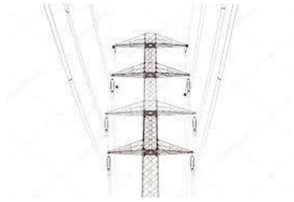
# HEAD BREAKING QUESTIONS

Things that make you go…what?

HIGHER LEVEL SYNOPTIC QUESTIONS

WHA PHYSICS
S McKelvie

A power pylon has 33Kv passing through a low resistance wire of 6KΩ. The wire is 149m long and reaches a temperature of $32^{0}$C. Calculate the power lost in the wires during transmission.



V = 33kV = 33,000V
R = 6kΩ = 6000Ω
P = P

V = I x R
V / R = I
33,000 / 6,000 = I
5.5A = I

$P = I^2 \times R$
$P = 5.5^2 \times 6000$
P = 181,500W

181.5 kW

Pylons are 95% efficient. How much time would it take to transfer 1.5MJ

P = 3,448.5kW = 3,448,500W
E = 1.5Mj = 1,500,000 J
t = t

P = E / t
t = E / P
t = 1,500,000 / 3,448,500
T = 0.43s

0.43 s

A toaster needs 64.12kJ to toast bread. It is plugged into the mains, and the heating element has a resistance of 0.076kΩ. How much time would it take to toast a slice of bread.


E = 64.12kJ = 64,120J
V = 230V
R = 0.076kΩ = 76Ω
t = t
I = 3.02A

V = I x R
V / R = I
230 / 76 = I
3.02A = I

E = V x I x t
E / (V x I) = t
64120 / (230 x 3.02) = t
92.31s = t
92.31 / 60 = 1.53 min

1.53 min

On Planet Steve, an object has 2.6MJ of KE was dropped from 1.3km. Calculate the mass of the object.

KE / GPE = 2.6MJ = 2,600,000J
Δh = 1.3km = 1300m
F or g = 2000N (N/Kg)

E = F x d
E / d = F
2,600,000 / 1300 = F
2000N = F

GPE = m x g x Δh
GPE / (g x Δh) = m
2,600,000 / (2000 x 1300) = m
1Kg = m

1 Kg

A Generator has an efficiency of 32% and produces 1.8kJ/s. What is the total amount of energy being transferred to the generator?

Eff. = 0.32
Use. = 1.8kJ/s = 1800W
Tot. = Tot.

Eff. = Use. / Tot.
Tot. = Use. / Eff.
Tot. = 1800 / 0.32
Tot. = 5625W or 5625J /s

5625 J

14% of the energy from the water is transferred in turbines. Deduce how much energy is in the flowing stream.

Eff. = 0.14
Use. = 5625J
Tot. = Tot.

Eff. = Use. / Tot.
Tot. = Use. / Eff.
Tot. = 5635 / 0.14
Tot. = 40,178.57

40.18 kJ

The Dam is 14m high and the water is 14ºC. Each particle of water has an internal energy store of 134.5pJ and oscillates at a frequency of 13GHz. Calculate the mass of the water flowing through the dam.

$\Delta h$ = 14m
m = m
g = 10N/kg
GPE = 40.18kJ = 40,180J

GPE = m x g x $\Delta h$
GPE / (g x $\Delta h$) = m
40,180 / (10 x 14) = m
287Kg = m

287 kg

Calculate the velocity of the water through the HEP stations.

m = 287Kg
KE = 40.18kJ = 40,180J
v = v

KE = 0.5 x m x $v^2$
v = $\sqrt{}$(KE / 0.5 x m)
v = $\sqrt{}$(40,189 / 0.5 x 287)
v = 16.73m/s

16.73 m/s

State whether these are series or parallel circuits. Explain your answer.

A: The power pack is set at 12V. There are two bulbs and 2 ammeters. One bulb has a voltage of 3V and a current of 1.2A.

The bulb has less voltage than total voltage
Must be in series because in parallel both bulbs would have 12V

B: The total voltage of this circuit is 9V and the total current is 3A. One bulb, when measured with an ohmmeter has a resistance of 2Ω. There are no smaller resistors than this one.

Resistance = voltage / current
Resistance = 9V / 3A
Resistance = 3Ω
Total resistance is more than 2Ω so must be in series.

C: The voltage over a bulb is 6V and the resistance is 0.51A. the voltage of an immersion heater is 14V and the resistance is 1.19Ω.

| Bulb | Heater | Must be in series as the current is the same. |
|---|---|---|
| V / R = I | V / R = I | |
| 6V / 0.51Ω = I | 14V / 1.19Ω = I | |
| 11.76A = I | 11.76A = I | |

An old generator produces 21Kj/min of useful energy with every litre of fuel used. Each litre of diesel contains 15,757J of chemical energy. What is the efficiency when the generator is filled with 3.3L of fuel and runs out in 2.5 mins ?

P = 21kJ / min = 0.35kW = 350W per lire
3.3L fuel = 51,998.1Kj / 2.5mins = 346, 653.3W
Use. = 350W
Tot. = 346,653.3W
Eff. = Eff.

