WORK-ENERGY-POWER

1 **(a)** Name the process by which energy is released in the core of the Sun.

.... [1]

(b) Describe how energy from the Sun becomes stored energy in water behind a dam.

....

....

....

.... [3]

(c) Data for two small power stations is given in Table 2.1.

	input to power station	**output of power station**
gas-fired	100 MW	25 MW
hydroelectric	90 MW	30 MW

Table 2.1

(i) State what is meant by the *efficiency* of a power station.

....

....

....

.... [1]

(ii) Use the data in Table 2.1 to explain that the hydroelectric station is more efficient than the gas-fired power station.

....

....

.... [1]

[Total: 6]

MARKING SCHEME:

(a)	fusion (of nuclei) CARE: NOT fission or fision ACCEPT fussion condone radiation as an extra		B1
(b)	radiant/heat energy from Sun or radiation from Sun energy from Sun raises temperature of water/heats water/melts ice energy from Sun evaporates water PE in cloud rain stored water has PE	) any 3	B1 × 3
(c) (i)	25/100 for gas-fired or 30/90 for hydroelectric or energy out/energy in or power out/power in		B1
(ii)	30/90 or 1/3 or 33% is more than 25/100 or ¼ or 25% OR lower input into hydroelectric station, but more output than gas-fired station IGNORE hydroelectric losses less than gas-fired losses		B1
			[6]

2 A cyclist rides up and then back down the hill shown in Fig. 3.1.

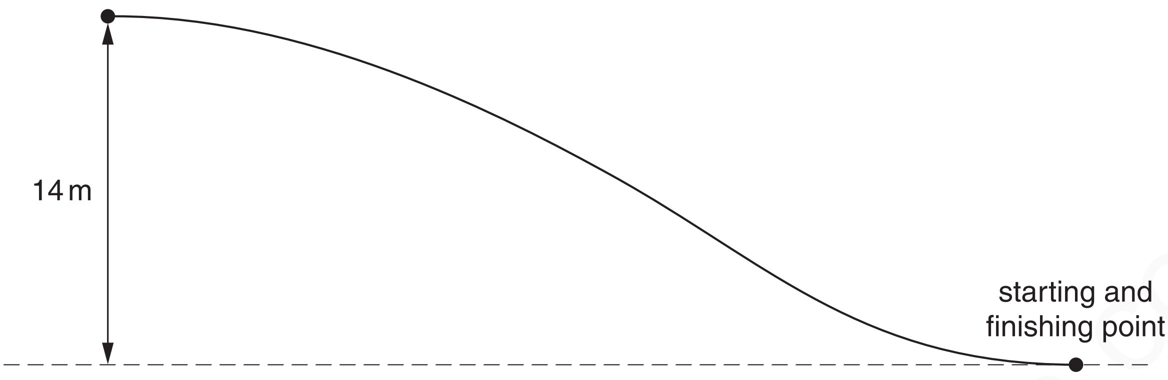

Fig. 3.1

The cyclist and her bicycle have a combined mass of 90 kg. She pedals up to the top and then stops. She turns around and rides back to the bottom without pedalling or using her brakes.

(a) Calculate the potential energy gained by the cyclist and her bicycle when she has reached the top of the hill.

potential energy = ... [2]

(b) Calculate the maximum speed she could have when she arrives back at the starting point.

speed = ... [3]

(c) Explain why her actual speed will be less than that calculated in **(b)**.

....

....

.... [1]

[Total: 6]

MARKING SCHEME:

(a)	mgh or 90 × 10 × 14 accept 9.8 or 9.81 instead of 10	C1
	12 600 J or 12348 J or 12360.6 J nothing else	A1
(b)	PE lost = KE gained or mgh = ½mv^2	C1
	(v^2 =) 280 e.c.f. or 274.4 or 274.68	C1
	16.7 m/s e.c.f. or 16.565 m/s or 16.573 m/s NOTE: 16.8 m/s gets A0	A1
(c)	energy lost or friction/air resistance/drag/wind resistance	B1

[6]

3 A wind turbine has blades, which sweep out an area of diameter 25 m.

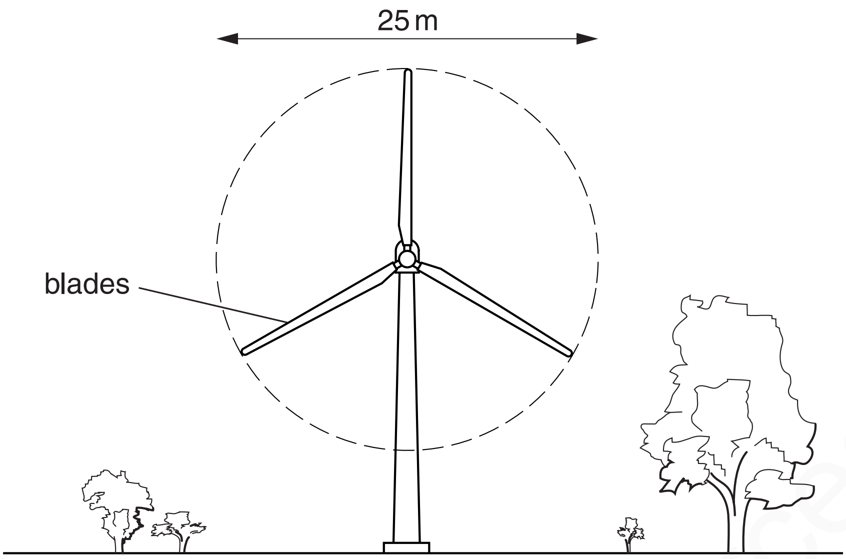

Fig. 5.1

(a) The wind is blowing directly towards the wind turbine at a speed of 12 m/s. At this wind speed, 7500 kg of air passes every second through the circular area swept out by the blades.

