Sec 4 Physics

Exam papers with worked solutions

SET A
PAPER 2
QUESTION

Compiled by

THE PHYSICS CAFE

READ THESE INSTRUCTIONS FIRST

Do not open the booklet until you are told to do so.

You are <u>required</u> to submit this booklet at the end of the paper.

Write your name, index number and class on all the work you hand in.
Write in dark blue or black pen.

Section A

Answer all questions.
Write your answers in the spaces provided on the question paper.

Section B

Answer **Questions 12** and **13** and **one** of the two alternative questions in **Question 14**.
Write your answers on the spaces provided on the question paper.

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

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] as the end of each question or part question.

Section A (50 marks)

Answer **all** questions.

1 Two friends are of the same height. They both lifted a pail of water of mass 5.0 kg as shown in **Fig. 1**.

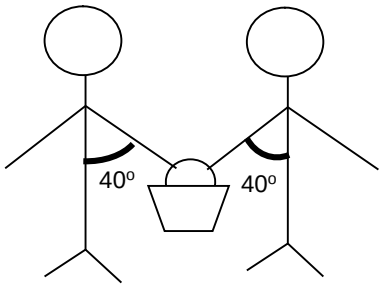

Fig. 1

(a) The angle between their arms and bodies are 40^0, by making a suitable vector diagram, determine the force each of them uses to hold the pail of water. [3]

(b) State one way in which they can use less force to hold the pail of water.

…….. [1]

2 **Fig. 2** shows the path of a roller coaster cart moving at various positions (**A** to **E**) along a smooth roller coaster. The 20.0 kg cart was released from a height of 30.0 m above ground with **an initial speed of 5.0 m/s**.

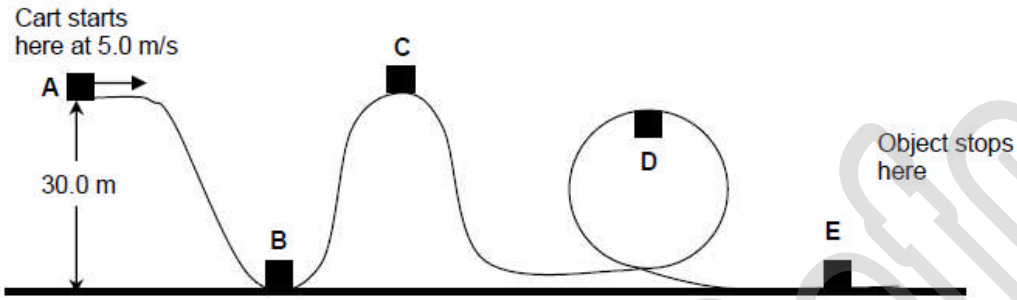

Fig. 2

(a) Calculate the maximum height (position **C**) the cart can reach. State the assumption made.

maximum height = ……. [2]

Assumption : ……..

…….. [1]

(b) Point **D** is the top of the circular loop.
(i) On **Fig. 2**, indicate the force(s) acting on the cart at that point.
(ii) Explain why no work is done on the cart even though the cart is still moving at that point.

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…….. [2]

3 **Fig. 3** shows a design of a hydraulic brake system.

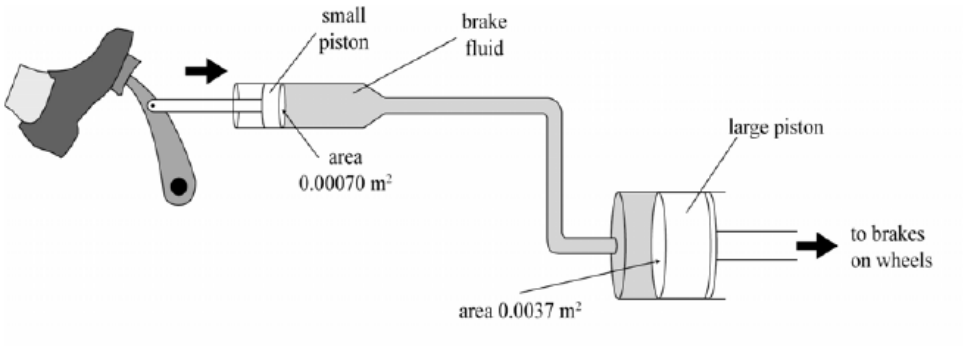

Fig. 3

(a) Explain how the force at the pedal can be transmitted to the large piston.

