PHYSICS FORMULA & Questions

P1 – Motion

Speed (m/s)

$$\text{Average Speed} = \frac{\text{Total distance}}{\text{Total time}}$$

$$v = \frac{s}{t}$$

v = average speed

s = total distance

t = time (ie. time taken)

Acceleration (m/s²)

$$a = \frac{v - u}{t}$$

v = final speed (m/s)
u = initial speed (m/s)
t = time taken (s)

When initial velocity is zero:

$$s = \tfrac{1}{2} a t^2$$

LEARN

s = distance in m

a = acceleration in m/s^2

t = time in s.

When initial velocity is zero.

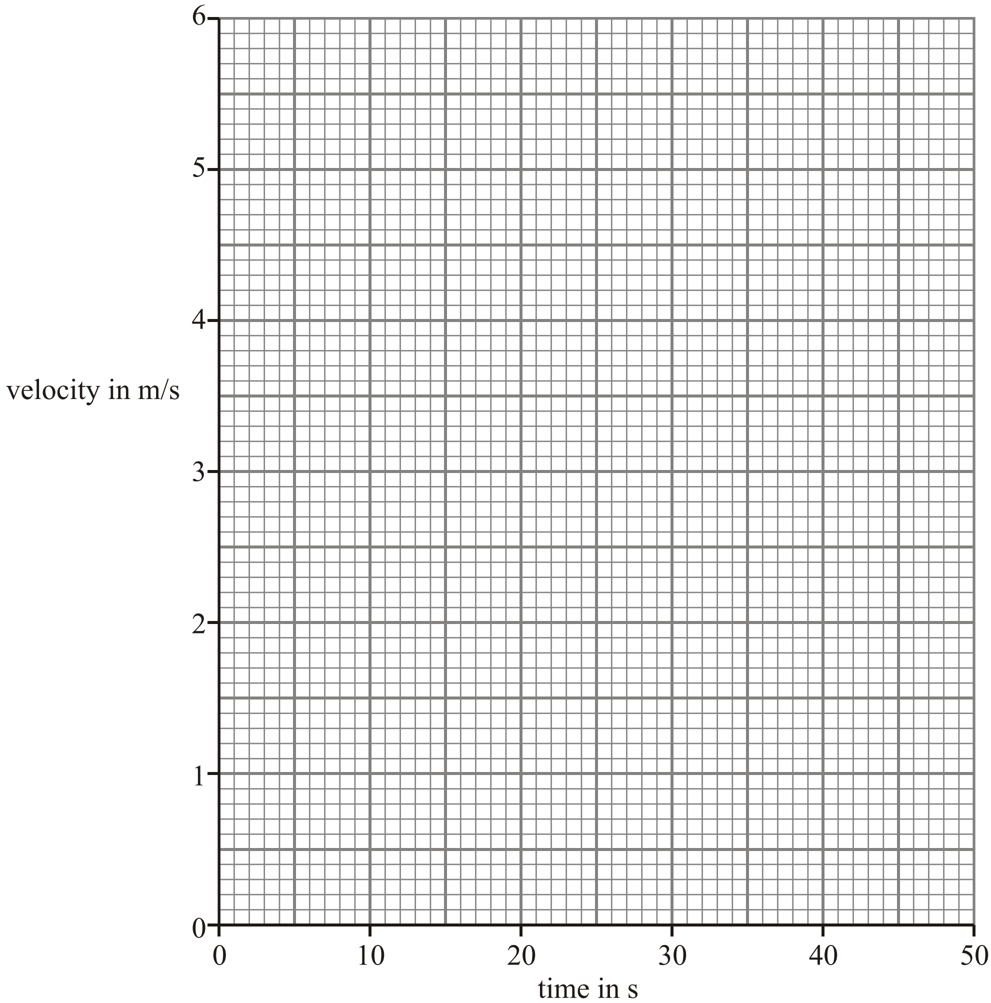
1.

A train accelerates from rest along a straight track.

The table shows how the train's velocity changes with time.

time (s)	0	10	20	25	30	40
velocity (m/s)	0	2	4	4.5	5	5

(a) Use the grid to draw a graph of velocity against time.



(2)

(b) What is the train's velocity at 15 s?

....

(1)

(c) (i) State the equation for acceleration in terms of velocity and time.

....

(1)

(ii) Calculate the acceleration of the train in the first 15 s.

....

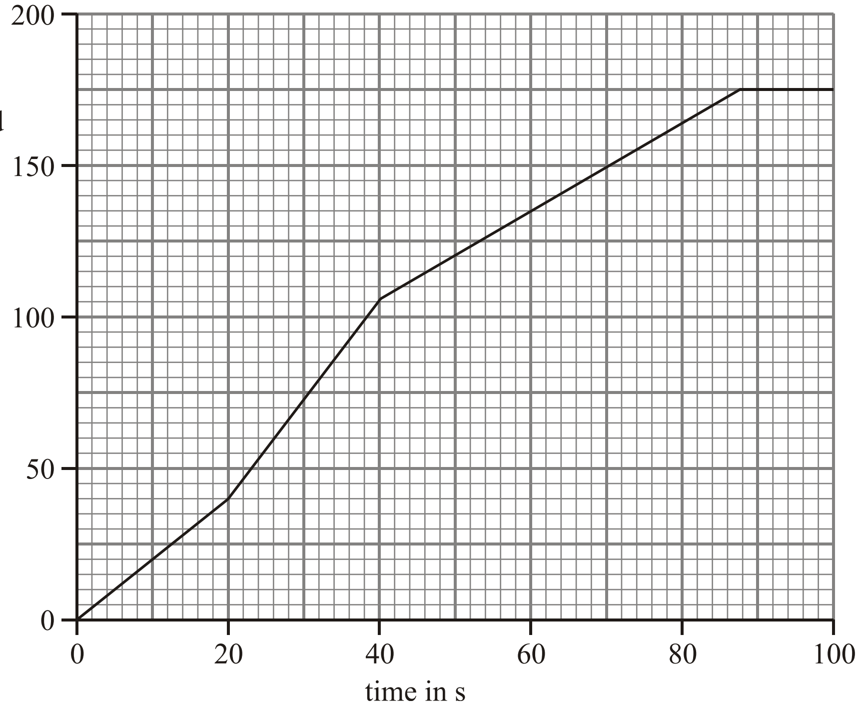
....

