

## Appendix I: Product Specification

category	#	D/W	weight	requirement	justification
miscellaneous	1	D	-	Must have maximum total weight of 30kg	weight study
	2	W	4	Should aim for target total weight of 12kg or less	weight study
	3	D	-	Major maintainance (ie. servicing bearings) must be required twice a year or less by a typical user	comparison to competitors
	4	D	-	Minor maintainance (ie. cleaning drivetrain) must be required one a week or less for a typical user	comparison to competitors
	5	D	-	The frame must last at least 5 years for a typical user	comparison to competitors
	6	D	-	All components must be compatible to allow for flexibility in alternative geometries	design brief - flexible
	7	D	-	Must be suitable for a rider up to 150kg	weight percentile & BMI chart
	8	D	-	Must be comfortable and safe to ride for 5.5km on public roads	<a href="#">average cycle ride distance</a>
	9	D	-	Must be capable of travelling at 25km/h on flat, smooth, dry tarmac	ISO 4210
	10	W	3	Should be capable of travelling at 10km/h on flat gravel paths	arbitrary target
	11	D	-	When sitting on the saddle with hips, knees, and ankles extended downward, the rider's toes should not be more than 200mm above the ground	want to avoid tallbikes or penny farthings
	12	D	-	Must have ground clearance of at least 150mm with pedals level	curb height
	13	W	1	Bike should be aesthetically pleasing	comparison to competitors
	14	W	2	Dissassembled, the bike should fit into a hard shell travel case with internal dimensions of 625 x 610 x 240 mm (preferably without detaching cables)	comparison to competitors
frame	15	W	3	Max. width between rider's knees of 250mm	feet 'shoulder width apart'
	16	D	-	Stack must be between 540mm and 590mm	geometry study
	17	W	3	Should be able to adjust stack between 520mm and 650mm	geometry study
	18	D	-	Reach must be between 375mm and 410mm	geometry study
	19	W	3	Should be able to adjust reach between 340mm and 460mm	geometry study
	20	D	-	Must be suitable for a rider 1680mm tall in a comfortable and safe riding position	me, as I'll be testing it
	21	W	5	Should be able to adjust frame to suit riders between 1400mm to 2000mm in height	UK height percentile chart
	22	D	-	Wheelbase must be between 985mm and 1110mm	geometry study
	23	W	4	Should be able to adjust wheelbase between 985mm and 1175mm	geometry study
	24	W	3	Trail should be between 55mm and 110mm	geometry study
	25	W	3	Fork rake should be between 40mm and 55mm	geometry study
	26	D	-	Standover height must be less than 860mm and suitable for the inseam of the intended rider (ie. about 700mm for a small frame)	geometry study
	27	W	4	Bottom bracket drop should be between 45mm and 75mm	geometry study

	28	W	4	Head tube angle should be between 65 deg and 75 deg	ISO 4210
	29	W	1	Should be able to mount standard mudguards and luggage racks to frame	comparison to competitors
	30	D	-	Frame and fork must withstand the falling striker impact test outlined in ISO4210-6 4.1 with no cracks, fractures or separation of components and with permanent deformation of not more than 30mm (can use computational test if necessary)	ISO 4210
	31	D	-	Frame and fork must withstand the falling frame impact test outlined in ISO4210-6 4.2 with no cracks, fractures or separation of components and with permanent deformation of not more than 60mm (can use computational test if necessary)	ISO 4210
	32	D	-	Fork must withstand the falling striker impact test outlined in ISO4210-6 5.4 with no cracks, fractures, or separation of components, and with permanent deformation of not more than 45mm (can use computational test if necessary)	ISO 4210
	33	D	-	Fork must withstand 1000N as a cantilever for 1 min (acting to bend rearward) with permanent deformation of not more than 10mm	ISO 4210
	34	D	-	Fork must withstand 5000N in tension for 1 min with no detachment or loosening of any components	ISO 4210
steering	35	D	-	Must be able to steer using handlebars	definition of a bicycle
	36	D	-	The range of motion of the handlebars must be at least +/- 60 deg from straight ahead, with no tight spots, stiffness, slackness, or wobble	ISO 4210
	37	D	-	Handlebar width must be between 350mm and 1000mm	ISO 4210
	38	W	2	Handlebar grips should be round with a diameter of 22.2mm	<a href="#">standard for flat bars</a>
	39	D	-	Handlebar grip nominal diameter must be between 12mm and 52mm	<a href="#">anthropometric data</a>
	40	W	4	Should be able to adjust position of handlebars to suit rider	comparison to competitors
	41	D	-	Handlebars and stem must withstand 600N exerted 50mm from the end of the handlebar grip parallel to fork steerer, for 1 min, with no cracking or fracture and permanent deformation of less than 15mm	ISO 4210
	42	D	-	Max. vertical distance between top of handlebars and top of saddle must not be more than 400mm	ISO 4210
	43	W	4	The steering axis should intersect a line perpendicular to the ground line, drawn through the wheel centre, at a point not lower than 15 % and not higher than 60 % of the wheel radius when measured from the ground line.	ISO 4210
	44	D	-	Must operate on two wheels	definition of a bicycle
wheels	45	D	-	Wheel rim diameter must be between 250mm and 1500mm	component study
	46	W	4	Wheels must rotate around axles with an axial and radial runout tolerance of 1mm if using rim brakes and 2mm if not	ISO 4210
	47	D	-	Hub bearings must have an effective coefficient of friction of less than 0.01	comparison to competitors
	48	D	-	Tyre width must be between 18mm and 130mm	component study