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…….. [2]

(b) Suggest why water is not suitable to be used as a brake fluid.

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…….. [1]

4 **Fig. 4** shows how a pencil and penknife can be used in a balancing trick.

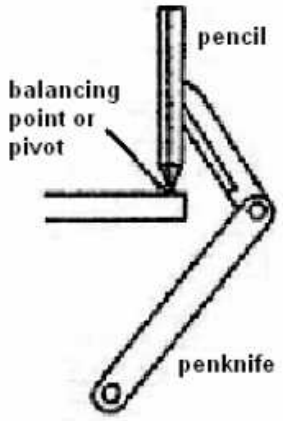

Fig. 4

(a) On **Fig. 4**, identify the position of the centre of gravity of the system and label it **X**. [1]

(b) State the type of equilibrium the system is in. Explain what happens when the pencil is slightly displaced.

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…… [3]

5 In **Fig. 5** shows a cylinder **C** with a movable piston **P**, with gas trapped in it. It shows the position of the piston when it is at 28 ^{0}C.

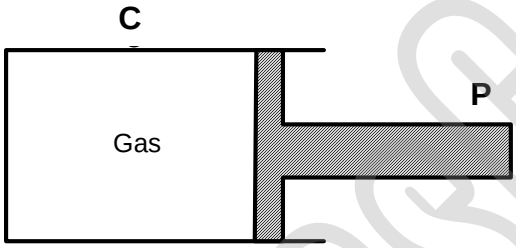

Fig. 5

As the gas in the piston is heated slowly, the piston **P** moves outwards until it reaches a steady temperature of 80 ^{0}C.

Compare the following properties of the gas molecules at 80 ^{0}C, with their properties at 28 ^{0}C. Complete the table below by stating less than, same as or greater than. [3]

Property of gas	**At 80 ^{0}C** *less than*, *same as* or *greater than*.
Speed of the gas molecules	
Pressure exerted by gas on wall of cylinder C.	
Frequency of collision between gas molecules and wall of cylinder C.	

6 **(a)** Explain what is meant by the phrase ***"specific heat capacity of ice is 2100 J/ (kg ^{0}C)"***.

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…….. [1]

(b) A student uses an electric heater of power 1.6 kW to melt and raise the temperature of 250 g of ice from -2.0^{0}C to 15.0^{0}C.

Specific latent heat of fusion of ice = 336 000 J / kg

Specific heat capacity of water = 4200 J / (kg ^{0}C)

(i) Explain briefly, using the kinetic theory, why the temperature remains constant at 0 ^{0}C for a while before rising again.

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[1]

…….

(ii) Calculate the time taken to raise the temperature of the ice from -2.0 ^{0}C to 15.0 ^{0}C.

time taken = ……. [2]

(c) **Fig. 6** below shows a tall cylinder filled with warm water and resting on a block of ice. The cylinder is placed on the ice for a long time and the room temperature is steady.

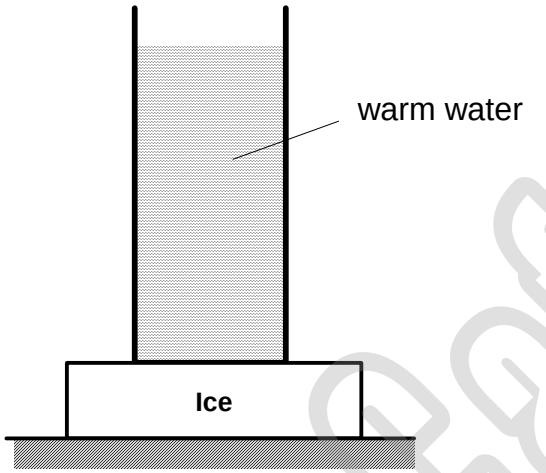

Fig. 6

Explain why the warm water takes a long time to cool.

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…… [2]

7 A converging lens has its principal focus located 10 cm from its optical centre.

(a) Explain what is meant by *principal focus*.

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…… [1]

(b) An object **O** is placed next to the lens as shown in **Fig. 7**.

