AB} \cdot AB = 7{,}15 \cdot 40 = 286 sm/s^2$$

Endi W_c-ni aniqlash uchun (5) tenglamani o'qlarga proeksiyalaymiz

$$W_{cx} = W_{CA}{}^{Ц} + W_A{}^n \cos 45° - W_A{}^\tau \sin 45° = 435.56 + 560 \cdot \frac{\sqrt{2}}{2} - 350 \cdot \frac{\sqrt{2}}{2} \approx 584 см/сек^2$$

$$W_{cy} = W_{CA}{}^{вр} - W_A{}^n \sin 45° - W_A \cos 45° = 286 - 560\frac{\sqrt{2}}{2} - 350 \cdot \frac{\sqrt{2}}{2} \approx -357 sm/s^2$$

$$W_c = \sqrt{W_{cx}{}^2 + W_{cy}{}^2} = \sqrt{584^2 + (-357)^2} = \sqrt{341056 + 127449} = \sqrt{468505} \approx 684.5 sm/s^2$$

Nazorat savollari.

1. Jismning tekis parallel harakati deb nimaga aytiladi?
2. Tekis shaklning harakat tekisligini tushuntiring.
3. Tekis shakl harakatining kinematik tenglamalarini yozib tushuntiring.
4. Tekis shaklning burchak tezligi deb nimaga aytiladi?
5. Tekis shaklning burchak tezlanishi deb nimaga aytiladi?
6. Tekis shakl nuqtasining tezligi ifodasini yozib tushuntiring?
7. Tezliklar oniy markazi qanday aniqlanad?
8. Tekis shakl nuqtasining tezlanishini qutb usulida qanday aniqlanadi?
9. Tezlanishlar oniy markazi qanday aniqlanadi?

1-test. Quyidagi ifodalardan tekis shakl harakatining kinematik tenglamalari, tekis shaklning burchak tezlanishi, tekis shakl nuqtasining tezlanishi ifodalarini ko'rsating?

1. $x_0 = f_1(t), y_0 = f_2(t), \varphi_0 = f_3(t)$; 2. $\omega_z = \frac{d\varphi}{dt}$; 3. $\varepsilon_z = \frac{d\omega_z}{dt} = \frac{d^2\varphi}{dt^2}$; 4. $\vec{\vartheta}_M = \vec{\vartheta}_0 + \vec{\vartheta}_{MO}$;
5. $\vec{a}_M = \vec{a}_0 + \vec{a}^\tau_{MO} + \vec{a}^n_{MO}$; 6. $\vartheta_M = \sqrt{\vartheta_0^2 + \vartheta_{MO}^2 + 2\vartheta_0\vartheta_{MO}\cos\alpha}$

2-test. Quyidagi ifodalardan tekis shaklning burchak tezligi, tekis shakl nuqtasining tezligi, M nuqta tezligining miqdori ifodalarini ko'rsating?

1. $x_0 = f_1(t), y_0 = f_2(t), \varphi_0 = f_3(t)$; 2. $\omega_z = \frac{d\varphi}{dt}$; 3. $\varepsilon_z = \frac{d\omega_z}{dt} = \frac{d^2\varphi}{dt^2}$; 4. $\vec{\vartheta}_M = \vec{\vartheta}_0 + \vec{\vartheta}_{MO}$;
5. $\vec{a}_M = \vec{a}_0 + \vec{a}^\tau_{MO} + \vec{a}^n_{MO}$; 6. $\vartheta_M = \sqrt{\vartheta_0^2 + \vartheta_{MO}^2 + 2\vartheta_0\vartheta_{MO}\cos\alpha}$

Foydalanilgan adabiyotlar

1 Rashidov T.R. va boshqalar. «Nazariy mexanika asoslari», T, «O'qituvchi»,1991 y.
2.M.M.Mirsaidov va boshqalar. «Nazariy mexanika», T, «Ilm ziyo» , 2009 y.
3. O.E.Kere va boshqalar. «Nazariy mexanika fanidan qisqa masalalar to'plami», T, «Yangi asr avlodi»,2008 y.

5- mustaqil ish mavzusi.
Nuqtaning murakkab hatakatidagi absolyut tezligi, tezlanishini aniqlash.

Reja:

1.Nuqta murakkab harakati tenglamasi va tezligi.

2- masala (K.11.2.1). Arava to'g'ri chiziqli yo'lda s=2t qonun asosida harakat qiladi.

M niqtaning aravaga nisbatan nisbiy harakat tenglamasi $x_M = 3t$ va $y_M = 4t$ bo'lsa, t=1s paytdagi M nuqtaning absolut tezligini toping. (6.40).

3. Murakkab harakatdagi nuqtaning tezlanishi.

4-masala (K.11.3.1). Arava gorizontal o'q bo'ylab harakatlanadi. Uning ichidagi M nuqta esa $x_1 = 0{,}3t^2$ va $y_1 = 0{,}5t^2$ tenglamalarga asosan siljiydi. Aravaning tezlanishi $a_e = 2m/s^2$ bo'lgan paytda nuqtaning absolut tezlanishini toping. (2,78)

5. Murakkab harakatda tezlanishlarni qo'shish.

6- masala (K.11.5.1). M nuqta koordinata boshidan sterjen bo'ylab harakatni boshlaydi. Uning tezligi o'zgarmas $\vartheta = 1m/s$ ga teng. Sterjen esa o'zgarmas $\omega = 2rad/s$ burchak tezlik bilan Oxy tekisligida aylanadi. M nuqtaning OM=0,5m paytdagi tezlanishini aniqlang. (4.47).

7. K-7 Hisob-grafik topshiriq. Murakkab harakatdagi nuqtaning absolyut tezligi va tezlanishini aniqlash

Tayanch so'z va iboralar: 1. Nuqtaning nisbiy harakati, 2. nuqtaning ko'chirma harakati, 3. Nuqtaning absolyut harakati, 4. Nuqtaning nisbiy harakat tenglamalarini Dekart koordinata o'qlaridagi ifodasi,5. Nuqtaning nisbiy tezligining ifodasi, 6. Nuqtaning ko'chirma tezligining ifodasi, 7. Nuqtaning absolyut tezligi ifodasi, 8. Nuqtaning absolyut tezligini qiymati(moduli) ni ifodasi, 9. Nuqtaning nisbiy tezlanishi, 10. Nuqtaning ko'chirma tezlanishi, 11. Koriolis tezlanishi, 12. Jukovskiy qoidasi bo'yicha Koriolis tezlanishi yo'nalishini aniqlash. 13. Nuqtaning absolyut tezlanishi, 14. Absolyut tezlanishning qiymati(moduli)ni ifodasi.

D jismga nisbatan M nuqta nisbiy harakat qilsin. M nuqtaning berilgan nisbiy harakat tenglamasi va D jism harakati uchun vaqtning $t=t_1$ paytdagi m nuqtaning absolyut tezligi va absolyut tezlanishi aniqlansin.

Mexanizm sxemasi 1-3(K-7) rasmda, hisoblash uchun zarur bo'lgan kattaliklar 1-jadvalda berilgan.

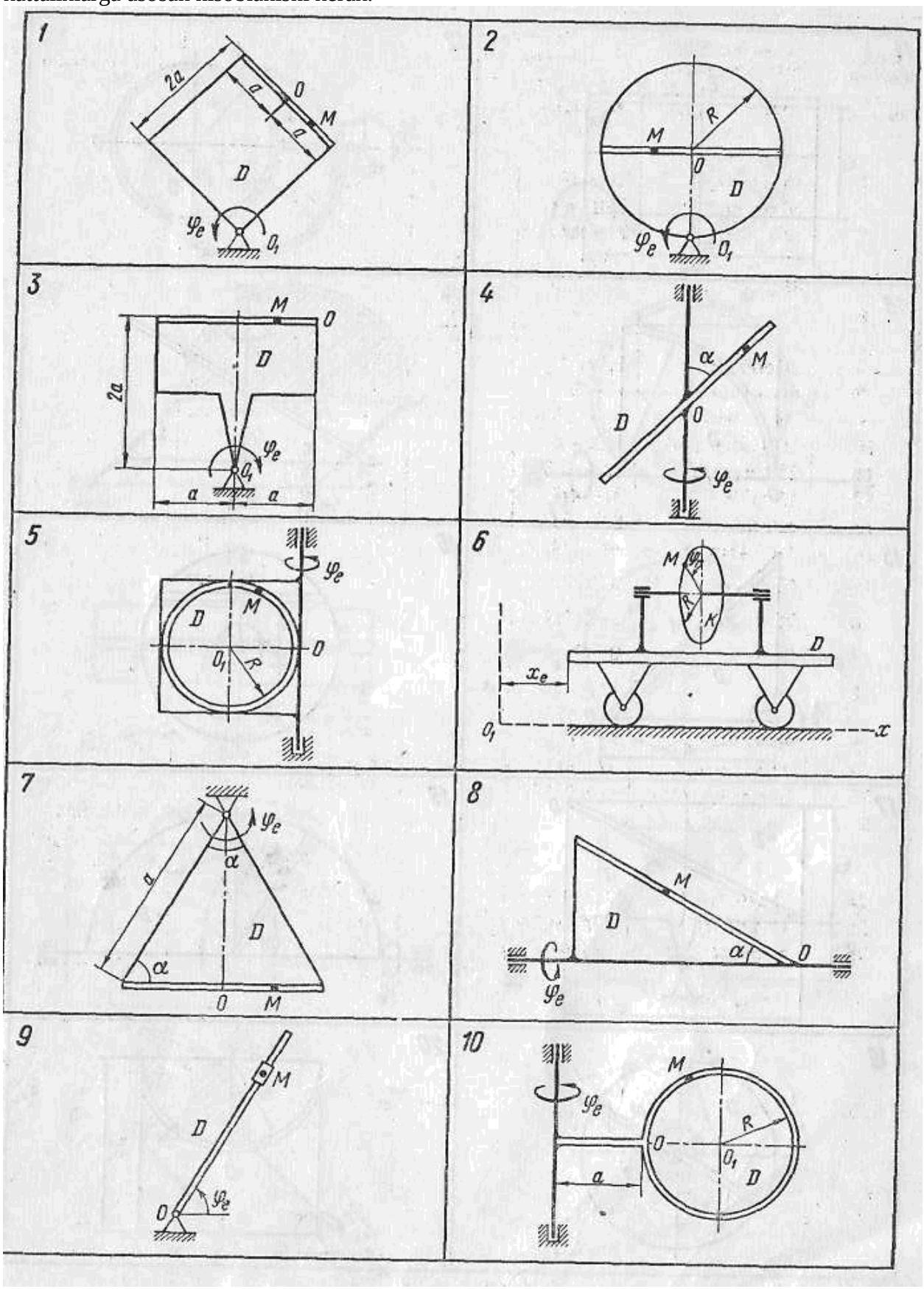
1- jadval

N.v.	Ur.ot.dv.toch. M OM=s_r=s_r(t),sm	Jismning har.teng		T_1, s	R, sm	A, sm	α, grad	Qushimcha ma'lumotlar
		$\varphi_e = \varphi_e(t), rad$	$x_e = x_e(t)$, sm					

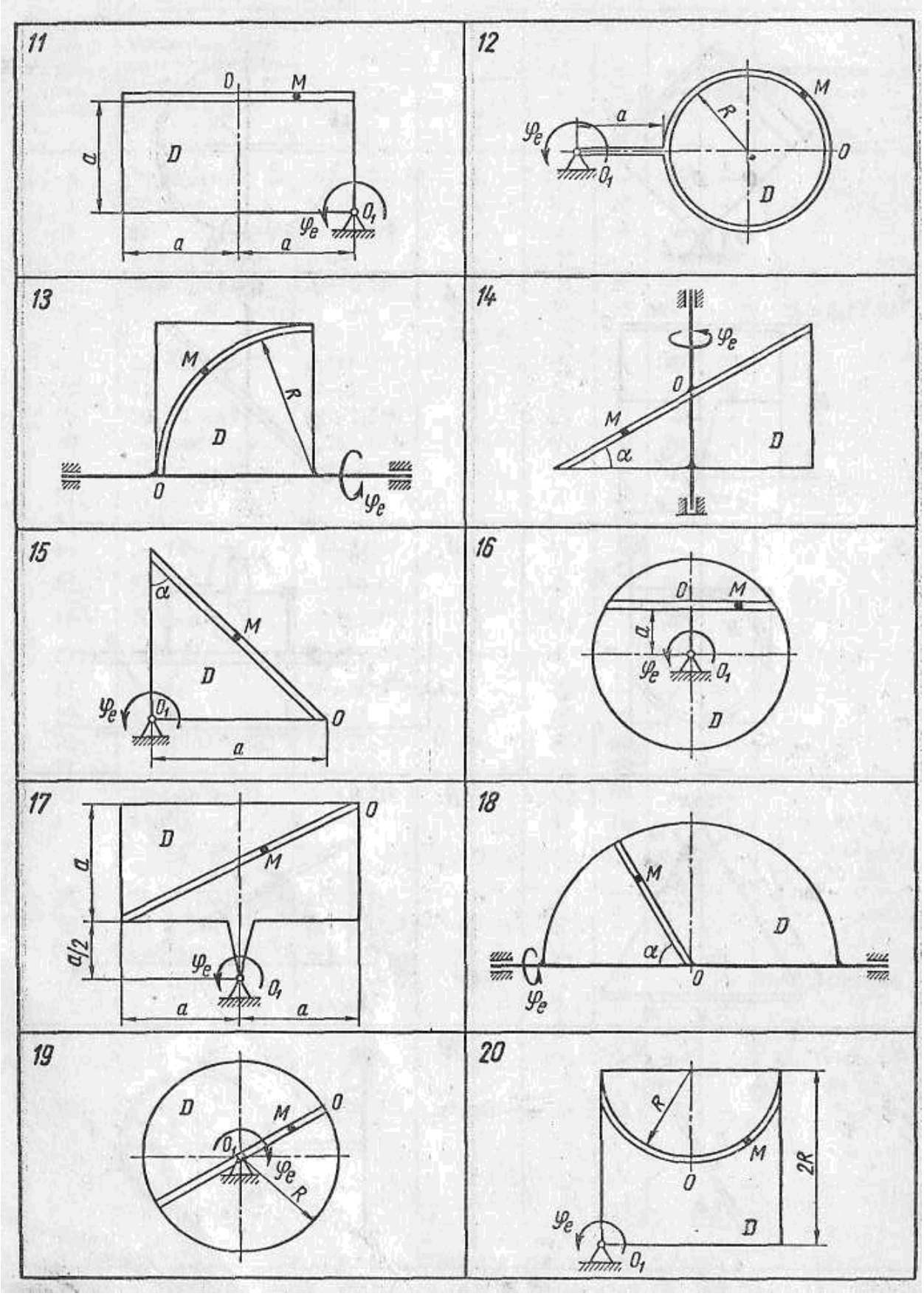
1	$18\ \sin(\frac{\pi t}{4})$	$2t^3 - t^2$	-	2/3	-	25	-	
2	$20\sin \pi t$	$0{,}4t^2 + t$	-	5/3	20	-	-	
3	$6t^3$	$2t + 0{,}5t^2$	-	2	-	30	-	
4	$10\sin(\pi t / 6)$	$0{,}6t^2$	-	1	-	-	60	
5	$40\pi \cos(\pi t / 6)$	$3t - 0{,}5t^3$	-	2	30	-	-	
6	-	-	$3t + 0{,}2'$	10/3	15	-	-	$\varphi_r = 0{,}15\pi t^3$
7	$20\cos 2\pi t$	$0{,}5t^2$	-	3/8	-	40	60	
8	$6(t + 0{,}5t^2)$	$t^3 - 5t$	-	2	-	-	30	
9	$10(1 + \sin 2\pi t)$	$4t + 1{,}6t^2$	-	1/8	-	-	-	
10	$20\pi \cos(\pi t / 4)$	$1{,}2t - t^2$	-	4/3	20	20	-	
11	$25\sin(\pi t / 3)$	$2t^2 - 0{,}5t$	-	4	-	25	-	
12	$15\pi t^3 / 8$	$5t - 4t^2$	-	2	30	30	-	
13	$120\pi t^2$	$8t^2 - 3t$	-	1/3	40	-	-	
14	$3 + 14\sin \pi t$	$4t - 2t^2$	-	2/3	-	-	30	
15	$5\sqrt{2}(t^2 + t)$	$0{,}2t^3 + t$	-	2	-	60	45	
16	$20\sin \pi t$	$t - 0{,}5t^2$	-	1/3	-	20	-	
17	$8t^3 + 2t$	$0{,}5t^2$	-	1	-	$4\sqrt{5}$	-	
18	$10t + t^3$	$8t - t^2$	-	2	-	-	60	
19	$6t + 4t^3$	$t + 3t^3$	-	2	40	-	-	
20	$30\pi \cos\ (\pi t / 6)$	$6t + t^2$	-	3	60	-	-	
21	$25\pi(t + t^2)$	$2t - 4t^2$	-	1/2	25	-	-	
22	$10\pi \sin(\pi t / 4)$	$4t - 0{,}2t^2$	-	2/3	30	-	-	
23	$6\pi t^2$	-	-	1	18	-	-	$\varphi = \pi t^3 / 6,$ $0_1 0 = 0_2 A = 20sm$
24	$75\pi(0{,}1t + 0{,}3t^3)$	$2t - 0{,}3t^2$	-	1	30	-	-	
25	$15\sin(\pi t / 3)$	$10t - 0{,}1t^2$	-	5	-	-	-	
26	$8\cos(\pi t / 2)$	$-2\pi t^2$	-	3/2	-	-	45	
27	-	-	$50t^2$	2	75	-	-	$\varphi_r = 5\pi t^3 / 48$
28	$2{,}5\pi t^2$	$2t^3 - 5t$	-	2	40	-	-	
29	$5\pi t^3 / 4$	-	-	2	30	-	-	$\varphi = \pi t^3 / 8,$ $0_1 0 = 0_2 A = 40sm$
30	$4\pi t^2$	-	$t^3 + 4t$	2	48	-	-	

Eslatma. Har bir variantdagi M nuqtaning holati, sxemadagi S_r ning musbat qiymatiga mos tushadi; 5,10,12,13,20-24, 28-30 variantlarda OM=S_r – aylananing yoyiga; 5,10.12,21,24 sxemalarda Om- markaziy eng kichik burchakka mos keluvchi yoy. M nuqtaning nisbiy harakati

6 va 27 variantlarda aniqlanadigan tenglamalari, 1- jadvalning oxirgi ustunida berilgan kattaliklarga asosan hisoblanishi kerak.



