Percentage	
Grade	

TUTOR ZONE

YOUR STEP TO SUCCESS

A Level Physics

Energy

Duration: 1 hour

Total Marks: 55

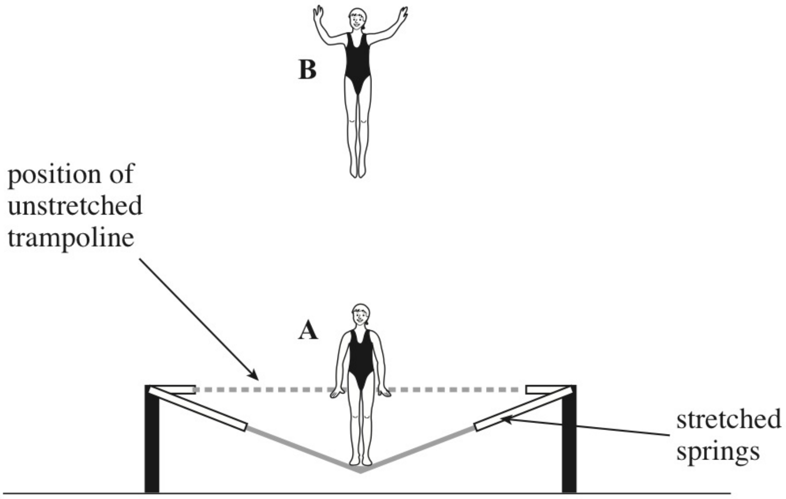
Information for Candidates:

- Use black or blue ink. HB pencil may be used for graphs and diagrams only.
- Answer **all** the questions.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Write your answer to each question in the space provided. If additional paper is used, the question number(s) must be clearly shown
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- You may use an electronic calculator.
- You are advised to show all the steps in any calculations.

Do not write in this table	
Question	Mark
TOTAL	

4 **Figure 4** shows a gymnast trampolining.

Figure 4



In travelling from her lowest position at **A** to her highest position at **B**, her centre of mass rises 4.2 m vertically. Her mass is 55 kg.

4 (a) Calculate the increase in her gravitational potential energy when she ascends from position **A** to position **B**.

answer = ... J

(2 marks)

4 (b) The gymnast descends from position **B** and regains contact with the trampoline when it is in its unstretched position. At this position, her centre of mass is 3.2 m below its position at **B**.

4 (b) (i) Calculate her kinetic energy at the instant she touches the unstretched trampoline.

answer = ... J

(1 mark)

4 (b) (ii) Calculate her vertical speed at the same instant.

answer = ... $m\,s^{-1}$

(2 marks)

4 (c) Draw an arrow on **Figure 4** to show the force exerted on the gymnast by the trampoline when she is in position **A**.

(1 mark)

4 (d) As she accelerates upwards again from position **A**, she is in contact with the trampoline for a further 0.26 s. Calculate the average acceleration she would experience while she is in contact with the trampoline, if she is to reach the same height as before.

answer = ... $m\,s^{-2}$

(2 marks)

Question 4 continues on the next page

4 (e) On her next jump the gymnast decides to reach a height above position **B**. Describe and explain, in terms of energy and work, the transformations that occur as she ascends from her lowest position **A** until she reaches her new position above **B**.

The quality of your written communication will be assessed in this question.

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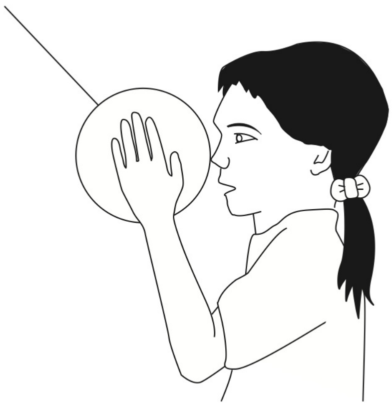
(6 marks)

14

***18** In a demonstration of energy transfer, a large pendulum is made by suspending a 7.0 kg bowling ball on a long piece of wire.

