Reg. No. :

Question Paper Code : 27425

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2015.

Second Semester

Marine Engineering

MV 6201 — MARINE ENGINEERING THERMODYNAMICS

(Regulations 2013)

Time : Three hours | Maximum : 100 marks

(Use of approved steam tables and Mollier chart is permitted)

(Use of Standard Thermodynamic Tables, Psychrometric chart is permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. What are open and closed systems?

2. Give the zeroth law and first law of thermodynamics.

3. State the Kelvin Planck and Clausius statements of second law of thermodynamics.

4. Distinguish between a refrigerator and a heat pump.

5. Define critical pressure and critical temperature.

6. What is meant by melting and evaporation?

7. Define an ideal gas and state its equation of state.

8. Draw the p-V diagram of an ideal Diesel cycle and indicate the processes.

9. What is Joule-Thomson coefficient? What does it signify?

10. Define stoichiometric air-fuel ratio and excess air ratio?

PART B — (5 × 16 = 80 marks)

11. (a) (i) Define mechanical, chemical and thermal equilibrium and explain each one of them. (8)

(ii) Classify and explain various thermodynamic processes. (8)

Or

(b) (i) A stationary fluid system goes through a cycle comprising the following processes :

(1) Process 1-2, constant volume heat addition of 235 kJ/kg

(2) Process 2-3, adiabatic expansion to its original pressure with loss of 70 kJ/kg in internal energy

(3) Process 3-1, constant pressure compression to its original volume with heat rejection of 200 kJ/kg

Determine the total heat and work transfer during the cycle. (8)

(ii) Apply the first law of thermodynamics to steam turbine, condenser, heat exchanger and steam nozzle and obtain the final expression. (8)

12. (a) (i) Explain the major reasons and causes of irreversibility. (10)

(ii) 1000 kJ of heat is transferred from a high temperature reservoir at 1000 K to a heat engine and heat is rejected to a low temperature reservoir at 500 K. Determine whether the cycle is impossible, reversible or irreversible for the following cases (1) 500 kJ of heat is rejected (2) 600 kJ of heat is rejected and (3) 400 kJ of heat is rejected. (6)

Or

(b) (i) Explain the principle of entropy increase and show that the entropy of an isolated system can never decrease. (8)

(ii) Derive an expression for availability in a closed system. (8)

13. (a) (i) Define saturated steam, dryness fraction and superheated steam. (6)

(ii) 3 kg of steam at 18 bar occupy a volume of 0.2550 m^3. During a constant volume process, the heat rejected is 1320 kJ. Determine the final internal energy, initial dryness and work done. (10)

Or

(b) (i) Draw a neat sketch of a PVT surface and explain. (8)

(ii) Steam expands isentropically in a nozzle from I MPa, 250°C to 10 kPa. The steam flow rate is 1 kg/s. Find the velocity of the steam at the exit from the nozzle and the exit area of the nozzle. Neglect the velocity of steam at inlet to the nozzle. The exhaust steam from the nozzle flows into the condenser and flows out as saturated water. The cooling water enters the condenser at 25°C and leaves at 35°C. Determine the mass flow rate. (8)

14. (a) (i) Write down the vander Waals equation of state. How does it differ from the ideal equation of state? What is cohesion force and co-volume? (8)

(ii) Draw the p-V and T-s diagrams of a Brayton cycle indicating the various processes and obtain the expression for thermal efficiency.(8)

Or

(b) An engine working on a dual cycle has a compression ratio of 10 and its maximum pressure is limited to 60 bar. If the heat supplied is 1700 kJ/kg, find the pressures and temperatures at the salient points of the cycle and the cycle efficiency. The pressure and temperature of air at the commencement of compression are 1 bar and 100°C respectively. Assume $C_p = 1.005$ kJ/kgK and $C_v = 0.717$ kJ/kgK. (16)

15. (a) (i) Derive the Maxwell's relations. (10)

(ii) Derive the Clausius-Clayperon equation. (6)

Or

(b) (i) Calculate the theoritical air fuel ratio for a fuel having the chemical formula CH_3OH. (6)

(ii) Explain the principle of operation of orsat apparatus. (10)

