PHYSICS ASSIGNMENT – DETAILED SOLUTIONS

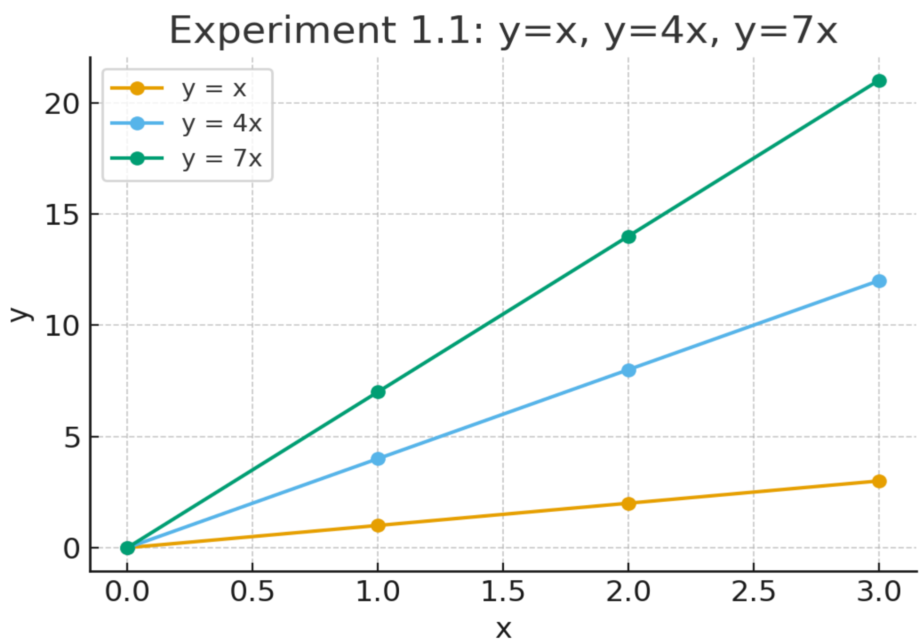
Experiment 1.1 — Question (rewritten):

Plot on the same diagram the following graphs: y = x, y = 4x, y = 7x. Measure the slope in each case.

Solution:

We choose x = 0,1,2,3 and compute corresponding y-values. The slopes are the coefficients of x: 1, 4 and 7.

x	y=x	y=4x	y=7x
0	0	0	0
1	1	4	7
2	2	8	14
3	3	12	21



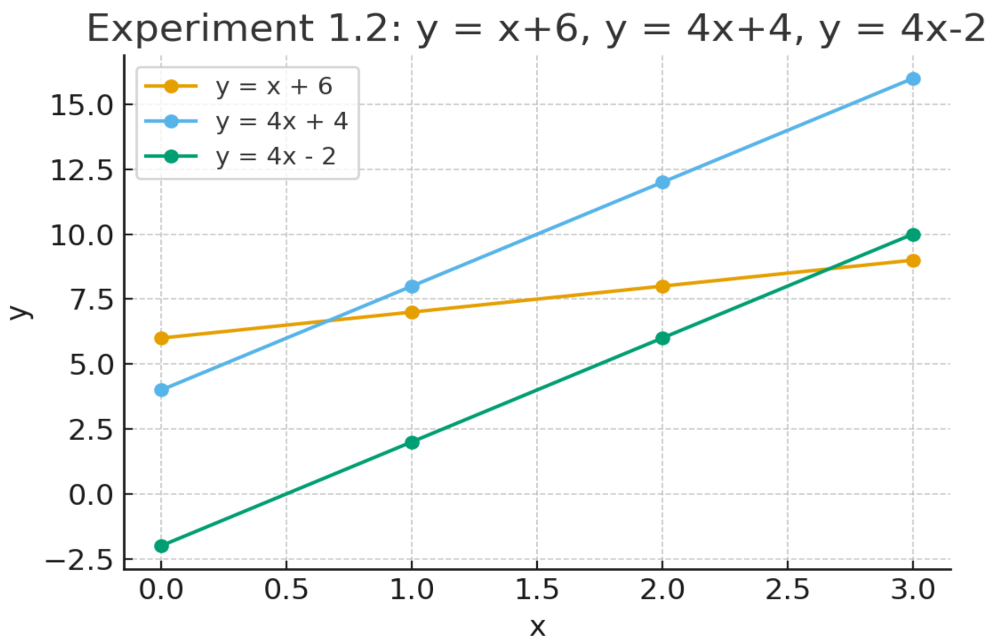
Experiment 1.2 — Question (rewritten):

Plot on the same diagram the following graphs: y = x + 6, y = 4x + 4, y = 4x - 2. Measure their slopes and intercepts.

Solution:

Slopes are coefficients of x: 1 for first, 4 for second and 4 for third. Intercepts (y when x=0) are 6, 4 and -2 respectively.

x	y = x+6	y = 4x+4	y = 4x-2
0	6	4	-2
1	7	8	2
2	8	12	6
3	9	16	10



Experiment 1.3 — Question (rewritten):

State what functions of S and T you would plot to obtain straight-line graphs in the following cases: (a) T = a S^n; (b) T = a e^{Sb}; (c) T^2 = a(S^2 + b^2)/S; (d) T = aS + bS^2.

