PHYSICS
AT WORK
for HKDSE

SKILL BUILDER

Sample

- Introduce the **6 essential skills** of learning Physics
- **Teaching notes** and **worksheets** in Word and/or PowerPoint formats
- **Electronic files** available on OUP web:

OXFORD
UNIVERSITY PRESS

www.oupchina.com.hk

Contents (sample)

Full version will be provided when officially published.

Introduction

This new series comes with a full set of features and worksheets for developing and sharpening students' skills required in the Physics Curriculum. The skills are divided into the following six areas:

- Writing skill NEW!
- Mathematical skill
- Drawing skill
- Graphical skill
- Problem-solving skill
- Experimental skill

This sample gives examples of these features and worksheets. Teachers are encouraged to make full use of them to develop students' skills in these areas.

Skill 1 Writing NEW!

Communication is an important aspect in the DSE Physics curriculum. It is one of the broad aims of the curriculum. In assessment, students are required to 'select, organise, and communicate scientific information clearly, precisely and logically'.

In DSE Papers 1B and 2, a sizeable portion of marks require candidates to give answers in sentences or even paragraphs. Competence in writing skill is important in achieving good results in the exam.

Unfortunately, reports on DSE Physics exams show that candidates are weak in answering 'essay questions or parts that require description'. Weaker candidates tend to give up answering such questions. Many candidates also lack the language ability to express their ideas accurately and logically.

It is not easy to help students build up the skill in answering this type of questions. They need specific training and repeated practice to gradually build up the skill throughout the whole course.

In view of this, ***Physics at Work for HKDSE*** include the following to help teachers and students overcome the difficulties.

1	A new type of example, Writing practice, is included in the Student's Book to help students build up their writing skill.
2	Extra worksheets are also available for further practice.

Student's Book

Book 1 Ch 2 p.32

Writing practice

Question

One way to thaw (defrost) a piece of frozen meat is to put it on a metal pan (Fig a). Explain why this method helps to speed up the thawing process. (2 marks)

Fig a

Carefully designed question with marks.

Tip

You may write the explanation by answering the following questions:

① Which material is responsible for the conduction? Is it a good or poor conductor?

② How does it affect the rate of conduction?

③ What is the direction of heat transfer?

Answer

Metal is a good conductor of heat. 1A

Therefore, heat is conducted quickly from the metal pan to the frozen meat. 1A

Demonstrate how to answer such questions. Answers are transferable to similar questions.

Practise yourself

1 Some ice is kept under water at the bottom of a boiling tube with a piece of wire gauze (Fig b). The top part of the water is then heated. When this part of water starts boiling, most of the ice remains unmelted. Explain the reason. (2 marks)

Video

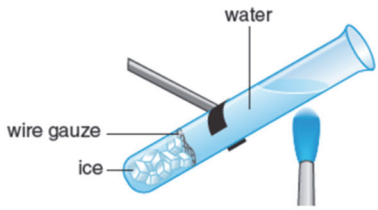


Fig b

2 Cyrus winds a piece of paper round a copper block. He then heats the paper with a Bunsen flame (Fig c). The paper does not burn after being heated for 1 minute. Explain the reason. (Given that paper has to reach 450 °C before it burns.) (2 marks)

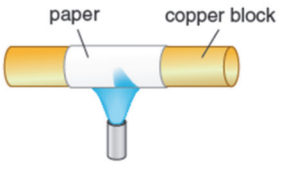


Fig c

Similar question(s) for repeated practice.

Answers provided at end of Book.

Book 2 Ch 9 p.416

Writing practice

Question

A car makes a turn in a circular path. Explain why the chance of skidding increases when the car moves at a higher speed. (2 marks)

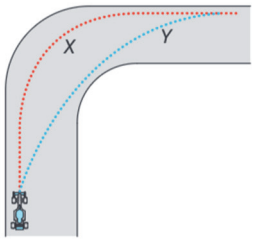
Answer

By $F = \frac{mv^2}{r}$, the car requires a larger centripetal force F when the speed v is higher. 1A

It is more likely that the friction is not large enough to provide the centripetal force required. 1A

Practise yourself

1 A race car is going to make a turn with a constant speed in car racing. If the driver wants to reduce the chance of skidding without lowering the car speed, which path, X or Y, should he take? Explain. (2 marks)



Explanation that involves reasoning with equation.

Book 4 Ch 2 p.92

Writing practice

Two identical resistors r are connected in series to a battery of e.m.f. ε. The current drawn from the battery is I (Fig a).

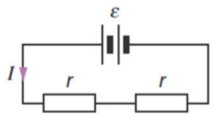


Fig a

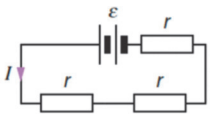


Fig b

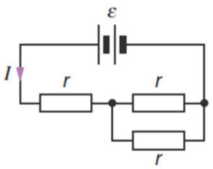


Fig c

Question 1

Explain how I will change if one more resistor r is connected as shown in Figure b. (2 marks)

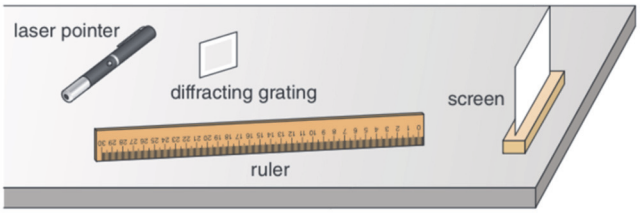
Answer

The equivalent resistance of the circuit will increase. 1A

By $I = \frac{V}{R}$, I will decrease. 1A

Writing practice

You are given a laser pointer, a diffraction grating with grating spacing d, a screen and a ruler.



Question 1

Question on describing experiment.

Describe how you would use the above apparatus to estimate the wavelength of the laser light. (4 marks)

Answer

Answer demonstrating how such question is answered.

Direct the laser beam perpendicularly to the grating to project an interference pattern on the screen. 1A

Measure the distance D between the grating and the screen. 1A

Measure the distance y between the zeroth-order and the nth-order bright fringes. 1A

Calculate the angle of diffraction θ_n by $\tan \theta_n = \frac{y}{D}$ and then calculate the wavelength of light λ by $d \sin \theta_n = n\lambda$. 1A

Question 2

Suggest and explain one precaution that can make the results more accurate. (2 marks)

Answer

Alternate answer that is also acceptable.

Or ▶

Measure the values of y using fringes of the same order on both sides and take the average of the two values obtained. 1A

This reduces the error due to the alignment of the screen, the grating and the laser beam. 1A

Using higher-order bright fringe rather than the first-order bright fringe when measuring y. 1A

This reduces the percentage error in y. 1A

Practise yourself

You are given a laser pointer, a double slit with slit separation a, a screen and a ruler.