1-rasm (K-7)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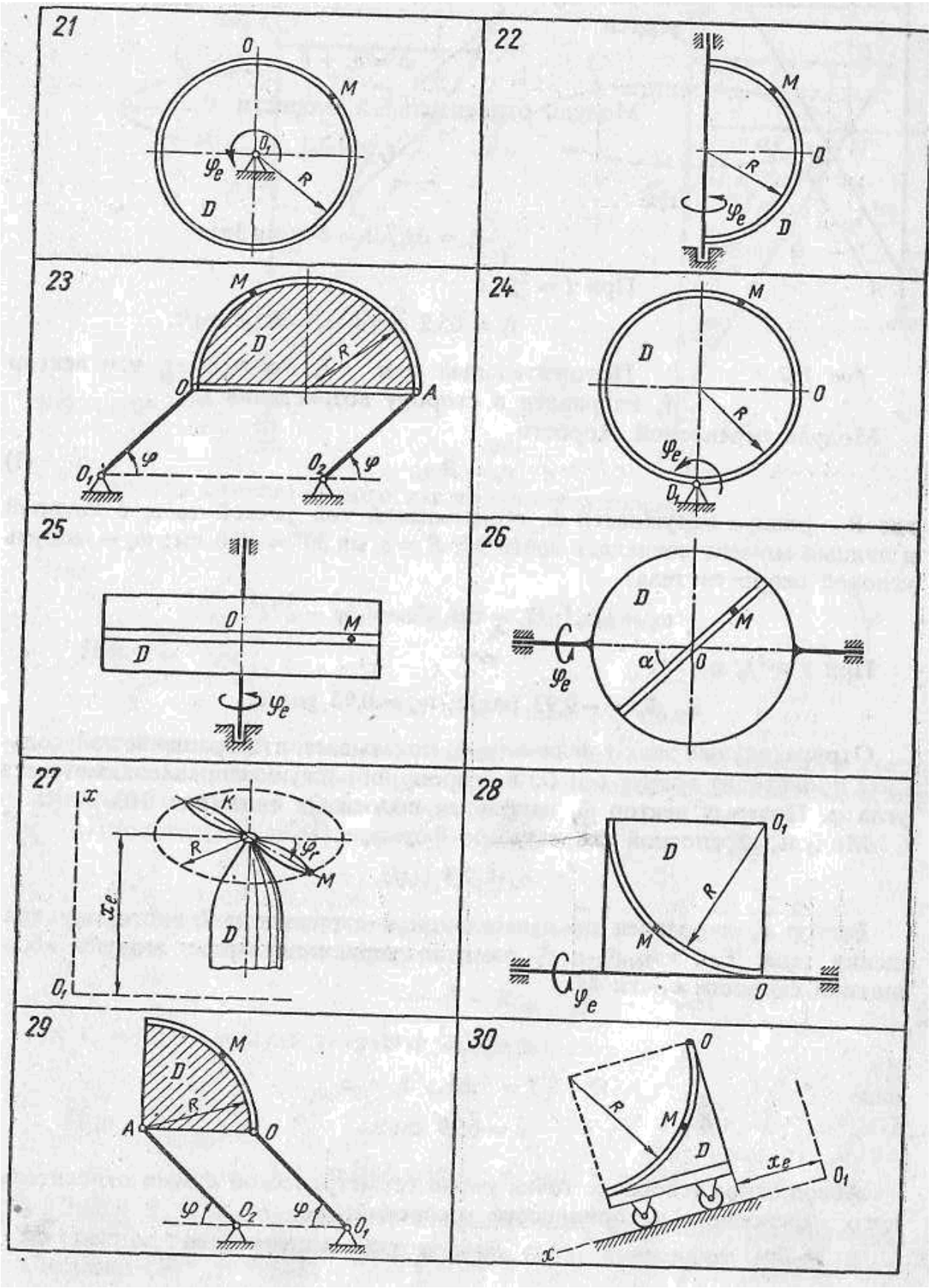
2-rasm (K-7)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3-rasm (K-7)

K-7-topshiriqni bajarishga doir 1- masala.

Berilganlar: Mexanizm sxemasi (1-rasm) ,

$S_r = OM = 16 - 8\cos 3\pi t \quad s;\ \varphi_e = 0{,}9t^2 - 9t^3 \ rra;\ t_1 = \frac{2}{9}s.\ \vartheta - ?, a - ?$

Yechish. Vaqtning berilgan paytidagi chizma tekisligi (1-rasm) D uchburchak tekisligiga mos tushadi. D jismdagi M nuqtaning holati S_r=OM masofa bilan aniqlanadi. Vaqtning t=2/9 s da $S_r = 16 - 8\cos(3\pi * \frac{2}{9}) = 20sm$ ga teng bo'ladi?

M nuqtaning absolyut tezligi, nisbiy va ko'chirma tezliklarining geometrik(vektorli) yig'indisiga teng bo'ladi.

$$\vec{\vartheta} = \vec{\vartheta}_r + \vec{\vartheta}_e$$

Nisbiy tezlik moduli $\vartheta_r = |\vec{\vartheta}_r|$, bu yerda $\vec{\vartheta}_r = \frac{dS_r}{dt} = 24\pi \sin 3\pi t$

t=2/9 s bo'lganda $\vec{\vartheta}_r = 65{,}2\frac{sm}{s}$;

$\vec{\vartheta}_r$ ning yo'nalishi, S_r ning o'sish yo'nalishi bilan mos tushsa, $\vec{\vartheta}_r$ ning ishorasi musbat bo'ladi. Ko'chirma tezlik qiymati

$$\vec{\vartheta}_e = \omega_e * R \qquad (1)$$

ga teng bo'ladi, bunda R- L aylananing radiusi vaqtning ayni paytdagi jismning M nuqtasiga mos tushadi, $R = S_r \sin 30^0 = 10sm;\ \omega_e$ - jismning burchak tezligi qiymati: $\omega_e = |\vec{\omega}_e|;\ \vec{\omega}_e = \frac{d\varphi_e}{dt} = 1{,}8t - 27t^2$

t=2/9 s bo'lganda $\omega_e = -0{,}93\frac{rad}{s};\ \omega_e = 0{,}93\frac{rad}{s}$

$\tilde{\omega}_e$ ning manfiy ishorasi,uchburchakning oZ o'qi atrofida φ burchak yo'nalishiga qarshi yo'nalishdagi harakatini ko'rsatadi. Shuning uchun $\vec{\omega}_e$ vektorning yo'nalishi oZ o'qining pastga qarab yo'nalgan bo'ladi (2-rasm, a).

(1) formula bilan aniqlanadigan ko'chirma tezlikning qiymati $\vartheta_e = 9{,}3\frac{sm}{s}$ ga teng bo'ladi. ϑ_e vektorning yo'nalishi L aylanaga urinma bo'lib, jismning aylanish yo'nalishlishida bo'ladi. Shunday qilib $\vec{\vartheta}_e$ va $\vec{\vartheta}_r$ lar o'zaro perpendikulyar bo'lib, M nuqtaning absolyut tezligi

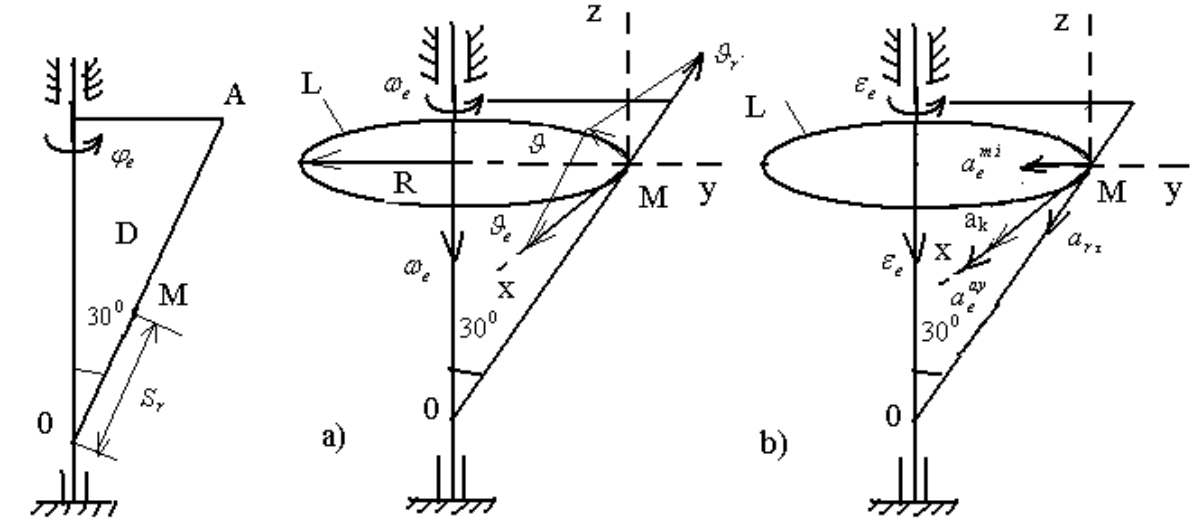
$$\vartheta = \sqrt{\vartheta_r^2 + \vartheta_e^2} = 65{,}9\frac{sm}{s}$$

Nuqtaning absolyut tezlanishi, nisbiy, ko'chirma, koriolis tezlanishlarning geometrik(vektorli) yig'indisiga teng bo'ladi:

$$\vec{a} = \vec{a}_r + \vec{a}_e + \vec{a}_k$$

yoki kengaytirilgan ko'rinishda

$$\vec{a} = \vec{a}_{r\tau} + \vec{a}_{rn} + \vec{a}_e^{ay} + \vec{a}_e^{m.i} + \vec{a}_k$$



1-rasm 2-rasm

Nisbiy urinma tezlanish qiymati: $a_{r\tau} = |\vec{a}_{r\tau}|$, bu yerda $\vec{a}_{r\tau} = \frac{d^2 S_r}{dt^2} = 72\pi^2 \cos 3\pi t$,

t=2/9 s bo'lganda $\vec{a}_{r\tau} = -355\frac{sm}{s^2}$; $a_{r\tau} = 355\frac{sm}{s^2}$.

$\vec{a}_{r\tau}$ ning manfiy ishorasi, $\vec{a}_{r\tau}$ ning yo'nalishi ham S_r ning manfiy yo'nalishi tomonga qarab yo'nalganligini ko'rsatadi. $\vec{\vartheta}_r$ va $\vec{a}_{r\tau}$ lar bir xil yo'nalishda bo'lganligi uchun M nuqtaning nisbiy harakatdagi tezlanishi tezlanuvchan bo'ladi.

Nisbiy normal tezlanish

$$a_{rn} = \frac{\vartheta_e^2}{\rho} = 0$$

ga teng bo'lganligi uchun nisbiy harakat traektoriyasi to'g'ri chiziqdan iborat bo'ladi ($\rho = \infty$) .

Ko'chirma aylanma harakat tezlanishi

$$a_e^{ay} = R\varepsilon_e, \qquad (2)$$

Bu yerda $\varepsilon_e = |\tilde{\varepsilon}_e|$ - D jismning burchak tezlanishi:

$\varepsilon_e = \frac{d^2\varphi_e}{dt^2} = 1{,}8 - 54t$, t=2/9 s bo'lganda $\tilde{\varepsilon}_e = -10{,}2\frac{rad}{s^2}$; $\varepsilon_e = 10{,}2\frac{rad}{s^2}$

$\vec{\varepsilon}_e$ va $\vec{\omega}_e$ bir xil yo'nalishda bo'lgani uchun D jismning aylanishi tezlanuvchan bo'ladi, $\vec{\varepsilon}_e$ va $\vec{\omega}_e$ vektorlarning yo'nalishi mos tushadi(103-rasm,a,b). (2) ifodaga asosan $a_e^{ay} = 102\frac{sm}{s^2}$

$\vec{a}_e^{ay}$ vektorning yo'nalishi $\vec{\vartheta}_e$ tomonga yo'nalgan bo'ladi.

Ko'chirma markazga intelma tezlanishining qiymati

$$a_e^{m.i} = R\omega_e^2 = 9\frac{sm}{s^2}$$

$a_e^{m.i}$ vektorning yo'nalishi, L aylananing markazi tomon yo'nalgan bo'ladi.

Koriolis tezlanishi; $\vec{a}_k = 2\vec{\omega}_e x \vec{\vartheta}_r$

Koriolis tezlanishining qiymati: $a = 2\omega_e \vartheta_r \sin(\vec{\omega}_e, \vec{\vartheta}_r)$

bu yerda $\sin(\vec{\omega}_e, \vec{\vartheta}_r) = \sin 150^0 = 0{,}5$

Yuqorida $\vec{\omega}_e$ va $\vec{\vartheta}_r$ larning topilgan qiymatlariga asosan $a_k = 61\frac{sm}{s^2}$.

$\vec{a}_k$ vektorning yo'nalishi 2-rasm,b.da ko'rsatilgan.

M nuqtaning absolyut tezlanishni son qiymati,proeksiyalar usulida aniqlanadi:

$a_x = a_e^{ay} + a_k;\ \ a_y = -a_e^{m.i} - a_{r\tau}\cos 60^0;\ \ a_z = -a_{r\tau}\cos 30^0;\ \ a = \sqrt{a_x^2 + a_y^2 + a_z^2}$

Hisob natijalari 2-jadvalda berilgan.

ω_e,	Tezlik,sm/s			ε_e,	Tezlanish , sm/s^2								
rad/s	ϑ_e	$\vec{\vartheta}_r$	ϑ	rad/s^2	$a_e^{m.i}$	$\vec{a}_e^{ay}$	a_{rn}	$a_{r\tau}$	$\vec{a}_k$	a_x	a_y	a_z	a
-0,93	9,3	65,2	65,9	-10,9	9	102	0	-305	61	163	-186	308	395

Nazorat savollari

1. Nuqta to'g'ri chiziqli harakatining differensial tenglamasini yozib tushuntiring?

2. Moddiy nuqtaga miqdor va yo'nalish jihatdan o'zgarmas bo'lgan F kuch ta'sir etganda harakat tenglamasini yozib tushuntiring.

3. Moddiy nuqtaga faqat vaqtga bog'liq kuch ta'sir etganda harakat tenglamasini yozib tushuntiring.

4. Moddiy nuqtaga faqat nuqtaning harakatiga bog'liq kuch ta'sir etganda harakat tenglamasini yozib tushuntiring.

5. Moddiy nuqtaga ta'sir etuvchi kuch faqat nuqtaning tezligiga bog'liq bo'lganda harakat tenglamasini yozib tushuntiring.

6. Nuqtaning erkin tebranma harakat differensial tenglamasini yozib tushuntiring.

7. Tezlikning birinchi darajasiga proporsional bo'lgan qarshilik kuchi ta'siridagi moddiy nuqtaning erkin tebranma harakati tenglamasini yozib tushuntiring.

8. Muhitning qarshiligi uncha katta bo'lmagan holda uning harakat tenglamasi ifodasini yozib tushuntiring.

9. Moddiy nuqtaning majburiy tebranma harakati deb nimaga aytiladi.

10) O'zgaruvchi kuch ta'siri ostidagi moddiy nuqta harakat differensial tenglamasini integrallashni tushuntiring.

1-test. Quyidagi ifodalardan moddiy nuqtaga miqdor va yo'nalish jihatdan o'zgarmas bo'lgan kuch ta'sir etgandagi harakat tenglamasini, moddiy nuqtaga faqat nuqtaning harakatga bog'liq kuch ta'sir etganda harakat tenglamasini, nuqtaning erkin tebranma harakat differensial tenglamalarini ko'[rsating.

1. $m\ddot{x} = F$ **;2.** $m\ddot{x} = x(t)$ **;3.** $m\frac{d\vartheta}{dt} = x(t)$ **;4.** $m\frac{d\vartheta}{dt} = f(\vartheta)]$ **;5.** $m\ddot{x} = -cx$ **;6.** $m\ddot{x} = -cx - \mu\dot{x}$ **;**

7. $x = e^{-nt}(c_1\cos k_1 t + c_2\sin k_1 t)$

2-test. Quyidagi ifodalardan moddiy nuqtaga faqat vaqtga bog'liq kuch ta'sir etganda harakat tenglamasini , moddiy nuqtaga ta'sir etuvchi kuch faqat nuqtaning tezligiga bog'liq bo'lganda harakat tenglamasini, muhitning qarshiligi uncha katta bo'lmagan holda uning harakat tenglamalari ifodasinlaerini ko'rsating.

1. $m\ddot{x} = F$ **;2.** $m\ddot{x} = x(t)$ **;3.** $m\frac{d\vartheta}{dt} = x(t)$ **;4.** $m\frac{d\vartheta}{dt} = f(\vartheta)]$ **;5.** $m\ddot{x} = -cx$ **;6.** $m\ddot{x} = -cx - \mu\dot{x}$ **;**

7. $x = e^{-nt}(c_1\cos k_1 t + c_2\sin k_1 t)$

6- **mustaqil ish mavzusi**
Erkin va o’zgaruvchi kuch ta’siri ostidagi nuqtaning differensial tenglamalari

Reja:

1. Differensial tenglamalarni integrallash. [(F=F(t); F=F(x); F=F(v) bo’lgan hollar uchun].

2. masala(K.13.1.10). Massasi m=1,4kg bo’lgan moddiy nuqta to’g’ri chiziq bo’ylab $x = 6t^2 + 6t + 3$ qonuni bilan harakat qilsa, teng ta’sir etuvchi kuchning miqdorini toping. (16,8).

3. Nuqtaning markaziy kuch ta’siridagi harakati.

4. masala (K.13.2.4). Massasi m=9 kg bo’lgan moddiy jism fazoda $\vec{F} = 5\vec{i} + 6\vec{j} + 7\vec{k}$ kuch ta’sirida harakatlanadi. Nuqtaning tezlanishini hisoblang. (1,17)

5. Muhit qarshilik kuchini hisobga olgan holda moddiy nuqtaning majburiy tebranma harakati.

6. masala (K.13.4.5). Massasi m=0,5 kg li yuk , prujinaga osilgan holda $\ddot{y} + 60y = 0$ tenglama bo’yicha tebranma harakat qiladi. Prujinaning bikrlik koeffisentini aniqlang. (30).

7. D-2. Hisob-grafik topshiriq. O’zgaruvchi kuch ta’siri ostidagi moddiy nuqta harakat differensial tenglamasini integrallash.

Tayanch so’z va iboralar:

1) nuqta to’g’ri chiziqli harakatining differensial tenglamasi; 2) moddiy nuqtaga miqdor va yo’nalish jihatdan o’zgarmas bo’lgan F kuch ta’sir etsin ($m\ddot{x} = F$);
3) moddiy nuqtaga faqat vaqtga bog’liq kuch ta’sir etsin ($m\ddot{x} = x(t)$); 4) moddiy nuqtaga faqat nuqtaning harakatiga bog’liq kuch ta’sir etsin [$m\frac{d\vartheta}{dt} = x(t)$]; 5) moddiy nuqtaga ta’sir etuvchi kuch faqat nuqtaning tezligiga bog’liq bo’lsin.
[$m\frac{d\vartheta}{dt} = f(\vartheta)$]; 6) Nuqtaning erkin tebranma harakat differensial tenglamasi
[$m\ddot{x} = -cx$]; 7) tezlikning birinchi darajasiga proporsional bo’lgan qarshilik kuchi ta’siridagi moddiy nuqtaning erkin tebranma harakati [$m\ddot{x} = -cx - \mu\dot{x}$]; 8) muhitning qarshiligi unga katta bo’lmagan hol. [$x = e^{-nt}(c_1 \cos k_1 t + c_2 \sin k_1 t)$]; 9) moddiy nuqtaning majburiy tebranma harakati;
10) O’zgaruvchi kuch ta’siri ostidagi moddiy nuqta harakat differensial tenglamasini integrallash.

D-2. Hisob-grafik topshiriqqa doir 1-masalani yechish namunasi.

m massali M jismni moddiy nuqta deb hisoblab, berilgan boshlang’ich shartga asosan, uning o’zgaruvchi $\vec{P} = x\vec{i} + y\vec{j} + z\vec{k}$ kuch ta’siridagi harakat tenglamasini aniqlang?

Hamma variantlarda z o'qi vertikal yo'nalgan,faqat 8 va 30 variantdan tashqari. Yechish uchun zarur bo'ladigan kattaliklar 1-jadvalda berilgan va quyidagi belgilashlar kiritilgan: $\vec{i},\vec{j},\vec{k}$ -koordinata o'qlarining ortlari (mos ravishda x,y,z); g=9,81 m/s^2 –erkin tushish tezlanishi; f-sirpanish ishqalanish koeffisenti; t- vaqt,s; $x,y,z,\dot{x},\dot{y},\dot{z}$ - mos ravishda nuqta koordinatalari va proeksiyasining tezliklari,m va m/s.

Hamma holatlarda $\vec{P}$ kuch $x,\dot{x},y,\dot{y}$ larga bog'liq bo'lib,nuqtaning harakatida uning son qiymati musbat deb olinadi.

