West Spring Secondary School

Thirst for Knowledge

MID YEAR EXAMINATIONS 2012

PHYSICS **5058**

SECONDARY 4 EXPRESS

NAME _____ ( ) **DATE** **09 May 12**

CLASS _____ **DURATION** **2 h 15 min**

Instructions to Candidates

Section A (20 Marks)

There are **twenty** questions in Section A. Answer **all** questions.
For each question there are four possible answers **A, B, C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Section B (50 Marks) and Section C (30 Marks)

Answer **all** questions in the question paper on the spaces provided.

The number of marks is given in brackets [ ] at the end of each question or part question.

Candidates are reminded that **all** quantitative answers should include appropriate units. Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of physics than for correct answers.

Take g to be 10 m/s^2.

100

For Examiner's Use

SETTER: **Mr Prakash**

This document consists of **21** printed pages including this cover page. **[Turn Over]**

Section A (20 Marks)

1 A pair of vernier callipers is used to measure the diameter of a boiling tube.

Diagram 1 shows the vernier scale when the jaws of the vernier callipers are closed.

Diagram 1

Diagram 2 shows the vernier scale when the boiling tube is clamped between the jaws of the vernier callipers.

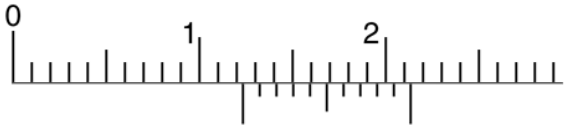
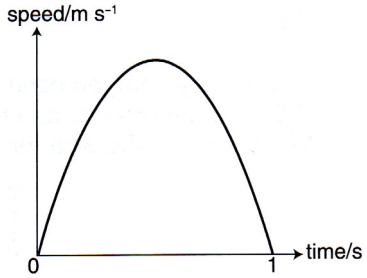


Diagram 2

What is the correct value of the diameter of the boiling tube?

A 1.23 cm **B** 1.25 cm **C** 1.27 cm **D** 1.31 cm

2 The graph shows the speed-time graph of a pendulum bob.



What is the period of the oscillation of the pendulum bob?

A 0.5 s **B** 1.0 s **C** 1.5 s **D** 2.0 s

3 A helicopter of mass 1000 kg rises vertically upwards with a uniform speed of 2 m/s.

What is the resultant force exerted on the helicopter as it rises?

A 0 N **B** 500 N **C** 2000 N **D** 10000 N

4 A bottle full of water has a mass of 250 g. When the same bottle is filled with liquid **X**, the mass becomes 160 g. The mass of the empty bottle is 100 g and the density of water is 1.0 g/cm^3.

What is the density of liquid **X**?

A 0.36 g/cm^3 **B** 0.40 g/cm^3 **C** 1.07 g/cm^3 **D** 2.50 g/cm^3

5 A car of total mass 850 kg slows down from 25 m/s to 12 m/s with a constant deceleration in 5 s.

What is the work done against the braking force?

A 11 kJ

B 110 kJ

C 204 kJ

D 266 kJ

6 Diagram 1 shows a mercury barometer and diagram 2 shows a mercury manometer placed in the same room.

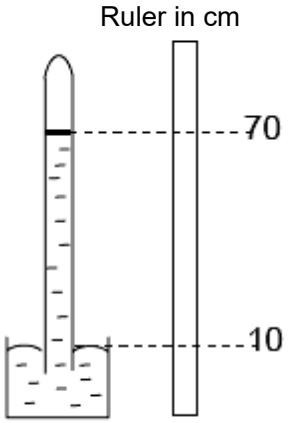


Diagram 1

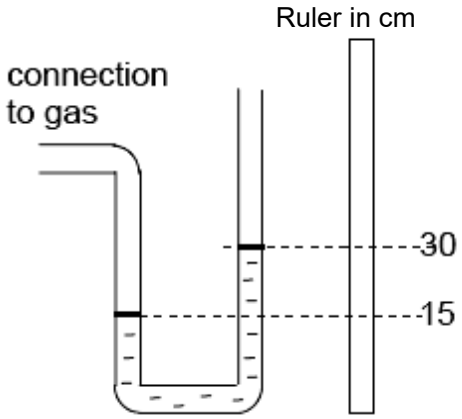
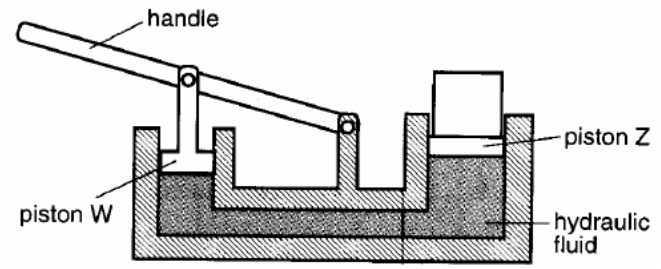


Diagram 2

What is the pressure of the gas?

A 15 cm Hg **B** 40 cm Hg **C** 75 cm Hg **D** 90 cm Hg

7 The diagram shows a simple hydraulic jack.

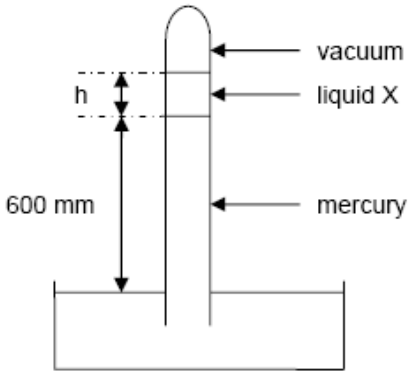


Which of the following modification will enable heavier loads to be lifted?

	Diameter of W	Diameter of Z
A	Doubled	Remains the same
B	Doubled	Halved
C	Remains the same	Halved
D	Halved	Doubled

8 The diagram shows a barometer which contains mercury and liquid X.

The atmospheric pressure is 750 mm Hg and the density of liquid X is $\frac{3}{4}$ of the density of mercury.



