WORK-ENERGY-POWER

1 **(a)** The boxes on the left contain the names of some sources of energy. The boxes on the right contain properties of some sources of energy.

Draw **two** straight lines **from each box** on the left to the two boxes on the right which describe that source of energy.

	renewable
solar energy	not renewable
natural gas	polluting
	not polluting

[2]

(b) Coal-fired power stations are polluting.

State an advantage of using coal as a source of energy.

....

....[1]

(c) A coal-fired power station generates electricity at night when it is not needed.

Some of this energy is stored by pumping water up to a mountain lake. When there is high demand for electricity, the water is allowed to flow back through turbines to generate electricity.

On one occasion, 2.05×10^8 kg of water is pumped up through a vertical height of 500 m.

(i) Calculate the weight of the water.

weight = ...[1]

(ii) Calculate the gravitational potential energy gained by the water.

energy gained = ...[2]

(iii) The electrical energy used to pump the water up to the mountain lake is 1.2×10^{12} J. Only 6.2×10^{11} J of electrical energy is generated when the water is released.

Calculate the efficiency of this energy storage scheme.

efficiency = ...[2]

[Total: 8]

MARKING SCHEME:

(a)	lines from solar energy to boxes 1 AND 4 only	B1
	lines from natural gas to boxes 2 AND 3 only	B1
(b)	(relatively) cheap OR widely available OR can be used on a large scale OR always available	B1
(c) (i)	2.05×10^9 N	B1
(ii)	use of *mgh* OR weight × *h*	C1
	1.03×10^{12} J NOT ecf from **(i)**	A1
(iii)	output energy ÷ input energy OR $6.2 \times 10^{11} \div 1.2 \times 10^{12}$	C1
	0.52 OR 52 %	A1

[Total: 8]

2 Fig. 1.1 shows a car on a roller-coaster ride.

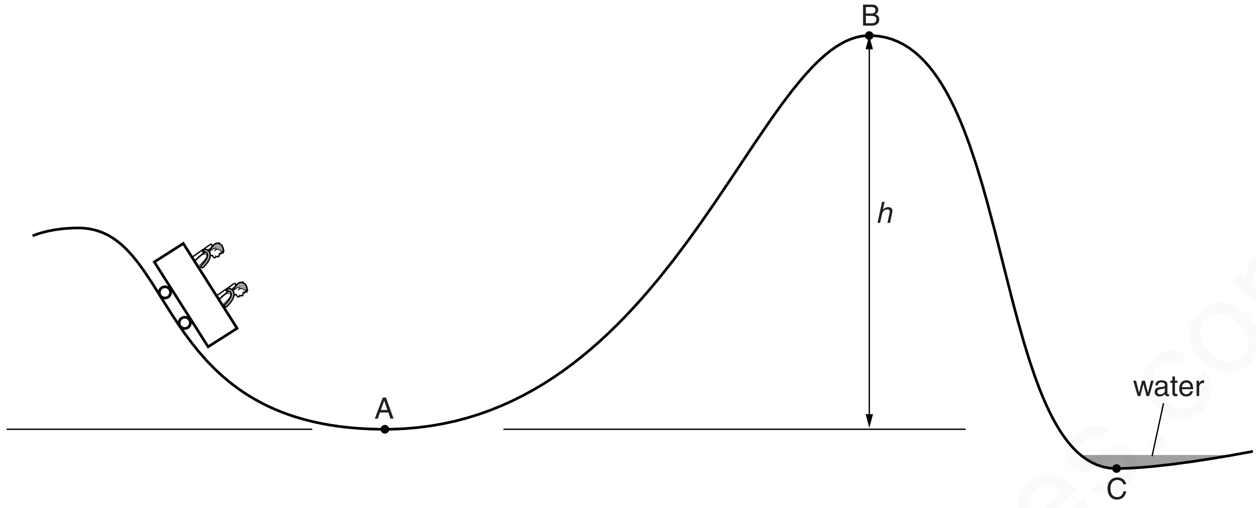

Fig. 1.1

mass of car = 600 kg
kinetic energy of car at point A = 160 kJ

(a) Calculate the speed of the car at A.

speed = ... [3]

(b) As the car travels from A to B, it loses 40 kJ of energy due to friction.