(i) Calculate the kinetic energy of the air travelling at 12 m/s, which passes through the circular area in 1 second.

kinetic energy = ... [3]

(ii) The turbine converts 10% of the kinetic energy of the wind to electrical energy.

Calculate the electrical power output of the turbine. State any equation that you use.

power = ... [3]

(b) On another day, the wind speed is half that in **(a)**.

(i) Calculate the mass of air passing through the circular area per second on this day.

mass = ... [1]

(ii) Calculate the power output of the wind turbine on the second day as a fraction of that on the first day.

fraction = ... [3]

[Total: 10]

(a)	**(i)**	$\frac{1}{2}mv^2$	C1
		$\frac{1}{2} \times 7500 \times 12 \times 12$	C1
		540 000 J OR 540 kJ	A1
	(ii)	$W = E/t$ in any form	B1
		10% × his **(a)**	C1
		54 000 W OR 54 kW e.c.f.	A1
(b)	**(i)**	3750 kg	B1
	(ii)	[If ecf from **(i)** and no other errors, maximum mark is 2]	
		mass: ½ OR correct sub in $\frac{1}{2}mv^2$	C1
		speed: ½ OR 6750 (J)	C1
		fraction = ⅛ / 0.125 / 1:8 ? 12.5 % (c.a.o.)	A1 [10]

4 A car of mass 900 kg is travelling at a steady speed of 30 m/s against a resistive force of 2000 N, as illustrated in Fig. 2.1.

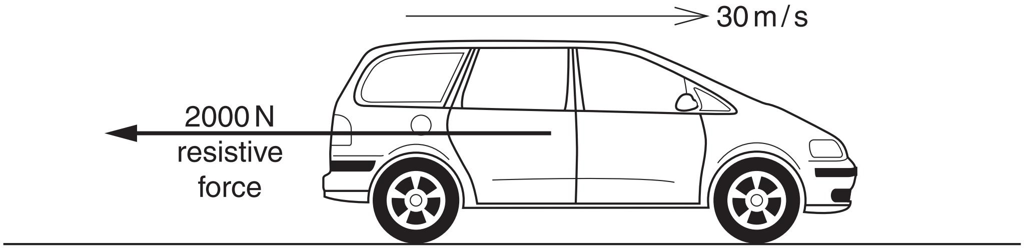

Fig. 2.1

(a) Calculate the kinetic energy of the car.

kinetic energy = ... [2]

(b) Calculate the energy used in 1.0 s against the resistive force.

energy = ... [2]

(c) What is the minimum power that the car engine has to deliver to the wheels?

minimum power = ... [1]

(d) What form of energy is in the fuel, used by the engine to drive the car?

.... [1]

(e) State why the energy in the fuel is converted at a greater rate than you have calculated in **(c)**.

....

.... [1]

[Total: 7]

MARKING SCHEME:

(a)	½mv^2 OR ½ × 900 x 30^2 405 000 J	C1 A1	
(b)	force x distance OR 2000 x 30 60 000 J OR 60 kJ	C1 A1	
(c)	60 000 W OR 60 000 J/s OR 60kW OR 60 kJ/s ecf from (b)	B1	
(d)	chemical	B1	
(e)	idea of energy loss / heat / sound / inefficiency / energy used within car / possibility of increase in P.E. Ignore work done against against friction	B1	[7]

5 A ball player bounces a ball of mass 0.60 kg. Its centre of mass moves down through a distance of 0.90 m, as shown in Fig. 1.1. Ignore air resistance throughout this question.

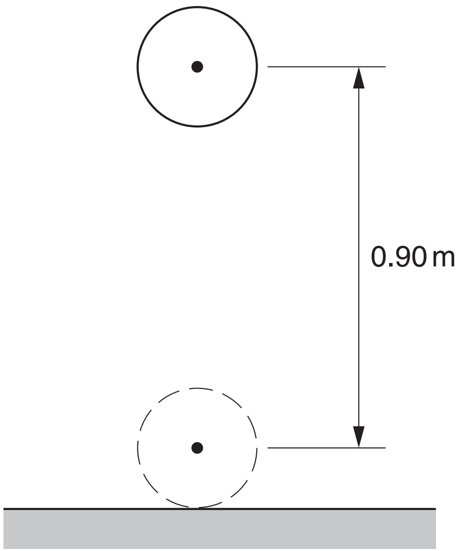

Fig. 1.1

(a) Calculate the decrease in gravitational potential energy of the ball as it moves down through the 0.90 m.

decrease in PE = ... [2]

(b) The ball hits the ground at 7.0 m/s.

