REDSPOT

O LEVEL

CLASSIFIED
WORKED SOLUTIONS

PHYSICS

Paper 2 (Theory) - All Variants

(Syllabus 5054)

period	2014 to 2024
contents	June & November, Paper 2 (P21 & P22), Worked Solutions
form	Topic By Topic
compiled for	O Levels

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TOPIC 4

Forces

Balanced & Un-balanced Forces, Friction, Circular Motion, Thinking & Braking distance

1. ***[June 2014/P22/Q1]***

Fig. 1.1 shows a lorry accelerating in a straight line along a horizontal road.

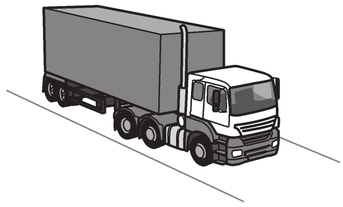


Fig. 1.1

(a) The driving force on the lorry in the forward direction is D and the total backward force on the lorry is B.

(i) State and explain whether D or B is the larger force.

....

.... [1]

(ii) Suggest one possible cause of the backward force B.

.... [1]

(b) The weight of the lorry is 300 000 N.

The gravitational field strength g is 10 N/kg.

(i) Calculate the mass of the lorry.

mass = ... [1]

(ii) The resultant force on the lorry is 15 000 N. Calculate the acceleration of the lorry.

acceleration = ... [2]

(c) Later, the lorry turns a corner at constant speed.

Explain why the lorry accelerates even though the speed is constant.

....

.... [1]

2. ***[Nov 2014/P21/Q1]***

Fig. 1.1 shows a motorcycle during a race.

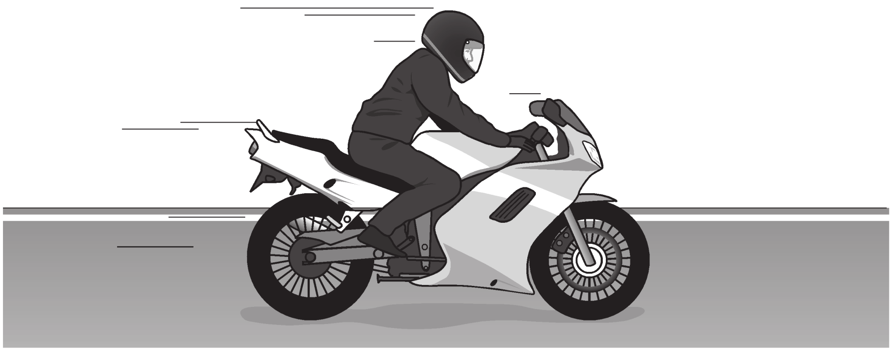


Fig. 1.1

The motorcycle accelerates along a straight section of the track from a speed of 40 m/s to maximum speed.

Fig. 1.2 is the speed-time graph for the motorcycle along the straight section of the track.

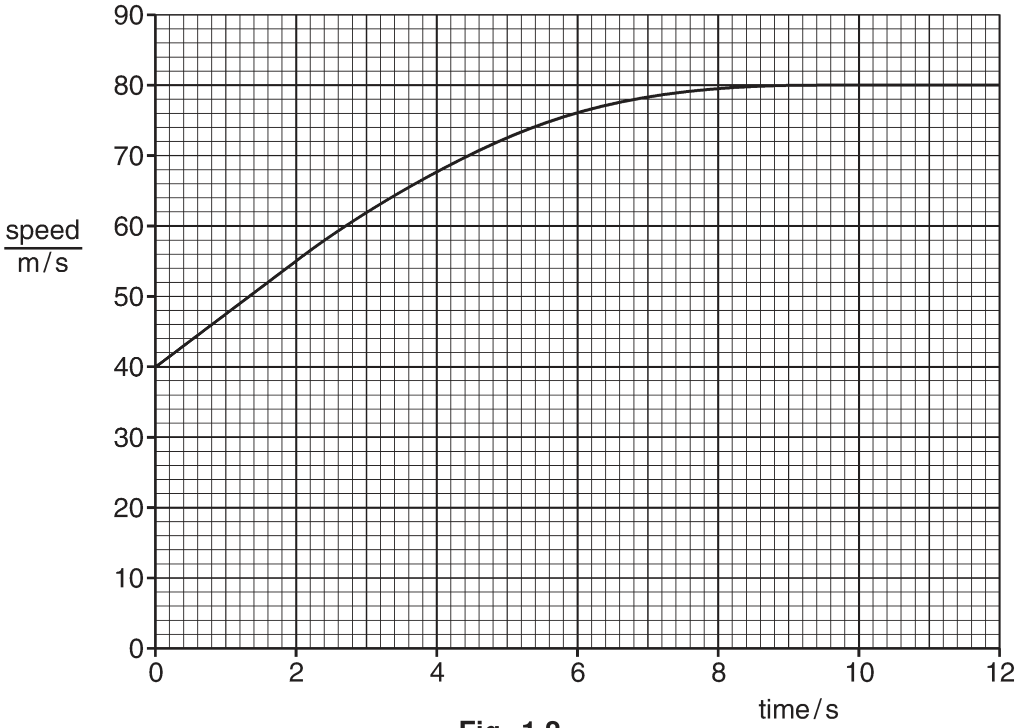


Fig. 1.2

The mass of the motorcycle is 180 kg.

(a) For the time 0 to 2.0 s, determine

(i) the acceleration of the motorcycle,

acceleration = ... [2]

(ii) the resultant force acting on the motorcycle.

force = ... [2]

(b) The driving force acting on the motorcycle remains constant throughout the 12 s spent on the straight section of track.

(i) Using Fig. 1.2, describe how the acceleration of the motorcycle changes during this time.

....

.... [1]

(ii) Explain, in terms of the forces acting, why the acceleration changes in this way.

....

....

....

.... [3]

---

3. ***[Nov 2014/P22/Q9]***

(a) Explain what is meant by *uniform acceleration*.

....

....

.... [2]

(b) Acceleration is a vector quantity.

State how a vector quantity differs from a scalar quantity.

....

