Year 12 Physics

Test 1

Time Allowed: 60 minutes

Total Marks: 60

02 December 2023

Calculator Allowed

Full Name of Student: ....

1.

Write down the units of the following physical quantities in terms of the base units.

(i) Pressure

$P = \frac{F}{A} \rightarrow \frac{N}{m^2} = \frac{kgms^{-2}}{m^2} = kgm^{-1}s^{-2}$

$kgm^{-1}s^{-2}$ [2]

(ii) Energy

Energy transferred = work done = Force x Dist.

$\therefore J = Nm$

$= kgms^{-2}m$

$= kgm^2s^{-2}$

kgm^2s^{-2} [2]

[Total for Question 1 = 4 marks]

2.

Fig. 1.1 shows the path of a car as it travels around a right-angled bend.

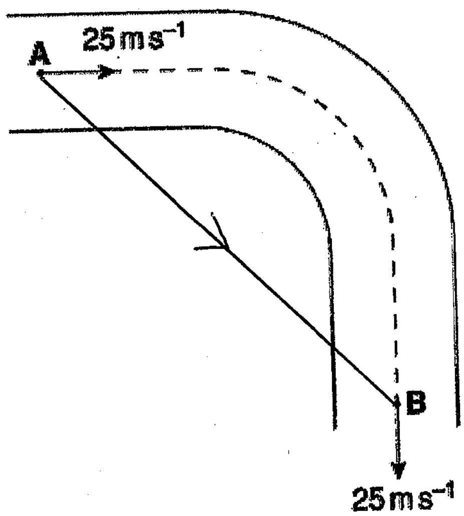


Fig. 1.1

The car travels from point **A** to point **B** in 7.6 s at a constant speed of 25 m s^{-1}. → $s = \frac{d}{t}$

(i) Calculate the distance the car travels in 7.6 s.

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

$d = s \times t$

$= 25 \times 7.6$

$= 190m$

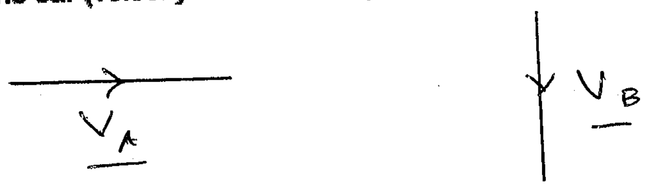
distance = 190 m [2]

(ii) Draw a line on Fig. 1.1 to show the displacement of the car having travelled from **A** to **B**. [1]

(iii) Explain why the velocity of the car changes as it travels from **A** to **B** although the speed remains constant.

Velocity is a vector that has a magnitude and direction. As the car travels from A to B the direction of its velocity changes. Hence its velocity changes. [2]

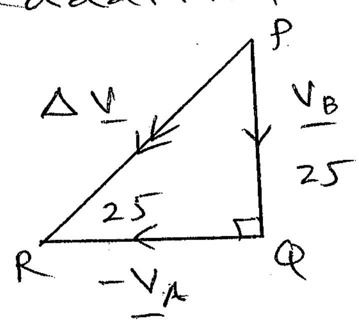
(iv) Using a labelled vector triangle, calculate the magnitude of the change in velocity of the car (velocity at **B** – velocity at **A**).



Change in velocity $= \underline{V}_B - \underline{V}_A$

$\Delta \underline{V} = \underline{V}_B + (-\underline{V}_A)$

(Add the vectors $\underline{V}_B$ and $(-\underline{V}_A)$ using the triangle law of vector addition.)



$PR^2 = 25^2 + 25^2$

$PR = 35.355...$

magnitude of velocity change = 35 (2 s.f) $m\,s^{-1}$ [3]

[Total for Question 2 = 8 marks]

3.

(a) (i) Below is a list of five quantities. Underline those that are scalar quantities.