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Question Paper Code : 57641

B.E./B.Tech. DEGREE EXAMINATION, MAY/JUNE 2016

Second Semester

Marine Engineering

MV 6201 – MARINE ENGINEERING THERMODYNAMICS

(Regulations 2013)

Time : Three Hours **Maximum : 100 Marks**

Answer ALL questions.
(Steam tables to be supplied)

PART – A (10 × 2 = 20 Marks)

1. 2 kg of air at 150 °C and 3 bar expands according to $PV^{1.2}$ = constant, to a final pressure of 1 bar. Find heat transfer, work transfer and change in internal energy. Take R = 0.287 kJ/kg K and γ = 1.4.

2. What is a steady flow process ?

3. A refrigerator transfers 120 kJ of heat from a cold space, and needs 40 kJ of work input. Calculate its coefficient of performance.

4. Explain concept of Second law of thermodynamics.

5. Determine the mean specific heat for superheated steam at 1 bar between temperatures of 150 °C to 200 °C using steam table.

6. Define the dryness fraction of the steam.

7. The thermal efficiency of an air-standard Diesel Cycle is 55% and compression ratio is 14. Find the cut-off ratio.

8. How does Atkinson cycle engine differ from other cycle ?

9. Define HCV and LCV.

10. Write Maxwell relation from Gibbs relation, du = T ds – p dv.

PART – B (5 × 16 = 80 Marks)

11. (a) (i) In a steady flow device, the inlet and outlet conditions are given below. Determine the heat loss/gain by the system.

Property	Inlet	Outlet
Pressure (bar)	10	8.93
Specific enthalpy (kJ/kg)	2827	2341
Velocity (m/s)	20	120
Elevation (m)	3.2	0.5

Fluid flow rate through the device is 2.1 kg/s. The work output of the device is 750 kW. **(12)**

(ii) A fluid system undergoes a non-flow frictionless process. The pressure and volume are related as $p = \frac{5}{V} + 1.5$, where p is in bar and V is in m^3. During the process, the volume changes from 0.15 m^3 to 0.05 m^3. Calculate the work done by the fluid. **(4)**

OR

(b) (i) Show that the thermodynamics properties relation, $\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{\gamma - 1}{\gamma}}$ **(6)**

(ii) A system undergoes a cyclic process composed of four processes. The energy transfer is tabulated below :

Process	Q (kJ/min)	W (kJ/min)	ΔU (kJ/min)
1-2	400	150	—
2-3	200	—	300
3-4	–200	—	—
4-1	0	75	—

Complete the table and determine the power output. **(10)**

12. (a) (i) Air expands steadily through a turbine from 200 kPa, 60 °C to 90 kPa, 15 °C. The entropy of the surroundings decreases by 0.04 kJ/kg°K. Would such a process be irreversible, reversible or impossible ? Why ? **(6)**

(ii) 300 kJ/s of heat is supplied at a constant fixed temperature of 290 °C to heat engine. The heat rejection takes place at 8.5 °C. The following results were obtained :

(1) 215 kJ/s are rejected

(2) 150 kJ/s are rejected

(3) 75 kJ/s are rejected.

Classify which of the result report a reversible cycle or irreversible cycle or impossible results. **(10)**

OR

(b) Two Carnot engines are working in series between a source and a sink. The first engine receives heat from a reservoir at a temperature of 1000 °K and rejects the waste heat to another reservoir at the temperature T_2. The second heat engine receives the heat energy rejected by the first engine. It converts some of energy into useful work and rejects the rest to a reservoir at temperature of 300 °K. (i) if they both deliver equal power, determine the efficiency of each engine (ii) If thermal efficiency of both engines are same, determine the intermediate temperature. **(16)**

13. (a) (i) Calculate volume, density, enthalpy and entropy of 2 kg of steam, at 80 °C and having a dryness fraction of 0.85. (Use steam tables) **(6)**

(ii) Explain the PVT surface and, discuss T-s, p-v and h-s diagrams. **(10)**

OR

(b) (i) The air in a car tyre was at a pressure of 3 bar and at 20 °C. After, the pressure rises to 3.5 bar. Estimate the temperature of air inside the tyre. **(6)**