.... [1]

(c) A rock from space is travelling in a straight line at high speed when it enters the Earth's atmosphere. Fig. 9.1 is the speed-time graph for the rock from time $t = 0$ to time $t = 50$ s.

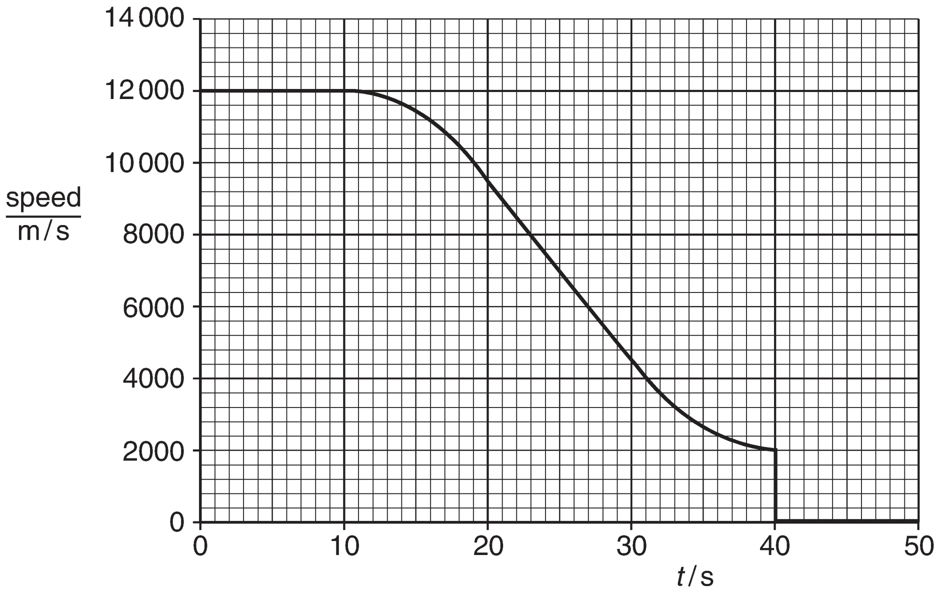


Fig. 9.1

(i) On Fig. 9.1, mark

- a letter X, where the rock is moving with a constant speed,
- a letter Y, where the rock has a uniform deceleration,
- a letter Z, where the rock has a non-uniform deceleration. [3]

(ii) At time $t = 25$ s, the mass of the rock is 8.4 kg. For the time $t = 25$ s, determine

1. the size of the acceleration of the rock,

acceleration = ... [3]

2. the size of the resultant force on the rock.

force = ... [2]

(iii) Fig. 9.2 shows the rock at $t = 25$ s.

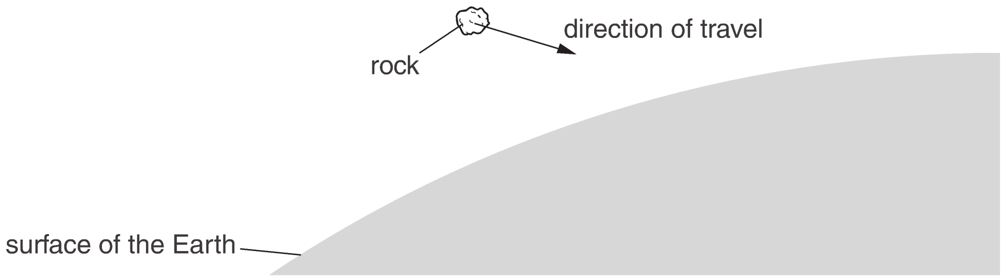


Fig. 9.2 (not to scale)

1. On Fig. 9.2, draw and label two arrows to show the directions of the gravitational force F and the air resistance R acting on the rock. [2]
2. Suggest why the size of the air resistance changes as the rock travels through the Earth's atmosphere.

....

.... [1]

(iv) Suggest what happens to the rock at $t = 40$ s.

....

.... [1]

4. ***[June 2015/P21/Q9]***

Fig. 9.1 shows a satellite in orbit around the Earth.

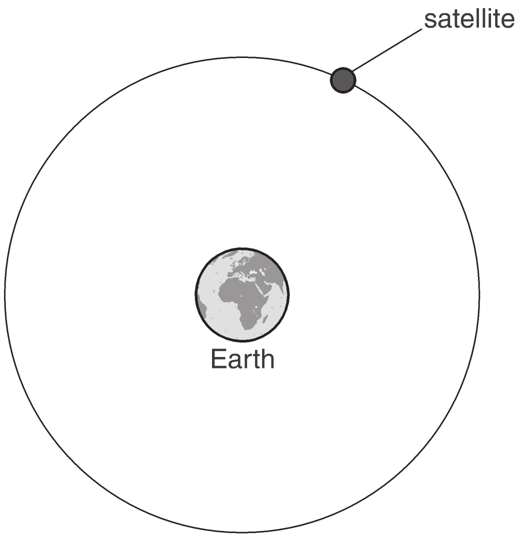


Fig. 9.1 (not to scale)

(a) The satellite travels at a constant speed in a circular orbit.

(i) Underline the quantities in the list below that are scalars.

acceleration force mass speed velocity [2]

(ii) The velocity of the satellite changes, but its speed is constant.

1. State what is meant by *velocity*. ....

....

.... [1]

2. Explain why the velocity changes. ....

....

.... [1]

(iii) Explain what makes this satellite move in an orbit that is circular.

....

....

....

.... [2]

(b) The satellite is placed into orbit by a rocket.
Fig. 9.2 shows the rocket as it takes off.
The rocket and fuel have a total mass of 40 000 kg and a total weight of 400 000 N.
The resultant force acting upwards on the rocket is 50 000 N.

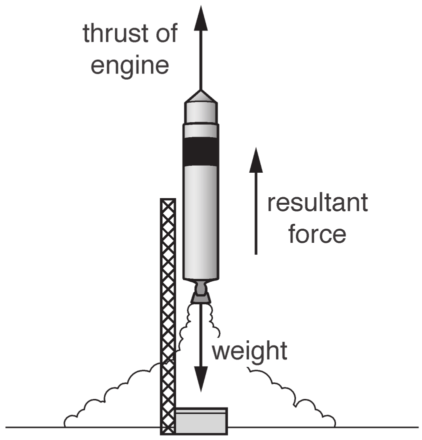


Fig. 9.2

(i) Calculate the thrust produced by the rocket engine.

thrust = ... [1]

(ii) Calculate the acceleration of the rocket.

acceleration = ... [2]

ANSWERS

Topic - 4

1. **(a) (i)** Since the lorry is accelerating, there is a net resultant force in the forward direction. Therefore, *D* is greater than *B*.

