Theoretical Problem 1: ISS Orbital Decay Dynamics

Q1 - Marking scheme

Question part	Total marks	Partial marks	Explanation for partial marks and special cases
A.1	**0.5**	**0.1** **0.1** **0.3**	Perturbation of air pressure correct Differential formula is correct Integral formula is correct (final answer)
A.2	**0.3**	**0.1** **0.2**	correct standard barometric formula correct calculation of h_0
A.3	**0.6**	**0.1** **0.2** **0.3**	Correct dependence of g_{h+} correct integration correct improved barometric formula
A.4	**0.4**	**0.2** **0.2**	correct analytic formula correct numerical values
A.5	**0.2**	**0.1** **0.1**	Correct air density Correct air concentration
B.1	**0.5**	**0.1** **0.1** **0.3**	Gravitation g_h Satellite velocity v_h Correct revolution period
B.2	**0.5**	**0.2** **0.3**	Kinetic and potential energy Total energy
B.3	**1.0**	**0.3** **0.2** **0.5**	Negative work by air drag force Perturbation of total energy Correct conservation formula
B.4	**0.5**	**0.1** **0.4**	Formula of the speed as dh/dt Correct formula for descent speed
B.5	**0.5**	**0.1** **0.4**	Descent rate per a revolution Total falling time written as an integral
C.1	**0.5**	**0.3** **0.1** **0.1**	Air drag force Air drag descending velocity Air drag descent rate per a revolution
C.2	**0.5**	**0.1** **0.1** **0.3**	Correct integral formula for the air descent rate Use of approximations taking into account $h_0 \ll h \ll R_E$ Correct total falling time in final integral form
D.1	**0.3**	**0.2** **0.1**	Drag force by oxygen ions Density of ionized oxygen molecules
D.2	**0.7**	**0.3** **0.4**	Descent velocity due to atomic oxygen Descent rate H_h^{ion}
E.1	**0.6**	**0.3** **0.3**	Number of electrons collected by the IS for time dt Magnitude of the inducted electric current
E.2	**0.6**	**0.2** **0.2** **0.2**	Averaged sine of the angle between magnetic field and ISS velocity Formula of Ampere's force Correct final answer
E.3	**0.8**	**0.3** **0.5**	Descent velocity due to Earth's magnetic field Descent rate H_h^{ind}

F.1	**0.4**	**0.02** each filled box	
F.2	**0.4**	**0.1** **0.1** **0.1** **0.1**	Value H_h^{air} at h=350km Value H_h^{air} at h=3750km Value H_h^{air} at h=400km Value H_h^{air} at h=410km
F.3	**0.2**	**0.2**	If answered: 1) Ampere 2) Oxygen ions 3) Air drag