What is the height, h of liquid X?

A 110 mm **B** 150 mm **C** 200 mm **D** 250 mm

9 The Brownian motion of smoke particles is caused by _____.

A convection currents in the air

B collisions between air molecules

C collisions betweens smoke particles

D collisions between smoke particles and air molecules

10 A gas is heated in a sealed container.

Which of the following does **not** increase?

A The average distance between the gas molecules.

B The average kinetic energy of the gas molecules.

C The number of collisions per second by the gas molecules on the walls of the container.

D The force due to the collisions between the gas molecules and the walls of the container.

11 The e.m.f. of a certain thermocouple with one junction X in pure melting ice and the other junction Y in steam is 3.9 mV. With X still in pure melting ice and Y now in a certain boiling liquid, the e.m.f. is -12.7 mV.

What would the boiling temperature of the liquid be?

A -426°C

B -326°C

C 326°C

D 426°C

12 Which of the following statements explains why water is used as a coolant in the radiator of a motor car?

A Water is non-volatile.

B Water has a high specific heat capacity.

C Water is non-corrosive.

D Water has a high specific latent heat of vaporisation.

13 Diagram 1 shows a displacement-time graph of a particular wave.
Diagram 2 shows a displacement-distance graph of the **same** wave.

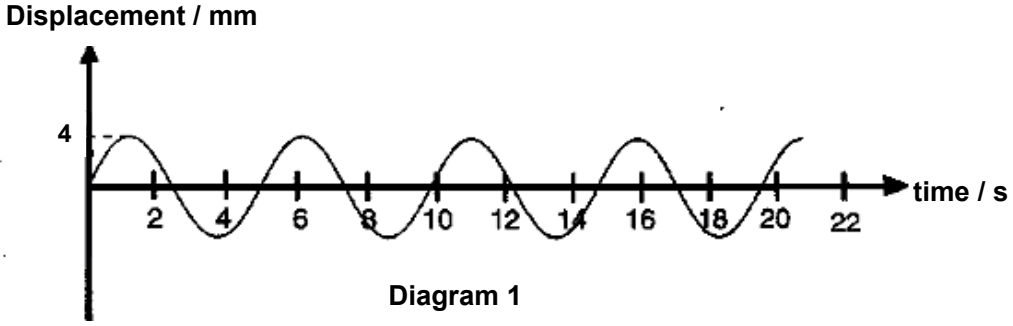


Diagram 1

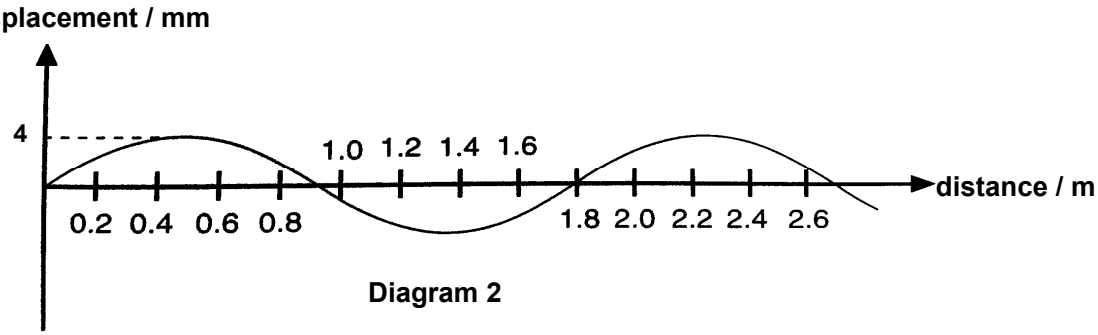
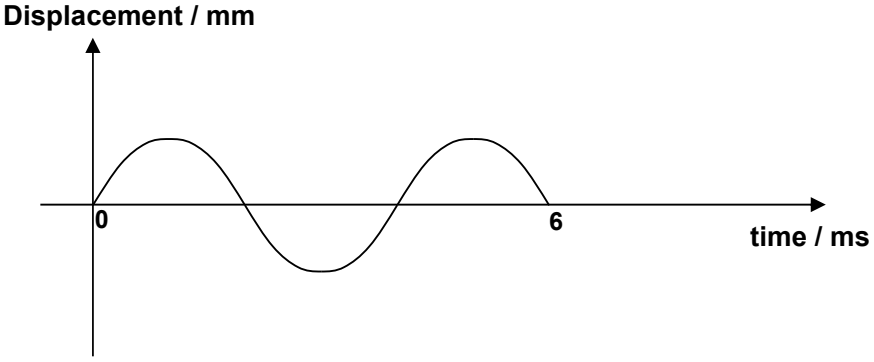


Diagram 2

What is the speed of the wave?

A 0.36 m/s **B** 0.72 m/s **C** 2.25 m/s **D** 9.30 m/s

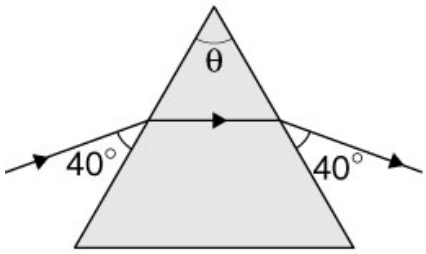
14 The graph shows a displacement-time graph of a sound wave.



What is the frequency of the sound wave?