(ii) Calculate the volume, enthalpy and internal energy of 2 kg of steam at 10.3 bar pressure in each of the following states: (Use steam tables)

(1) Dryness fraction of 0.85

(2) Dry and saturation steam

(3) at a temperature of 220 °C. **(10)**

14. (a) Consider an ideal air-standard Brayton cycle in which the air into the compressor is at 100 kPa, 20 °C, and the pressure ratio across the compressor is 12:1. The maximum temperature in the cycle is 1100 °C, and the air flow rate is 10 kg/s. Assume constant specific heat for the air (C_p= 1.004 kJ/kg K). Determine the compressor work, the turbine work, and the thermal efficiency of the cycle. **(16)**

OR

(b) In a Diesel cycle, the compression ratio is 15. Compression begins at 0.1 MPa. The heat added is 1 .675 MJ/kg. Find (a) the maximum temperature in the cycle, (b) work done per kg of air (c) the cycle efficiency (d) the temperature at the end of the isentropic expansion (e) the cut-off ratio and (f) the MEP of the cycle. **(16)**

15. (a) Let assume, u = f(T, v) and s = f(T, v);

Show that $du = C_v dT + \left[T\left(\frac{\partial p}{\partial T}\right)_v - p\right]dv$, Notations are usual meanings. **(16)**

OR

(b) (i) Calculate the Stoichiometric Air-Fuel ration :

(1) CH_4

(2) $C_{8.5}H_{18.4}$

(3) CH_3OH **(6)**

(ii) A petrol sample contains 15% of hydrogen, 85% of carbon, and 50% excess air is supplied to ensure complete combustion. Determine the percentage analysis of dry products of combustion by mass. **(10)**

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Question Paper Code : 72290

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2017.

Second Semester

Marine Engineering

MV 6201 – MARINE ENGINEERING THERMODYNAMICS

(Regulations 2013)

Time : Three hours Maximum : 100 marks

(Use of Steam Table, Mollier Chart and Thermodynamics properties table are permitted)

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. A fluid system undergoes a non-flow frictionless process. The pressure and volume are related as $p = \frac{5}{V} + 1.5$, where p is in bar and V is in m^3. During the process, the volume changes from 0.15 m^3 to 0.05 m^3. Calculate the work done by the fluid.

2. Apply steady – flow energy equation to each of the following :
   (a) Steam turbine
   (b) Nozzle
   (c) Boiler

3. Define heat engine and heat pump.

4. What do you understand about availability and unavailability of energy?

5. Draw the PVT surface and mention important points.

6. Define dryness fraction.

7. Define Calorific Value of the fuel.

8. Draw the P-V and T-s diagram of Stirling cycle.

9. Define equation of state.

10. Define HCV and LCV?

PART B — (5 × 16 = 80 marks)

11. (a) A system undergoes a cyclic process composed of four processes The energy transfer is tabulated below :

Process	Q (kJ/min)	W (kJ/min)	ΔU (kJ/min)
1-2	400	150	–
2-3	200	–	300
3-4	–200	–	–
4-1	0	75	–

Complete the table and determine the power output. (16)

Or

(b) In a steady flow device, the inlet and outlet conditions are given below. Determine the heat loss/gain by the system.

Property	Inlet	Outlet
Pressure (bar)	10	8.93
Specific enthalpy (kJ/kg)	2827	2341
Velocity (m/s)	20	120
Elevation (m)	3.2	0.5

Fluid flow rate though the device is 2.1 kg/s. The work output of the device is 750 kW. (16)

12. (a) (i) Calculate the COP of a heat pump operating between 25°C and 5°C. (5)

(ii) What is the Clausius inequality? (6)

(iii) A refrigerator and heat pump operates between same temperature limits. If the COP of the refrigerator is 4, what is the COP of heat pump? (5)

Or

(b) A reversible heat engine operates between two reservoirs at temperature of 600°C and 40°C. The engine drives a reversible refrigerator which operates between reservoirs at temperatures of 40°C and –20°C. The heat transfer to the heat engine is 2000 kJ and net work output of the combined engine refrigerator plant is 360 kJ. Evaluate the heat transfer to the refrigerant and the net heat transfer to the reservoir at 40°C. (16)