1 Describe how you would use the above apparatus to estimate the wavelength of the laser light. (4 marks)

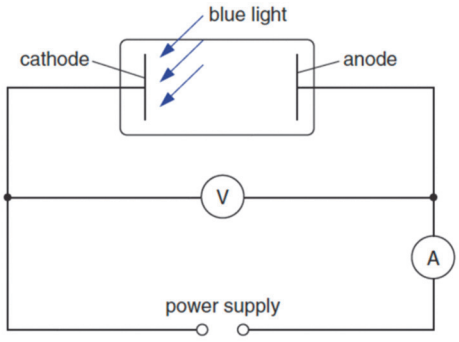
2 Suggest and explain one precaution that can make the results more accurate. (2 marks)

Questions also cover Elective topics.

Book E2 Ch 1 p.25

Writing practice

In a photoelectric effect experiment, when the photocell is illuminated by blue light, a photoelectric current is measured.



Question 1

The output voltage of the power supply is adjusted until the ammeter reading drops to zero. How will the ammeter reading change if the intensity of the blue light increases? Explain. (3 marks)

Answer

The ammeter reading remains zero. 1A

Increasing the intensity will not increase the energy carried by each incident photon. 1A

The maximum KE of photoelectrons emitted will not change and the photoelectrons still cannot reach the anode. 1A

Question 2

How will the stopping potential change if ultra-violet radiation is used instead of blue light? Explain. (3 marks)

Answer

The stopping potential will be larger. 1A

A photon of ultra-violet radiation has higher energy than a photon of blue light. 1A

The maximum KE of photoelectrons emitted will be higher, resulting in a larger stopping potential. 1A

Practise yourself

In a photoelectric effect experiment, when the photocell is illuminated by blue light, a photoelectric current is measured.

1 How will the stopping potential change if the intensity of the blue light increases? Explain. (3 marks)

2 Photoelectric current is measured when green light is used instead of blue light. How does the stopping potential change when green light is used? Explain. (3 marks)

The Student's Book contains a large number of Writing practice to help students build up their writing skill.

Book 1

Chapter	Page no.	Question
2	32	**Explain** why a metal pan helps speed up the thawing process.
3	78	**Explain** why the measured value of c of water is higher than the actual value.
4	111	**Explain** how the value of l_f of ice will be affected if the control apparatus is not set up.
	113	**Explain** how the energy lost to the surroundings affects the value of l_v in the experiment.
5	180	Using kinetic theory, **explain** the increase in gas pressure inside a closed bottle with dry ice.

Book 2

Chapter	Page no.	Question
2	51	**Describe** the motion of the girl from t = 0 to t = 50 s.
3	135	**Explain** the normal force acting on the boy by the lift when an upward-moving lift is slowing down.
5	234	How should the magnitude of F change to keep the rod horizontal? **Explain**.
6	272	**Describe** the energy conversion of Edwin from the beginning of the jump to the moment when he reaches point Y.
7	333	**Explain** how this design of the seat belts protects the drivers and passengers.
9	416	**Explain** why the chance of skidding increases when the car moves at a higher speed.
10	467	If A is further away from the Earth than B, how is the orbital speed of A compared to B? **Explain** your answer.

Books 3A and 3B

Chapter	Page no.	Question
3	107	**Describe** how you can find the focal length of the lens using the given apparatus.
5	82	1 **Explain** why a stationary wave is formed on the string. 2 **Explain** whether the new wave has more or fewer loops if the tension in the string is gradually reduced.
6	125	1 **Describe** how you would use the given apparatus to estimate the wavelength of the laser light. 2 Suggest and **explain** one precaution that can make the results more accurate.

Book 4

Chapter	Page no.	Question
1	6	1 **Explain** why the plastic bag becomes negatively charged after it is rubbed by the cloth. 2 **Describe** and **explain** the direction of the net electrostatic force acting on the metal can by the plastic bag.
2	92	1 **Explain** how *I* will change if one more resistor is connected in series to the circuit. 2 **Explain** how *I* will change if one more resistor is connected in parallel to the circuit.
3	133	1 **Explain** why the voltmeter reading is smaller than the theoretical value. 2 **Describe** an experiment to show how the terminal voltage of the battery is affected by the total resistance of the circuit.
4	165	1 Should the switch of an appliance be installed in the neutral wire? **Explain**. 2 **State** two advantages of connecting wall sockets in parallel instead of in series.
7	295	1 **Explain** why an external force is needed to keep *AB* moving along the horizontal conducting rails. 2 **Explain** whether there is current flowing through *AB* if *AB* and *CD* move at the same velocity.
8	334	1 Does a current pass through the load connected to the secondary coil of the transformer? **Explain**. 2 If another load is connected in parallel to the original load, how will the primary current change? **Explain**.

Book E1

Chapter	Page no.	Question
2	78	**Explain** how the orbital period of the spacecraft changes if it fires its engine momentarily to boost up its speed.

Book E2

Chapter	Page no.	Question
1	25	1 In the photoelectric effect experiment, **explain** how the ammeter reading will change if the intensity of the blue light increases. 2 **Explain** how the stopping potential will change if UV is used instead of blue light.
2	73	1 Use Bohr's model to **explain** why the lines are discrete. 2 **Explain** why Rutherford's model cannot explain the discrete bright lines.
3	119	How will the resolving power of the TEM change if the accelerating voltage in the electron gun increases? **Explain**.