A $\frac{1000}{2}$ Hz **B** $\frac{1000}{4}$ Hz **C** $\frac{1000}{6}$ Hz **D** $\frac{1}{2}$ Hz

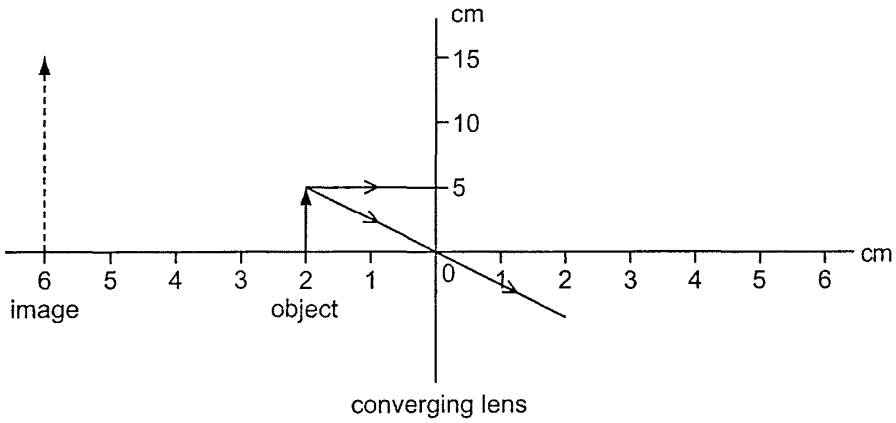
15 A light ray passes through a triangular glass prism as shown. The refractive index of glass is 1.5.



What is the value of angle θ?

A 51° **B** 53° **C** 61° **D** 65°

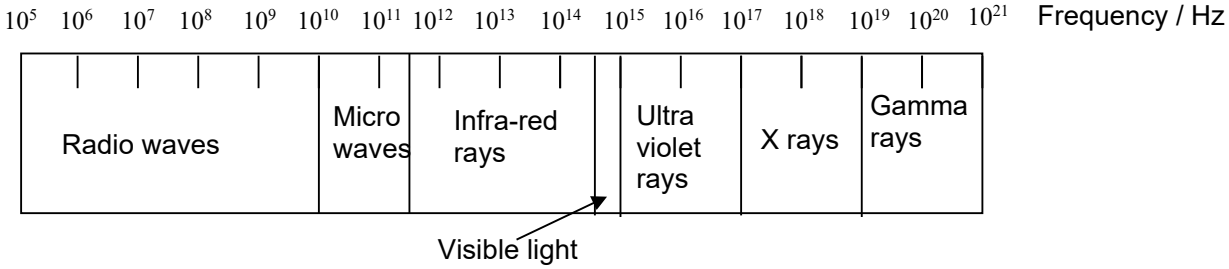
16 An object 5.0 cm high is placed 2.0 cm from a converging (convex) lens which is being used as a magnifying glass. The image produced is 6.0 cm from the lens and is 15.0 cm tall.



What is the focal length of the lens?

A 2.0 cm **B** 3.0 cm **C** 4.0 cm **D** 6.0 cm

17 The table shows the electromagnetic spectrum and the range of frequencies for each electromagnetic wave and rays.



A radiation P, has wavelength of 1.0 cm in vacuum, which section of the spectrum is P in?

A Radio Waves

B Micro Waves

C Infra Red rays

D Visible light

18 In a Chinese Orchestra performance, a student commented on the sounds of the erhu and the cello. Notes from the erhu are softer and higher pitched than the notes from the cello.

Which of the following statements is correct?

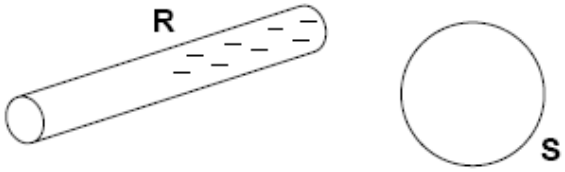
A Notes from the erhu have higher amplitude and a longer period.

B Notes from the erhu have a lower amplitude and a shorter period.

C Notes from the cello have a higher amplitude and a shorter period.

D Notes from the cello have a lower amplitude and a longer period.

19 An insulated charged rod R is used to give a permanent charge to an isolated conducting sphere S by electrostatic induction.



What is the required sequence of events?

A	Move R closer to S	→	connect S to earth	→	remove R	→	remove earth connection from S
B	Move R closer to S	→	connect S to earth	→	remove earth connection from S	→	remove R
C	Move R to make contact with S	→	remove R				
D	Move R to make contact with S	→	connect S to earth	→	remove R	→	remove earth connection from S

20 The lengths of two copper wires are in the ratio 1 : 2 and their radii are in the ratio 2 : 1.

What is the ratio of their resistances?

A 1 : 1 **B** 1 : 2 **C** 1 : 4 **D** 1 : 8

- End of Section A -

Section B (50 Marks)

1 Fig. 1.1 shows a cricket ball as it comes into contact with a cricket bat.

Fig. 1.1

The cricket ball has a mass of 0.16 kg and it hits the bat with a speed of 25 m/s. After being in contact with the bat for 0.0013 s, the ball rebounds with a speed of 22 m/s in the direction exactly opposite to its original direction.

(a) State the difference between *speed* and *velocity*.

.....

..... [1]

(b) Calculate

(i) the change in velocity of the cricket ball,

velocity change = ... [1]

(ii) the average acceleration of the ball whilst it is in contact with the bat,

acceleration = ... [2]

(iii) the average force exerted on the ball by the bat.

force = ... [2]

2 Fig. 2.1 shows a section of a roller-coaster in a vertical plane. An empty vehicle of mass 500 kg has a speed of 4.0 m/s at point A. The surface of the roller-coaster track has negligible friction.

