Energy Conversions.

1.

Quantity	Symbol	Unit	Abbreviation.
force	F	Newton	N
current	I	Ampere	A
voltage	V	Volt	V
time	t	second	s
energy	ϵ	Joule	J
power	P	Watt	W

2. (a) $P = \frac{\epsilon}{t}$

(b) $P = IV$

(c) $\epsilon_p = mgh$

3. (a) potential energy → kinetic energy

(b) chemical energy → heat energy

(c) nuclear energy → heat energy

(d) kinetic energy → electrical energy

3. (e) light energy → electrical energy

(f) kinetic energy → potential energy

4. (a) $P = \frac{E}{t} = \frac{480}{8} = \underline{60W}$

(b) $E = Pt = 20 \times 5 = \underline{100J}$

(c) $t = \frac{E}{P} = \frac{10\,000}{500} = \underline{20s}$

5. (a) Meter 'X' is in series with the bulb.

(b) Meter 'Y' is in parallel with the bulb.

(c) Meter 'X' is the ammeter.

(d) Meter 'Y' is the voltmeter.

(e) $I = 50mA = 0.05A$

$V = 2V$

$P = IV = 0.05 \times 2 = \underline{0.1W}$

(f) $E = Pt = 0.1 \times 3 = \underline{0.3J}$

6. (i) $E_p = mgh = 25 \times 10 \times 6 = 1500J$

(ii) $E_p = mgh = 2 \times 10 \times 70 = 1400J$

→ The 25kg crate has gained more potential energy.

7. (a) $E_p = mgh = 0.01 \times 10 \times 0.7$

$= \underline{0.07J}$

(b) (i) 0.07J is minimum energy required each second.

(ii) 0.07J per second = 0.07Watts

$P = IV = 0.07W.$ $V = 12V$

$$I = \frac{P}{V} = \frac{0.07}{12} = 0.0058A$$

$= \underline{5.8mA}.$

→ The current required is 5.8mA.

(iii) ① The pump will not be 100% efficient.

② The water will experience air resistance as it travels between the washer nozzle and the windscreen.

8. (a) 1300MW = 1300J/s.

1300J/s × 2 = $\underline{2600J/s}$

→ 2600J of heat energy are produced each second.

8. (b). Heat produced = 2600J/s.

$$\frac{1.2 \times 10^{12}}{2600} = \underline{4.6 \times 10^{8}\ s} \ (5342 \text{ days})!$$

(c) (i) Coal fired power stations have the following disadvantages;
pollution (smoke, sulphides)
large volumes of CO_2 produced.

(ii) Nuclear power stations have the following disadvantages;
waste products are radioactive
waste products have long ½ lives
→ storage issuses
safety issues.

9. (i) (a) Water flows downhill from dam to turbines (potential → kinetic)

rotating turbines produce electricity (kinetic → electrical).

(b) This is done to ensure that water is available from the <u>reservoir</u> to meet demand the next day. The electrical energy used is not required by consumers and would otherwise have been wasted.

9. (ii) (a) $E_p = mgh$ $\quad M = 10^{10}$ kg

$h = 400$ m

$E_p = 10^{10} \times 10 \times 400$

$= 4 \times 10^{13}$ J

$= \underline{4 \times 10^{7} \text{ MJ}}$ (40 000 000 MJ)

(b) 60 000 kg per minute

→ 1000 kg per second.

So E_p gained per second

$= mgh$

$= 1000 \times 10 \times 400$

$= 4 \times 10^{6}$ J (4 MJ)

4×10^{6} J required each second

→ power of pump $= \underline{4 \times 10^{6} \text{ W}}$ (4 MW)

(c) More power is needed because;

① the pump is not 100% efficient

② frictional forces oppose motion of the water as it travels through the pipe.

10. (a) $E_p = mgh$ $\quad$ $m = 400\,kg$, $h = 2m$

$= 400 \times 10 \times 2$

$= \underline{8000J}$

→ The crate gains 8000J of potential energy.

(b) 10kW = 10 000J/s

in 5s the crane uses (10000×5)

$= \underline{50000J}$

11. (a) Summer: E_p per second $= mgh$

$= 10\,000 \times 10 \times 15$

$= 1\,500\,000\ J/s$

if there are no energy losses, the

E_p in $= E_{elec.}$ out

i.e. Max power o/p = 1500 000J/s

$= \underline{1.5MW.}$ (summer)

Winter: E_p per second $= mgh$

$= 120\,000 \times 10 \times 15$

$= 18\ MJ/s$

→ Max power o/p in winter = $\underline{18MW}$

(b) If overall efficiency is 85%, then

$$P_{summer} = 1.5\text{MW} \times 0.85 = \underline{1.275\text{MW}}$$

$$P_{winter} = 18\text{MW} \times 0.85 = \underline{15.3\text{MW}}.$$

12.

(a) $P = IV = 2\text{A} \times 24\text{V} = \underline{48\text{W}}$

(b) $P = \frac{E}{t} = \frac{E_p}{t} = \frac{mgh}{t}$

$$= \frac{2 \times 10 \times 3}{5} = \frac{60}{5}$$

so $P_{out} = \underline{12\text{W}}$

(c) Wasted energy = input energy − output energy

$$= (5 \times 48) - 60$$

$$= 240 - 60$$

$$= \underline{180\text{J}}$$

180J of energy are wasted in 5s.

(d) The main form of wasted energy is <u>heat</u>.

13. (a) $E_p = mgh$ $m = 2kg$
$h = 1.2m$

$= 2 \times 10 \times 1.2$

$= \underline{24J}$

The mass gains 24J of potential energy.

(b) $E = Pt = (IV) \times t$ $I = 1.5A$
$V = 12V$
$t = 4s$

$= 1.5 \times 12 \times 4$

$= \underline{72J}$

72J of electrical energy was supplied to the motor.

(c) $$\text{Efficiency} = \frac{\text{output energy}}{\text{input energy}} \times 100\%$$

$$= \frac{24}{72} \times 100\%$$

Efficiency $= \underline{33.3\%}$

14. (a) The energy we start with is chemical energy. (stored in the petrol).

(b) $E_p = mgh$

$m = 1500\text{kg}$
$h = 20\text{m}$

$= 1500 \times 10 \times 20$

$= \underline{300\,000\text{J}}$.

The crate gains 300 000J of potential energy.

(c) $1\text{kg} \rightarrow 20\text{MJ}$
$0.75\text{kg} \rightarrow \underline{15\text{MJ}}$

The crane uses 15 MJ of energy during the lift.

(d) $$\text{Efficiency} = \frac{\text{output energy}}{\text{input energy}} \times 100\%$$

$$= \frac{300\,000\text{J}}{15\,000\,000\text{J}} \times 100\%$$

Efficiency $= \underline{2\%}$

The system is 2% efficient.