EuPhO 2019 Theory 1 Marking Scheme Timestamp: June 2nd, 21:00

Part	Criteria	Max	Points
a.1	Realizing that the velocity is constant	1.0	
a.2	Realizing that the droplet temperature during melting equals 0 °C	1.0	
a.3	Using Newton's cooling law and realizing that proportionality factor is constant	1.0	
a.4	Expressing heat by area and equating it with latent heat	1.0	
a.5	Determining the areas in the graphs	0.5	
a.6	Calculating the mass fraction	0.5	
	Subtotal part a.	**5.0**	
b.1	Arguing that the temperature of the droplet closely follows the temperature profile (explicit or implicit) *(0.5 for making use of this fact, 0.5 for motivating it)*	1.0	
b.2	Formulating differential equation for the (relative) droplet temperature	1.0	
b.3	Finding solution for (relative) temperature	1.0	
b.4	Determining relevant parameter in solution from previous results	0.5	
b.5	Realizing that exponential part is negligible at ground level	1.0	
b.6	Giving numerical result for droplet temperature	0.5	
	Subtotal part b.	**5.0**	

Details:

- Part b.: If students take the final temperature as equal to atmospheric temperature at ground without proper derivation they are awarded 1.5 point at maximum for part b.
- Part b.: Alternatively to b.2-b.5 students can also determine the change rate of droplet temperature with height, realize that this is much higher (for given temperatures) than the change rate of atmospheric temperature and from that argument that it is sufficient to look at the limiting case where the rate change of droplet and atmospheric temperature equal. This should also be awarded full marks.

General rules:

- **Follow the marking scheme!** Be consistent and generous.
- Make sure to look at all the scanned pages.
- Make notes for moderation (preferably in pdfs or alternatively on paper).
- Propagating errors: students are penalised *only* at the point of the original mistake, unless the result has wrong dimensions or other obviously physically wrong nature.
- All equations correct, numerical answer is wrong from calculation error: **-0.1** unless answer is clearly physically unreasonable.