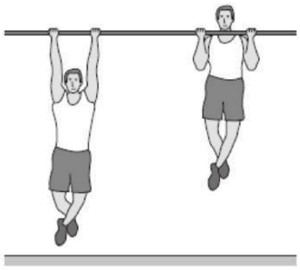
Multi-Step Calculations for Paper 1



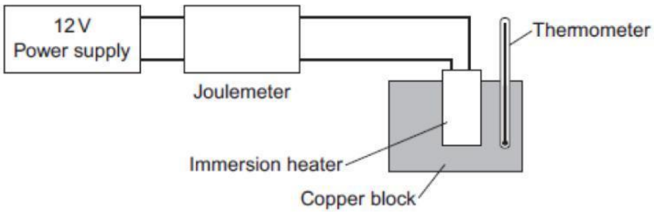
Gravitational field strength = 9.8 N/kg

1 Each time the student does one chin-up he lifts his body 0.40 m vertically upwards. The mass of the student is 65 kg. The student is able to do 12 chin-ups in 60 seconds. Calculate the power developed by the student.

2 The National Grid supplies a house with 18,000,000 J of energy in 1 hour. What was the average current supplied to the house during that hour?

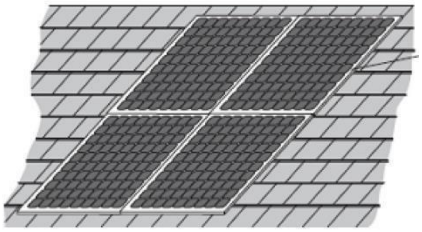
3 The speed of a toy rocket just after being launched is 12 m/s. The mass of the rocket is 0.05 kg. Calculate the maximum height the rocket will reach. Ignore the effect of air resistance.

4 A 2.0 kg copper block was heated up by 20 C in a time of 5 min when connected to the 12 V power supply.



The specific heat capacity of copper is 385 J/kg C

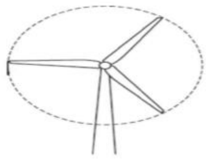
a) Calculate the thermal energy transferred to the block.
b) Calculate the electrical energy suppled to the block assuming the efficiency is 0.7
c) Calculate the resistance of the immersion heater.



5 The maximum power available from the photovoltaic cells shown in the diagram is 1.4×10^3 W

a) How long, in minutes, does it take to transfer 168 kJ of energy?
b) The cost of installing the panels is £6000. The cost of electricity is 40p per kWh.

On average the panels operate for 6.5 hours per day supplying 1.4 kW of electricity. Calculate the time needed before the £6000 cost of the panels is recovered.

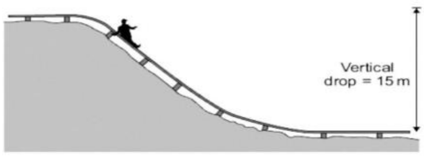


6 When a wind turbine is operating, 15 000 kg of air, moving at a speed of 12 m/s pass through it in one second driving the turbine blades around. This gives an electrical output from the turbine of 450 kW.
Calculate the efficiency of the turbine.

7 An electric motor was used to lift a mass.
The motor was supplied with a potential difference of 120 V and drew a current of 2.4 A The motor lifted a mass of 100 kg through a height of 0.8 m in a time of 12 s.
Calculate the efficiency of the motor.

8 A bungee jumper of mass 75 kg leapt from a bridge attached to a bungee of unstretched length 25 m At the lowest point the jumper was 92.2 m below the bridge.
a) Calculate the energy lost by the jumper and hence the energy gained by the bungee cord.
b) Calculate the spring constant of the bungee cord.

9 Calculate the maximum possible speed of the 90 kg person at the bottom of the slide.



10 A kettle connected to the 230 V mains supply draws a current of 10.5 A The kettle contains 1.2 kg of water at 20 C. Calculate how long it will take to heat the water to 100 C. The specific heat capacity of water is 4200 J/kg C

HINTS

1. $E_p = m \times g \times h$

Total energy = $12 \times E_p$

$P = E \div t$

2. hours → seconds × 3600

$P = E \div t$

Mains voltage = 230 V

P = I x V → rearrange to give equation for I

3. $E_k = 0.5 \times m \times v^2$

$E_k = E_p$

$E_p = m \times g \times h$ → find the KE, tis will be the amount of Ep when the rocket is no longer moving and is at the highest point

4. a) $\Delta E = m \times c \times \Delta\vartheta$

b) Efficiency = useful energy output ÷ total energy in

c) $P = E \div t$

P = I x V → rearrange to give equation for I

V = I x R → rearrange to give equation for R

5. a) $P = E \div t$ → rearrange to give equation for t

Seconds → minutes ÷ 60

b) Calculate cost per day

Divide £6000 by cost per day

6. $E_k = 0.5 \times m \times v^2$

$P = E \div t$

Efficiency = useful power output ÷ total power in

7. Calculate power input → P = I x V

Calculate energy input → $P = E \div t$ → rearrange to give equation for E

Calculate energy output → $E_p = m \times g \times h$

Efficiency = useful energy output ÷ total energy in

8. a) $E_p = m \times g \times h$

a) $E_e = 0.5 \times k \times e^2$ → rearrange to give equation for k

9. $E_p = m \times g \times h$

$E_p = E_k = 0.5 \times m \times v^2$ → rearrange to give equation for v

10. Mains voltage = 230V

$\Delta E = m \times c \times \Delta\vartheta$

P = I x V

$P = E \div t$ → rearrange to give equation for t