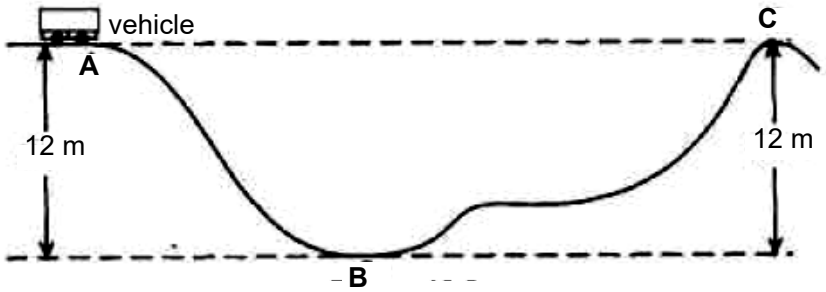


Fig. 2.1

(a) State the principle of conservation of energy

……

..…… [1]

(b) Calculate the speed of the empty vehicle at point B.

speed = ……..…… [2]

(c) To make the ride more exciting, the owner wants to increase the height of point C.

If the speed of the empty vehicle remains unchanged, calculate the maximum height the empty vehicle could reach at point C.

height = ……..…… [2]

(d) You have been employed by the owner of the roller coaster to think of ways to enable the empty vehicle to go over the maximum height which you have calculated in **(c)**, at point C. One of the ways is to increase the speed of the empty vehicle at point A.

Suggest another way how you could make it happen, without any calculations.

…… [1]

3 Heat is transferred by conduction, convection and radiation.

(a) (i) State which of the three methods is responsible for the transfer of heat from the Sun to the Earth.

.... [1]

(ii) Explain why the other two methods cannot be involved in this transfer.

....

.... [1]

(b) A hand feels hot when placed above a lighted match, as shown in Fig. 3.1.

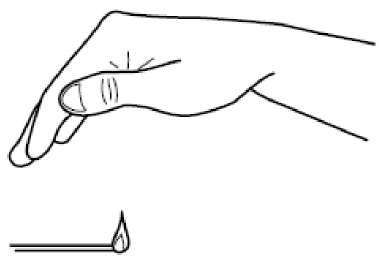


Fig. 3.1

Explain in detail how convection causes this to happen.

....

....

.... [2]

4 Water at a temperature of 16 °C enters an ice-making machine and emerges as ice cubes at a temperature of –5 °C. The melting point of ice is 0 °C.

(a) Calculate the total energy removed from 1.0 kg of water as it cools from 16 °C, changes into ice, and then cools to –5 °C.

specific heat capacity of liquid water = 4.2×10^3 J / (kg °C)
specific latent heat of fusion of water = 3.4×10^5 J / kg
specific heat capacity of ice = 2.1×10^3 J / (kg °C)

energy = ... [3]

(b) Using ideas about molecules,

(i) explain why energy is needed to change ice into water,

……..……..

……..…….....….

...……..……..… [1]

(ii) suggest why less energy is needed to change ice into water than to change the same mass of water into steam.

……..……..

……..…….....….

...……..……..… [1]

5 **ABCD** is a narrow beam of light ray emerging from an irregular shaped glass block as shown in Fig. 5.1.

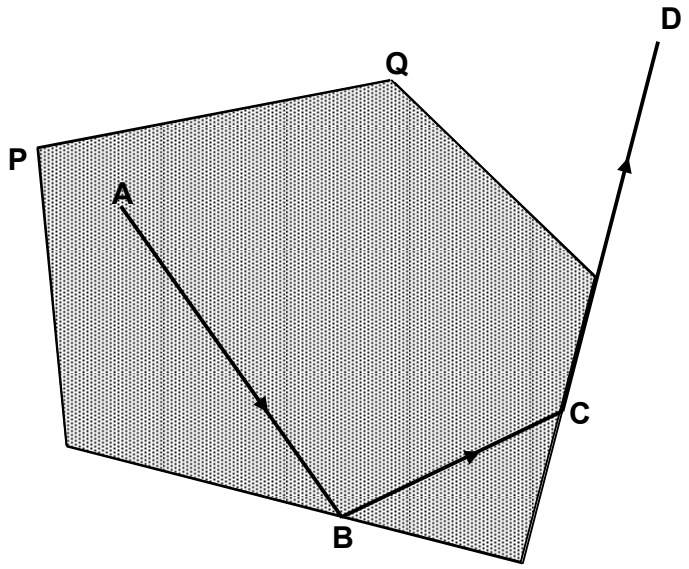


Fig. 5.1

(a) By **measuring** an appropriate angle on Fig. 5.1, determine the refractive index of the glass block. Indicate on Fig. 5.1 the angle you have measured.

Refractive Index = …… [2]

(b) State and explain what happened to the light ray at **B**.

.....

.....

..... [2]

(c) By producing the light ray at **A** back to boundary **PQ**, draw **<u>to scale</u>** the path of the light ray before entering the surface **PQ**. Show any calculations (in the space below) where necessary. [3]

6 Fig. 6.1 shows how ultrasound is used to produce an image of the heart.

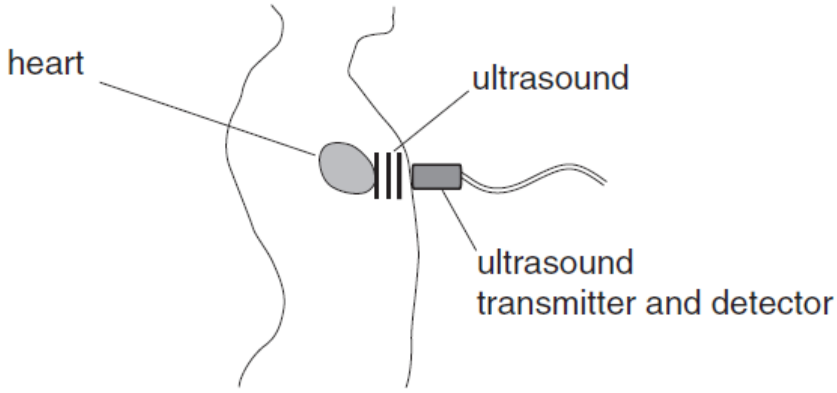


Fig. 6.1

(a) Define *ultrasound*.