Calculate the initial energy given to the ball by the player.

energy given = ... [3]

(c) On another occasion, the player throws the ball into the air, to a height of 4.0 m above the ground. The ball then falls to the ground.

During the impact, 22% of the ball's energy is lost.

(i) Suggest one reason why energy is lost during bouncing.

....

.... [1]

(ii) Calculate the height to which the ball rises after the bounce.

[2]

(iii) An observer who sees the ball bounce says, "That ball should be slightly warmer after that bounce."

Explain why the observer's statement is true.

....

....

.... [1]

[Total: 9]

MARKING SCHEME:

(a)	mgh in any form, numbers, words, symbols	C1	
	5.4 J OR 5.297 J OR 5.292 J OR 5.3 J OR 5.29 J	A1	
(b)	½mv² in any form, numbers, words, symbols	C1	
	14.7 (J)	C1	
	(energy given by player =) 9.3 J OR his **(b)** – **(a)** correctly evaluated	A1	
(c) (i)	friction with <u>floor / inside ball</u> OR energy to deform ball OR sound OR idea of hysteresis of rubber ignore heat / air resistance	B1	
(ii)	78% OR ratio of PEs accept (14.7 × 0.78 =) 11.47 (J) OR (0.78 × 0.9 =) 0.702 (m)	C1	
	3.12 m to at least 2 sig figs	A1	
(iii)	idea of (some of) energy <u>lost</u> / <u>becomes</u> / <u>converted</u> / <u>transferred</u> to heat in ball ignore friction	<u>B1</u>	[9]

6 An ornamental garden includes a small pond, which contains a pumped system that causes water to go up a pipe and then to run down a heap of rocks.

Fig. 3.1 shows a section through this water feature.

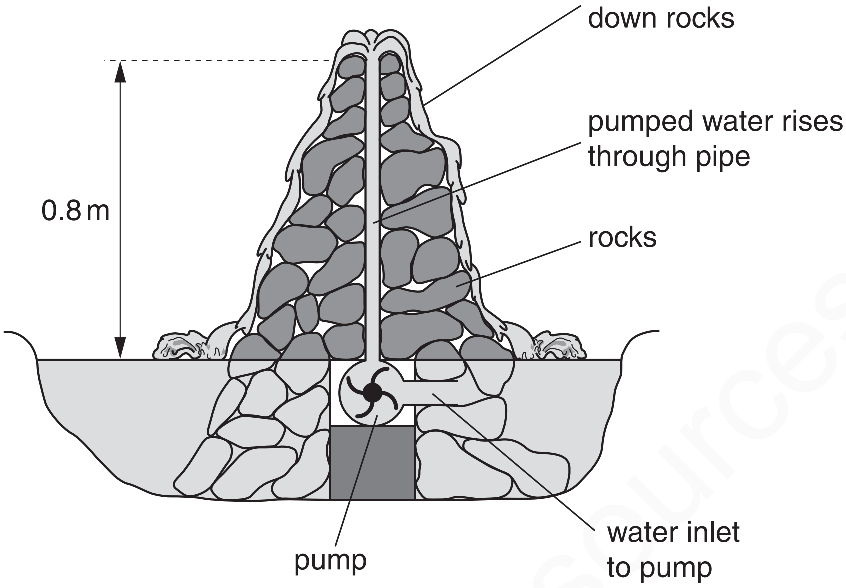

Fig. 3.1

The density of water is 1000 kg/m^3. A volume of 1 litre is equal to 0.001 m^3.

(a) Calculate the mass of 1 litre of water.

mass = ... [2]

(b) Calculate the work done raising 1 litre of water through a height of 0.8 m.

work = ... [2]

(c) The pump lifts 90 litres of water per minute.

Calculate the minimum power of the pump.

power = ... [2]

(d) The pump is switched off.

Immediately after the pump is switched off, what is the value of the water pressure at the bottom of the 0.8 m pipe, due to the water in the pipe?

pressure = ... [2]

[Total: 8]

MARKING SCHEME:

(a) mgh in any form, numbers, words, symbols	C1	
5.4 J OR 5.297 J OR 5.292 J OR 5.3 J OR 5.29 J	A1	
(b) ½mv^2 in any form, numbers, words, symbols	C1	
14.7 (J)	C1	
(energy given by player =) 9.3 J OR his **(b)** – **(a)** correctly evaluated	A1	
(c) **(i)** friction with floor / inside ball OR energy to deform ball OR sound OR idea of hysteresis of rubber ignore heat / air resistance	B1	
(ii) 78% OR ratio of PEs accept (14.7 × 0.78 =) 11.47 (J) OR (0.78 × 0.9 =) 0.702 (m)	C1	
3.12 m to at least 2 sig figs	A1	
(iii) idea of (some of) energy lost / becomes / converted / transferred to heat in ball ignore friction	B1	[9]