Solution (rewritten):

(a) Take logs: log T = log a + n log S → plot log T vs log S. Slope = n, intercept = log a.

(b) Take natural log: ln T = ln a + b S → plot ln T vs S. Slope = b, intercept = ln a.

(c) Rearrange: T^2 = a(S + b^2/S) → plot T^2 (y-axis) vs [S + (b^2/S)] (x-axis). Slope = a.

(d) Divide by S: T/S = a + b S → plot T/S (y-axis) vs S (x-axis). Slope = b, intercept = a.

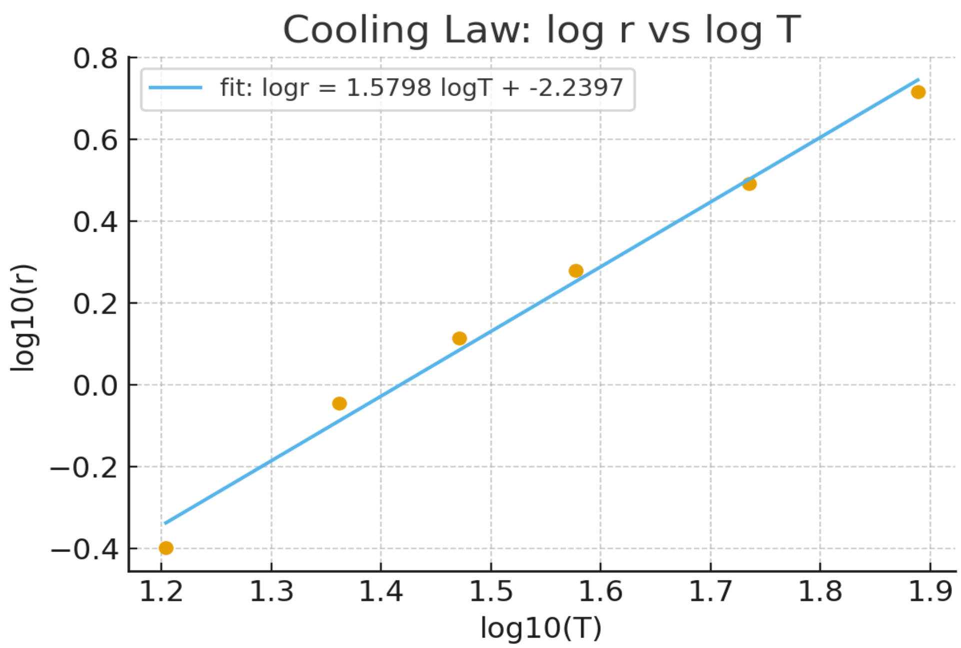
Experiment 1.4 — Question (rewritten):

Assuming the law of cooling is r = a T^n, find the values of a and n by plotting a suitable graph. Given data of rate r and temperature excess T.

Solution (rewritten):

Take common logarithm: log r = log a + n log T. Plot log r (y) vs log T (x). The slope of the straight line is n and the intercept is log a.

T (°C)	r (°C/min)	log10(T)	log10(r)
77.4	5.2	1.8887	0.7160
54.3	3.1	1.7348	0.4914
37.8	1.9	1.5775	0.2788
29.6	1.3	1.4713	0.1139
23.0	0.9	1.3617	-0.0458
16.0	0.4	1.2041	-0.3979



Result of linear fit: log r = n log T + log a with n = 1.5798 and log10(a) = -2.2397. Therefore a = 3.0000.

Experiment 1.5 — Question (rewritten):

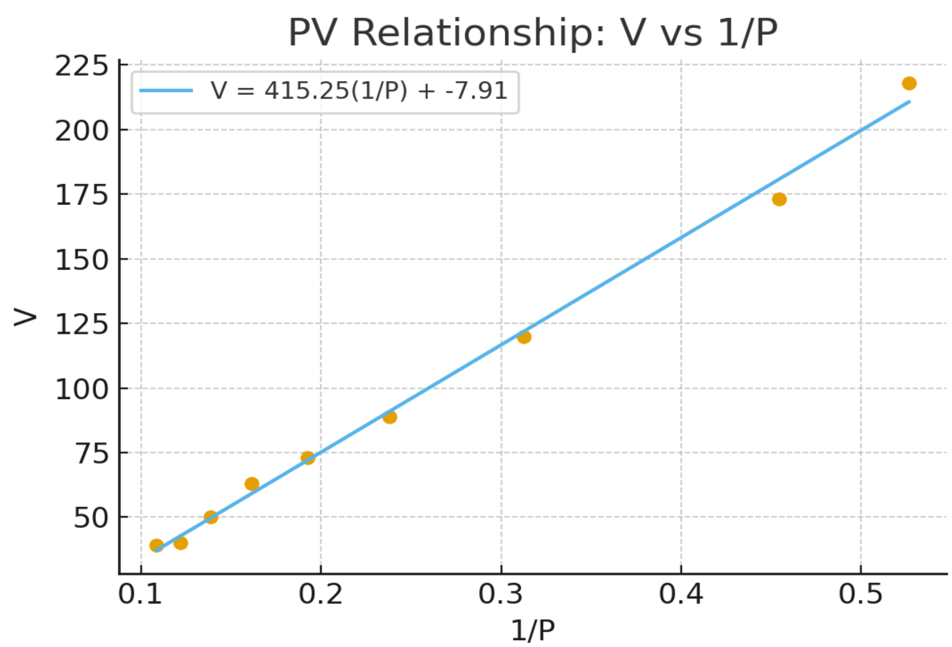
Measurements of two related quantities P and V were made: P = [1.9,2.2,3.2,4.2,5.2,6.2,7.2,8.2,9.2] and V = [218,173,120,89,73,63,50,40,39]. It is known PV = constant. Reduce the results to a straight line graph and find the constant.