……

……. [1]

(b) The ultrasound has a wavelength of 1.2 mm. The speed of the ultrasound in the human body is 1500 m / s.

Calculate the frequency of the ultrasound.

frequency = …… [2]

(c) Ultrasound is a longitudinal wave.
Describe how particles in the body move as the ultrasound passes.

You may draw a diagram if you wish.

……

……

……. [2]

(d) There are small bubbles of gas in the body.

Explain why these bubbles expand and contract as the ultrasound passes.

……

……. [1]

7 Fig. 7.1 shows a workman using a cordless electric drill.
The motor of the drill is powered by a rechargeable battery with an electromotive force (e.m.f.) of 18 V.
When the drill is used, the power supplied to the motor is 450 W.

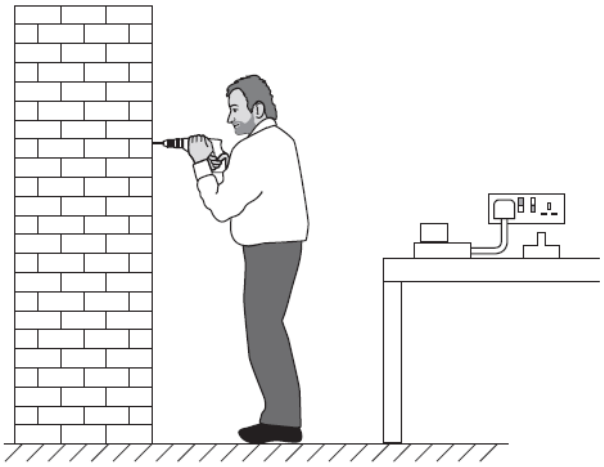


Fig. 7.1

(a) Explain what is meant by an *e.m.f. of 18 V*.

……

..... [2]

(b) The workman uses the drill for 90 minutes.

Calculate

(i) the electrical energy supplied to the motor,

energy = ... [2]

(ii) the charge that the battery supplies.

charge = ... [2]

8 A black box containing an unknown electrical circuit element is connected to a circuit as shown in Fig. 8.1.

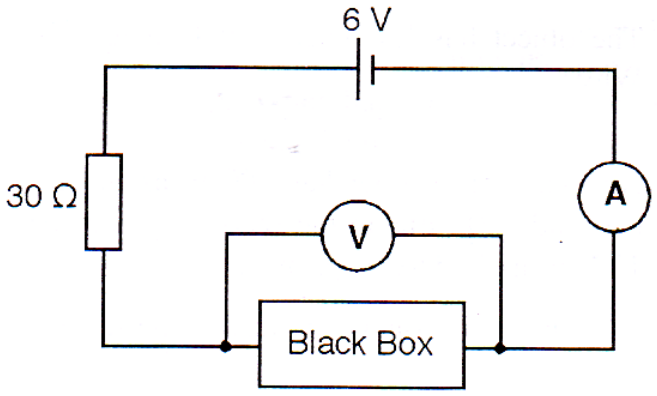


Fig. 8.1

A voltmeter is connected across the black box. The ammeter reading is zero.

(a) State the reading of the voltmeter.

……..……..…… [1]

(b) Suggest one possible electrical circuit component that may be found inside the black box. Explain your answer.

……..……

……..……

……..……

……..…….... [2]

(c) The terminals of the 6 V d.c. power supply are reversed and the ammeter reading is 0.40 A.

(i) Calculate the potential difference across the 30 Ω resistor.

Potential difference = ……..…… [1]

(ii) Hence, deduce the identity of the electrical circuit element inside the black box. Explain your deduction.

……..……

……..……

……..……

……..…….... [2]

9 Fig. 9.1 shows an electrical circuit.

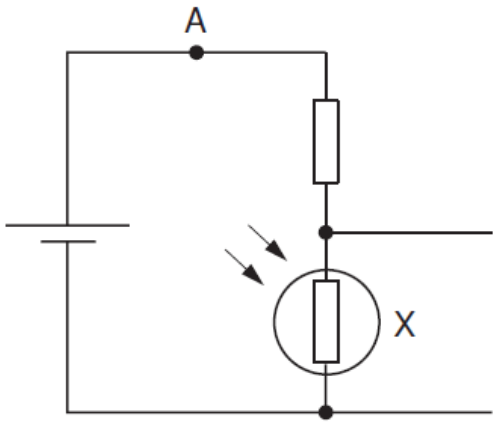


Fig. 9.1

(a) On Fig. 9.1, draw an arrow at **A** to show the direction of flow of the electrons in the wire. [1]

(b) State the name of component **X**.

.....[1]

(c) State and explain how the potential difference across **X** varies as the light shining on it becomes brighter.

.....

.....

.....

.....[2]

Section C (30 Marks)

10 Read the following passage about ejection seats and answer the questions that follow.

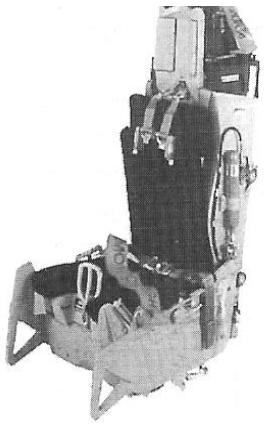


Fig. 10.1

Fig. 10.2

Ejection seats shown in Fig. 10.1 are important devices in military planes. The pilot, together with the seat, is ejected out of the plane in an emergency. Fig. 10.2 shows a test of the ejection process.
A dummy pilot sitting on the ejection seat is initially placed on the ground. The ejection process can be divided into two phases:

Phase 1: At time t = 0 s, a rocket installed under the seat is ignited. From t = 0 to 0.5 s, the seat accelerates upwards.

Phase 2: At t = 0.5 s, the rocket exhausts its fuel. After a while, the seat reaches its maximum height. The seat is then detached from the dummy and a parachute carried by the dummy is opened. The dummy eventually reaches the ground.