The car just manages to roll over the crest of the hill at B.

Calculate the height h.

height h = ... [2]

(c) At C, the car is slowed down by a shallow tank of water and the kinetic energy of the car is reduced to zero.

Make **three** suggestions for what happens to this kinetic energy.

1. ....

2. ....

3. ....

[3]

[Total: 8]

(a)	½ mv^2	C1	
	correct rearrangement to find v/v^2	C1	
	23 m/s	A1	[3]
	bald 0.73 scores first two marks		
(b)	use of *mgh* (= 160 000 – 40 000 = 120 000 J)	C1	
	h = 20 m	A1	[2]
(c)	any three points from:		
	KE of <u>water</u>		
	PE of <u>water</u>		
	sound		
	heat/friction		
	Award one mark for each correct point	B3	[3]

3 Fig. 1.1 shows a simple pendulum being used by a student to investigate the energy changes at various points in the pendulum's swing.

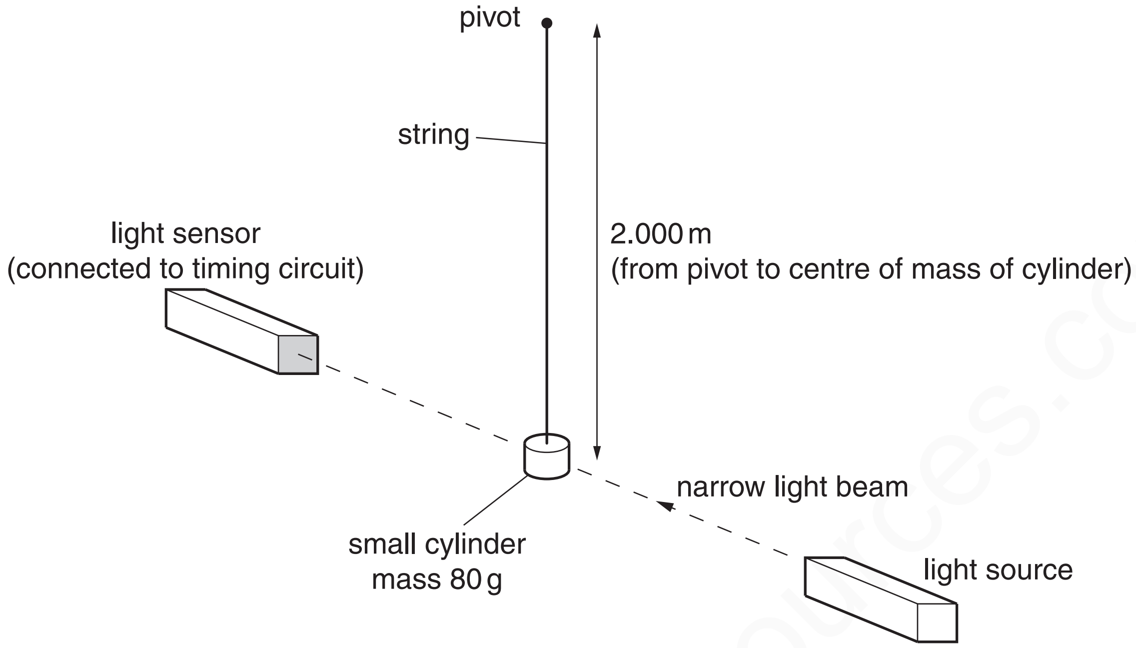

Fig. 1.1

(a) When the string is displaced by a small angle from the vertical, the height of the cylinder changes so that its centre of mass is now 1.932 m below the pivot. Determine the gravitational potential energy gained by the cylinder. Use $g = 10\,\mathrm{m/s^2}$.

gravitational potential energy gained = ... [3]

(b) The cylinder is released from the displaced position in **(a)**. Calculate the expected speed of the cylinder when the string is vertical.

expected speed = ... [2]

(c) As the string passes through the vertical, the narrow beam of light is interrupted by the cylinder for 22 ms. The cylinder has a diameter of 2.5 cm.

