1. a) 1200 hp, 883 kW (Super-sport)

Mostly mechanical energy

b) My car: 2000 Nissan Maxima

222 hp, 166 kW

$\frac{1200 hp}{222 hp} = 540\%$

c) 1.4 gal/min

d) $\left(1.4 \frac{gal}{min}\right)\left(\frac{33.41 kWh}{1 gal}\right)\left(\frac{3600 s}{1 h}\right)\left(\frac{1 min}{60 s}\right) = 2806 kW$

$= 2.81E6 W$

e) $\frac{883 kW}{2806 kW} = 31\%$ efficiency @ max engine power

f) 2806kW − 883kW = 1923kW = 1.923E6 W

$1.923E6 W \cdot \left(\frac{1 \text{ bulb}}{100 W}\right) = 1.923E4$ bulbs

This is a lot of heat to dissipate!

g) $CO_2 = 12 + 2(16) = 44$ amu

C = 12 amu

$\frac{CO_2}{C} = \frac{44}{12} = 3\frac{2}{3}$

$\left(1.4 \frac{gal}{min}\right)\left(\frac{1 min}{60 s}\right)\left(\frac{6.2 \text{ lbs gas}}{1 gal}\right)\left(\frac{3 \text{ lbs } CO_2}{1 \text{ lb gas}}\right)\left(\frac{1 kg}{2.2 lbs}\right)$

$= \boxed{0.197 \frac{kg\ CO_2}{s}}$ → $\left(\frac{0.197 kg\ CO_2}{1 s}\right)\left(\frac{12 \text{ amu } C}{44 \text{ amu } CO_2}\right)$

$\boxed{= 0.0537 \frac{kg\ C}{s}}$

$\left(0.197 \frac{kg\ CO_2}{s}\right)\left(\frac{720 sec}{12 min}\right)$

$\boxed{= 142 \frac{kg\ CO_2}{12 min}}$ → $\left(\frac{142 kg\ CO_2}{12 min}\right)\left(\frac{12 \text{ amu } C}{44 \text{ amu } CO_2}\right)$

$\boxed{= 39 \frac{kg\ C}{12 min}}$

h) According to the World Bank Databank:

Country	(Salary / person)	(Price / 0.5 Salary/person)
USA	$53470	101 people
Guat	$ 3340	1617 people
Congo	$ 430	12559 people

Price of Veyron: $2.7E6

c) I couldn't find specific data except for the USA. Instead I found percentages of people with $50m+ per region, and used that data to estimate.

According to EIA and Statista.com:

Region	# of ppl with NW $50m+	Population	Percentage
North Am.	65,475	459.5E6	0.014%
Latin Am.	31,369	477.6E6	6.57E-3%
Africa	1024	1049.5E6	9.76E-5%

Since these population percentages are for $50m, I would estimate that the percentage of $30m+ NW is about double, so:

USA	0.028%
Guat	0.013%
Congo	0.00020%

2. Using the Harman formula, a vertical jump can be used to estimate power

Please derive how this is $P = \Delta E / \Delta t$

Peak P = 61.9 (jump height in cm) + 36·(body mass in kg) + 1822 ?

Jump = 86.5cm, mass = 102 kg } Peak P = 10848 W = 14.5 hp = 36993 BTU/hr

Avg P = 21.2 (jump height in cm) + 23 (body mass in kg) − 1393 = 2787 W = 3.7 hp = 9503 BTU/hr

Power can also be calculated from food intake.

$$\text{food intake} \approx \left(2200 \frac{kcal}{day}\right)\left(\frac{1\ day}{86400\ s}\right)\left(\frac{4184\ J}{1\ kcal}\right) = 107\ W = 0.1\ hp = 364.9\ BTU/hr$$

∴ The food power can be sustained as long as I get that much daily. The jump power could be sustained based on food intake:

↘

$$\frac{(107\ \frac{J}{s})(86400\ s)}{(2787\ \frac{J}{s})} = 3317\ s \approx 55\ min$$

The max sustained jumping time based just on food intake would be 55 mins, not including daily life functions.

I don't think you are capable of doing constant verticle jumping for 55 min. but it is worth noting that 55 min of verticle jumping will use up an entire day's worth of calories - actually more, because the ATP cycle is less than 100% efficient

3. 1) CO_2 motor.

I like how simple this motor is. The work put into this motor is from compressing the gas into a tank. Since the pressure drops only slightly but the volume increases by a lot as the gas is released into the cylinder, this creates a lot of work.

2) Four stroke

Work is put in by compressing the air/fuel mixture and once it's ignited, a lot more work comes out.

3) Diesel

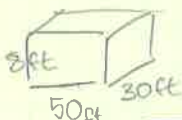
Work is put in by compressing the air fast enough that when the fuel is injected, it ignites. More work comes out by the expanding gas from ignition.