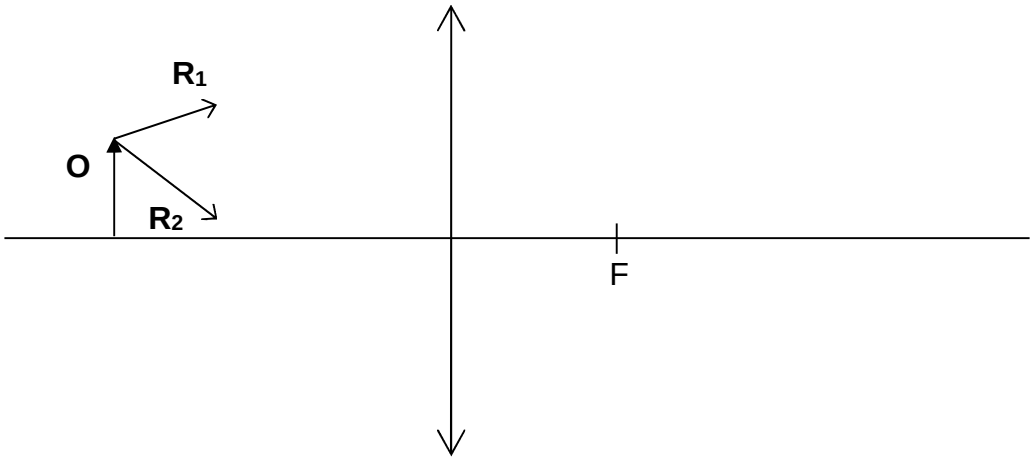

Fig. 7

(i) Construct ray diagram on **Fig. 7** to locate the image. Label the image as **I**.

(ii) Complete the paths of the rays R_1 and R_2 on **Fig. 7.** [3]

8 **(a)** Explain why a small piece of neutral paper is attracted to a positively charged rod.

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…….. [2]

(b) **Fig. 8** below shows the process of an electric-spray painting of a car body. Even though this method is more expensive than normal spray painting, the finishing produced is of a much better quality.

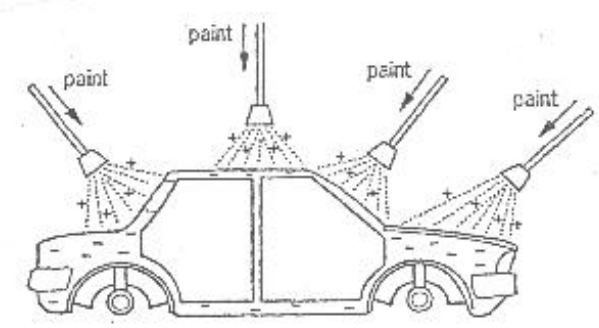

Fig. 8

Explain, using the law of electrostatic, how electric-spray painting produces a high quality finishing.

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……………………………………………………………………………. [2]

9 The electrical circuit in a kitchen has two lamps and a microwave oven connected in parallel to the mains supply. **Fig. 9** shows part of the circuit. Each lamp is labelled 240 V, 30W and the microwave oven is rated 240 V, 800 W. The symbol of the microwave oven is shown below:

Fig. 9

(a) On **Fig. 9**, draw the two lamps, the microwave oven and their switches to show how they are connected in the circuit. [2]

(b) **(i)** Draw a feature on the microwave oven to indicate that it is safe to use. [1]

(ii) Explain why this feature is important in the safe use of the microwave oven.

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…………………………………………………………………... [1]

(c) By showing appropriate calculation, what is the fuse rating shown on **Fig. 9**.

fuse rating = ……. [2]

10 **Fig. 10** below shows a design for a simple circuit breaker.

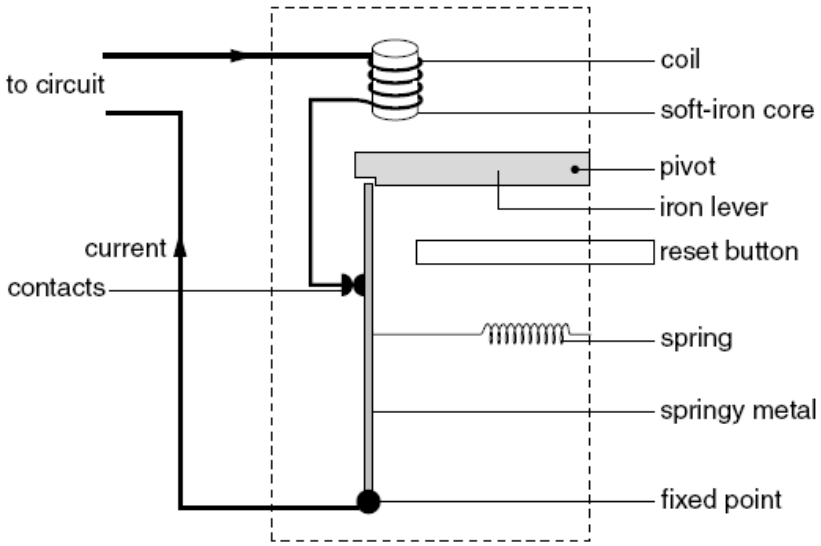

Fig. 10

(a) When there is a large current in the circuit, explain how the circuit breaker operates to break the circuit.

