ST PAUL'S SCHOOL
# JUNIOR SCHOLARSHIP EXAMINATION

PHYSICS

NAME _____

MAY 2013

SECTION A – PHYSICS

Much has been written in the press and discussed on television and radio about global energy issues and alternatives to fossil fuels. The following questions are about some of the different types of alternative energy already in use in different parts of the world.

In an HEP (hydro-electric power) station, water from the higher reservoir flows through a turbine which drives a generator to produce electricity. The falling water loses GPE (gravitational potential energy) and gains KE (kinetic energy).
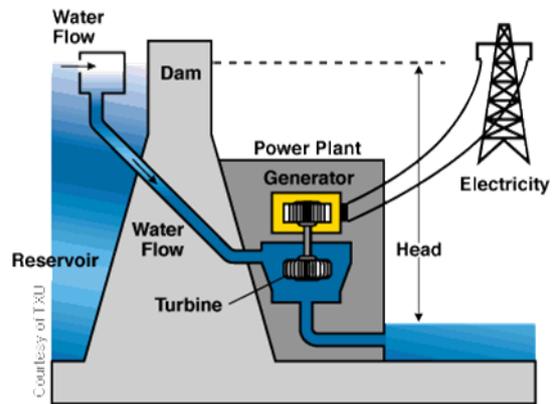
The equation for GPE is **GPE = mass x gravitational field strength x vertical height**

and for KE is **KE = ½ mass x speed². ** Both GPE and KE are measured in Joules.

1. If the height of the dam is 100 m, the mass of water passing through one turbine in one second is 1 x 1,000,000 kg and the gravitational field strength is 10 N/kg, calculate the loss in GPE of the water every second.

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2. Assuming that all of this energy is converted into KE, calculate the speed of the water as it enters the turbine.

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3. Do you think that the loss in GPE will be equal to the electrical energy generated?
    Explain your reasoning.

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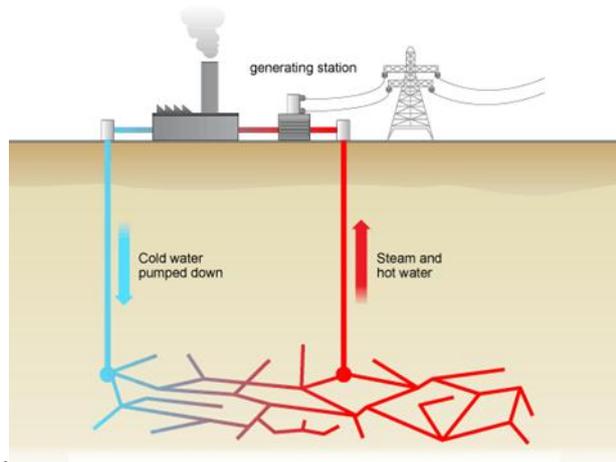   ……………………………………………………………………………………………

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In Iceland, which is a volcanic island sitting on the Mid-Atlantic Ridge, most of the
energy generated comes from geothermal sources underground. All of the island's hot
water is heated geothermally and the streets of the capital, Reykjavik, are heated through
the winter the same way.

4. What do you think might be responsible for the heat energy coming from underground?

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5. Suggest two reasons why the geothermal heating of the streets could be a problem.

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TURN OVER

How does a wind turbine work?

Inflow of wind

Inflow of wind activates rotor (A) & blades (B)

Rotor & blades spin the main shaft (C) and gearbox (D), which spins the generator (G), resulting in electrical output
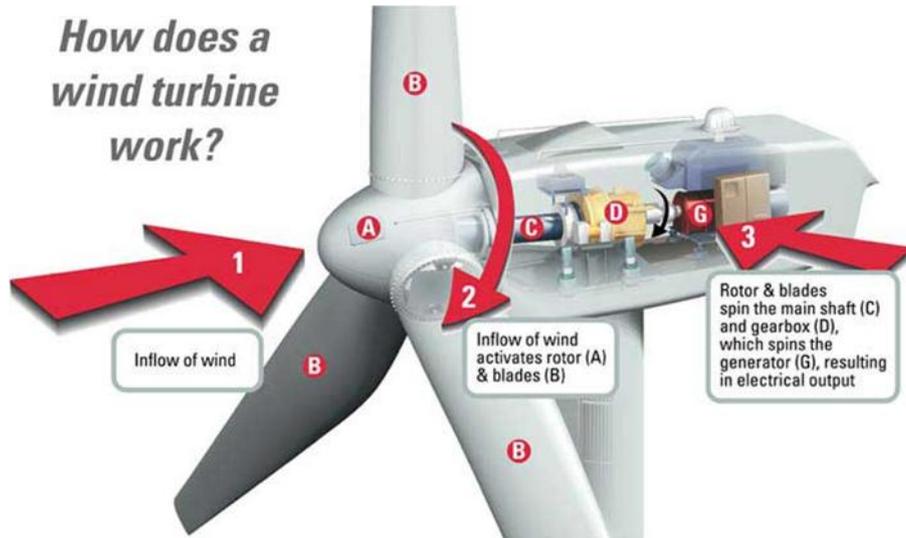
Wind farms have caused a certain amount of controversy because the windmills are said to be an eyesore. They have been constructed on land and in the sea, and transfer the KE of the wind into electrical energy.

