**O Level Combined Physics Structured**

**Energy, Work Done and Power Test 1.0**

Q1

A lorry of mass $4.4 \times 10^4$ kg travels along a straight, horizontal road at 20 m/s.

**(a)** Calculate the kinetic energy of the lorry.

kinetic energy = ................................ [2]

**(b)** The lorry driver sees an obstruction ahead and applies the brakes. The lorry slows down and comes to a stop. The lorry stops at a distance of 40 m from where the driver first applies the brakes. This distance is known as the braking distance, *d*.

As the lorry slows down, work is done by the braking force, $F_b$, exerted on the lorry.

**(i)** State the formula that relates work done to the average braking force.

............................................................................................................[1]

**(ii)** Calculate the average braking force exerted on the lorry.

average braking force = ................................[2]

**(c)** The lorry has a total of 6 wheels. The contact area of each wheel with the ground is 355 $cm^2$.

Calculate the pressure exerted by the lorry on the ground, leaving your answer in Pa. The gravitational field strength is 10 N/kg.

pressure = ................................[2]

Q2

Fig 5.1 shows a pump in a hydroelectric plant that is used to transport water up a hill at night to a reservoir.

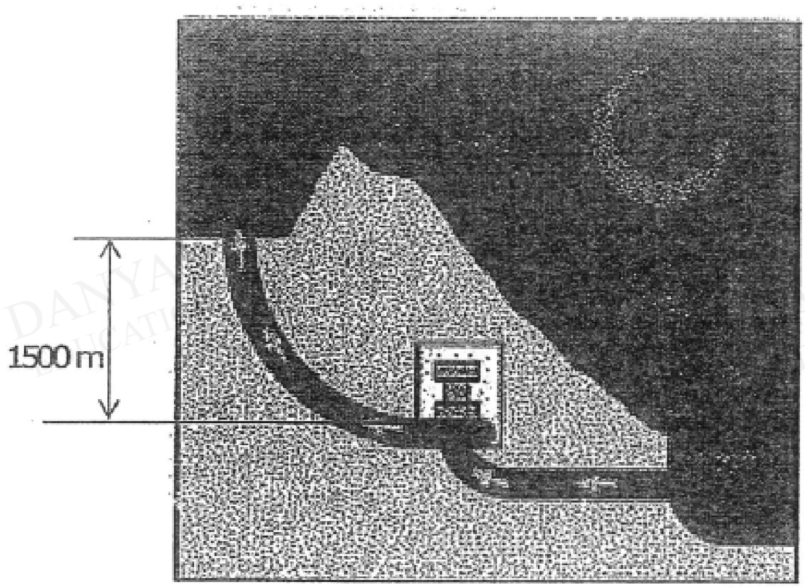



Fig 5.1

(a) The pump handles $1.60 \times 10^6$ kg of water every second. Calculate the rate of work done by the pump in transporting the water to the reservoir.

rate of work done = .................. J/s [2]

**(b)** Fig 5.2 shows the same hydroelectric plant where water from the reservoir is used to generate electricity in the day by turning turbines in the plant.

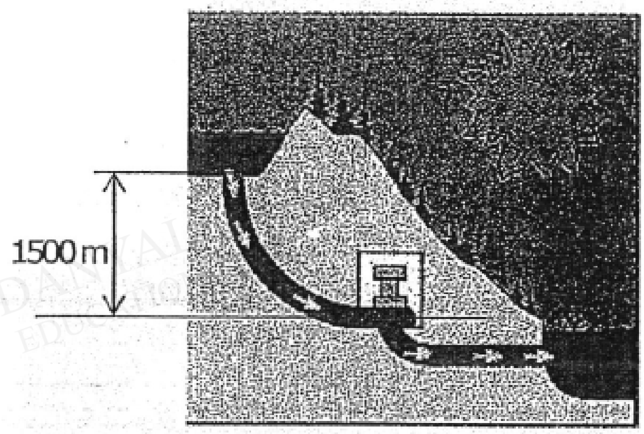



**Fig 5.2**

Given that $7.2 \times 10^9$ W of power is wasted due to frictional losses, calculate the rate of kinetic energy converted and hence the speed of the water just before it hits the turbines. Assume the turbine also handles $1.60 \times 10^6$ kg of water every second.

rate of kinetic energy = ................................... J/s

speed of water = ................... m/s [3]

Q3

A car of mass 1000 kg is moving at 20 m/s along a straight horizontal road.