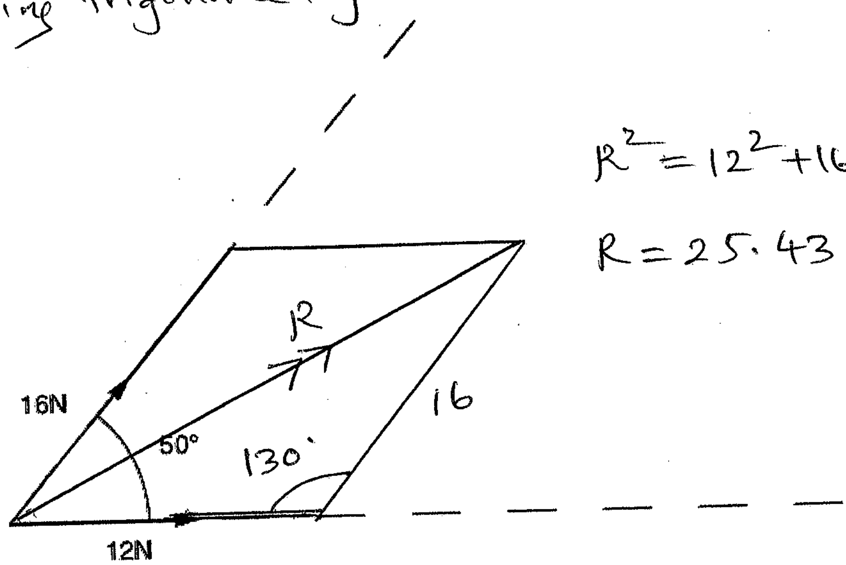
acceleration   energy   force   power   speed   [1]

(ii) What is a vector quantity?

A quantity that has a magnitude and direction. [2]

(b) Fig. 1.1 shows the direction of two forces of 16 N and 12 N acting at an angle of 50° to each other.

For this question, you can either draw a scale diagram and measure the resultant force from the diagram or you can sketch a diagram and calculate using trigonometry.



$R^2 = 12^2 + 16^2 - 2 \times 12 \times 16 \cos 130°$

$R = 25.432....$

Fig. 1.1

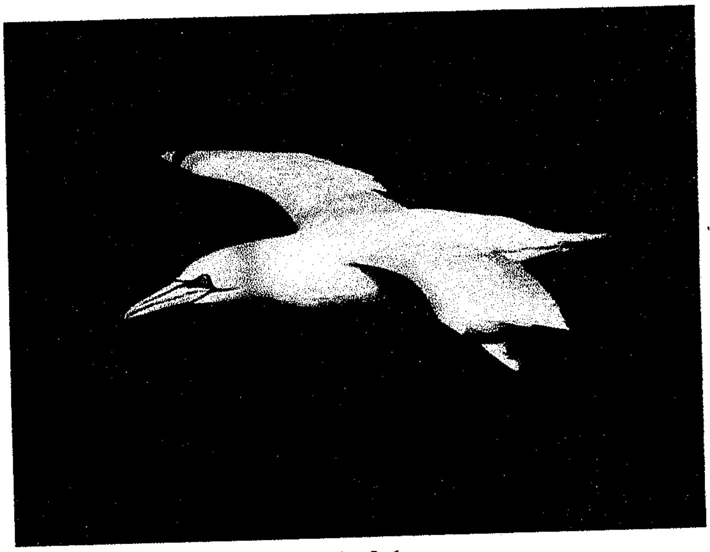
Using Fig. 1.1, draw a vector diagram to determine the magnitude of the resultant of the two forces.

magnitude of resultant force ....25........ N
(2 s.f.) [3]

[Total for Question 3 = 6 marks]

4.

Fig. 2.1 shows a gannet hovering above a water surface.