Fig. 10.3 shows the velocity-time graph of the dummy during the ejection process. Assume that the motion of the dummy is vertical throughout the process and the effect of air resistance is negligible before the parachute is opened.

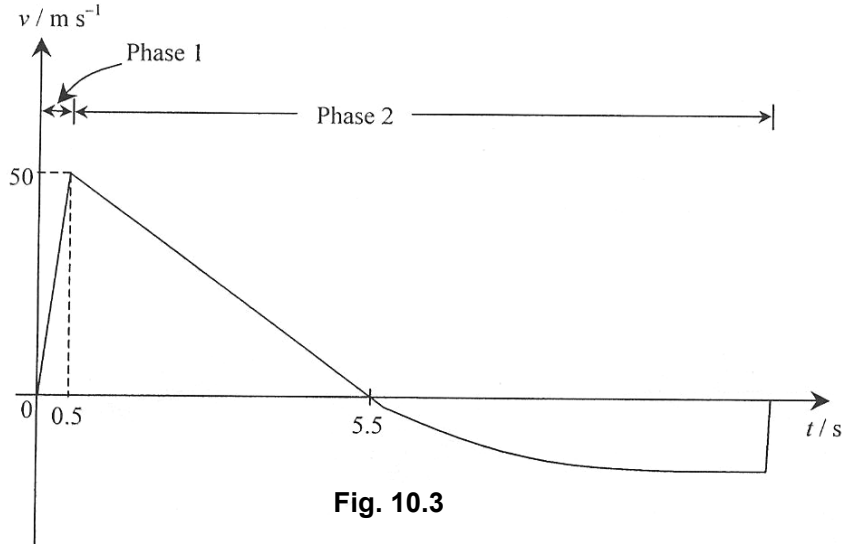


Fig. 10.3

Source: http://www.science.howstuffworks.com/ejection-seat2.htm

(a) On Fig. 10.3, label with a point **P** on the graph which corresponds to the instant when the dummy reaches the maximum height above the ground. [1]

(b) Calculate the maximum height above the ground reached by the dummy.

height = ……..…….…….. [2]

(c) The mass of the dummy is 80 kg.

Calculate the force exerted by the ejection seat on the dummy in Phase 1.

force = ……..…….…….. [3]

(d) The following sentence describes the motion of the dummy during phase 2.

After the parachute has been opened, the dummy accelerates at first at a decreasing rate and then falls with a uniform velocity until it reaches the ground as shown in Fig. 10.3.

By considering the forces acting on the dummy, explain why the dummy

(i) accelerates at a decreasing rate,

……...……...….

……...……

……...……

……...…… [3]

(ii) falls with a uniform velocity.

……...……...….

……...……

……...……

……...…… [2]

11 Fig. 11.1 shows a 12 V battery connected with 5 resistors, which are of 5Ω, 3Ω, 2Ω, 2Ω and 4Ω.

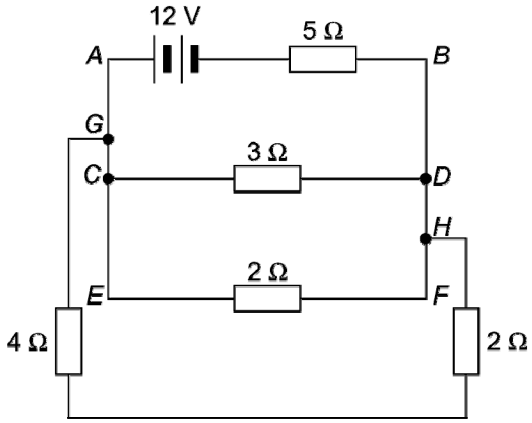


Fig. 11.1

(a) Calculate the effective resistance of the circuit.

Effective resistance = ... [3]

(b) Calculate the current passing through the battery.

Current = ... [2]

(c) Calculate the potential difference across the points **GH**.

Potential difference = ... [2]

(d) Calculate the current flowing through the 3 Ω resistor.

Current = ... [2]

12 Lasik (laser-assisted in situ keratomileusis) has become a popular refractive surgery for correcting myopia commonly known as short-sightedness for many teenagers and young adults. Many patients choose Lasik as an alternative to wearing corrective eyeglasses or contact lenses.

The surgery involves the use of laser (light amplification by stimulated emission of radiation) to permanently remove some of the corneal tissue and thereby changing the shape of the cornea.

Fig. 12.1 shows the information about the wavelength and the output power of some types of laser.

types of laser	wavelength /m	output power /W
Excimer	1.93×10^{-7}	20.0
Argon	4.98×10^{-7}	2.0
Krypton	5.68×10^{-7}	0.5
HeNe	$6.33 \times \times 10^{-7}$	0.005
Yag	10.6×10^{-7}	50.0

Fig. 12.1

The visible spectrum has wavelengths ranging from 4.0×10^{-7} m to 7.0×10^{-7} m.

(a) Which type of laser emits ultraviolet radiation?

…… [1]

(b) State **two** uses of ultraviolet radiation.

……

…… [2]

(c) Calculate the frequency of light from the HeNe laser. State clearly any constant used.

frequency = ……[2]

(d) During a lasik treatment, light from the Excimer laser is used to treat a patient's eye. This laser fires 15 short pulses of light. Each pulse lasts 0.5s.

Calculate the energy given out by the laser during the treatment.

energy = ……[2]

(e) Despite this advancement in technology, not all short-sighted patients can undergo lasik treatment. They still need to rely on the traditional diverging lens to help them to see far objects.
Fig. 12.2 shows the condition of short-sightedness where the image formed is in front of the retina.