Book E3

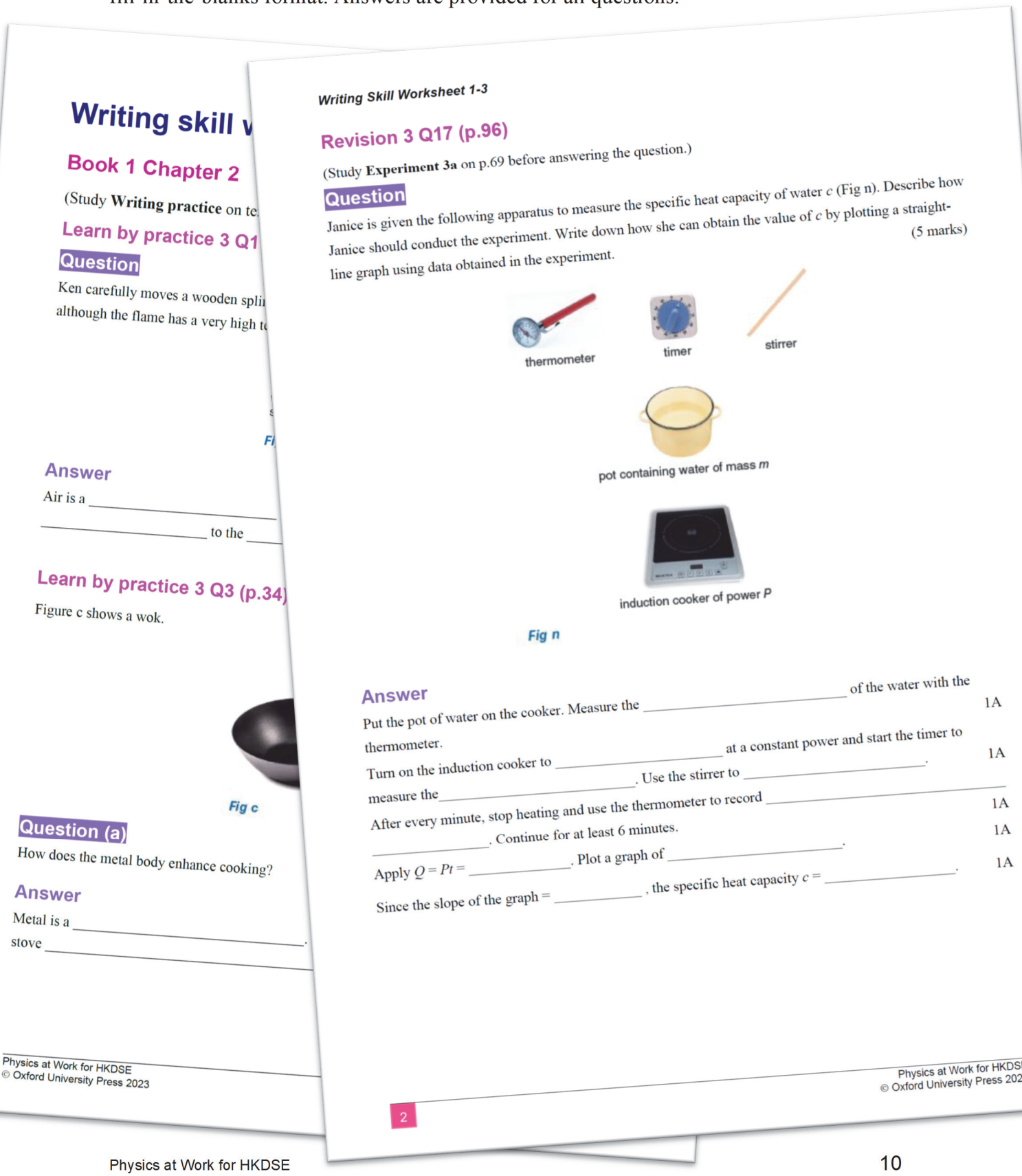
Chapter	Page no.	Question
1	24	**Describe** the change of state of the refrigerant and the heat exchange when it flows through the evaporator coil in an air conditioner.

Book E4

Chapter	Page no.	Question
1	10	1 **Describe** the accommodation process of the eye in order to keep seeing the object clearly. 2 By considering the lens formula, **explain** why making the lens thinner during accommodation can help an eye to see an object moving away from it clearly.
2	95	**Explain** why the surface of a gallstone appears to be bright in an ultrasound image.
3	128	**Explain** the appearance of the lungs, i.e. region *A*, on the X-ray image.

Worksheets

To give students further practice, extra worksheets are provided to help them answer selected questions in Student's Books. The questions are in fill-in-the-blanks format. Answers are provided for all questions.



Writing skill v

Book 1 Chapter 2

(Study **Writing practice** on te

Learn by practice 3 Q1

Question

Ken carefully moves a wooden spli
although the flame has a very high t

Answer

Air is a _____

_____ to the _____

Learn by practice 3 Q3 (p.34)

Figure c shows a wok.

Fig c

Question (a)

How does the metal body enhance cooking?

Answer

Metal is a _____.

stove _____

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Writing Skill Worksheet 1-3

Revision 3 Q17 (p.96)

(Study **Experiment 3a** on p.69 before answering the question.)

Question

Janice is given the following apparatus to measure the specific heat capacity of water c (Fig n). Describe how Janice should conduct the experiment. Write down how she can obtain the value of c by plotting a straight-line graph using data obtained in the experiment. (5 marks)

thermometer

timer

stirrer

pot containing water of mass m

induction cooker of power P

Fig n

Answer

Put the pot of water on the cooker. Measure the _____ of the water with the thermometer. 1A

Turn on the induction cooker to _____ at a constant power and start the timer to measure the _____. Use the stirrer to _____. 1A

After every minute, stop heating and use the thermometer to record _____ _____. Continue for at least 6 minutes. 1A

Apply $Q = Pt$ = _____. Plot a graph of _____. 1A

Since the slope of the graph = _____, the specific heat capacity c = _____.

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2

Skill 2 Mathematics

Student's Book

To facilitate students' access to the content of this skill, a short version is put beside the related contents and a long version at the end of the same book. Simple questions are included in the long version to familiarize students with the skill.

Book 2 Ch 1 p.9

b Displacement on a plane

Suppose you move towards the north from D to E and then towards the east to F (Fig. 1.2g). Your total displacement from D is $\overrightarrow{DF}$.

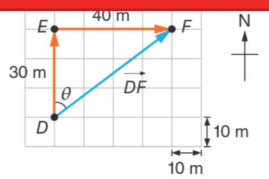


Fig 1.2g *Calculating displacement on a plane.*

The magnitude and direction can be found by using *Pythagoras' theorem* and *trigonometric ratios* as follows.

Magnitude:

$$DF = \sqrt{30^2 + 40^2} = 50 \text{ m}$$

Direction:

$$\tan\theta = \frac{40}{30}$$

$$\theta = 53.1°$$

As a result, $\overrightarrow{DF}$ is 50 m (N53.1°E).

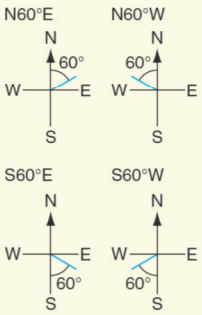
Skill *Mathematics*

Pythagoras' theorm and trigonometric ratios

▸ p.483

Reduced bearings

Directions can be represented by *reduced bearings*. See the examples below.

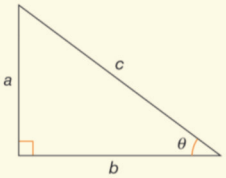


Skill
Mathematics

Pythagoras' theorem and trigonometric functions

Pythagoras' theorem states that the three sides of a right-angled triangle are related by the following equation:

$c^2 = a^2 + b^2$



For the right-angle triangle, the trigonometric functions (sin, cos and tan) are defined as follows. Their inverse functions ($\sin^{-1}$, $\cos^{-1}$ and $\tan^{-1}$) can be used to find the value of angle if the ratio of sides is given.

$$\sin\theta = \frac{\text{opposite side}}{\text{hypotenuse}} = \frac{a}{c} \qquad (\theta = \sin^{-1}\frac{a}{c})$$

$$\cos\theta = \frac{\text{adjacent side}}{\text{hypotenuse}} = \frac{b}{c} \qquad (\theta = \cos^{-1}\frac{b}{c})$$

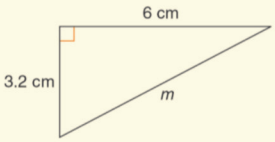
$$\tan\theta = \frac{\text{opposite side}}{\text{adjacent side}} = \frac{a}{b} \qquad (\theta = \tan^{-1}\frac{a}{b})$$

Practise yourself

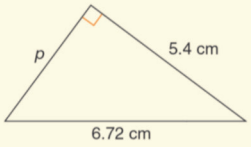
Answers to **Practice yourself** are provided at the end of the Book.