   (ii) Air resistance (or friction between tyres and road).

   (b) (i) $\text{Mass} = \frac{W}{g} = \frac{300000}{10} = 30000 \text{ kg}$

   (ii) $a = \frac{F}{m} = \frac{15000}{30000} = 0.5 \text{ m/s}^2$

   (c) The direction, and hence the velocity of the lorry changes, causing the lorry to accelerate.

2. **(a) (i)** Using graph, $a = \frac{v-u}{t}$

   $= \frac{55-40}{2} = 7.5 \text{ m/s}^2$

   (ii) $F = ma$

   $= 180 \times 7.5 = 1350 \text{ N}$

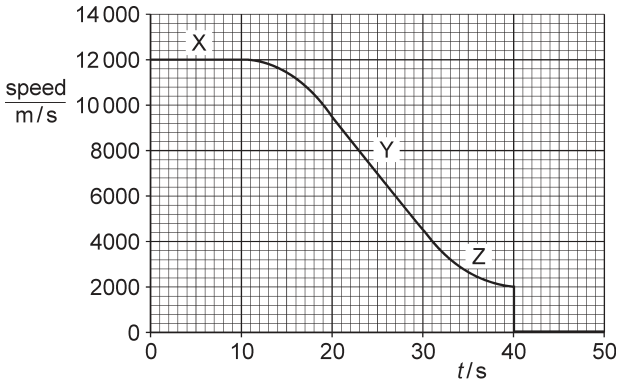
   (b) (i) Acceleration of motorcycle decreases from 7.5 m/s^2 to zero.

   (ii) As the motorcycle accelerates, the air resistance acting on it increases with the increase in speed. The air resistance eventually becomes equal to the driving force. The resultant force then becomes zero and the motorcycle moves with a constant speed.

3. **(a)** A body is said to have a uniform acceleration, if its velocity is increasing at a constant rate.

   (b) Scalar quantities have only magnitude but vector quantities have magnitude and direction.

   (c) (i)



   (ii) 1. Taking (23, 8000) and (27, 6000) on the graph,

   acceleration = gradient of graph

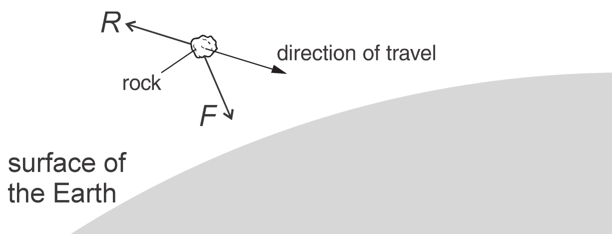
   $= \frac{8000-6000}{23-27} = -500 \text{ m/s}^2$

   $\therefore$ size of acceleration $= 500 \text{ m/s}^2$

   2. $F = ma$

   $= 8.4 \times 500 = 4200 \text{ N}$

   (iii) 1.



   2. As the speed of the rock changes, the size of the air resistance also changes, because,

   air resistance $\propto$ speed

   (iv) It hits the surface of earth and stops.

4. **(a) (i)** <u>mass</u> & <u>speed</u>

   (ii) 1. Velocity is the speed of a body with a direction.

   2. The velocity changes due to the change in direction.

   (iii) The force of gravity from the earth acts as centripetal force on the satellite and makes it to move in a circular orbit.

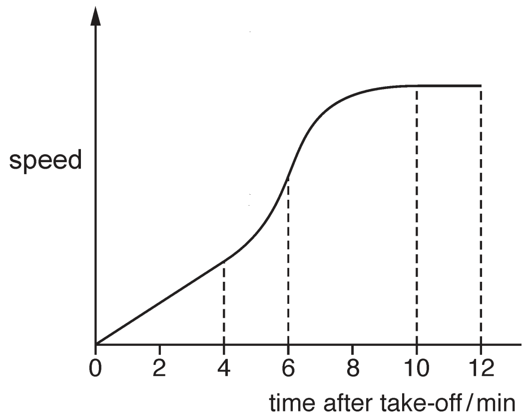
(b) (i) Thrust = weight + resultant force

$= 400000 + 50000 = 450000$ N

(ii) $a = \dfrac{F}{m} = \dfrac{50\,000}{40\,000} = 1.25$ m/s^2

(c) (i) A body is said to be moving with a uniform acceleration if its velocity changes by equal amount in equal intervals of time.

(ii)



(iii) The distance travelled can be determined by calculating the area under the speed-time graph.

5. (a) (i) $W = mg$

$= 1.2 \times 10 = 12$ N

(b) (i) 1. F = zero

2. $F = 12$ N (or F is equal to the weight of the block.)

3. As the block of ice accelerates, its speed increases. As a result the force F of air resistance also increases.

(ii) The gravitational potential energy of the block changes to the thermal energy.

Or, The gravitational potential energy changes into kinetic energy of air.

(iii) Kinetic energy $= \dfrac{1}{2} \times 1.2 \times 40^2 = 960$ J

6. (a) Initially, there is no air resistance and the diver falls with the only force of gravity (weight). So his initial acceleration is

$$a = \frac{F}{m} = \frac{600}{60} = 10 \text{ m/s}^2$$

(b) This is because the upward force of air resistance increases due to the larger area of parachute and becomes greater than the downward force of weight.

