8.1 Energy Density Practice 2020 *[18 marks]*

1. Which of the following energy sources results from the solar energy incident on Earth? *[1 mark]*

   A. Nuclear fission

   B. Wind energy

   C. Nuclear fusion

   D. Geothermal energy

Markscheme

B

2. Which of the following is a renewable and non-renewable energy source? *[1 mark]*

	Renewable	Non-renewable
A.	uranium	coal
B.	tidal	uranium
C.	uranium	biogas
D.	natural gas	biogas

Markscheme

B

3. The energy source that currently provides the greatest proportion of the world's total energy demand is *[1 mark]*

   A. coal.

   B. oil.

   C. natural gas.

   D. uranium.

Markscheme

B

4. Which energy resource is renewable? *[1 mark]*

A. Natural gas
B. Uranium
C. Biogas
D. Coal

Markscheme

C

5. The original source of the electrical power produced by a wind generator is *[1 mark]*

A. the Sun’s radiated energy.

B. the gravitational energy of the Sun and the Moon.

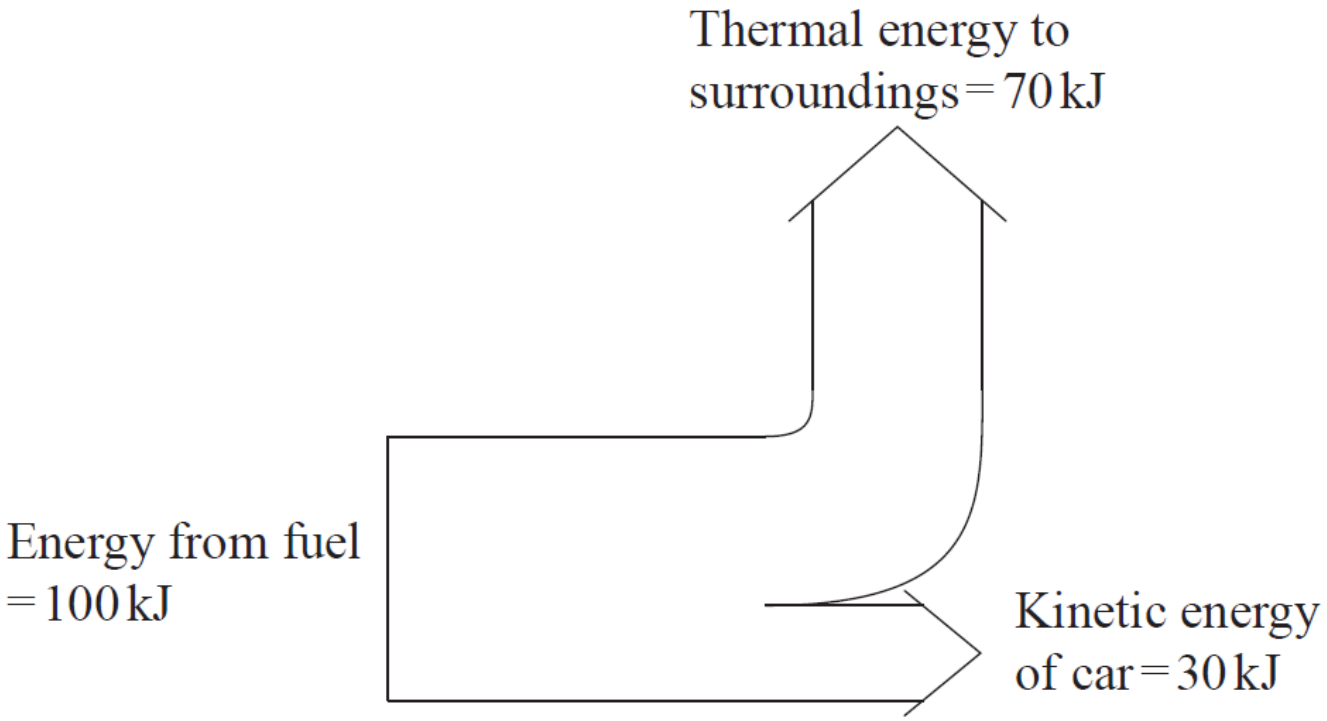
C. nuclear energy stored within atoms in the Earth’s atmosphere.

D. the Earth’s internal energy.

Markscheme

A

6. The diagram below shows an energy flow diagram (Sankey diagram) for a car. *[1 mark]*



What is the efficiency of the car?

A. 30%

B. 40%

C. 70%

D. 100%

Markscheme

A

This question is in **two** parts. **Part 1** is about a nuclear reactor. **Part 2** is about simple harmonic oscillations.

Part 1 Nuclear reactor

7. The reactor produces 24 MW of power. The efficiency of the reactor is 32 *[4 marks]* %. In the fission of one uranium-235 nucleus 3.2×10^{-11}J of energy is released.

Determine the mass of uranium-235 that undergoes fission in one year in this reactor.

Markscheme

power produced $\left(\frac{24}{0.32}\right)$=75MW;
energy produced in a year (75×10^6×365×24×60×60=)2.37×10^{15}J;
number of reactions required in one year $\left(\frac{2.37\times10^{15}}{3.2\times10^{-11}}\right) = 7.39 \times 10^{25}$;
mass used (7.39×10^{25}×235×1.66×10^{-27})≈29kg;

or

mass used $\left(\frac{7.39\times10^{25}}{6.02\times10^{23}} \times 235 \times 10^{-3}\right) = 29\text{kg}$;

This question is in **two** parts. **Part 1** is about a lightning discharge. **Part 2** is about fuel for heating.

Part 2 Fuel for heating

8a. Define the *energy density* of a fuel. *[1 mark]*

Markscheme

energy (released) per unit mass;

Accept per unit volume or per kg or per m³.

Do not accept per unit density.

A room heater burns liquid fuel and the following data are available.

$$\begin{aligned}
&\text{Density of liquid fuel} && = 8.0 \times 10^2 \text{kg m}^{-3} \\
&\text{Energy produced by 1m}^3\text{of liquid fuel} && = 2.7 \times 10^{10} \text{J} \\
&\text{Rate at which fuel is consumed} && = 0.13 \text{g s}^{-1} \\
&\text{Latent heat of vaporization of the fuel} && = 290 \text{kJ kg}^{-1}
\end{aligned}$$

8b. (i) Use the data to calculate the power output of the room heater, ignoring the power required to convert the liquid fuel into a gas. *[5 marks]*

(ii) Show why, in your calculation in (b)(i), the power required to convert the liquid fuel into a gas at its boiling point can be ignored.

Markscheme

(i) volume of fuel used per second $= \frac{\text{rate}}{\text{density}}$ $\left(= 1.63 \times 10^{-7}\ (\text{m}^3)\right)$;

$\text{energy} = 2.7 \times 10^{10} \times 1.63 \times 10^{-7}$;

$= (4.3875 =)\ 4.4\ \text{kW}$;

*Award **[3]** for bald correct answer.*

(ii) power required $= (2.9 \times 10^5 \times 0.13 \times 10^{-3} =)\ 38\ \text{W}$;

small fraction/less than 1% of overall power output / *OWTTE*;

8c. State, in terms of molecular structure and their motion, **two** differences *[2 marks]* between a liquid and a gas.

1.

2.

Markscheme

sensible comment comparing molecular structure;

e.g. liquid molecular structure (more) ordered than that of a gas.

in gas molecules far apart/about 10 molecular spacings apart / in liquid molecules close/touching.

sensible comment comparing motion of molecules;

e.g. in liquid: molecules interchange places with neighbouring molecules / no long
distance motion.
in gases: no long-range order / long distance motion.