lower secondary

challenging drill solutions book A

solutions to drill questions from top schools

- new solutions from top schools since 2003
- complete step-by-step solutions
- complete and true encyclopedia of question-types
- comprehensive "trick" questions revealed
- critical errata corrected and edition updated

thomas bond MA (Cantab)
chris hughes MSc (Londin.)

updated edition

THEMIS

SCIENCE

SCIENCE

Lower Secondary
Challenging Drill Solutions
Book A

solutions to drill questions from top schools

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Updated Edition

Thomas Bond
Chris Hughes

Cosmic's mission is to bring knowledge to the masses. We firmly believe that education is the greatest enabler in enriching the lives of millions. This journey began with the publication of our first book in 1994.

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version 1.02

Foreword

"Give a man a fish, and you feed him for a day; teach him to fish – and you feed him for a lifetime."

— *author unknown*

Every one of the **guide** series is a *fisherman* book – *i.e.*, they teach *concepts*. Each step in the *concept* is thoroughly explained and illustrated further by *worked examples* or *problems*.

The ***effective*** or ***critical*** **guide** fundamental series is best suited for beginners. Although these *guides* are complete on their own, but we do encourage students who become more familiar with the subject matter; to progress to more *extensive guides*. It is not unusual for certain schools wanting to broaden their students' minds to teach beyond the actual examination (exam) syllabus *per se*. For this, students are best advised to immediately use the ***complete*** or ***total*** **guide** extensive series.

For students with *extreme intelligence*, they will find the *guides* a little too cumbersome to refer. They should then use the *fisherman fast-learner* books, *i.e.*, books that are to help prepare students taking the actual exams (quickly). These books provide the ***critical*** **study notes** to all exam concepts.

Knowing how to use the fishing rod, line, sinker, hook and bait to fish is not enough; one still needs the *encyclopedia of fish*, *i.e.*, the ***challenging*** **learn-by-example** (LBE) fundamental series. Out there, there will be many kinds of fish; each requires slightly different method to catch, for example, capturing a shark definitely demands a different technique from that of catching a salmon. In the same way, one must get familiar with the various exam question-types so that one can confidently score. The *challenging LBE* series provides training up to ordinary exam-standard. Again, for students going beyond, the ***demanding*** **LBE** extensive series is a must-have.

Lastly, you should not neglect fundamental *work-out* with our ever-popular ***challenging*** **drill questions** (with answer keys only) and **solutions**. Again for students with *extreme intelligence*, do complement learning with our ***oh-my-god*** **(*omg*) drill questions** (with solutions), an all-embracing extensive *work-out* series.

For teachers, please use the **teacher's reference** (*coming soon*).

Each year, popular "past-years exam questions" books are usually printed without accompanying accurate solutions, mark schemes and appropriate examiners' requirements; for this lack, please use our fully compatible ***complete*** **yearly solutions** series. In addition to accurate answer scripts, common errors as highlighted by the exam board are also appended. Due to popular demand, we have reinforced some of these commonly-asked-ordinary-exam-questions as ***challenging*** **practice questions** and **solutions**.

Knowledge is power. But, there are publications out there that provide **false information** and it may be difficult for students to separate **accurate education** from this *false information*. The trust in our extremely rigorous publishing control allows us to be confident in the **reliable truth** the students would receive.

Latest and continuous updates and errata are available at <**www.yellowreef.com**> and one may purchase these reliable publications from your nearest major bookstore or online from <**www.stargazz.com**>.

All of the above books are created to fulfill the urgent need in mastering the subject matter most efficiently. It will undoubtedly provide a firm platform for the student to score extremely well in his/her exams. But knowledge at its highest form is not a science but an art; to do this, please use our **journey** books – the ultimate mastery of the art form.

"Using the right tool at each appropriate stage of exams preparation saves time. No point trying to pretend that a simple screwdriver would suffice at all situations."

"If I have seen yonder, it is by standing on the shoulders of giants." – *Sir Isaac Newton*

"The actual journey of inspiration only begins when one takes the first step towards learning humbly from the masters." *– paraphrased by the authors*

"The human form factor remains unchanged, so learn it, love it and master it and you lord over all things." – *Chris Hughes*

"Look at the examples around you, therefore, never chase after money. If truth be told, it is one's passion that gets the ultimate prize. Derive first the pleasure of creating things that are untouchable by all principalities." – *Thomas Bond*

version 3.20 – 05-09
ℂQRNZ
9646

A token of appreciation

Hard as we tried. No matter how careful our repetitive effort in seeking out errors in our publications; some typographical, factual or calculation oversights still elude us. For that, we hope you could accept our sincere apologies here and would greatly appreciate it if you could point them out to us either through email [*sales@yellowreef.com*] or website [*http://www.yellowreef.com*].

In our continuous and relentless pursuit of excellence, we would like to extend a very small token of appreciation to you for these selfless feedbacks (per mistake reported).

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By this partnership of collective wisdom, we truly hope to provide **accurate education** to users of our excellent publications.

version 1.04

Leveling the playing field

A **level playing field** is a concept about fairness, not that each player has an equal chance to succeed, but that they all play by the same set of rules.

Not every person is born with a silver spoon in his mouth, *i.e.*, born into a wealthy family. There is, therefore, no such thing as a *level playing field* to begin with. Even so, it is not a peccadillo to be born poor.

Although wealth is not an absolute measure of one's happiness and self-worth, it nevertheless provides one with a sense of well-being.

If one is unskilled, one has no choice but to take on only lowly paying jobs which require little or no job knowledge, such as a street-cleaner or a dish-washer (no pun intended).

In order to improve one's standing in the society, one has to be schooled in both knowledge and skill. In its broad sense, **education** refers to any act or experience that has a formative effect on the mind, character, or physical ability of an individual. It is usually transmitted through schools, colleges and universities.

With *education*, one can choose to be a chef, a dancer, an artiste, a lawyer, an engineer, a doctor, an accountant or even a banker. Even though one might have come from a lowly background, one can still advance comfortably to higher rungs of the society and improves one's life.

Save for, if one still has the passion to be the best street-cleaner or dish-washer in town, why not? One can still choose his or her own path.

Hence, *education* is about having one's own choice and definitely one's ultimate leveler.

But, the process of *education* is not cheap.

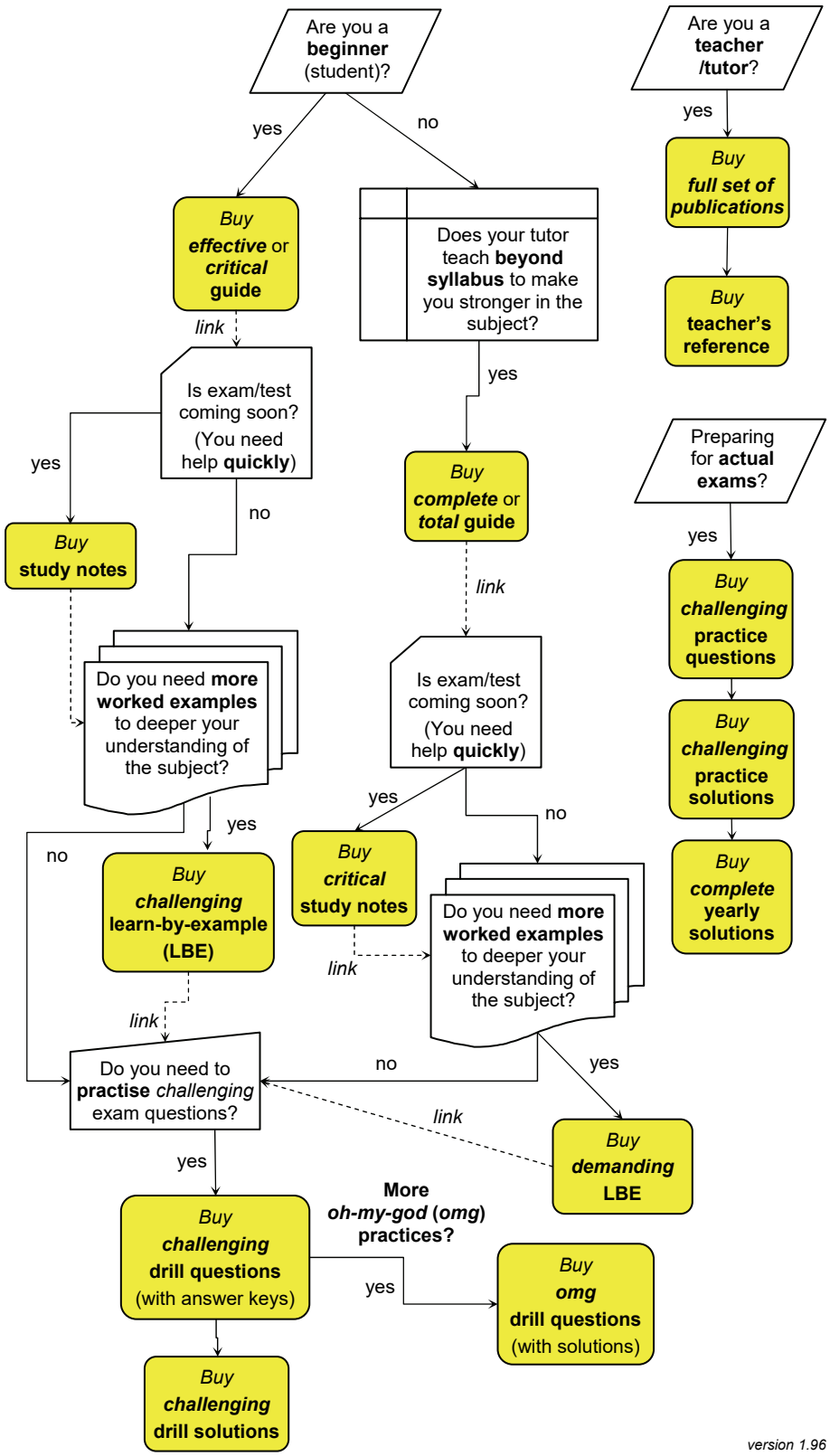
We are prepared to assist in whatever ways we can to provide this leveler. Any students that are currently under any *financial assistance schemes* or deem unable to procure any of our publications to improve their grades or if you are a compassionate teacher or parent involves with these students, please do get in touch with us at <*sales@yellowreef.com*> on the number of **free copies** you need.

For those of you who are not eligible for this help, but still wanted some form of help, please visit <*www.yellowreef.com*> and look under the <*books*> or <*solutions*> sections for some free goodies.

Here, may we wish all talents, big and small, be allowed to blossom to their fullest extent.

version 1.03

ROAD MAP



CONTENT

content

Catalogue

	ordinary level	*advanced level*
effective or ***critical*** **guide**	An ample *effective* guide for students starting out at Sec 3 and *critical* at Sec. 4 or 5.	An ample *effective* guide for students starting out at JC year 1 and *critical* at JC year 2.
critical **study notes**	An intense and sharp delivery of concepts. The structure and organization are direct verbatim imports from top schools.	An intense and sharp delivery of concepts. The structure and organization are direct verbatim imports from top colleges.
challenging **learn-by-example (LBE)**	The MCQs / structure questions were taken from actual exams. The deliberations were from easy to hard. (topical)	The MCQs / structure questions were taken from actual exams. The deliberations were from easy to hard. (topical)
challenging **drill questions** (with answer keys)	For practice. The MCQs / structure questions were taken from actual preliminary exams of *top schools*. (topical)	For practice. The MCQs / structure questions were taken from actual preliminary exams of *top colleges*. (topical)
challenging **drill solutions**	The step-by-step solutions to *challenging* drill questions.	The step-by-step solutions to *challenging* drill questions.
complete **guide**	A complete and total deliberation of extensive concepts taught in *top schools*.	A complete and total deliberation of extensive concepts taught in *top JCs*.
demanding **LBE**	The MCQs / structure questions were taken from actual exams worldwide. The deliberations were from easy to hard. (topical)	The MCQs / structure questions were taken from actual exams worldwide. The deliberations were from easy to hard. (topical)
oh-my-god **drill questions / solutions**	For practice. The MCQs / structure questions with solutions were taken from actual exams of *top schools* worldwide. (topical)	For practice. The MCQs / structure questions with solutions were taken from special and/or H3 actual exams worldwide. (topical)
challenging **practice questions**	Mock exam questions arranged in a topical order.	Mock exam questions arranged in a topical order.
challenging **practice solutions**	Solutions to mock exam questions arranged in a topical order.	Solutions to mock exam questions arranged in a topical order.
complete **yearly solutions**	The solutions to actual exams arranged in a yearly format.	The solutions to actual exams arranged in a yearly format.
teacher's reference	A complete and comprehensive guide for teachers.	A complete and comprehensive guide for teachers.

version 1.69

- **Compile school notes /Write novels**
- **Draw /Design comics/art books**
- **Compose popular tunes /lyrics /Sing**
- **Act**

We are looking for talented person(s) who could help us to:

- prepare school education books for *advanced*, *ordinary* or *primary* levels.
- write *short stories* or *novel* according to our requirements.
- write simple *English readers*.
- draw *comics* and design *cartoon guides*/*art books*.
- compose popular *tunes*, *lyrics* and perform the *compositions*.
- write, produce, direct or act in a *short skit*, *movie* or *talk-shows*.
- compose, write, conduct or sing a *song* and its *mtv*.

The person(s) must possess the following:

1. creative and genuine.
2. familiar with Microsoft Word 2003/2007 or later, mathtype 5.2 (or Equation editor 2007 or later) and drawing tools. Adobe Acrobat Professional CS3 or later installed.
3. owns a fast Microsoft Windows PC (with proper internet connection), and skilled in working with clip arts and text. ability to produce quality work fast and on-time (only a short time would be allowed). must have distinction grade for the assignment subject-type (e.g. distinction for additional math for assignment in additional mathematics notes; other subjects may be english (AL), geography (AL), biology (AL), mathematics and so on).
4. must be an undergraduate / graduate / nafa / lesalle / music school or higher.
5. must be committed to the job assigned (you cannot quit half-way, otherwise we will withhold payment).
6. Graphics, music or movie guys, please be familiar with your own skills and softwares.

This is not a pure typist job. Prospective candidate will work from home and be paid on a per-job basis. Further details and contract will be disclosed to successful candidates.

Interested applicant please email us at <**sales@yellowreef.com**> with your name, recent photo, full CV (include all o-level, a-level, uni results), contact numbers, email address, subject(s) that scored distinction(s), scans of your identity card or identification papers (we don't wish to employ illegals).

Payment is by direct-bank-in to personal bank account.

As you must learn and know more about us before your interview, you are required to go to any established popular bookstores and ask for the text/assessment department. In that section, look for the labels: **yellowreef***,* **cosmic** *and* **step-by-step***. Questions will be asked about these books/DVDs or music CDs.*

If you are successful, you will serve under an appropriate supervisor.

Lastly you must be a **fun guy** to work with …

Go to www.yellowreef.com and register as a member of the forums and get the latest updates. Full job scope and complete details are provided.

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You are talented, sign up now, *i.e.*, if you can:

- **Sing/Act** – write/compose/sing a song; write/act/direct a movie, show or skit,
- **Draw/Write** – Draw/paint a cartoon book, comic or art; write a novel or short story, or
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sign up with us today ... (coming soon)

version 1.01

1

THE SCIENTIFIC ENDEAVOUR

Learning Outcomes

Candidates should be able to:

Knowledge, Understanding and Application

(a) recognize that the study and practice of science involve three major elements: attitudes, processes or methods, and products.

(b) recognise that the products of science are the tested data collected by scientists for centuries and explain with examples how people working with science have formulated concepts, principles and theories.

(c) show an awareness that science is not confined to the laboratory, but is manifested in all aspects of the world.

(d) discuss the uses and benefits of science and technology to society.

(e) show an awareness of the limitations of science and technology in solving societal problems.

Skills and Processes

(a) use scientific inquiry skills such as posing questions, designing investigations, evaluating experimental results and communicating learning.

(b) evaluate the benefits and limitations of science and technology.

(c) communicate their ideas on the benefits and limitations of science through discussions and presentations.

Ethics and Attitudes

(a) show an appreciation that scientific inquiry requires attitudes such as curiosity, creativity, integrity, openmindedness and perseverance.

(b) value individual effort and working in a team as part of scientific inquiry.

(c) show an appreciation of the moral and social issues in the applications of science.

(d) value individual effort and working in a team as part of scientific inquiry.

❶ The scientific endeavour

MCQs

01-M-01

D

A luminous flame is weak and unsteady. The flame is orange colour and is not as hot as non-luminous flame.

01-M-02

B

To support apparatus during experiments.

01-M-03

D

A scientist has to be open-minded and humble, to recognize that products of science are the tested data collected by scientists for centuries.

01-M-04

B

Returning unused chemicals to their containers may contaminate the whole bottle because the beakers or test tube used may not be absolutely clean.

01-M-05

B

test tube
containing small amounts of liquid chemicals for heating or mixing or to aid pouring of a liquid from the test tube to a beaker

pipette
for measuring a specific volume of liquid i.e. 10.0 cm^3 or 25.0 cm^3

dropping funnel
used to transfer fluids, especially useful when there is a need to add reagents slowly

measuring flask
come in a number of shapes and a wide range of sizes. Used for making solutions or for holding, containing, collecting, or sometimes volumetrically measuring chemicals.

01-M-06

C

By using the test tube holder, it helps to prevent burns. To avoid getting scaled from accidental spill, we have to hold the test tube at an angle away from anyone.

01-M-07

B

The symbol with the hand and test tubes is the sign for corrosive substances. The other symbol with a fan is the sign for radioactive substances.

01-M-08

A

The skull-and-crossbones symbol, consisting of a human skull and two bones crossed together under the skull, is a common symbol for poison. In this case, mercury is a poisonous chemical element.

01-M-09

B

The flame symbol on the bottle of alcohol represents flammable/highly flammable substance.

01-M-10

D

This symbol represents irritating or simulative substances. These substances involve health risk or can irritate the skin.

01-M-11

C

This is an evaporating dish which is used to evaporate liquid in a solution.

01-M-12

A

Invention of nuclear weapons are harmful to people and their environment.

01-M-13

A

The proper use of a water trough is to contain water while preparing gases.

01-M-14

D

If any chemical come in contact with any part of your body, wash it thoroughly under running tap water.

01-M-15

C

A strike back in a Bunsen burner can occur when there is too much air entering the barrel.

01-M-16

B

In order to conduct a fair test on the rate of evaporation of two liquids, equal volumes of liquids must be used (constant variables).

01-M-17

A

Since Jack suspects that the decline in harvest is due to the fertilizers used, he should use different brands of fertilizers as experimental variable.

01-M-18

B

A yellow flame is luminous due to small soot particles in the flame, thus leaves a layer of carbon on whatever it is heating.

01-M-19

D
Chemicals should not be tasted unless instructed by teacher.

Excess should not be poured back into the bottle as it will result in contamination.

Students should always report any spills or accidents happened in the laboratory.

01-M-20

D

The variables must be identified before carrying out the experiment. Introducing new variables during the experiment will compromise the results.