(c) (i) Terminal velocity = 5.0 m/s

(ii) From graph,

5.5 m/s corresponds to 720 N

Resultant force = upward force − downward force

$= 720 - 600 = 120$ N

7. (a) Kinetic energy

$\rightarrow$ Thermal (or internal) energy

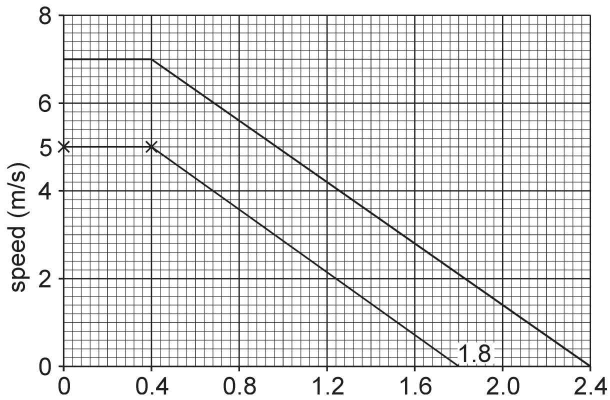
(b) (i) Reaction time = 0.40 s

(ii) Distance = speed $\times$ time

$= 7 \times 0.40 = 2.8$ m

(iii) Braking distance can be found by calculating the area under graph between 0.4 s and 2.4 s.

(iv)



(v) There is less friction between the tyres and the wet road. Hence, on applying the brakes, less deceleration takes place and the bicycle takes longer time to stop.

8. (a) Velocity is a vector quantity and has a direction. Speed is a scalar quantity and does not have direction.

(b) (i) $F = ma$

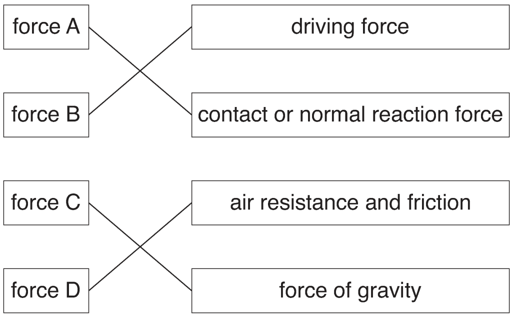
$= 800 \times 1.5 = 1200$ N

(ii) It is because some of the force of the engine is used to overcome the air resistance and friction acting on the car.

(iii) $v - u = at$

$v - 25 = 1.5 \times 4.0 \quad \Rightarrow \quad v = 31$ m/s

9. (a)



(b) (i) $W = mg$

$8000 = m \times 10 \quad \Rightarrow \quad m = 800$ kg

(ii) Resultant force

= forward driving force − backward resistance

$= 1000 - 600 = 400$ N

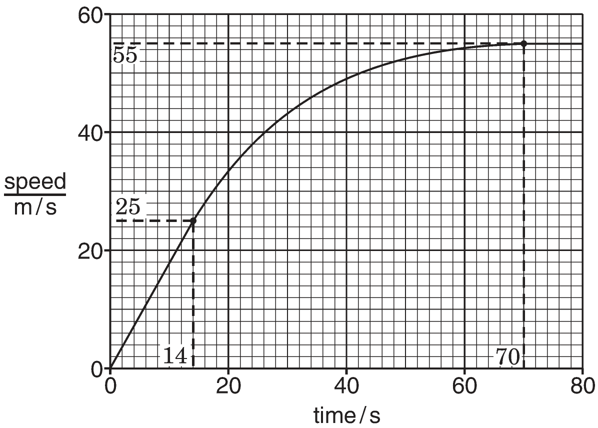
(iii) $a = \dfrac{F}{m} = \dfrac{400}{800} = 0.5\ \text{m/s}^2$

(c) $v - u = at$

$20 - u = 1.6 \times 5.0 \quad \Rightarrow \quad u = 12$ m/s

10. (a) (i) $a = \dfrac{v-u}{t} = \dfrac{25-0}{14} = 1.79 \approx 1.8\ \text{m/s}^2$

(ii)



(b) On applying the brakes, a backward force acts on the car as well as on the driver via the seat belt. This slows down both of them. In contrast, the bag continues to move forward due to inertia as no backward force acts on it.

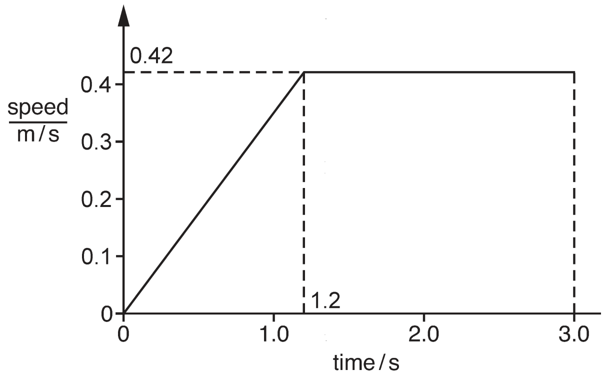
11. (a) (i) Resultant force $= ma$

$= 160 \times 0.35 = 56$ N

(ii) $v = u + at$

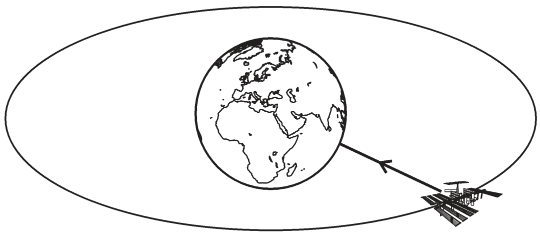
$= 0 + 0.35 \times 1.2 = 0.42$ m/s

(b) (i)



(ii) Distance moved by the astronaut can be found by calculating the area under the speed-time graph (i.e. area of trapezium).

(c) (i) 1.



2. This force is caused by the attraction from the earth's gravitational field.

(ii) The rate of change of distance moved in a specified direction is called the velocity.

Alternatively:
The change of displacement per unit time is called the velocity

(iii) 1. The velocity of the space station changes because its direction changes during its motion in a circular orbit.

2. Kinetic energy remains constant as the speed of the space station is constant during its motion in the circular orbit.

12. (a) (i) The forces which are equal and opposite and have no resultant.

(ii) The box must slide as the frictional force work only when two surfaces rub with each other.

(iii) The forces are balanced when the box moves with a constant velocity.

TOPIC 20

Electric Circuits

Circuit Diagrams & Circuit Components, Series & Parallel Circuits, Action and Use of Circuit Components

1. ***[June 2014/P21/Q7]***

(a) Fig. 7.1 shows a variable potential divider (potentiometer) connected to a 6.0 V battery.