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……. [3]

(b) State one modification you would make to the circuit-breaker to enable it to operate at a greater current.

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…….. [1]

11 **(a)** **Fig. 11.1** shows a wooden box placed in the earth's magnetic field. The box contains an instrument that is affected by magnetic field.

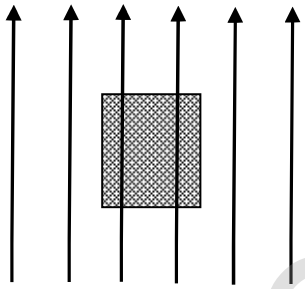

Fig. 11.1

(i) Suggest a method by which you could screen off magnetic field in the box.

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……... [1]

(ii) Sketch a diagram to show how the earth's magnetic field lines would be affected in your method. [1]

(b) **Fig. 11.2** shows how permanent magnets are used in a d.c. motor.

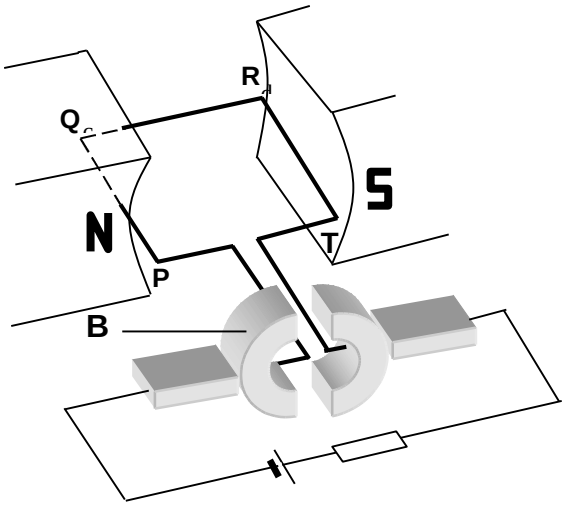

Fig 11.2

(i) Explain why the coil **PQRT** turns when the switch is closed.

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…….. [3]

(ii) Name feature **B** and state its function.

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…….. [2]

Section B (30 marks)

Answer **Questions 12** and **13** in this section.
Answer only **one** of the two alternative questions in **Question 14**.

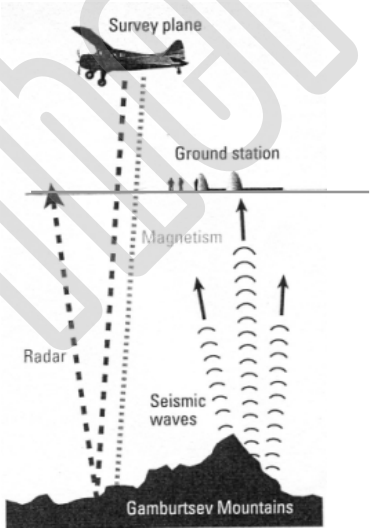
12 The **Gamburtsev Mountain Range** is a sub-glacial mountain range located in Eastern Antarctica. The range, hidden under hundreds of meters of ice, was discovered by the 3rd Soviet Antarctic Expedition in 1958.

Sound waves that were bounced off the buried ground revealed a ghostly outline of the mountains under the ice. It is approximately 1,200 kilometres long, and the mountains are believed to be about 2,700 metres high, although they are completely covered by over 600 metres of ice and snow.

For one survey conducted from 2007 to 2009, two Twin Otter aircraft outfitted with ice penetrating radars, gravity meters and magnetometers, crisscrossed the skies covering 120,000 km of the Antarctica. The findings were published in mid Nov 2011 in the journal *Nature*.

Amazingly, the radar also showed that liquid water is present under the ice. Scientists had to endure surface temperatures of around -30^{o}C during the survey, but the temperature under the ice is as high as -2^{o}C. The immense pressure of the ice above causes ice to melt at lower temperatures than it does at the surface, so the water can exist as liquid at the base of the ice.