**(a)** Calculate the kinetic energy of the car.

kinetic energy = ..................................[1]

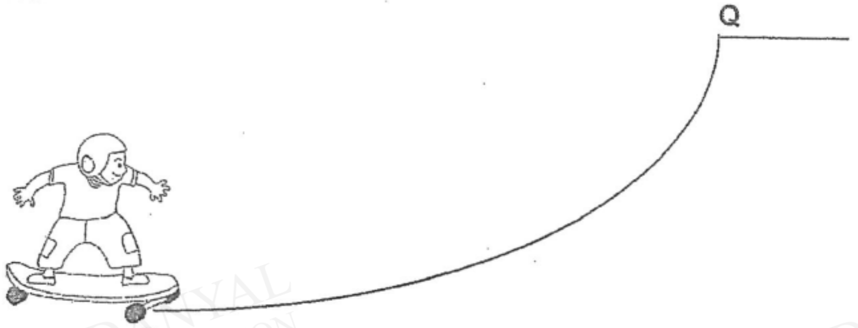
**(b)** The car is stopped by a constant braking force in a distance of 40 m.

Calculate the size of this braking force, stating clearly how you arrive at your answer.

braking force = ................................ [3]

Q4

A boy on a skateboard has a total mass of 65 kg. He glides up to the top of a slope with a certain amount of kinetic energy at point **P**. The height at the top of the slope, **Q** is 3 m.




Assume air resistance is negligible,

a) Calculate the total gain in potential energy when the boy reached **Q**, the top of the slope. [2]

gain in potential energy = .................................. J

b) State the kinetic energy of the boy at point **P**. [1]

..........................................................................................................................

c) Calculate the speed of the boy at point **P**. [2]

speed = .............................. m/s

d) In reality, the speed of the boy at point **P** will be higher than the value calculated in part c). Explain why. [1]

..........................................................................................................................

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Q5

A water pump lifts 500 kg of water every minute from a well 25 m deep. The gravitational field strength is 10 N/kg.

**(a)** Calculate the gravitational potential energy gained by the water every minute.

gravitational potential energy = ................ J [2]

**(b)** What power was used to lift the water from the well?

Power = ................. W [2]

**(c)** In a practical situation, the pump needs to produce more energy per minute than the value calculated in (a) in order to lift the water. Explain why this is so.

..........................................................................................................

..........................................................................................................[1]

**Answers**

**Energy, Work Done and Power Test 1.0**

Q1

| | | | | |
|---|---|---|---|---|
| (a) | KE = | $\frac{1}{2}mv^2$ | | |
| | = | $\frac{1}{2} \times 4.4 \times 10^4 \times 20^2$ | | C1 |
| | = | 8.8 MJ | | A1 |
| (b)(i) | work done = average braking force x braking distance<br>Or work done = $F_b \times d$ | | | B1 |
| (ii) | average braking force x 40 = | $8.8 \times 10^6$ | Allow ECF from (a) | C1 |
| | average braking force = | 220 kN | | A1 |
| (c) | P = | $\frac{F}{A}$ | | |
| | = | $\frac{4.4 \times 10^4 \times 10}{6 \times 355 \times 10^{-4}}$ | | C1 |
| | = | $2.07 \times 10^6$ Pa | Award 1 mark if students did every correct calculation and left answer in $N/cm^2$ | A1 |

Q2

| | | |
|---|---|---|
| 5a) | Rate of work done = mgh / t = (m/t) g h = $(1.60 \times 10^6)(10)(1500)$<br>$= 2.4 \times 10^{10}$ J/s | |
| b) | GPE converted to KE and heat loss<br><br>In 1 second:<br>GPE = KE + $7.2 \times 10^9$<br>$2.4 \times 10^{10}$ = KE + $7.2 \times 10^9$<br>KE = $1.68 \times 10^{10}$ J/s<br><br>$\frac{1}{2}(1.6 \times 10^6)v^2 = 1.68 \times 10^{10}$<br>v= 145 m/s | 1<br><br>1<br>1 |

Q3

a KE = ½ $mv^2$
= ½ x 1000 kg x $(20 \text{ m/s})^2$
= **200 kJ**

b Work done by braking force on the car = KE of the car
F x 40 m = 200 000J
Braking force = 200 000J / 40m
= **5 000 N**



Q4

a) Gain in PE = mgh = 65 x 10 x 3 [1] = 1950 N

b) K.E = 1950N

c) 1950 = ½ $(65)v^2$ [1] ➔ v = 7.75 m/s [1]

d) Some K.E is needed to convert to friction with the ground and other wasted energy when moving up the slope. [1]

Q5

| | | |
|---|---|---|
| (a) | Gain in G.P.E, $E_p$ = m g h<br>= 500 x 10 x 25<br>= 125 000 J or 130 000 J<br>= 125 kJ or 130 kJ | <br>[1]<br>[1] |
| (b) | Power, P = $\frac{E}{t}$<br>= $\frac{125000}{60}$<br>= 2080 W or 2100 W | <br>[1]<br>[1] |
| (c) | There is energy losses due to friction in the operation of the pump. | [1] |