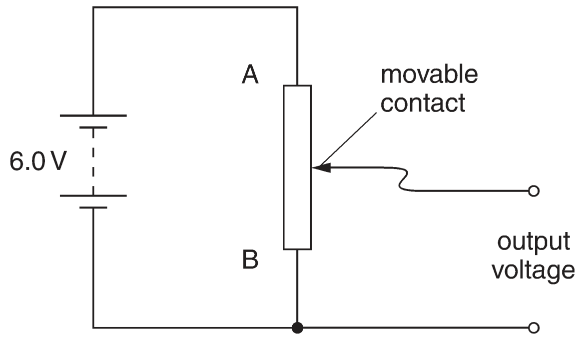


Fig. 7.1

The movable contact can slide between A and B. As it moves, the output voltage changes.

Complete the table below to show the output voltage when the contact is at A and at B.

position of movable contact	A	B
output voltage		

[2]

(b) Fig. 7.2 shows a thermistor in a potential divider circuit that is used to monitor temperature. The fixed resistor has a resistance of 2000 Ω.

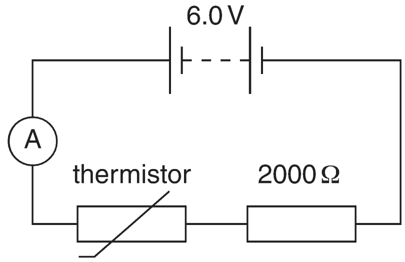


Fig. 7.2

(i) Explain why the voltage across the thermistor decreases as its temperature rises.

....

.... [2]

(ii) At one temperature, the thermistor has a resistance of $1000\,\Omega$. Calculate the current in the thermistor.

current = ... [2]

2. ***[Nov 2014/P21/Q11]***

A student makes a 2.0 V battery by connecting two cells of electromotive force (e.m.f.) 2.0 V in parallel. The battery, an ammeter with different ranges and three different resistors are used to set up the circuit shown in Fig. 11.1.

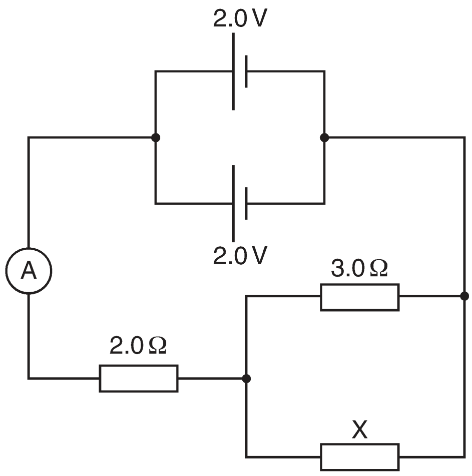


Fig. 11.1

(a) (i) Explain what is meant by *electromotive force*.

....

....

.... [2]

(ii) State one advantage of using two cells in parallel rather than using a single 2.0 V cell.

....

.... [1]

(b) Resistor X and the $3.0\,\Omega$ resistor have a combined resistance that is equal to $2.0\,\Omega$. Calculate

(i) the total resistance of the circuit,

total resistance = ... [1]

(ii) the resistance of X.

resistance of X = ... [2]

(c) **(i)** Determine the reading of the ammeter.

reading = ... [2]

(ii) Suggest a suitable range for the ammeter.

.... [1]

(d) The current in the 2.0 Ω resistor is I_2. The current in the 3.0 Ω resistor is I_3. The current in X is I_X. State the equation that relates I_2, I_3 and I_X.

.... [1]

(e) State the potential difference (p.d.) across

(i) the 2.0 Ω resistor,

p.d. = ... [1]

(ii) the 3.0 Ω resistor.

p.d. = ... [1]

(f) The student sets up a second circuit using a variable d.c. power supply, an ammeter and a 12 V metal filament lamp. The circuit is shown in Fig. 11. 2.

The d.c. power supply is set to 12 V and the ammeter reading is 1.5 A.

The student changes the e.m.f. of the d.c. power supply to 6.0 V. The lamp dims and the ammeter reading changes.

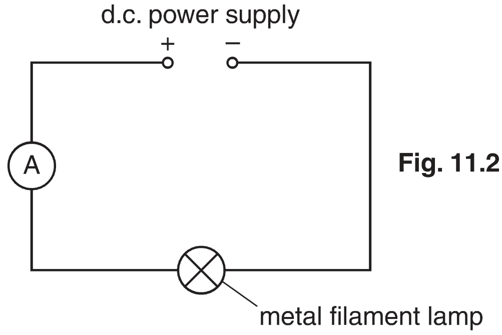


Fig. 11.2

(i) State and explain what happens to the resistance of the metal filament of the lamp.

....

....

.... [2]

(ii) State whether the new ammeter reading is less than, equal to or greater than 0.75 A.

.... [1]

3. ***[June 2015/P21/Q6]***

Fig. 6.1 shows a circuit that contains a resistor connected to a power supply of 6.0 V and a lamp L.

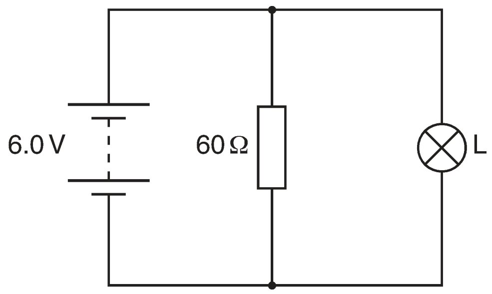


Fig. 6.1

The resistor has a resistance of 60 Ω. The lamp is marked 6.0 V, 0.90 W.

(a) Calculate

(i) the current in the resistor,

current = ... [2]

(ii) the current in the power supply.

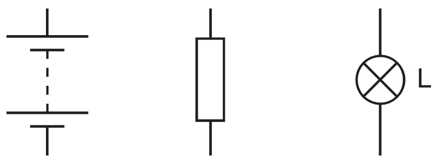
current = ... [2]

(b) A second lamp is added to the circuit shown in Fig. 6.1.

The second lamp is in series with the 60 Ω resistor, but is **not** in series with lamp L.

(i) In the space below draw a circuit diagram of this new circuit.

The power supply, 60 Ω resistor and lamp L have been drawn for you.