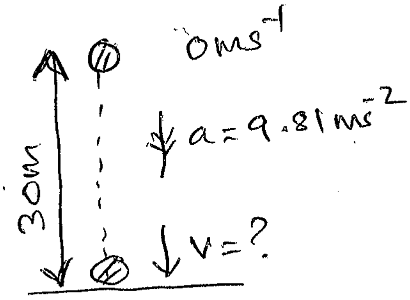


Fig 2.1

The gannet is 30m above the water. It folds in its wings and falls vertically in order to catch a fish that is 6.0m below the surface.

Ignore air resistance.

Calculate

(i) the speed that the bird enters the water

$v^2 = u^2 + 2as$

$v^2 = 0^2 + 2(9.81)(30)$

$v = 24.261....$

speed = 24 ms^{-1} [2]
(2 s.f.)

(ii) the time taken for the bird to fall to the water surface.

$s = ut + \frac{1}{2}at^2$

$30 = (0)t + \frac{1}{2}(9.81)t^2$

$60 = 9.81t^2$

$t = 2.473....$

time = 2.5 s [2]
(2 s.f.)

[Total for Question 4 = 4 marks]

5.

Fig. 2.1 shows a graph of velocity v against time t for a train that stops at a station.

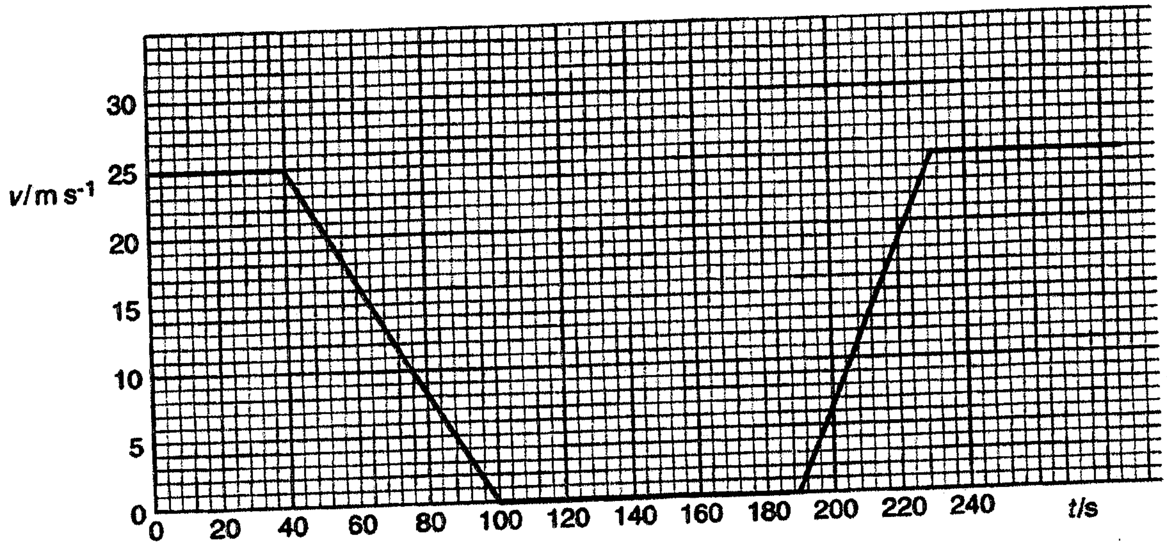


Fig. 2.1

(i) For the time interval $t = 40$ s to $t = 100$ s, calculate

1. the acceleration of the train,

Acceleration = gradient = $-\frac{25}{60} = -0.42 ms^{-2}$

acceleration ....-0.42.... m s^{-2}
(2 s.f.)

2. the distance travelled by the train.

Distance = Area = $\frac{1}{2} \times 60 \times 25 = 750$m

distance ....750.... m

[4]

(ii) Calculate the distance travelled by the train during its acceleration from rest to 25 m s^{-1}.

Distance = Area = $\frac{1}{2} \times 40 \times 25 = 500$M

distance ....500.... m

[1]

(iii) Calculate the journey time that would be saved if the train did not stop at the station but continued at a constant speed of 25 m s^{-1}.