6.   The mass of air moving towards the blades is proportional to its speed. Using the kinetic energy equation given at the start of the paper, by what factor would the kinetic energy increase if the wind speed doubled?

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7.   Much of the wind will actually pass through the spaces between the blades and between individual windmills. In the space on the next page, sketch a possible plan (birds' eye) view of the arrangement of the windmills which would optimise the energy conversion. Include at least three rows with four windmills in each row.

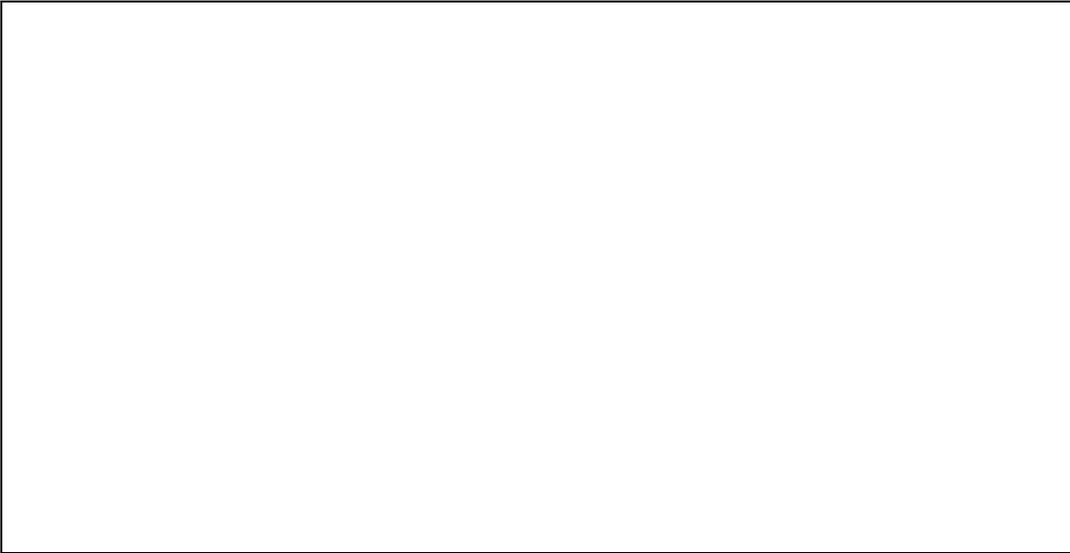   **Explain your choice of arrangement**.

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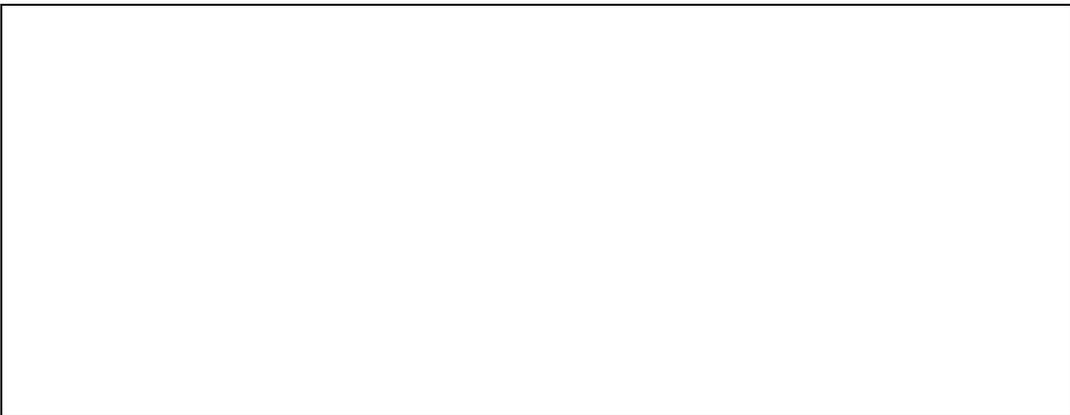…………………………………………………………………………………………..........

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8.   A student wants an estimate for the height of a windmill. When he is standing
     2 km away from the windmill, his thumbnail, held at arm's length, exactly covers
     the whole of the windmill. If his thumb nail is 1 cm long and his arm is 50 cm
     long, estimate the height of the windmill in m. Show your working – a sketch may
     help.

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TURN OVER

Solar panels receive sunlight and convert it into electrical energy. The amount of solar energy arriving in the UK every second is approximately 1300 J/m². Each of the panels on the roof is 2 m x 1 m and is 20% efficient at converting solar energy into electricity.

9.   Show that the amount of solar energy arriving in one second on the **panels** shown is approximately 1.4×10^5J (140,000 J)

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10.   Calculate how much electrical energy is produced every second.

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9. Treating the roof like a battery, draw a circuit diagram in the space below to show how 3 identical lights, each with its own switch, could be independently controlled so that one light can be on while the other two are switched off.

[3]

END OF PHYSICS

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