1 Find the unknown in each of the following right-angled triangles.

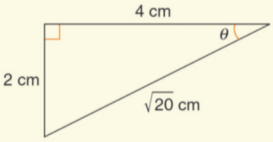
(a)



(b)

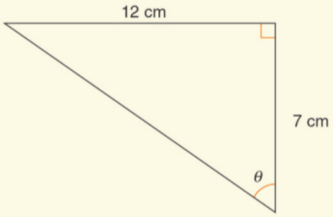


2 For the right-angled triangle below, find (a) $\sin\theta$; (b) $\cos\theta$; and (c) $\tan\theta$.

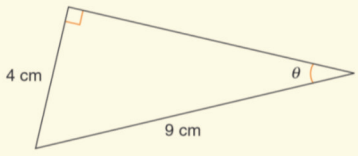


3 Find the unknown in each of the following right-angled triangles.

(a)

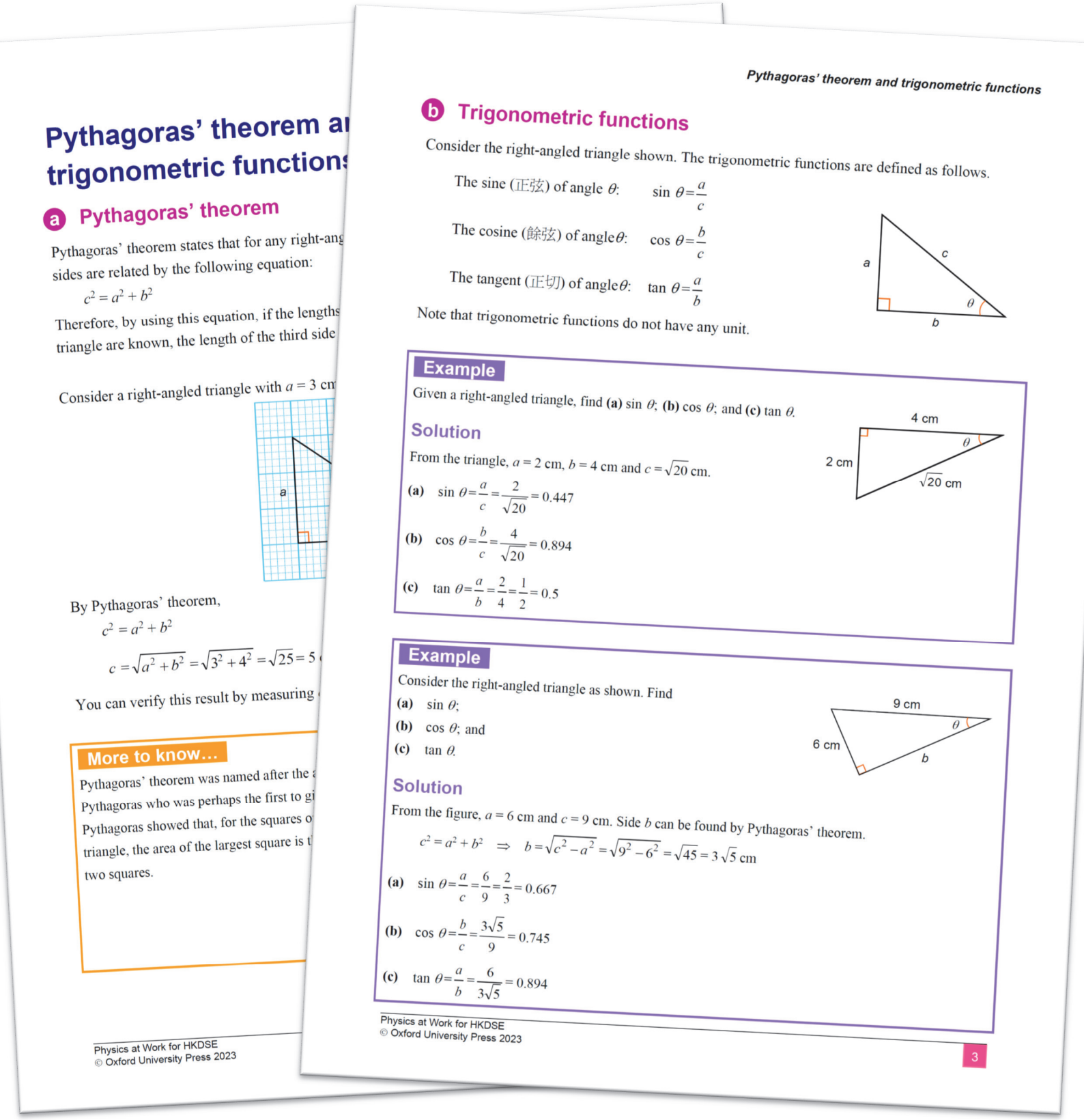


(b)



Worksheets

More detailed worksheets are available separately. If teachers want to give students a more in-depth review of the topic, they can ask students to complete the worksheets in class or at home.



Pythagoras' theorem ar
trigonometric function

a Pythagoras' theorem

Pythagoras' theorem states that for any right-ang
sides are related by the following equation:

$c^2 = a^2 + b^2$

Therefore, by using this equation, if the lengths
triangle are known, the length of the third side

Consider a right-angled triangle with $a = 3$ cm

a

By Pythagoras' theorem,

$c^2 = a^2 + b^2$

$c = \sqrt{a^2 + b^2} = \sqrt{3^2 + 4^2} = \sqrt{25} = 5$

You can verify this result by measuring

More to know...

Pythagoras' theorem was named after the
Pythagoras who was perhaps the first to gi
Pythagoras showed that, for the squares o
triangle, the area of the largest square is t
two squares.

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Pythagoras' theorem and trigonometric functions

b Trigonometric functions

Consider the right-angled triangle shown. The trigonometric functions are defined as follows.