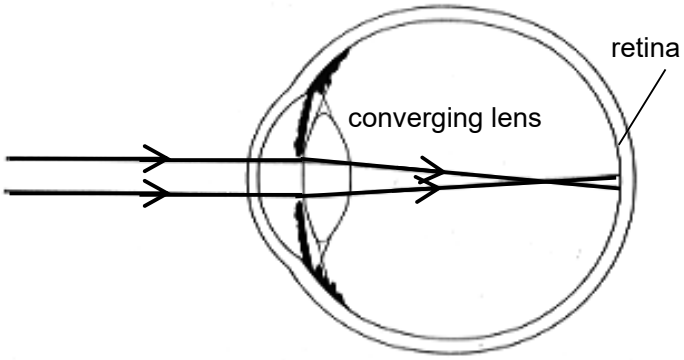


Fig. 12.2

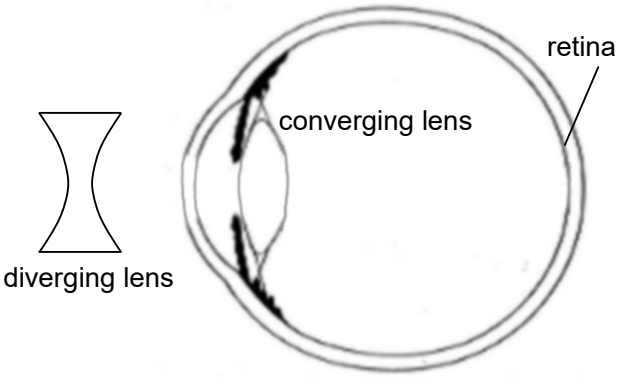


Fig. 12.3

On Fig. 12.3, complete the light path to show how the use of a diverging lens can help to focus a distant object on the retina. Explain how the diverging lens achieves this.

……

……

…… [2]

(f) Describe the characteristics of the image formed on the retina.

……

…… [1]

- End of Paper -

Sec 4 Physics Mid Year 2012 Answers

1	2	3	4	5	6	7	8	9	10
B	D	A	B	C	C	D	C	D	A
11	12	13	14	15	16	17	18	19	20
B	B	A	B	C	B	B	B	B	D

1 **(a)** velocity has a direction/is a vector **or** speed does not have a direction/is not a vector **or** displacement/time **and** distance/time
(**ign** speed is a scalar) B1

(b) **(i)** (–) 47 m/s B1

(ii) (a =) v/t **or** 47/0.0013 C1
(–) 3.6(1538 etc.) × 10^4 m/s^2 A1

(iii) (F =) ma **or** 0.16 × 3.6 × 10^4 C1
(–) 5.8(**or** 5.78461 etc.) × 10^3 N A1

2

a. Energy can neither be created nor destroyed.
It can be converted from one form to another / transferred from one body to another.

b. Let the speed be v
KE at B = GPE at A + KE at A
$0.5 \times 500 \times v^2 = 500 \times 10 \times 12 + 0.5 \times 500 \times 4^2$
$250\ v^2 = 64000$
$v^2 = 256$
$v = 16\ ms^{-1}$

c. Let maximum height be h
GPE at C = GPE at A + KE at A = 64000
$500 \times 10 \times h = 64000$
$h = 12.8$ m

d. ~~Increase the speed of the vehicle at A. /~~ Increase the height at A.

3 **(a)** **(i)** Radiation
(ii) Conduction and convention needs matter/particles

(b) Volume of air increases and becomes less dense and rises towards the hand.

4 **(a)** $Q = mc\Delta\theta + ml_f + mc\Delta\theta$
$= (1)(4200)(16-0) + (1)(340000) + (1)(2100)[0-(-5)]$
$= 67200 + 340000 + 10500$
$= 417700$ J (418000 J 3 s.f)

(b) **(i)** break bonds // separate molecules // give molecules more P.E.
(ii) (different) change in distance // molecules not so far apart // incomplete bond breaking // doesn't push atmosphere back // less work against atmosphere

5

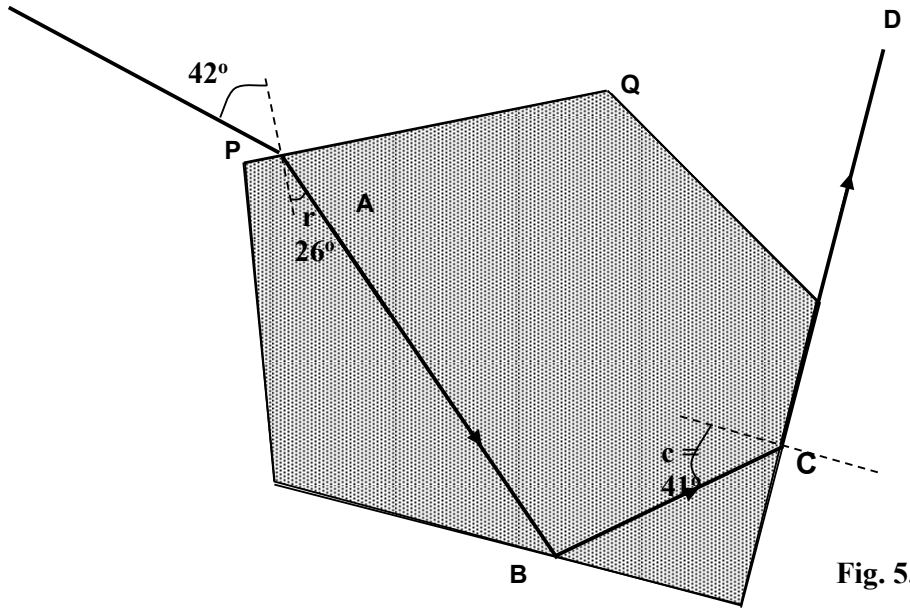


Fig. 5.1

(a) By measurement, the critical angle, c, is 42°

$$\acute{\eta} = \frac{1}{\sin c}$$

$$= \frac{1}{\sin 41^{o}} = 1.52$$

(b) It went through total internal reflection. At B, as the light ray travels from the denser medium towards a less dense medium, the angle of incidence at B in the denser medium is more than the critical angle of 42° and so total internal reflection occurs. [2]

