Question	Answer	Marks
1 (a)	Power is equal to the rate of work done.	1
1 (b) (i)	The tension in the cable is equal to the weight because the net force is zero. tension = $m g$ = 1500 × 9.81 tension = 1.47×10^4 N	1 1 1
1 (b) (ii)	power = $F v = m g \times v$ power = 1500 × 9.81 × 1.2 power = 1.77×10^4 W	1 1 1
2 (a)	kinetic energy = $\frac{1}{2}$ × mass × speed^2	1
2 (b) (i)	initial KE = $\frac{1}{2} \times 3.0 \times 10^{-2} \times 200^2$ (= 600 J) final KE = $\frac{1}{2} \times 3.0 \times 10^{-2} \times 50^2$ (= 37.5 J) Loss in KE = 600 – 37.5 Loss in KE = 562.5 J	1 1 1
2 (b) (ii)	work done = (loss in) KE $a = \frac{(v^2 - u^2)}{2s}$ $F \times 1.5 \times 10^{-2} = 562.5$ $a = (-)1.25 \times 10^6$ force = 3.75×10^4 N	 1 1
2 (c)	Measure the mass m of the student using scales. Measure the distance x between two fixed markers using a tape measure (or metre rule) and the time t taken for the student to travel between these two markers using a stopwatch. Determine the speed v using $v = \frac{x}{t}$. The kinetic energy is determined using $E_K = \frac{1}{2} m v^2$	1 1 1 1
3 (a)	total energy of a (closed) system remains constant or Energy cannot be created or destroyed (it can only be transferred into other forms) or total initial energy = total final energy	1
3 (b)	work done = force × distance moved in the direction of the force Unit: N m or J	1
3 (c) (i)	kinetic energy → heat	1
3 (c) (ii)	($E = \frac{1}{2} m v^2$) $8.4 \times 10^{16} = \frac{1}{2} \times 3.0 \times 10^8 \times v^2$ $v^2 = \frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}$ or $v = \sqrt{\frac{2 \times 8.4 \times 10^{16}}{3.0 \times 10^8}}$ $v = 2.37 \times 10^4$ m s^{-1}	1 1
3 (c) (iii)	$8.4 \times 10^{16} = F \times 200$ $F = \frac{8.4 \times 10^{16}}{200}$ force = 4.2×10^{14} N	1 1 1
4 (a)	base unit for force = base unit for mass (kg) × base unit for acceleration (m s^{-2}) base unit for force = kg m s^{-2} base unit for work done = base unit for force (kg m s^{-2}) × base unit for distance (m) base unit for work done = kg m^2 s^{-2}	1 1 1

Question	Answer	Marks
4 (b) (i)	speed $v = \frac{12}{8.0}$ $E_k = \frac{1}{2} m v^2 = \frac{1}{2} \times 70 \times \left(\frac{12}{8.0}\right)^2$ $E_k = 79$ J	1 1 1
4 (b) (ii)	$h = 12 \sin 32°$ $E_p = m g h = 70 \times 9.81 \times (12 \sin 32°)$ $E_p = 4.37 \times 10^3$ J	1 1 1
4 (b) (iii)	$P = \frac{4.37 \times 10^3}{8.0}$ $P = 546$ W	1 1
5 (a)	The initial energy of the skydiver is gravitational potential energy. As he descends, there is loss of gravitational potential energy and gain in kinetic energy. At steady (terminal) velocity, the kinetic energy remains the same. The loss of gravitational potential energy is equal to energy transferred to the air as kinetic energy or as heat.	1 1 1 1
5 (b)	rate of work done = $F v = m g \times v$ rate of work done = $80 \times 9.81 \times 45$ rate of work done = 3.53×10^4 W	1 1 1
6 (a)	Energy is defined as the capacity to do work. Power is the rate of work done (or rate of energy transfer).	1 1
6 (b)	A power of 1 watt is equal to 1 joule of work done per second.	1
6 (c) (i)	gain in GPE = $m g h = (70 \times 8) \times 9.81 \times 120$ gain in GPE = 6.59×10^5 J	1 1
6 (c) (ii)	minimum power $P = \frac{\text{total work done}}{\text{time}}$ $P = \frac{[(70 \times 8) + 1500] \times 9.81 \times 120}{55}$ $P = 4.4 \times 10^4$ W	1 1 1
7 (a) (i)	average speed = $\frac{5000}{900}$ (= 5.56 m s^{-1}) kinetic energy = $\frac{1}{2} m v^2 = \frac{1}{2} \times 70 \times \left(\frac{5000}{900}\right)^2$ kinetic energy = 1080 J	1 1 1
7 (a) (ii)	loss in GPE = $m g h = 70 \times 9.81 \times 520$ loss in GPE = 3.57×10^5 J	1 1
7 (a) (iii)	Energy is dissipated as work is done against resistive forces; hence the loss in GPE is not equal to the average KE of the runner.	1
7 (b) (i)	The total energy of a closed system remains constant – energy can neither be created nor destroyed.	1
7 (b) (ii)	gain in KE = loss in GPE $\frac{1}{2} m v^2 = m g h$ or $v = \sqrt{2 g h}$ $v = \sqrt{2 \times 9.81 \times 520}$ m s^{-1} (more than 100 m s^{-1}, if there are no losses)	1 1 1
8 (a)	loss in GPE = $m g h = 72 \times 9.81 \times 60$ loss in GPE = 4.238×10^4 J	1 1
8 (b)	KE = $\frac{1}{2} m v^2 = \frac{1}{2} \times 72 \times 20^2 = 1.44 \times 10^4$ J work done against resistive forces = $(4.238 - 1.440) \times 10^4$ work done against resistive forces = 2.798×10^4 J	1 1 1
8 (c)	distance travelled = $\frac{60}{\sin(35)}$ = 104.6 m $2.798 \times 10^4 = F \times 104.6$ (work done = $F x$) $F = 270$ N	1 1 1