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Renewable Source of Energy

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CLASS TEST 2019-2020

MECHANICAL ENGINEERING

Date of Test : 08/09/2019

ANSWER KEY ➤ Renewable Source of Energy

1.	(c)	6.	(c)	11.	(b)	16.	(a)	21.	(d)
2.	(d)	7.	(c)	12.	(b)	17.	(c)	22.	(c)
3.	(c)	8.	(d)	13.	(a)	18.	(d)	23.	(c)
4.	(c)	9.	(b)	14.	(d)	19.	(c)	24.	(a)
5.	(d)	10.	(d)	15.	(c)	20.	(d)	25.	(b)

DETAILED EXPLANATIONS

1. (c)

$$P = \frac{1}{2}\rho A V^3$$

- Wind power plants have relatively little impact on the environment as compared to fossil fuel power plants.
- The air motion result from un-even heating of the atmosphere by the sun, creating temperature, density and pressure difference.
- Wind energy can be available continuously throughout 24-hour day for much longer periods, though it can vary a great extent including no wind periods.

Disadvantages:

- It is dispersed, erratic and location specific source.
- Noise generated by wind turbine is of more than 85 db, hence badly affect ecosystem.
- Main concerns for wind turbine have been the noise produced by the rotor blades, visual impacts, and deaths of birds and bats that fly into the rotors (avian/bat mortality).

2. (d)

Given:

Rotor diameter = 80 m

$\Rightarrow$ Radius, R = 40 m

Free wind speed, u_0 = 15 m/s

Tip speed ratio, $\lambda_0 = \frac{R\omega}{u_0}$

$$4 = \frac{40 \times \omega}{15}$$

ω = 1.5 rad/s

If N is rotor speed in rpm, $\omega = \frac{2\pi N}{60}$

$$1.5 = \frac{2 \times 22}{60 \times 7} \times N$$

$$N = \frac{15}{10} \times \frac{7 \times 60}{2 \times 22}$$

N = 14.32 rpm ≈ 15 rpm

3. (c)

Consider water trapped at high tide in a basin of area A. The potential energy in the mass of water stored in incremental head dh above the head h is:

$$dW = dm.g.h$$

But $dm = \rho.A.dh$

Thus, $dW = \rho A g h\, dh$

Total potential energy of water stored in the basin is:

$$W = \int_0^R \rho A g h\, dh$$

$$W = \frac{1}{2}\rho A g R^2 \text{ Joules}]$$

(Hence, tidal power is proportional to square of the range)

Where, ρ = Density of water

g = Acceleration due to gravity

4. (c)

Lift force produces more torque in comparison to the drag force.

5. (d)

S.No.	Name of fuel cell	Operating temperature(°C)
1	PAFC	150 - 200
2	AFC	90
3	MCFC	600 - 700
4	SOFC	700-1000

6. (c)

All these terms are related to bio-mass conversion technologies:

- Pelletization reduces moisture to about 7 to 10 percent and increase the heat value of the biomass. It is used in steam power plants and gasification system.
- Briquetting is brought about by compression and squeezing out moisture and breaking down the elasticity of the wood and bark.
- Incineration means direct combustion of biomass for immediate useful heat.
- The basic thermochemical process to convert biomass into a more valuable and/or convenient product is known as pyrolysis.

7. (c)

Given:

$$\frac{\text{Maximum Current}}{\text{Current circuit current}} = \frac{I_{max}}{I_{sc}} = \frac{1}{2}$$

Maximum voltage that cell can give $= V_{max} = 0.045 \text{ V/cm}^2$

Open circuit voltage $= V_{oc} = 0.6 \text{ V/cm}^2$

Then, Fill factor, FF $= \frac{I_{max} \times V_{max}}{I_{sc} \times V_{oc}} = \frac{1}{2} \times \frac{0.045}{0.6} = 0.0375$

8. (d)

- As the conversion of chemical energy of fuel to electrical energy occurs directly without intermediate thermal stage, the efficiency of conversion is better and not limited by carnot efficiency of thermal stage.
- Fuel cell plant can be installed near the point of use, thus transmission and distribution losses are avoided.
- Availability of choices from large number of possible fuels.

9. (b)

The solar constant, I_{sc} is defined as the energy received from the sun per unit time, on a unit area of surface perpendicular to the direction of propagation of the radiation at the top of the atmosphere and at the earth's mean distance from the sun.