01-M-21

B

test tube
containing small amounts of liquid chemicals for heating or mixing or to aid pouring of a liquid from the test tube to a beaker

crucible
for heating a solid directly over a flame

beaker
for containing or collecting chemicals

evaporating dish
to evaporate the liquid in a solution over a Bunsen burner

01-M-22

C

Kerosene is both flammable and toxic.

01-M-23

B

Burette is used for measuring the volume of liquid to an accuracy of 0.1 cm^3.

01-M-24

C

Science enables us to **solve** problems and improve lifestyles. It does not create problems.

01-M-25

A

Observation helps us to gather information by using our five senses.

Classification is the process of categorizing information.

Prediction requires guessing the most probable result of a future event based upon on evidence or trends.

Communication involves using words, symbols or graphics to describe an object, action or event.

Questions

01-Q-01

(a) flammable

(b) poisonous

01-Q-02

(a) Brand A has a better absorbency.

(b) Independent variable is the brand of the kitchen towel. Dependent variable will be the amount of water observed. The controlled variables are the temperature of water and the amount of kitchen towels used for each brand.

(c) 1. Fill a beaker of water of 100ml.

2. Cut a strip of kitchen towel of one of the brands of 5cm by 30cm.

3. Dip 3cm of the strip into the beaker of water.

4. Remove the strip after 15s and check the amount of water left in the beaker and record it.

5. Repeat steps 1 to 4, 3 times with the same brand of kitchen towel and find the average of the amount of water left in the beaker.

6. Repeat steps 1 to 5 with a different brand of kitchen towel.

7. Compare the results, the brand that has less amount of water left in the beaker has a better absorbency.

01-Q-03

(a) Conical flask

(b) The function of a conical flask is for containing chemicals or collecting liquids while preventing spillage, i.e. during titration.

01-Q-04

(a) Barrel; Air hole

(b) To allow air to enter for combustion. It can be adjusted to control the type and size of flame.

01-Q-05

(a) DBECA

(b) A typical luminous flame will be observed, with distinct 'blue region'.

(c) Ineffective combustion caused by lack of oxygen during burning and the presence of impurities in the wood will require longer burning.

01-Q-06

(a) Boiling tube / beaker.

(b) Non-luminous flame.

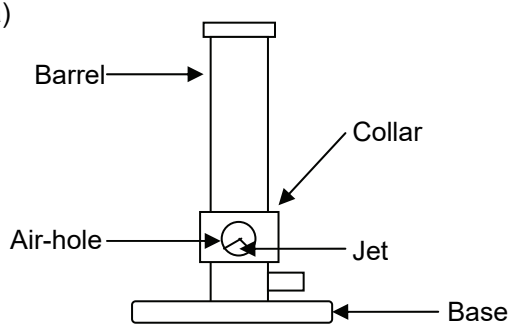
It has high temperature.

It does not give out soot

It has a steady flame.

01-Q-07

(a)



(b) Barrel – to raise the flame to a suitable height for heating.

Collar – control the amount of air entering.

(c) Use the collar to open the air hole fully.

01-Q-08

(a) Burette

For measuring the volume of liquid to an accuracy of 0.1 cm^3.

(b) Pipette

For measuring a specific volume of liquid i.e. 10.0 cm^3 or 25.0 cm^3.

(c) Liebig condenser

To allow the distilled vapour to condense in order to collect the liquid.

(d) Distilling flask

For containing the liquid mixture in which the component liquid will be distilled when heated.

(e) Beaker

For containing or collecting chemicals.

(f) Evaporating dish

To evaporate the liquid in a solution over a Bunsen burner.

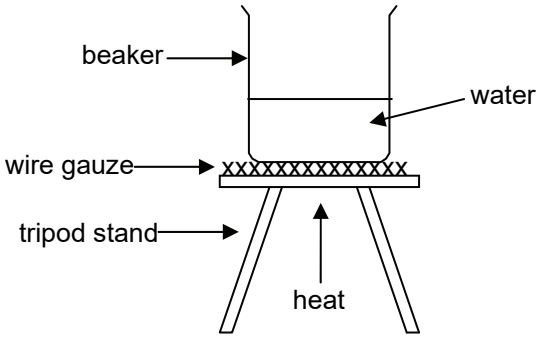
01-Q-09

(a) Test tube or boiling tube

(b) Pipette or measuring cylinder

(c) Gas jar

01-Q-10



1 •6

01-Q-11

(a) Record observations or measurements.

(b) Carry out experiment to test hypothesis.

(c) Accept the results

(d) Reject the results

(e) Suggest a new hypothesis.

2

EXPLORING DIVERSITY OF MATTER BY THEIR PHYSICAL PROPERTIES

Learning Outcomes

Candidates should be able to:

Knowledge, Understanding and Application

(a) explain the choice of the main classes of materials (metals, ceramics, glass, plastics, fibres) in the production of common household items, in terms of their properties, e.g.
- density
- strength
- hardness
- flexibility
- electrical conductivity
- thermal conductivity
- boiling/melting point

Skills and Processes

(a) make estimations and measure accurately length, volume and mass (including volume and mass of liquids and solids but not of gases) of matter using appropriate instruments (metre rule, measuring tape, vernier calipers, measuring cylinder, displacement can, electronic balance) and methods

(b) calculate density using the formula (density = mass/volume) and use the appropriate unit

(c) predict whether an object will sink or float by comparing its density with that of its surrounding medium

(d) classify a number of common everyday objects and recognise that there are many ways of classifying the same group of objects

(e) use data on the properties of different materials to evaluate their uses

(f) communicate their findings on classification and justify their reasons

Ethics and Attitudes

(a) display the habit of sustainable use of materials, e.g. preferential choice of products made from biodegradable materials, practising the 3Rs: reduce, reuse, recycle

(b) evaluate the environmental impact of excessive use of paper and disposal of plastics

(c) demonstrate precision and accuracy in making measurements (taking into consideration parallax and zero errors)

❷•❶ Basic scientific measurements

MCQs

02-1-M-01

B

SI unit of length is meter.

02-1-M-02

C

Time interval shown on the stopwatch is 4 minutes 25.16 seconds.

An electronic stop watch can measure up to an accuracy of 0.01 second.

02-1-M-03

D

Metre rule measures length of up to 100 cm while vernier calipers measure external and internal diameters of cylindrical and spherical objects with short lengths.

02-1-M-04

B

Volume of water before the stone is placed inside the measuring cylinder is 42 cm³.

02-1-M-05

D

Volume of stone = 66 - 42
= 24 cm³

Mass of stone = Density x Volume
= 2 x 24
= 48 g

02-1-M-06

B

Area = Length x Width
= 21 x 29.7
= 627 cm²

Volume = Length x Width x Thickness
= 21 x 29.7 x 0.005
= 3 cm³

02-1-M-07

C

Lower the stone to the bottom of the displacement can is **NOT** necessary in order to obtain an accurate result.

02-1-M-08

D

As shown in the diagram, the object floats in salt water of density 1.10 g/cm^3. This implies that the object is less dense than salt water.

	Liquid	Density / g cm^3	Status of object in diagram
(A)	Oil	0.890	Sink
(B)	Honey	1.40	Float
(C)	Water	1.00	Sink Midway
(D)	Glycerine	1.26	Sink

The object should float in glycerine with density 1.26 g/cm^3, thus Option D is incorrect.

02-1-M-09

D

Volume of cube = 4 x 4 x 4
= 64 cm³

Mass of cube = Density x Volume
= 8 x 64
= 512 g

02-1-M-10

C

Half an hour of coffee break = 0.5 h

A quarter of an hour stationary in a traffic jam = 0.25 h

Non travelling time = 0.5 + 0.25 = 0.75 h

Travelling time = 2 – 0.75
= 1.25 h

Speed = Distance / Time
= 75 / 1.25
= 60 km/h

02-1-M-11

D

Volume is the amount of space a substance occupies.

02-1-M-12

C

Original length of ribbon = 2.5 cm x 4
= 10 cm
= 100 mm

02-1-M-13

A

To correctly read the volume of a liquid, the eye has to be positioned at the same level as the meniscus to avoid parallax error.

02-1-M-14

D

Parallax error occurs when the eye is not correctly positioned when taking a reading regardless the type of measuring instruments used.

02-1-M-15

D

Density = Mass / Volume
= 2 / 1
= 2 g/cm³

If mass and volume is doubled, the density will be unchanged.

Density = Mass / Volume
= (2 x 2) / (1 x 2)
= 4 / 2
= 2 g/cm³

02-1-M-16

B

Mass of an object remains the same regardless of object's position such as on the moon or on earth.

SI unit of mass is kilogram.

The weight of an object is different from its mass. Weight is the force of gravity acting on an object and is dependent on the location.

Option A, C and D is incorrect.

The mass of an object depends on the number and size of each particle which make up the object, therefore changing its shape will not change the mass.

Only option B is correct.

02-1-M-17

C

Volume of soup = ¾ x 80 = 60 cm³

Density of soup = Mass / Volume
= 64.7 / 60
= 1.08 g/cm³.

02-1-M-18

B

Period of the pendulum = 18.8 / 20 = 0.94 s

02-1-M-19

A

The digital display of the time of an electronic stopwatch makes reading time easier. Option A is correct.

The electronic stopwatch can measure time intervals accurate to the hundredth of a second. Thus option B is incorrect.

The electronic stopwatch can measure time intervals in hours. Thus option C is incorrect.

The presence of more knobs to control time management is not a main advantage over mechanical stopwatch. Thus option D is incorrect.

02-1-M-20

C

Time = Distance / Speed
= 400 / 330
= 1.21 s

02-1-M-21

A

Time taken = 2 / 4 = 0.5 s

02-1-M-22

C

Liquid Y's density = Mass / Volume
= 164 / 20
= 8.2 g/cm³

Metals with density greater than 8.2 g/cm³ will sink to the bottom of the jar which is Copper and Gold. Thus option C is correct.

02-1-M-23

B

Rate compares two different physical quantities, usually with time.

A plant grows taller each day. This is a comparison of length and time.

A boy cycles from home to school in 20 minutes. This is a comparison of distance and time. Thus option B is correct.

02-1-M-24

A

An electronic stop watch can measure up to an accuracy of 0.01 sec.

02-1-M-25

D

15 kilometres = 150 0000 centimetres.

2900 metres = 2.9 kilometres.

3600 seconds = 1 hour

Thus option A, B and C are incorrect.

1 kg = 1000g
53.8 kg = 53.8 x 1000 = 53800 g

Only option D is correct.

02-1-M-26

D

Floor area = 1000 x 600 = 600000 cm²

Tile area = 20 x 20 = 400 cm²

Number of tiles needed = 600000 / 400
= 1500

02-1-M-27

C

	First Reading	Second Reading	Average Readings
(A)	0.31 kg	0.33 kg	0.32 kg
(B)	0.33 kg	0.32 kg	0.325 kg
(C)	0.36 kg	0.42 kg	0.39 kg
(D)	0.37 kg	0.30 kg	0.335 kg

The average reading for C is 0.39 kg which is the least accurate from its record 0.35 kg. Thus option C is the answer.

02-1-M-28

D

SI unit of area is square metre. Thus option A is correct.

SI unit of temperature is Kelvin. Thus option B is correct.

SI unit of time is second. Thus option C is correct.

SI unit of weight is Newton. Only option D is wrongly paired.

02-1-M-29

C

Time taken in hours = 2200 – 0900 = 13 h

Time taken in minutes = 65 – 25 = 40 min

Total time taken = 13 h 40 min

02-1-M-30

C

Distance = Speed x Time
= 4.5 x 1.5
= 6.75 m

02-1-M-31

C

Total number of hours in 2 days = 48 h

Plant's new height = (48 / 8) x 2 cm
= 12 cm
= 0.12 m

Plant's total new height = 0.12 + 0.21
= 0.33 m

02-1-M-32

B

Time taken for 1st 6 km = Distance / Speed
= 6 / 18
= 1/3 h

Time taken in minutes = 1/3 x 60 min
= 20 min

Distance left for rest of the journey = 14 - 6
= 8 km

Time taken for rest of 8 km = Distance/Speed
= 8 / 16
= 1/2 h

Time taken in minutes = 1/2 x 60 min
= 30 min

Total time taken in minutes = 20 + 30
= 50 min

02-1-M-33

C

Density of P = Mass / Volume
= 50 / 100
= 0.5 g/cm³

Density of Q = Mass / Volume
= 100 / 100
= 1 g/cm³

Density of R = Mass / Volume
= 50 / 25
= 2 g/cm³

P, Q and R have different densities. Thus option C is correct.

02-1-M-34

C

The periodic time of a simple pendulum is dependent on the length of the pendulum.

02-1-M-35

C

Volume of grape = 25 - 10 = 15 ml

02-1-M-36

B

Mass of 1 cm³ block of steel
= Density x Volume
= 8 x 1
= 8 g

Number of 1 cm³ block of cork needed
= 8 / 0.25
= 32

02-1-M-37

A

Rate of fuel consumption = 450 / 30
= 15 km / l

02-1-M-38

B

Only the vernier calipers can measure up to a precision of 0.08 cm. For the other instruments, the smallest possible reading will be 1 mm (0.1 cm).

02-1-M-39

B

1 cm = 10 mm
1 cm² = 100 mm²

02-1-M-40

A

Measure the temperature of the water will not help you take an accurate reading.

Questions

02-1-Q-01

(a) Total distance = 6 x 36 = 216 km

(b) Time = 3 x 1/60 = 0.05 h

(c) Time = Distance / Speed
= 216 / 200
= 1.08
Minimum time needed = 1.08 + (2 x 0.05)
= 1.18 h

(d) Minimum time needed = 1.18 x 60 x 60
= 4248 s

(e) Rate of fuel consumption = 216 / 80
= 2.7 km/l

02-1-Q-02

(a) Koh's family
average water consumption rate
= 16000/4
= 4000 litres/person

(b) Mohammad's family
average water consumption rate
= 24500/7
= 3500 litres/person

(c) No, it is not fair. The water consumption rate for Mr Mohammad's family is lower than Mr Soh's family. Mr Mohammad uses more water because there are more members.

02-1-Q-03

(a) SI unit for volume = m^3

SI unit for period of a pendulum = s

SI unit for rate of change in displacement = m/s

SI unit for rate of change in mass = kg/s

(b) Weight is measured by a spring balance.

(c) It can measure the internal diameter of tubes.

(d) Tail

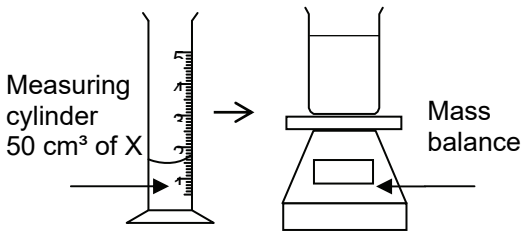
(e) There is no zero error when closed completely.

(f) She used the part of the vernier calipers that is used to measure the internal diameter, not the external diameter.

02-1-Q-04

(a) Mass of X, use an electronic balance.
Volume of X, use a measuring cylinder.

(b)



1. Pour X into measuring cylinder until it reaches 50 cm^3 mark.
2. Using a mass balance, measure mass of an empty beaker. Record this down.
3. Remove beaker and transfer X from measuring cylinder into beaker.
4. Measure mass of beaker and X with mass balance. Record this down.
5. Mass of X is calculated by subtracting 2. from 4.
6. Density of X is calculated from mass/volume.

(c) (i) Its density is greater than water at temperature below 24°C.

(ii) Density is mass per unit volume

When temperature of X is lowered, its volume contracts, causing the density to increase to above that of water.

When temperature of X is raised, its volume expands, causing the density to decrease to below that of water.

02-1-Q-05

(a) Cork

Cork with density of 0.25 g/cm³ will float in turpentine because it is less dense than turpentine with density of 0.90 g/cm³.

(b) Aluminium or Copper

Both aluminium and copper with density of 2.70 g/cm³ and 8.90 g/cm³ respectively will sink in water because they are denser than water with density of 1.0 g/cm³.

If both aluminium and copper are placed in mercury with density of 13.60 g/cm³, they will float because they are less dense than mercury.

(c) Liquid in beaker X is water.

Ice cube with density of 0.92 g/cm³ will float in water because it is less dense than water with density of 1.0 g/cm³.

Liquid in beaker Y is alcohol.

Ice cube with density of 0.92 g/cm³ will sink in alcohol because it is denser than alcohol with density of 0.80 g/cm³.

02-1-Q-06

(a) It is for maintaining the cork to remain fully submerged in the water.

(b) Volume of cork = 27.2 - 18
= 9.2 cm³

(c) Density = Mass / Volume
= 6.85 / 9.2
= 0.74 g/cm³

(d) 1 cm³

(e) Sally must prevent spillage which will result in inaccuracy.

02-1-Q-07

(a) Time in hours = 24/60
= 0.4 h

Average speed = Distance / Time
= 18/0.4
= 45 km/h

(b) Time taken = Distance / Speed
= 23/50
= 0.46 h
= 0.46 x 60
= 28 min

(c) Time in hours = Distance / Speed
= 36/60
= 0.6 h

Distance = Speed x Time
= 50 x 0.6
= 30 km

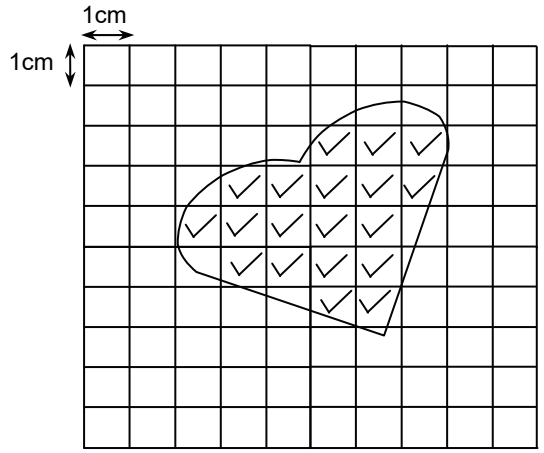
02-1-Q-08

(a) Firstly, calculate the area of each unit square.

Secondly, count the number of squares occupied by the pendant. A square is considered occupied if it occupies more than half the square.

Lastly, multiply the number of squares with the area of each of the unit square

(b)



(c) Area of unit square = 1 cm²

Number of squares occupied = 19

Estimate of area of pendant = 1 x 19
= 19 cm²

(d) Use grid squares of smaller dimension.

02-1-Q-09

(a) (i) Burette and pipette

(ii) Measuring cylinder

(b) (i) Measure the mass of a substance

(ii) Measure the weight of a substance

02-1-Q-10

(a) The hot air balloon will rise.

(b) The heated air above the candle rises up as the density decreases. At the same time, it also lifts up the air balloon.

(c) The volume of the air has caused the density of the heated air to decrease. This is because density depends on mass per unit volume.

❷•❷ Classification of matter

MCQs

02-2-M-01

C

Only metals are malleable because they can be beaten and bent into shapes without breaking.

Non-metals are generally brittle, poor electrical conductors and have low density.

Thus option C is correct.

02-2-M-02

A

An object that successfully scratches the other object and is not scratched by the other is considered to be the harder object of the two.

A is not able to scratch the other two substances means A is the least hard. B is not able to scratch C means C is harder than B.

Thus option A is correct.