(If we consider the journey from t = 40sec up to t = 230 sec, that would be sufficient because at other times it travels at $25 ms^{-1}$.)

Distance travelled from t = 40 to t = 230 is,
750 + 500 = 1250m.

Actual Time ~~to~~ taken = 230 − 40 = 190 sec.

time saved ....140.... s

Time that would have taken if it travelled at $25 ms^{-1}$ = $\frac{1250}{25}$
= 50 sec.

[3]

[Total for Question 5 = 8 marks]

∴ Time that would be saved = 190 − 50
= 140 sec.

6.

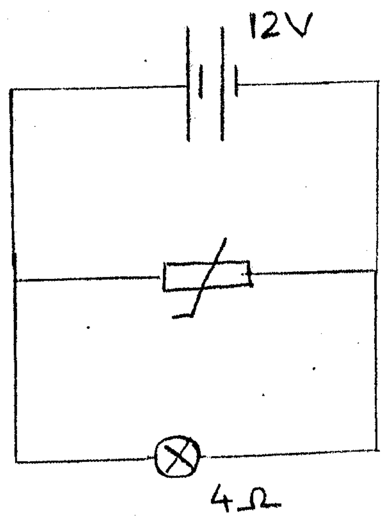


Fig. 9

A thermistor and a lamp are connected as shown in Fig.9 to a battery of emf 12V and negligible internal resistance.

The lamp has a fixed resistance of 4 Ohms.

At a certain temperature, the resistance of the thermistor is 6 Ohms.

At this temperature, calculate,

(a) the current flowing through the lamp.

$V = IR$ for the lamp

$12 = I(4)$

$I = 3A$

[2]

(b) the current supplied by the battery.

$V = IR$ for the thermistor,

$12 = I(6)$

$I = 2A$

∴ Current supplied by the battery

$= 3 + 2$

$= 5A$

[3]

(c) the energy transferred by the battery in 2 minutes.

$E = VIt$ for the battery

$E = 12 \times 5 \times 120$

$= 7200\,J$

[2]

After a while, the room temperature drops to a lower temperature.

(d) State and explain what happens to the brightness of the lamp as the room temperature drops.

As the temperature drops, the resistance of the ~~filament lamp incr~~ thermistor increases. However this has no effect on the brightness of the lamp because the p.d. across the lamp still remains 12V as this is a parallel circuit. ~~Hence~~ ~~the current~~ As the lamp has a fixed resistance, this means current through the lamp also stays the same. Hence its brightness remains the same.

[3]

[Total for Question 6 = 10 marks]

7.

(a) In terms of energy transfers, state one major difference between electromotive force (e.m.f.) and potential difference (p.d.).

Electromotive force is the energy transformed from some other form to electrical energy per unit charge whereas p.d. is the energy tranformed from electrical to some other form per unit charge. [1]

(b) State one similarity between potential difference and electromotive force.

Both are energy transferred per unit charge. [1]

(c) Fig. 3.1 shows two resistance wires **X** and **Y** connected in series to a battery.

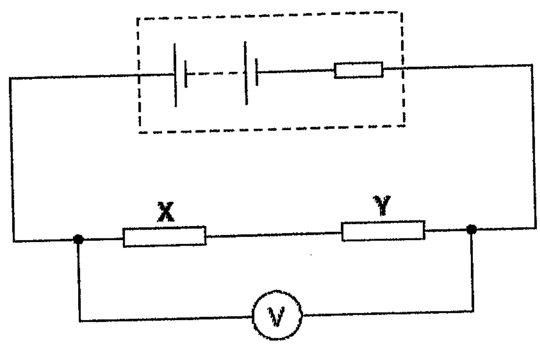


Fig. 3.1

(i) The voltmeter has an infinite resistance. Explain why the voltmeter reading is not equal to the e.m.f. of the battery.