....

(2)

(Total 6 marks)

2. A man walks from home to a bus stop.



Use this distance-time graph to answer the questions.

(a) (i) How far did the man walk during the first 20 s of his journey?

....

(1)

(ii) How can you tell that the man's speed increased after 20 s?

....

(1)

(b) The bus stop is 175 m from the man's home.

(i) How long did it take him to walk to the bus stop?

....

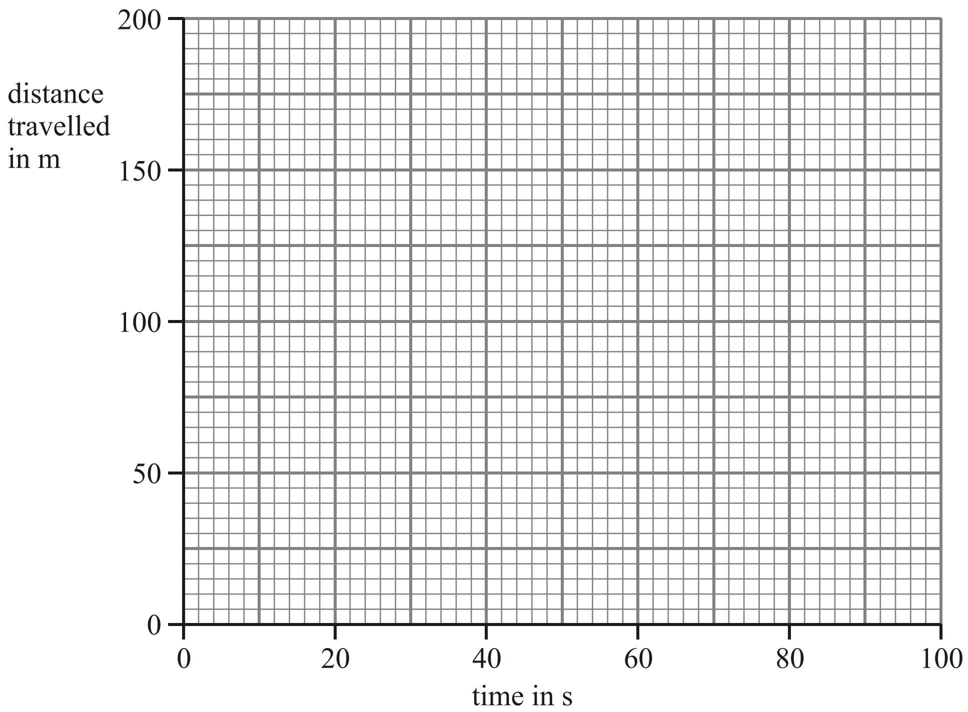
(1)

(ii) How can you tell that he stopped moving when he reached the bus stop?

....

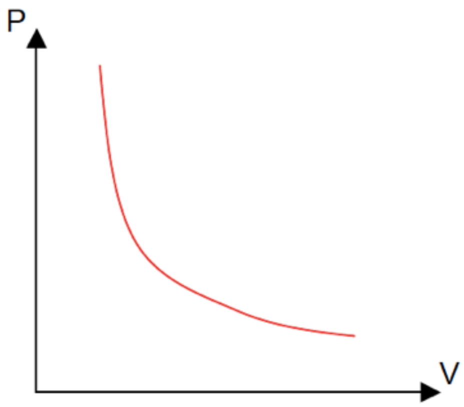
(1)

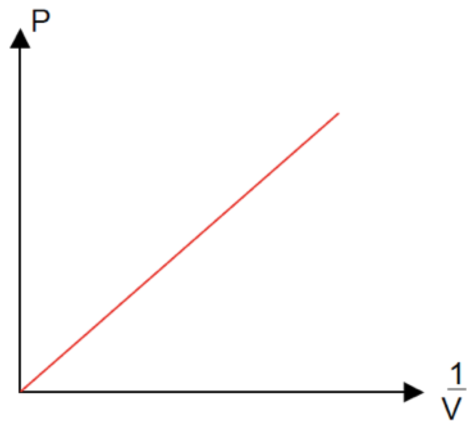
(c) Later in the day the man walks from the bus stop to his home.
He walks at a steady (constant) speed and reaches home after 96 s.
Use the grid below to draw a distance-time graph for his walk home.



(3)
(Total 7 marks)