1-jadval

n.v	M, kg	F,N	Boshlang'ich shartlar							
			f	X_0	Y_0	Z_0	$\dot{x}_0$	$\dot{y}_0$	$\dot{z}_0$	Eslatma
			M				m/s			
1	2	$-0{,}5(\dot{x}\vec{i}+\dot{z}\vec{k})$	-	0	-	0	20	20	-	
2	0,25	$100x\vec{i}$	0,3	0,03	-	-	0,5	-	-	-
3	2	$-(20x-4\dot{x})\vec{i}$	0	0,15	-	-	1	-	-	
4	m	$-\mu z^2\vec{k}$	-	-	-	a	-	-	$\sqrt{2\mu/ma}$	P>0,a>0
5	50	$-(5x-25\dot{x})\vec{i}$	0	0	-	-	1	-	-	
6	m	$-m\mu x^{-3}\vec{i}$	0	a	-	-	υ_0	-	-	$\vartheta_0>0$
7	2	$4\vec{i}\cos(\pi t/6)+\dot{y}\vec{j}$	0	0	0	-	0	3	-	
8	150	$120t(\vec{i}\cos 30+\vec{k}\sin 30)$	0	0	0	0	0,5	2	0	
9	1	$4r(\vec{i}\cos\varphi+k\sin\varphi)$	-	0	-	2	5	-	0	
10	1	$-3\sqrt{\dot{x}}\vec{i}$	0	0	-	-	16	-	-	
11	20	$-3\vec{\vartheta}$	-	-	0	0	-	15	0	$\dot{y}>0,\dot{z}>0$
12	m	$-mgR^2z^{-2}\vec{k}$	-	-	-	R	-	-	$\sqrt{2gR}$	R>0
13	m	$-9mr(\vec{i}\cos\alpha+\vec{j}\cos\beta+$ $+\vec{k}\cos\gamma)$	-	2	2	2	1	0	1	
14	1,5	$(4{,}5+3x)\vec{i}$	0,1	1	-	-	0,3	-	-	
15	1,5	$(6-1{,}5z+3\dot{z})\vec{k}$	0	-	-	0,5	-	-	1	
16	100	$-20\dot{x}\vec{l}$	0	0	-	-	2,5	-	-	
17	1	$5(1-e^{-2t})\vec{i}$	0	0	-	-	0	-	-	

18	2	$-6\dot{x}^2$	0	0	-	-	10	-	-	
19	6	$(30e^{-3t}-18\dot{x}-12x)\vec{i}$	0	0	-	-	10	-	-	
20	0,1	$-0,2\dot{z}^4\vec{k}$	-	-	-	200	-	-	0,1	
21	0.1	$0,1\dot{z}^3\vec{k}$	-	-	-	300	-	-	2,5	
22	m	$-4mr(\vec{i}\cos\varphi+\vec{j}\sin\varphi)$	0	20	0	0	0	8	0	
23	100	$50(3+x)\vec{i}$	0,2	0	-	-	1	-	-	
24	3	$-3(\dot{x}+2x)\vec{i}$	0	0	-	-	2	-	-	
25	1,5	$-7,5(\dot{x}^3\vec{i}-2g\vec{k})$	-	0	-	100	4	-	0	
26	0,1	$-(2\dot{z}^3-0,981)\vec{k}$	-	-	-	0	-		7	
27	2	$3t\vec{i}$	0	0	0	-	3	4	0	
28	4	$-2(\dot{x}\vec{i}+\dot{y}\vec{j}+\dot{z}\vec{k})$	-	0	0	0	1	1	2	
29	0,01	$-3\sqrt[3]{\dot{z}}\vec{k}$	-	-	-	0	-	-	125	
30	100	$120(7,5+t)(\vec{i}\cos 30+$ $+\vec{k}\sin 30)$	0,25	0	-	0	0,5	-	0	

Topshiriqni bajarishga doir masala.

Berilganlar: $m=1kg, x_0=0, z_0=10m, \dot{x}_0=20m/s, \dot{z}_0=0, \vec{p}=cr(\vec{i}\cos\varphi+\vec{k}\sin\varphi);$
$\vec{R}=-\alpha\dot{\vec{r}}, c=4N/m, \alpha=2N*s/m, F(x)-?$

1. R=0; $t=0; z_0=10m, x=0, \dot{x}_0=20m/s, \dot{z}_0=0$

$$m\ddot{x}=-cr\cos\varphi; m\ddot{z}=-cr\sin\varphi-G$$

$$cos\varphi=\frac{x}{r}, \sin\varphi=\frac{y}{r} \qquad (1')$$

$$m\ddot{x}=-cr*\frac{x}{r}=-cx; m\ddot{z}=-cr*\frac{z}{r}=-cz-G$$

$$\ddot{x}+\frac{c}{m}x=0; \ddot{x}+k^2x=0; \ddot{z}+k^2y=-g$$

$$k=\sqrt{\frac{c}{m}}; k=\sqrt{\frac{4^2}{1}=2rad/s;} \qquad (1)$$

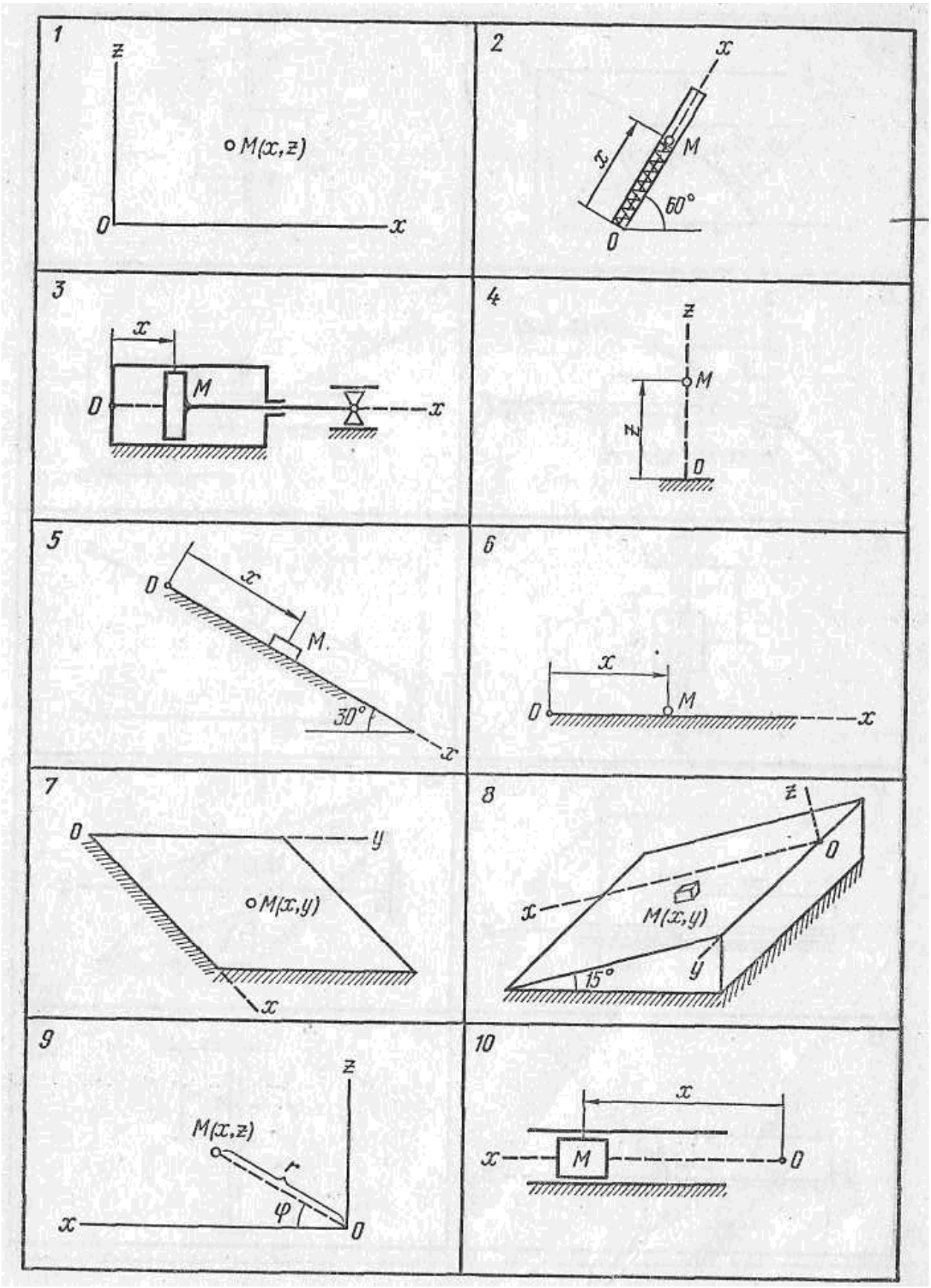
(3) tenglamaning yechimi quyidagicha bo'ladi.

$$x=C_1\cos kt+C_2\sin kt;\ \ z=C_3\cos kt+C_4\sin kt-\frac{g}{k^2} \qquad (2)$$

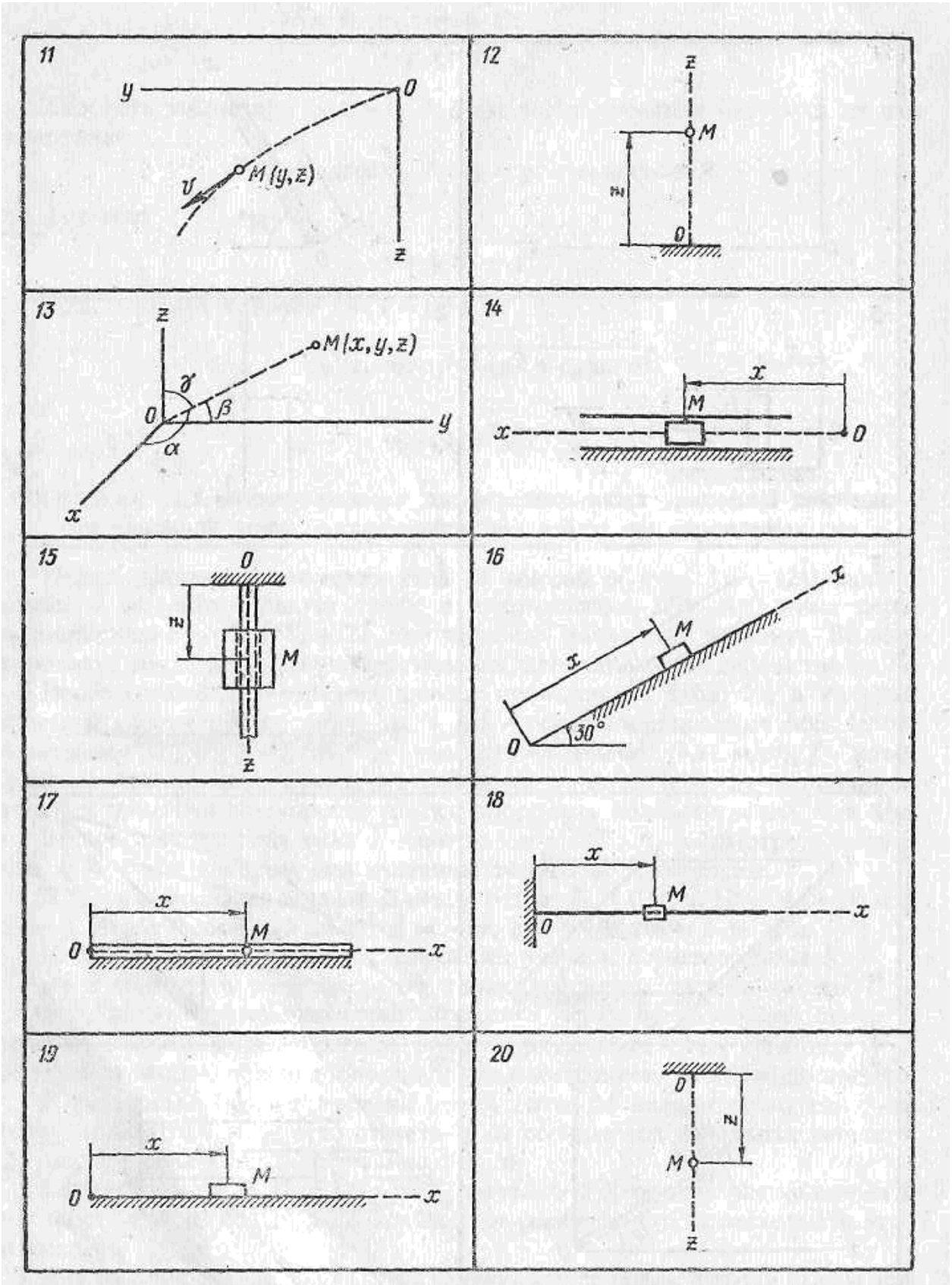
(1) dan t vaqt bo'yicha hosila olamiz.

$$\dot{x}=-kC_3\sin kt+C_2k\cos kt;\ \ \dot{z}=-C_3k\sin kt+C_4k\cos kt \qquad (3)$$

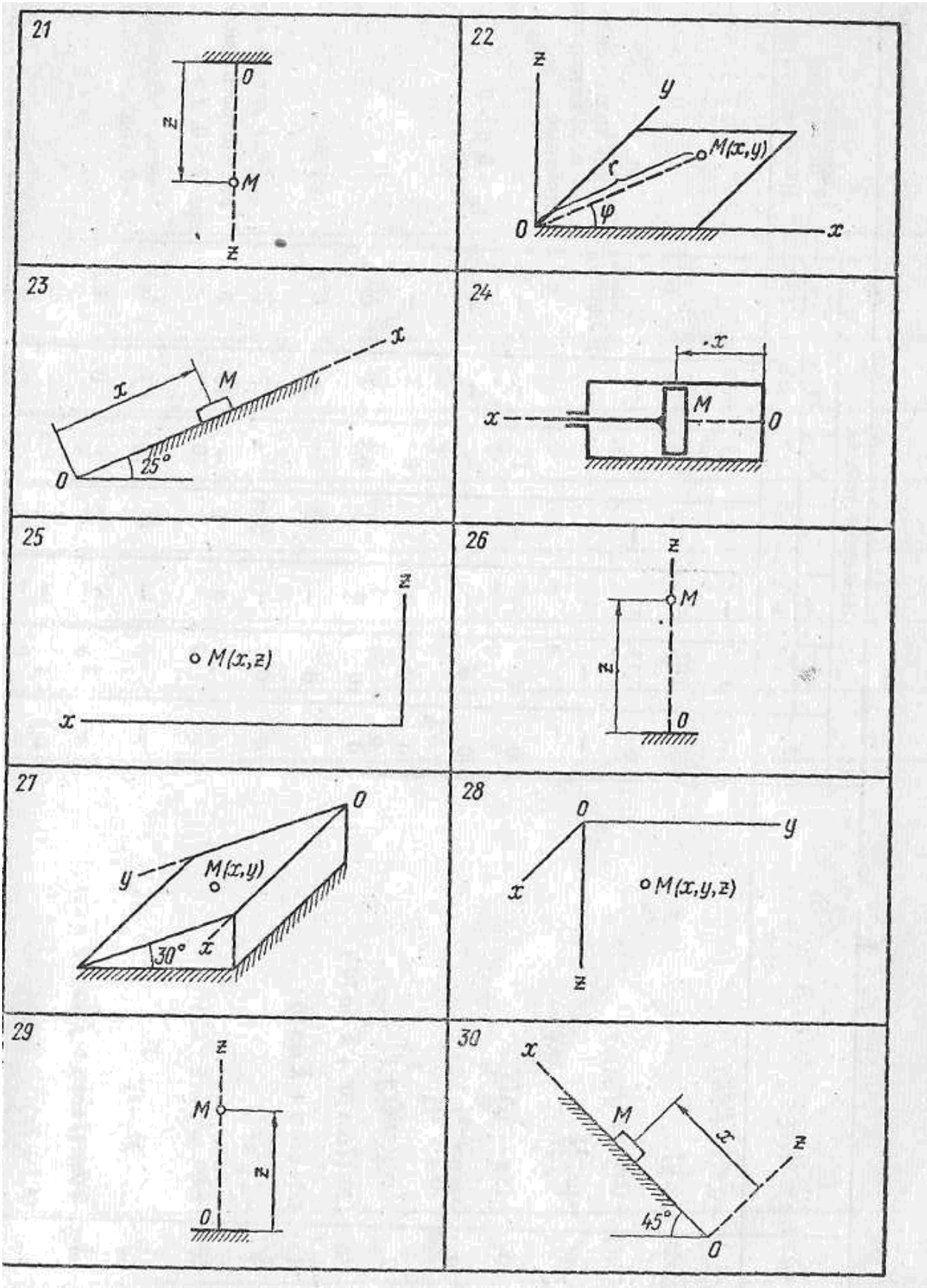
Integrallash doimiylari C_1, C_2, C_3, C_4 larni boshlang'ich shartdan aniqlaymiz.


1
z
M(x,z)
0
x
2
x
z
M
60°
0
3
x
M
0
x
4
z
M
z
0
5
0
x
M
30°
x
6
x
M
0
x
7
0
y
M(x,y)
x
8
z
0
x
M(x,y)
15°
y
9
z
M(x,z)
r
φ
x
0
10
x
x
M
0

1-rasm (D-2)


11
y
O
M (y, z)
v
z
12
z
M
z
O
13
z
M (x, y, z)
γ
O
β
y
α
x
14
x
M
x
O
15
O
z
M
z
16
x
M
x
O
30°
17
x
M
O
x
18
x
M
O
x
19
x
M
O
x
20
O
z
M
z

2-rasm (D-2)


21
0
M
z
22
z
y
M(x,y)
r
φ
0
x
23
x
M
0
25°
24
x
M
0
25
z
M(x,z)
x
26
z
M
0
27
0
y
M(x,y)
30°
x
28
0
y
x
M(x,y,z)
z
29
z
M
0
30
x
M
x
z
45°
0

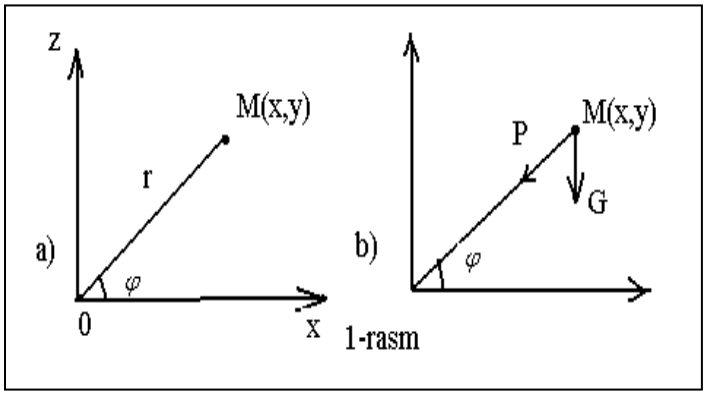
3-rasm (D-2)

t=0 bo'lgan $x_0 = 0; \dot{x}_0 = 20; z_0 = 10m; \dot{z} = 0$ (4)

(4) ni (2) ga v(3) qo'yib,hosil qilaqmiz:

$$x_0 = C_1; \dot{x}_0 = C_2 k; z_0 = C_3 - \frac{g}{k^2}; \dot{z}_0 = C_4 k$$

bundan $C_1 = 0; C_2 = \frac{\dot{x}_0}{k}; C_3 = z_0 + \frac{g}{k^2}; C_4 = 0$ (5)



1-rasm

(5) ni (2) ga qo'yib oxirgi harakat tenglamasini hosil qilamiz

$$x = \frac{\dot{x}_0}{k}\sin kt = 10\sin 2t; \quad z = (z_0 + \frac{g}{k^2})\cos kr - \frac{g}{k^2} = 12{,}45\cos 2t - 2{,}45 \qquad (6)$$

$$\dot{x} = \dot{x}_0 \cos kt = 20\cos 2t; \quad \dot{z} = -k(z_0 + \frac{g}{k^2})\sin kt = -24{,}9\sin 2t \qquad (7)$$

Nuqta izining tenglamasini hosil qilish uchun (6) ni quyidagicha yozamiz:

$$\frac{x}{\dot{x}_0 / k} = \sin kt; \quad \frac{z + g/k^2}{z_0 + \frac{g}{k^2}} = \cos kt$$

$\cos^2 kt + \sin^2 kt = 1$ asosiy ayniyatga asosan

$$\frac{x^2}{10^2} + \frac{(z + 2{,}45)^2}{2{,}45^2} = 1 \qquad (8)$$

$$T = \frac{2\pi}{k} = \pi = 3{,}14s$$

$$F = \pi ab = \pi(z_0 + \frac{g}{k^2})\frac{\dot{x}_0}{k}$$

2.Nuqtaning qarshilikli harakatida tezligini va tezlanishini aniqlash .