GPR (Ground Penetrating Radar) operation requires an understanding of electromagnetic wave propagation and geophysical investigation concepts. When an electromagnetic wave encounters an interface between two materials of differing dielectric properties, one portion of the wave travels through the interface into the new material, and the rest is scattered or reflected in other directions. The proportion of the wave reflected depends on the relative dielectric constants of the two materials. When the two materials have greatly different relative dielectric constants, a large reflection and a correspondingly small transmission occur at the interface.



The following data can be used to answer the questions below.

Material	Dielectric Constant
Air	1
soil	2.5
Polar ice	4
water	81
Speed of radar in air = 3.0 x 10^8 m/s	
Speed of radar in ice = 1.5 x 10^8 m/s	
Speed of sound in air = 330 m/s	
Speed of sound in ice = 3152 m/s	

Adapted from Current Science Asia Edition 2010 Issue 5 and
http://www.nature.com/nature/journal/v479/n7373/fig_tab/nature10566_F3.html

(a) Sound waves were projected downwards towards the mountains from the ground station. The echo was detected 0.80 s later. Find the depth of the ice below the ground station.

depth of ice = …….. [2]

(b) The survey plane flying, at a height of 3000m above the ice, over another region send out a radar pulse and detected the return pulse 6.4×10^{-5} s later. Determine the depth of the ice above the mountains at that position.

depth of ice = …….. [3]

(c) Explain why water can exist as liquid at the base of the ice.

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…… [1]

(d) The surface temperature is -30 ^{0}C but the temperature under the ice can be as high as -2 ^{0}C. Suggest an explanation for this observation.

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…… [2]

(e) How were the scientists able to distinguish whether the radar waves emitted hit the solid mountain or the water?

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…… [2]

13 A candle flame is used to heat 200g of water in an open beaker as illustrated in **Fig. 13.**

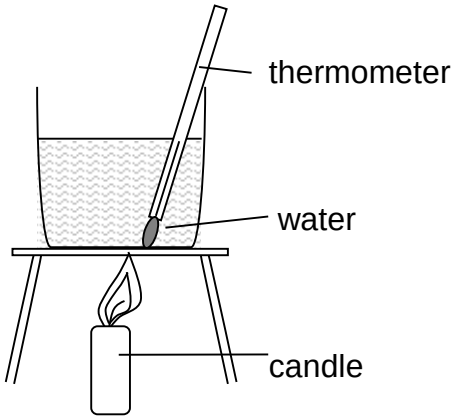

Fig. 13

The temperature of the water is recorded every two minutes for twelve minutes to give the following results:

Time in minute	0	2	4	6	8	10	12
Temperature in ^{o}C	15	30	44	57	67	74	77

(a) Plot a graph of temperature against time and use the graph to predict the likely final temperature if heating continued in the same way for another six minutes.

final temperature = …… [5]

(b) Estimate the net energy per second gained by the water in 9 minutes after heating started.

Suggest how the energy reaches the water from the candle.

net energy gained per second = ……. [3]

(c) Would the candle be able to boil the water? Explain your answer.

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……. [2]

14 EITHER

Fig. 14.1 shows two coils of copper wires wound on a soft iron rod. Each coil can slide easily on the rod. Coil **P** is connected in series to a battery and a switch **S**. Coil **Q** is connected to a sensitive zero-centre meter. As **S** is closed, a deflection is seen on the meter for a short time; during this time the coils slide apart a little.

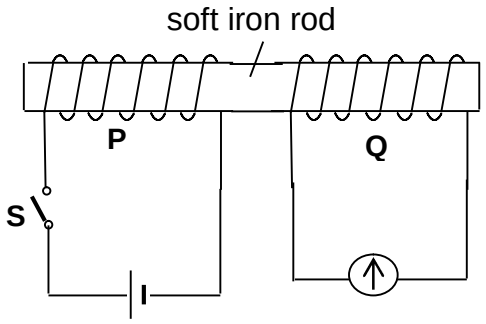

Fig. 14.1

(a) Explain briefly, why there is a deflection on the meter.

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…… [3]

(b) State and explain what happens to the two coils as **S** is opened.