13. (a) (i) Explain the uses h-s for water chart with the help of neat diagram. (8)

(ii) What is superheated steam? Discuss the advantages of the superheating steam. (8)

Or

(b) A gas initially at a pressure of 520 kPa and a volume of 142 litres undergoes a process and has a final pressure of 170 kPa and a volume of 275 litres. During the process, the enthalpy decreases by 65 kJ. Take Cv = 0.718 kJ/kg K. Determine (i) change in internal energy (ii) specific heat at constant pressure and (iii) specific gas constant. (16)

14. (a) An engine working on Otto cycle has a volume of 0.45 m^3, pressure 1 bar and temperature 30°C at the beginning of compression stroke. At the end of compression stroke, the pressure is 11 bar, 210 kJ of heat is added at constant volume. Determine (i) Pressure, Temperature and volume at salient points in the cycles (ii) % clearance (iii) Efficiency (iv) Net work per cycle (v) MEP (vi) Ideal power developed by the engine if the number of working cycles per minute is 210. (16)

Or

(b) The pressure and temperature at the beginning of compression in an air-standard dual cycle are 1 bar and 30°C respectively. The compression ratio is 9. The maximum pressure in the cylinder is limited to 60 bar. The heat is added during constant pressure up to 4% of the swept volume. Assuming cylinder bore and stroke as 250 mm and 300 mm respectively, determine (i) air standard efficiency of the dual cycle (ii) power developed, if the number of working cycles are 3 per second. For air take C_v = 0.71 kJ/kg°K and Cp = 1.0 kJ/kg°K. (16)

15. (a) The gravimetric analysis of a sample of coal gives 80% of carbon, 12% of H_2 and 8% of ash. Calculate the theoretical air required and analysis of products by volume. (16)

Or

(b) What is the use of Orsat apparatus? Discuss its working with the help of a neat sketch. (16)

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Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 77247

B.E./B.Tech. DEGREE EXAMINATION, APRIL/MAY 2015.

Second Semester

Marine Engineering

MV 6201 — MARINE ENGINEERING THERMODYNAMICS

(Regulation 2013)

Time : Three hours Maximum : 100 marks

(Use of approved steam tables and Mollier chart is permitted)

Answer ALL questions.

PART A — ($10 \times 2 = 20$ marks)

1. Define an isolated system.

2. Under what conditions is the work done equal to $\int_1^2 pdV$?

3. Write the Kelvin-Planck statement of the second law.

4. Give the criteria of reversibility, irreversibility and impossibility of a thermodynamic cycle.

5. Mention any two methods for measuring quality of steam.

6. Define critical point of water.

7. What is the effect of regeneration on Brayton cycle efficiency?

8. Mention the four processes which constitute the Ericsson cycle.

9. Define higher heating value of a fuel.

10. What is the condition for exact differential?

PART B — (5 × 16 = 80 marks)

11. (a) Details of a 12-cylinder, single-acting, two-stroke marine diesel engine is given below:

Speed- 150 rpm; Cylinder diameter-0.8 m; Stroke of piston- 1 .2 m; Area of indicator diagram- 5.5×10^{-4} m^2; Length of diagram- 0.06 m; spring value- 147 MPa per m. Find the net rate of work transfer from the gas to the pistons in kW.

Or

(b) (i) A mass of 1.5 kg of air is compressed in a quasi-static process from 0.1 MPa to 0.7 MPa for which pv = constant. The initial density of air is 1.16 kg/m^3. Find the work done by the piston to compress the air. (7)

(ii) Show that energy is a property of a system. (9)

12. (a) (i) Show that the efficiency of all reversible heat engines operating between the same temperature levels is the same (8)

(ii) Which is the more effective way to increase the efficiency of a Carnot engine: to increase T_1, keeping T_2 constant; or to decrease T_2, keeping T_1 Constant? Justify your answer. (8)