Solution (rewritten):

Since PV = k, V = k (1/P). So plot V (y) against 1/P (x). The slope gives k if the intercept is near zero.

P	V	1/P
1.9	218	0.526316
2.2	173	0.454545
3.2	120	0.312500

4.2	89	0.238095
5.2	73	0.192308
6.2	63	0.161290
7.2	50	0.138889
8.2	40	0.121951
9.2	39	0.108696



Linear fit: V = 415.247(1/P) + -7.912. Estimated constant k ≈ 415.247.

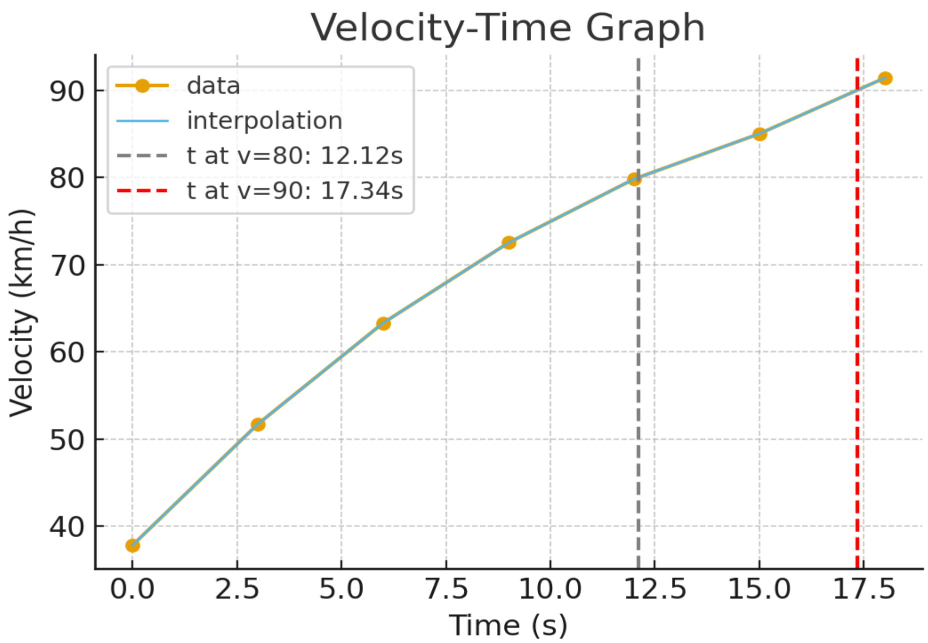
Experiment 1.6 — Question (rewritten):

The speedometer readings at the ends of successive intervals of 3 seconds are (km/h): 37.8, 51.7, 63.3, 72.5, 79.8, 85.0, 91.4. Plot the velocity-time graph in convenient units and find from the graph (a) the distance in km covered while the speed increased from 80 to 90 km/h, and (b) the acceleration when speeds are 50, 70 and 90 km/h.

Solution (rewritten):

t (s)	v (km/h)
0	37.8
3	51.7
6	63.3
9	72.5
12	79.8
15	85.0

18	91.4



(a) By linear interpolation on the velocity-time curve we find time at v=80 km/h: t = 12.12 s and at v=90 km/h: t = 17.34 s.

Time interval Δt = 5.23 s. Distance = $\int v \, dt$ (convert time to hours). Computed distance ≈ 0.1230 km.

(b) Acceleration at given speeds:

At v = 50 km/h → dv/dt = 4.6333 km/h/s which is 1.2870 m/s^2 (rounded). Time corresponding ≈ 2.63 s.

At v = 70 km/h → dv/dt = 3.0667 km/h/s which is 0.8519 m/s^2 (rounded). Time corresponding ≈ 8.18 s.

At v = 90 km/h → dv/dt = 2.1333 km/h/s which is 0.5926 m/s^2 (rounded). Time corresponding ≈ 17.35 s.

END OF SOLUTIONS