P2 – Kinetic model





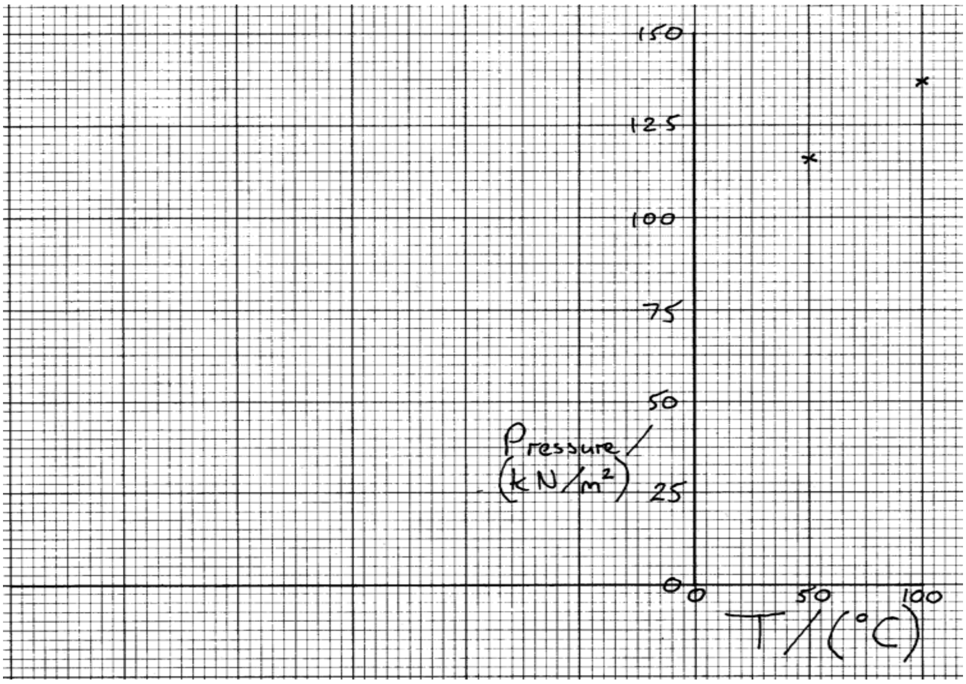
$$P_1V_1 = P_2V_2$$

This is called Boyle's Law

1.
A cylinder of oxygen has a volume of 20 litres and contains gas at a pressure of 10^6 Pa (1,000,000 Pa). What would be the volume of this gas at normal atmospheric pressure (100,000 Pa)?

2. A gas was heated in a round-bottomed flask. The container was sealed and the gas pressure and temperature were recorded.

Temperature (^0C)	0.0	30.0	50.0	70.0	100.0
Pressure (kN/m^2)	95	108	116	123	143



a. Plot the remaining 3 points on the graph and draw the line of best fit:

(3)

b. Using the graph at what temperature will the pressure of the gas be zero?

(1)

c.

i. At what temperature would you expect the pressure of the gas to be zero, not using the graph? ________________ ^0C

(1)

ii. What is the equivalent temperature in K? _______________

(1)

iii. What has happened to the particles of the gas?

____

(1)

3. Use the kinetic theory of gases to explain why the pressure exerted by an ideal gas increases when it is heated at constant volume,

....

....

………

………

P3 – Electricity

One coulomb is the charge passing any point in a circuit when a steady current of 1 ampere flows for 1 second.

$$Q = I \times t$$

$$V = \frac{E}{Q}$$

A potential difference of 1 Volt means that each Coulomb of charge will have one Joule of energy.

$$V = IR$$

Ohm's Law

$$P = \frac{E}{t}$$

Power is defined as how much energy you transfer per unit time (W, watts)

$$R \propto \frac{l}{A}$$

$$P = IV$$

$$E = VIt$$

Resistance in wire proportional to the length and inversely proportional to its cross-sectional area.

1. Some torches (flashlights) use a filament lamp. Fig. 12.1 shows a circuit for measuring the current through a filament lamp as the potential difference is changed.

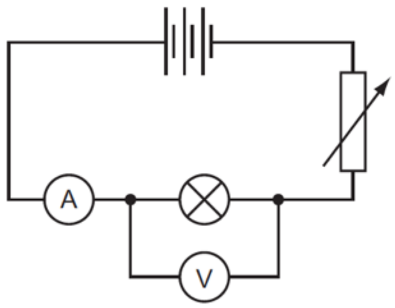


Fig. 12.1

Fig. 12.2 shows a graph of the results from an experiment using this circuit.

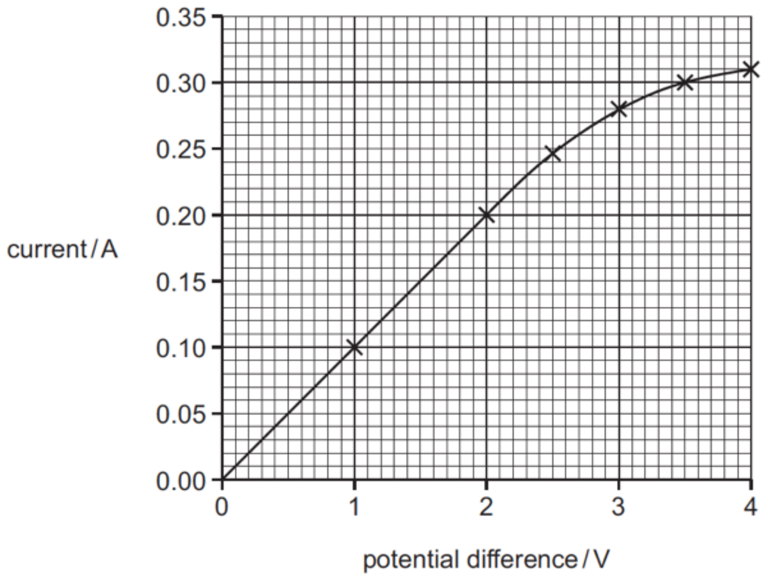


Fig. 12.2

(i) Use the graph to calculate the resistance of the lamp when the potential difference was 2.0 V and when the potential difference was 4.0 V.

State the formula that you use and show your working.

formula used

working

resistance at 2.0 V ....

resistance at 4.0 V .... [2]

(ii) Describe how the current through the filament lamp changes as the voltage increases above 2.0 V.

....

.... [1]

(iii) Use your answer to **(i)** to explain why the current changes in this way.

2. A plastic toy car is being pushed along a plastic surface.

While the car is moving, the wheels are rubbing against the plastic surface. The car becomes electrostatically charged with a positive charge.

Explain how this happens.

....

....

....

....

.... [3]

3. Fig. 10.1 shows a battery with an e.m.f of 12 V supplying power to two lamps.

The total power supplied is 150 W when both lamps are on.