02-2-M-03

C

The tiles are better conductors of heat than the carpet. Hence they do not trap heat and this increases the transfer of heat to the surroundings. The tiles will be cold.

The carpet itself is a poor conductor of heat. Hence the heat will be trapped and this reduces the transfer of heat to the surroundings. The carpet will be warm.

Therefore a tiled floor is normally colder than the carpet. Thus option C is correct.

02-2-M-04

C

Aluminium, copper, steel and iron belongs to the same class of material called metals.

02-2-M-05

D

The heat is lost to the surrounding air quickly from the water surface. Hence water takes longer time to boil.

Thus option D is correct.

02-2-M-06

A

Matter is anything that occupies space and has mass. Air, ice and oil have mass and volume hence they are examples of matter.

Vacuum does not have mass and volume, hence it is not a example of matter.

Thus option A is correct.

02-2-M-07

A

The black panels are meant to allow the electromagnetic waves of the sun to enter the solar heater. The black surfaces are good absorbers and bad reflectors of heat, hence the temperature is also increased.

Thus option A is correct.

02-2-M-08

C

Brass is a metal therefore it is a good conductor of heat energy.

Air and water are poor conductors of heat energy but when compared to vacuum, it can still conduct more heat than vacuum. Therefore vacuum is the poorest conductor of heat energy.

Thus option C is correct.

02-2-M-09

B

The measure of a material's ability to withstand scratches and wear is hardness.

The measure of a material's ability to bend without breaking is flexibility.

Alloys are strong because they are made by mixing with metals or non-metals.

Pure metals are usually weak. Only this statement is correct.

Thus option B is correct.

02-2-M-10

A

Ceramic, fibre and glass are classified as non-metals which are poor conductors of heat.

Although ceramic and glass have high melting points, they are not good conductors of heat.

Fibre tends to melt on heating, so it is not a good conductor of heat.

Metals are good conductors of heat.

Thus option A is correct.

02-2-M-11

D

Pure substances boil at a fixed temperature while impure substances boil over a range of temperatures.

Pure substances melt at a fixed temperature while impure substances melt over a range of temperatures.

Thus option D is correct.

02-2-M-12

C

A good thermal conductor allows heat to flow through the material readily.

A bad thermal insulator allows heat to flow through the material readily.

As such, a bad thermal insulator is actually a good thermal conductor.

Thus option C is correct.

02-2-M-13

D

Strength is a measure of how much force or weight a material is able to support without breaking or tearing.

02-2-M-14

B

Brick is one example made from ceramic.

Ceramic is hard, strong but brittle. It has a high melting point therefore it is resistant to heat.

02-2-M-15

B

Corrosion, transparency to light and waterproof are all different properties of matter. Only flammability is not a property of matter.

02-2-M-16

C

Melting point is a fixed temperature at which a substance changes from solid to liquid.

Boiling point is a fixed temperature at which a substance changes from liquid to gas.

Solid M is a pure substance because it has fixed melting and boiling point.

“Its boiling point must be above 90°C.” is correct because the liquid has not changed to gas at 90°C.

“Its melting point is above 37°C.” is correct because solid M has changed to liquid at 90°C.

Thus option C is correct.

02-2-M-17

C

Hardness is a measure of its ability to scratch another object without itself being scratched.

Repeated scratches are created during the cutting of diamonds. It is this property of hardness that allows diamond to be a cutting tool.

02-2-M-18

C

Reaction with carbon dioxide is a chemical property, hence it is not a physical property of matter.

02-2-M-19

D

Ceramic, glass and metal have high density.

Only plastic has low density, therefore it is very light.

02-2-M-20

C

The object is less dense than water. This can be deduced because the object floats on water.

The object has a low solubility in water. This can be deduced because the object does not dissolve in water.

The beaker is made of material which has low solubility in water. This can be deduced because the material does not dissolve in water.

Water has a higher density than the beaker. This cannot be deduced because the diagram does not show the sinking or floating of the beaker in water.

Thus option C is correct.

02-2-M-21

A

A good electrical conductor allows electricity to flow through the material readily.

A bad electrical insulator allows electricity to flow through the material readily.

As such, bad electrical insulators are actually good electrical conductors.

In option A, magnesium, potassium and zinc are all metals which are bad electrical insulators (good electrical conductors).

In option B, mercury and steel are metals but sulphur is a non-metal which is a good electrical insulator (bad electrical conductor).

In option C, aluminium and gold are metals but glass is a non-metal which is a good electrical insulator (bad electrical conductor).

In option D, iron and lead are metals but nylon is a non-metal which is a good electrical insulator (bad electrical conductor).

Thus option A is correct.

02-2-M-22

D

Low compressibility of the material should be considered when making basketballs because this will enable the balls to bounce.

02-2-M-23

A

Gases have high compressibility than liquids and solids. That is why gases can be squeezed easily.

Water is liquid while ice and tennis ball are solid.

Thus option A is correct.

02-2-M-24

C

Gases have high boiling and melting points. Only this statement is wrong. Gases generally have low boiling and melting points.

Thus option C is correct.

02-2-M-25

B

Copper, mercury, silver and zinc are all metals.

Although all metals are solids at room temperature, mercury is an exception.

Mercury is a liquid at room temperature because it has a melting point lower than room temperature.

02-2-M-26

C

High melting point of the material should be considered when making cooking pot so that it will not melt at high temperatures.

02-2-M-27

A

For option A, the rough black surface is a good absorber and a bad reflector of heat, therefore it absorbs heat in the fastest way.

For option B, though black is a good absorber of heat, the shiny surface is a bad absorber and a good reflector of heat.

For option C, the rough white surface is a bad absorber and a good reflector of heat.

For option D, the silver shiny surface is also a bad absorber and a good reflector of heat.

Thus option A is correct

02-2-M-28

D

Substances which have melting point that is below 25°C and boiling point that is above 25°C are liquids at room temperature 25°C.

Thus option D is correct

02-2-M-29

A

Aluminium is most suitable for making aircraft because its low density allows for light-weight that is needed for flying.

02-2-M-30

B

Metals are malleable therefore they can be beaten and bent into shapes without breaking, hence copper can be used to make working tools.

02-2-M-31

C

Ceramic, glass and plastic are all man-made materials except metal. Metal can be found naturally.

Fibre can be found naturally or man-made.

Questions

02-2-Q-01

(e) Electrical and heat conductivity

(f) Hardness is the ability to withstand scratches or wear.

Ductility is the ability of metals to be drawn into thin wires without cracking or breaking.

(g)

Property	Material
Transparent and brittle	Glass
Can be beaten into shapes	Metal
Can be woven into fabrics	Fibre
High melting points	Ceramic/Metal
Easily formed into shapes	Plastic

02-2-Q-02

(a) (i) High density of steel makes the book trolleys heavy.

(ii) Strength of steel makes the book trolleys able to carry large amounts of books.

(b) Metals are good conductors of electricity but non-metals are poor conductors of electricity.

Metals are good conductors of heat but non-metals are poor conductors of heat.

Metals generally have high melting and boiling points but non-metals have low melting and boiling points.

02-2-Q-03

(a) False

(b) A matter exists as a liquid when its melting point is lower than room temperature, not when melting point is higher than the room temperature.

(c) Ice: solid

Oil: liquid

Steam: gas

02-2-Q-04

(d) Plastic is made of petroleum.

(e) Plastic is fairly strong and durable material.

Plastic has low density, hence it is very light.

Plastic is a poor conductor of heat and electricity.

(f) Plastic is non-biodegradable which means it cannot be decomposed completely. Hence, it is not environmental friendly.

02-2-Q-05

(a) Put ice in two separate beakers, Beaker A and Beaker B.

Put a thermometer into each beaker and record the temperature.

Add a teaspoon of salt into Beaker B.

Record the temperature of the two beakers every three minutes.

(b) For Beaker A with pure ice, the temperature remains at 0°C until all the ice melts.

For Beaker B with ice-salt mixture, the temperature drops to below 0°C and the ice melts over a range between -5°C to 0°C.

(c) Impure substances melt over a range of temperature. Salt is the impurities that makes the ice in Beaker B impure.

02-2-Q-06

Property	Ceramic	Fibre	Glass
Density (High / Low)	High	Low	High
Electrical conductivity (Yes / No)	No	No	No
Hardness (Hard / Soft)	Hard	Soft	Hard
High melting point (Yes / No)	Yes	No	Yes
Thermal conductivity (Yes / No)	No	No	No

Property	Metal	Plastic
Density (High / Low)	High	Low
Electrical conductivity (Yes / No)	Yes	No
Hardness (Hard / Soft)	Hard	Soft
High melting point (Yes / No)	Yes	No
Thermal conductivity (Yes / No)	Yes	No

02-2-Q-07

(a)

Material	Uses of material
Plastic	Handle
Metal	Body of electric iron
Ceramic	Insulator for heating element

(b)

Physical Property	Explanation
Good insulator of electricity and heat	As plastic is a good insulator of electricity and heat, it protects us from electric currents and heat from the iron.
Good conductor of heat	As metal is a good conductor of heat, it can transmit heat from the heating element to the iron quickly.
High melting point	Ceramic is able to withstand high temperatures of the heating element.

02-2-Q-08

(a) Choice of Material: Copper

Reason: Copper is a good conductor of electricity, hence it allows electricity to flow through it quickly.

(b) Choice of Material: Plastic

Reason: Plastic is a poor conductor of electricity, hence it does not allow electricity to flow through it easily. In this way, users are protected from getting electric shock.

(c) Choice of Material: Aluminium

Reason: Aluminium is light and malleable, hence it is easy to carry and can be beaten into sheets without breaking.

02-2-Q-09

(a) Physical Property: High melting point

Reason: Tungsten has high melting point, hence it will not melt easily at extremely high temperatures

(b) Physical Property: Good conductor of heat

Reason: Stainless steel is a good conductor of heat, hence it allows heat to pass through it easily to achieve fast and effective heating.

(c) Physical Property: Flexibility

Reason: Nylon is flexible and strong, hence it is stretchable and does not break easily.

3

EXPLORING DIVERSITY OF MATTER BY ITS CHEMICAL COMPOSITION

Learning Outcomes

Candidates should be able to:

Knowledge, Understanding and Application

(a) recognise that substances can be classified as elements, compounds and mixtures

(b) distinguish among elements, compounds and mixtures

(c) state that elements are the basic building blocks of living and non-living matter

(d) recognise that elements are classified according to their properties

(e) show an understanding that compounds are substances consisting of two or more chemically combined elements

(f) show an understanding that mixtures are made up of two or more elements and/or compounds that are not chemically combined

(g) distinguish among solute, solvent and solution

(h) show an understanding that solutions and suspensions are mixtures

Skills and Processes

(a) classify elements as metals and non-metals based on their characteristic properties

(b) investigate the factors that affect the solubility and rate of dissolving of substances

Ethics and Attitudes

(a) evaluate how the disposal of harmful pure substances (e.g. mercury) and mixtures (e.g. sewage) impact the environment

❸•❶ Elements, compounds and mixtures

MCQs

03-1-M-01

D

An element is the simplest form of pure substance. It cannot be broken into simpler substance by any chemical/physical methods.

03-1-M-02

C

A compound is two or more elements chemically combined together.

03-1-M-03

C

Compounds are formed when compounds or elements are chemically combined together.

03-1-M-04

C

A mixture may contain elements, compounds or both. They are not chemically combined together.

03-1-M-05

D

Mixtures can be solids, liquids or gases.

03-1-M-06

C

An alloy is a mixture of two or more elements. A mixture contains varied amounts of its components.

03-1-M-07

D

The element is Silicon.

03-1-M-08

D

Across the period, elements change from metallic to non-metallic. They are arranged in order of increasing atomic number (the number of protons found in the nucleus of that element).

03-1-M-09

D

Copper, zinc, tin and sodium are metals.

03-1-M-10

B

A compound is chemically combined with a fixed proportion of each element. It has different properties from the elements that formed it. During the chemical reaction, energy is taken in or given out. The Periodic Table classifies elements according to their chemical properties.

03-1-M-11

C

Mercury (metallic element) is a liquid at room temperature

03-1-M-12

D

Elements in the same group (column) have similar properties.

03-1-M-13

C

The compound is Marble.

03-1-M-14

D

Iron reacts with oxygen of the air in the presence of water to form a brownish compound, iron oxide.

03-1-M-15

B

Metals are malleable.

03-1-M-16

C

Mercury is the only metal that exists in the form of liquid at room temperature. It is used in thermometers to measure temperature.

03-1-M-17

C

Copper, Aluminium and Mercury

03-1-M-18

A

Metals have high melting point and high density.

03-1-M-19

D

Water is formed when hydrogen and oxygen are chemically combined. It can only be broken down by electrolysis.

03-1-M-20

B

Distillation is a physical method used to separate a mixture of liquids with different boiling points.

03-1-M-21

B

Oxygen, aluminium, bromine and calcium.

03-1-M-22

C

Magnesium burns in air to form magnesium oxide.

03-1-M-23

D

Water can only be broken down into hydrogen and oxygen by electrolysis.

03-1-M-24

C

Sand

03-1-M-25

D

Element – Carbon;
Compound – Water,
Mixture – Milk

03-1-M-26

D

Sugar dissolved in the water to form sugar solution. There is no chemical reaction involved.

03-1-M-27

C

A mixture is formed as no chemical reactions are involved.

03-1-M-28

A

Lithium, Sodium, Potassium

03-1-M-29

D

Copper can be used for making coins, gas and water pipes, electrical wires and cables, alloys like brass and bronze

03-1-M-30

A

Decomposition breaks down a compound into simpler compounds or its component elements.

03-1-M-31

B

Distilled water and chalk.

03-1-M-32

D

Carbon is a non-metal while iron is a metal. Non-metals are brittle while metals are malleable. Thus, increasing carbon would make steel more brittle than iron.

03-1-M-33

D

Transitions metals are elements in between metallic and non- metallic elements in the Periodic Table.

03-1-M-34

C

A chemical reaction between iron and sulphur.

03-1-M-35

B

Pure elements exist as atom or molecules. For example oxygen (O_2).

03-1-M-36

C

Compounds can only be separated by chemical methods while mixture by physical methods.

03-1-M-37

A

He (Helium).

03-1-M-38

C

Aluminium is used because it is light, strong and malleable.

03-1-M-39

C

A compound.

03-1-M-40

C

They have similar chemical properties.
As we move down the group, the melting and boiling points of the elements decrease.

Questions

03-1-Q-01

(a) (i) The hand will feel the heat of the flame in a very short time. The metal may glow red-hot.

(ii) The hand will feel the heat of the flame after a longer time. The wood may also get charred.

(b) Copper

(c) Metals are much better heat conductors as compared to non-metals.

03-1-Q-02

(a) Hydrogen, Oxygen and Sulphur.

(b) In terms of physical properties:
Sodium – Shiny, sonorous, malleable metal that 'sizzles' in water
Chlorine – Gas
Sodium chloride – Soluble in water, crystalline in nature)

In terms of chemical properties:
Sodium conducts electricity while chlorine is a non-conductor. Sodium chloride conducts electricity when it is molten.

03-1-Q-03

(a) a compound; magnesium and oxygen chemically combined to form a new substance; irreversible

(b) a mixture; consists of oxygen, nitrogen, carbon dioxide, noble gases and pollutants; not chemically combined; can be separated by physical method.

03-1-Q-04

(a) (i) Calcium, Carbon and Oxygen

(ii) Carbon, Hydrogen and Oxygen

(b) (i) Metals : B, C; Non-metals: A, D

(ii) Metals have high boiling point; high melting point; high density/ or Non-metals have low boiling point; low melting point; low density.

(iii) Good conductors of heat/ electricity; Poor conductors of heat / electricity

(c) (i) Helium is very light (an inert gas -)

(ii) Copper is a conductor of electricity and it is cheaper

03-1-Q-05

(a) An element cannot be further split into 2 or more simpler substances by chemical reactions, while a compound can be split into its components. A compound made from 2 elements has different properties as compared to its constituents.

(b) Air is a mixture. The constituent gases are not chemically combined together. The constituents in the mixture can be mixed in any proportion by mass.

03-1-Q-06

(a) Magnesium

(b) Metal

(c) MgO

03-1-Q-07

(a) A pure substance; cannot be broken down into simpler substances by any ordinary chemical reactions.
(Or, an element is the simplest kind of matter and are substances which cannot be split into 2 or more simpler substances by chemical reactions.)

(b) Gold exists as an element whereas iron exists as compounds in iron ore.

(c) Without heating: A mixture is formed; iron and sulphur retain their appearance and properties.

With heating: A compound / new substances (iron sulphide) formed with different properties.

03-1-Q-08

(a) Mixture. The different components' ratio can be adjusted for different configurations. A mixture has no fixed component ratios.

(b) Oxygen is reactive (participates in chemical reactions), while argon is inert. Oxygen combusts with metal, while argon doesn't.

03-1-Q-09

(a) Na, Mg, Al.

(b) Li, Na, K

(c) Oxygen, sulphur

(d) Argon, helium

03-1-Q-10

(a) potassium sulphate + copper hydroxide

(b) magnesium chloride + hydrogen

03-1-Q-11

(a) (i) A, B, C & D

(ii) F & G

(iii) Yes. They are of the same group, sharing similar chemical properties.

(b) Iodine

(c) Magnesium

03-1-Q-12

(a) (i) TRUE

(ii) TRUE

(iii) FALSE

(iv) TRUE

(b) 1. Can only be separated by chemical methods; 2. Can only exist in fixed proportions; 3. Cannot be separated by physical methods like filtration.

(c) An element is the most fundamental and simplest unit. Mixture is a group of 2 or more molecules/elements

An element exists in a nature. Mixtures are produced by physically mixing elements/molecules.

03-1-Q-13

(a) (i) Aluminium – Lowest density allows for light-weight, needed for flying

(ii) Copper – Highest electrical conductivity, necessary for good electrical conductivity in wiring.

(iii) Platinum – Highest melting point allows other metals to melt first before it does.

(b) Lead and Tin. They each have the lowest melting point among the other metals.

Notes:

4

EXPLORING DIVERSITY OF MATTER USING SEPARATION TECHNIQUES

Learning Outcomes

Candidates should be able to:

Knowledge, Understanding and Application

(a) show an awareness of basic principles involved in the following separation techniques: magnetic attraction, filtration, evaporation, distillation and paper chromatography

(b) explain how the constituents of a mixture can be separated based on their properties, using the following techniques: magnetic attraction, filtration, evaporation, distillation, paper chromatography

(c) state some examples of the applications of the various separation techniques in everyday life and industries

(d) show an awareness of the techniques involved in obtaining drinking water from non-potable sources (e.g. distillation of sea water in desalination plants, and filtration and *reverse osmosis of sewage water)

Skills and Processes

(a) separate constituents of mixtures using the appropriate separation techniques

Ethics and Attitudes

(a) show an appreciation of why water is a precious resource and the need to conserve it

(b) show objectivity and accuracy in systematic investigations involved in the separation of mixtures

❹ Separation of mixtures

MCQs

04-M-01

A

Distillation separates a liquid (solvent) from a solution. It involves the process of boiling and condensation. The liquid with the lowest boiling evaporate first and is collected through condensation.