Harakatning qarshilik kuchi:

$$\vec{R} = -\alpha\dot{\vec{r}} = -\alpha\vec{\vartheta} = -\alpha(\vec{i}\dot{x} + \vec{k}\dot{z})$$

Moddiy nuqta harakatining differensial tenglamalari qo'yidagicha

$$m\ddot{x} = -cx - \alpha\dot{x}; \quad m\ddot{z} = -cz - \alpha\dot{z} = -G$$

$$\ddot{x} + 2n\dot{x} + k^2 x = 0; \quad \ddot{z} + 2n\dot{z} + k^2 z = 0 \qquad (9)$$

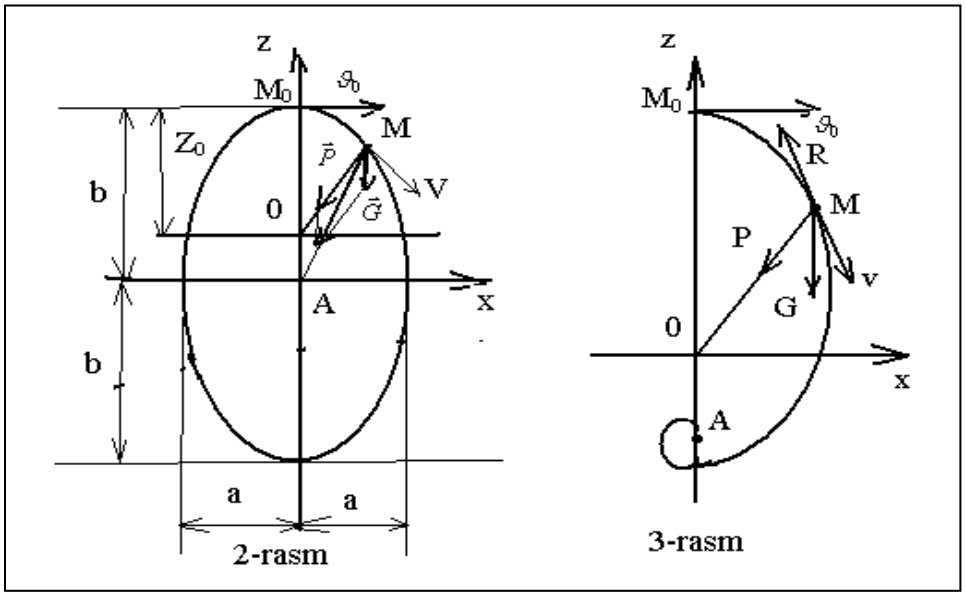
$$2n = \frac{\alpha}{m}; n = 1s^{-1}; k^2 = \frac{c}{m}; k = 2$$

Shunday qilib n<k bo'lgani uchun (9) ni yechimi quyidagicha bo'ladi/

$$x = e^{-nt}(\tilde{C}_1 \cos k_{1t} + \tilde{C}_2 \sin k_1 t); \quad z = e^{-nt}(\tilde{C}_3 \cos kt + \tilde{C}_4 \sin k_1 t) - \frac{g}{k^2} \qquad (10)$$

$$k_0 = \sqrt{k^2 - n^2} = \sqrt{4-1} = 1{,}73 rad/s$$

(10) dan vaqt bo'yicha hosila olamiz:



$$\dot{x} = e^{-nt}(-\tilde{C}_1 k_0 \sin k_0 t + \tilde{C}_2 k_0 \cos k_0 t) - ne^{-nt}(\tilde{C}_1 \cos k_0 t + \tilde{C}_2 \sin k_0 t)$$
$$\dot{z} = e^{-nt}(-\tilde{C}_3 k_0 \sin k_0 t + \tilde{C}_4 k_0 \cos kt) - e^{-nt}(\tilde{C}_3 \cos k_0 t + \tilde{C}_4 \sin k_0 t) \quad (11)$$

Boshlangich shartlar (4) ni (10) va (11) ga quyamiz:

$$x_0 = \tilde{C}_1; \dot{x}_0 = \tilde{C}_2 k_0 + n\tilde{C}_1; z_0 = \tilde{C}_3 - \frac{g}{k^2}; \dot{z}_0 = \tilde{C}_4 k_0 - n\tilde{C}_3$$

bundan

$$\tilde{C}_1 = 0; \tilde{C}_2 = \frac{\dot{x}_0}{k_0}; \tilde{C}_3 = z_0 + \frac{g}{k^2}; \tilde{C}_4 = \frac{n}{k_0}(z_0 + \frac{g}{k^2}) \quad (12)$$

(12) ni (10) ga quyib, yakuniy harakat tenglamasini hosil qilamiz:

$$x = \frac{\dot{x}_0}{k_0} e^{-nt} \sin k_0 t = 11{,}56 \sin 1{,}73t$$

$$z = (z_0 + \frac{g}{k^2}) e^{-nt}(\cos k_0 t + \frac{n}{k_0} \sin k_0 t) - \frac{g}{k^2} = \quad (13)$$

$$= 12{,}45 e^{-t}(\cos 1{,}73t + 0{,}577 \sin 1{,}73t) - 2{,}45$$

Nuqtaning traektoriyasi A nuqta atrofida spiral shaklida bo'ladi, $\vec{P}$ va $\vec{G}$ kuchlarni o'zaro ta'sirda muvozanatlashadi. Nuqta radius- vektorining bir marta aylanishi uchun ketgan vaqt davr

$$T = \frac{2\pi}{k} = 3{,}63s$$

Nazorat savollari

1. Nuqta to'g'ri chiziqli harakatining differensial tenglamasing yozib tushuntiring.
2. Moddiy nuqtaga miqdor va yo'nalish jihatdan o'zgarmas bo'lgan F kuch ta'sir etgandagi differensial tenglamasini yozing.
3. Moddiy nuqtaga faqat vaqtga bog'liq kuch ta'sir etgandagi differensial tenglamasini yozing .

4. Moddiy nuqtaga faqat nuqtaning harakatiga bog'liq kuch ta'sir etgandagi differensial tenglamasini yozing .

5. Moddiy nuqtaga ta'sir etuvchi kuch faqat nuqtaning tezligiga bog'liq bo'lgan ifodasini yozing.

6. Nuqtaning erkin tebranma harakat differensial tenglamasi

7. Tezlikning birinchi darajasiga proporsional bo'lgan qarshilik kuchi ta'siridagi moddiy nuqtaning erkin tebranma harakati differensial tenglamasini yozing

8. Muhitning qarshiligi unda katta bo'lmagan holdagi differensial tenglamasini yozing

9. Moddiy nuqtaning majburiy tebranma harakati tenglamasini yozing.

10. O'zgaruvchi kuch ta'siri ostidagi moddiy nuqta harakat differensial tenglamasini integrallash ifodasini yozing..

1-test. Quyidagi ifodalardan moddiy nuqtaga miqdor va yo'nalish jihatdan o'zgarmas bo'lgan F kuch ta'sir etgandagi differensial tenglamasini, moddiy nuqtaga faqat nuqtaning harakatiga bog'liq kuch ta'sir etgandagi differensial tenglamasini , nuqtaning erkin tebranma harakat differensial tenglamalarini ko'rsating?

1. $m\ddot{x} = F$; 2. $m\ddot{x} = x(t)$; 3. $m\frac{d\vartheta}{dt} = x(t)$; 4. $m\frac{d\vartheta}{dt} = f(\vartheta)]$; 5. $m\ddot{x} = -cx$; 6. $m\ddot{x} = -cx - \mu\dot{x}$;

7. $x = e^{-nt}(c_1 \cos k_1 t + c_2 \sin k_1 t)$

2-test. Quyidagi ifodalardan moddiy nuqtaga faqat vaqtga bog'liq kuch ta'sir etgandagi differensial tenglamasi, moddiy nuqtaga ta'sir etuvchi kuch faqat nuqtaning tezligiga bog'liq bo'lgandagi differensial tenglamasi, tezlikning birinchi darajasiga proporsional bo'lgan qarshilik kuchi ta'siridagi moddiy nuqtaning erkin tebranma harakati differensial tenglamalari ifodasini ko'rsating?

1. $m\ddot{x} = F$; 2. $m\ddot{x} = x(t)$; 3. $m\frac{d\vartheta}{dt} = x(t)$; 4. $m\frac{d\vartheta}{dt} = f(\vartheta)]$; 5. $m\ddot{x} = -cx$; 6. $m\ddot{x} = -cx - \mu\dot{x}$; 7. $x = e^{-nt}(c_1 \cos k_1 t + c_2 \sin k_1 t)$

BBB jadvalini to'ldirish uchun tavsiyalar

1. Tayanch ibora va tushunchalar bilan tanishib chiqing.

2. BBB jadvalini to'ldirish uchun tayanch ibora va tushunchalarning tartib Raqamidan foydalaning.

Bilaman	Bilishni xohlayman	Bildim
1	2	3

Foydalanilgan adabiyotlar

1. Rashidov T.R. va boshqalar. «Nazariy mexanika asoslari», T, «O'qituvchi»,1991 y.
2. M.M.Mirsaidov va boshqalar. «Nazariy mexanika», T, «Ilm ziyo» , 2009 y.
3. O.E.Kere va boshqalar. «Nazariy mexanika fanidan qisqa masalalar to'plami», T, «Yangi asr avlodi»,2008 y.

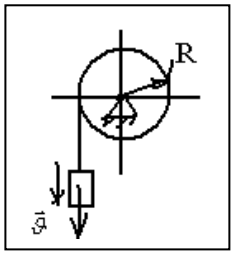
7- **mustaqil ish mavzusi.**
Dinamikaning umumiy teoremalariga asosan, qattiq jism harakatini tekshirish.

Reja:

1. Qattiq jism va mexanik sistemaning kinetik energiyasi.

2. masala (K.15.4.3). Massasi m=30 kg, radiusi R=1m bo'lgan bir jinsli disk tinch holatdan tekis tezlanish $\varepsilon = 2rad/s$ bilan aylana boshlasa, t=2s paytdagi diskning kinetik energiyasini hisoblang. (120).

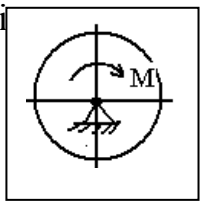
3.Qattiq jism va mexanik sistema uchun kinetik energiyaning o'zgarishi haqidagi teorema.



4. **masala (K.15.5.4).** Massasi m=4 kg bo'lgan yuk pastga tushadi.Radiusi R=0,4m li silindrning aylanish o'qiga nisbatan inersiya momenti $J = 0{,}2kg*m^2$ bo'lsa, yuk $\vartheta = 2m/s$ tezlikka ega bo'lgan paytda sistemaning kinetik energiyasi qanchaga teng? (10,5).

5.Mexanik sistema uchun kinetik energiyaning o'zgarishi haqidagi teorema.

6. masala (K. 15.6.5). Aylanish o'qiga nisbatan inersiya momenti 3 kg*m^2 bo'lgan rotorga o'zgarmas juft kuch momenti $M = 9N*$ ta'sir etsa, uning burchak tezlanishini aniqlang. (3)



7. D-11. Hisob-grafik topshiriq. Qattiq jismning ilgarilanma va aylanma harakatlarini tekshirish.

TAYANCH SO'Z VA IBORALAR: 1) Mexanik sistemaning harakat differensiai tenglamalari;($m_\nu \frac{d^2\vec{r}_\nu}{dt^2} = \vec{F}_\nu^e + \vec{F}_\nu^i$). 2) moddiy nuqtaning harakat miqdori (q=mv); 3) moddiy nuqtalar sistemasining harakat miqdori ($\vec{Q} = \sum m_\nu \vartheta_\nu = M\vartheta_s$);
4) kuch impul'si ($\vec{S} = \vec{F} * t$); 5) nuqta harakat miqdorining o'zgarishi haqidagi teoremaning differensial tenglamasi $d(m\vec{\vartheta}) = d\vec{S}$, 6) sistema harakat miqdorining o'zgarishi haqidagi teoremaning differensial tenglamasi ($\frac{d\vec{Q}}{dt} = \vec{R}_e$).
7) moddiy nuqta harakat miqdorini momenti va sistemaning kinetik momenti
($\vec{k}_0 = \vec{M}_0(m\vec{\vartheta}) = \vec{r}xm\vec{\vartheta}$; $\vec{K}_0 = \sum \vec{M}_0(m_\nu \vec{\vartheta}_\nu)$;
8) qo'zg'almas o'q atrofida aylanuvchi jismning aylanish o'qiga nisbatan kinetik momenti ($k_z = I_z\omega$); 9) huqta harakat miqdori momentining o'zgarishi haqidagi teorema ($\frac{d\vec{k}_0}{dt} = \vec{M}_0(\vec{F})$; 10) sistema kinetik momentining o'zgarishi haqidagi teorema ($\frac{dK_0}{dt} = \vec{M}_0^e; \frac{dK_z}{dt} = M_z^e$); 11) sistema kinetik momentining saqlanish qonuni
($\vec{M}_0^e = 0; \frac{dK_0}{dt} = 0; \vec{K}_0 = const$)

D11- topshiriq. Qattiq jismning ilgarilanma va aylanma harakatini tekshirish.

Mexanik sistema(g'ildirak 1 va 2) va yuk 3 dan tashkil topgan. G'ildirakka 1 ta M=M(t) juft kuchning momenti yoki harakatlantiruvchi kuch F=F(t) quyilgan.Harakatlanish vaqti t=0 dan boshlanadi, u holda g'ildirak burchak tezligi ω_{10} bo'ladi. 2 g'ildidakning qarshilik kuchini momenti M_C ga ting bo'ladi. 1 va 2 g'ildirakning massalari m_1 va m_2 , 3 yukning massasi m_3 ga teng bo'ladi. Katta va kichik aylanalarning radiuslari R_1 ,r_1 , R_2, r_2 bo'ladi. Mexanik sistemaning sxemasi 1-3 rasmlarda ko'rsatilgan,yechishda zarur bo'ladigan kattaliklar 1 jadvalga berilgan.Mexanik sistemalardagi jismning harakat tenglamasi 1-jadvalning oxirgi bo'limida ko'rsatilgan. Shuningdek ipning taranglik kuchi,1 va 2 g'ildiraklarning urinish nuqtasidagi aylanma siquvchi S_1 va S_2 kuchlar ham topiladi. 1 va 2 g'ildiraklarni inersiya radiuslari i_{x1} va i_{x2} lar 1-jadvalga berilmagan bo'lsa,to'liq bir jinsli disk deb qaraladi.

Nom.var. 1-3 rasm	m_1, kg	m_2, kg	m_3, kg	R_1, sm	r_1, sm	R_2, sm	r_2, sm	i_{x1}, sm	i_{x2}, sm	M, n*m	P,N	M_C, N*m	ω_{10} a/s	t_1, s	Lis.h.o' Nom.
1	100	300	500	20	-	60	40	-	50	2100+20t	-	1000	2	2	1
2	300	80	500	70	50	20	-	60	-	-	10200+100t	600	1	0,5	2
3	200	100	400	60	-	30	20	60	28	6100+20t	-	800	0,5	2,5	1
4	100	250	300	20	-	50	30	-	40	1000+40t	-	1400	1,5	2	1
5	150	300	600	30	-	50	20	-	30	-	5500+200t	1500	2	1	3
6	400	250	600	70	-	30	20	70	28	4800+19t	-	800	3	4	1
7	300	200	40	60	40	30	20	50	20	-	3000+100t	500	0	3	3
8	300	250	700	50	30	40	20	40	30	-	9700+50t	500	1	2	1
9	200	100	500	80	60	20	-	70	-	5900+30t	-	600	2	3	2
10	250	100	400	40	20	30	-	30	-	2500+50t	-	1200	0	1,5	2
11	150	300	700	40	30	60	30	30	40	-	3900+50t	1000	1	2	1
12	100	200	600	30	20	60	-	28	60	-	5700+59t	1500	2	2	1
13	180	100	300	50	40	30	20	42	20	-	2700+200t	400	0,5	1	2

14	150	80	400	40	20	30	-	30	-	1800+20t	-	700	1,5	2,5	3
15	300	180	500	20	10	50	-	14	50	700+49t	-	300	0	1,5	1
16	300	250	400	60	40	50	30	50	40	-	7300+100t	1200	1	2	1
17	250	100	800	50	30	20	-	40	-	5400+20t	-	900	2	2	1
18	200	100	600	20	-	50	-	-	50	1900+20t	-	1500	0,5	1	2
19	250	150	400	50	30	30	20	40	28	-	14200+200t	500	0,5	2	1
20	400	100	800	50	20	30	-	40	-	3700+50t	-	1200	2	1	2
21	200	150	300	50	40	30	20	42	20	-	3800+100t	800	1	1,5	2
22	250	100	800	60	20	10	-	50	-	-	9700+200t	700	2	0,5	1
23	200	80	400	40	20	30	-	30	-	2300+20t	-	900	0,5	1	2
24	100	200	500	30	-	40	20	-	30	-	12600+100t	500	1,5	1	1
25	150	80	400	60	=	20	-	60	-	4900+40t	-	800	0	1,5	2
26	250	200	500	50	20	40	30	40	30	-	3500+159t	700	1,5	1	1
27	250	150	500	50	30	40	30	42	30	-	15200+100t	700	1,5	1	1
28	60	200	900	20	-	60	10	-	50	900+10t	-	1500	0	2	2
29	50	200	500	20	-	40	30	-	35	2100+20t	-	1000	2	0,5	1
30	300	60	600	50	30	20	-	40	-	-	7200+50t	700	1,5	1	2

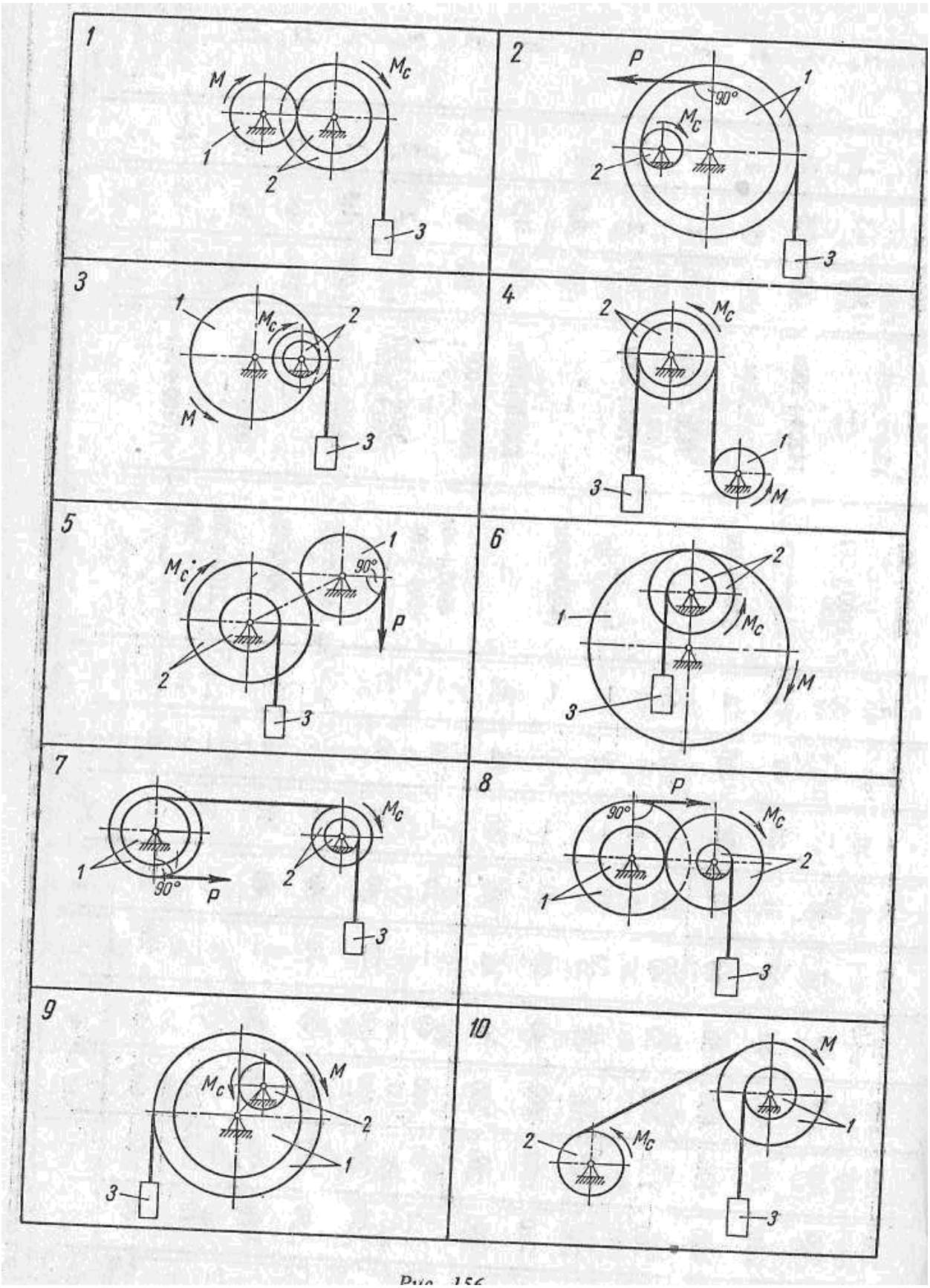
Topshiriqni bajarish bo'yicha masalalar yecghishdan namunalar.