10. (d)

Given: P_{40} = 728 W/m², H_1 = 40 m, P_{10} = ?, H_2 = 10 m

$$\alpha = \frac{1}{6}$$

We know that,

$$\frac{P_1}{P_2} = \left(\frac{H_1}{H_2}\right)^{3\alpha}$$

$$\frac{P_{40}}{P_{10}} = \left(\frac{40}{10}\right)^{3\times\frac{1}{6}}$$

$$\frac{P_{40}}{P_{10}} = (4)^{1/2}$$

$$P_{10} = \frac{P_{40}}{2} = \frac{728}{2} = 364 \text{ W/m}^2$$

11. (b)

Given: l = 1.5 m; θ = 23°,

$$\text{Concentration ratio, } C = \frac{1}{\sin(\theta/2)} = \frac{1}{\sin 11.5°} = 5.0$$

$$\text{Aperture, } W = C \times \text{Width}$$

$$= 5 \times 20 = 100 \text{ cm} = 1 \text{ m}$$

Now, $$\frac{\text{Concentrator area}}{\text{Aperture area}} = 1 + C$$

$$\frac{A_{conc.}}{W \times L} = (1 + 5)$$

$$A_{conc.} = 6 \times 1 \times 1.5$$

$$\text{Area of concentration, } A_{conc.} = 9 \text{ m}^2$$

12. (b)

$$\text{Radius, } R = \text{Length of blade} = 10\sqrt{7} \text{ m}$$

$$\text{Power available, } P_{avail} = \frac{1}{2}\rho A V^3$$

$$= \frac{1}{2}\times 1 \times \pi \times (10\sqrt{7})^2 \times (10)^3$$

$$= \frac{1}{2}\times\frac{22}{7}\times 10\sqrt{7}\times 10\sqrt{7}\times 10^3 = \frac{1}{2}\times\frac{22}{7}\times 100\times 7\times 10^3$$

$$= 11 \times 10^5$$

$$P_{avail} = 1.1 \text{ MW}$$

Now maximum power obtained, $p_{max} = c_p \times P_{avaial}$

$$P_{max} = 0.593 \times 1.1 = 652.3 \text{ kW}$$

13. (a)

Bio-diesel is a liquid fuel produced from non-edible oil seeds such as Jatropha, Karanja etc., which can be grown on wasteland. The oil extracted from these seeds has high viscosity (20 times that of diesel) which causes serious problem in case of lubrication like oil contamination and injector choking.

16. (a)

Tilt factor of reflected radiation,

$$r_r = \rho\left[\frac{1-\cos\beta}{2}\right]$$

$$\Rightarrow \quad r_r = 0.60\left[\frac{1-\cos 60^\circ}{2}\right] = 0.15$$

18. (d)

$$\text{Fill Factor (FF)} = \frac{I_{max}\ V_{max}}{I_{sc}\ V_{oc}} = \frac{5\times 0.12}{10\times 0.18} = 0.33$$

19. (c)

Maximum efficiency of solar chimney is given by

$$\eta_{max} = \frac{gH}{c_p T_a}$$

$$0.05 = \frac{9.81\times H}{1.005\times 10^3 \times 300}$$

$$\Rightarrow \quad H = 1536.7 \text{ m}$$

20. (d)

The conversion efficiency of a photovoltaic (PV) cell, or solar cell, is the percentage of the solar energy shining on a PV device that is converted into usable electricity.

Given: Power output, $P = 200$ W

$$\eta_{conversion} = 25\% = 0.25$$

$$I = 2000 \text{ W/m}^2$$

We have $\eta_{conversion} = \dfrac{P}{I\times A}$

$$\therefore \quad A = \frac{200}{2000\times 0.25} = 0.4 \text{ m}^2$$

21. (d)

PV installations can operate for 100 years or even more with little maintenance or intervention after their initial set-up, so after the initial capital cost of building any solar power plant, operating costs are extremely low compared to existing power technologies.

22. (c)

Compared to fixed bed gasifiers, in fluidized bed gasifier, the gasification temperature is relatively low; an even temperature is selected in the range of 750°C to 900°C.

23. (c)

As $v \propto H^{\alpha}$

$$\Rightarrow \quad \frac{v_2}{v_1} = \left(\frac{H_2}{H_1}\right)^{\alpha}$$

$$\text{or} \quad \frac{15}{10} = \left(\frac{H_2}{8}\right)^{0.50}$$

$$\Rightarrow \quad H_2 = 18 \text{ m}$$

25. (b)

$$\text{Power required} = \frac{P_g}{\eta_E} = \frac{420}{0.35} = 1200 \text{ kW}$$

Power delivered by biomass= 0.80 × 1200 = 960 kW

$$\eta_{\text{gasifier}} = \frac{P_{\text{Biomass}}}{\dot{m} \times C.V.}$$

$$\text{or} \quad \dot{m} = \text{feedrate of biomass} = \frac{960}{0.75 \times 16000}$$

$$\Rightarrow \quad \dot{m} = 0.08 \text{ kg/s}$$

$$\text{or} \quad \dot{m} = 288 \text{ kg/h}$$

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