A student is invited to pull the ball back until it just touches her nose and then to release it and stand perfectly still while waiting for the ball to return.



The following instructions are given:

Do not push the ball – just release it. Do not move your face before the ball returns.

(a) Explain this demonstration and the need for these instructions.

(6)

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(b) The bowling ball is raised through a vertical distance of 1.5 m.

(i) Calculate the gravitational potential energy gained by the ball.

(2)

....

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....

Gravitational potential energy = ...

(ii) Calculate the speed of the ball at the bottom of its swing.

(2)

....

....

....

Speed = ...

(Total for Question 18 = 10 marks)

16 The 'Stealth' roller coaster at the Thorpe Park theme park is advertised as reaching 135 km $hour^{-1}$ from rest in 2.3 seconds.

Most roller coasters are driven slowly up to the top of a slope at the start of the ride. However the carriages on 'Stealth' are initially accelerated horizontally from rest at ground level by a hydraulic launch system, before rising to the top of the first slope.

(a) (i) Calculate the average acceleration of the carriages.

135 km $hour^{-1}$ = 37.5 m s^{-1}

(2)

....

....

....

....

Average acceleration = ...

(ii) Calculate the minimum average power which must be developed by the launch system.

mass of carriages and passengers = 10 000 kg

(3)

....

....

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....

....

Minimum average power = ...

(iii) Suggest why the power in (ii) is a minimum value.

(1)

....

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*(b) The force required to launch 'Stealth' is not always the same. The ride is monitored and the data from preceding launches is used to calculate the required force.

If the mass of the passengers for a particular ride is significantly more than for preceding launches, this can lead to 'rollback'. This is when the carriages do not quite reach the top of the first slope and return backwards to the start.

Explain why 'rollback' would occur in this situation.

(3)

(c) Suggest why roller coasters may have a greater acceleration when the lubricating oil between the moving parts has had time to warm up.

(2)

(Total for Question 16 = 11 marks)

7 Fossil fuels will eventually run out. This has led to scientists looking for alternative sources of energy. Tidal stream systems use the kinetic energy of seawater to generate electrical energy during the incoming and outgoing tides. Fig. 7.1 shows a twin-turbine system in which flowing seawater turns the turbine blades.

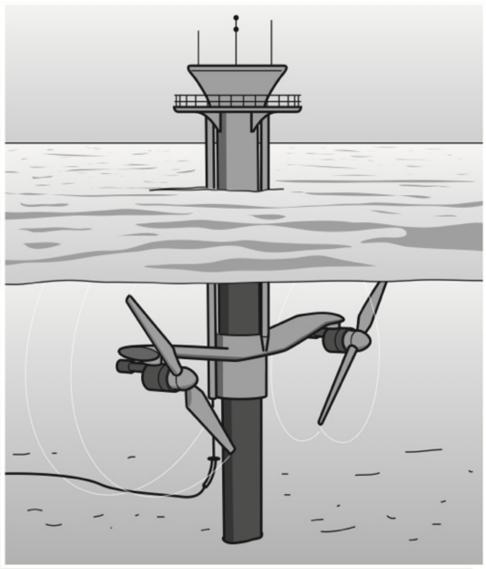

Fig. 7.1

When operating, 9.7×10^5 kg of seawater travelling at a speed of $3.0\,\mathrm{m\,s^{-1}}$ passes through each turbine every second. Each turbine generates 1.2×10^6 W of electrical power.

(a) Define *power*.

....

.... **[1]**

(b) The input power to each turbine is the kinetic energy of the seawater that flows through each turbine in one second.

Show that the input power to each turbine is 4.4×10^6 W.

[2]

(c) Calculate the percentage efficiency of each turbine.

efficiency = ... % **[1]**

(d) In one second, a cylinder of seawater of mass 9.7×10^5 kg passes through each turbine at a speed of $3.0\,m\,s^{-1}$. Calculate the radius of each turbine. The density of seawater is $1030\,kg\,m^{-3}$.

radius = ... m **[3]**

(e) Tidal stream systems require less space than conventional wind turbines that are found in windy regions of this country.