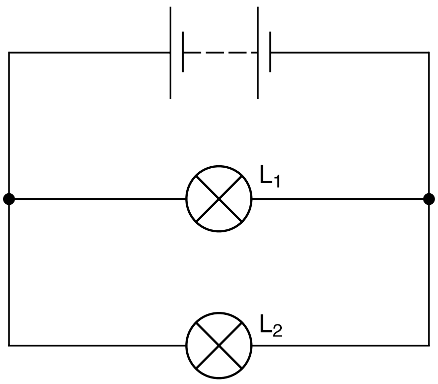


Fig. 10.1

(a) Calculate the current supplied by the battery when both lamps are on.

current = ... [2]

(b) The current in lamp L_2 is 5.0 A.

Calculate

(i) the current in lamp L_1,

current = ...

(ii) the power of lamp L_1,

power = ...

(iii) the resistance of lamp L_1.

resistance = ...
[6]

4.

A student compares three different metal wires to see which is the best conductor of electricity. She passes a current of 0.4 A through each wire in turn and measures the voltage required.

Table 1.1 shows her results.

Table 1.1

wire	voltage / V
A	0.3
B	2.6
C	6.2

(a) Which wire is the best conductor of electricity?

Explain your answer.

....

.... [2]

(b) Calculate the resistance of wire **A**.

State the formula that you use and show your working.

formula used

working

.... [2]

(c) While doing the experiment the student notices that all of the wires get hot.

(i) Calculate the power consumption in wire **C**.

State the formula that you use and show your working.

formula used

working

.... [2]

(ii) Use your answer to **(i)** to suggest which wire gets the hottest.

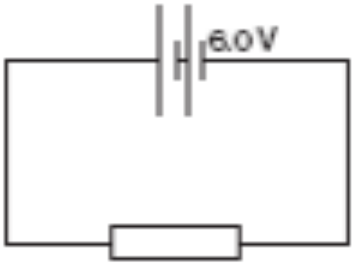
Give a reason for your answer.

....

.... [1]

(d) Calculate the quantity of charge which flows through wire **B** in one minute.

5.
A battery has a resistor connected across its terminals. The e.m.f. of the battery is 6.0V.



The battery causes 90C

(a). Calculate

(i). the current in the circuit,

Current = ……………………..

(ii). the resistance of the circuit,

Resistance = …………………

(iii). the electrical energy transformed in the circuit in 45s,

Energy = ……………………..

(6)

(b). Explain what is meant by the term *e.m.f. of the battery*.

……

……

……

(2)

SERIES CIRCUIT:

In a series circuit the current is the same in all places in the circuit.

$$I_1 = I_2 = I_3$$

In a series circuit the sum of the voltages across each element will equal the total voltage.

$$V_1 + V_2 = V_{total}$$

$$R_T = R_1 + R_2 + \ldots$$

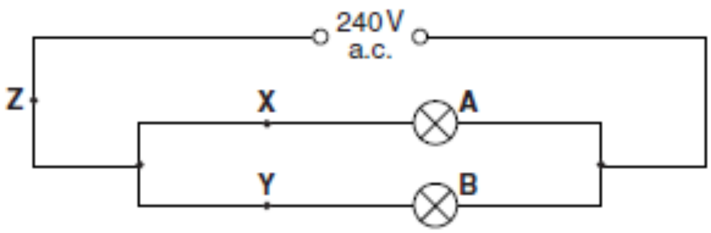
PARALLEL CIRCUIT:

The total current arriving at a junction = the total current leaving the junction. **A1 = A2 + A3**

The potential difference across each branch of a parallel circuit is the same

$$R_T = \frac{R_1 R_2}{R_1 + R_2}$$

1. The figure below shows how two security lamps are connected to a mains supply.



Lamp **A** is labelled 240 V, 600W and lamp **B** is labelled 240 V, 300W.

(a) Calculate the currents at points **X**, **Y** and **Z**.

current at **X** = ...

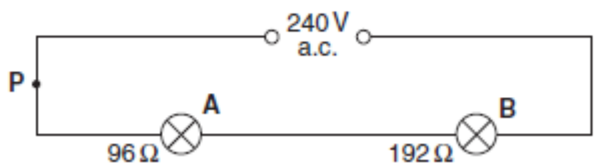
current at **Y** = ...

current at **Z** = ... [2]

(b) The resistance of lamp **A** is 96Ω and the resistance of lamp **B** 192 Ω. Using these
values, or by an alternative method, calculate the total circuit resistance. (Ignore the
resistance of the circuit wiring.)

resistance = ... [3]

(c) The next figure 2 shows the same lamps connected differently.



(i) Calculate the current at **P**.

current at **P** = ...

(ii) Calculate the potential difference across **A** and across **B**.

potential difference across **A** = ...

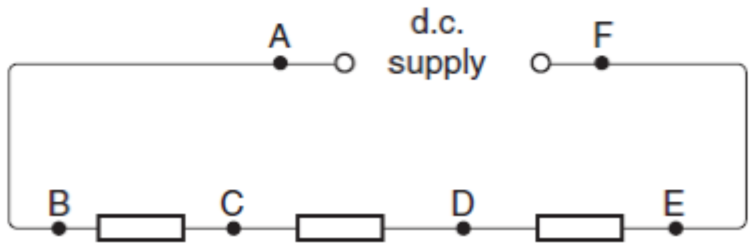
potential difference across **B** = ...
[3]

(d) (i) With reference to values already worked out, explain why the lamps should be
connected as in the first figure and not the second figure.

(ii) The two lamps are to be switched on and off independently. State and explain
which circuit is better for this purpose when suitably placed switches are included.

[4]

2. Three identical resistors are connected in series as shown below.



A) If the current at point C is 2.0 A what is the current at point D?
_________________ [1]

B) State the ratio of the potential difference between points A and D compared to the potential difference between points F and D. (i.e. calculate V_{AD}/V_{FD}) [2]

C) The potential difference between B and C is 8.0 V. The middle resistor is replaced by a resistor with a lower resistance. What will happen to the potential difference between B and C? (Select one)
[1]

- ○ It will go down
- ○ It will stay the same
- ○ It will go up

D) Justify your answer to part C)

[2]

3.

(a) Fig. 10.1 shows the current being measured in different parts of a circuit, which includes three identical lamps and three ammeters, **P**, **Q** and **R**.