04-M-02

B

Fractional distillation is used to separate a mixture of liquids, such as petroleum with different boiling points.

04-M-03

B

Fractional distillation is used to separate a mixture of liquids with different boiling points. The mixture is separated into fractions by boiling and condensation, thus the liquid with the lowest boiling point will be vapourized and collected first.

04-M-04

A

Distillation separates a liquid (solvent) from a solution. It involves the process of boiling and condensation. The liquid with the lowest boiling evaporate first and is collected through condensation.

04-M-05

A

Fractional distillation is used to separate a mixture of liquids with different boiling points. The oils in crude oil have different boiling points and thus vapourize and condense at different temperatures.

04-M-06

C

Oil and water are known as immiscible liquids that do not mix with one another. They can only be separated using a separating funnel.

04-M-07

B

The mask acts as a filter to remove the pollutants from the air breathed in.

04-M-08

C

Salt will dissolve in water to form salt solution. Sand is separated from the mixture by filtration. By heating the salt solution, salt crystals are collected.

04-M-09

B

Magnet is used to remove the iron filing from the mixture. Water is added to dissolve the sugar. The funnel with filter paper is used to separate the sand and the sugar solution. The sugar solution is left in the evaporating dish to crystallize into sugar crystals.

04-M-10

B

Tea leaves are insoluble solids that can be separated from the liquid using filtration. Distillation is used to separate liquids with different boiling points. Evaporation is used to obtain dissolved solid from a solution.

04-M-11

C

Ensure the smooth boiling of the mixture

04-M-12

B

Evaporation separates a solid dissolved in a liquid.

04-M-13

C

A mixture can be separated by physical methods such as crystallisation.

04-M-14

D

I – Solution
II – Water out
III – Water in and
IV – Distillate.

04-M-15

D

Distilled water is added to the mixture to dissolve the sugar. Filtering the mixture separates the dust from the sugar solution. Crystallisation is used to obtained sugar from the sugar solution.

04-M-16

D

Chromatography can be used to separate mixtures of liquids or gases. Filtration is used to separate insoluble solids from liquids. Evaporation is used to obtain dissolved solid from a solution by heating. Crystallisation is used to obtain soluble solid from a solution when heating the solution will decompose the solids

04-M-17

A

Filter paper

04-M-18

B

Filtrate

04-M-19

C

The chalk will be collected as residue by the filter paper and the water as filtrate. The other three options cannot be separated by filtration. Option A is a mixture of sugar and salt solution. Option B is sugar solution. Option D is a mixture of two solids.

04-M-20

D

The solid is prevented from spurting out when all the solvent has evaporated.

04-M-21

C

The three types of chromatography are paper chromatography, liquid chromatography and gas chromatography.

04-M-22

D

A mixture can be separated by physical methods such as chromatography. A compound cannot be separated by physical method.

04-M-23

C

Paper chromatography can be used to test the contents in the food colouring. This is because the solubility of the different components is different in a particular solvent and hence they will travel up the paper chromatography at different speeds.

04-M-24

A

Both substances must be soluble in the chromatography solvent in order to travel up the paper chromatography.

04-M-25

D

In paper chromatography, different components travel up the paper chromatography at different distance. The two colourings in the fruit drink travel the same distance as the colouring of 2 and 5.

04-M-26

C

Only three colours can be seen on the filtrate paper.

04-M-27

C

There are liquid chromatography and gas chromatography but there is no solid chromatography.

04-M-28

B

Immiscible liquids cannot mix into one another. An example is oil and water. They can only be separated using a separating funnel.

04-M-29

D

Iron is a magnetic material, thus a magnet can be used to attract the iron filings and separate them from the chalk.

04-M-30

C

In distillation, liquid with the lowest boiling point will boil and evaporate first. Thus it will be collected first via condensation. This method is used when the mixture contains two or more liquid and only one liquid is to be obtained. If more than one liquid is to be obtained from a mixture, fractional distillation is to be used.

04-M-31

A

The membrane in reverse osmosis removed dissolved impurities in sea water to create drinkable water.

04-M-32

B

Membrane removed the dissolved impurities in sea water to create drinkable water.

04-M-33

D

Not all solid that is soluble in a liquid can be separated from the liquid by evaporation. Under heating, salt is stable but sugar is not. The heating process required to dry off the liquid during evaporation will burn the sugar while salt will be separated from the liquid.

04-M-34

A

In a mixture, one of the components has to be ferromagnetic in order to separate its components. Except for copper, iron, nickel and cobalt are ferromagnetic.

04-M-35

C

There is only one spot above A and E while the rest show several spots of different coloured components above it.

04-M-36

B

The coloured components in the coloured substance dissolve in the chromatography solvent and travel up the paper chromatography at different distance.

04-M-37

B

Water is poured into the mixture to dissolve copper sulphate salt as sand is insoluble. Through filtration sand is obtained as residue and copper sulphate solution as filtrate. During heating, the filtrate evaporated to saturation, then cooled for crystallisation to take place.

04-M-38

C

During distillation, sea water is heated, forming water vapour that condenses into pure water. Freezing only change the physical states of sea water. Chromatography separate mixtures but pure water cannot be obtained. Filtration is used to separate an insoluble solid from a liquid.

04-M-39

D

Desalination is the removal of salt from seawater. In reverse osmosis, dissolved impurities are removed from sea water creating pure water.

04-M-40

B

Heating is a chemical method of separation via thermal decomposition.

Questions

04-Q-01

(a) Evaporate

(b) Crystallisation

(c) Evaporation is used for salt as salt does not decompose under heat. Crystallisation is used as sugar must not be heated as it will decompose into carbon, an irreversible process.

04-Q-02

(a) (A) retort stand, (B) distilling flask, (C) condenser, (D) conical flask

(b) To ensure smooth heating/boiling.

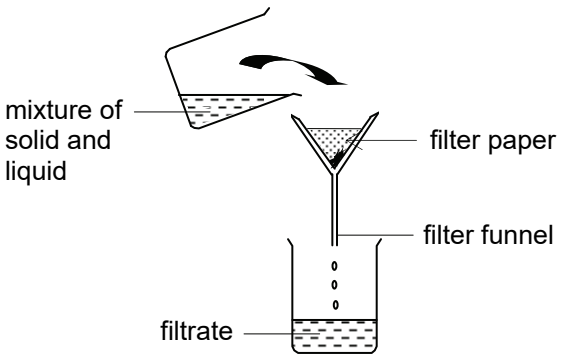
(c) (i) sea water/ orange juice/ muddy water/ water and alcohol

(ii) <u>How distillation works:</u>

- only the solvent (water) vaporizes;
- the solute (salt) remains in the flask
- water vapour condenses in the condenser;
- pure water is obtained

(* water and alcohol – different boiling point)

04-Q-03



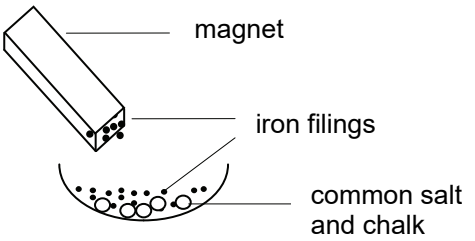
<u>Steps:</u>

1. add water (solvent) into the mixture.
2. stir with a glass rod; salt dissolves in water.
3. carry out filtration; salt solution is collected as the filtrate.
4. chalk is left on the filter paper as residue.

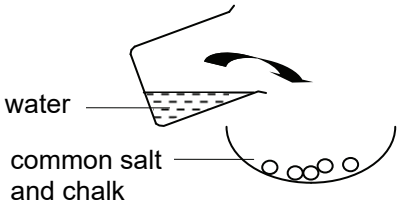
04-Q-04

<u>Steps:</u>

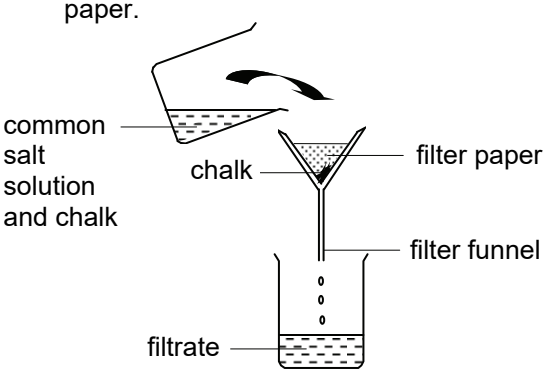
1. Using a magnet, the iron filings can first be removed.



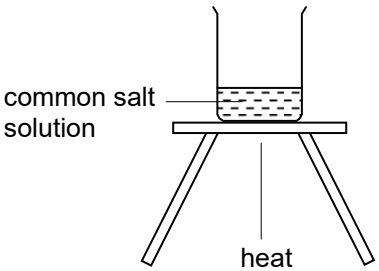
2. Add water to dissolve the common salt.



3. Filter out the chalk (residue) using filter paper.



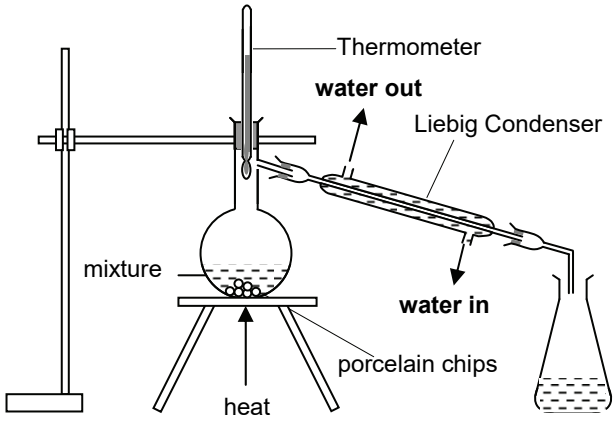
4. Heat the filtrate to dryness to obtain the salt



04-Q-05

(a) Thermometer – To detect and observe the boiling point
Liebig condenser – To condense the steam into water (liquid)

(b)



Tap water will be supplied from the bottom inlet and out from the top outlet. This is to allow more time for the water to remain in the condenser for better heat removal as the piped water has to work against gravity to reach the top outlet.

(b) Pure water

04-Q-06

(a) Fractional Distillation

(b) Methanol will be obtained first. It has the lowest boiling point, thus it will boil first and condense first.

04-Q-07

(a) (i) Different components are more attracted to paper than others. This thus causes differential rates of movement for the different components.

(ii) Solvent type and delivery type (downward movement or upward movement)

(b) (i) No. It is made up of many different dyes (mixture).

(ii) Dyes B, C and D

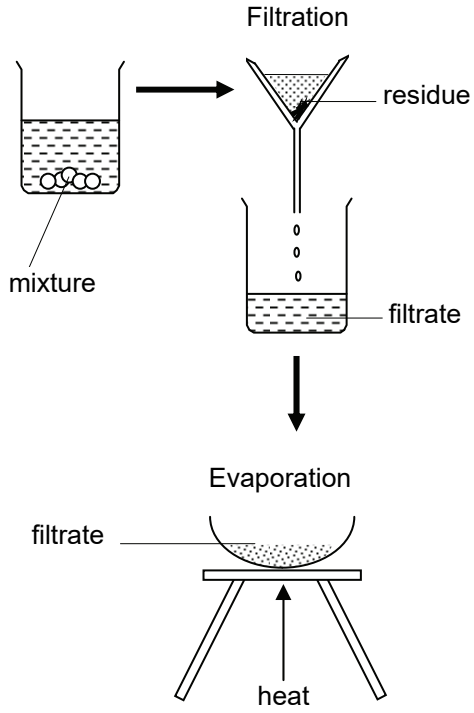
(iii) A suitable solvent has to be chosen such that ample separation is obtained for clearer identification of the dyes as the components seem to be very close to each other. Also, we must ensure that no other soluble indicators are used (such as in marking the starting point) to prevent any unnecessary smudging that may interfere with the observations.

(c) To test for illegal substances in urine samples and the identification of food dyes in food.

04-Q-08

(a) First separation method: Filtration
Second separation method: Evaporation or crystallisation

(b)



Steps:

1. Add water to mixture of salt and green beans
2. Stir until all salt are dissolved
3. Pour this into a filter funnel as shown above
4. The residue which are green beans are collected in the filter paper
5. The filtrate is salt solution
6. Pour filtrate into an evaporating dish as shown above

7. After heating for some time, salt crystals will be left behind in the evaporation dish

(c) No. Both sugar and salt dissolves in water.

04-Q-09

(a) A, B, D

(b) Dye B. It never moved from the original level (starting point).

(c) It contains Dye A and B which are bad on people.

04-Q-10

(a) At the bottom of the flask which is heated.

(b) Porcelain chips can be added to allow smooth heating.

04-Q-11

(a) Chromatography

(b) 4

(c) Alcohol

04-Q-12

(a) Filtration

(b) In the mixture of chalk and salt, chalk is insoluble in water. In the mixture of salt and sugar, both are soluble in water.

04-Q-13

(a) Simple distillation

(b) 101 Degree Celsius (Impurities will be present, raising BP)

(c) Liebig Condenser

(d) Steam (Gas) - > Liquid (Pure Water)

(e) Ethanol from water

04-Q-14

(a) Use a magnet to remove the iron from the mixture. Add water to dissolve the salt. Through filtration, the sand is collected as residue in the filter paper and salt solution is obtained as the filtrate. By heating the filtrate to dryness, the salt can be re-crystallized again.

(b) (i) 2 dyes

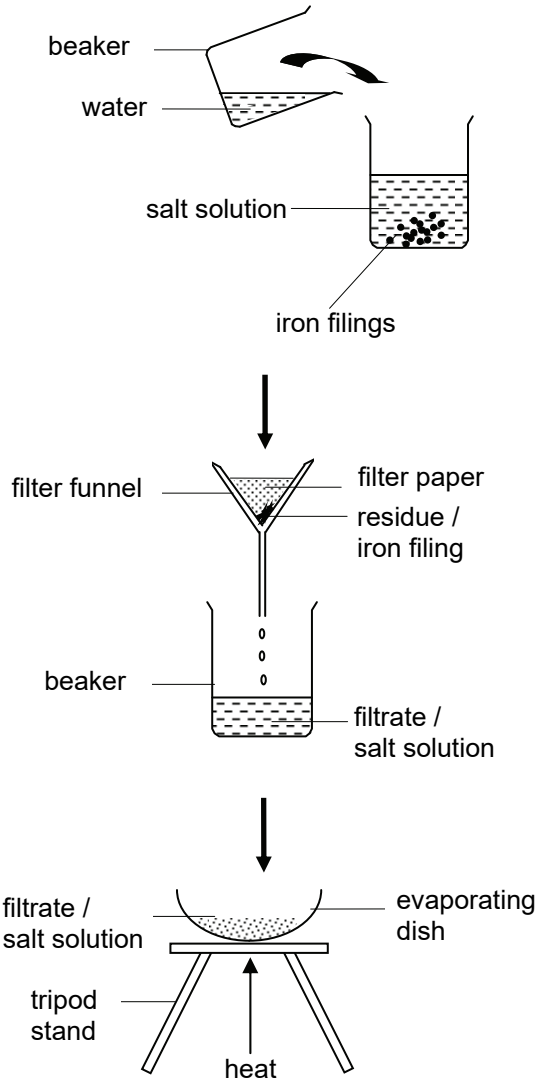
(ii) Mixing green colour in A and red colour in D

(iii) It is able to effectively separate the dyes due to the fact that a common solvent is used.

04-Q-15

(a) (i) Add water to dissolve the kitchen salt. Using filter paper, the iron filings canbe filtered out as the residue while the filtrate will be dissolved kitchen salt. By placing the dissolved salt in an evaporating dish, the dissolved salt can be heated to dryness, leaving the salt crystals behind.

(ii)



(b) (i) Ink Q

(ii) Ink S

(c) (i) Distillation

(ii) Crystallisation

(iii) Evaporation to dryness

Notes:

5

UNDERSTANDING DIVERSITY OF LIVING THINGS

Learning Outcomes

Candidates should be able to:

Knowledge, Understanding and Application

(a) show an awareness of biodiversity as the variety of life on earth, including variety within each species of plant and animal

(b) recognise that classifying living things into major taxonomic groups enables us to make sense of the biodiversity around us

(c) show an awareness that bacteria could have beneficial or harmful effects (e.g. bacteria in the digestive tract could help in digestion or cause infections)

(d) recognise the importance of biodiversity to the stability of natural systems, and its benefits to humans (provision of resources like food, medicine, raw materials, etc.)

Skills and Processes

(a) construct and use simplified dichotomous keys in identifying and classifying living organisms

Ethics and Attitudes

(a) discuss the reasons for the depletion or extinction of some plants or animals (e.g. hunting, disease, invasive species, changes to or destruction of habitat)

(b) show an awareness of how teamwork and perseverance are important in the study of biodiversity

5 Classification of plant and animal life

MCQs

05-M-01

C

The colour of the animal is not considered a fundamental feature when classifying organisms.

05-M-02

C

Puffer fish is cold blooded but penguin is warm blooded. Thus option A and B are incorrect.

Penguin is classified under bird and puffer fish is classified under fish. Both bird and fish are vertebrates that have backbones. Thus option D is incorrect, only option C is correct.

05-M-03

D

Reptile has body temperature that fluctuates with their surroundings but they breathe through their lungs. Option A is incorrect.

Amphibian has body temperature that fluctuates with their surroundings but they breathe through their lungs when they are on land and through their moist skin when they live in water. Option B is incorrect.

Insect has body temperature that fluctuates with their surroundings but breathes via a respiratory system which is a complex network of tubes and is not protected via slimy hard scales. Option C is incorrect.

Fish has body temperature that fluctuates with their surroundings and they breathe through gills. It also has overlapping slimy, hard scales to protect them from diseases and other organisms. Only option D is correct.

05-M-04

C

The prawn is classified under crustacean which has more than four pairs of legs and lives in water. It also has two pairs of feelers.

05-M-05

A

Animal (I) has wings and backbones. Dove matches the keys here.

Animal (II) has wings but does not have backbones. Mosquito matches the keys here.

Animal (III) has dry scaly skin, lay eggs and does not have wings. Monitor lizard matches the keys here.

Animal (IV) does not have dry scaly skin, lay eggs and does not have wings. Frog matches the keys here.

Animal (V) lives in water, lay eggs and does not have wings. Shark matches the keys here.

Animal (VI) lives on land, does not lay eggs and does not have wings. Sheep matches the keys here.

Thus option A is correct.

05-M-06

D

Algae have no roots, no stems, no leaves and they live in water or wet places.

05-M-07

C

Invertebrates are animals that do not have back bones.

05-M-08

C

Classification makes it easier for us to study the living things.

Classification allows us to understand living things better.

Classification allows us to easily identify new species of living things.

05-M-09

A

Mushroom is not algae but fungi. It is also not reproduced from seeds but reproduced from spores. It has no chloroplasts and feeds on dead organisms. Thus option A is correct.

05-M-10

D

Virus does not reproduce by spores.

Moss reproduces by spores produced in capsules.

Pine tree reproduces by seeds produced in the cones.

Bird nest fern reproduce by spores found in spore bags on the underside of leaves.

Only moss and bird nest fern are reproduced by spores and thus option D is correct.