Berilganlar.

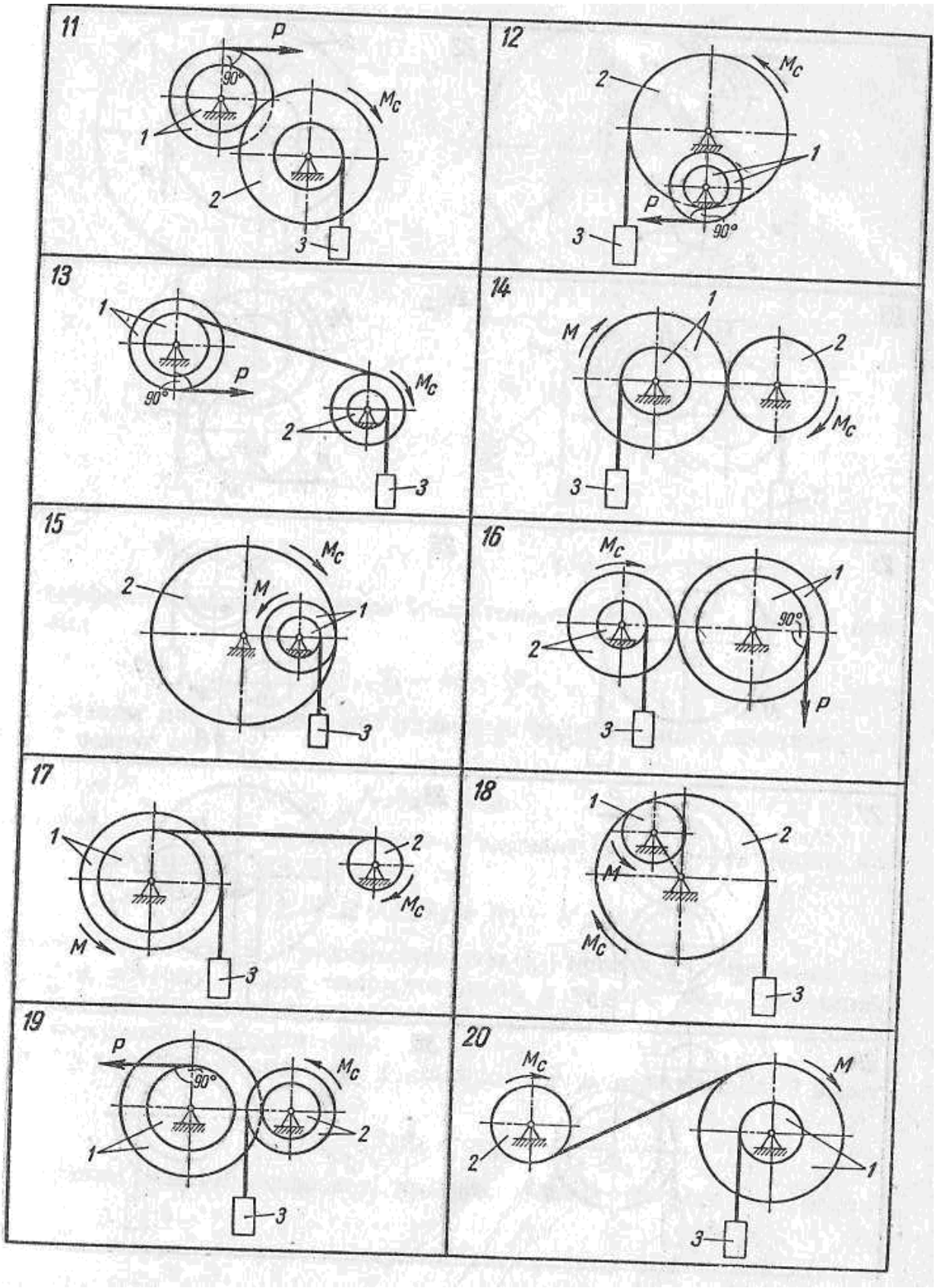
$m_1 = 100kg; m_2 = 150kg; m_3 = 400kg; M = 4200 + 200t \quad N * m; M_s = 2000N * m = const;$

$R_1 = 60sm; R_2 = 40sm; r_2 = 20sm; i_{x_1} = 20\sqrt{2}; i_{x_2} = 30sm; \omega_{10} = 2rad/s; t_1 = 1s; \varphi_2 = f(t) - ?,$

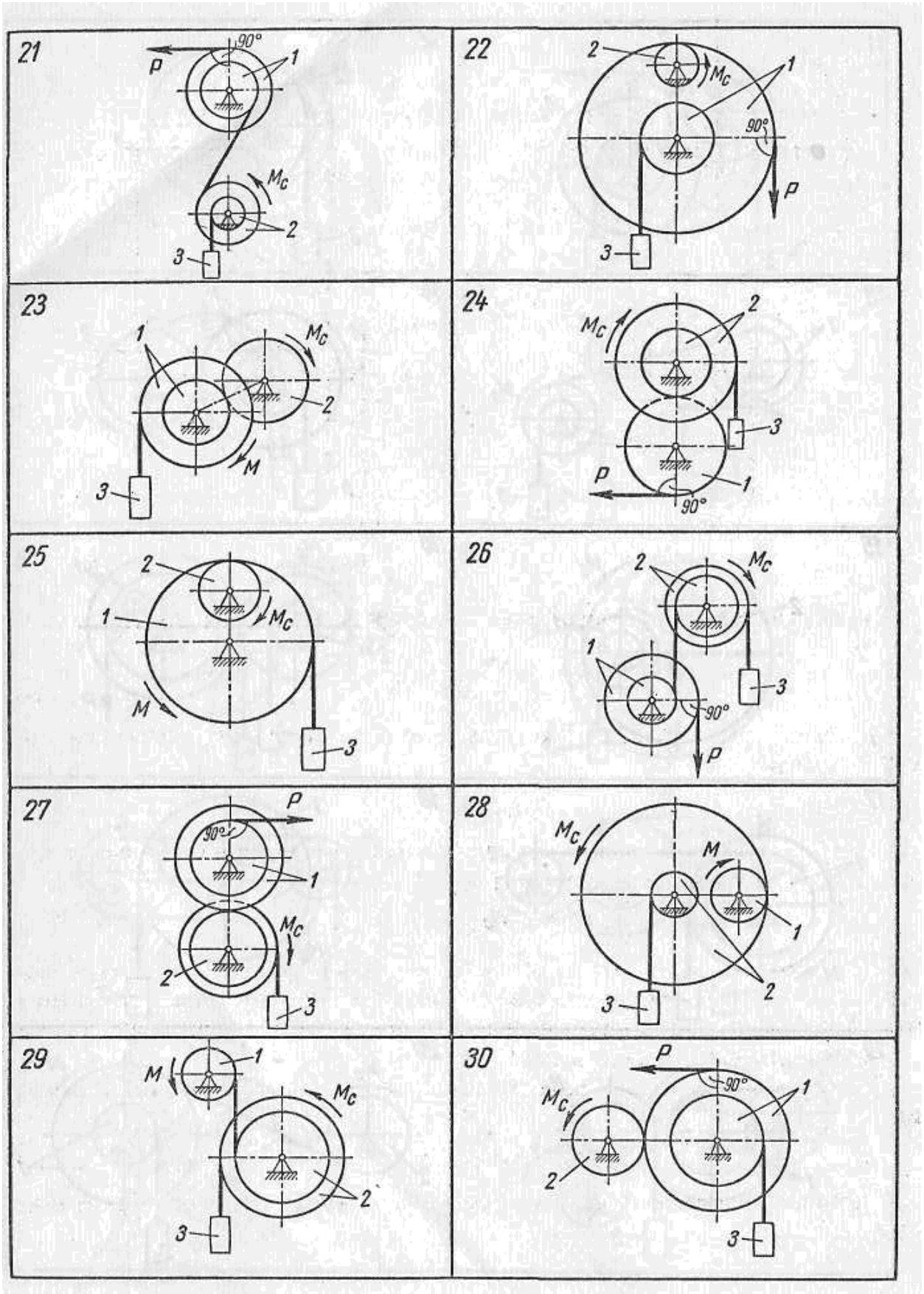
$S - ?, T - ?$


1
M
M_c
1
2
3
2
P
90°
1
M_c
2
3
3
1
M_c
2
M
3
4
2
M_c
1
3
M
5
1
90°
M_c
P
2
3
6
2
1
M_c
3
M
7
1
90°
P
M_c
2
3
8
P
90°
M_c
1
2
3
9
M
M_c
2
1
3
10
M
2
M_c
1
3

1-rasm (D-11)


11
P
90°
Mc
1
2
3
12
Mc
2
1
P
90°
3
13
1
P
90°
Mc
2
3
14
1
M
2
Mc
3
15
Mc
2
M
1
3
16
Mc
1
90°
2
P
3
17
1
2
Mc
M
3
18
1
2
M
Mc
3
19
P
90°
Mc
1
2
3
20
Mc
M
2
1
3

2-rasm (D-11)



3-rasm (D-11)

Yechish. Berilgan mexanik sistemada 1 va 2 xalqa mexanizmi qo'zg'almas o'q atrofida aylanadi, yuk 3 esa yuqoriga ilgarilanma harakat qilib ko'tariladi.

Uchta jismning har birining harakat differensial tenglamasini tuzish uchun bir-biri bilan 1 va 2 xalqalar tishli bog'lanishda 3 yuk ushlab turiladi (1-rasm,b). Mexanizmdagi 1 xalqaga G_1 og'irlik kuchi, harakatlantiruvchi moment M ,podshipnikning reaksiya kuchi $\vec{y}_A, \vec{z}_A$, aylanma siqish kuchi $\vec{S}_1$ va 2 xalqa tomonidan $\vec{N}_1$ normal reaksiya kuchi ta'sir etadi.

Mexanizmdagi 2 xalqaga og'irlik kuchi $\vec{G}_2$, qarshilik momenti M_S,podshipnikning reaksiya kuchini tashkil etuvchilari $\vec{y}_B, \vec{z}_B$, ipning taranglik kuchi $\vec{T}$, osilgan 3 yuk, aylanishdagi siqish(bosim) kuchi $\vec{S}_2$ va 1 xalqa tomonidan $\vec{N}_2$ normal reaksiya kuchlari ta'sir etadi. 3 yukka og'irlik kuchi G_3 va ipning taranglik kuchi T` qo'yilgan bo'ladi.

Ma'lumki $\vec{S}_2 = -\vec{S}_1, \vec{N}_1 = -\vec{N}_2 va \vec{T}' = -\vec{T}$.

X_1 o'qi atrofida 1 xalqaning aylanma harakat differensial tenglamasini tuzamiz:

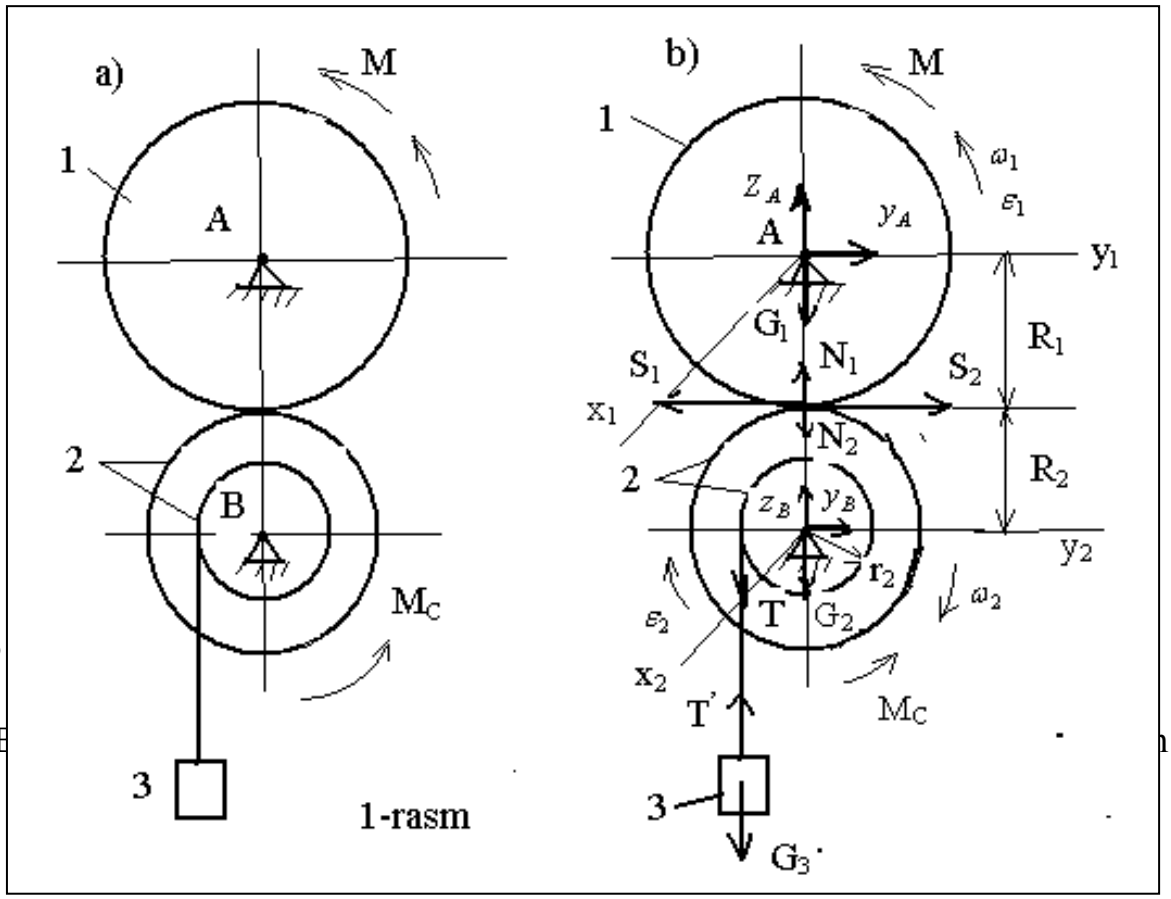
$$J_{x_1}\ddot{\varphi}_1 = M^E_{x_1}$$

Bu yerda $M^E_{x_1} = \sum M^E_{ix_1}$ - x_1 o'qiga nisbatan aylanuvchi 1 xalqaga qo'yilgan tashqi kuchlarning bosh momenti

$$\sum M^E_{ix_1} = M - S_1 R_1$$

1 xalqaning aylanma harakat differensial tenglamasi quyidagicha bo'ladi.

$$J_{x_1}\ddot{\varphi}_1 = M - S_1 R_1 \qquad (1)$$



3

E . 3

2 halqaning x_2 o'qiga nisbatan harakat differensial tenglamasini ruzamiz:

$$J_{x_2}\ddot{\varphi}_2 = M_{x_2}$$

X_2 o'qiga nisbatan aylasnuvchi 2 xalqaga quyilgan tashqi kuchlarning bosh momenti

$$\sum Mix_2 = S_2R_2 - Tr_2 - M_S$$

2 xalqaning aylanma harakat differensial tenglamasi quyidagicha bo'ladi:

$$J_{x_2}\ddot{\varphi}_2 = S_2R_2 - Tr_2 - M_S \quad (2)$$

$$\sum Z_i^E = T^{'} - G_3$$

3 yukning ilgarilanma harakat differensial tenglamasi

$$m_3\ddot{Z} = T - G_3 \quad (3)$$

(1),(2),(3) tenglamalardagi noma'lum kuchlar T`=T$^{'}$ va $\vec{S}_1 = \vec{S}_2 = \vec{S}$,xuddi shuningdek mos ravishda $\ddot{\varphi}_1(t), \ddot{\varphi}_2(t), \ddot{Z}(t)$ funksiyalar 1,2 halqalarning burchakli tezlanishi va 3 yukning tezlanishidir.

Ko'rsatilgan funksiyalarning bir-biri bilan bog'lanishi $\dot{\varphi}_1 = \frac{\vartheta_1}{R_1}, \dot{\varphi}_2 = \frac{\vartheta_2}{R_2}, \ddot{\varphi}_2 = \frac{a_2}{R_2}, \ddot{\varphi}_1 = \frac{a_1}{R_1}, \vartheta_1 = \vartheta_2, a_1 = a_2$ bo'lgani uchun

$$\ddot{\varphi}_1 / \ddot{\varphi}_2 = R_2 / R_1 \quad (4)$$

$$\ddot{Z} = \ddot{\varphi}_2 r_2 \quad (5)$$

T,S va $\ddot{\varphi}_2$ lar uchta tenglamalardagi noma'lumlardir. (4) dan $\ddot{\varphi}_1$ ni topamiz: $\ddot{\varphi}_1 = \frac{\ddot{\varphi}_2 R_2}{R_1}$ va (1) ga quyamiz:

$$J_{x_1}\ddot{\varphi}_2 R_2 / R_1 = M - SR_1 \quad (6)$$

(1) dan T ni yuqotish uchun T (T=T`)ni aniqlaymiz;

$$T = m_3\ddot{Z} + G_3$$

(5) nihisobga olib, yozamiz

$$T = m_3\ddot{\varphi}_2 r_2 + G_3$$

U holda (2) ifoda quyidagi ko'rinishda yoziladi:

$$J_{x_2}\ddot{\varphi}_2 = S_2R_2 - (m_3\ddot{\varphi}_2 r_2 + G_3)r_2 - M_S,$$

yoki

$$(J_{x_2} + m_3r_2^2)\ddot{\varphi}_2 = S_2R_2 - G_3r_2 - M_S \quad (7)$$

(6) va(7) dan S (S=S_1=S_2) ni yo'qotish uchun (6)ni R_2 ga, (7) ni R_1 ga ko'paytiramiz:

$$J_{x_1}\ddot{\varphi}_2 R_2^2 / R_1 = MR_2 - S_1R_1R_2$$

$$(J_{x_2} + m_3r_2^2)\ddot{\varphi}_2 R_2 = S_2R_2R_1 - G_3r_2R_1 - M_sR_1$$

bu ifodalarni o'zari qo'shib quyidagini hosil qilamiz:

$$\ddot{\varphi}_2[J_x\,(R_2^2 / R_1) + J_{x_2}R_1 + m_3r_2^2R_1] = MR_2 - G_3r_2R_1 - M_sR_1$$

bundan

$$\ddot{\varphi}_2 = \frac{MR_2R_1 - (m_2gr_2 + M_s)R_1^2}{J_{x_1}R_2^2 + (J_{x_2} + m_3r_2^2)R_1^2} \quad (8)$$

ifoda yordamida mexanizmdagi 2 xalqaning burchak tezlanishi aniqlanadi.