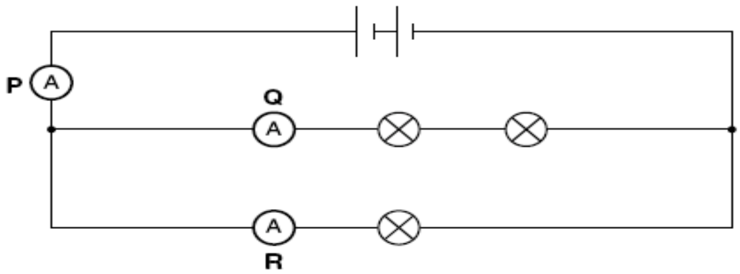


Fig. 10.1

(i) Which ammeter, **P**, **Q** or **R**, shows the largest current?

Explain your answer.

....

.... [2]

(ii) Which ammeter, **P**, **Q** or **R**, shows the smallest current?

Explain your answer.

....

.... [2]

(b) Fig. 10.2 shows a similar circuit, containing three identical resistors but no ammeters.

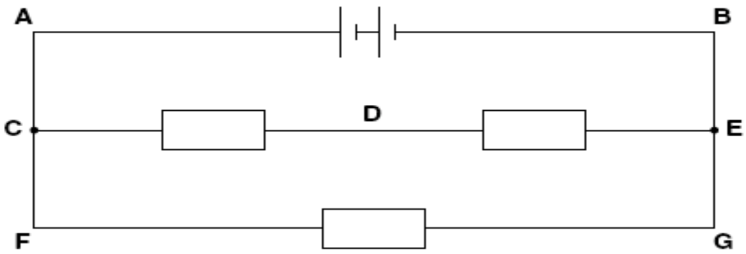


Fig. 10.2

(i) A voltmeter connected across **AB** reads 3 V.

What would the voltmeter read when connected across

CD, ……………………

FG? …………………… [2]

(ii) The current through **CD** is 0.1 A.

Calculate the resistance of one resistor.

Show your working and state any formula that you use.

.... [2]

(iii) Calculate the total resistance of the circuit between **C** and **E**.

Show your working and state any formula that you use.

.... [2]

P11 – Electromagnetism

Transformers:

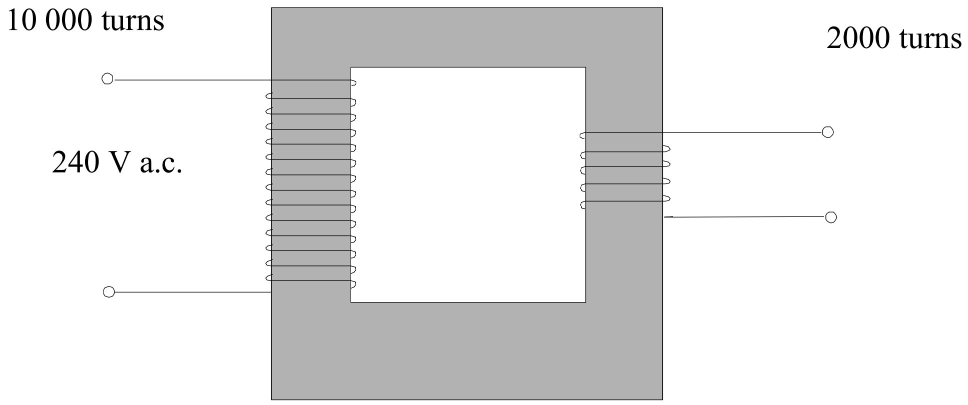
$$\frac{N_p}{N_s} = \frac{V_p}{V_s}$$

Input Power = Output Power

$$V_p I_p = V_s I_s \quad ? \text{W}$$

(a) An appliance in a house has a transformer. The transformer is used to reduce the voltage to the level needed by the appliance.

The diagram shows the transformer.



(i) Suggest a suitable material for the core of the transformer.

(1)

(ii) The transformer has 10 000 turns on the input side and 2000 turns on the output side. If the mains voltage of 240 volts is applied to the input, calculate the output voltage.

....

....

....

(3)

P4/P10 – Light and Sound

wave speed = frequency x wavelength

$$V = f\lambda$$

the wave equation

(a) A signal generator connected to a loudspeaker produces a sound wave. With the frequency of the signal generator set to 2000 Hz the sound wave has a wavelength of 0.17 m in air.

Calculate the speed of sound in air.

Speed ....

(3)

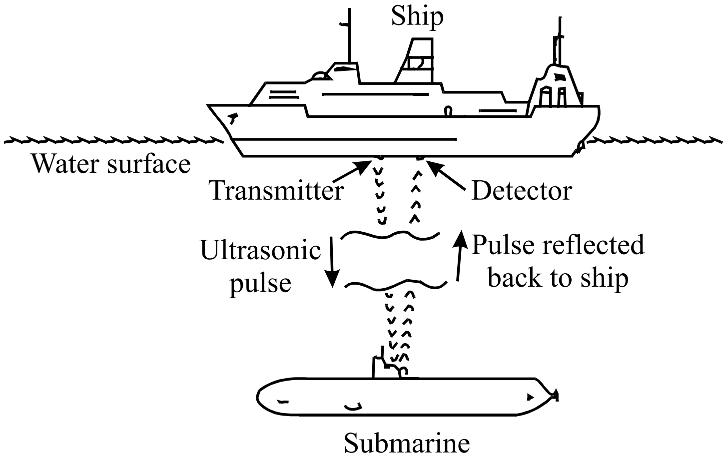
(b) The speed of sound in water is 1400 m/s.

A sound wave has a frequency of 2000 Hz. Calculate its wavelength in water.

Wavelength ....

(3)

(c) Echo sounders are used at sea to locate underwater objects, such as submarines.
The diagram below shows how an echo sounder works.



(i) What are ultrasonic waves?

....

....