The sine (正弦) of angle θ: $\sin\theta = \frac{a}{c}$

The cosine (餘弦) of angle θ: $\cos\theta = \frac{b}{c}$

The tangent (正切) of angle θ: $\tan\theta = \frac{a}{b}$

Note that trigonometric functions do not have any unit.

a, c, θ, b

Example

Given a right-angled triangle, find **(a)** $\sin\theta$; **(b)** $\cos\theta$; and **(c)** $\tan\theta$.

4 cm, θ, 2 cm, $\sqrt{20}$ cm

Solution

From the triangle, $a = 2$ cm, $b = 4$ cm and $c = \sqrt{20}$ cm.

(a) $\sin\theta = \frac{a}{c} = \frac{2}{\sqrt{20}} = 0.447$

(b) $\cos\theta = \frac{b}{c} = \frac{4}{\sqrt{20}} = 0.894$

(c) $\tan\theta = \frac{a}{b} = \frac{2}{4} = \frac{1}{2} = 0.5$

Example

Consider the right-angled triangle as shown. Find

(a) $\sin\theta$;

(b) $\cos\theta$; and

(c) $\tan\theta$.

9 cm, θ, 6 cm, b

Solution

From the figure, $a = 6$ cm and $c = 9$ cm. Side b can be found by Pythagoras' theorem.

$c^2 = a^2 + b^2 \Rightarrow b = \sqrt{c^2 - a^2} = \sqrt{9^2 - 6^2} = \sqrt{45} = 3\sqrt{5}$ cm

(a) $\sin\theta = \frac{a}{c} = \frac{6}{9} = \frac{2}{3} = 0.667$

(b) $\cos\theta = \frac{b}{c} = \frac{3\sqrt{5}}{9} = 0.745$

(c) $\tan\theta = \frac{a}{b} = \frac{6}{3\sqrt{5}} = 0.894$

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3

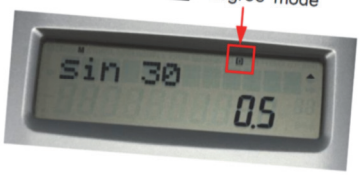
More to know...

In a right-angled triangle with an acute angle θ, the sides of triangle are named as follows:

Hypotenuse (斜邊): the longest side in the triangle which is opposite the right angle

Adjacent side (鄰邊) of θ: the side next to θ (not the hypotenuse)

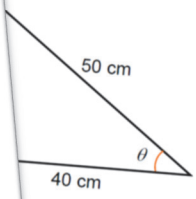
Opposite side



triangle with $\theta = 30°$. From this, we can

with the same θ will remain the same no

d on θ only.



$= \frac{30}{50} = \frac{3}{5}$

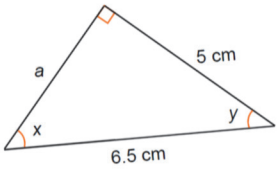
$= \frac{40}{50} = \frac{4}{5}$

$\frac{30}{40} = \frac{3}{4}$

tions is given. This can also be

Example

Find the unknowns in the following figure.



Solution

By Pythagoras' theorem,

$a^2 = 6.5^2 - 5^2$

$a = \sqrt{6.5^2 - 5^2} = 4.15 \text{ cm}$

$\sin x = \frac{5}{6.5} \Rightarrow x = 50.3°$

$\cos y = \frac{5}{6.5} \Rightarrow y = 39.7°$

More to know...

In the above example, we need to find the inverse of a sine ratio. We can use the following expression.

$x = \sin^{-1}\left(\frac{5}{6.5}\right) = 50.3°$

The symbol $\sin^{-1}$ means the inverse sine. We should note that $\sin^{-1} x$ is NOT equal to $\frac{1}{\sin x}$.

Press SHIFT + [sin] when finding x using a scientific calculator.

The symbol for the inverse of other trigonometric functions are as follows:

The inverse cosine: $\cos^{-1}$

The inverse tangent: $\tan^{-1}$

More examples on finding the unknown angles or unknown length of the sides of a right-angled triangle are shown on the next page.

Skill 3 Drawing

Students are often required to draw diagrams in exam. Worksheets are available for students to sharpen their drawing skills mentioned in the Student's Books. The examples and questions in the worksheets are different from those in the Student's Books.

Book 2 Ch 3 p.106

Use free-body diagrams to show the forces acting on objects.

DSE exam

15(1B)Q4(c), 19(1A)Q8

3 Free-body diagrams

A **free-body diagram** is used to display all the forces acting on an object.

In Figure 3.1l, when the sledge is pulled by the huskies, there are four forces acting on the sledge, namely tension, normal force, weight and friction. From that, we can draw the free-body diagram for the sledge (Fig 3.1m).

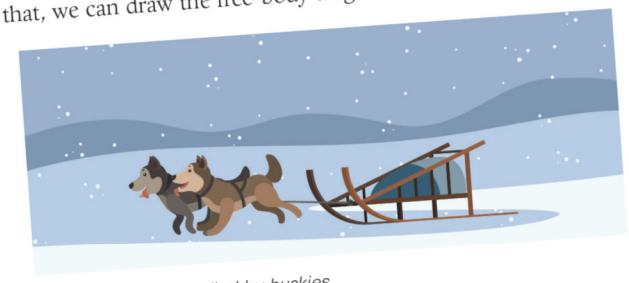
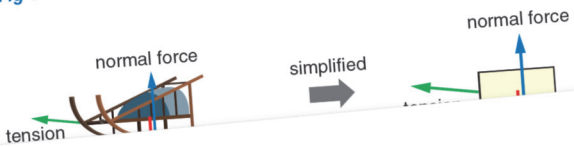


Fig 3.1l A sledge pulled by huskies.



Skill Drawing

Drawing free-body diagrams

① Draw only one object. Do **not** draw the other objects that interact with it.

② For a complicated shape, simply draw it as a rectangle.

③ Identify all the forces **acting on the object**. Ignore the forces acted by it on other objects.

④ Draw each force as an arrow in the correct direction. It is a good practice to draw a longer arrow to represent a larger force (but not necessarily in scale).

⑤ Label the arrows.

Book 2 Ch 3 p.106
Skill: drawing

Drawing free-body diagrams

A free-body diagram (f.b.d.) shows all the forces acting on an object or a system. It is a useful tool for analyzing the motion of the object.

Example

Draw the free-body diagram for a TV resting on a cabinet.

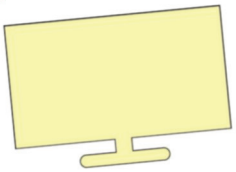
Solution

① Identify all the forces acting on the object and their directions.