1 va 2 halqalarning x_1 va x_2 o'qiga nisbatan inersiya momenti:

$$J_{x_1} = m_1i_{x1}^2; J_{x_2} = m_2i_{x2}^2$$

Berilgan kattaliklarni qo'yib,aniqlaymiz:

$$J_{x1} = 8kg * m^2; J_{x_2} = 13{,}5kg * m^2$$

Endi (8) dan quyidagini hosil qilamiz:

$$\ddot{\varphi}_2 = \ 4{,}034t + 0{,}4597 \qquad (9)$$

Bu tenglamani 2 marta integrallab, masala shartidagi boshlang'ich shart,t=0 bo'lganda (2) dan $\frac{\ddot{\varphi}_1}{\ddot{\varphi}_2}\frac{R_2}{R_1}; yoki \ddot{\varphi}_2 = \frac{\ddot{\varphi}_1 R_1}{R_2}$ ga asosan

$\varphi_{20} = 0; \dot{\varphi}_{20} = \omega_{10}\frac{R_1}{R_2}$ yoki $\dot{\varphi}_{20} = 3rad/s$

(9) nibirinchi integrali $\dot{\varphi}_2 = 2{,}017t^2 + 0{,}4597t + C_1$,

Ikkinchi integrali $\varphi_2 = 0{,}672t^3 + 0{,}23t^2 + C_1 t + C_2$

Bu ifodalarni t=0 da quyidagicha yozamiz:

$$\dot{\varphi}_{20} = \ C_1, \varphi_{20} = C_2$$

Bundan C_1=3 rad/s,C_2=0

2 zvenoning burchak tezligi quyidagicha ko'rinishda bo'ladi.

$$\dot{\varphi}_2 = \ 2{,}017t^2 + 0{,}4597t + 3(rad/s)$$

2 halqaning aylanma harakat tenglamasi

$$\varphi_2 = 0{,}672t^3 + 0{,}23t^2 + 3t(rad)$$

(2) dan ipning taranglik kuchi T ni aniqlaymiz:

$$T = m_3\ddot{z} + G_3 \text{ yoki } T = m_3\ddot{\varphi}r_2 + m_3 g$$

t=1 s bo'lganda (9) ifodadan va berilganlardan aniqlaymiz.

T=4285 N

Aylanma siquvchi (bosim) kuchini (2)dan aniqlaymiz:

$$S = S_2 = (J_{x2}\ddot{\varphi}_2 + Tr_2 + M_S)/R_2$$

t=1s bo'lganda S=7295 N bo'ladi.

Nazorat savollari

1. Mexanik sistemaning harakat differensiai tenglamalari ifodalarini yozib tishuntiring?
2 Moddiy nuqtaning harakat miqdori deb nimaga aytiladi?
3. Moddiy nuqtalar sistemasining harakat miqdori ifodasini yozib tushuntiring?
4. Kuch impul'si deb nimaga aytiladi?
5. Nuqta harakat miqdorining o'zgarishi haqidagi teoremaning differensial tenglamasing yozib tushuntiring.
6. Sistema harakat miqdorining o'zgarishi haqidagi teoremaning differensial tenglamasini yozib tushuntiring?
7. Moddiy nuqta harakat miqdorini momenti va sistemaning kinetik momenti ifodalarini yozib tushuntiring.
8. Qo'zg'almas o'q atrofida aylanuvchi jismning aylanish o'qiga nisbatan kinetik momenti ifodasini yozib tushuntiring.
9. Nuqta harakat miqdori momentining o'zgarishi haqidagi teoremani ta'riflang.
10. Sistema kinetik momentining o'zgarishi haqidagi teoremani formulasini yozib ma'nosini tushuntiring.
11. Sistema kinetik momentining saqlanish qonuni ifodasini yozib tushuntiring .

1-test. Quyidagi ifodalardan mexanik sistemaning harakat differensial tenglamasi ifodasini , kuch impul'si ifodasini, sistema harakat miqdorining o'zgarishi haqidagi teoremaning differensial tenglamalarini ko'[rsating.

1. $m_\nu \frac{d^2\vec{r}_\nu}{dt^2} = \vec{F}_\nu^e + \vec{F}_\nu^i$;2. $\vec{Q} = \sum m_\nu \vartheta_\nu = M\vartheta_s$; 3. $\vec{S} = \vec{F} * t$;4. $d(m\vec{\vartheta}) = d\vec{S}$;5. $d(m\vec{\vartheta}) = d\vec{S}$;

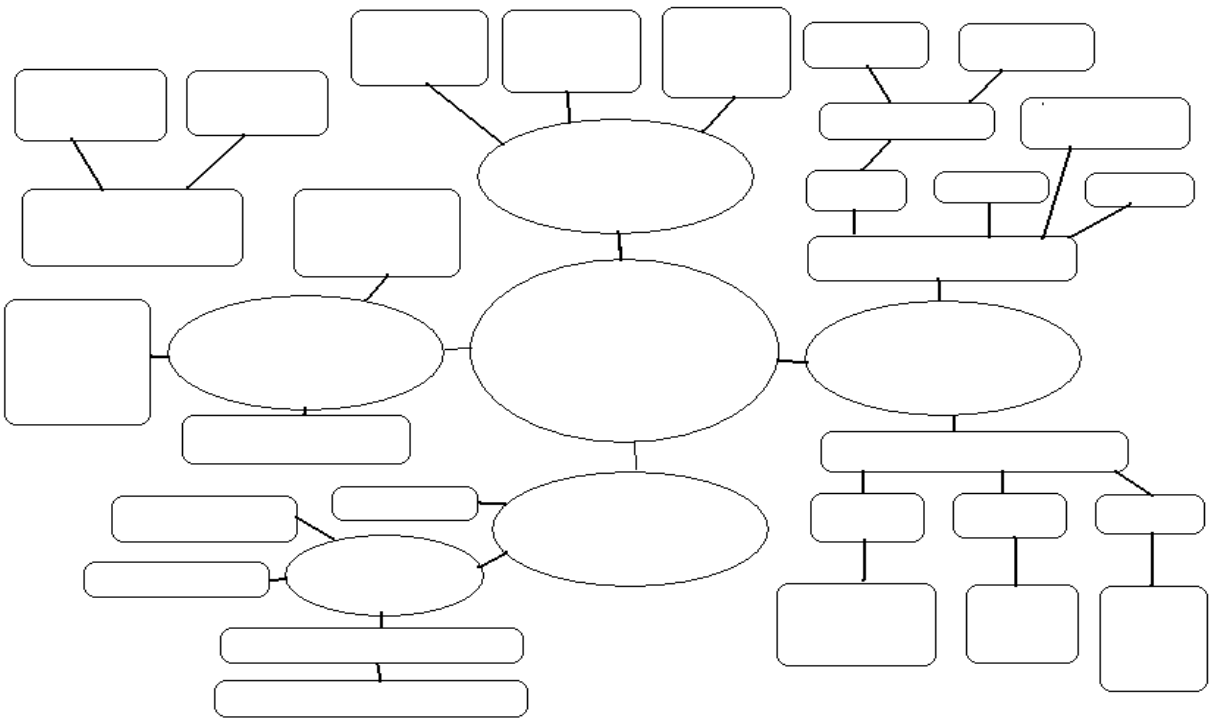
6. $\frac{d\vec{Q}}{dt} = \vec{R}_e$;7. $\vec{k}_0 = \vec{M}_0(m\vec{\vartheta}) = \vec{r}xm\vec{\vartheta}$; $\vec{K}_0 = \sum \vec{M}_0(m_\nu \vec{\vartheta}_\nu)$;8. $k_z = I_z\omega$;9.

$\frac{dK_0}{dt} = \vec{M}_0^e; \frac{dK_z}{dt} = M_z^e$;10. $\vec{M}_0^e = 0; \frac{dK_0}{dt} = 0; \vec{K}_0 = const$

2-test. Quyidagi ifodalardan Moddiy nuqtalar sistemasining harakat miqdori ifodasini , nuqta harakat miqdorining o'zgarishi haqidagi teoremaning differensial tenglamasini, sistema kinetik momentining o'zgarishi haqidagi teoremasi ifodalarini ko'[rsating. $m_\nu \frac{d^2\vec{r}_\nu}{dt^2} = \vec{F}_\nu^e + \vec{F}_\nu^i$;2. $\vec{Q} = \sum m_\nu \vartheta_\nu = M\vartheta_s$; 3. $\vec{S} = \vec{F} * t$;4. $d(m\vec{\vartheta}) = d\vec{S}$,5. $d(m\vec{\vartheta}) = d\vec{S}$ 6. $\frac{d\vec{Q}}{dt} = \vec{R}_e$;7. $\vec{k}_0 = \vec{M}_0(m\vec{\vartheta}) = \vec{r}xm\vec{\vartheta}$; $\vec{K}_0 = \sum \vec{M}_0(m_\nu \vec{\vartheta}_\nu)$;8. $k_z = I_z\omega$;9. $\frac{dK_0}{dt} = \vec{M}_0^e; \frac{dK_z}{dt} = M_z^e$;10. $\vec{M}_0^e = 0; \frac{dK_0}{dt} = 0; \vec{K}_0 = const$

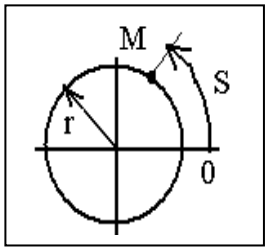
Klasterni tuzish qoidalari **13-ilova**

1. Topshiriqni diqqat bilan o'qib chiqing.
2. Fikrlarni tarmoqlantirish jarayonida paydo bo'lgan har bir fikrni yozing.
3. Imlo xatolar va boshqa jihatlarga e'tibor bermang.
4. Belgilangan vaqt tugamaguncha yozishni to'xtatmang, fikringizni jamlashga harakat qiling.
5. Fikrlarni chegaralamang, ular o'rtasida o'zaro aloqadorlikka e'tibor qarating.



8- mustaqil ish mavzusi.
Mumkin bo'lgan ko'chish prinsipi ,dinamikaning umumiy tenglamasi va zarba nazariyasiga asosan qattiq jismning harakatini tekshirish.

Reja:



1.Harakat miqdori momenti va uning o'zgarishi haqidagi teorema.

2. 1masala (K.14.5.4). Massasi m=0,5 kg bo'lgan M moddiy nuqta $s = 0{,}5t^2$ qonun asosida radiusi r=0,5m li aylana bo'ylab harakat qiladi. Nuqtaning t=1s dagi harakat miqdori momentini aylana markaziga nisbatan aniqlang. (0,25).

3. Zarba vaqtida sistema harakat miqdorining o'zgarishi haqidagi teorema.

4. masala (K.14.6.3). Massasi m=1kg bo'lgan moddiy nuqta $x = 2t, y = t^3, z = t^4$ qonun asosida harakatlansa, t=1s paytdagi nuqtaga ta'sir qiluvchi barcha kuchlarning teng ta'sir etuvchining ox o'qiga nisbatan momentini aniqlang. (6).

5. Zarba vaqtida sistema kinetik momentining o'zgarishi haqidagi teorema.

6. masala. (k.14.6.12. Jism Oz vertikal o'q atrofida ikki juft kuchlar momentlari $\vec{M}_1 = 3\vec{i} + 4\vec{j} + 5\vec{k}$ va $\vec{M}_2 = 4\vec{i} + 6\vec{j} + 4\vec{k}$ ta'sirida aylanadi. Agar jismning Oz o'qqa nisbatan inersiya momenti 3 kg*m^2 bo'lsa, muvozanat holatdan aylanishni boshlagan jismning t=2s dagi burchak tezligini aniqlang. (6)

7. D-19. Hisob-grafik topshiriq. Birinchi darajali erkin mexanik sistemaning harakatini tekshirishda dinamikaning umumiy tenglamasini qo'llanilishi.

Tayanch so'z va iboralar: 1) Zarba va zarba vaqti; 2) zarbali kuchi impul'si ($\vec{S} = \int_0^t \vec{F} * dt$); 3) zarba vaqtida nuqta harakar miqdorining o'zgarishi ($m\vec{u} - m\vartheta = \vec{s}$);

4) zarba vaqtida sistema harakat miqdorining o'zgarishi haqidagi teoremasi ($\vec{Q} - \vec{Q}_0 = \sum \vec{S}_\nu^e$); 5) zarba vaqtida sistema kinetik momentining o'zgarishi haqidagi teorema ($\vec{K}_0 - \vec{K}_0^{'} = \sum \vec{M}_0(\vec{S}_\nu^e)$);

6) Kel'vin teoremasi ($A = \frac{1}{2}\vec{S}(\vec{u} - \vec{\vartheta})$); 7) zarbadagi tiklovchi koeffisenti ($k = \frac{u}{\vartheta} = \frac{S_2}{S_1}$);

8) Elastik zarba (0<k<1); 9) sharchaning zarbadan oldingi va zarbadan keyingi tezliklari

($\vartheta = \sqrt{2gh_1}$; $u = \sqrt{2gh_2}$)

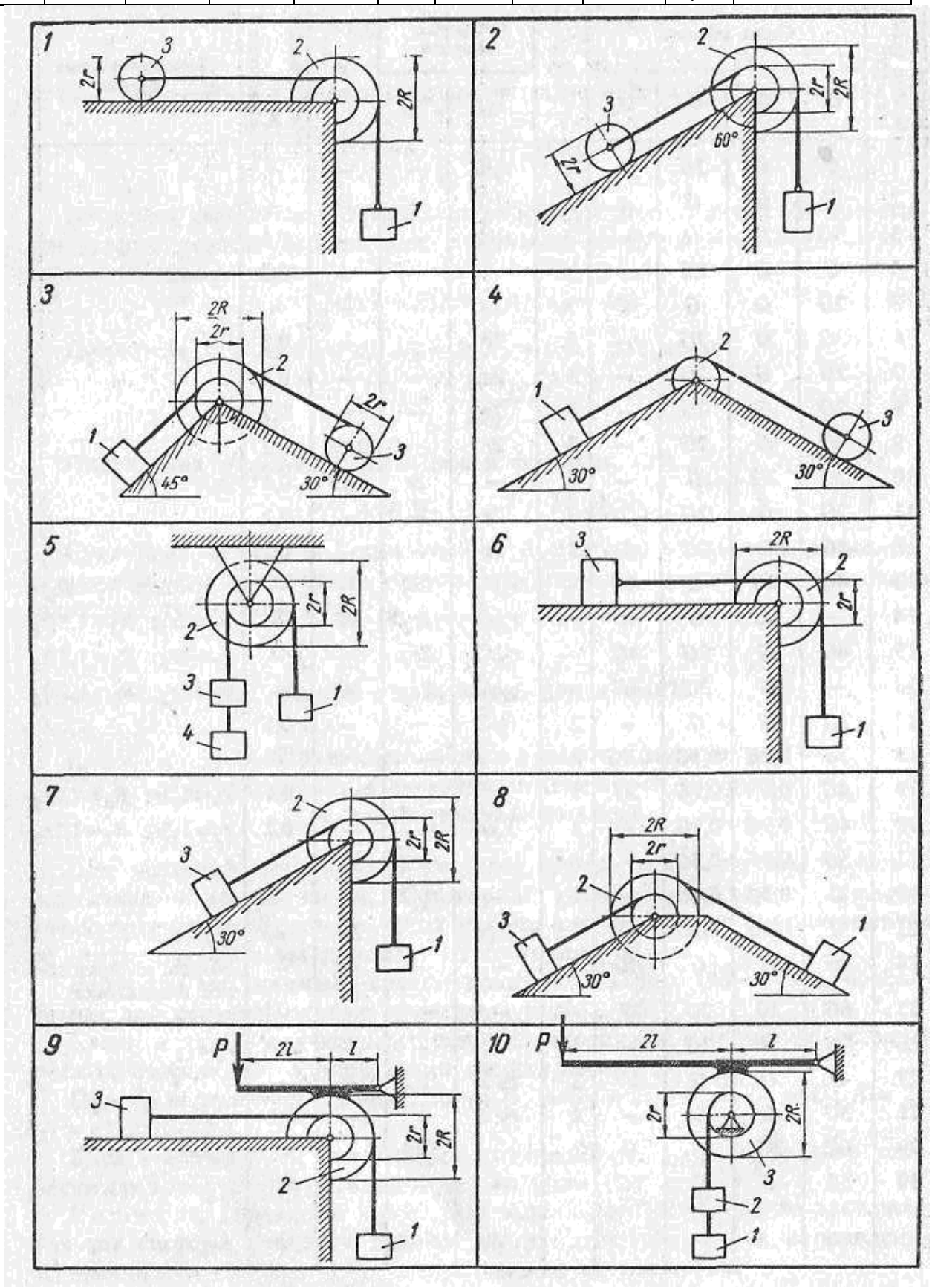
D-19. Hisob-grafik topshiriq. Birinchi darajali erkin mexanik sistemaning harakatini tekshirishda dinamikaning umumiy tenglamasini qo'llanilishi.

Berilgan mexanik sistema uchun ip bilan bog'langan yukning tezlanishini va iplarning taranglik kuchlarini aniqlang. Aylanishdagi ishqalanish va podshipnikning qarshilik kuchini hisobga olmang. Sistema tinch holatdan boshlab harakatlana boshlaydi. Mexanik sistemaning variantlari 1-3 rasm(D-19)da, yechish uchun zarur bo'lgan kattaliklar 1-jadvalda keltirilgan. Blok yoki shkiv , katka yoki g'ildiraklarning inersiya radiuslari jadvalda berilmagan bo'lsa, ularni bir jinsli to'liq silindr deb hisoblang.

