Questions on Work & Energy – Mark Scheme

1. Any suitable example of something strained (eg: stretched elastic band) **B1**

[1]

2. (a) (i) (one of the) force × perpendicular distance between the forces B1

(ii) torque = 1200 × 0.4 C1

= 480 Nm A1

[allow one mark for 1200 × 0.2 = 240 (N m)]

(b) (i) work = force × distance (moved) B1

= 2 × 1200 × 2 × π × 0.2 B1

= 3016 (J) A0

(ii) power = work done / time C1

= 3000 / (1/40)

= 1.2×10^5 (W) A1

[7]

3. (a) One reading from the graph e.g. 1.0 N causes 7 mm C1

Hence 5.0 (N) causes 35 ± 0.5 (mm) A1

(allow one mark for 35 ± 1 (mm)

(b) (i) Force on each spring is 2.5 (N) C1

extension = 17.5 (mm) allow 18 (mm) or reading from graph A1

[allow ecf from (a)]

(ii) strain energy = area under graph / ½ F × e C1

= $2 \times 0.5 \times 2.5 \times 17.5 \times 10^{-3}$

= 0.044 (J) A1

[allow ecf from (b)(i)]

(c) E = stress / strain C1

Stress = force / area and strain = extension / length C1

extension = (F × L) / (A × E)

= $(5 \times 0.4) / (2 \times 10^{-7} \times 2 \times 10^{11})$

= $5.(0) \times 10^{-5}$ (m) A1

	(d)		strain <u>energy</u> is larger in the spring	B1
			extension is (very much larger) (for the same force) for the spring	B1
				[11]
4.	(a)	(i)	speed = d / t	C1
			= 24 / 55	
			= 0.436 (m s^{-1}) allow 0.44 *do not allow one sf*	A1
		(ii)	kinetic energy = ½ m v^2	C1
			= 0.5 × 20 × $(0.436)^2$	
			= 1.9 (J) note ecf from (a)(i)	A1
		(iii)	potential energy = mg h	C1
			= 20 × 9.8 × 4	
			= 784 (J)	A1
			penalise the use of g = 10	
	(b)	(i)	power = energy / time or work done / time	C1
			= (15 × 784) / 55	
			note ecf from (a)(iii)	
			= 214 (W)	A1
		(ii)	needs to supply children with kinetic energy	B1
			air resistance	B1
			friction in the bearings of the rollers / belt	B1
			total mass of children gives an average mass of greater than 20 kg	B1
			Max B2	
				[10]

5. Energy cannot be created or destroyed; it can only be transferred/transformed into other forms
or
The (total) energy of a system remains constant
or
(total) initial energy = (total) final energy (AW)

Allow: *'Energy cannot be created / destroyed / lost'*

B1

[1]

6.	(i)	Density = mass / volume	B1
		Area × length = mass / density	
		Area = $(2.0 \times 10^{-3}) / (7800 \times 0.5)$ or $2.56 \times 10^{-7} / 0.5$	B1
		$= 5.1(3) \times 10^{-7}$ m^2	A0
	(ii)	E = (F × l) / (A × e) / stress = F / A (1.6×10^8 and strain = e / l (8×10^{-4})	C1
		F = (E × A × e) / l	
		$= (2 \times 10^{11} \times 5.1 \times 10^{-7} \times 4.0 \times 10^{-4}) / 0.5$	C1
		=82 (N) (81.6)	A1
	(iii)	Diameter for D is half G hence area is ¼ of G Extension is 4 × greater Tension required is the same = 82 (N)	A1
	(iv)	The extension is proportional to the force / Hooke's law (OWTE)	B1

[7]

7.	(i)	1	Elastic as returns to original length (when load is removed)	B1
		2	Hooke's law is obeyed as force is proportional to the extension Example of values given in support from table	B1 B1
	(ii)		Measure (original) length with a (metre) rule / tape	B1
			Suitable method for measuring the extension e.g. levelling micrometer and comparison wire or fixed scale plus vernier or travelling microscope and marker / pointer	B1
	(iii)		E = stress / strain	C1
			$= (25 \times 1.72) / (1.8 \times 10^{-7} \times 1.20 \times 10^{-3})$	C1
			$= 1.99 \times 10^{11}$ (Pa)	A1