(i) Calculate the actual speed of the cylinder.

actual speed = ...

(ii) Suggest how the difference between the actual and expected speeds could occur.

....

....

....

....
[3]

[Total: 8]

(a)	Δh = 0.068 m	C1	
	use of *mgh*	C1	
	0.054 J/Nm	A1	[3]
(b)	$\frac{1}{2}mv^2$ = candidate's **(a)**	C1	
	1.2 m/s ecf from **(a)**	A1	[2]
(c)	**(i)** use of distance ÷ time	C1	
	= 1.1 m/s	A1	
	(ii) air or wind resistance / friction / heat / thermal energy OR correct mention of experimental error e.g. width of cylinder	B1	[3]

4 Fig. 3.1 shows a water turbine that is generating electricity in a small tidal energy scheme.

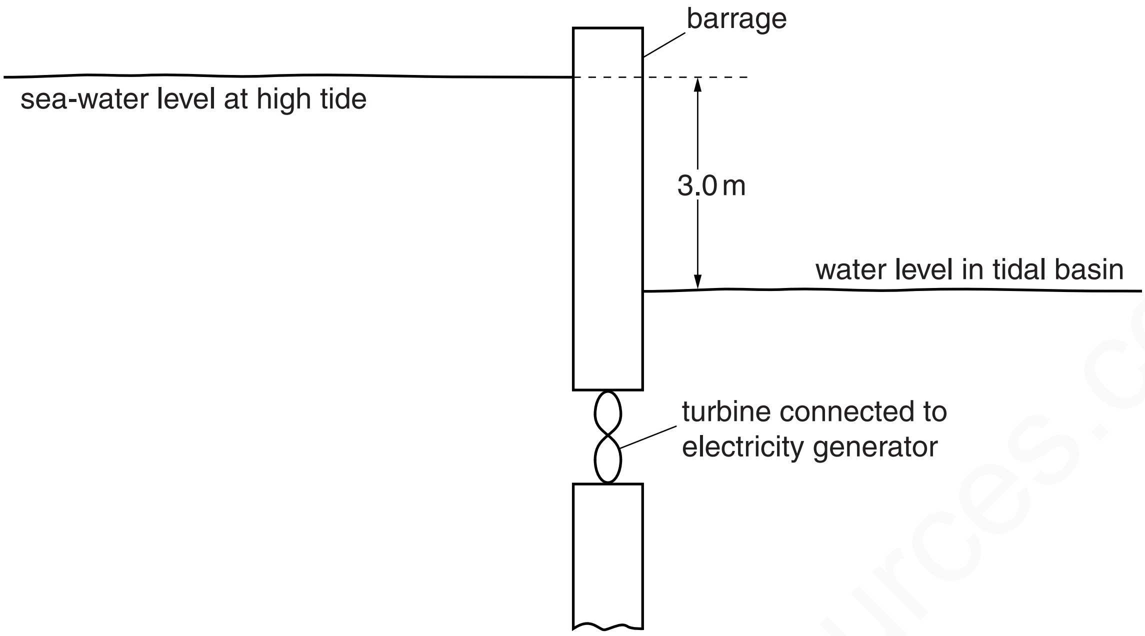

Fig. 3.1

At high tide, 1.0 m^3 of sea-water of density 1030 kg / m^3 flows through the turbine every second.

(a) Calculate the loss of gravitational potential energy when 1.0 m^3 of sea-water falls through a vertical distance of 3.0 m.

loss of gravitational potential energy = ... [3]

(b) Assume that your answer to **(a)** is the energy lost per second by the sea-water passing through the turbine at high tide. The generator delivers a current of 26 A at 400 V.

Calculate the efficiency of the scheme.

efficiency = ...% [3]

(c) At low tide, the sea-water level is lower than the water level in the tidal basin.

(i) State the direction of the flow of water through the turbine at low tide.

....

(ii) Suggest an essential feature of the turbine and generator for electricity to be generated at low tide.