(ii) The pulse travels from the transmitter to the submarine and back to the detector. The time taken is 0.1 s.

Calculate the distance between the submarine and the ship.

Distance ....

(6)

(Total 12 marks)

P5 – FORCES & DENSITY

DENSITY = MASS / VOLUME	**Mass** "resists" change in motion

$$W = mg$$

WEI
the force of gra

Hooke's Law **The extension of a spring is proportional to the load**

F = kx

extension = (stretched length) - (unstretched length)

Force = mass x acceleration

F= ma

Pressure = $\frac{\text{Force}}{\text{Area}}$

$P = \frac{F}{A}$

1. A rectangular block of metal is 50mm long, 40mm wide and has a thickness of 5mm. It weighs 0.25N.

Calculate:

a) the volume of the piece of metal

(2)

b) the density of the metal

(3)

c) the pressure on the table when on its largest surface

(3)

2. The acceleration of free fall near the surface of the Earth is 9.8 m/s^2.

The acceleration of free fall near the surface of the Moon is 1.6 m/s^2.

Calculate the weight of an object of mass 6.0kg

(i) near the surface of the Earth,

(2)

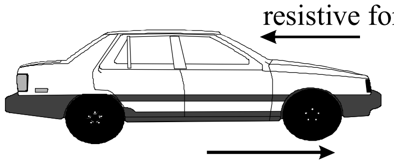
(ii) near the surface of the Moon.

(2)

3. What causes a moving body to resist a change in its state of motion?

..

4. The diagram shows the forces on a car travelling along a level road.



(a) How can you tell that the car is accelerating forwards?

(1)

(b) The total mass of the car is 850 kg.

Calculate the acceleration of the car.

(3)

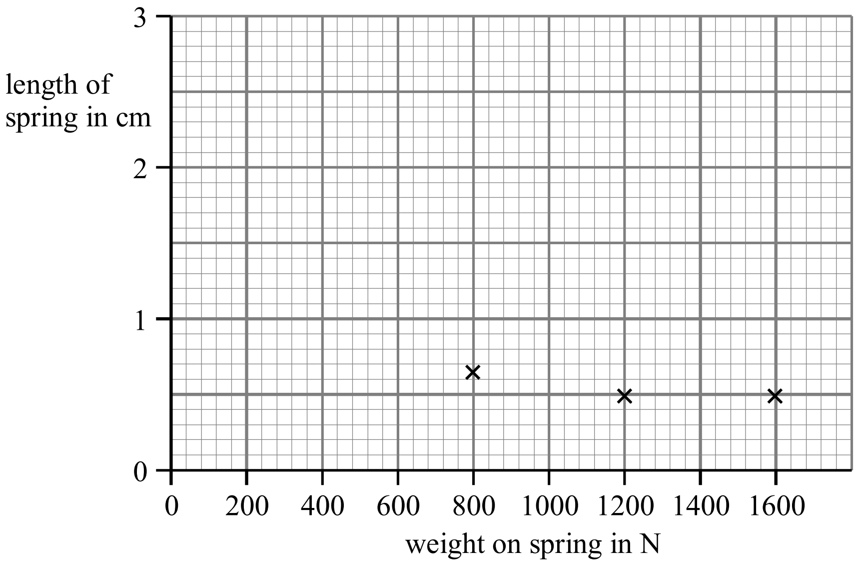
(c) Explain how the horizontal forces on the car change when the driver takes her foot off the accelerator and applies the brake.

(3)

5. Springs can be used to measure weight. The table contains data about a spring inside bathroom scales for weighing people.

weight (N)	**length (cm)**
0	2.40
200	1.85
400	1.30
600	0.85

(a) Use the data in the table to complete the graph.



(3)

(b) What happens to the spring when someone stands on the scales?

....

(1)

(c) How long is the spring when a boy who weighs 500 N stands on the scales?

.... cm

(1)

(d) How long is the spring after the boy steps off the scales?

.... cm

(1)

(e) Suggest why the spring does not change in size when the weight on it increases from
1 200 N to 1 600 N.

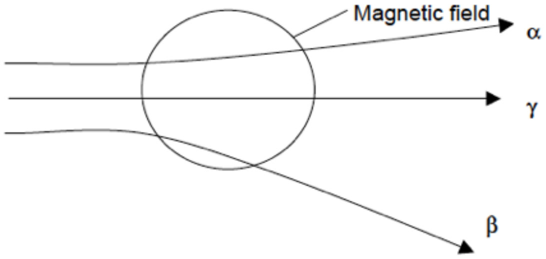
(1)

(f) How could the scales be adapted to measure the weight of people who are heavier than 1 200 N?

(1)

P6 – NUCLEAR PHYSICS

Type	Relative Charge	Relative Mass	Nature	Penetrating ability	Range in air	Ionising ability
α particles	positive (+2) deflected by electric and magnetic fields	4 a.m.u.	helium nucleus (2 protons and 2 neutrons)	absorbed by skin or a sheet of paper	a few cm	very great (10^5 ion pairs per cm)
β particles	negative (-1) deflected by electric and magnetic fields	1/1840 a.m.u.	electron	absorbed by a few mm of aluminium	a meter or so	much less than α particle (100 ion pairs per cm)
γ rays	none undeflected by electric and magnetic fields	none	electro-magnetic radiation of very short wavelength	very penetrating absorbed by thick lead or concrete	very high	very low



Alpha Decay can be represented by the equation below.

$$^{238}_{92}U \longrightarrow {}^{4}_{2}He + {}^{234}_{90}Th$$

$^{4}_{2}He$ represents an alpha particle.

Beta Decay: a high E electron is emitted

$$^{14}_{6}C \longrightarrow {}^{0}_{-1}e + {}^{14}_{7}N$$

Half life is the time taken for the number of unstable atoms of a particular isotope to become **half** the original number. It does not matter how many atoms you start with, after 1 half life, half the atoms have decayed.