[1]

(ii) The two lamps are identical.
Explain why the second lamp is dimmer than lamp L.
A calculation is not required.

....

....

.... [1]

---

4. ***[June 2015/P22/Q10 b]***

Fig. 10.1 shows a relay connected to a cell and a switch.

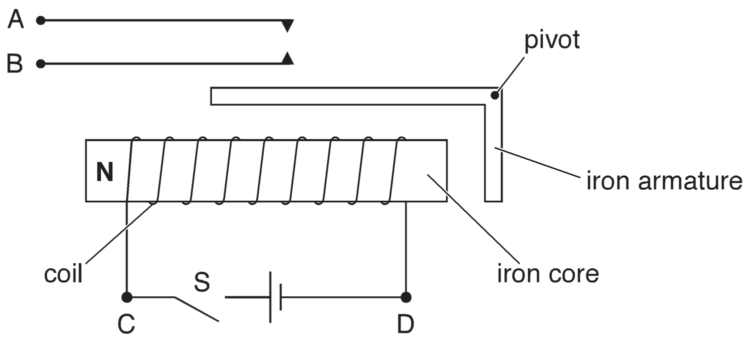


Fig. 10.1

When switch S is closed, the iron core is magnetised and the iron armature is attracted to the core.
Fig. 10.2 shows the relay connected in a circuit to a 12 V battery. The bell is not ringing.

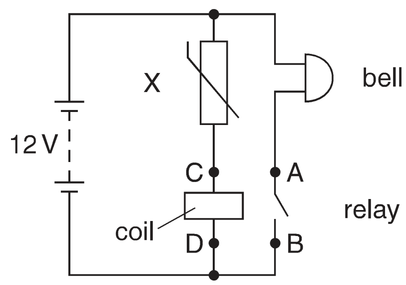


Fig. 10.2

(i) State the name of component X.

.... [1]

(ii) Explain why the bell rings when the temperature of X rises.

....

....

.... [2]

(iii) When the resistance of X is $2000\,\Omega$, the current in the coil is 1.5 mA. This causes the contacts in the relay to close. The resistance of the bell is $200\,\Omega$. . Calculate

1. the potential difference (p.d.) across X,

p.d. = ... [2]

2. the p.d. across the coil,

p.d. = ... [1]

3. the current in the battery.

current = ... [2]

(iv) Component X is removed from the circuit and replaced by a different component Y. The bell now rings when bright light shines on Y.

State the name of component Y.

.... [1]

---

5. ***[Nov 2015/P21/Q8]***

A potential divider is made from a light-dependent resistor (LDR) and a $6.0\,k\Omega$ fixed resistor. The potential divider is connected in series with a 12 V d.c. power supply and a voltmeter is connected across the $6.0\,k\Omega$ resistor. Fig. 8.1 is the circuit diagram.

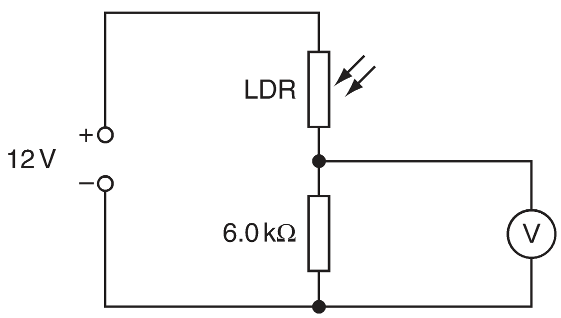


Fig. 8.1

A light shines on the LDR. The resistance of the LDR is $2.0\,k\Omega$.

ANSWERS

Topic - 20

1. (a)

position of movable contact	A	B
output voltage	6.0 V	0 V

(b) (i) The resistance of the thermistor decreases and the current in the circuit increases. As a result, the voltage across the thermistor decreases and the voltage across $2000\,\Omega$ resistor increases.

(ii) Current $= \dfrac{6.0}{(1000 + 2000)} = 0.002$ A $= 2$ mA

2. (a) (i) It is the work done by the electrical source in driving a unit charge round a complete circuit.

(ii) The battery continues to work even if one cell is flat.

Or, One cell can be replaced without switching off the circuit.

(b) (i) Total resistance $= 2.0 + 2.0 = 4.0\,\Omega$

(ii) For the resistors of $3.0\,\Omega$ and $X\,\Omega$ in parallel,

$$\frac{1}{R_{\text{Total}}} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\Rightarrow \quad \frac{1}{2.0} = \frac{1}{3.0} + \frac{1}{X} \quad \Rightarrow \quad X = 6\,\Omega$$

(c) (i) $I = \dfrac{V}{R} = \dfrac{2.0}{4.0} = 0.50$ A

(ii) 0 – 5.0 A

(d) $I_2 = I_3 + I_X$

(e) (i) p.d. across $2.0\,\Omega$ resistor $= 1.0$ V

(ii) p.d. across $3.0\,\Omega$ resistor $= 1.0$ V

(f) (i) The temperature of the metal filament of the lamp decreases. As a result, the resistance of the metal filament decreases.

(ii) It is greater than 0.75 A.

3. (a) (i) Current $= \dfrac{V}{R}$

$= \dfrac{6.0}{60} = 0.10$ A

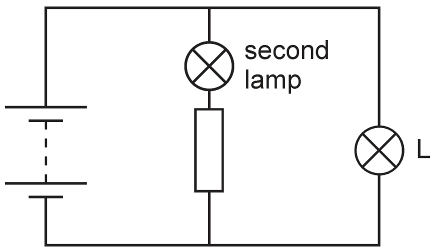
(ii) Current through lamp $= \dfrac{P}{V}$

$= \dfrac{0.90}{6.0} = 0.15$ A

$\therefore$ Current through power supply

$= 0.10 + 0.15 = 0.25$ A

(b) (i)



(ii) It is due to the less voltage across this lamp because the lamp shares the voltage with the resistor.

4. (i) Thermistor.

(ii) The resistance of the thermistor decreases which increases the current in the coil and the coil is strongly magnetised. The coil then attracts the armature and closes the switch of the bell circuit and the bell rings.