05-M-11

D

The first part of a scientific name is the genus of the organism while the second part is the species of the organism.

05-M-12

D

Organism (I) do not have chlorophyll. Among fern, moss and fungus, fungus matches the keys here.

Organism (II) has chlorophyll, seeds and flowers. Among grass and pineapple, grass matches the keys here.

Organism (III) has chlorophyll and seeds but no flowers. Among grass and pine, pine matches the keys here.

Organism (IV) has chlorophyll and leaves but no seeds. Among fern, moss and algae, both fern and moss matches the keys here.

Organism (V) has chlorophyll but no seeds and leaves. Among algae and fern, algae match the keys here.

Thus option D is correct.

05-M-13

A

Dichotomous keys divide a group into two smaller groups each time.

05-M-14

A

The correct hierarchy from the top should be as follows: Kingdom, phylum, class, order, family, genus, species.

05-M-15

A

Amphibians spend all their lives in water. This is incorrect because they spend part of their lives in water and part of it on land.

Young amphibians breathe through their lungs and skin. This is incorrect because young amphibians breathe through their gills.

The body temperature of amphibians does not change with the environment. This is incorrect because they are cold blooded so their body temperature changes with the environment.

The process of change from young to adult for amphibians is metamorphosis. This is correct. Thus option A is correct.

05-M-16

C

All birds can fly. This is incorrect because not all birds can fly. Some birds like the penguins, kiwi, turkey and ostrich cannot fly

All birds have wings. This is correct.

Birds have streamlined bodies covered with feathers. This is correct.

The body temperature of birds does not change with the environment. This is correct because birds are warm blooded. Thus option C is correct.

05-M-17

D

Bat is a flying vertebrate with membranous wings. It is grouped under mammals.

Frog is a vertebrate with powerful legs and webbed feet. It is grouped under amphibians.

Lizard is a vertebrate with long slender body and four legs. It is grouped under reptiles.

Spider is an invertebrate with two body segments and four pair of jointed limbs.

05-M-18

D

Man is a mammal because he is warm blooded like all other mammals.

05-M-19

B

Dugong is a sea mammal.

Platypus is a land mammal.

Seal is a sea mammal.

Walrus is a sea mammal.

05-M-20

A

Tulip is a flowering plant and is reproduced by seeds produced in fruits.

Pine is a conifer and is reproduced by seeds produced in cones.

Dragon's scale fern is reproduced by spores produced on the underside of leaves.

Club moss is reproduced by spores produced in capsules.

Only tulip and pine are reproduced by seeds and thus option A is correct.

05-M-21

D

Conifers, ferns and mosses are non-flowering plants, thus they are under plant kingdom.

Protists are neither plant nor animal, thus they are not under plant kingdom. Option D is correct.

05-M-22

D

Shark has a highly streamlined body while whale has a spindle-like shaped body.

Shark is a fish and it is cold blooded while whale is a mammal and it is warm blooded.

Both shark and whale have backbone as they are vertebrates.

Shark breathes through its gills just like other fishes while whale breathes through its lung just like other mammals. Thus option D is correct.

05-M-23

D

Conifers, compound ferns and simple ferns have roots while mosses do not have true roots.

Mosses have simple stems and tiny leaves only. Thus option D is correct.

05-M-24

B

Arthropods have segmented bodies, jointed legs and a hard external skin called exoskeleton.

Arthropods can be sub-divided into insects, myriapoda, arachnids and crustaceans.

Butterfly is insect, lobster is crustacean and mite is arachnid. They all have exoskeleton.

Frog is an amphibian and it does not exoskeleton. Thus option B is correct.

05-M-25

A

Annelids are invertebrates without jointed legs. They take in oxygen through their moist skin. They are worm-like animals with segmented bodies. Thus only option A is correct.

05-M-26

B

Mosses can be found in damp and shady places.

Fern can be found in damp but bright places as it needs sufficient sunlight.

Algae can be found in very damp places or in water.

Thus option B is correct.

05-M-27

B

Both hibiscus and rose are flowering plants which have stem and leaves. Thus option B is correct.

Questions

05-Q-01

(a) Two major groups of plants are flowering plants and non-flowering plants.

(b) (i) Both pine tree and bird's nest fern are non-flowering plants.

Both pine tree and bird's nest fern have roots, stems and leaves.

(b) (ii) Pine tree reproduces by seeds produced in the cones while bird's nest fern reproduces by spores found in spore bags on the underside of leaves.

Pine tree has small needle-like leaves while bird's nest fern has large, long leaves.

(c) (i) Algae do not have roots, stems or leaves.

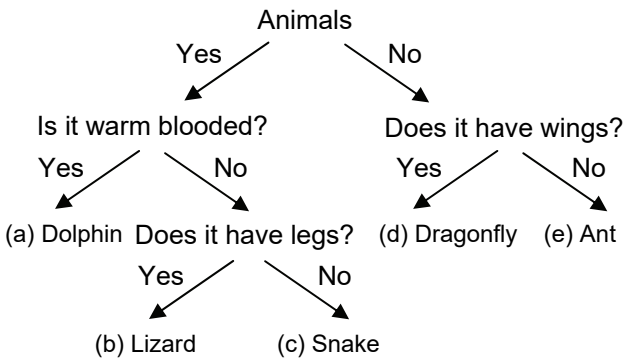
Algae are non-flowering plants.

(c) (ii) Both algae and fern are non-flowering plants.

(c) (iii) Algae have no roots, stems or leaves while fern has roots, stems and leaves.

(d) No. Fungi do not have chlorophyll and are unable to make their own food unlike plants.

05-Q-02



05-Q-03

(a) False

(b) The lizard has dry leathery skin and lives on land but the salamander has loose and moist skin.

The lizard lives on land but the salamander lives on both land and in water.

The lizard lays eggs which have thick, hard and leathery shells but the salamander lays eggs which are soft and have a slimy jellylike surrounding coat.

(c) Lizard: Reptile

Salamander: Amphibian

05-Q-04

Plant-eater (Herbivore)
Bee
Caterpillar
Rabbit
Squirrel

Animal-eater (Carnivore)
Lizard
Owl
Scorpion
Toad

Animal-eater and plant-eater (Omnivore)
Bear
Chicken
Man
Woodpecker

05-Q-05

(a) Put equal number of tadpoles in two separate beakers, Beaker A and Beaker B.

In Beaker A, put a water plant and place it near the window.

Pour a layer of oil over the water for both beakers.

Observe what happens after a week.

(b) The tadpoles in Beaker B died while the tadpoles in Beaker A are still alive.

(c) The layer of oil prevents oxygen from dissolving in the water. But as time passes, the dissolved oxygen in each beaker is used up. However Beaker A has fresh supply of oxygen as the plant is able to make food and produce oxygen. Therefore tadpoles in Beaker A are still alive. Tadpoles in Beaker B died as a result of lack of dissolved oxygen in the water.

05-Q-06

(a) Scaly skin

(b) Lungs

(c) Fur

(d) Give birth to their young

(e) Scales

(f) Gills

(g) Give birth to their young

(h) Gills

(i) Exoskeleton

(j) Lay eggs

05-Q-07

(a) (i) Insects have three body segments (head, thorax and abdomen) and three pairs of legs attached to the middle segment (thorax).

Some insects live on land while others live in water.

Insects breathe via a respiratory system which is a complex network of tubes.

All of the above are characteristics of insects.

(ii) Myriapoda has many legs.

Some myriapoda are carnivorous while others feed on decaying vegetation.

All of the above are characteristics of myriapoda.

(iii) Arachnids have two body segments, four pairs of legs and no compound eyes.

They breathe in air either through lungs and/or through the tracheal system.

All of the above are characteristics of arachnids.

(iv) Crustaceans have shells on the outside of their body.

They breathe through gills. They take in dissolved oxygen from salt water or fresh water.

All of the above are characteristics of crustaceans.

(b) No. Anthropods have segmented bodies, jointed legs and a hard external skin called exoskeleton. They are invertebrates that do not have backbones.

Notes:

6

MODEL OF CELLS – THE BASIC UNITS OF LIFE

Learning Outcomes

Candidates should be able to:

Knowledge, Understanding and Application

(a) show an understanding of the functions of the different parts of a typical cell, including the nucleus which contains genetic material that determines heredity.

(b) recognise that in multicellular organisms (both plants and animals), cells are the basic building blocks that are organised into tissues, organs and systems.

(c) show an understanding that typical plant and animals cells are models used to represent their various forms.

(d) explain the significance of the division of labour, even at the cellular level

Skills and Processes

(a) use the microscope safely and correctly to identify the different parts of a typical cell (plant or animal) viz.

- cell wall
- cell membrane
- cytoplasm
- nucleus
- vacuole
- chloroplast

(b) infer whether an organism is an animal or a plant, based on its cellular composition

Ethics and Attitudes

(a) show an awareness of the moral and social issues related to organ donation/sale and *application of genetic science

6 Cells

MCQs

06-M-01

C

Cell membrane is partially permeable. This is to allow diffusion to take place.

06-M-02

D

Red blood cells do not contain nucleus. With this feature, the cells are able to squeeze easily through small blood vessels.

06-M-03

C

Cell membrane, Intestinal membrane and Nucleus membrane are partially permeable while Cell wall is not.

06-M-04

D

Red blood cell does not contain nucleus.

06-M-05

C

An animal cell does not contain more chromosomes than a plant cell.

06-M-06

D

L – Red blood cell. It transports oxygen to all parts of the body.

M – Plant cell.

N – Muscle cell. It causes body movement.

06-M-07

B

Euglena gracilis, paramecium and amoeba proteus are unicellular organisms. Poliovirus is a type of virus.

06-M-08

C

The purpose of adding iodine solution is to stain the cell so as to get a clearer image of the onion skin under the microscope.

06-M-09

A

X – Mitochondrion. It enables respiration to take place.

Y – Cell membrane. It controls the movement of substances into and out of the cell.

Z – Cytoplasm. A jelly-like substance in which many chemical reactions take place.

06-M-10

D

A normal human being has 23 pairs of chromosomes which is equal to 46 chromosomes.

06-M-11

C

Cytoplasm is a transparent, jelly-like substance made up of mainly water and small amount of food particles.

06-M-12

C

Q is a typical plant cell and R is a root hair cell. Both Q and R can be found in a plant.

P is a red blood cell and S is a muscle cell. Both P and S can be found in an animal cell.

06-M-13

B

Haemoglobin exists in red blood cell and is responsible for transporting oxygen.

06-M-14

D

When aerobic cellular respiration occurs in the mitochondria, sugars are broken down, and carbon dioxide, energy and water are produced.

06-M-15

A

Chromosomes are thread-like materials that contain genes made of DNA. It does not interfere with functions of the cell.

06-M-16

D

One of the functions of the skeletal system is to protect the organs.

06-M-17

B

Epithelial tissue covers and protects an animal cell. Epidermal tissue in a plant cell performs similar function.

06-M-18

C

Nucleus controls all the activities that take place in a cell.

06-M-19

D

X – Chloroplast. It contains chlorophyll which is needed for photosynthesis.

Y – Cell wall of the plant cell. It is made of cellulose and gives the cell its regular shape.

Z – Sap vacuole found inside the plant cell.

06-M-20

A

The function of the cell membrane of an animal cell allows some substances to pass through.

06-M-21

A

Amoeba is a unicellular organism, therefore it does not need division of labour.

06-M-22

B

Tissue is made up of same kind of cells.

06-M-23

C

Muscle tissue can contract and relax, therefore produce motion.

06-M-24

A

A is a chloroplast found only in plant cells. It contains chlorophyll and is the site for photosynthesis where the plants make their food.

06-M-25

A

The basic unit of an organism is made up of a cell.

06-M-26

B

The reasons for putting a cover slip over a stained specimen for microscopic observation are to keep the specimen flat for observation, to prevent the objective lens from getting wet and to prevent the specimen from drying up.

06-M-27

D

Chromosomes are thread-like materials that contain genes made of DNA. DNA contains genetic information from the parents which determines how an organism looks and behaves.

06-M-28

D

Paramecium is a unicellular organism which does not require division of labour.

06-M-29

B

The function of a circulatory system is to pump blood from heart to the lungs and carries oxygen from lungs to other parts of body.

06-M-30

D

Stems are responsible for transportation of food and water in the plant.

Roots are responsible for absorption of water and mineral salts.

Questions

06-Q-01

(a) A is an eye piece. B is an objective/ objective lens.

(b) C, diaphragm. Open up the diaphragm fully to let all the light through.

06-Q-02

(a) It shows the three characteristics features of plants i.e. presence of cellulose cell wall and chloroplast and the ability to make and store starch.

(b) It does not have a large central vacuole that is found in mature plant cells.

(c) Plant cells are generally bigger than animal cells; Plant cells usually contain chloroplasts which are green in colour and easily visible; Plant cells have distinct cell walls which are thicker and easily stained. (any 2 reasons)

06-Q-03

(a) To deliver oxygen, food and other nutrients around the body.

(b) It is disc-shaped, with a depression in the centre which will allow it to twist itself to squeeze through the narrow capillaries. The extra surface area will also allow for faster diffusion.

(c) An animal cell has a nucleus, while a red blood cell does not have a nucleus. There are not distinct components in a red blood cell compared to a typical animal cell.

(d) It transports water from the roots through the stem and to the leaves and to also provide support.

(e) The xylem cells allow for fast diffusion of water, aiding water intake.

(f) An animal cell lacks a cell wall, while a plant cell has a cell wall.

06-Q-04

(a) B - cell membrane of the plant cell which controls the entry of substances.

(b) E - chloroplast in the plant cell which involves in the process of photosynthesis.

(c) A - cell wall of the plant cell which is a fully permeable boundary.

06-Q-05

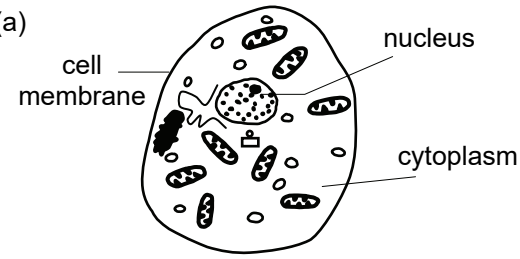
(a) E – Red blood cell.

(b) C – Nerve cell/Neuron.

(c) A and B – Plant cells.

06-Q-06

(a)



(b)

Part of Cell	Animal Cell	Plant Cell
Chloroplasts	Absent	Present
Cell Wall	Absent	Present
Cytoplasm	Fills most of the cell	Only a thin layer lining cell wall
Vacuole	Small and many	Large, and usually only one is present
Shape	Irregular shape	Regular shape

06-Q-07

An organ. A tissue is a collection of cells of the same function while an organ consists of many types of tissues with different functions. The skin consists of different tissues that have different functions, making it an organ.

06-Q-08

(a) Neuron. It transmits electrical impulses.

(b) Brain.

06-Q-09

(a) F – Cell wall.

(b) A – Cell membrane.

(c) D – Nucleus.

(d) E – Vacuole.

06-Q-10

(a) Muscular tissue – Essential to 'mash' and mix the ingested food with the digestive juices.

Glandular tissue – For the absorption of broken-down food.

(b) (i) Facilitates photosynthesis.

(ii) Provides support, rigidity and turgidity to the plant cells i.e. Cell wall.

06-Q-11

(a) Red blood cell and white blood cell.

(b) Red blood cell transports oxygen throughout the body while the white blood cells are antibodies that are present to combat foreign bodies.

(c) Animal cells have no cell wall while plant cells have cell walls. Animal cells do not have chloroplast while plant cells have chloroplasts.

06-Q-12

(a) (i) Organ is made up of a complex group of tissues working together to perform one or more functions for an organism.

(ii) A system is made up of various organs working together to keep an organism alive.

(b) (i) Respiratory system. This system allows breathing.

(ii) Circulatory system. The heart pumps blood to the lungs. The blood carries oxygen from the lungs to other parts of the body.

(iii) Plant transport system. This system transports water and dissolved minerals salts from one part of the plant to another.

(iv) Nervous system. This system enables an organism to respond to changes in the environment.

(v) Reproductive system. This system enables an organism to reproduce.

7

MODEL OF MATTER – THE PARTICULATE NATURE OF MATTER

Learning Outcomes

Candidates should be able to:

Knowledge, Understanding and Application

(a) show an awareness that according to the Particulate Nature of Matter, matter is made up of small discrete particles which are in constant and random motion

(b) show an understanding of the simple model of solids, liquids and gases, in terms of the arrangement and movement of the particles

Skills and Processes

(a) use of models to explain melting and boiling in terms of conversion of the three states of matter

(b) use of models to explain expansion and contraction, and the conservation of mass during these processes

(c) compare the properties of solids, liquids and gases (e.g. volume, shape, density, compressibility) in terms of the arrangement and movement of the particles

Ethics and Attitudes

(a) show an appreciation of how in practice, models are constructed to explain phenomena

(b) show an appreciation of scientific attitudes such as creativity and open-mindedness in creating models to explain the fundamental nature of things and the willingness to re-examine existing models

❼ Particulate model of matter

MCQs

07-M-01

A

Matter is made up of small discrete particles that are too small to be seen.

07-M-02

B

Granite is a solid which has a definite shape and therefore vibrates at fixed position.

07-M-03

B

By heating the wire, the particles gained energy and will move faster.

07-M-04

B

Particles of air are far apart from each other and there is a lot of space between the gas particles. The gas particles move closer by filling up the empty spaces when they are compressed.

07-M-05

D

A change in state causes a change in the distance between the molecules **AND** their speed of motion. Molecules are closed packed in solid state. The change in state from a liquid to a gas is called evaporation.

07-M-06

D

Gas particles are widely spaced out and therefore able to fill up any container completely.

07-M-07

A

Heat does not affect the size and weight of the particles. The particles gain energy from the heat so that they can move faster and further apart.

07-M-08

A

When matter is cooled down, particles lose energy. They will move slowly and come closer together.

07-M-09

B

Liquid can turn into gas without boiling through the process of evaporation. The liquid becomes vapour below the boiling point. When the water evaporates, the water particles escape from the surface.

07-M-10

B

Sodium melts at 98°C which is only 2°C apart from 100°C. Therefore, the particles only move slightly and are still closely packed.

07-M-11

C

The smell of ammonia is easily detected.

07-M-12

A

The lava changed from liquid state to solid state which indicated change of state rather than formation of new substance.

07-M-13

C

X is the flame region whereby the particles gain energy. When the particles have more energy, they move faster and further apart.

Y is the top portion of the wax whereby the wax is melting from solid to liquid.

Z is the middle portion of the wax whereby it has a fixed shape. This represents the property of a solid.

07-M-14

D

Heat causes the particles to gain energy and move further apart.

07-M-15

A

Forces of attraction between the gas particles are weak therefore they move freely and randomly in all directions.

07-M-16

D

The gas particles are constantly moving freely and randomly around. These constant and random motions allow the whole gas jar to be filled up.

07-M-17

C

Solids are closely packed in a regular pattern and held in fixed positions by strong attractive forces.

07-M-18

D

The change in the motion of the atoms and molecules.

07-M-19

D

Dissolving occurs when particles of a solute is placed in between particles of a solvent. Both evaporation and boiling involve change of state from liquid into gas. Melting involves change of state from solid to liquid.