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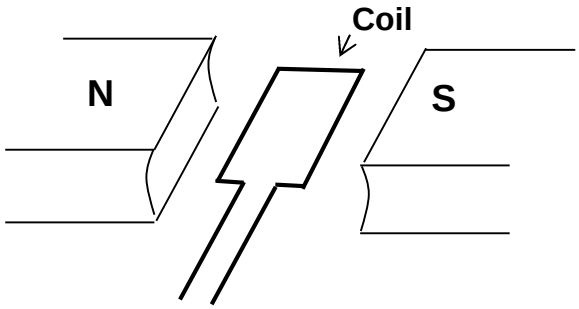
…… [2]

(c) **Fig. 14.2** below shows some parts of an a. c. generator

Fig. 14.2



(i) Add and label on **Fig. 14.2** the missing components necessary to for the a. c. generator to work. [2]

(ii) You are given a bulb and a diode. Describe how would you use these components to verify that the generator in **Fig. 14.2** produces alternating current and not direct current?

Add this external circuit to the diagram in **Fig.14.2.**

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…… [3]

14 OR

Fig 14.3 shows a trolley of mass 0.80 kg sliding down a 30º inclined plane. The plane is composed of two portions made of different materials. They join at Q. The speed-time graph of the trolley in portions PQ and QR is shown in **Fig. 14.4**
Take the gravitational field strength of the earth to be 10 N/kg

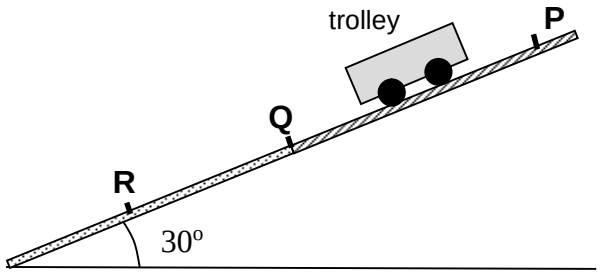

Fig. 14.3

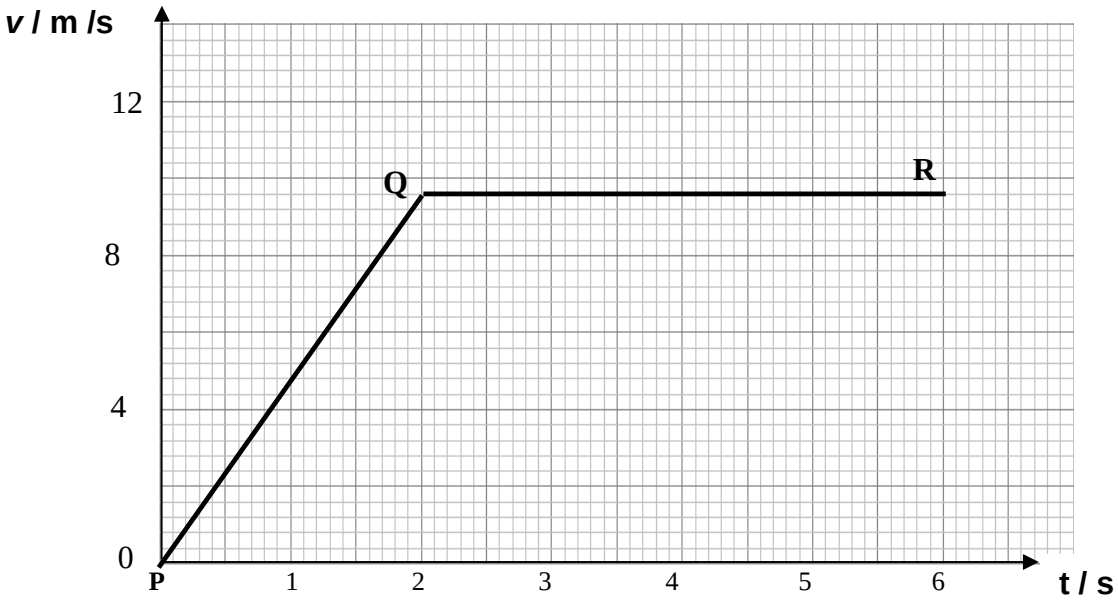

Fig. 14.4

(a) For the motion along the portion **PQ**, find

(i) the acceleration of the trolley.

acceleration = …… [2]

(ii) the distance travelled by the trolley.

distance = …….. [2]

(b) For the motion along the portion **QR**, find

(i) the resultant force acting on the trolley.

resultant force = …….. [1]

(ii) the frictional force acting on the trolley.

frictional force = …….. [2]

(c) Now the trolley is projected upwards from point **R** along the inclined plane at a certain initial speed and passes **P**.

Sketch the speed-time graph for the upward motion from **R** to **P**. Label your graph clearly. [3]

END OF PAPER