Question 4		
(a)	(ΔEp= $mg\Delta h$) = **55** × 9.8(1) × 4.2 ✓ = 2300 (J) ✓ (2266.1)	**2**
(b) (i)	(E_k = 3.2/4.2 x 2264 or uses suitable kinematics equation) = 1700(J) ✓ (= 1724.8 = 1720) ecf 4 (a)	**1**
(b) (ii)	($E_k = \frac{1}{2}mv^2$ = 1724.8) $v = \sqrt{\frac{2 \times 1724.8}{55}} = \sqrt{62.72}$ ecf (b) (i) or use of $v^2 = 2as$ ✓ = 7.9 m s^{-1} ✓ (= 7.9196)	**2**
(c)	one arrow, vertical, upward pointing, starts on soles of feet ✓	**1**
(d)	(use of $\alpha = \frac{\Delta v}{\Delta t}$ gives) = $\frac{7.920}{0.26}$ ✓ or ecf 4 (b) (ii)/0.26 = 30 (m s^{-2}) ✓ (30.46) **or use** $\alpha = \frac{2s}{t^2}$ of or $\alpha = \frac{v^2}{2s}$ ✓ allow incorrect values of *s* here = 29.6 or 31.4 respectively ✓	**2**

(e)	**The candidate's writing should be legible and the spelling, punctuation and grammar should be sufficiently accurate for the meaning to be clear.** The candidate's answer will be assessed holistically. The answer will be assigned to one of three levels according to the following criteria. **High Level (Good to excellent): 5 or 6 marks** The information conveyed by the answer is clearly organised, logical and coherent, using appropriate specialist vocabulary correctly. The form and style of writing is appropriate to answer the question. Candidate must state that: • (elastic potential) energy is transformed to **kinetic or** trampoline does work (on gymnast) • (KE) is transformed into (gravitational) **potential** energy • (the gymnast) must 'jump'/bend knees/do work/'use' chemical energy/supply energy (to increase height) For 6 marks, must also state that (the gymnast) must overcome resistive forces (drag/heat loss/reference to energy 'lost' in trampoline, etc) **Intermediate Level (Modest to adequate): 3 or 4 marks** The information conveyed by the answer may be less well organised and not fully coherent. There is less use of specialist vocabulary, or specialist vocabulary may be used incorrectly. The form and style of writing is less appropriate. Candidate must state **one** from: • chemical energy (transferred) to elastic, kinetic or gravitational energy • PE (from trampoline) to KE (of gymnast) • KE (gymnast) to (G)PE (gymnast) **and one** of the following: • work is done by the trampoline (on the gymnast) • that work is done on the trampoline (by the gymnast) • work done against resistive forces • (additional) energy input required (to achieve additional height) **Low Level (Poor to limited): 1 or 2 marks** The information conveyed by the answer is poorly organised and may not be relevant or coherent. There is little correct use of specialist vocabulary. The form and style of writing may be only partly appropriate. Candidate must • give **one** relevant energy gain or loss in the system **or** state that energy is input to reach greater height For two marks, a relevant energy transformation must be given **or** one further marking point from next page	**max 6**

	Further marking points: • (to reach the same height) the gymnast must do work in order to replace the energy wasted as the springs and the trampoline (rubber) unload (contract) • to reach a greater height, the gymnast must do additional work by (bending and) extending her legs (jumping) as the trampoline moves upwards • the additional downward force keeps the trampoline extended for longer, thus increasing the impulse • correct reference to law of energy conservation	
	Total	**14**

Question Number	Answer	Mark
18 (a)	Explain this demonstration and the need for the precautions. QWC – spelling of technical terms must be correct and the answer must be organised in a logical sequence Max 4 from this part It will not strike the student's face / at most will just touch / returns to starting point The total energy of the pendulum is constant / energy is conserved It cannot move higher than its starting point … … because that would require extra gpe (consequent on previous mark) Mention specific energy transfer: gpe → ke / ke → gpe Energy dissipated against air resistance … … will stop it quite reaching its starting point (consequent on attempt at describing energy loss mechanism) Max 4 from this part Pushing does work on the ball / pushing provides extra energy If pushed, it can move higher (accept further) … will hit the student If the face moves (forward) the ball may reach it (before it is at its maximum height) OR if the face moves (back) the ball won't reach it	**(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **(1)** **Max 6**
18 (b) (i)	Calculate the gravitational potential energy gained by the ball. Use of gpe = *mgh* Correct answer (100 J) <u>Example of calculation</u> gpe = *mgh* = 7 kg x 9.81 N kg^{-1} x 1.5 m = 103 J	**(1)** **(1)**
18 (b) (ii)	Calculate the speed of the ball at the bottom of its swing Use of ke = 1/2 mv^2 Correct answer (5.4 m s^{-1}) <u>Example of calculation</u> 103 J = 1/2 mv^2 v = √(2 x 103 J / 7 kg) = 5.4 m s^{-1} (Use of 100 J → 5.3 m s^{-1})	**(1)** **(1)**
	Total for question 18	**10**