07-M-20

C

Gas particles move freely and randomly in all direction and are far apart. When it is heated, the particles gain energy. This enables the particles to move further apart.

Liquid particles move around randomly and are closer to each other compared to gas particles.

07-M-21

B

Molecules of solid have the least energy of movements and only vibrate at their fixed positions. Thus, they are unable to move at high speed. It has a fixed shape because the particles are closely packed together in a regular pattern.

07-M-22

C

Change of state from solid to liquid requires heat energy.

07-M-23

A

The melting point of a substance is defined as the temperature at which a solid becomes a liquid.

07-M-24

B

Sublimation is the change of state directly from solid to gas.

07-M-25

D

Particles of gas are constantly moving freely and randomly at all directions. It does not vibrate at fixed positions and are not arranged in a regular pattern. Its particles are further apart compared to liquid particles.

07-M-26

C

Steam at 100°C is a gaseous state. Gas particles are moving freely and randomly at all directions therefore the most disordered.

Ice at 0°C is at solid state where particles are held in regular pattern and vibrate at fixed positions. Water at 0°C and 100°C are in liquid state where particles move about randomly around one another.

07-M-27

B

Solid particles vibrate at fixed positions. Liquid particles move randomly around one another. Gas particles move freely and randomly.

Solid particles are closest together. Liquid particles are less closely packed. Gas particles are far apart.

Only solid particles have fixed shape. Liquid and gas particles do not have a fixed shape.

07-M-28

A

X is sublimation as it involves change of state from solid to gas. Y is condensation as it involves change of state from gas to liquid. Z is freezing as it involves changing from liquid to solid.

07-M-29

C

Substance S's melting point is 24°C which is above the temperature of a cold day (22°C). Therefore, it still remains as a solid at 22°C. On a warm day (34°C), substance S has already change to liquid and would not change its state until it reaches its boiling point of 80°C.

07-M-30

D

Solid is denser than liquid. Sound travels fastest in gases. There is greater space between particles in a gas than liquid.

The attractive forces between solid particles are the strongest compared to liquid and gas.

07-M-31

C

When steam condenses, the particles lose energy therefore, the molecules move closer together.

Questions

07-Q-01

(a) Melting. This involves solid (ice cube) becoming liquid (water).

(b) Boiling. This involves liquid (pot of water) becoming gas (steam).

(c) Freezing/solidify. This involves liquid (molten gold) becoming solid (molten gold hardens).

(d) Condensing. This involves gas (steam) becoming liquid (water droplets).

07-Q-02

The solid particles are closely packed in regular pattern. The particles can only vibrate about their fixed positions and unable to slide past each other.

07-Q-03

(a) (i) Vibrate about fixed positions.

(ii) Vibrate about fixed positions but able to slide past each other.

(iii) Bounce randomly around its container.

(b) (i) Close.

(ii) Far apart.

(c) (i) Fixed positions.

(ii) Able to slide past each other.

(iii) No fixed positions.

07-Q-04

(a) more

(b) very strong

(c) faster

(d) liquid

07-Q-05

(a) Boiling (Evaporation).

(b) Boiling point. It is the temperature when a liquid becomes a gas.

(c) The heat energy input is being used to break the intermolecular attraction instead of raising the temperature.

(d) Between sections M to N, the state is liquid and gas as this is the state where the liquid is changing into gas. The state beyond section N is gas whereby the liquid has completely changed into gas.

07-Q-06

(a) B. Its boiling point is lower than room temperature.

(b) D. Its melting point is at 44°C which is within the range of 0°C to 50°C. Therefore, there will be physical change.

(c) A. It has the widest range of temperature and it exists as a liquid from -82°C until 430°C.

07-Q-07

Solid – particles vibrate at fixed positions; closely packed and orderly arranged.

Liquid – particles can move freely throughout the liquid; further apart (more space in between particles).

07-Q-08

(a) 50°C

(b) 110°C

(c) (i) Liquid state.

(ii) Liquid and gaseous state.

07-Q-09

The liquid particles are closely packed together in irregular pattern. However, when the two liquids are poured together, the small particles are able to occupy some of the same in between the water particles. This causes the volume of the mixture to be less than the sum of the two separate volumes of liquids.

07-Q-10

(a) X. A dining table is a solid which is best represented by X (particles are closely packed).

(b) Y. A glass of water is made up of liquid which is best represented by Y (particles are less closely packed than solid).

(c) Z. A balloon consists of gas which is best represented by Z (particles are far apart).

07-Q-11

(a) A is a solid (particles are closely packed). B is a gas (particles are far apart).

(b) S. Evaporation is the change of state from liquid to gas.

(c) Q represents melting. Melting is involved solid becoming liquid.

07-Q-12

Substance	State
A	liquid
B	solid
C	gas
D	gas
E	liquid

07-Q-13

(a)(i) Particles in liquid move about randomly and around one another.

(ii) After freezing has taken place, the particles are more closely packed therefore only able to vibrate at its fixed positions.

(iii) Heat energy is used to move the particles closer, thus the temperature remains constant.

(b) (i) Sublimation.

(ii) Strength of forces for Figure 1 (solid state) is very strong as the particles are held closely together. As for Figure 2 (gaseous state), it has very weak attractive forces.

Figure 1 has the least energy of movement while Figure 2 has the greatest energy of movement.

07-Q-14

(a) S. Sublimation involves solid becoming gas or vice versa.

(b) Q. Condensation involves gas becoming liquid.

(c) P. Melting involves solid becoming liquid.

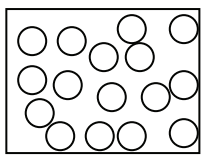
(d) R. Evaporation involves liquid becoming gas.

07-Q-15

(a) (i) solid.

(ii) gas.

(b)



07-Q-16

(a) Q. When it is at 46°C, the substance will be a solid as this temperature is below its melting point.

(b) R. When it is at 114°C, the substance will be a liquid as this temperature is between its melting and boiling points.

(c) S. When it is at 173°C, the substance will be a gas as this temperature is above its boiling point.

Notes:

8

MODEL OF MATTER – ATOMS AND MOLECULES

Learning Outcomes

Candidates should be able to:

Knowledge, Understanding and Application

(a) describe an atom as an electrically neutral entity made up of a positively charged nucleus (protons and neutrons) with negatively charged electrons moving round the nucleus

(b) show an awareness that atoms of an element have a unique number of protons

(c) recognize that atoms have mass that is contributed by the mass of nucleus

(d) show an understanding that a molecule is a group of two or more atoms chemically combined together

(e) state the number and types of atoms, given the chemical formula of a compound (writing of chemical formula is not required)

Skills and Processes

(a) compare the relative size of an atom to other objects

(b) compare atoms and molecules

Ethics and Attitudes

(a) show an appreciation of how in practice, models are constructed, justified and continuously revised as they are used to probe new phenomena and collect additional data (e.g. the various atomic models)

(b) show an appreciation of scientific attitudes such as creativity and open-mindedness in creating models to explain the fundamental nature of things and the willingness to re-examine existing models

(c) show an awareness that technologies resulting from knowledge of the atom have created social and ethical issues, risks and costs (e.g. atomic bomb)

❽ Atoms and molecules

MCQs

08-M-01

A

An atom is electrically neutral when the number of protons and electrons are equal in an atom.

08-M-02

B

The chemical properties of an atom are dependent on the number and arrangement of electrons.

08-M-03

A

Water vapour is made up of two elements, oxygen and hydrogen.

08-M-04

D

The chemical formula of a compound will not indicate the size of each molecule of the compound.

08-M-05

D

$CaCO_3$ – 1 Ca, 1 C, 3 O total is 5 atoms

C_2H_4Cl – 2 C, 4 H, 1 Cl total is 7 atoms

K_2SO_4 – 2 K, 1 S, 4 O total is 7 atoms

C_6H_6 – 6 C, 6 H total is 12 atoms

Therefore, C_6H_6 has the most number of atoms.

08-M-06

A

The Periodic Table contains symbols of **elements** not molecules.

08-M-07

A

The atomic number of an element is the number of protons in its atom which is equal to the number of electrons. Calcium has an atomic number of 20 means that it has 20 protons and 20 electrons.

08-M-08

C

Molecule of an element consists of only one kind of atoms. There C is the only option with the same symbol.

08-M-09

C

II is wrong because the molecule contains three oxygen **elements** not molecules.

08-M-10

B

Diagram B represents a mixture of two elements. An element consists of one kind of atom and can exist as atoms or molecules. Other diagrams represent mixture of compounds (consist of atoms of two or more different elements).

08-M-11

C

An atom of an element has no electric charge due to the equal number of protons and electrons.

08-M-12

A

Number on top represents the mass number which is the total number of protons and neutrons (in this case is 5n + 4p = 9). The number below represents the atomic number which is the number of protons (in this case is 4p).

08-M-13

D

Atomic number represents the number of protons. In this case, it is 8 protons. Mass number is the sum of protons and neutrons. In this case, 18 – 8 = 10 neutrons. This ion gains two electrons, therefore, there are 10 electrons (8 + 2) in Z.

08-M-14

D

Isotopes are different atoms with the same number of protons but different numbers of neutrons.

08-M-15

D

2 C atoms, 6 H atoms and 1 O atom. Total is 9 atoms.

08-M-16

C

Mass number for N is 14, H is 1 and oxygen is 16. Total molecular mass of ammonium nitrate is (14 x 2 N atoms) + (1 x 4 H atoms) + (16 x 3 O atoms) = 80.

08-M-17

D

When a chemical reaction takes place, atoms rearrange themselves to form new molecules.

08-M-18

D

Air contains atoms of gases. It contains molecules made up of both like and unlike atoms.

08-M-19

D

Atomic number is used to decide their order in the Periodic Table.

08-M-20

B

H_2SO_4 contains 3 types of atoms – hydrogen, sulphur and oxygen. For the rest, they contain maximum 2 types of atoms.

08-M-21

D

The number below represents the atomic number which is the number of protons (in this case is 82). The number of electrons is equal to the number of protons (in this case is 82).

08-M-22

D

In diagram D, there are some atoms that are not bound together which indicates incomplete chemical reactions. For the rest of the diagrams, the atoms are bounded together.

08-M-23

C

Oxygen originally has 8 electrons and O^{2-} means it gains 2 electrons. Therefore, total number of electrons is 10. Nitrogen originally has 7 electrons and N^{3-} means it gains 3 electrons. Therefore, total number of electrons is also 10.

08-M-24

A

$C_2H_4O_2$ – 2 carbon atoms, 4 hydrogen atoms and 2 oxygen atoms.

08-M-25

A

Potassium has an atomic number of 19 and contains 20 neutrons. Its atoms are smaller than Bromine (atomic number 35). Atoms are electrically neutral because the number of protons and electrons are equal. Therefore, the potassium atom does not have a positive electric charge.

08-M-26

B

Sodium hydroxide is made up of sodium, hydrogen and oxygen.

08-M-27

B

The number above represents mass number while the number below is the proton number. When an element loses electrons, it is positively charged.

08-M-28

C

The number of positive charge for an ionic compound always equals to the number of negative charge. Potassium ion K^+ has a single positive charge. Sulphate ion SO_4^{2-} has two negative charges. Two potassium ions are needed to balance the sulphate ion. Therefore, the formula is K_2SO_4.

$Mg^{2+} + CO_3^{2-}$ results in $MgCO_3$ instead of Mg_2CO_3.

$Al^{3+} + OH^-$ results in $Al(OH)_3$ instead of $AlOH_3$.

$Al^{3+} + NO_3^-$ results in $Al(NO_3)_3$ instead of $Al(NO_3)_2$.

08-M-29

D

An ionic bond is a type of bond that involves a metal and a non-metal. Sodium (metal) will form an ionic compound with fluorine (non-metal).

08-M-30

C

H_2SO_4 consists of 2 hydrogen atoms, 1 sulphur atom and 4 oxygen atoms. Total is 7 atoms.

08-M-31

C

Its mass number is 3 and atomic number is 2. Therefore, it contains a total of three protons and neutrons (2 protons and 1 neutron).

08-M-32

D

An element with proton number 3 is Lithium which is under Group I of Periodic Table. Lithium forms ions by losing electrons. It also reacts with cold water.

08-M-33

A

Group II element has two valence electrons at the outermost shell while Oxygen has six valence electrons at the outermost shell. Group II element readily loses two electrons to Oxygen (which gains two electrons) to form an ionic bond. This results in the formulae YO.

08-M-34

B

Iron (III) ion Fe^{3+} has 3 positive charges. Sulphate ion SO_4^{2-} has two negative charges. Two iron (III) ions are needed to balance with three sulphate ions. Therefore, the formulae is $Fe_2(SO_4)_3$.

08-M-35

A

A molecule of element is made up of the same kind of atoms. H_2 is a molecule of element. K is an atom. CO and NH_3 is molecule of compounds because they are made up of different kind of atoms.

08-M-36

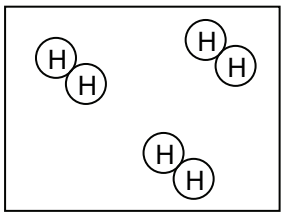
A

Atom Q with atomic number 16 is sulphur. Sulphur ion (S^{2-}) has two negative charges. Atom Y with atomic number 19 is potassium. Potassium ion (K^+) has a positive charge. Two potassium ions are needed to balance with one sulphur ion. Therefore, the formula is Y_2Q.

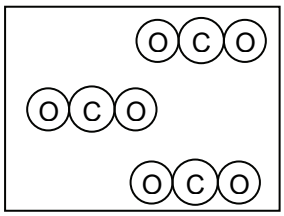
Questions

08-Q-01

(a)



An element



A compound

(b) Similarity: Both are made up of two or more atoms. Difference: Compound molecule consists of different atoms but element is the same.

(c) For compound, we need at least 2 different type of atom to join together.

08-Q-02

(a) 20 protons, 20 neutrons, 20 electrons. Calcium has an atomic number of 20. This means that the number of protons is 20. The number of electrons is 20 too since the number of protons and the number of electrons are equal. Its mass number (sum of protons and neutrons) is 40. In this case, 40 (mass number) – 20 (protons) = 20 electrons.

(b) (i) Ions are formed by losing or gaining of electrons.

(ii) Cation. It loses electrons to be positively charged.

(iii) 1 calcium and 2 chlorine.

(c) nucleus, proton, neutron, electron

08-Q-03

(a) 4 atoms, 1N & 3H atoms.

(b) 3 atoms, 1Pb & 2Cl atoms.

(c) 9 atoms, 1Cu, 2N & 6O atoms.

(d) 10 atoms, 2C, 7H & 1O atoms.

08-Q-04

(a) Increasing atomic number (number of protons).

(b) (i) 2. Lithium loses one electron to become Li^+.

(ii) 3. Its atomic number is 3 which equals to the number of protons.

(iii) Be^{2+}. Beryllium loses two electrons to become Be^{2+}. 4 electrons – 2 electrons.

(iv) 4. Its atomic number is 4 which equals to the number of protons.

(v) 10. Oxygen gains two electrons to become O^{2-}. 8 electrons + 2 electrons.

(vi) 8. Its atomic number is 8 which equals to the number of protons.

(vii) F^-. Fluorine loses one electrons to become F^-. 10 electrons – 1 electron.

(viii) 9. Its atomic number is 9 which equals to the number of protons.

08-Q-05

(a) It shows the components of a chemical.

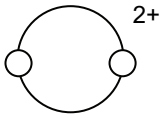
(b) (i) Glucose.

(ii) C, H and O atoms.

(c) (i) 9 represents the sum of protons and neutrons. 4 represents the numbers of protons.

(ii) Protons:4, Electrons:4, Nuetrons:5

(iii)



08-Q-06

(a) C,D. A is sodium, B is calcium, C is oxygen, D is argon and E is lithium. Among these elements, oxygen and argon are non-metal.

(b) A, E. Sodium and lithium belong to Group I.

08-Q-07

(a) $Mg(OH)_2$

(b) CuO

(c) $Al_2(SO_4)_3$

08-Q-08

(a) Sodium.

(b) Na^+. Sodium loses one electron to form a positive ion.

08-Q-09

(a) Ca.

(b) H.

(c) Be, Mg & Ca.

(d) O & S.

08-Q-10

(a) Charge: +, Type of particle: Na.

(b) Charge: Neutral, Type of particle: N.

(c) Charge: -, Type of particle: F.

08-Q-11

(a) (i) (2,6)

(ii) (2,8,4)

(b) (i) 12

(ii)14

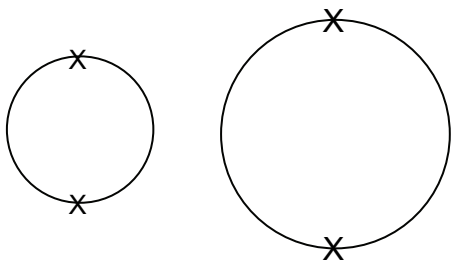
(c) Sodium.

08-Q-12

(a) (i) 4 protons.

(ii) 24 protons and neutrons.

(b)



(c) They both have 2 valence electrons, thus belonging in Group 2

08-Q-13

(a) (i) Number of protons within the nucleus.

(ii) Number of protons and electrons within the nucleus

(b) (i) None.

(ii) Li, Be, B, F, Na

(iii) He, C, N, O, Ne

(c) 24

(d) $^{10}_{5}B$ $^{11}_{5}B$

08-Q-14

(a) P and S. Same number of electrons and protons, making them electrically neutral..

(b) T. It has fewer electrons than protons, making it positively charged.

(c) No. Atoms, such as P and S have totally different proton and neutron numbers.

08-Q-15

(a) Atoms of an element.

(b) Molecules made up of 2 types of atoms.

(c) Mixture of 2 types of diatomic molecules.

(d) Mixture of 2 types of molecules.

08-Q-16

(a) (i) $Ca(OH)_2$.

(ii) $CaCl_2$

(b) (i) Ga_2SO_4.

(ii) $GaCl_3$.

08-Q-17

(a) Metal – C and D, Non-metal – A, B and E.

(b) A.

(c) D.

(d) E.

(e) D and B.

(f) E.

08-Q-18

Isotopes are same element with different number of neutrons/mass.

08-Q-19

(a) The electronic configuration of N is 2, 5 and P is 2,8,5. Since both elements have 5 valence electrons, they belong to Group V (the same group).

(b) The electronic configuration of Al is 2,8,3 and S is 2,8,6. Since both elements have three electrons shells, they belong to Period three or the same period.

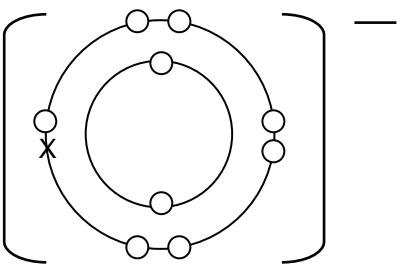
(c) The electronic configuration of potassium atom is 2,8,8,1 and potassium ion is 2,8,8. The potassium atom has 1 electron less than potassium ion. The potassium atom is electrically neutral and the potassium ion has a positive charge.