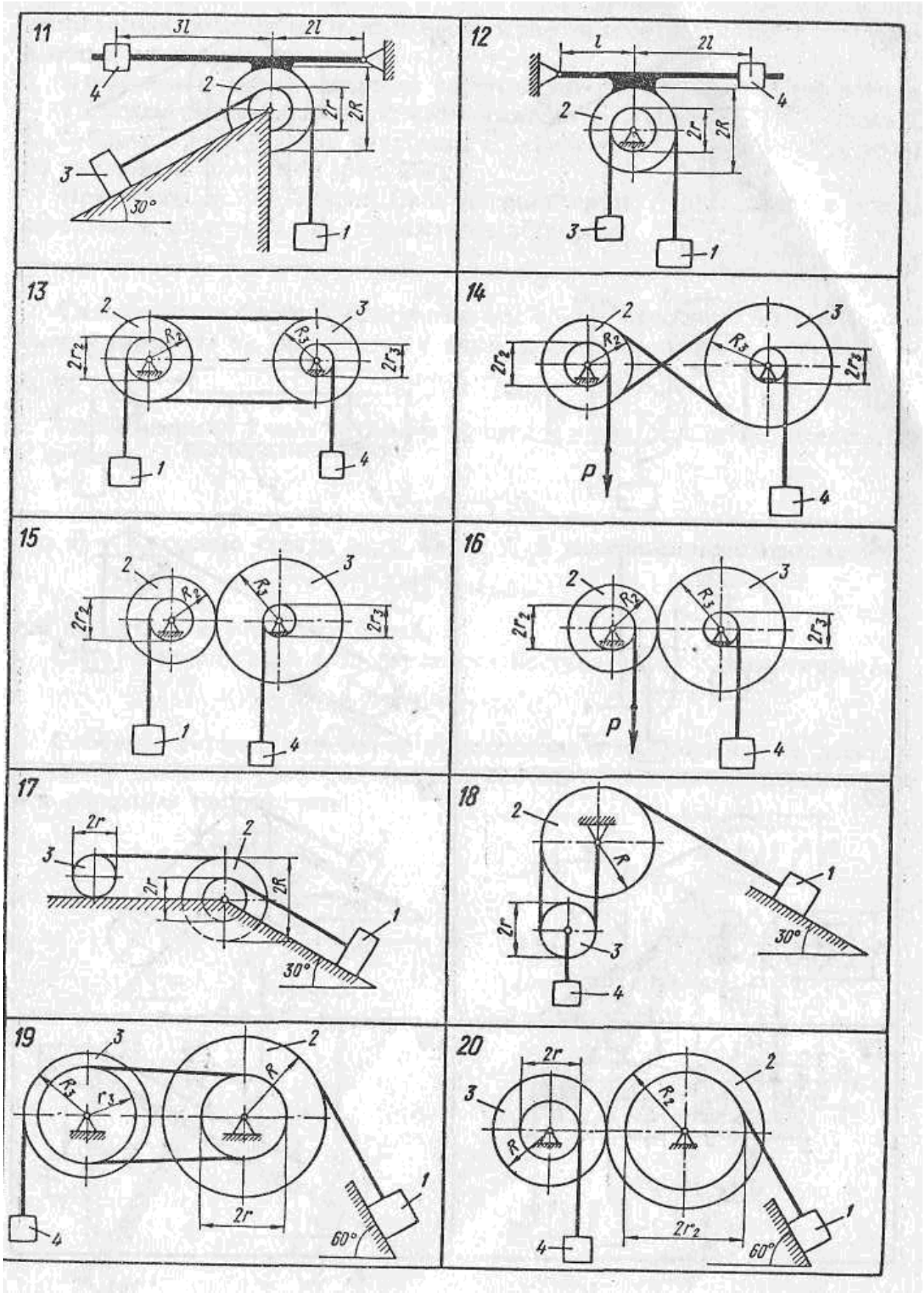
1-jadval

N.v	Og'irlik kuchlari				R/r	Inersiya radiuslari		P	Ish-sh kof-ti	Qushimcha ma'lumotlar
	G_1	G_2	G_3	G_4		i_{2x}	i_{2x}			
1	G	G	3G		2	$r\sqrt{2}$	-	-	-	
2	G	G	G	-	2	$r\sqrt{2}$	-	-	-	
3	3G	G	G	-	2	$r\sqrt{2}$	-	-	0,1	
4	G	G	2G	-	-	-	-	-	0,2	$r_2=r_3$
5	2G	G	G	-	3	2r	-	-	-	
6	2G	G	2G	-	3	2r	-	-	0,2	
7	2G	G	2G	G	3	2r	-	-	0,2	
8	2G	G	2G	-	3	2r	-	-	0,2	
9	2G	G	2G	-	3	2r	-	0,2G	0,2	
10	2G	2G	G	-	4	-	2r	G/3	0,4	
11	2G	G	2G	0,2G	3	2r	-	-	0,2	
12	2G	G	2G	0,2G	3	2r	-	-	0,2	
13	4G	2G	G	4G	-	$r_2\sqrt{2}$	$2r_3$	-	-	$R_2=2r_3;R_2=R_3$
14	-	2G	G	4G	-	$r_2\sqrt{2}$	$2r_3$	8G	-	$r_2=2r_3;R_3=1,5R_2$
15	4G	G	2G	4G	-	$r_2\sqrt{2}$	$2r_3$	-	-	$r_2=2r_3;R_3=1,5R_2$
16	-	G	2G	4G	-	$r_2\sqrt{2}$	$2r_3$	4G	-	$r_2=2r_3;R_3=1,5R_2$
17	2G	G	G	-	2	$r\sqrt{2}$	-	-	0,1	
18	3G	0,2G	0,1G	0,5G	2	-	-	-	0,4	
19	4G	0,3G	0,2G	3G	3	2r	1,2r	-	0,1	$r_3=1,2r;R_3=1,2r_3$
20	4G	0,2G	0,1G	3G	2	1,6r	$r\sqrt{2}$	-	0,2	$r_2=1,5r;R_2=1,2r_2$
21	5G	0,1G	0,2G	-	3	-	$r\sqrt{2}$	G	-	
22	G	0,2G	0,3G	-	2	-	$r\sqrt{2}$	G	-	
23	G	0,2G	0,1G	-	1,5	1,2r	-	2G	-	$R_3=1,2r$
24	2G	G	G	8G	-	-	-	-	-	
25	6G	2G	2G	G	-	-	-	-	-	$r_3=r_4$
26	6G	G	2G	-	-	-	-	-	-	
27	G	G	G	4G	2	$r\sqrt{2}$	$r\sqrt{2}$	-	-	$r_3=r_2$
28	3G	G	G	-	2	$r\sqrt{2}$	-	-	0,1	

29	6G	3G	G	G	2	-	$r\sqrt{2}$	-	-	$I_{4x}=i_{3x}$
30	8G	G	G	2G	-	-	-	-	0,1	



1-rasm (D-19)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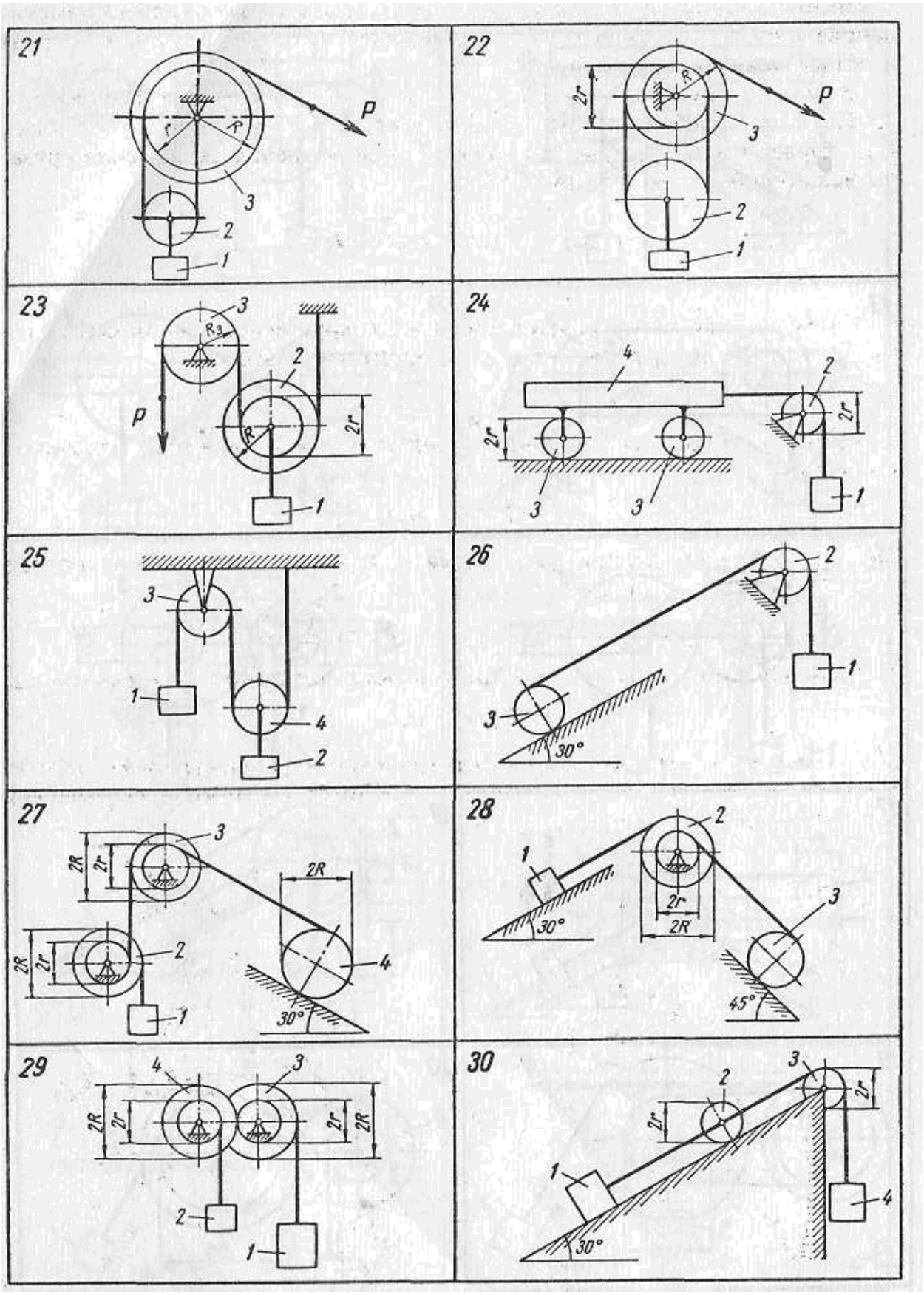
2-rasm (D-19)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4
30°

3-rasm (D-19)

D-19. Hisob-grafik topshiriqqa doir 1-masalani yechish namunasi.

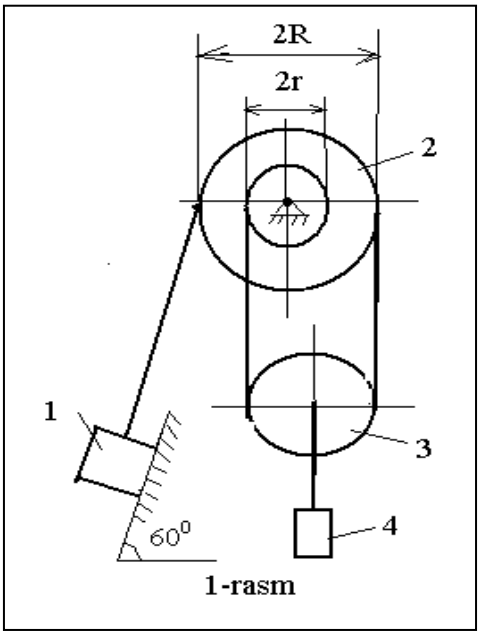
Berilganlar: $G_1 = G_2 = 2G;\ G_3 = G_4 = G;\ R = 2r;\ i_{2x} = 2\sqrt{2};\ f = 0{,}2.$ 3 blok- tutash bir jinsli silindr (1 – rasm) 1 va 4 yukning tezlanishini va 1-2 va 3-4 iplarning taranglik kuchini aniqlang.

Yechish.Topshiriqni yechishda dinamikaning umumiy tenglamasi

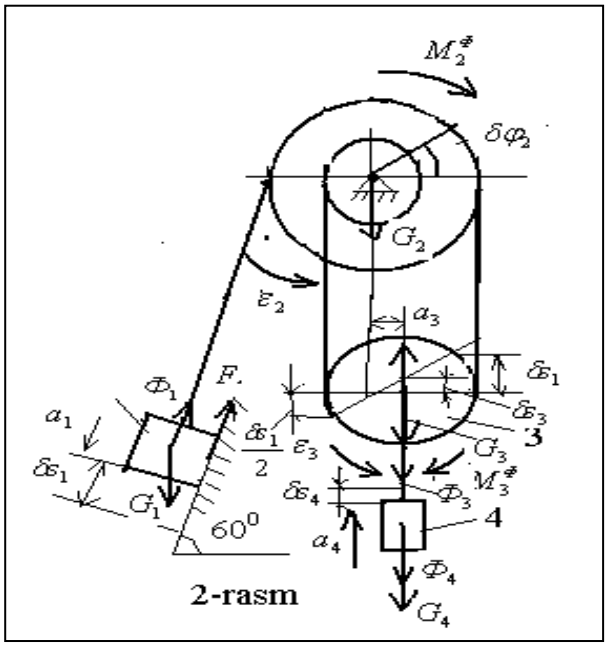
$$\sum(\vec{F}_\nu + \vec{R}_\nu + \vec{\Phi}_\nu)\delta\vec{r}_\nu = 0 \qquad (1')$$

dan foydalanamiz. Sistema tinch holatdan harakat yo'nalishida tekis tezlanuvchan harakat qilsin. Sistemadagi jismlarga ta'sir etuvchi kuchlar orasida ishqalanish kuchi ham bo'lib,uning yo'nalishi sistemaning berilgan harakat,yo'nalishishiga qarab aniqlanadi.

Agar tanlangan sistemaning harakat yo'nalishi xato tanlansa, aniqlanadigan tezlanish ishorasi «-» chiqadi. Bu holatda ishqalanish kuchlarining va inersiya kuchlarining yo'nalishini o'zgartirib, dinamikaning umumiy tenglamasini qo'llash kerak.



1-rasm



2-rasm

Berilgan masalada sistema harakatida 1 yuk pastga tushadi. Berilgan kuchlarni ko'rsatamiz: $\vec{G}_1$-1 blokni og'irlik kuchi, $\vec{G}_2$- 2 blokni og'irlik kuchi, $\vec{G}_3$-3 blokni og'irlik kuchi, $\vec{G}_4$- 4 blokni og'irlik kuchi, $\vec{F}$ - 1 yukning qiya tekislikdagi ishqalanish kuchi (2-rasm). Quyilgan inersiya kuchlari $\vec{a}$ - tezlanish bilan ilgarilanma harakat qilayotgan 1 yukning inersiya kuchi quyidagicha vector ifoda bilan aniqlanadi.

$$\vec{\Phi}_1 = -m_1\vec{a}_1$$

2 blokni inersiya kuchlari, qo'zg'almas o'q atrofida ε_2 burchak tezlanish bilan aylanishi natijasida juft kuchning momentini hosil qiladi.

$$M_2^\Phi = J_{2x}\varepsilon_2$$

3 blokning inersiya kuchi, tekis harakat hosil qiladi va quyidagi vektor ifoda bilan aniqlanadi:

$\vec{\Phi}_3 = -m_3\vec{a}_3$

Bunda $\vec{a}_3$ - 3 blok massa markazining tezlanishi. Juft kuch momenti

$M_3^{\Phi} = J_{3x}\varepsilon_{3,}$

Ifoda bilan aniqlanadi. Bunda ε_3 - 3 blokning burchak tezlanishi.

$\vec{a}_4$ tezlanish bilan ilgarilanma harakat qilayotgan 4 yukning inergiya kuchi

$\vec{\Phi}_4 = -m\vec{a}_4$

Sistemaning mumkin bo'lgan kuchishining yo'nalishi, uning haqiqiy harakat yo'nalishida hosil bo'ladi. (2-rasm).

Dinamikaning umumiy tenglamasini (1') ga asosan tuzamiz.

$$G_1\delta s_1 \sin 60^0 - F\delta s_1 - \Phi_1\delta\, s_1 - M_2^{\Phi}\delta\varphi_2 - G_3\delta s_3 - \Phi_3\delta s_3 - M_3^{\Phi}\delta\varphi_3 - G_4\delta s_4 - \Phi_4\delta s_4 = 0 \quad (1)$$

Bu yerda $\delta\varphi_2$ va $\delta\varphi_3$ - 2 va 3 bloklarning burilish burchaklari.

Mumkin bo'lgan kuchishlarning bog'lanishlari, tezliklarning bog'lanishlaridek bo'ladi.

Sistemadagi jismlarning massa markazini tezligini,burchak tezliklarini 1 yukning tezligi orqali ifodalaymiz.. 2 rasmda ko'rsatilgandek, 3 blokning tezliklar oniy markazi,2 blokning markazi bilan bir vertikalda yotadi. 3 blok markazi bilan 2 blokni tezliklar oniy markazi orasidagi masofa quyidagicha aniqlanadi:

$$b = 3r/2 - r = \frac{r}{2}$$

Endi quyidagilarni aniqlaymiz:

$$\omega_2 = \omega_3 = \frac{\vartheta_1}{R} = \frac{\vartheta_1}{2r};\quad \vartheta_3 = \vartheta_4 = \omega_3 b = \frac{\vartheta_1}{4} \qquad (2)$$

Mumkin bo'lgan kuchishlar orasidagi bog'lanishlar ham quyidagicha bo'ladi:

$$\delta\varphi_2 = \delta\varphi_3 = \delta s_1/2r;\quad \delta s_3 = \delta s_4 = \delta s_1/4 \qquad (3)$$

(1) tenglama (3) ni hisobga olsak quyidagicha ko'rinishda bo'ladi:

$$G_1 \sin 60^0 - F - \Phi_1 - M_2^{\Phi}/2r - \frac{G}{4} - \frac{\Phi_3}{4} - \frac{M_3^{\Phi}}{2r} - \frac{G_4}{4} - \frac{\Phi_4}{4} = 0 \qquad (4)$$

hisoblashda quyidagilarni hosil qilamiz:

$$G_1 = G_2 = 2G = 2mg;\quad G_3 = G_4 = G = mg; F = fG_1\cos 60^0 = fmg; \Phi_1 = m_1a_1 = 2ma_1;$$

$$M_2^{\Phi} = J_{2x}\varepsilon_2 = m_2 i_{2x}^2\varepsilon_2 = 4mr\varepsilon_2;\quad \Phi_3 = m_3a_3 = ma_3;\quad M_3^{\Phi} = J_{3x}\varepsilon_3 = [m_3(1{,}5r)^2/2]\varepsilon_3 = \quad (5)$$

$$= 9mr^2\varepsilon_3/8;\quad \Phi_4 = m_4a_4 = ma_4$$

(2) ifodaga asosan tezlanishlar orasidagi bog'lanishlar quyidagicha bo'ladi.

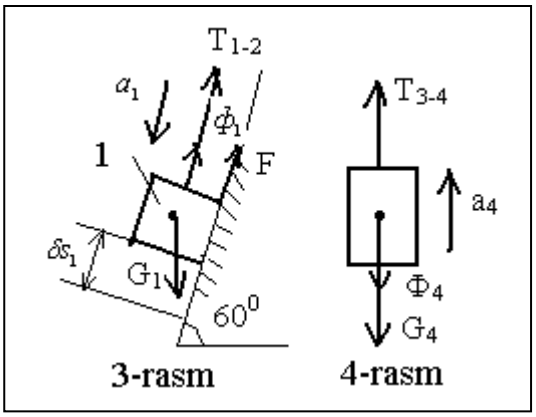
$$\varepsilon_2 = \varepsilon_3 = \frac{a_1}{2r};\quad a_3 = a_4 = \frac{a_1}{4} \qquad (6)$$

(5) va (6) ni (4) ga qo'yib, hosil qilamiz:

$$g\sqrt{3} - fg - 2a_1 - a_1 - \frac{g}{4} - \frac{a_1}{16} - \frac{9a_1}{32} - \frac{g}{4} - \frac{a_1}{16} = 0$$

bundan

$$a_1 = \frac{g(\sqrt{3} - f - 0{,}5)}{3{,}41} = 2{,}96\frac{m}{s^2};\quad a_4 = \frac{a_1}{4} = 0{,}74\frac{m}{s^2}.$$



3-rasm 4-rasm

1-2 ipning taranglik kuchini aniqlash uchun ipni kesib,uning o'rniga 2 yukning T_{1-2} ni quyami(3-rasm).

Dinamikaning umumiy tenglamasi:

$$G_1\delta s_1 \sin 60^0 - F\delta s_1 - \Phi_1\delta\, s_1 - T_{1-2}\delta s_1 = 0$$

Bundan $T_{1-2} = G_1 \sin 60^0 - F - \Phi_1 = 2G\sin 60^0 - 2Gf\cos 60^0 - \frac{2a_1 G}{g} = 0{,}93G$

3-4 ipning taranglik kuchini aniqlash uchun ipni uzib,uning o'rniga 4 yukka ta'sir etadigan T_{1-2} ni aniqlaymiz (4-rasm). Dinamikaning umumiy tenglamasini tuzmasdan ham Dalamber prinsipi $\sum \vec{F}_\nu + \sum \vec{R}_\nu + \sum \vec{\Phi}_\nu = 0$

ifodasiga asosan $T_{3-4} = G_4 + \Phi_4 = G + (\frac{G}{g})a_4 = 1{,}08G$ ni aniqlaymiz.

D-19. Hisob-grafik topshiriqqa doir 2-masalani yechish namunasi.

2-masala(D.19. 28-V).