(iii) 1. p.d. $= IR$

$= (1.5 \times 10^{-3}) \times 2000 = 3.0$ V

2. $V = 12 - 3.0 = 9.0$ V

$\therefore$ p.d. accross the coil $= 9.0$ V

3. Current in bell $= \dfrac{V}{R}$

$= \dfrac{12}{200} = 0.06$ A $= 60$ mA

Current in the battery

= Current in coil branch

+ Current in bell branch

$= 1.5$ mA $+ 60$ mA $= 61.5$ mA

(iv) Light dependent resistor (LDR).

5. (a) (i) $\text{Current} = \dfrac{V}{(R_1 + R_2)}$

$= \dfrac{12}{(2000 + 6000)}$

$= 1.5 \times 10^{-3}\ \text{A} = 1.5\ \text{mA}$

(ii) $V = I \times R$

$= (1.5 \times 10^{-3}) \times 6000 = 9.0\ \text{V}$

(b) The voltmeter reading increases as the resistance of the LDR falls.

(c) It can be used in an automatic light switch.

6. (a) (i) $I_B = I_1 = I_2$

(ii) The p.d. of the battery is the sum of the p.d. across the fixed resistor and p.d. across the variable resistor, i.e. $V_B = V_1 + V_2$.

(b) $I = \dfrac{V}{R} = \dfrac{9.0}{(1000 + 500)} = 0.0060\ \text{A}$

7. (a) It is the amount of work done by the source of electrical energy in moving a unit charge round a complete circuit.

(b) (i) 1. $I_B = I_1 = I_2$

2. $E = V_1 + V_2$

(ii) $\text{Current} = \dfrac{V}{R}$

$= \dfrac{12}{(18 + 30)} = 0.25\ \text{A}$

(iii) $V = I \times R = 0.25 \times 18 = 4.5\ \text{V}$

(iv) $\text{Power} = V \times I$

$= 4.5 \times 0.25 = 1.125\ \text{W}$

(c) The current passing through a metallic conductor is directly proportional to the voltage, provided the physical conditions, such as temperature are kept constant.

(d) (i) Resistance $R \propto$ Length l

(ii) $R \propto \dfrac{1}{A}$

(e) First band = Orange.

Second band = Black.

Third band = Black.

8. (a) Combined resistance of parallel resistors

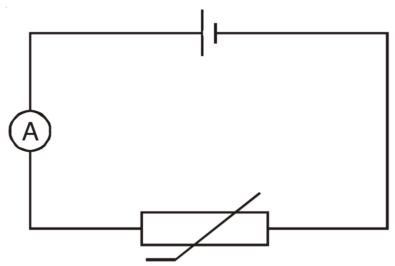
$\dfrac{1}{R} = \dfrac{1}{20} + \dfrac{1}{40} \Rightarrow \dfrac{1}{R} = \dfrac{3}{40} \Rightarrow R = 13.3\ \Omega$

Total resistance $= 20 + 13.3 = 33.3\ \Omega$

(b) • $V_2 = V_3$

• V_1 is larger than either V_2 or V_3

9. (a)



(b) (i) 1. $V = IR = 0.05 \times 240 = 12\ \text{V}$

2. Current at 40 °C = 0.12 A

$\text{Resistance} = \dfrac{V}{I} = \dfrac{12}{0.12} = 100\ \Omega$

(ii) Comparing the change in resistance in two equal changes in temperature:

Change in Temperature	Change in Resistance
40 °C – 20 °C = 20 °C	240 – 100 = 140 Ω
60 °C – 40 °C = 20 °C	100 – 48 = 52 Ω

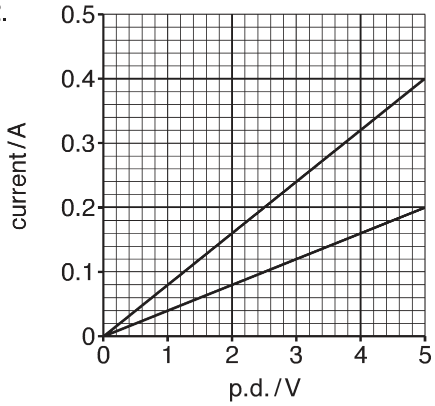
It shows that the change in resistance is not same for equal changes in temperature.

10. (a) (i) The current flowing in the metal wire is directly proportional to the potential difference across it, i.e. $I \propto V$.

(ii) The straight line graph with constant gradient shows that the temperature of the wire is constant.

(iii) 1. Since $R \propto \dfrac{1}{A}$ so, the resistance of the new wire is twice as large.

2.



(b) **(i)** 1. Total resistance $= \left(\dfrac{1}{\dfrac{1}{R_1}+\dfrac{1}{R_2}}\right) + R_3$

$$= \left(\dfrac{1}{\dfrac{1}{20}+\dfrac{1}{80}}\right) + 24 = 40\ \Omega$$

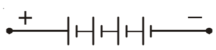
2. Current $= \dfrac{V}{R} = \dfrac{6.0}{40} = 0.15$ A

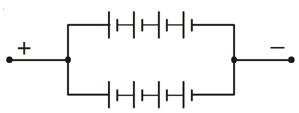
3. The p.d. across $20\ \Omega$ resistor is same as the combined p.d. across the parallel resistors. Thus,

Combined $V =$ Combined I $\times$ Combined R

$= 0.15 \times 16 = 2.4$ V

(ii) 1. The e.m.f of a cell is defined as the work done by the cell to drive a unit charge round a complete circuit, i.e. e.m.f $= \dfrac{\text{work done}}{\text{charge}}$.

2. 

3. 

(c)
- It lasts for a longer time.
- It contains more energy
- If one cell fails, the battery still continues to work normally.

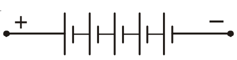
11. **(i)** Total resistance $= R_1 + \left(\dfrac{1}{\dfrac{1}{R_2}+\dfrac{1}{R_3}}\right)$

$$= 18 + \left(\dfrac{1}{\dfrac{1}{60}+\dfrac{1}{15}}\right) = 30\ \Omega$$

(ii) Current $= \dfrac{V}{R} = \dfrac{7.5}{30} = 0.25$ A

(iii) 1. Largest : <u>$18\,\Omega$ resistor</u>

2. Smallest : <u>$60\,\Omega$ resistor</u>

(iv) 

(v) Its resistance increases and the current passing through it decreases.