(c) By measurement, angle r in the medium at the surface PQ is 26°. [Except 25°-27°]

$$n = \frac{\sin i}{\sin r}$$

sin i = 1.52 x sin 26°

i = 42° [Nearest Degree]

6 (a) (sound) too high a frequency to be heard or (frequency) above 20 kHz

(b) (f =) v/λ or v = f λ algebraic or numerical
1 250 000 Hz

(c) vibrate/oscillate
vibration etc. in same direction as/parallel to wave/energy or horizontally

(d) pressure increases and decreases or compressions and rarefactions or particles come together and move apart

7 (a) 18 J of energy is needed to drive a unit charge around the complete circuit.

(b)(i) E = Pt = (450)(90 x 60) = 2430 000 J

(ii) Q = E/V = 2430 000/18 = 135 000 C

8 (a) 6 V

(b) Circuit Component: **An Open switch. Blown fuse. Blown bulb. A cell of 6 V with terminals reversed. A diode in reverse bias. A voltmeter, LDR in the dark, thermistor at low temperature**

Explanation: in terms of (i) **open circuit** or (ii) **extremely high resistance** depending on the component you choose.

(c) (i) V = IR
= (0.40)(30)
=12 V

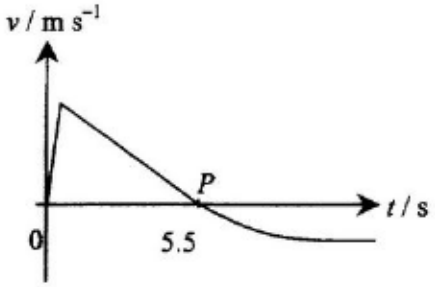
(ii) Since the only component with resistance is the 30 Ω fixed resistor and the p.d. across it is 12 V, the total e.m.f of the circuit is 12 V. Hence, the circuit element is a 6 V cell/battery in series with terminals in the opposite direction to the 6 V cell shown in fig. 8.1.

9 (a) arrow anticlockwise anywhere near top line of circuit

(b) LDR or light dependent resistor

(c) Under bright condition, the resistance of X decreases. By the idea of potential divider, the potential difference across X decreases too.

10 (a & b & c)

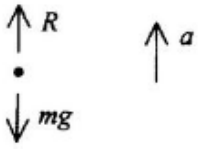


Maximum height reached by the dummy
= area under the v-t graph from $t = 0$ to 5.5 s

$$= \frac{50 \times 5.5}{2}$$

= 137.5 m (OR ≈ 138 m)

Let R be the force exerted by the ejection seat on the dummy in Phase 1.



Acceleration of the dummy $a = \frac{v-u}{t}$

$$= \frac{50}{0.5} = 100 \text{ m s}^{-2}$$

Equation of motion of the dummy:

$R - mg = ma$
$R = m(g + a)$
$= 80(10 + 100)$
$= 8800$ N

10(d)(i) As the speed of dummy increases, the air resistance on dummy increases while the dummy's weight remains constant. Hence, the downward resultant force acting on the dummy decreases. Using a = F/m, the dummy's acceleration decreases too.

(ii) As the speed of dummy increases, the air resistance on dummy increases until the air resistance and the weight are equal. Hence, the resultant force acting on the dummy is 0 N. Using a = F/m, the dummy stops accelerating and move at a uniform velocity.

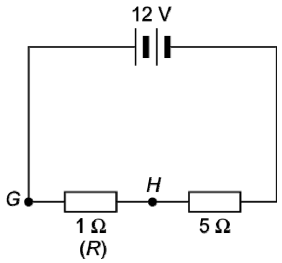
11 (a) The equivalent resistance of the branch $GH = 4\ \Omega + 2\ \Omega = 6\ \Omega$.
Since the resistance at the branch *GH*, *EF* and *CD* are in parallel,
their equivalent resistance: $\frac{1}{R} = \frac{1}{6} + \frac{1}{2} + \frac{1}{3}$

$R = 1\ \Omega$

Since *R* is in series with the 5 Ω resistor, the equivalent resistance of the circuit
$R_{eff} = 5\ \Omega + 1\ \Omega$
$= 6\ \Omega$

(b) $I = \frac{V}{R} = \frac{12}{6}$
$= 2$ A

(c) Since we only know the total current flows through the circuit, we should consider the simplified circuit:



Hence, the required voltage $V = IR$
$= 2\ \text{A} \times 1\ \Omega$
$= 2$ V

(d) As branch *CD* is in parallel with branch *GH*, the voltage across them are the same. Hence, the current flowing through the 3 Ω resistor is, $I = \frac{V}{R} = \frac{2}{3}$
$= 0.667$ A

12

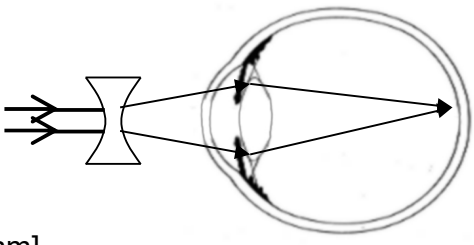
(a) Excimer

(b) sterilisation in hospitals or sunbed or check for counterfeit note (Any 2)

(c) $v = f\lambda$ [1]
3×10^8 m/s = f x $6.33\ 10^{-7}$
f = **4.74×10^{14} Hz**

(d) energy = Pt [1]
=15 x 0.5 x 20
= **150 J**

(e)



[1 for diagram]

Diverging lens diverge the rays a little and then converge.

(f) Real, inverted and diminished. [All three correct to get 1 mark.]