	49	D	-	There must be at least 6mm of clearance between the tyre and the frame/fork/mudguard/any attachment bolts	ISO 4210
	50	D	-	Wheels must be centrally aligned in fork and frame	ISO 4210
	51	W	5	When secured with wheel retention device, wheels must resist 2300N for 1 min with no relative motion between axle and fork/frame	ISO 4210
braking	52	D	-	There must be at least two independently actuated brakes	UKSI 19831176, ISO 4210
	53	D	-	At least one brake must act on each wheel	UKSI 19831176, ISO 4210
	54	D	-	Any hand-operated brakes must be arranged left-hand rear, right-hand front	PBSR, ISO 4210
	55	D	-	Braking mechanisms must be adjustable to ensure they are effective even with some wear or with different wheels etc.	ISO 4210
	56	W	5	Max. stopping distance of 7m from 25 m/s dry or 5m from 16 km/h wet using both brakes	ISO 4210
	57	W	5	Max. stopping distance of 15m from 25 m/s dry or 10m from 16 km/h wet using rear brake only	ISO 4210
	58	W	4	Wet:Dry performance ratio as calculated in ISO 4210 must be at least 0.4	ISO 4210
	59	D	-	No component of braking system must fail during above track tests	ISO 4210
	60	D	-	In the above track tests, stopping must be smooth and safe, without excessive skidding, and the rider must not lose control or put a foot on the ground	ISO 4210
	61	D	-	Bike must be propelled by pedalling	definition of a bicycle
drivetrain	62	W	4	Crank length should be between 165mm and 175mm	geometry study
	63	W	4	Bike should be able to lean sideways by at least 25 deg without pedal touching the ground (in any crank position)	ISO 4210
	64	D	-	Pedal/crank/bottom bracket assembly should rotate smoothly with no tight spots, stiffness, slackness, wobble, or binding	ISO 4210
	65	W	4	Pedals should have 100mm clearance with steered arc of front tyre	ISO 4210
	66	D	-	Assembled drive system must be able to withstand a perpendicular force of 1500N exerted on the pedal with the driven wheel clamped for 1 min with no cracking or deformation of components	ISO 4210
	67	D	-	If relevant, belt tensile strength must be at least 4000N or chain tensile strength must be at least 8000N	ISO 4210
	68	W	5	Transmission must have a nominal efficiency of at least 90%	comparison to competitors
	69	D	-	Bike must have a seat for the rider to sit on	definition of a bicycle
seat	70	D	-	Seat must be securely attached	ISO 4210
	71	W	4	Seat height should be between 850mm and 1050mm	based on my inseam
	72	W	4	Should be able to adjust seat height with a range of at least 200mm	component study
	73	D	-	Maximum seat height must be at least 635mm	ISO 4210
	74	W	2	Should be able to adjust horizontal position of saddle with a range of at least 30mm	component study
	75	W	2	Should be able to adjust angle of saddle with a range of at least 5 deg	component study

	76	W	1	Pedals should have yellow front and rear reflectors	RVLR, ISO 4210
	77	W	5	All materials should be weather resistant (including rain, frost, and UV)	usage environment
	78	D	-	Bike must function between -5 deg C and 40 deg C	usage environment
	79	D	-	Bike must withstand structural integrity test outlined in ISO 4210-3 Annex A with no component failure, loosening, or misalignment	ISO 4210-3 Annex A
safety	80	D	-	Bike must pass a road test of at least 1km fully loaded, demonstrating stable handling in braking and steering, and no component failure, loosening, or misalignment. It must be possible to safely ride with 1 hand (as when giving turn signals).	ISO 4210-2 4.19
	81	D	-	A safety factor of 2.5 should be used during design calculations	<a href="#">safety factor guidelines</a>
	82	D	-	There must be no sharp protruding edges	ISO 4210-2
	83	W	5	Except for screw threads which protrude by 1 major diameter or less, any protrusions must be protected, especially where they could be impacted during a fall	ISO 4210-2
	84	D	-	All components must be securely fastened together such that they cannot be accidentally unfastened during normal use	ISO 4210-2
	85	D	-	All fastenings must be able to withstand the estimated shear and tensile loads they will be subjected to with a safety factor of 8.5	<a href="#">safety factor guidelines</a>
	86	D	-	All safety critical screw threads must have locking devices (such as lock nuts or loctite) in order to resist vibration	ISO 4210
	87	D	-	Frame fatigue strength after 100,000 cycles must be at least 83.3% tensile strength	ISO 4210-2 4.8.4,5,6
	88	W	-	Must be able to attach front(white) and rear(red) lights and reflectors, and a bell	PBSR, RVLR
	89	W	3	Should have either a chain/belt cover or a disc with diameter at least 10mm larger than pulley/sprocket protecting drivetrain	ISO 4210
	90	D	-	Must be able to source all components and raw materials for £1,200 or less	cost study
	91	W	5	Should aim for a target price of £200 or less	cost study, FYP budget
	92	D	-	Must be possible to manufacture components safely with only the tools available to a layman	design brief - accessible
	93	W	4	Should be possible to manufacture components safely in 20 hours or less and with only one person (can use vices to secure work)	design brief - accessible; weekend project manhours
	94	D	-	All materials must be commercially available to a layman	design brief - accessible
	95	D	-	Sourcing materials and manufacturing methods must be consistent/repeatable from documentation	design brief - open source
assembly	96	W	4	Should be able to assemble in 3 hours or less with only one person	design brief - accessible
	97	D	-	Must be able to assemble in 3 hours or less with two people	design brief - accessible
	98	W	5	Should be able to assemble with only simple hand tools and without a jig	design brief - accessible
	99	D	-	Assembly process must be non-destructive	design brief - flexible