....

....

....
[2]

[Total: 8]

(a)	(mass flow rate =) 1030 (kg/s)	C1	
	use of *mgh*	C1	
	loss of GPE = 1030 × 10 × 3 = 30 900 J or Nm ecf from 1st line	A1	[3]
(b)	output power = (26 × 400 =) 10 400 (W)	C1	
	efficiency = output (power)/input (power) with/without 100 OR= output/input with/without 100 OR any numbers that clearly show relationship the correct way up is intended	C1	
	efficiency = (100 × 10 400/30 900 =) 33.7% at least 2 s.f. allow ecf from **(a)** and 1st line of **(b)**	A1	[3]
(c) (i)	from basin/to sea/from right/to left	B1	
(ii)	turbine design allows rotation in both directions OR meaningful comment on change of pitch OR generator works when rotating in either direction	B1	[2]

[Total: 8]

5 An electric pump is used to raise water from a well, as shown in Fig. 3.1.

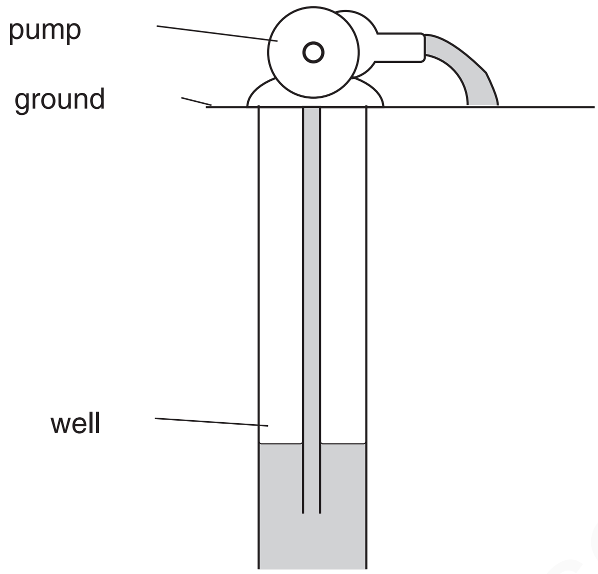

Fig. 3.1

(a) The pump does work in raising the water. State an equation that could be used to calculate the work done in raising the water.

....[2]

(b) The water is raised through a vertical distance of 8.0 m. The weight of water raised in 5.0 s is 100 N.

(i) Calculate the work done in raising the water in this time.

work done = ...[1]

(ii) Calculate the power the pump uses to raise the water.

power = ...[1]

(iii) The energy transferred by the pump to the water is greater than your answer to **(i)**. Suggest what the additional energy is used for.

....[1]

(a)	work = force x distance = force of gravity/weight x (vertical) distance/height		C1 A1	**2**
(b)	**(i)**	work = (100 x 8) = 800 J	A1	
	(ii)	power = (800/5) = 160 W	A1	**2**
	(iii)	increases the k.e. of the water (ignore heat/sound)	B1	**1** **[5]**

6 A student wishes to work out how much power she uses to lift her body when climbing a flight of stairs.

Her body mass is 60 kg and the vertical height of the stairs is 3.0 m. She takes 12 s to walk up the stairs.

(a) Calculate

(i) the work done in raising her body mass as she climbs the stairs,

work = ... [2]

(ii) the output power she develops when raising her body mass.

power = ... [2]

(b) At the top of the stairs she has gravitational potential energy.

Describe the energy transformations taking place as she walks back down the stairs and stops at the bottom.

....

....

....

.... [2]

[Total: 6]

(a)	**(i)** work done = force x dist or 600 x 3 or 60 x 3 or fd or mgh	C1	
	work = 1800 J c.a.o. accept j or Nm for unit	A1	[2]
	(ii) power = work/time or 1800/12 e.c.f.	C1	
	power = 150 W e.c.f. accept J/s or NM/s for unit	A1	[2]
(b)	P.E. decreases/transformed (ignore mention of KE)	C1	
	all the decrease becomes heat (ignore mention of sound)	A1	[2]

[Total: 6]