Forces acting on the TV:

- Weight W, pointing downwards
- Normal force N (by the cabinet), perpendicular to the cabinet surface (i.e. upwards)

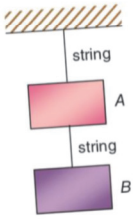
② Draw the object. For a complicated shape, draw the outline of the shape or simply draw it as a point.



or

● TV

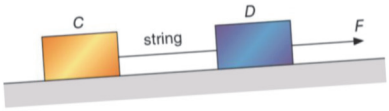
(e) Blocks *A* and *B* connected by a string and suspended from the ceiling



Free-body diagram for block *A*:

Free-body diagram for block *B*:

(f) Blocks *C* and *D* connected by a string and pulled by a fo



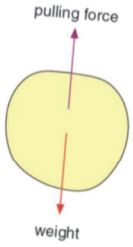
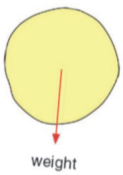
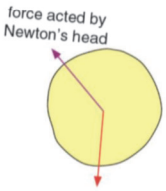
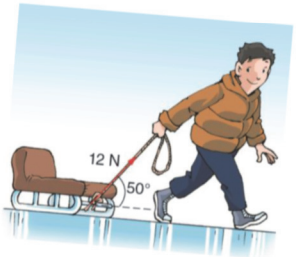
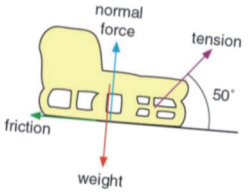
Free-body block *C*:

(g) A ball being thrown upwards and then falling dow

Fre
the
up

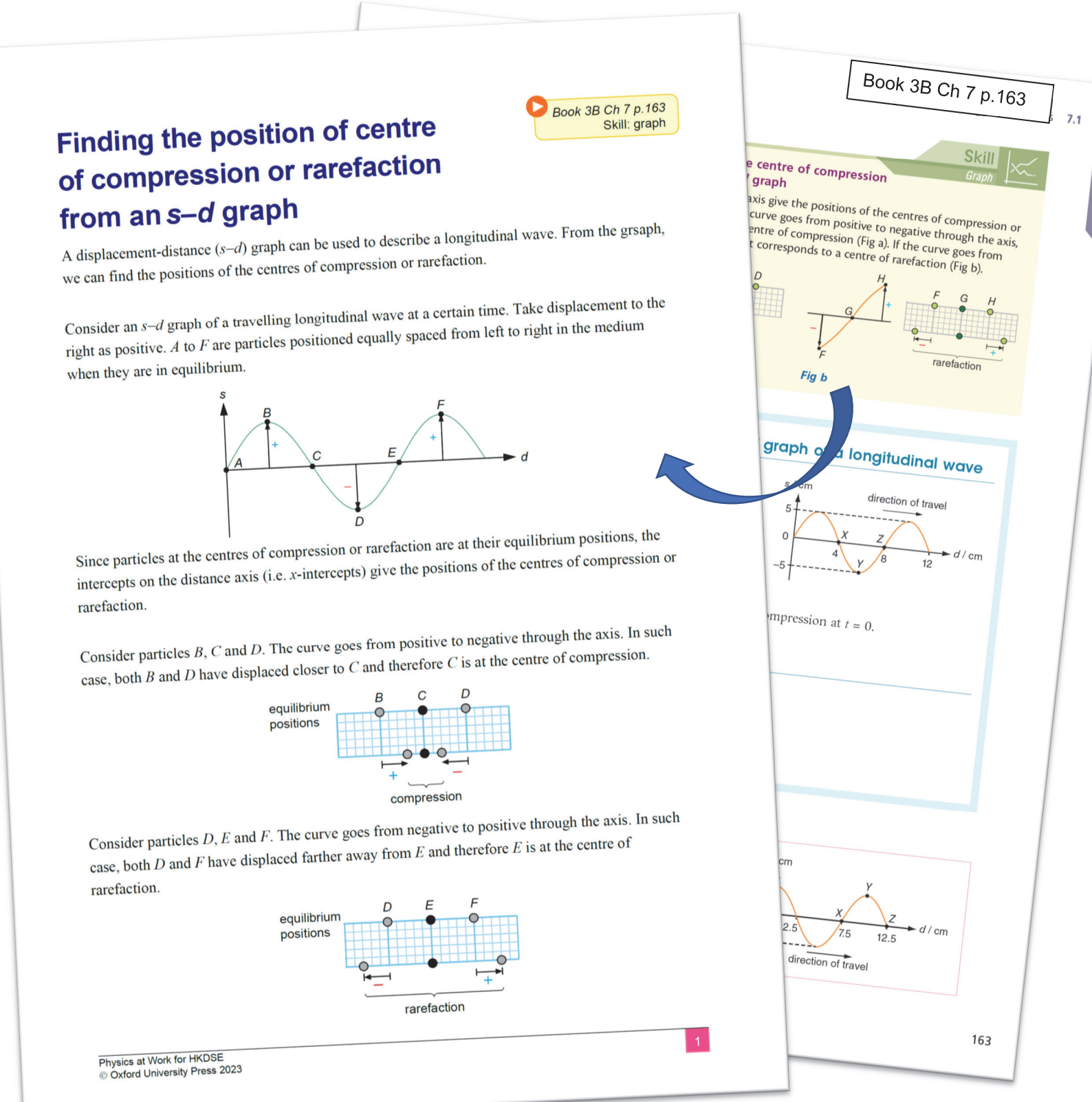
(h) Spacecraft moving in outer space, engines

The following are some more examples of free-body diagrams.

1 An apple hanging from a branch 	Free-body diagram for the apple: 
2 An apple falling (no air resistance) 	Free-body diagram for the apple: 
3 An apple hitting Newton's head 	Free-body diagram for the apple: 
4 A sleigh pulled by a boy 	Free-body diagram for the sleigh: 

Skill 4 Graph

Students must be able to read and draw graphs in studying physics. Worksheets are available for students to sharpen their graphical skills mentioned in the Student's Books.



Book 3B Ch 7 p.163
Skill: graph

Finding the position of centre of compression or rarefaction from an *s*–*d* graph

A displacement-distance (*s*–*d*) graph can be used to describe a longitudinal wave. From the grsaph, we can find the positions of the centres of compression or rarefaction.

Consider an *s*–*d* graph of a travelling longitudinal wave at a certain time. Take displacement to the right as positive. *A* to *F* are particles positioned equally spaced from left to right in the medium when they are in equilibrium.

Since particles at the centres of compression or rarefaction are at their equilibrium positions, the intercepts on the distance axis (i.e. *x*-intercepts) give the positions of the centres of compression or rarefaction.

Consider particles *B*, *C* and *D*. The curve goes from positive to negative through the axis. In such case, both *B* and *D* have displaced closer to *C* and therefore *C* is at the centre of compression.

Consider particles *D*, *E* and *F*. The curve goes from negative to positive through the axis. In such case, both *D* and *F* have displaced farther away from *E* and therefore *E* is at the centre of rarefaction.