12. **(a)** **(i)** $\dfrac{1}{R_{Total}} = \dfrac{1}{R_1} + \dfrac{1}{R_2}$

$R_{Total} = \dfrac{R_1 \times R_2}{R_1 + R_2}$

$= \dfrac{1800 \times 9000}{1800 + 9000} = 1500\ \Omega$

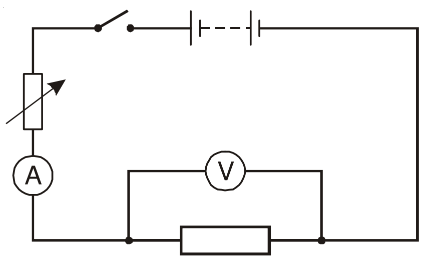
(ii) Current $= \dfrac{V}{R} = \dfrac{4.5}{1500} = 0.003$ A

$\therefore$ Reading on Ammeter $= 0.003$ A

(b) **(i)** The resistance of the LDR decreases, so the current through it increases.

(ii) The current in $1800\ \Omega$ resistor does not change because the value of its resistance and the potential difference across it remains the same.

13. **(a)**



(b) **(i)** Resistance $= \dfrac{V}{I} = \dfrac{4.2}{1.2} = 3.5\ \Omega$

(ii) The resistor overheats because the power delivered to it is,

$P = V \times I$

$= 4.2 \times 1.2 = 5.04$ W

5.04 W is too large as compared to its given power rating of 3 W.

(iii) No, the resistors do not overheat, as now half the voltage (2.1 V) is across each resistor and half the current (0.6 A) passes through each resistor, so a quarter of power is delivered to each resistor.

14. **(a)** It is the amount of energy transferred to move a unit charge through a resistor.

(b) **(i)** Current $= \dfrac{V}{R} = \dfrac{9.6}{40} = 0.24$ A

(ii) e.m.f. $= I \times (R_1 + R_2)$

$= 0.24 \times (10 + 40) = 12$ V

(c) Voltmeter with a scale of 0 – 20 V is the best to measure the given p.d. of 9.6 V.

The 0 – 2 V voltmeter has a smaller range and cannot measure 9.6 V.

The 0 – 200 V voltmeter would produce a small deflection which may cause inaccuracy when noting the reading.

(d) (i) $P = I^2R$

$= (0.24)^2 \times (10) \approx 0.58\ \text{W}$

(ii) It is because $\frac{1}{2}P$ rated resistor blows due to high current.

(e)

quantity	increases, decreases or stays the same as resistor R is added	brief explanation
current in 10 Ω resistor	increases	Effective resistance of parallel combination and hence total resistance of circuit decreases.
p.d. across 10 Ω resistor	increases	p.d. is proportional to current.
p.d. across 40 Ω resistor	decreases	Since, p.d across 10 Ω increases, so it decreases across 40 Ω resistor, because sum of p.d's is 12 V.

15. (a) (i) Total resistance $= R_1 + \left(\dfrac{1}{\frac{1}{R_2} + \frac{1}{R_3}} \right)$

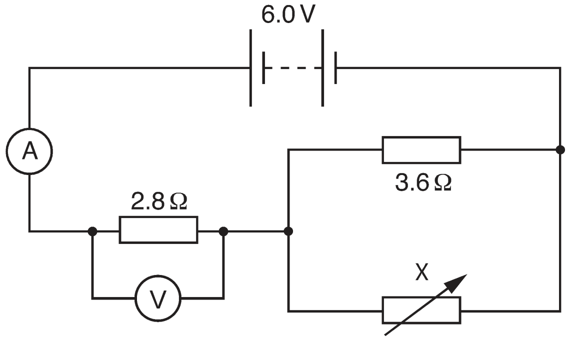
$= 2.8 + \left(\dfrac{1}{\frac{1}{3.6} + \frac{1}{1.8}} \right)$

$= 2.8 + 1.2 = 4.0\ \Omega$

(ii) Current $= \dfrac{V}{R} = \dfrac{6.0}{4.0} = 1.5\ \text{A}$

(b) (i) It is the amount of work done in moving a unit charge through a component in a circuit.

(ii)



(iii) The total resistance in the circuit increases. As a result, the current through the 2.8 Ω resistor as well as the p.d. across it decreases.

16. (a) Electrons flow in the copper wires towards the ammeter.

Or, The electrons are flowing from the negative terminal towards the positive terminal of the battery.

(b) (i) Thermistor.

(ii) Combined resistance of parallel resistors,

$\dfrac{1}{R} = \dfrac{1}{1.5} + \dfrac{1}{6.0} \Rightarrow R = 1.2\ \Omega$

Total resistance $= 1.2 + 1.3 = 2.5\ \Omega$

(iii) Current $= \dfrac{V}{R} = \dfrac{12}{2.5} = 4.8\ \text{A}$

(iv) $I_A = I_R + I_Z$

(c) (i) Number of cells $= \dfrac{12}{1.5} = 8$ cells

(ii) e.m.f. = 1.5 V

17. (a) (i) Current in the circuit

$= \dfrac{V}{R} = \dfrac{12}{1200 + 2000} = 3.75 \times 10^{-3}\ \text{A}$

p.d. across $2000\ \Omega = IR$

$= (3.75 \times 10^{-3}) \times 2000 = 7.5\ \text{V}$

(ii) With the increase in temperature, the resistance of the thermistor decreases and current in the circuit increases.

For the fixed resistor of $2000\ \Omega$,

$V = IR$ where R is constant and I increases, so V increases.

(b) As the temperature rises, the resistance of the thermistor decreases and the current in the coil increases. This causes the coil to become magnetised and attract the armature of the relay. The switch is then closed and the lamp is switched on.

18. (a) Current $= \dfrac{V}{R} = \dfrac{6.0}{15} = 0.40\ \text{A}$

(b) Current in lamp Q $= 0.65 - 0.40 = 0.25\ \text{A}$

Resistance of lamp Q $= \dfrac{V}{I}$

$= \dfrac{6.0}{0.25} = 24\ \Omega$