08-Q-20

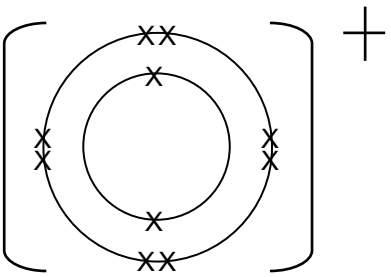
(a) The unlabelled atom is oxygen. Since the atom has 8 electrons, it will have 8 protons which is oxygen atom.

(b) H_2O.

08-Q-21



E



G

08-Q-22

(a) (i) 2 carbon atoms, 4 hydrogen atoms, 2 oxygen atoms.

(ii) 2 Bromine atoms

(b) (i) $CaCl_2$.

(ii) $MgSO_4$

9

RAY MODEL OF LIGHT

9.1 Properties of light

9.2 Reflection of light

9.3 Refraction of light

9.4 Spectrum of light, dispersion of light and prism

9.5 Colours

Learning Outcomes

Candidates should be able to:

Knowledge, Understanding and Application

(a) show an understanding that the ray model represents the path taken by light

(d) recognise that light travels in a straight line, forming shadows when blocked (e.g. eclipse)

(e) explain how reflection is affected by a smooth and rough surface using the ray model of light

(f) describe the effects and uses of reflecting surfaces (e.g. plane and curved)

(g) *show an understanding that the change in the speed of light in different media causes refraction (calculation of angles not required)

(h) describe some effects of refraction

(i) describe the dispersion of white light by a prism using the ray model of light

(j) *explain how we see the colour of objects in white light and coloured light such as red, blue and green

Skills and Processes

(a) investigate the effects of reflection and *refraction in practical activities and make inferences through observations in everyday life (e.g. as the moon orbits the earth, different parts of it reflects light from the sun, resulting in different moon phases)

(b) investigate the characteristics of the image formed by a plane mirror

Ethics and Attitudes

(a) evaluate the impact of light produced by technology, on society and the environment (e.g. city lights can improve night visibility but cause light pollution, disorientation of birds, and use up a lot of electrical energy)

❾•❶ Properties of light

MCQs

09-1-M-01

C

Different forms of electromagnetic waves exist that are distinguished by their frequencies and wavelengths. Visible light, the most familiar form of electromagnetic waves, may be defined as the part of the spectrum that is detectable by the human eye. It has frequencies in the region of 10^{15} Hz.

09-1-M-02

A

The speed of light is 3×10^8 ms^{-1} in a vacuum and is faster in air than in water. Speed of light changes as it passes through different mediums; in general of increasing order of speed: solid, liquid, air.

09-1-M-03

B

The theory that light travels in a straight line was first proposed by the ancient Greeks. In 1690, Dutch mathematician and natural philosopher Christiaan Huygens published his "Treatise on Light", the first formal wave theory on light.

09-1-M-04

B

Luminous objects emit light on their own.

09-1-M-05

B

Non-luminous objects do not emit light on their own. We are able to see them because light is reflected off them into our eyes.

09-1-M-06

A

Opaque objects do not allow light to pass through them. Translucent objects allow some light to pass through them.

09-1-M-07

B

Because electromagnetic waves travel at a speed that is precisely the same as the speed of light in vacuum, one is led to believe (correctly) that light is an electromagnetic wave.

09-1-M-08

C

Shadows are formed because light travels in a straight line. When light shines on an opaque object, some rays of light are blocked while other rays continue to travel in straight lines. The area behind an object that receives no light becomes dark. This area is called a shadow.

09-1-M-09

B

Translucent objects are those that allow some light to pass through them.

09-1-M-10

B

When light shines on an opaque object, some rays of light are blocked by the opaque objects while other rays around it continue to travel in straight lines. The area behind the object that receives no light becomes dark. This area is called a shadow.

09-1-M-11

C

When the source of light is from a point, the shadow is well defined. However, in an extended light source, there is multiple point source of light.

Each of these points cast a slight different shadow. Hence the overall effect is a partially dark shadow.

09-1-M-12

C

A converging beam of light is one with light rays travelling in angles such that all the light rays meet and pass through a point called the focus.

09-1-M-13

D

A small hole allows minimal light rays to pass through and thus a single and sharp image is formed but the image is dim. A large hole will, however, allow many light rays to pass through and thus produces multiple but blurred images, which are bright.

09-1-M-14

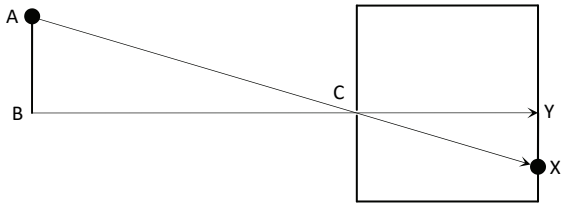
B

Triangle ABC and triangle XYC are similar.

This means that $\frac{XY}{AB} = \frac{YC}{BC} = \frac{\text{image distance}}{\text{object distance}}$

Hence when the object distance is increased, size of image decreases.

☺ Note: A simplified setup diagram is shown below.



09-1-M-15

A

The umbra is the darkest part of a shadow. The penumbra is the region in which only a portion of the object is obscuring the light source.

09-1-M-16

D

The umbra is the darkest part of a shadow.

09-1-M-17

D

A solar eclipse occurs when the Moon passes between the Sun and the Earth so that the Sun is wholly or partially obscured.

09-1-M-18

C

Microwaves, radio waves, infra-red, red visible and ultra-violet are all part of the electromagnetic spectrum. All electromagnetic waves travel at the same speed of 3×10^8 ms^{-1}. Sound has a longer wavelength than electromagnetic waves and travels at a slower speed of 331 ms^{-1}.

09-1-M-19

B

Radio waves, visible light and x-rays are transverse waves and are part of the electromagnetic spectrum which travels at a speed of 3×10^8 ms^{-1}. Sound is a longitudinal wave and travels at a slower speed of 331 ms^{-1}.

09-1-M-20

D

A lunar eclipse occurs whenever the Moon passes through some portion of the Earth's shadow.

Questions – 9.1

09-1-Q-01

They travel at the same frequency but the wavelength and speed of light in the glass both decrease.

09-1-Q-02

(a) transparent

(b) translucent

(c) opaque

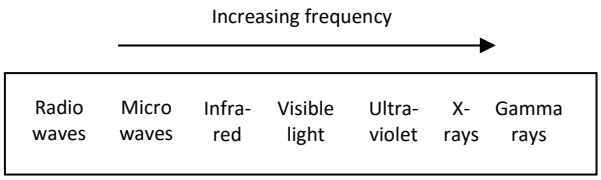
09-1-Q-03

The image becomes blurred but brighter.

09-1-Q-04

(a) Radio waves, microwaves, ultra-violet, x-rays, gamma rays (any three).

(b)



(c) (i) Gamma rays

(ii) Ultra-violet rays

❾•❷ Reflection of light

MCQs

09-2-M-01

D

The law of reflection states that the angle of incidence is equal to the angle of reflection. Therefore

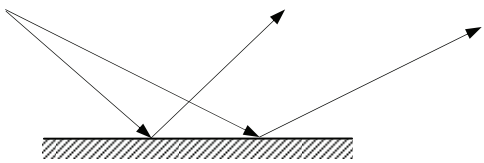
$$\text{angle of incidence} = \frac{90°}{2}$$
$$= 45°$$

09-2-M-02

B

When a diverging beam of light hits a smooth surface, it will be reflected as a diverging beam.

☺ Note: A simplified setup diagram is shown below.



09-2-M-03

A

Non-luminous objects do not emit light on their own. We are able to see them because light is reflected off them into our eyes.

09-2-M-04

C

The law of reflection states that the incident ray, the reflected ray and the normal at the point of incidence lie on the same plane.

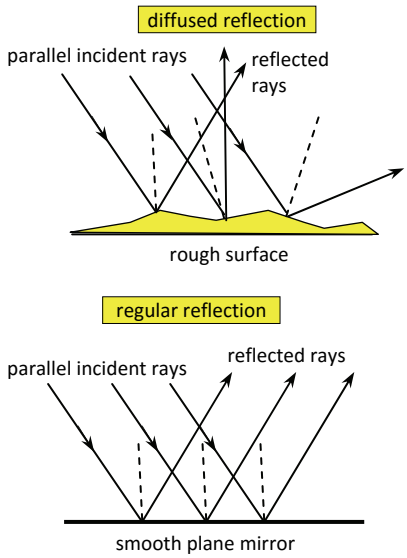
09-2-M-05

C

Spectacles use lens. Dentist's mirror uses concave mirrors to magnify the image. A kaleidoscope uses plane mirror to reflect light in its application.

09-2-M-06

A



09-2-M-07

A

The characteristics of the image in a pinhole camera are real and inverted.

09-2-M-08

C

One of the characteristics of an image resulting from a plane mirror is that it is laterally inverted.

09-2-M-09

B

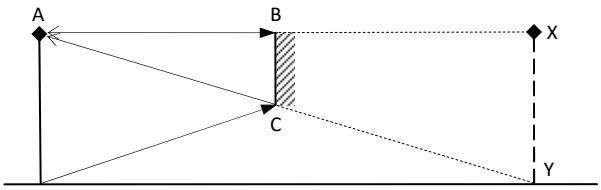
The image in a convex mirror is upright, virtual and reduced in size. Hence the convex mirror provides a wider view of the objects behind the car.

09-2-M-10

A

Triangle *ABC* and triangle *AXY* are similar.

This means that $\frac{BC}{XY} = \frac{AB}{AX} = \frac{1}{2}$



09-2-M-11

A

The object and the image are moving towards the mirror at the same speed. Hence the relative speed between the object and the image is twice that of the object.

09-2-M-12

D

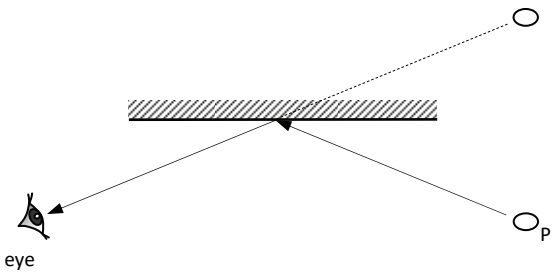
The law of reflection states that the angle of incidence is equal to the angle of reflection. The angle of incidence is the angle between the incident ray and the normal.

Hence, required angle $= 90° - 40°$
$= 50°$

09-2-M-13

D

One of the characteristics of an image resulting from a plane mirror is that the distance between the object and the mirror is equal to the distance between the image and the mirror.



09-2-M-14

A

When a parallel beam of light hits a smooth surface, it will be reflected as a parallel beam. This is because the angle of incidence and the angle of reflection are the same for all the light rays in the beam.

09-2-M-15

A

Regular reflection occurs when an incident parallel beam remains a parallel beam after reflection. This happens only over smooth surfaces.

09-2-M-16

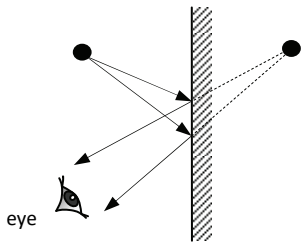
B

A dentist's mirror is required to magnify the objects and therefore uses concave instead of convex mirror.

09-2-M-17

C

An image can only be seen in a mirror only when the extended virtual lines converge behind the mirror to from the virtual image.



09-2-M-18

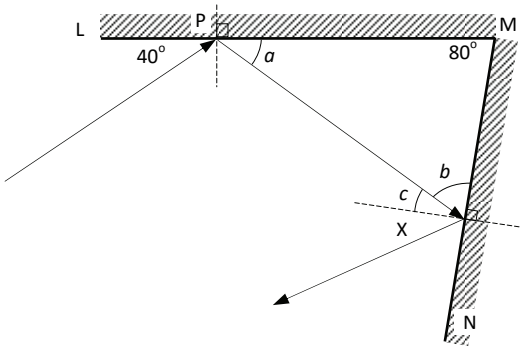
A

Angle $a = 40^o$

Angle $b = 180^o - 80^o - 40^o$
$= 60^o$

Angle X = Angle c
$= 90^o - 60^o$
$= 30^o$

(the angle of incidence is equal to the angle of reflection)



09-2-M-19

B

The new distance between the image and the mirror is now equal to the new distance between the man and the mirror.

09-2-M-20

B

The angle of incidence is bound by the incident ray and the normal to the plane mirror.

09-2-M-21

D

The image formed in a mirror is the same colour as the object. The image is upright, virtual and laterally inverted. The image has the same size as the object. The distance between the object and the mirror is equal to the distance between the image and the mirror.

☺ Note: Virtual images are images that are formed in locations where light does not actually reach.

09-2-M-22

D

When the two mirrors are placed facing and parallel to each other (i.e., a parallel mirror system), there are an infinite number of images. Each image is the result of an image of an image, or an image of an image of an image, and so on.

09-2-M-23

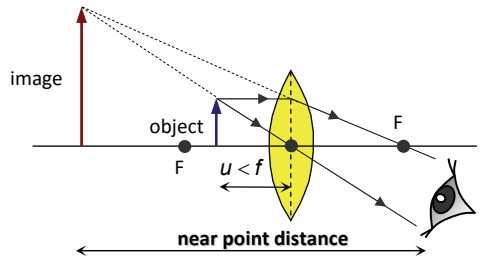
C

The image of a projector is formed by a convex lens. Hence the image is real, inverted and enlarged. The overhead projector uses a mirror to invert the image on the screen back to the upright position.

09-2-M-24

B

The words viewed through a magnifying glass will appear bigger and further.



09-2-M-25

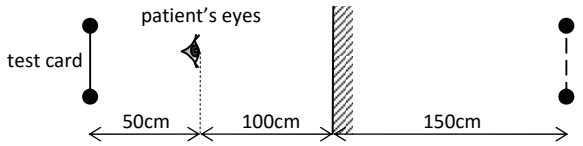
B

The principal focus is also known as the focal point. It is a point at which parallel rays will converge after passing through the lens.

09-2-M-26

D

The distance between the image and the mirror is equal to the distance between the object and the mirror.



Questions – 9.2

09-2-Q-01

The law of reflection states that the angle of incidence is equal to the angle of reflection and that the incident ray, the reflected ray and the normal at the point of incidence lie on the same plane.

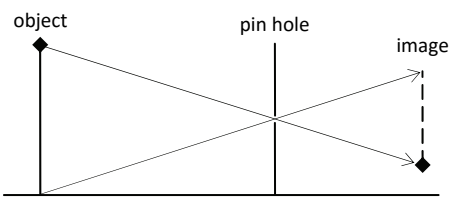
09-2-Q-02

The six characteristics of an image formed by a plane mirror are:

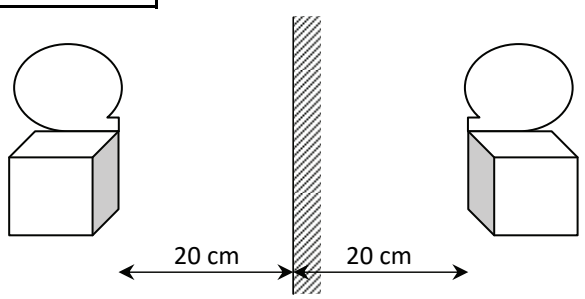
- same colour as the object
- upright
- virtual
- laterally inverted
- same size as the object.
- The distance between the object and the mirror is equal to the distance between the image and the mirror.

09-2-Q-03

In pinhole camera, converging rays passes through the pin hole and falls on a screen, resulting in an inverted, real image.

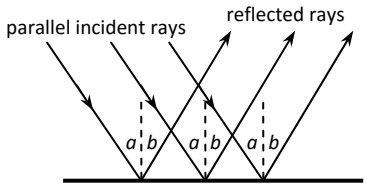


09-2-Q-04



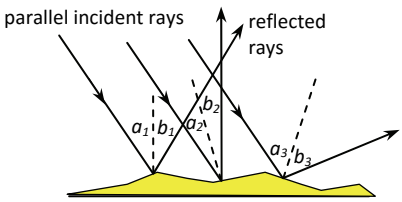
09-2-Q-05

regular reflection



angles of incidence a = angles of reflection b

diffused reflection



angles of incidence a = angles of reflection b

a_1, a_2 and a_3 need not be equal

b_1, b_2 and b_3 need not be equal

Regular reflection occurs on smooth and polished surfaces such as a plane mirror. Diffused reflection occurs on uneven and rough surfaces such as a piece of paper.

A clear image is produced in regular reflection while diffused reflection does not produce a clear image.

The individual rays from a parallel beam are reflected at the same angle from the surface in regular reflection. However the individual rays from a parallel beam are reflected in different directions and angles in diffused reflection.

09-2-Q-06

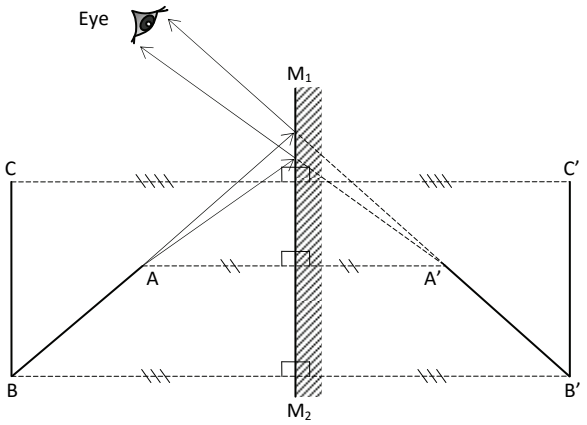
(a) Convex. Convex mirror allows the driver to have a wider view.

(b) Concave. Concave mirror has a magnifying effect; hence the specimen's image can be magnified.

(c) Plane. The image produced will be in exact proportion as the object.

09-2-Q-07

(a) and (b)



(c) The reflection of ABC is a virtual image.

09-2-Q-08

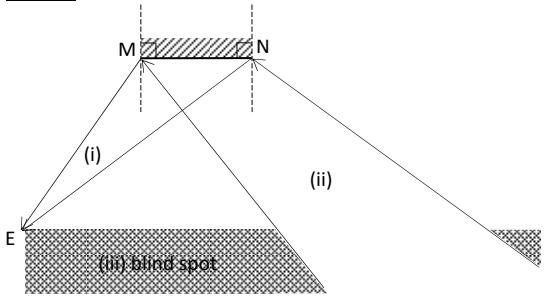
(a) Light travels in straight line.

(b) The image is laterally inverted.

09-2-Q-09

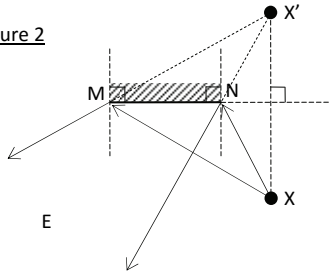
(a)

Figure 1



(b) (i)

Figure 2

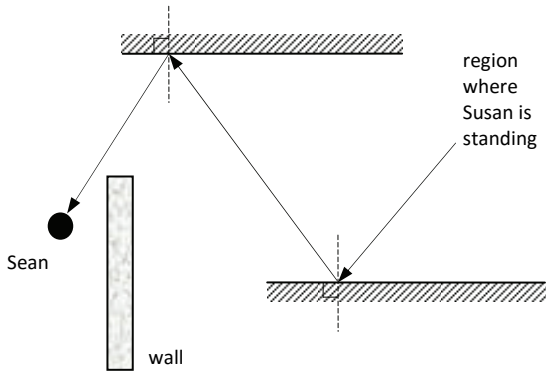


(ii) The distance between the object and the mirror is the same as the distance between the image and the mirror. The size of the object is the same as the size of the image.