1

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Book 3B Ch 7 p.163

7.1

Skill Graph

e centre of compression
graph

axis give the positions of the centres of compression or curve goes from positive to negative through the axis, entre of compression (Fig a). If the curve goes from t corresponds to a centre of rarefaction (Fig b).

Fig b

graph o a longitudinal wave

mpression at $t = 0$.

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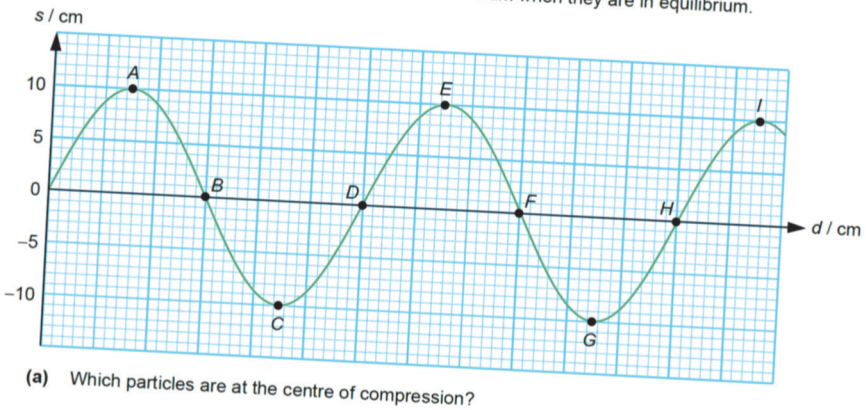
Finding the position of centre of compression or rarefaction from an s–d graph

Exercise

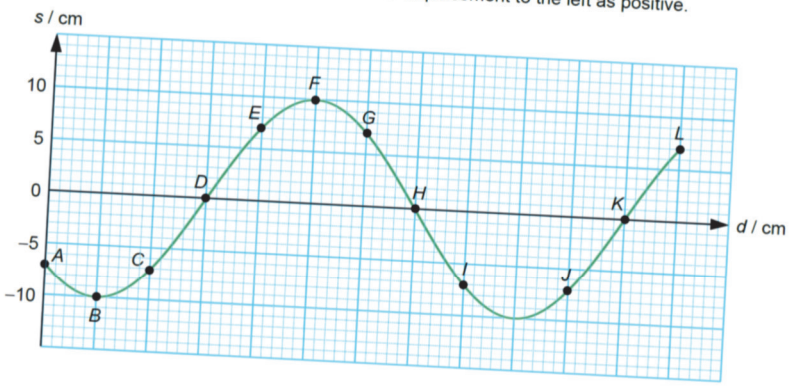
1 The following figure shows the displacement–distance (*s*–*d*) graph of a longitudinal wave at a certain time. The wave is travelling to the right. Take displacement to the right as positive. *A* to *I* are particles positioned equally spaced from left to right in the medium when they are in equilibrium.



(a) Which particles are at the centre of compression?

(b) Which particles are at the centre of rarefaction?

2 A longitudinal wave is travelling to the left. The figure shows the displacement–distance (*s*–*d*) graph of a longitudinal wave at a certain time *t*. *A* to *L* are particles positioned equally spaced from left to right in the medium when they are in equilibrium. Take displacement to the left as positive.



Skill 5 Problem-solving

Special skills are needed in solving some questions. The time needed to solve such questions can be greatly reduced if students are familiar with the skills. Worksheets with extra examples and questions are available for students to sharpen their problem-solving skills mentioned in the Student's Book.

Book 2 Ch 4 p.190

Skill
Problem-solving

Resolving forces when net force is non-zero

① Draw a free-body diagram for the object of interest.
② Choose two perpendicular directions that are convenient to solve the problem, e.g. parallel and perpendicular to the object's moving direction.
③ Define the positive directions.
④ Resolve forces and find the resultant force in each direction in ②.
⑤ Apply the equation $F_{net} = ma$ and solve for the unknowns.

Tip
Since the truck does not move in vertical direction, the resultant force along this direction is zero.

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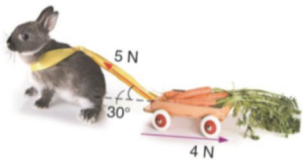
Resolving forces when the net force is non-zero

Book 2 Ch 4 p.190
Skill: problem-solving

In cases when the forces are coplanar, we usually resolve the forces into components along two perpendicular directions and then apply Newton's second law in each of these directions separately. The component of the net force in each direction determines the acceleration in that direction.

Example

A cart of carrots is pulled by a rabbit and moves horizontally. The string of the cart is at an angle of 30° to the horizontal. The tension in the string is 5 N. The friction acting on the cart is 4 N. The total mass of the cart including the carrots is 0.8 kg. Find the acceleration of the cart.



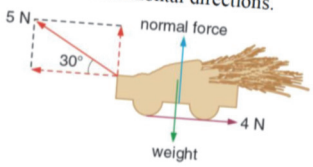
Solution

① Draw the free-body diagram for the object of interest.

Free-body diagram for the cart:

② Choose two perpendicular directions for resolving the forces. You should choose the directions that are convenient to solve the problem, e.g. the object's moving direction.

Resolve the tension along the vertical and horizontal directions.



③ Define the positive directions.

Take the direction to the left as positive.

④ Find the net force in each direction.

Since the cart moves horizontally, we only need to consider the horizontal direction.

Net force along the horizontal direction $= 5 \cos 30° - 4 = 0.330$ N

⑤ Apply the equation $F = ma$ and solve for the unknowns.

By $F = ma$, $a = \frac{F}{m} = \frac{0.330}{0.8} = 0.413$ m s^{-2}

The acceleration of the cart is 0.413 m s^{-2} towards the left.

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1

Exercise

1 A boy pushes a cart of toys on a horizontal ground with a force of 10 N. His force acts at an angle of 56° to the horizontal. The total mass of the cart including the toys is 1.2 kg. The friction between the cart and the ground is 5 N. What is the acceleration of the cart?

① Draw the free-body diagr

② Choose two perpendicular
to solve the problem, e.g. t

Free-body diagram for th

③ Define the positive directions.

Take the direction to the righ

④ Find the net force in each directi

Since the cart moves horizont

Net force along the horizontal

$= F\cos\theta - f$

=

=

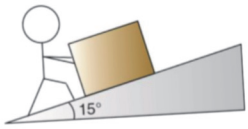
⑤ Apply the equation $F = ma$ and solv

Along the horizontal direction, by

The acceleration of the cart is ___

Example

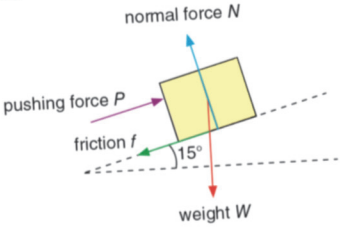
A worker pushes a box up a slope at an angle of 15° to the horizontal. He applies a pushing force of 100 N parallel to the slope. The mass of the box is 20 kg. The friction acting on the box by the slope is 40 N. Find the acceleration of the box.