4) Two-stroke

Work is done by compressing the air fuel mixture in the cylinder. It is ignited and produces more work on the piston.

correct
I think what the question was asking is what if we also ~~made~~ kept the house @ 1500 ft²

11.8



floor: 1500 ft² @ R-5 $(ft^2 \cdot °F \cdot h / BtU)$
ceiling: 1500 ft² @ R-30
~~windows: 500 ft² @ R-3~~
walls: 1280 ft² @ R-13

a) $\frac{1}{13}(1280ft^2 - 500ft^2) + \frac{1}{30}(1500ft^2) + \frac{1}{5}(1500ft^2) + \frac{1}{3}(500ft^2)$ (wall − win; ceiling; floor; win)

$= 577\ \frac{BTU}{hr \cdot °F}$

$Q_{total} = (8000\ \frac{°F \cdot day}{yr})(\frac{24\ h}{day})(577\ \frac{BTU}{h \cdot °F}) = 1.1E8\ \frac{BTU}{yr} \approx 1100$ Therm

\#1000

b) $\frac{1}{19}(1280ft^2 - 500ft^2) + \frac{1}{30}(1500ft^2) + \frac{1}{7}(500ft^2) + 0.45(500ft^2)$

$= 387\ \frac{BTU}{hr \cdot °F}$ $\quad \frac{387-577}{(\frac{387-577}{2})} = -39.4\%$ less energy

11.9

a) $R_{total} = (11) + 2(0.45) + 2(0.4) = \boxed{12.7}$

b) 

c) $R_{total} = 3(6.3) + 2(0.45) + 2(0.4) = \boxed{20.6}$

11.11

R-30 ceilings, R-19 walls (x4), R-10 floor, R-1 windows

$$Q = L^2\left[\frac{1}{30} + 4\left(\frac{1}{19}\right) - 0.16\left(\frac{1}{19}\right) + \frac{1}{10} + 0.16\right]\left(6000\ \frac{°F\,day}{year}\right)\left(\frac{24\ h}{day}\right)$$

$ft^2\,°F\,h/BTU$ — $4\times$(area not wall because it's window) $+ \left(18\ \frac{MBTU}{year}\right)$

$$Q = L^2[0.495]\left(\frac{6000\ °F\,day}{year}\right)\left(\frac{24\ h}{day}\right) + 18\ \frac{MBTU}{year}$$

$$= L^2(71280) + 18\ \frac{MBTU}{year}$$

$L = 50ft$: $(50)^2(71280) + 18E6\ \frac{BTU}{year}$

$$Q = 1.962E8\ \frac{BTU}{year}$$

$L = 100ft$: $(100)^2(71280) + 18E6\ \frac{BTU}{year}$

$$Q = 7.308E8\ \frac{BTU}{year}$$

See work on next page

11.12

$$DD = \sum_{j=1}^{7.30}(65°F - T_{outside})_i = 90\,days(65°F - 20°F) + 60\,days(65°F - 40°F) + 60\,days(65°F - 55°F)$$

$$= 4050\ °F\,days + 1500\ °F\,days + 600\ °F\,days$$

$$\boxed{= 6150\ °F\,days}$$

11.11 [R-10] Floor $= L^2 =$ ceiling [R-30]

Wall $= (4L^2)(1 - \text{window}) = (.84)(4L^2)$ [R-19]

Window $= (4L^2)(.16)$ [R-1]

Q_{Less}: we <u>don't</u> lose $\frac{18 \text{ MBTU}}{\text{year}}$ ... that was an example — we lose $\frac{1}{3}$ according to the problem: $\eta_{heating} = \frac{2}{3}$

$\frac{3.36}{19} \approx \frac{3.5}{20} \sim .17$

Floor, Ceiling, Wall, Window

$$\dot{Q} = \frac{1}{\eta}\left[L^2\right]\left[\frac{1}{10} + \frac{1}{30} + (.84)\cdot 4 \cdot \frac{1}{19} + \frac{(.16)\cdot 4}{1}\right]\frac{BTU}{°F \cdot hr \cdot ft^2}$$

$$= \frac{3}{2}\left[L^2\right]\left[0.1 + 0.033 + 0.17 + 0.64\right]\frac{BTU}{°F \cdot hr \cdot ft^3}$$

Hey Folks! it's all about the windows!

$$\frac{\dot{Q}}{V} = \frac{3}{2L}\left[0.943\right]\frac{BTU}{°F \cdot hr \cdot ft^2} \quad (\approx 1)$$

$V = L^3$

$$= \frac{3}{2L}\frac{BTU}{°F \cdot hr \cdot ft^2}$$

for 6000 °F day (24 hr) $= 144000$ °F hr $= 1.44 \times 10^5$ °F hr/yr

$L = 50$ ft

$$\frac{Q}{V} = \frac{3}{100 \text{ ft}}\frac{BTU}{°F \cdot hr \cdot ft^2} \cdot 1.44 \times 10^5 \frac{°F \, hr}{yr}$$

$\approx 4.3 \times 10^3 \frac{BTU}{ft^3 \cdot yr}$, for $L = 100$ ft, it's just half, that $\approx 2.15 \times 10^3 \frac{BTU}{ft^3 \cdot yr}$