1. Complete the table below, for each constituent of the atom:

Name of Particle	Charge (relative)	Location	Mass (relative to neutron)
Neutron			___
		In nucleus	About the same
Electron	-1		

[2]

6. Thorium-228 and thorium-230 are two radioactive isotopes with half lives of 1.9 years and 80 000 years respectively.

a) Using a periodic table, determine how many protons, neutrons and electrons there are in one atom of thorium-228.

Protons ____________________ Neutrons _________________________ Electrons _________________

[3]

b) With reference to thorium-228 and thorium-230, explain the meaning of the word *isotope*.

____

____

____

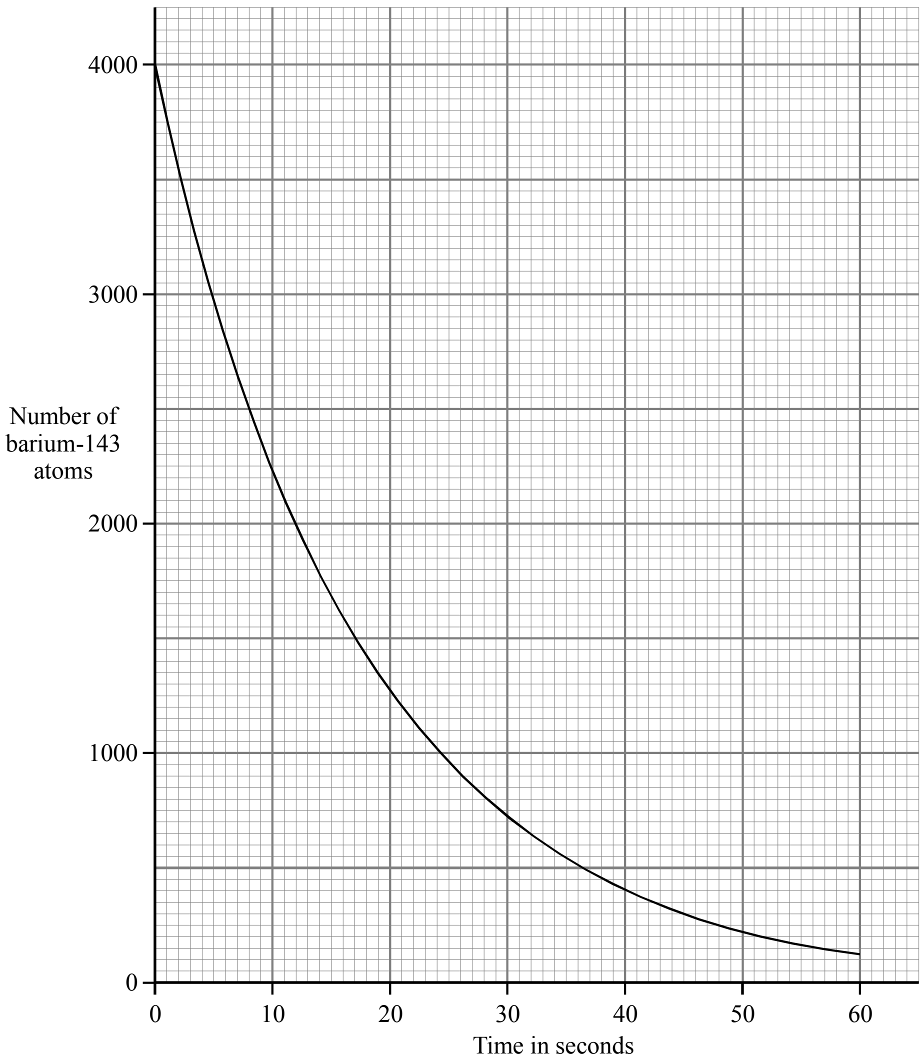
[2]

c) A sample of thorium-228 of mass 16g was stored for 10 years. Calculate the mass of thorium-228 that will remain after 5.7 years. Show your working.

228
Th
90

[2]

2. (a) The graph shows how a sample of barium-143, a radioactive *isotope* with a short *half-life,* decays with time.



(i) What is meant by the term *isotope?*

(2)

(ii) Use the graph to find the half-life of barium-143.

Half-life = ... seconds

(1)

(b) Humans take in the radioactive isotope carbon-14 from their food. After their death, the proportion of carbon-14 in their bones can be used to tell how long it is since they died. Carbon-14 has a half-life of 5700 years.

(i) A bone in a living human contains 80 units of carbon-14. An identical bone taken from a skeleton found in an ancient burial ground contains 5 units of carbon-14. Calculate the age of the skeleton. Show clearly how you work out your answer.

Age of skeleton = ... years

(2)

(ii) Why is carbon-14 unsuitable for dating a skeleton believed to be about 150 years old?

(1)
(Total 6 marks)

P7 – WORK and POWER

Work done = Force x Distance

or W = F x d

POWER Power is the rate at which work is done. It is the amount of work done in 1 second. You already met this idea in P3.

$$\text{Power} = \frac{\text{Work done}}{\text{Time taken}} = \frac{\text{Energy transferred}}{\text{Time taken}}$$

P = W/t or E/t

KINETIC ENERGY

$$KE = \frac{1}{2}mv^2$$

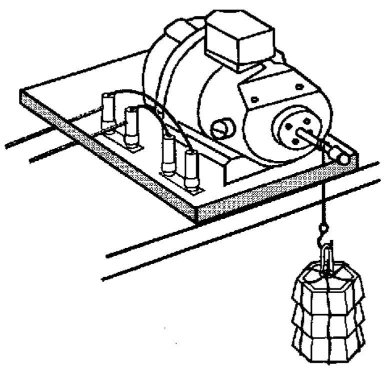
POTENTIAL ENERGY

$$PE = mgh$$

Efficiency = power out/power in x100%

Efficiency = energy out/energy in x100%

1. (a) An electric motor is used to raise a mass of 1.5 kg through a vertical height of 1.2 m. The load is raised at a steady speed.