Solution

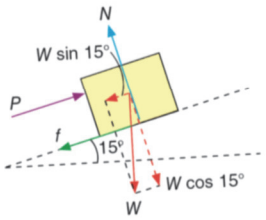
① Draw the free-body diagram for the object of interest.

Free-body diagram for the box:



② Choose two perpendicular directions for resolving the forces. You should choose the directions that are convenient to solve the problem, e.g. the object's moving direction.

Resolve the weight W of the box along directions parallel and perpendicular to the slope.



③ Define the positive directions.

Take the direction up the slope as positive.

④ Find the net force in each direction.

Since the box moves along the slope, we only need to consider the direction along the slope.

Net force along the slope $= P - W\sin 15° - f$

$= 100 - 20 \times 9.81 \times \sin 15° - 40$

$= 9.22$ N

⑤ Apply the equation $F = ma$ and solve for the unknowns.

By $F = ma$,

$$a = \frac{F}{m} = \frac{9.22}{20} = 0.461 \text{ m s}^{-2}$$

The acceleration of the box is 0.461 m s^{-2} up the slope.

Skill 6 Experiment

Students may not have enough chances to do experiments. They may not be familiar with the details of an experiment or the apparatus. The experimental skills in Student's Books and the corresponding worksheets should be helpful to students.

Book 4 Ch 2 p.61

Electric current 2.1

Skill Experiment

ranges of measurements. Look at the scale

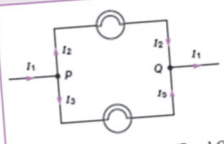
scale for 1-A terminal
maximum reading = 1 A
'8' in scale = 0.8 A

scale for 5-A terminal

rom deflecting out of the scale, or the ammeter
is within that range.

d conservatio of

charge flowing in a closed circuit is constant and
ite at any point, the total charge flowing towards
the total charge leaving that point. This gives the

tion	Parallel connection
	
ny point must be the $= I_2 = I_3$	Current entering a junction (P and Q) must be the same as that leaving the junction: $I_1 = I_2 + I_3$

rrent is the same at all points in a series connection.
urrent flowing into a junction is equal to the total
nts flowing out from the same junction.

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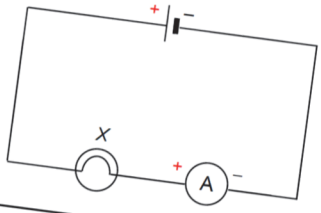
Tips about using a multi-range ammeter

Book 4 Ch 2 p.61
Skill: experiment

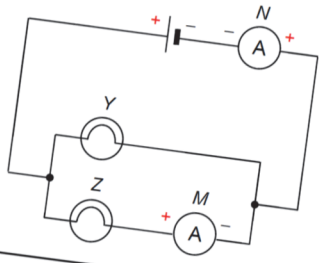
An ammeter can be used to measure the size of a current in a circuit.

Circuit symbol for ammeter

An ammeter should be connected in a chain with a circuit component to measure the current passing through it. The following figures show two examples.



The ammeter measures the current passing through bulb X (or the battery).A



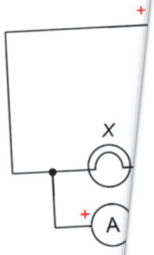
Ammeter M measures the current passing through bulb Z.
Ammeter N measures the current passing through the battery.

1

Exercise

1 Determine in each of the
current passing through

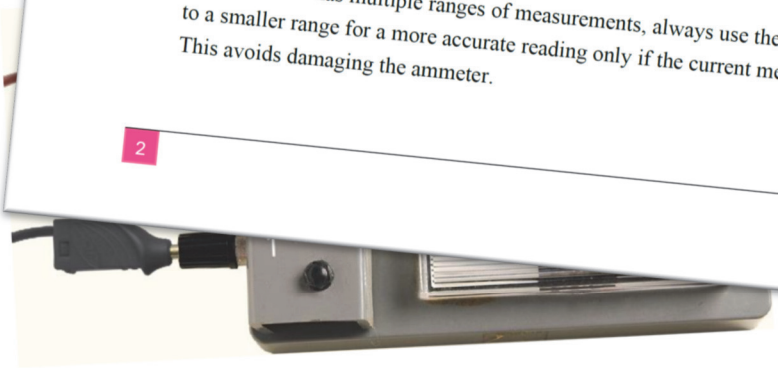
(a)



2 Read the ammete

(a)

(b)

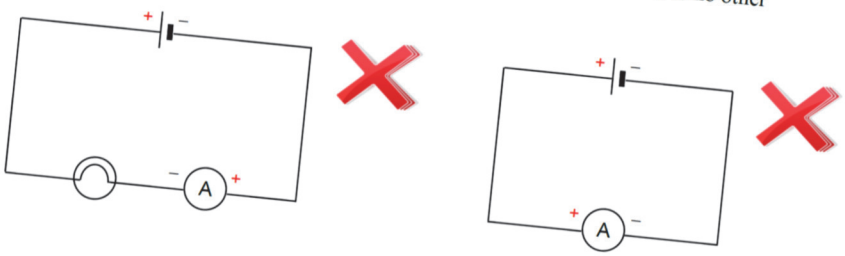


Tips about using a multi-range ammeter

Precautions:

1 The red terminal (+ terminal) of an ammeter should lead to the + terminal of the power source, and the black terminal (− terminal) to the − terminal.

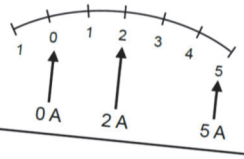
2 An ammeter should not be connected across a source directly when there is no other component in the circuit.

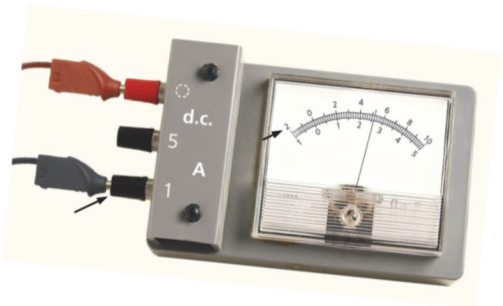


The ammeters could be damaged!

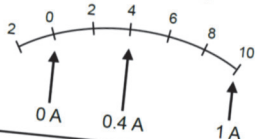
3 Some ammeters have more than one red/black terminal for different ranges of measurements.

When the 5-A terminal is connected,
maximum reading = 5 A
∴ We use the lower scale:





When the 1-A terminal is connected,
maximum reading = 1 A
∴ We use the upper scale:



4 If an ammeter has multiple ranges of measurements, always use the largest range first. Switch to a smaller range for a more accurate reading only if the current measured is within that range. This avoids damaging the ammeter.

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