(i) Explain why a tidal stream turbine system of identical size to a wind turbine system will produce greater power for the same water or wind speed.

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....

.... **[1]**

(ii) Suggest one further advantage of tidal stream systems over conventional wind farms.

....

.... **[1]**

[Total: 9]

END OF QUESTION PAPER

6 **(a)** Power can be measured in watts. Define the *watt*.

....

.... **[1]**

(b) An electric motor-driven crane is used to raise a load of bricks of mass 700 kg through a vertical height of 8.5 m in a time of 45 s. The efficiency of the motor-driven crane is 30%. Calculate

(i) the gravitational potential energy E_p gained by the bricks

E_p = ... J **[1]**

(ii) the output power of the motor-driven crane

output power = ... W **[1]**

(iii) the input power to the motor-driven crane.

input power = ... W **[1]**

[Total: 4]

6 **(a)** Define *work done by a force*.

....

....

.... **[1]**

(b) A crate is pushed along a rough horizontal surface at a constant speed. State what happens to the work done on the crate.

In your answer, you should use appropriate technical terms, spelled correctly.

....

....

.... **[1]**

(c) Define the *watt*.

....

.... **[1]**

(d) Fig. 6.1 shows an electric crane lifting a mechanical digger.

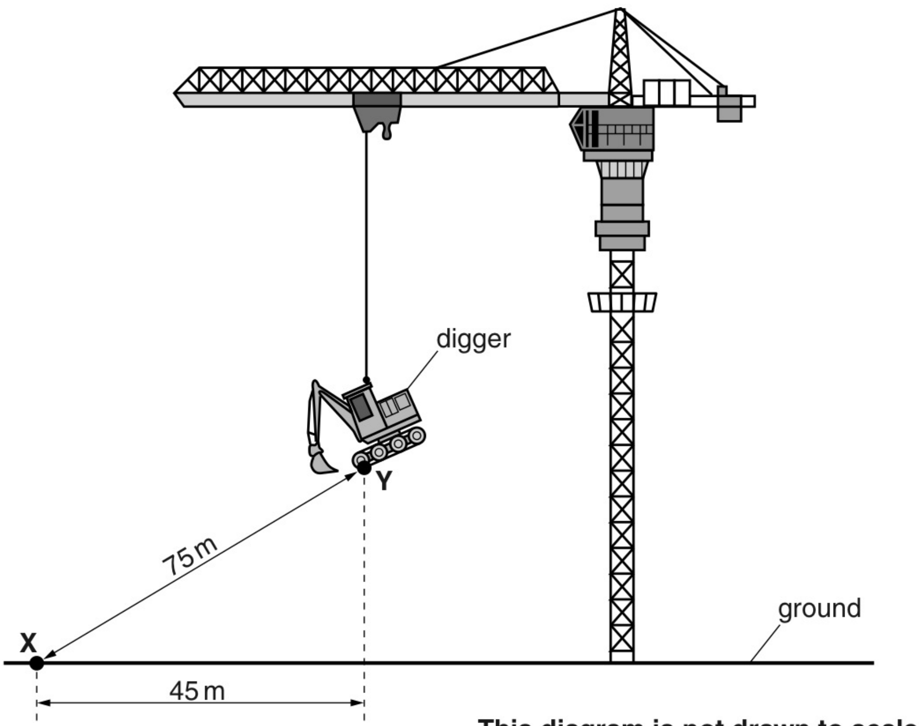

Fig. 6.1

The mass of the digger is 5200 kg. The crane takes 1.5 minutes to lift the digger from **X** to **Y**.

(i) Calculate the rate of work done to lift the digger from **X** to **Y**.

rate of work done = ... $J s^{-1}$ **[3]**

(ii) The total input power to the motors of the crane is 170 kW. Calculate the efficiency of the lifting operation.

efficiency = ... % **[1]**

[Total: 7]