(i) Calculate the increase in gravitational potential energy of the load when it is raised through 1.2 m.
The gravitational field strength is 10 N/kg.

....

....

....
(3)

(ii) The time taken to raise the load is 4.0 s.
Calculate the power output of the electric motor as it raises the load.

....

....

....
(3)

(iii) The input power to the motor as it raises the load is 30W.
Calculate the efficiency of the motor.

....

....

....
(3)

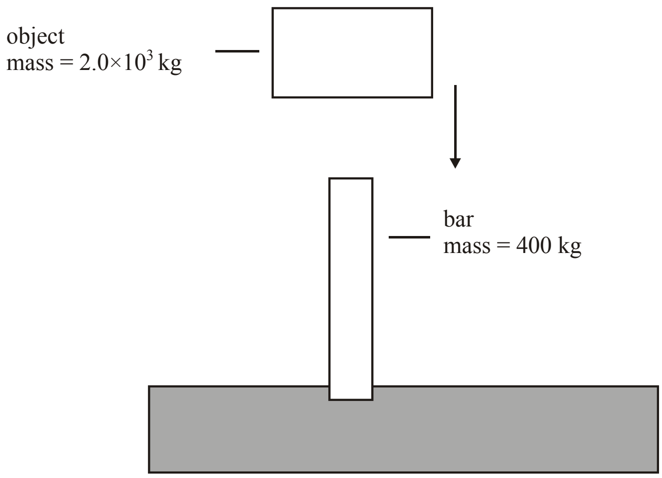
(b) Suggest a reason why the power given out by the motor is less than the power put in.

....

....
(1) **(Total 10 marks)**

2. This question is about driving a metal bar into the ground.

Large metal bars can be driven into the ground using a heavy falling object.



In the situation shown, the object has a mass 2000 kg. The object falls from a height of 8 meters.

(a) Determine the kinetic energy of the object when it hits the bar.

....

....

.... (3)

b) Assume that all the objects kinetic energy is transferred to the bar. The bar travels 0.50 m into the ground. What is the average resistive force acting on the bar

....

....

.... (3)

P8 – HEATING

Specific Heat capacity, c

$$E = mc\Delta T$$

4 Fig. 4.1 shows apparatus that a student uses to make an estimate of the specific heat capacity of iron.

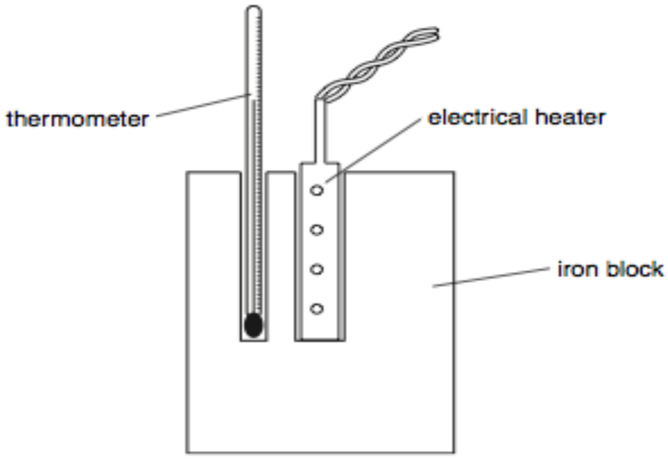


Fig. 4.1

(a) The power of the heater is known. State the four readings the student must take to find the specific heat capacity of iron.

1. ....
2. ....
3. ....
4. .... [3]

(b) Write down an equation, in words or in symbols, that could be used to work out the specific heat capacity of iron from the readings in **(a)**.

[2]

(c) **(i)** Explain why the value obtained with this apparatus is higher than the actual value.

....

.... [1]

(ii) State one addition to the apparatus that would help to improve the accuracy of the value obtained.

....

.... [1]

2.

Some water is heated electrically in a glass beaker in an experiment to find the specific heat capacity of water. The temperature of the water is taken at regular intervals.

The temperature-time graph for this heating is shown in Fig. 4.1.

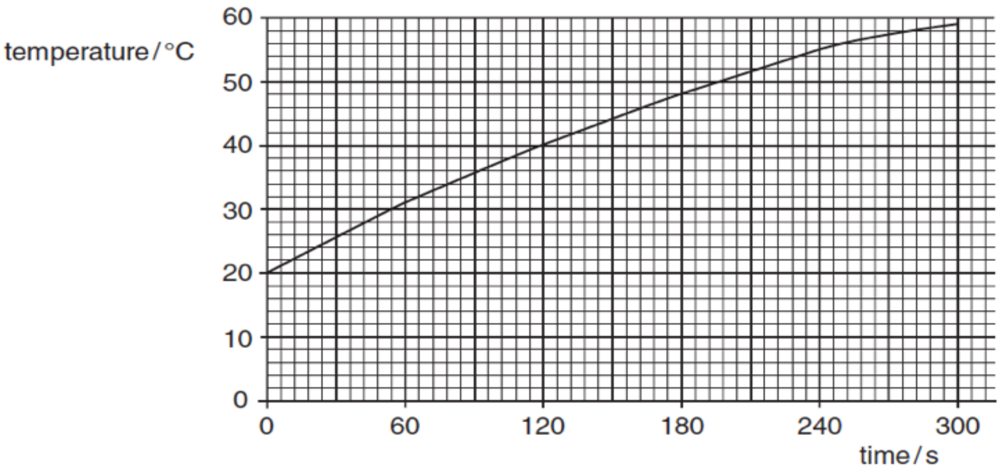


Fig. 4.1

(a) **(i)** Use the graph to find

1. the temperature rise in the first 120 s,

....

2. the temperature rise in the second 120 s interval.

....

(ii) Explain why these values are different.

....

....

[2]

(b) The experiment is repeated in an insulated beaker. This time, the temperature of the water increases from 20 °C to 60 °C in 210 s. The beaker contains 75 g of water. The power of the heater is 60 W. Calculate the specific heat capacity of water.

specific heat capacity = ...[4]