Eff. = Use. / Tot.
Eff. = 350 / 346, 653.3
Eff. = 0.001

0.1 %

After lubrication with 3.5% m/vmmol silica lubricant, it is no 20% efficient. Calculate the useful energy output.

Eff. = 0.2
Use. = Use.
Tot. = 346, 653.3W

Eff. = Use. / Tot.
Use. = Tot. x Eff.
Use. = 346, 653.3 x 0.2
Use. = 69, 330W

69, 330 Js

A rocket is launched at 450m/s. The mass of the booster is 8 tonnes and the mass of the probe is 2.7 tonnes. How high did the rocket reach?

$v = 450 m/s$
$m = 8T + 2.7T = 10.7T = 10{,}700 Kg$
$\Delta h = \Delta h$

$KE = 0.5 \times m \times v^2$
$KE = 0.5 \times 10{,}700, \times 450^2$
$KE = 1, 083, 375, 000 J$

$GPE = m \times g \times \Delta h$
$KE = m \times g \times \Delta h$
$KE / (m \times g) = \Delta h$
$1{,}083, 375, 000 / (10, 700 \times 10) = \Delta h$
$10, 125 m = \Delta h$

10.125 km

What velocity would the rocket have to reach to achieve low earth orbit at 114km

$v = 450 m/s$
$m = 10{,}700 Kg$
$g = 10 N/Kg$
$\Delta h = 114 Km = 114, 000 m$

$GPE = KE$
$m \times g \times \Delta h = 0.5 \times m \times v^2$

$$\sqrt{\frac{m \ x \ g \ x \Delta h}{0.5 \ x \ m}} = v$$

$$\sqrt{\frac{10{,}700 \ x \ 10 \ x \ 114{,}000}{0.5 \ x \ 10{,}700}} = v$$

$1{,}509.96 m/s = v$

1,510 m/s

Mr Hewitt lifts a box of glue to a shelf. The box is 8.6kg and the shelf is 1.6m high. How much energy was transferred in the process?

m = 6.8Kg
d = 1.6m
E = E
F = 68N

W = m x g
W = 68N
E = F x d
E = 68 x 1.6
E = 108.8J

108.8 J

This proved too much, and Mr Hewitt hurt his back. He rigged a motor to the mains electricity and included a 3A fuse for safety. What would be the minimum time that the motor would need to lift the box.

v = 230V
I = 2.99A
E = 108.8J
t = t

E = V x I x t
E / (V x I) = t
108.8 / (230 x 2.99) = t
0.158s = t

0.16 s

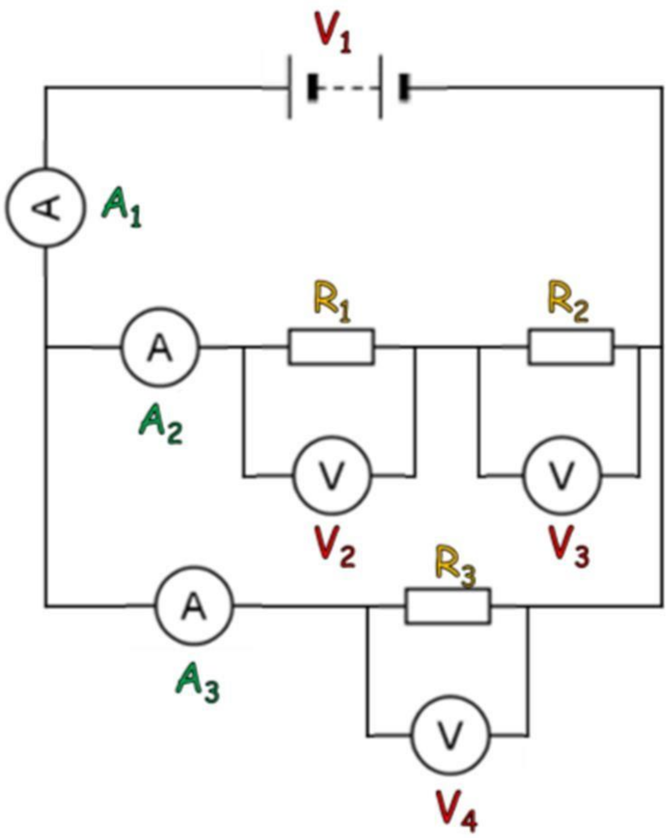
The efficiency of the motor is only 5%. How long would it actually take to lift the box?