Since the battery has an internal resistance and there is a current in the circuit, there is a potential drop due to internal resistance. [1]

(ii) The resistance of wire **X** is four times greater than the resistance of wire **Y**. The voltmeter reading is 6.0V. Use your knowledge of potential divider circuits to calculate the potential difference across the wire **Y**.

$$\text{p.d. across } Y = \frac{1}{1+4} \times 6 = 1.2V$$

potential difference = 1.2 V [3]

(iii) The wires **X** and **Y** are connected in **parallel** to the battery. Explain which of the two wires will dissipate greater power.

~~Par~~ Connected in parallel means the p.d. across them will be equal. Since $P = V^2/R$ and Y has a lower resistance, Y will dissipate greater power. **[2]**

[Total for Question 7 = 8 marks]

8.

Fig. 4.1 shows an electrical circuit.

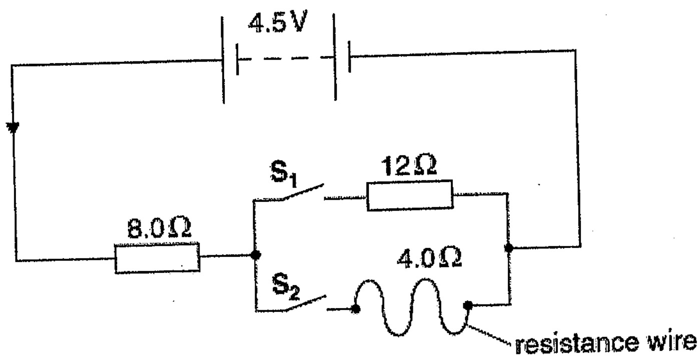


Fig. 4.1

The battery has e.m.f. 4.5V and has negligible internal resistance. The resistance wire has resistance 4.0Ω, length 15 cm and cross-sectional area 2.3×10^{-8} m².

(i) Suggest how you can arrange switches S_1 and S_2 (e.g. opened or closed) so that the circuit has a total resistance of 12Ω.

Switch S_1 should be opened while switch S_2 is closed. [1]

(ii) Calculate the resistivity of the material of the resistance wire.

$$R = \rho \frac{l}{A}$$

$$4 = \frac{\rho \times 15 \times 10^{-2}}{2.3 \times 10^{-8}}$$

$\rho = 6.133\ldots \times 10^{-7}$ Ωm

resistivity = 6.1×10^{-7} (2 s.f.) unit Ω m [4]

(iii) When both switches are **closed**, calculate

1 the **total** resistance of the circuit

~~R~~ Parallel part: $\frac{1}{R} = \frac{1}{12} + \frac{1}{4} \Rightarrow R = \frac{12 \times 4}{12+4}$

$R = 3\Omega$

$R_T = 8 + 3 = 11\Omega$

resistance = ...11.......... Ω [3]

2 the total electrical power delivered by the battery

$P = \frac{V^2}{R}$ for the battery

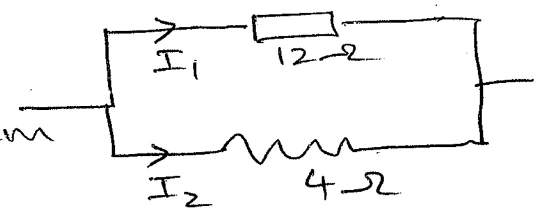
$P = \frac{4.5^2}{11} = 1.8409\ldots$ W

power = ...1.8.......... W [3]

(2 s.f.)

3 the ratio

$$\frac{\text{current in the } 12\,\Omega \text{ resistor}}{\text{current in the resistance wire}}$$



As 12Ω & 4Ω are in parallel, p.d. across them is the same.

$V = IR$

$\therefore I_1(12) = I_2(4)$

$\frac{I_1}{I_2} = \frac{4}{12} = \frac{1}{3}$ //

ratio = ...$\frac{1}{3}$.......... [1]

[Total for Question 8 = 12 marks]

~~I_3~~

- End of Test -