[8]

8. (i) $E_p = mgh$ and $E_k = \frac{1}{2}mv^2$ (Allow Δh for h)

Not: $E_k = mgh$

B1

(ii) $mgh = \frac{1}{2}mv^2$

B1

$v^2 = 2gh$ or $v = \sqrt{2gh}$

B1

[3]

9. (i) $m = \rho V$

__Allow__ any subject for the density equation

C1

$m = 1.0 \times 10^3 \times (1.2 \times 10^{-2} \times 2.0 \times 10^7)$

C1

mass of water = 2.4×10^8 (kg)

A0

(ii) loss in potential energy = $2.4 \times 10^8 \times 9.81 \times 2.5 \times 10^3$

__Allow__ 1 mark for '5.89×10^{12} (J)

C1

30% of GPE = $0.3 \times 5.89 \times 10^{12}$ (= 1.77×10^{12})

__Allow__ 2 marks for '1.77×10^{12} (J)'

C1

power = $\frac{1.77 \times 10^{12}}{900}$

C1

power = $1.9(63) \times 10^9$ (W) (≈ 2 GW)

***Note**: $\frac{5.89 \times 10^{12}}{900}$ (= 6.5 GW) scores 2 marks*

A0

(iii) Any correct suitable suggestion; eg: the energy supply is not constant/ cannot capture all the rain water / large area (for collection)

***Note:** Do not allow reference to 'inefficiency' / 'cost'*

B1

[6]

10. (a) The graph shows length and not extension of the spring / spring has original length (of 2.0 cm) (AW)

***Allow**: 'length cannot be zero'*

B1

(b) Straight line (graph) / linear graph / force ∝ <u>extension</u> / constant gradient (graph)

Not 'force $\propto$ length'

B1

(c) force constant = $\frac{2.0}{0.04}$

***Note**: The mark is for any correct substitution*

C1

force constant = 50 (N m^{-1})

***Allow:** 1 mark for 0.5 (N m^{-1}) – 10^n error*

***Allow** 1 mark for 5/12 × 10^{-2} = 41.7 or 4/10 × 10^{-2} = 40 or 3/8 × 10^{-2} = 37.5 or 2/6 × 10^{-2} = 33.3 or 1/4 × 10^{-2} = 25*

A1

(d) work done = $\frac{1}{2}Fx$ or $\frac{1}{2}kx^2$ or 'area under graph'

C1

work done = $\frac{1}{2} \times 3.0 \times 0.06$ or $\frac{1}{2} \times 50 \times 0.06^2$

Possible ecf

work done = 0.09 (J)

***Note:** 1 sf answer is allowed*

A1

(e) Find the gradient / slope (of the tangent / graph)

B1

Maximum speed at 1.0s / 3.0s / 5.0s / steepest 'part' of graph / displacement = 0

***Allow:** 2 marks for 'steepest / maximum gradient'*

B1

[8]

11.	(i)	Tension = Weight / mg	C1
		$= 1.5 \times 10^3 \times 9.8$ using g =10 –1	
		= 14700 (N)	A1
	(ii)	time = 25 / 1.6 = 15.6 (s)	A1
	(iii)	PE = mgh	C1
		PE / t = (14700 × 25) / 15.6 or 14700 × 1.6	C1
		= 24000 (23520) (J s^{-1})	A1
		or power = F × v	C1
		= 14700 × 1.6	C1
		= 24000 (23520) (J s^{-1})	A1
	(iv)	(gain in PE per second = output power used to lift weight) power = 24000 (23520) (W) / allow those answers that suggest greater due to friction in lifting mechanism	B1

[7]

12.	(a)	Young modulus = stress/strain (As long as elastic limit is not exceeded)	B1
	(b)	Strain has no units because it is the ratio of two lengths.	B1

[2]