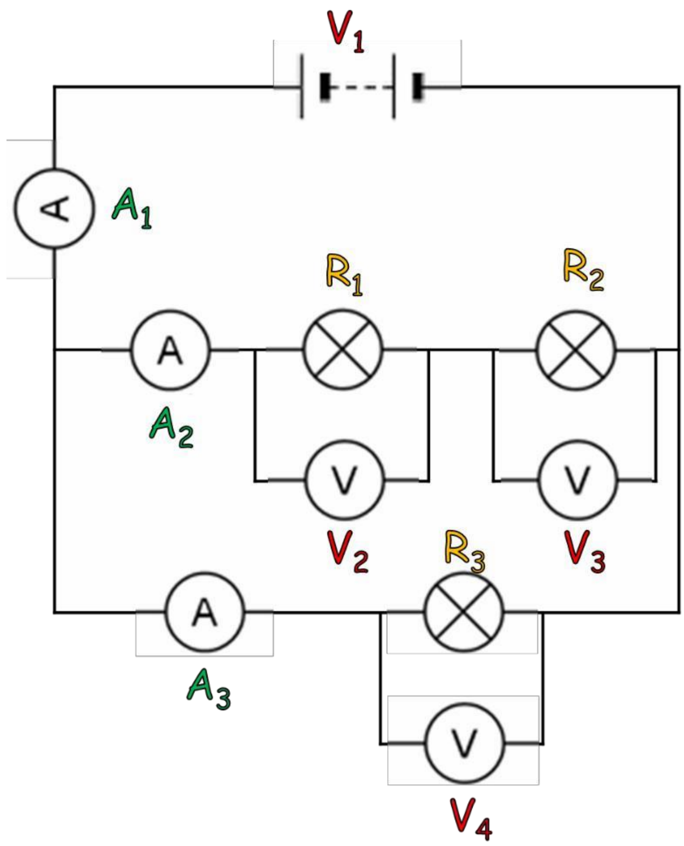
Eff. = 0.05
Use. = 108.8J
Tot. = Tot.
V = 230V
I = 2.99A

Eff. = Use. / Tot.
Tot = Use. / Eff.
Tot. = 108.8 / 0.05
Tot. = 2176J

E = V x I x t
E / (V x I) = t
2176 / (230 x 2.99) = t
3.154s = t

3.15 s




The power pack gives 12V to the circuit.

The resistor $R_3$ has a rating of 10Ω. Calculate the current in $A_3$.

$V = 12V$
$I = I$
$R = 10\Omega$

$V = I \times R$
$I = V / R$
$I = 12 / 10$
$I = 1.2A$

1.2 A

The current shown in $A_1$ is 2.5A. Calculate the current in $A_2$.

$I_{TOT} = I_1 + I_2$
$I_{TOT} = 2.5A$
$I_1 = I$
$I_2 = 1.3A$

1.3 A

$V_2$ shows a rating of 5V. Calculate the calculate the value of $R_1$.

$V = 5V$
$I = 1.3A$
$R = R$

$V = I \times R$
$V / I = R$
$5 / 1.3 = R$
$3.85\Omega = R$

3.85 Ω

Calculate the value of $R_2$.

$V_{TOT} = V_1 + V_2$
$V_{TOT} = 12V$
$V_1 = 5V$
$V_2 = 7V$

$V = 7V$
$I = 1.3A$
$R = R$

$V = I \times R$
$V / I = R$
$7 / 1.3 = R$
$5.38\Omega = R$

5.38 Ω

Calculate the resistance in the whole circuit.

$V = 12V$
$I = 2.5A$
$R = R$

$V = I \times R$
$V / I = R$
$12 / 2.5 = R$
$4.8\Omega = R$

4.8 Ω

Show the potential difference of the complete circuit is 12V.

$V = V$
$I = 2.5A$
$R = 4.8\ \Omega$

$V = I \times R$
$V = 2.5 \times 4.8$
$V = 12V$

12V V

Explain why the resistance of the circuit is less than 10Ω.

The potential difference is the same across the resistors but in parallel the current has more than one route this increases the total current around the loop which decreases the resistance using V=IR

Calculate the power transferred in the circuit using the voltage and current in the circuit.

$P = P$
$I = 2.5A$
$V = 12V$

$P = I \times V$
$V = 2.5 \times 4.8$
$V = 12V$

12V W

Using the power rating, show the total resistance of the circuit is less than 10Ω.

_______W

The Power of the circuit decreased by 50% when the filament lamps were added. Calculate the new current at $A_1$.

_______A

Calculate the current at $A_2$.

_______A

$V_2$ shows a rating of 4V, calculate the resistance in $R_1$.

________Ω

Calculate the resistance of the filament lamp in $R_2$.

________Ω

Explain why the resistance of the filament lamps has increased.

Using the equation $P=I^2R$, calculate the resistance of the complete circuit.

________Ω

Using the rules of resistance in series and parallel circuits, confirm this calculation is correct.

The dancing minion has a power rating of 6W.

Calculate the amount of energy transferred in 2 minutes of dancing.

________J

The minion is powered by a 2V button battery, calculate the current.

________A

What is the energy transferred if the minion dances for 6 minutes?

________J

After 6 minutes the chemical store of the battery has reduced, the current is now 2A, calculate the charge flowing in the circuit.

________C

The new voltage is 1.5V. Calculate the energy transferred in the 6 minutes.

________J

Calculate the resistance in the circuit after the battery depleted.

________Ω

The dancing minion is replaced with a new 2V battery. The power rating is now 8W. Calculate the time taken to transfer 1000J of energy if the charge is 20C.

________J

Notes