Or

(b) An ice-making plant produces ice at atmospheric pressure and at 0°C from water at 0°C. The mean temperature of the cooling water circulating through the condenser of the refrigerating machine is 18°C. Evaluate the minimum electrical work in kWh required to produce 1 tonne of ice. Latent heat of fusion of ice is 333.5 kJ/kg. (16)

13. (a) A vessel of volume 0.04 m^3 contains a mixture of saturated water and saturated steam at a temperature of 250°C. The mass of the liquid present is 9 kg. Find the pressure, the mass, the specific volume, the enthalpy, the entropy and the internal energy. (16)

Or

(b) A rigid tank contains 10 kg of water at 90°C. If 8 kg of the water is in the liquid form and the rest is in the vapour form, determine (i) the pressure in the tank and (ii) the volume of the tank. (16)

14. (a) The compression ratio of an air-standard Otto cycle is 9.5. Prior to the isentropic compression process, the air is at 100 kPa, 35°C, and 600 cm^3. The temperature at the end of the isentropic expansion process is 800 K. Using specific heat values at room temperature; determine (i) the highest temperature and pressure in the cycle; (ii) the amount of heat transferred in, in /kJ; (iii) the thermal efficiency; and (iv) the mean effective pressure. (16)

Or

(b) An ideal diesel engine has a compression ratio of 20 and uses air as the working fluid. The state of air at the beginning of the compression process is 95 kPa and 20°C. If the maximum temperature in the cycle is not to exceed 2200 K, determine (i) the thermal efficiency and (ii) the mean effective pressure. Assume constant specific heats for air at room temperature. (16)

15. (a) Derive the Clasius-Claperon equation. (16)

Or

(b) Isooctane is burned with air in an engine at an equivalence ratio of 0.8333. Assuming complete combustion, write the balanced chemical reaction equation. Calculate: (i) Air-fuel ratio. (ii) How much % excess air is used? (16)

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Question Paper Code : 80764

B.E./B.Tech. DEGREE EXAMINATION, NOVEMBER/DECEMBER 2016.

Second Semester

Marine Engineering

MV 6201 – MARINE ENGINEERING THERMODYNAMICS

(Regulation 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Write the sign conversion for heat and work transfer for each of the following processes :

   (a) Gas in an insulated cylinder expands as the piston is slowly moved outward.

   (b) A viscous fluid is stirred by a paddle wheel in an insulated closed tank.

2. Differentiate between first law of thermodynamics and second law of thermodynamics.

3. Define entropy.

4. Differentiate between reversible and irreversible process.

5. Define triple point.

6. 1 kg of steam at 2550 kPa occupies a volume of 0.2742 m^3. Identify the type of steam and also find the steam temperature.

7. Draw p-V and T-s diagram for Atkinson cycle.

8. Define cut-off ratio.

9. Define Stoichiometric air-fuel ratio.

10. Using $du = Tds - pdv$ equation, prove that $\left(\frac{\partial u}{\partial v}\right)_p = \frac{C_p}{v_\beta} - p$. Notations are usual meanings.

PART B — (5 × 16 = 80 marks)

11. (a) (i) Steam enters the nozzle, operating at stead state at 30 bar and 350°C with negligible velocity and exits at 15 bar and a velocity of 500 m/s. The mass flow rate is 2.22 kg/s. determines the (1) exit temperature of steam and (2) exit area of nozzle. (8)

(ii) Air initially at 60 kPa pressure, 800 K temperature and 0.1 m^3 volume is compressed isothermally until the volume is halved, and subsequently the air is cooled at constant pressure till the volume is halved again. Sketch the process on a pV plane and determine (1) total work interaction and (2) total heat rejection. Assume ideal-gas behavior for air and take C_p = 1.005 kJ/kgK. (8)

Or

(b) (i) 1 kg of a certain gas undergoes a reversible constant pressure process at 1.2 bar during which its volume changes from 1 m^3 to 1.8 m^3 and the temperature changes from 50°C to 370°C. The specific heat for a substance at constant pressure is given by $C_p = \left(1.1 + \frac{40}{T+30}\right)$ kJ/kg K, where T is in °C. Find (1) heat supplied (2) work done (3) change in internal energy. (8)