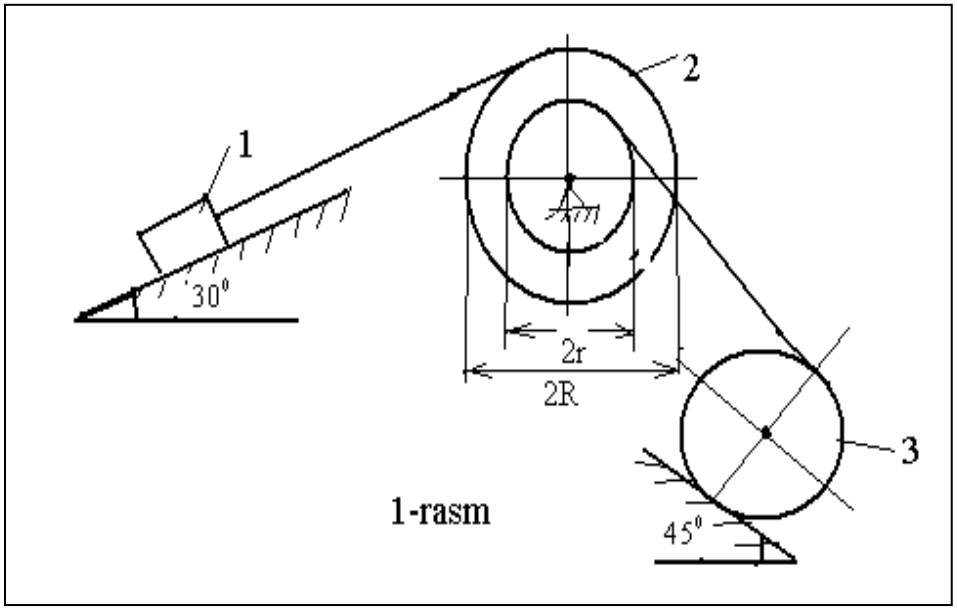
Berilganlar: $G_1 = 3G;\ G_2 = G, G_3 = G;\ R = 2r;\ i_{2x} = r\sqrt{2};\ f = 0{,}1, a_1 - ?, T_{1-2} - ?, T_{3-2} - ?.$

2 shkiv, 3-g'ildirak tutash bir jinsli silindr (1 – rasm) 1 yukning tezlanishini va 1-2 va 2-3 iplaqrningh taranglik kuchini aniqlang.

Yechish.Topshiriqni yechishda dinamikaning umumiy tenglamasi

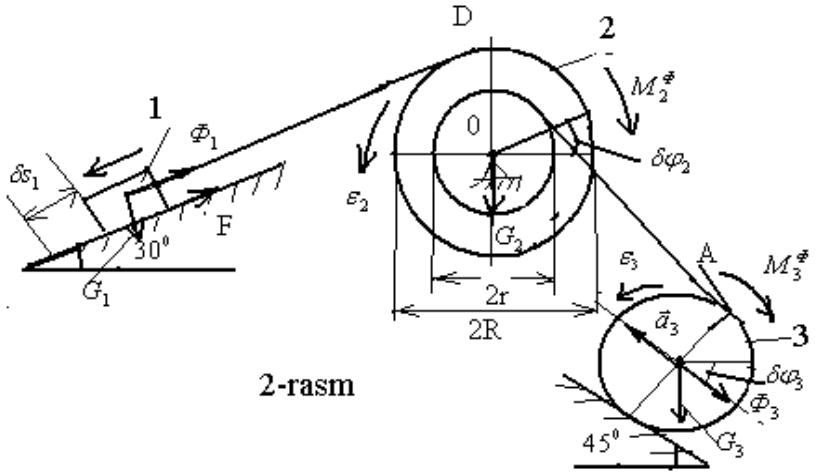
$$\sum(\vec{F}_\nu + \vec{R}_\nu + \vec{\Phi}_\nu)\delta\vec{r}_\nu = 0 \qquad (1')$$

dan foydalanamiz. Sistema tinch holatdan harakat yo'nalishida tekis tezlanuvchan harakat qilsin. Sistemadagi jismlarga ta'sir etuvchi kuchlar orasida ishqalanish kuchi ham bo'lib,uning yo'nalishi sistemaning berilgan harakat,yo'nalishishiga qarab aniqlanadi. Agar tanlangan sistemaning harakat yo'nalishi xato tanlansa, aniqlanadigan tezlanish ishorasi «-» chiqadi. Bu holatda ishqalanish kuchlarini va inersiya kuchlarining yo'nalishini o'zgartirib, dinamikaning umumiy tenglamasini qo'llash kerak.



1-rasm

Berilgan masalada sistema harakatida 1 yuk pastga tushadi. Berilgan kuchlarni ko'rsatamiz: $\vec{G}_1$-1 blokning og'irlik kuchi, $\vec{G}_2$- 2 shkivnibg og'irlik kuchi, $\vec{G}_3$-3 g'ildirakning og'irlik kuchi, $\vec{F}$ - 1 yukning qiya tekislikdagi ishqalanish kuchi (2-rasm).



2-rasm

Qo'yilgan inersiya kuchlari $\vec{a}$ - tezlanish bilan ilgarilanma harakat qilayotgan 1 yukning inersiya kuchi quyidagicha vektor ifoda bilan aniqlanadi.

$\vec{\Phi}_1 = -m_1\vec{a}_1$ 2 shkiv inersiya kuchlari, qo'zg'almas o'q atrofida ε_2 burchak tezlanish bilan aylanishi natijasida juft kuchning momentini hosil qiladi.

$M_2^{\Phi} = J_{2x}\varepsilon_2$

3 g'ildirakni inersiya kuchi, tekis harakat hosil qiladi va quyidagi vektor ifoda bilan aniqlanadi:

$\vec{\Phi}_3 = -m_3\vec{a}_3$

bunda $\vec{a}_3$ - 3 g'ildirakning massa markazini va juft kuch momenti hosil bo'ladi.

$M_3^{\Phi} = J_{3x}\varepsilon_{3,}$

bunda ε_3 - 3 g'ildirakning burchak tezlanishi.

Sistemaning mumkin bo'lgan kuchishining yo'nalishi, uning haqiqiy harakat yo'nalishida hosil bo'ladi. (2-rasm).

Dinamikaning umumiy tenglamasini ($1^{'}$) ga asosan tuzamiz.

$$G_1\delta s_1 \sin 30^0 - F\delta s_1 - \Phi_1\delta s_1 - M_2^{\Phi}\delta\varphi_2 - \Phi_3\delta s_3 - M_3^{\Phi}\delta\varphi_3 - G_3\delta s_3 \cos 45^0 = 0 \qquad (1)$$

Bu yerda $\delta\varphi_2$ va $\delta\varphi_3$ - 2 shkiv va 3 g'ildirakni burilish burchaklari.

Mumkin bo'lgan kuchishlarni bog'lanishlari, tezliklarni bog'lanishlaridek bo'ladi.

Sistemadagi jismlarning massa markazini tezligini,burchak tezliklarini 1 yukning tezligi orqali ifodalaymiz.. 2 rasmda ko'rsatilgandek, 3 g'ildirakning tezliklar oniy markaziga nisbatan, uning A nuqtasining va markazining tezligi

$$\vartheta_3 = \frac{\vartheta_A}{2} = \frac{\vartheta_1}{4}, \quad \vartheta_A = \omega_2 r_2 = \frac{\vartheta_1 r}{2r} = \frac{\vartheta_1}{2} \qquad (2)$$

Ifoda bilan aniqlanadi.

Endi quyidagilarni 2-shkiv va 3 g'ildirakning burchak tezligi, burilish burchaklarini aniqlaymiz:

$$\omega_2 = \frac{\vartheta_1}{R} = \frac{\vartheta_1}{2r};\ \ \omega_3 = \frac{\vartheta_A}{2r_3} = \frac{\vartheta_1}{2*2r_3} = \frac{\vartheta_1}{4*1{,}5r} = \frac{\vartheta_1}{6r}, r_3 = 1{,}5r; \qquad (2')$$

Mumkin bo'lgan kuchishlar orasidagi bog'lanishlar ham quyidagicha bo'ladi:

$$\delta\varphi_2 = \frac{\delta s_1}{2r};\ \ \delta\varphi_3 = \frac{\delta s_1}{6r};\ \ \delta s_3 = \frac{\delta s_1}{4} \qquad (3)$$

(3) tenglamani hisobga olsak (1) ifoda quyidagicha ko'rinishda bo'ladi:

$$2{,}6G^0 - F - \Phi_1 - M_2^{\Phi}/2r - \frac{\Phi_3}{4} - \frac{M_3^{\Phi}}{6r} - 0{,}18G_3 = 0 \qquad (4)$$

Hisoblashda quyidagilarni hosil qilamiz:

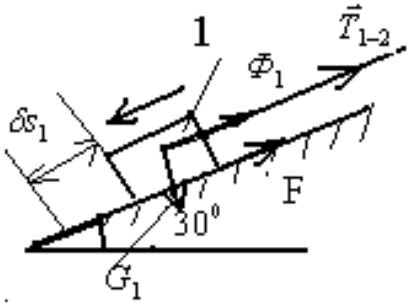
$$G_1 = 3G;\ \ G_2 = G; G_3 = G; F = fG_1\cos 30^0 = 0{,}26G; \Phi_1 = m_1a_1 = \frac{3Ga_1}{g} = 0{,}3Ga_1;$$

$$M_2^{\Phi} = J_{2x}\varepsilon_2 = m_2 i_{2x}^2\varepsilon_2 = \frac{G_2 2r^2}{g} * \frac{a_1}{2r} = 0{,}1Gra_1;\ \ \Phi_3 = m_3a_3 = ma_3 = \qquad (5)$$

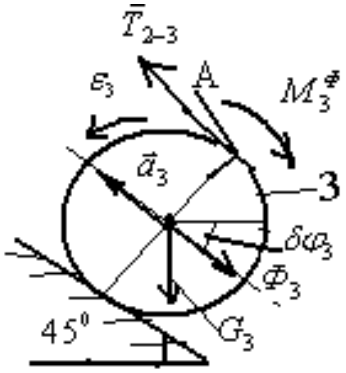
$$\frac{Ga_1}{4g} = 0{,}025Ga_1;\ \ M_3^{\Phi} = J_{3x}\varepsilon_3 = [m_3(1{,}5r)^2/2]\varepsilon_3 = 0{,}019Gr;$$

(4) ifodaga asosan tezlanishlar orasidagi bog'lanishlar quyidagicha bo'ladi.

$$\varepsilon_2 = \frac{a_1}{2r};\ \ a_3 = \frac{a_1}{4}; \varepsilon_3 = \frac{a_1}{6r} \qquad (6)$$



3-rasm



4-rasm

(5) va (6) ni (4) ga quyib, hosil qilamiz:

$$2{,}6G - 0{,}36Ga_1 - 0{,}26G - 0{,}05Ga_1 - 0{,}0063Ga_1 - 0{,}0031G - 0{,}18G = 0$$

bundan

$$a_1 = \frac{2{,}129}{0{,}36} = 5{,}9\frac{m}{s^2}$$

1-2 ipning taranglik kuchini aniqlash uchun ipni kesib,uning o'rniga 1 yukning T_{1-2} ni quyamiz(3-rasm).

Bu sistemaning qismi uchun dinamikaning umumiy tenglamasini yozamiz:

$$G_1\delta s_1\sin 30^0 - F\delta s_1 - \Phi_1\delta s_1 - T_{1-2}\delta s_1 = 0$$

bundan $T_{1-2} = G_1\sin 30^0 - 0{,}26G - 1{,}77G = -0{,}53G$

2-3 ipning taranglik kuchini aniqlash uchun ipni uzib,uning o'rniga g'ildirakka ta'sir etadigan $T_{2\text{-}3}$ ni aniqlaymiz (4-rasm). Dinamikaning umumiy tenglamasini tuzmasdan ham Dalamber prinsipi $\sum \vec{F}_\nu + \sum \vec{R}_\nu + \sum \vec{\Phi}_\nu = 0$

Ifodasiga asosan $T_{3-2} = G_3 \cos 45^0 + \Phi_3 = 0{,}025G + 3G0{,}71 = 2{,}28G$ ni ainqlaymiz.

Nazorat savollari

1. Zarba va zarba vaqti deb nimaga aytiladi?
2. Zarba kuchi impul'si ifodaasini yozib ma'nosini tushuntiring.
3. Zarba vaqtida nuqta harakar miqdorining o'zgarishi ifodagini yozib ma'nosini tushuntiring.
4. Zarba vaqtida sistema harakat miqdorining o'zgarishi haqidagi teoremasini yozib ma'nosini tushuntiring.
5. Zarba vaqtida sistema kinetik momentining o'zgarishi haqidagi teoremani formulasini yozib ma'nosini tushuntiring.
6. Kel'vin teoremasi formulasini yozib ma'nosini tushuntiring.
7. Zarbadagi tiklovchi koeffisent deb nimaga aytiladi?
8. Elastik zarbada tiklanish koeffisenti qanday bo'ladi?
9. Sharchaning zarbadan oldingi va zarbadan keyingi tezliklari ifodalarini yozib tushuntiring?

1-test. Quyidagi ifodalardan zarba kuchi impul'si ifodaasini, zarba vaqtida sistema harakat miqdorining o'zgarishi haqidagi teoremasining ifodasini, zarbadagi tiklovchi koeffisent ifodalarini ko'rsating.

1. $\vec{S} = \int_0^t \vec{F} * dt$; 2. $m\vec{u} - m\vartheta = \vec{s}$; 3. $\vec{Q} - \vec{Q}_0 = \sum \vec{S}_\nu^e$; 4. $\vec{K}_0 - \vec{K}_0^{'} = \sum \vec{M}_0(\vec{S}_\nu^e)$; 5. $A = \frac{1}{2}\vec{S}(\vec{u} - \vec{\vartheta})$; 6. $k = \frac{u}{\vartheta} = \frac{S_2}{S_1}$); 7. (0<k<1); 8. $\vartheta = \sqrt{2nh_1}$ $u = \sqrt{2gh_2}$

2-test. Quyidagi ifodalardan zarba vaqtida nuqta harakar miqdorining o'zgarishi ifodagini,zarba vaqtida sistema kinetik momentining o'zgarishi haqidagi teoremani formulasini, , zarbadagi tiklovchi koeffisent ifodalarini ko'rsating.

1. $\vec{S} = \int_0^t \vec{F} * dt$; 2. $m\vec{u} - m\vartheta = \vec{s}$; 3. $\vec{Q} - \vec{Q}_0 = \sum \vec{S}_\nu^e$; 4. $\vec{K}_0 - \vec{K}_0^{'} = \sum \vec{M}_0(\vec{S}_\nu^e)$; 5. $A = \frac{1}{2}\vec{S}(\vec{u} - \vec{\vartheta})$; 6. $k = \frac{u}{\vartheta} = \frac{S_2}{S_1}$); 7. (0<k<1); 8. $\vartheta = \sqrt{2nh_1}$ $u = \sqrt{2gh_2}$

Foydalanilgan adabiyotlar

1. Рашидов Т.Р. ва бошқалар. « Назарий механика асослари», Т.: «Ўқитувчи»,1991 й.
2. M.M.Mirsaidov va boshqalar. «Nazariy mexanika», T, «Ilm ziyo» , 2009 y.
3. O.E.Kere va boshqalar. «Nazariy mexanika fanidan qisqa masalalar to'plami», T, «Yangi asr avlodi»,2008 y.

I L O V A L A R

1 Ba`zi astronomik kattaliklar.

Yerning radiusi…….$6,37*10^6$m
Yerning massasi……$5,98*10^{24}$kg
Quyoshning radiusi……$6,95*10^8$m
Quyoshning massasi……..$1,98*10^{30}$kg
Oyning radiusi……...$1,74*10^6$m
Oyning massasi…… $7,33*10^{22}$kg
Yerning markazidan quyoshning markazigacha bo`lgan masofa……$1,49*10^{11}$m
Yerning markazidan Oyning markazigacha bo`lgan masofa …….$3,84*10^8$m
Oyning Yer atrofida aylanish davri…….....27,3 sutka $2,36*10^6$s

2.***Qattiq jismlarning qayishqoqlik doimiysi (yaxlitlangan qiymatlar)***

Modda	Yung moduli E,GPa	Siljish moduli G,GPa
Alyuminiy	69	24
Volfram	380	140
Temir (po`lat)	200	76
Mis	98	44
kumush	74	27

3. Sinus va tangens funksiyalarining 0-90^0 burchaklar uchun qiymastlari jadvali.

Gradus	sinus	tangens	gradus	Sinus	Tangens	gradus	Sinus	Tangens
0	0,0000	0,0000	31	0,5150	0,6009	61	0,8746	1,804
1	0,0175	0,0175	32	0,5299	0,6249	62	0,8829	1,881
2	0,0349	0,0349	33	0,5446	0,6494	63	0,8910	1,963
3	0,0523	0,0524	34	0,5592	0,6745	64	0,8988	2,050
4	0,0698	0,0699	35	0,5736	0,7002	65	0,9063	2,145
5	0,0872	0.0875	36	0,5878	0,7265	66	0,9135	2,246
6	0,1045	0,1051	37	0,6018	0,7536	67	0,9205	2,356
7	0,1219	0,1228	38	0,6157	0,7813	68	0,9272	2,475
8	0,1392	0,1405	39	0,6293	0,8098	69	0,9336	2,605
9	0,1564	0,1584	40	0,6428	0,8391	70	0,9397	2,747
10	0,1736	0,1763	41	0,6561	0,8693	71	0,9455	2,904
11	0,1908	0,1944	42	0,6691	0,9004	72	0,9511	3,078
12	0,2079	0,2126	43	0,6820	0,9325	73	0,9563	3,271
13	0,2250	0,2309	44	0,6947	0,9657	74	0,9613	3,487
14	0,2419	0,2493	45	0,7071	1,0000	75	0,9659	3,732
15	0,2588	0,2679	46	0,7193	1,036	76	0,9703	4,011
16	0,2756	0,2867	47	0,7314	1,072	77	0,9744	4,331

17	0,2924	0,3057	48	0,7431	1,111	78	0,9781	4,705
18	0,3090	0,3249	49	0,7547	1,150	79	0,9816	5,145
19	0,3256	0,3443	50	0,7660	1,192	80	0,9848	5,671
20	0,3420	0,3640	51	0,7771	1,235	81	0,9877	6,314
21	0,3584	0,3839	52	0,7880	1,280	82	0,9903	7,115
22	0,3746	0,4040	53	0,7986	1,327	83	0,9925	8,144
23	0,3907	0,4245	54	0,8090	1,376	84	0,9945	9,514
24	0,4067	0,4452	55	0,8192	1,428	85	0,9962	11,43
25	0,4226	0,4663	56	0,8290	1,483	86	0,9976	14,30
26	0,4384	0,4877	57	0,8387	1,540	87	0,9986	19,08
27	0,4540	0,5095	58	0,8480	1,600	88	0,9994	28,64
28	0,4695	0,5317	59	0,8572	1,664	89	0,9988	57,29
29	0,4848	0,5543	60	0,8660	1,732	90	1,0000	----
30	0,5000	0,5774						

Foydalanilgan adabiyotlar

1. Шохайдарова Р. ва бошқалар «Назарий механика», Т.: «Ўқитувчи»,1992 й.
2. Рашидов Т.Р. ва бошқалар. « Назарий механика асослари», Т.: «Ўқитувчи»,1991 й.
3. Мешчерский И.В. «Назарий механикадан масалалар тўплами». Т.: «Ўқитувчи»,1990 й.
4. M.M.Mirsaidov va boshqalar. «Nazariy mexanika», T, «Ilm ziyo» , 2009 y.
5. O.E.Kere va boshqalar. «Nazariy mexanika fanidan qisqa masalalar to'plami», T, «Yangi asr avlodi»,2008 y.
6. «Сборник заданий для курсовых работ по теоретической механике» под редакций А.А.Яблонского, «Высшая школа» , 1985 г.

M U N D A R I J A