Question Number		Mark
16(a) (i)	Use of equation of motion suitable for a, e.g. $v = u + at$ (1) a = 16.3 m s^{-2} (2.1 ×10^5 km h^{-2} or 58.7 km h^{-1} s^{-1}) (1) Example of calculation $a = \frac{37.5 \text{ m s}^{-1} - 0}{2.3 \text{ s}}$ a = 16.3 m s^{-2}	**2**
16(a) (ii)	Use of $E_k = ½ mv^2$ (1) Use of $P = E/t$ (1) Power = 3.1×10^6 W (1) **Or** Use of $F = ma$ (must be a from (i)) **and** Use of equation to find distance **and** use of work done = Fd (1) Use of $P = E/t$ (1) Power = 3.1 × 10^6 W (1) (distance = 43 m) Examples of calculations E_k = ½ × 10 000 kg × (37.5 m s^{-1})^2 = 7.03 ×10^6 J Power = 7.03 × 10^6 J / 2.3 s = 3.1 × 10^6 W	**3**
16(a) (iii)	Energy transferred by heating **Or** energy transferred due to friction **Or** work done against friction **Or** idea that more energy required (due to energy transfer) due to friction. (1) (do not accept 'lost' but accept air resistance as an alternative to friction)	**1**
***16(b)**	(QWC – Work must be clear and organised in a logical manner using technical wording where appropriate) larger force is needed **Or** the (same) force is insufficient (1) need same acceleration/ (max) velocity **OR** acceleration/(max) velocity is too small (1) more energy needed (to reach top) **Or** insufficient energy (to reach top) (1)	**3**
16 (c)	Viscosity of oil decreases (with increasing temperature) **Or** the (warm) oil is less viscous (1) (accept a reverse argument e.g. when cold oil is more viscous) Lower frictional/resistive force **Or** less viscous drag (1)	**2**
	Total for question 16	**11**

Question			Answer	Marks	Guidance
7	(a)		power = work done/ time or energy/time or 'rate of work done'	B1	
	(b)		power = KE/time Using $\frac{1}{2}mv^2$ (power =) ½ × 9.7 × 10^5 (kg s^{-1}) × 3.0^2 (power =) 4.365 × 10^6 (W)	C1 C1 A0	**Allow**: 1 mark for a bald answer of 4.37 × 10^6 since this is a 'show' question
	(c)		efficiency = $\frac{1.2}{4.4} \times 100$ efficiency = 27 %	B1	**Note**: Answer to 3 sf is 27.3% if 4.4 × 10^6 is used **Note**: Answer is 27.5% if 4.365 × 10^6 is used **Not**: 0.27
	(d)		(volume per second =) 9.7 × 10^5/1030 or 941.7 mass per second = density × volume per second 9.7 × 10^5 = 1030 × (3.0 × π × r^2) $r^2 = \frac{9.7 \times 10^5}{1030 \times 3\pi}$ radius = 10 (m)	C1 C1 A1	**Allow** any subject **Allow**: 2 marks for 100 (m); answer not square rooted
	(e)	(i)	water has greater density or water has greater mass / KE for the same volume	B1	
		(ii)	Any one from: • Not an eyesore / cannot be seen • Not noisy • Predictable energy (with in and out tides) • Do not occupy space on the land	B1	**Allow** other sensible suggestions
			Total	**9**	

Question			Answer	Marks	Guidance
6	**(a)**		(1 watt is equal to) 1 joule (of energy transferred) per second	B1	**Allow**: (1) J s^{-1} **Not**: '1 J (of energy transferred) in 1 s' because the per or rate idea is not clear **Note**: Do not allow mixture of quantity and unit. Eg: '1 J per unit time' or 'energy per second'
	(b)	**(i)**	E_p = 700 × 9.81 × 8.5 E_p = 5.8(4) × 10^4 (J)	B1	
		(ii)	output power = $\frac{5.84 \times 10^4}{45}$ output power = 1.3 × 10^3 (W)	B1	Possible ecf from **(i)**
		(iii)	input power = 1.3 × 10^3/0.3 input power = 4.3 × 10^3 (W)	B1	Possible ecf from **(ii)**
			Total	**4**	

Question			Answers	Marks	Guidance
6	(a)		force distance moved / travelled in the direction of the force	B1	**Allow** force displacement in direction of force
	(b)		(Work done against friction generates) heat / thermal energy / internal energy	B1	**The term *heat* / *thermal* / *internal* to be included and spelled correctly to gain the B1 mark.**
	(c)		1 J (of work done) per second	B1	**Allow** (1 W = 1) J s^{-1} or J/s **Allow** (1) joules per second **Not** W = 1 J in 1 s **Allow** full credit as long as the definition for the 'watt' is not confused with the definition for 'power' (Examples: power = rate of work done; W = 1 J s^{-1} ✓ The rate of work done. It is J per s watt = rate of work done, W = 1 J s^{-1})
	(d)	(i)	vertical distance = $(75^2 - 45^2)^{1/2}$ or vertical distance = 60 (m) work done = 5200 9.81 60 or work done = 3.06 10^6 (J) power = 3.06 10^6/90 power = 3.4 10^4 (J s^{-1})	C1 C1 A1	**Allow** 2 marks for an answer of 2.04 10^6 (J s^{-1}); 1.5 used instead of 90 s No credit for [5200 *g* 75]/90 or [5200 *g* 45]/90
		(ii)	efficiency = $\frac{34}{170}$ 100 efficiency = 20 %	B1	Possible ecf from **(i)**
			Total	**7**	