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ENG 284
MECHATRONICS ENGINEERING

(a)

$$\frac{dy}{dt} = ky$$

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$$\frac{1}{y} dy = k dt$$

$$\int \frac{1}{y} dy = \int k dt$$

$$\ln y = k \int dt$$

$$\ln y = kt + C$$

$$y = e^{kt+C}$$

$$\therefore y = C e^{kt}$$

Since the bacteria doubles

$$0 \text{ hour} = 20$$

$$5 \text{ hour} = 40$$

$$\text{At } y(5) = 40$$

$$40 = 20 e^{5k}$$

$$2 = e^{5k}$$

Multiply both sides by \ln

$$\ln 2 = 5k$$

$$k = \frac{\ln 2}{5}$$

$$k = 0.1386$$

$$y = 20 e^{kt}$$

After $1\frac{1}{2}$ days

which is $24 + 12 = 36$ hours

$$y = 20 e^{0.1386 \times 36}$$

$$y = 2938$$

The bacteria growth (exponential growth) depends on the initial value.

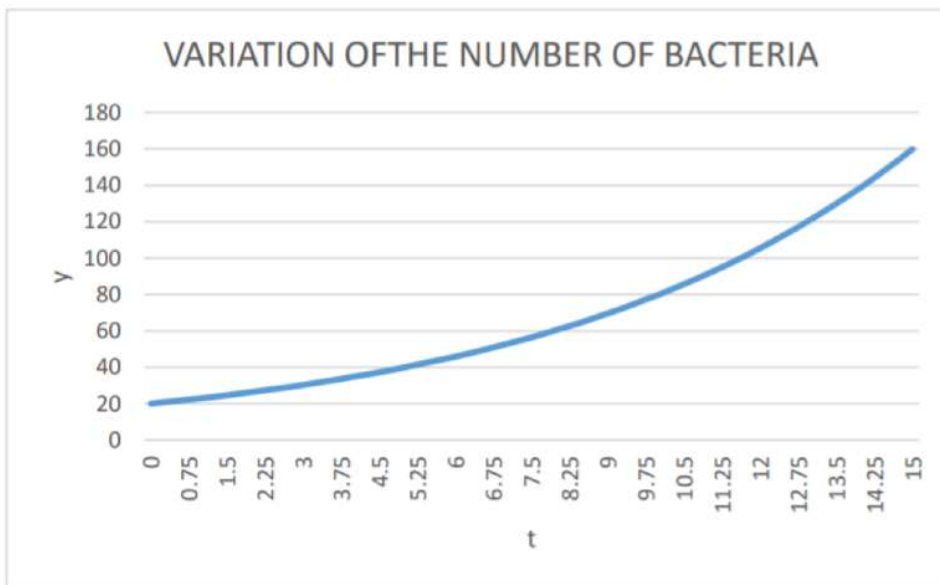
$$kx = \frac{1}{26}$$

$$26x = 1/26$$

$$y=20*\exp(0.1386*t)$$

t	y
0	20
0.25	20.70515
0.5	21.43515
0.75	22.1909
1	22.97329
1.25	23.78327
1.5	24.6218
1.75	25.4899
2	26.3886
2.25	27.319
2.5	28.28219
2.75	29.27934
3	30.31165
3.25	31.38036
3.5	32.48675
3.75	33.63214
4	34.81792
4.25	36.04551
4.5	37.31638
4.75	38.63205
5	39.99411
5.25	41.4042
5.5	42.864
5.75	44.37527
6	45.93982
6.25	47.55953
6.5	49.23636
6.75	50.9723
7	52.76944
7.25	54.62995
7.5	56.55606
7.75	58.55007
8	60.61439
8.25	62.75149
8.5	64.96394
8.75	67.25439
9	69.6256
9.25	72.08041
9.5	74.62177
9.75	77.25273
10	79.97645
10.25	82.79621
10.5	85.71538
10.75	88.73747
11	91.86612

11.25	95.10507
11.5	98.45822
11.75	101.9296
12	105.5234
12.25	109.2438
12.5	113.0955
12.75	117.0829
13	121.2109
13.25	125.4845
13.5	129.9087
13.75	134.489
14	139.2307
14.25	144.1396
14.5	149.2216
14.75	154.4827
15	159.9294



$$y=c*\exp(0.1386*t)$$

c	10	30	50
t	y(10)	y(30)	y(50)
0	10	30	50
0.5	10.71758	32.15273	53.58788
1	11.48665	34.45994	57.43323
1.5	12.3109	36.9327	61.5545
2	13.1943	39.58291	65.97151
2.5	14.14109	42.42328	70.70547
3	15.15583	45.46748	75.77914
3.5	16.24337	48.73012	81.21687
4	17.40896	52.22688	87.04481
4.5	18.65819	55.97456	93.29094
5	19.99706	59.99117	99.98528
5.5	21.432	64.296	107.16
6	22.96991	68.90973	114.8495
6.5	24.61818	73.85453	123.0909
7	26.38472	79.15416	131.9236
7.5	28.27803	84.83408	141.3901
8	30.30719	90.92158	151.536
8.5	32.48197	97.4459	162.4098
9	34.8128	104.4384	174.064
9.5	37.31088	111.9327	186.5544
10	39.98823	119.9647	199.9411
10.5	42.85769	128.5731	214.2885
11	45.93306	137.7992	229.6653
11.5	49.22911	147.6873	246.1455
12	52.76168	158.285	263.8084
12.5	56.54773	169.6432	282.7387
13	60.60547	181.8164	303.0273
13.5	64.95437	194.8631	324.7719
14	69.61535	208.8461	348.0768
14.5	74.61079	223.8324	373.0539
15	79.96468	239.8941	399.8234
15.5	85.70277	257.1083	428.5138
16	91.8526	275.5578	459.263
16.5	98.44373	295.3312	492.2186
17	105.5078	316.5235	527.5391
17.5	113.0788	339.2365	565.3941
18	121.1931	363.5793	605.9655
18.5	129.8896	389.6689	649.4482
19	139.2102	417.6306	696.0511
19.5	149.1996	447.5988	745.9981
20	159.9058	479.7175	799.5292
20.5	171.3803	514.1409	856.9015

21	183.6782	551.0345	918.3908
21.5	196.8585	590.5754	984.2924
22	210.9846	632.9538	1054.923
22.5	226.1244	678.3731	1130.622
23	242.3505	727.0515	1211.753
23.5	259.741	779.2231	1298.705
24	278.3794	835.1383	1391.897
24.5	298.3553	895.0659	1491.777
25	319.7646	959.2938	1598.823
25.5	342.7102	1028.13	1713.551
26	367.3023	1101.907	1836.511
26.5	393.659	1180.977	1968.295
27	421.9071	1265.721	2109.535
27.5	452.1822	1356.546	2260.911
28	484.6297	1453.889	2423.148
28.5	519.4056	1558.217	2597.028
29	556.677	1670.031	2783.385
29.5	596.6228	1789.868	2983.114
30	639.4351	1918.305	3197.175