(ii) A turbine operating on air has inlet conditions of 10 bar, 750 K and 200 m/s, while exit conditions are 1.25 bar and 40 m/s. The mass flow rate of air is 1000 kg/h. The flow of air is assumed to be reversible adiabatic. Calculate (1) the temperature of air at exit and (2) the power output of the turbine. Take C_p = 1.053 kJ/kg K and adiabatic index = 1.375. (8)

12. (a) A reversible heat engine operates in two environments. In the operation, it draws 12000 kW from a source at 400°C and in the second operation. It draws 25000 kW from a source at 100°C. In both operations, the engine rejects heat to a thermal sink at 20°C. Determine the operation in which the engine delivers more power. (16)

Or

(b) A heat engine is supplied with 1130 kW of heat at a constant temperature of 292 °C and it rejects heat at 5°. The following results were recorded : (i) 834 kW heat is rejected (ii) 556 kW heat is rejected and (iii) 278 kW heat is rejected. Determine whether results report a reversible cycle. Irreversible or impossible. (16)

13. (a) Using tables, calculate the volume, enthalpy and internal energy of 2 kg of steam at 10.3 bar pressure in each of the following state : (i) Dryness fraction of 0.85 (ii) dry and saturated steam and (iii) at a temperature of 220°C. (16)

Or

(b) (i) Draw neatly and briefly discuss about P-V diagram for water. (8)

(ii) Steam expand 10 bar, 350°C expand isentropically to 0.1 bar. Find the work done per kg of steam. Use Mollier chart. (8)

14. (a) An engine operates on air standard Diesel cycle. The pressure and temperature at the beginning of compression are 100 kPa and 27°C. The compression ratio is 18. The heat added per kg of air is 1850 kJ. Determine maximum pressure, maximum temperature, thermal efficiency, network done and mean effective pressure of the cycle. Assume $\gamma = 1.4$, $C_p = 1.005$ kJ/kgK. (16)

Or

(b) The pressure ratio and maximum temperature of a Brayton cycle are 5:1 and 923 K respectively. Air enters the compressed at 1 bar and 298 K. Calculate for 1 kg of air flow, the compressor work, turbine work and the efficiency of the cycle. (16)

15. (a) With the help of Gibbsian relations, show that Four Maxwell relation using partial derivative. (16)

Or

(b) A sample of dry anthacite has the following composition by mass : C = 90%, H = 3%, 0 = 2.5%, N = 1%, S = 0.5% and ash = 3%. Calculate

(i) Stoichiometric A/F ratio and

(ii) A/F ratio when 20% excess air is supplied. (16)

Reg. No. :

Question Paper Code : 97247

B.E./B.Tech. DEGREE EXAMINATION, DECEMBER 2015/JANUARY 2016.

Second Semester

Marine Engineering

MV 6201 — MARINE ENGINEERING THERMODYNAMICS

(Regulations 2013)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. State the concept of continuum as referred in thermodynamics.

2. What are the conditions for thermodynamics equilibrium?

3. State the second law of thermodynamics.

4. Define Entropy.

5. What is called pure substance in thermodynamics?

6. Why are charts and tables used in thermodynamics?

7. State Otto cycle.

8. Define Sterling cycle.

9. State Maxwell relations as defined in second law of transformation.

10. Define the term heat value with reference to fuels.

PART B — (5 × 16 = 80 marks)

11. (a) State a equation for a state that includes both properties for equilibrium. (16)

Or

(b) Explain briefly work against heat with a suitable example. (16)

12. (a) How does reversibility and irreversibility adopted in a natural process? (16)

Or

(b) State the Carnot theorem and state how efficiency in derived. (16)

13. (a) State the thermodynamics first and second law combined with an expression. (16)

Or

(b) Describe the phase changes of pure substance with simple sketches. (16)

14. (a) Describe the process of sterling cycle with suitable sketches. (16)

Or

(b) State the differences between Otto and Diesel cycle. (16)

15. (a) Discuss briefly the theoretical and excess air required for combustion. (16)

Or

(b) Discuss the importance of air and fuel ratio for combustion of fuel. (16)

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