09-2-Q-10

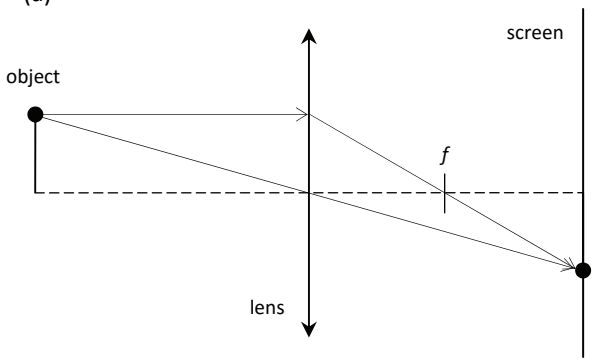
(a) Light travels in straight line. The wall blocks the light directly from Susan from reaching Sean.

(b)



09-2-Q-11

(a)

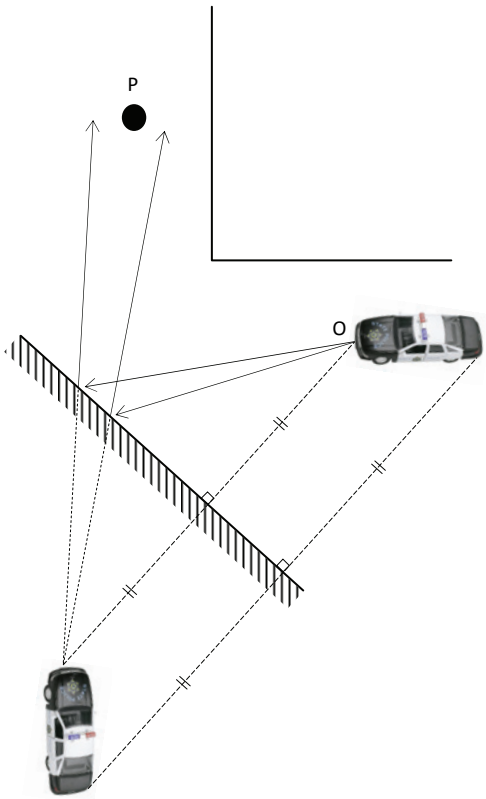


(b) The image is real and inverted.

(c) Focal point *f* is shown as above.

09-2-Q-12

(a)



(b) The characteristics of the image are virtual, laterally inverted, upright, same size as the object, same colour as the object (choose any three).

❾•❸ Refraction of light

MCQs

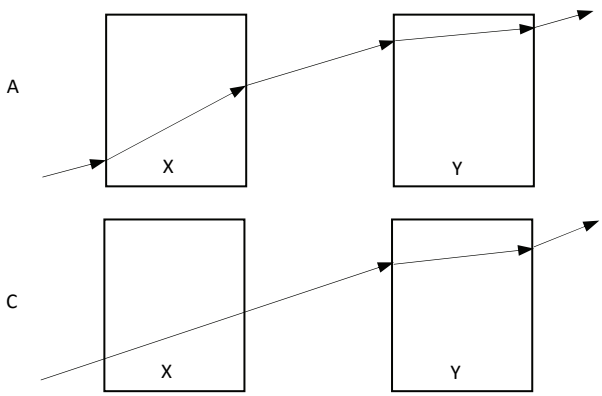
09-3-M-01

A

The refracted ray, as light passes through from one medium to another and then back into the first medium, is always parallel to the incident ray.

Hence options B and D are ruled out immediately since the incident ray and emergent ray through medium X are not parallel.

Option C is not the answer because the ray of light did not bend as it travels through medium X.



09-3-M-02

C

The refracted ray, as light passes through from one medium to another and then back into the first medium, is always parallel to the incident ray. In this case, the refracted ray is 30° to the normal.

Hence option C is the correct answer as the refracted ray is 60° from the medium, i.e. 30° to the normal.

09-3-M-03

B

Magnified view of objects is achieved using lenses, not a consequence of refraction.

09-3-M-04

C

Refraction is the bending of light rays as they travel from a less dense medium to a denser medium or vice versa.

09-3-M-05

C

One of the effects of refraction is that objects in water appear nearer to the surface.

09-3-M-06

B

The frequency of a wave (light is a longitudinal wave) does not change as the wave passes from one medium to another. Therefore, because the relation $v = f\lambda$, where v is the speed of light, f is the frequency and λ is the wavelength, must be valid in both media and because the speed changes, it follows that the wavelength of light changes.

09-3-M-07

B

One of the effects of refraction is that objects in water appear nearer to the surface.

09-3-M-08

C

When light travels from a less dense medium into a denser medium, the light rays bend towards the normal.

09-3-M-09

D

The refracted ray, as light passes through from one medium to another and then back into the first medium, is always parallel to the incident ray.

09-3-M-10

A

Due to refraction, objects that are partly submerged in water appear to be bent towards the surface.

09-3-M-11

D

Speed of light changes as it passes through different mediums; in general increasing order of speed: solid < liquid < air.

09-3-M-12

B

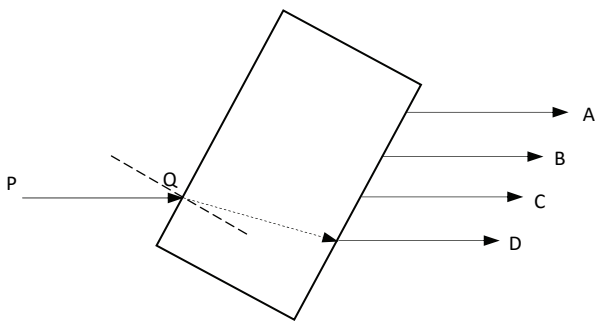
One of the effects of refraction is that objects in water appear nearer to the surface.

09-3-M-13

D

The refracted ray, as light passes through from one medium to another and then back into the first medium, is always parallel to the incident ray.

When light travels from a less dense medium (air) into a denser medium (glass block), the light rays bend towards the normal. Therefore the answer is option D.



09-3-M-14

C

When light travels from a denser medium (water) into a less dense (air) medium, the light rays bend away from the normal.

Speed of light changes as it passes through different mediums; in general increasing order of speed: solid < liquid < air.

09-3-M-15

B

The refracted ray, as light passes through from one medium to another and then back into the first medium, is always parallel to the incident ray.

09-3-M-16

D

Speed of light changes as it passes through different mediums; in general increasing order of speed: solid < liquid < air.

Questions – 9.3

09-3-Q-01

The first law of refraction states that the incident ray, the refracted ray and the normal all lie on the same plane.

The second law of refraction (Snell's Law) states that for two given media, the ratio of the sine of the angle of incident to the sine of the angle of refraction is a constant. This ratio is also called the refractive index.

09-3-Q-02

Reflection is the bouncing off of light rays as they hit the surface of an object. Refraction is the bending of light rays as they travel from one medium to another. This is caused by a change in the speed of light.

In reflection, the incident and reflected rays travel at the same speed of 3×10^8 ms^{-1}. However, in refraction, the incident and refracted rays travel at different speeds.

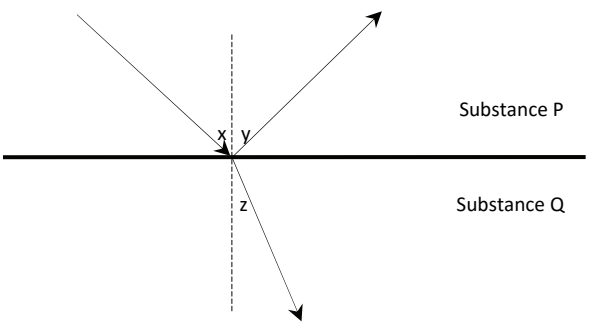
The angle of incidence is equal to the angle of reflection. However, the angle of incidence is not equal to the angle of refraction.

09-3-Q-03

1. The pond appearing shallower than its actual depth.
2. A stick place in a glass of water appears bent.

09-3-Q-04

(a)



(b) (i) refractive index, $n = 2.4$

$$\frac{\sin(x)}{\sin(z)} = 2.4$$

$$\sin(z) = \frac{\sin(80°)}{2.4}$$

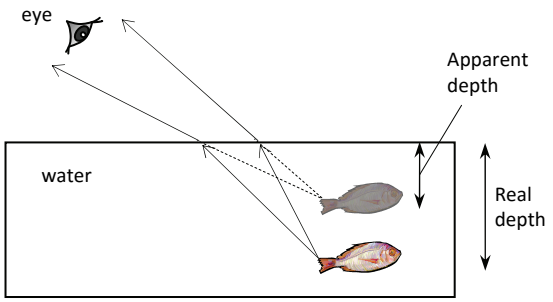
$$z = 24.2^{o}$$

(ii) Yes. The manner in which the light rays are refracted is consistent for two given media, regardless of the direction from the light rays come from.

09-3-Q-05

(a) The ratio of speed of light in air to speed of light in water is 1.33.

(b) (i)(ii)



(iii) The image is virtual since it cannot be captured on screen and the light rays did not actually travel to the image.

❾•❹ Spectrum of light, dispersion of light and prism

MCQs

09-4-M-01

A

Dispersion of light occurs because the different colours of white light refract at different angles. Red light bends the least and violet light bends the most.

09-4-M-02

A

As light passes through a prism, it is refracted by the angles and plane faces of the prism and each wavelength of light is refracted by a slightly different amount. Violet has the shortest wavelength and is refracted the most. Red has the longest wavelength and is refracted the least.

09-4-M-03

C

Light is composed of seven different colours though it appears white.

09-4-M-04

A

The frequency of a wave (light is a longitudinal wave) does not change as the wave passes from one medium to another. Light is composed of seven different colours. These colours are red, orange, yellow, green, blue, indigo and violet.

Each colour of light has a different wavelength and hence is refracted by a slightly different amount when passed through a prism.

09-4-M-05

B

Refraction is the bending of light rays as they travel from a less dense medium (air) to a denser medium (prism) or vice versa.

09-4-M-06

D

Dispersion of light occurs because the different colours of white light refract at different angles, splitting white light into its seven component colours.

09-4-M-07

D

When a beam of white light passes through a glass prism, the light splits into colours of a rainbow. This is called the spectrum of white light.

09-4-M-08

C

Red light bends the least and violet light bends the most.

09-4-M-09

B

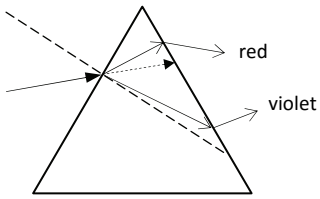
Light can be split into its seven component colours by passing it through a prism. The seven colours can be recombined into white light by passing them through a second prism.

09-4-M-10

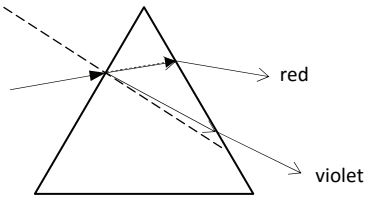
C

When light travels from a less dense medium into a denser medium, the light rays bend towards the normal.

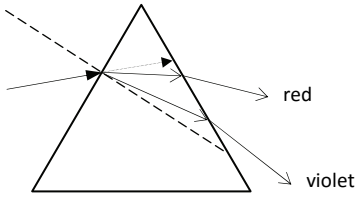
A.



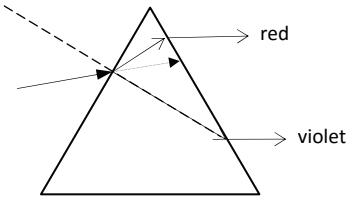
B.



C.



D.



Questions – 9.4

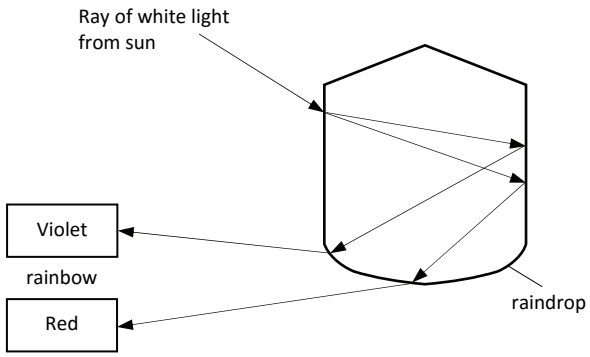
09-4-Q-01

Dispersion of light is the splitting of white light into its spectrum of seven colour components. These colours are red, orange, yellow, green, blue, indigo and violet.

09-4-Q-02

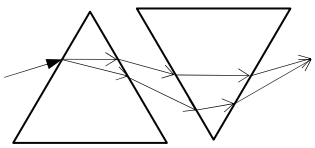
(a) Sunlight enters the water droplets and different colour components of the white light slow down by different speeds. As a result, different colours of the white light are refracted at different angles and bend towards the normal at different angles. Upon leaving the water droplets, the separate colours will bend again but now away from the normal to produce the colours of a rainbow.

(b)



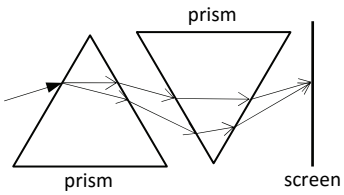
09-4-Q-03

The colours of the spectrum can be recombined to form white light by passing them through another similar prism, which should be inverted. Another method is by spinning a Newton's disc.



☺ A Newton's disc is a disc with seven segments of the rainbow colours. When the disc is rotated, the colours fade to appear white.

09-4-Q-04



Use a prism to split a white light. Insert another prism to recombine the colours to get the white light.

❾•❺ Colours

MCQs

09-5-M-01

B

The human eye is able to see the colour of an object because that particular spectrum of visible light is reflected from the object into the eye.

09-5-M-02

A

A red colour object appears red under white light because it reflects only the red colour component into our eyes and absorbs the rest. Therefore when cyan (blue + green) light is shone on the red screen, it would not reflect any of these lights and thus the object appears black.

09-5-M-03

C

Cyan is a secondary colour formed by mixing green and blue lights.

09-5-M-04

D

White light can be obtained by mixing either the seven components of white light or by mixing the three primary colours which are red, green, and blue. Magenta is a secondary colour formed by mixing red and blue colours. Hence a green and magenta lights combination will give white colour light.

09-5-M-05

A

Cyan is a secondary colour formed by mixing green and blue colours. Hence a red and cyan lights combination will give white colour light.

09-5-M-06

D

Yellow is a secondary colour formed by mixing red and green colours. Thus red and yellow will give yellow.

Orange is a combination of 100% red and 50% green. Thus blue and orange will give white.

Cyan is a secondary colour formed by mixing green and blue. Thus red and cyan lights combination will give white colour light.

09-5-M-07

D

A gold colour object appears gold under white light because it reflects only the gold combinations (yellowish) into our eyes and absorbs the rest. Therefore when only blue light is shone, the gold car would not reflect the blue light and thus the car appears black.

09-5-M-08

B

Yellow is a secondary colour formed by mixing red and green colours. A yellow car appears yellow under white light because it reflects both the red and green colour components into our eyes and absorbs the rest.

Therefore when cyan (blue + green) light is shone, the yellow car would reflect only the green component into our eyes, thus the car appears green.

09-5-M-09

B

The colour of an object is the colour of the light that is reflected from it into our eyes. If no light is reflected, the object appears black.

09-5-M-10

C

A colour filter is a clear plastic sheet or glass that only allows some colours to pass through. The other colours are absorbed.

Only red and green lights will pass through the yellow light filter, and then only green light will pass through the cyan light filter.

09-5-M-11

A

After white light is passed through magenta and cyan light filters, blue light will emerge. (option A)

After white light is passed through red and magenta light filters, red light will emerge. (option B)

After white light is passed through yellow and green (and vice versa) light filters, green light will emerge. (options C and D)

A yellow car appears yellow under white light because it reflects both the red and green colour components into our eyes and absorbs the rest. Therefore option B will result in the car appear red while options C and D will make the car look green in colour. Only option A will ensure that the car reflects no lights and thus appear black.

09-5-M-12

B

Magenta is a secondary colour formed by mixing red and blue colours. Therefore when cyan (blue + green) light is shone, magenta paper would reflect only the blue component into our eyes, thus making the coloured paper appears blue.

09-5-M-13

C

In this case, illuminating a green-leafed plant with green light will result in the plant not absorbing any light at all since it reflects green light.

09-5-M-14

C

White colour can be obtained by mixing the three primary colours: red, blue and green. Yellow is obtained by mixing red and green.

09-5-M-15

A

A blue colour object appears blue under white light because it reflects only the blue colour component into our eyes and absorbs the rest. Therefore when yellow (red + green) light is shone, the blue stripes would not reflect any of these lights and thus the stripes appear black. The white stripes, however, would reflect the yellow colour.

Questions – 9.5

09-5-Q-01

(i) green

(ii) cyan

(iii) cyan

(iv) red, green, blue

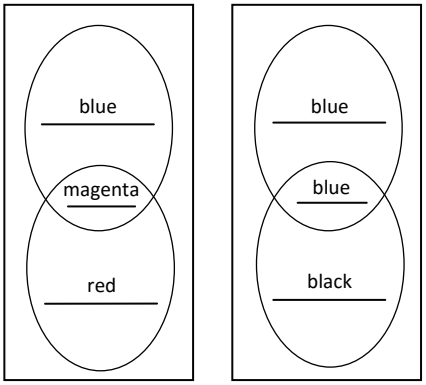
09-5-Q-02

The object appears black as it absorbs all the colour components of light and reflects none.

09-5-Q-03

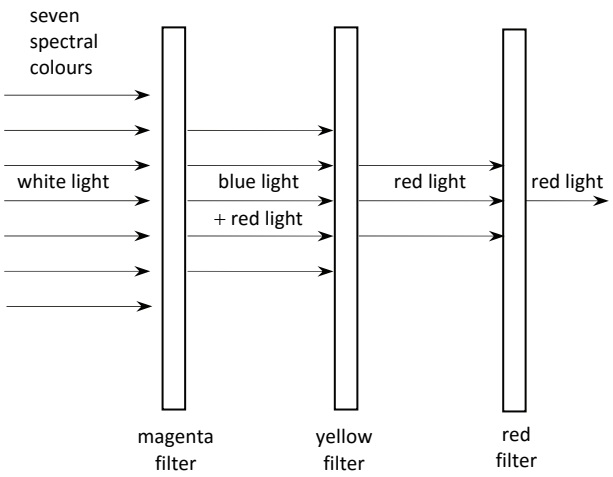
Colour of light	Colour of the object when shine with various coloured lights				
	White	Red	Blue	Magenta	Yellow
White	White	Red	Blue	Magenta	Yellow
Red	Red	Red	Black	Red	Red
Green	Green	Black	Black	Black	Green
Blue	Blue	Black	Blue	Blue	Black
Magenta	Magenta	Red	Blue	Magenta	Red

09-5-Q-04



White screen Blue screen

09-5-Q-05



Notes: