Name: ……………………………………….……….. Reg. No. ………… Class: ……………

St. Margaret's Secondary School

Preliminary Examinations 2010

Founded 1842

PHYSICS 5058/02

Secondary 4 Express

17th September 2010
Duration : 1 hour 45 minutes
Total Marks : 80

READ THESE INSTRUCTIONS FIRST

Do not open this Booklet until you are told to do so.

Write your name, register number and class in the spaces at the top of this page and on any separate writing paper used.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 11 has a choice of parts to answer.

Write your answers to Section A and to Questions 9 and 10 in the spaces provided on the Question Paper. Write your answer to Question 11 on the lined pages and, if necessary, continue on the separate Answer Paper provided.
At the end of the examination, fasten all your work securely together.

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.

The number of marks is given in brackets [ ] at the end of each question or part question.
When necessary, assume the acceleration due to gravity, g to be 10 m/s^2.

Section A

Answer **all** the questions in this section.

1 Fig. 1.1 shows an archer drawing back a bow to shoot an arrow horizontally towards a target. When he releases the arrow, it is accelerated over a distance of 0.40 m by the bow. It leaves the bow with a speed of 80.0 m/s, heading on a direct line to the centre of the target which is 16.0 m away.
Assume that air resistance is negligible and that the arrow hits the target.

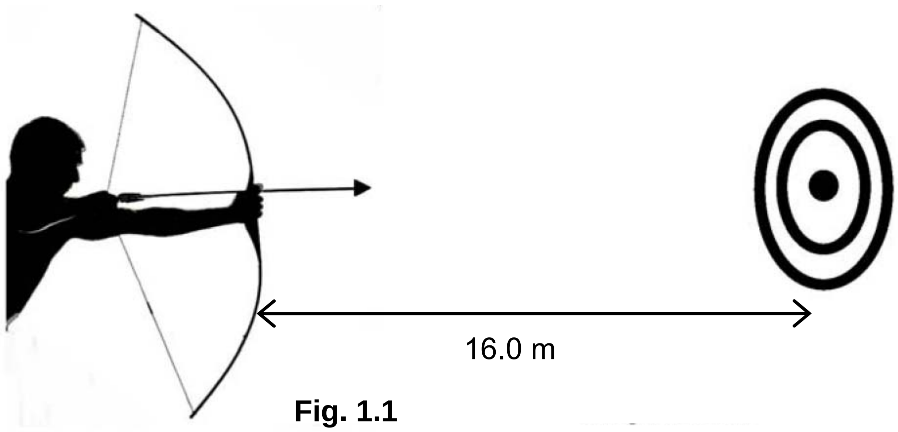


Fig. 1.1

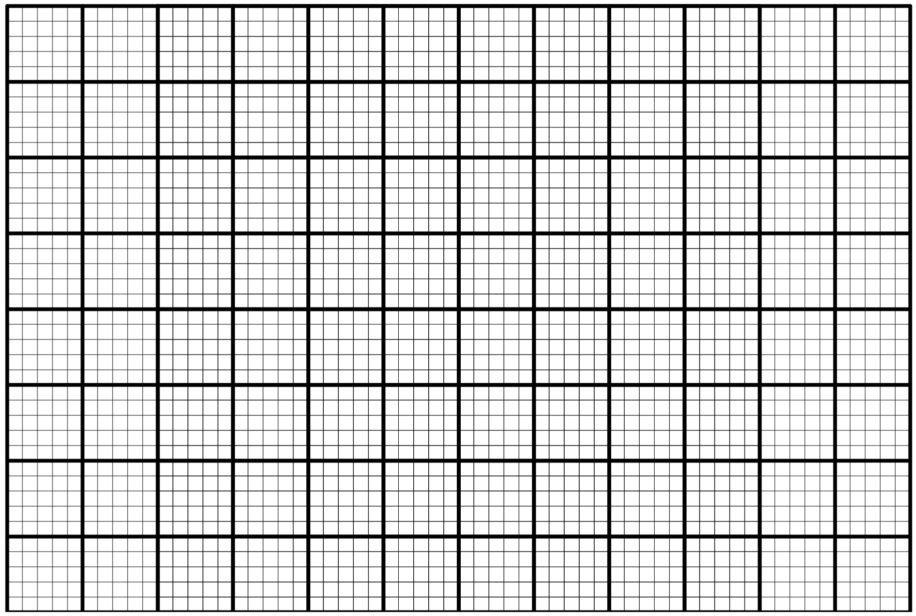
(a) Calculate the time taken for the arrow to travel the distance of 0.40 m from release by the archer until the arrow just leaves the bow. Assume that the arrow has constant acceleration over this time.

time = ... s [2]

(b) Calculate the magnitude of the acceleration of the arrow over the 0.40 m in part **(a)**.

acceleration = ... m/s^2 [2]

(c) Sketch a speed-time graph of the motion of the arrow in Fig. 1.2 below. Your graph should start at the time when the archer releases the arrow and end after the arrow has hit the target. Label your graph appropriately, indicating clearly when the arrow leaves the bow and when the arrow hits the target.



[4]

Fig. 1.2

2 Fig. 2.1 shows a child sitting on a child seat and Fig. 2.2 shows a simplified drawing of the same child seat. The total weight, W, of the child and the seat is 12.0 cm from C.

Fig. 2.1

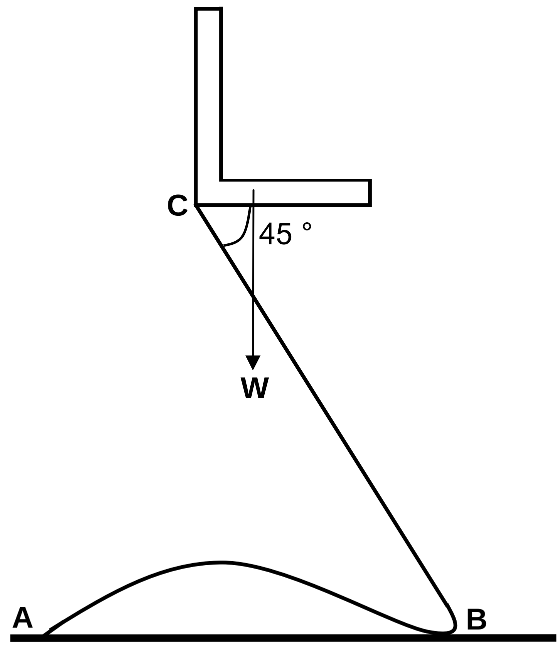


Fig. 2.2

(a) Draw on Fig. 2.2, the position of the force(s) that will hold the child seat in equilibrium. Indicate clearly the direction of this/these force(s). [1]

Given that the total mass of the child and the seat is 10.8 kg, the length of BC is 70.0 cm and the horizontal distance AB is 60.0 cm, calculate

(b) the total weight, W of the child and the seat,

weight = ... N [1]

(c) the force(s) needed to keep the child seat in equilibrium when the child is on it.

force = ... N

force (if any) = ... N [4]

3 Fig. 3.1 shows water held by a dam. The maximum depth of the water is 120 m. Water flowing through the pipe passes through the turbine and generates electricity. The density of water is 1000 kg/m^3.

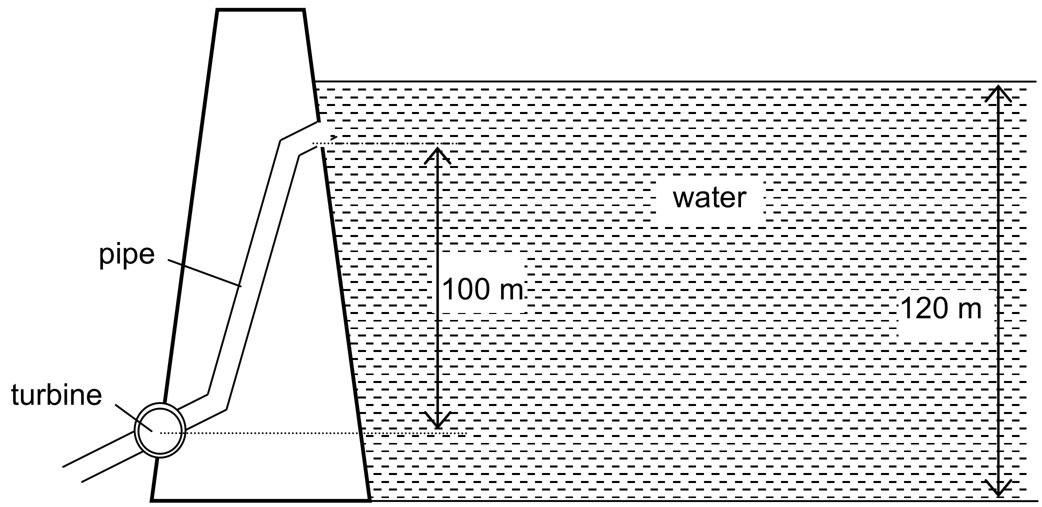


Fig. 3.1

(a) Determine the pressure due to the water at the base of the dam.

pressure = ... Pa [2]

(b) Explain why the dam is thicker at the base than at the top.

....

....

.... [2]

(c) **(i)** Determine the speed of the water hitting the turbine.

speed = ... m/s [2]

(ii) If the turbine is only able to convert 60 % of the supplied energy into electrical energy, calculate the power generated, given that the rate of water hitting the turbine is 3600 kg/s.

power = ... W [2]

4 Fig. 4.1 shows a sealed syringe that contains gas, at atmospheric pressure and many very small dust particles suspended in the gas. The piston moves freely along the cylinder without any friction. No gas can escape.

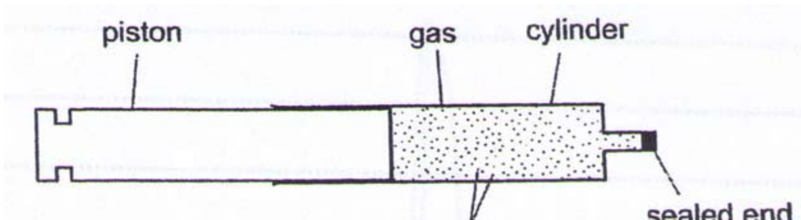


Fig. 4.1

(a) Explain why the dust particles stay suspended in the gas and do not fall to the bottom of the syringe.

....

.... [2]

(b) As the syringe is heated, the piston moves outwards and stops moving when the temperature is steady.
Using the kinetic model, explain

(i) why the piston moves outwards,

....

.... [1]

(ii) why the piston stops moving.

....

....

.... [2]

5 Fig. 5.1 shows a ray of monochromatic light incident on an interface of air and corn oil at an angle of 35°. The ray is transmitted through parallel layers of corn oil and glycerol and is then reflected from the surface of a plane mirror, located below and parallel to the glycerol layer. The ray then emerges from the corn oil back into the air at point P. The refractive index of corn oil is 1.47.

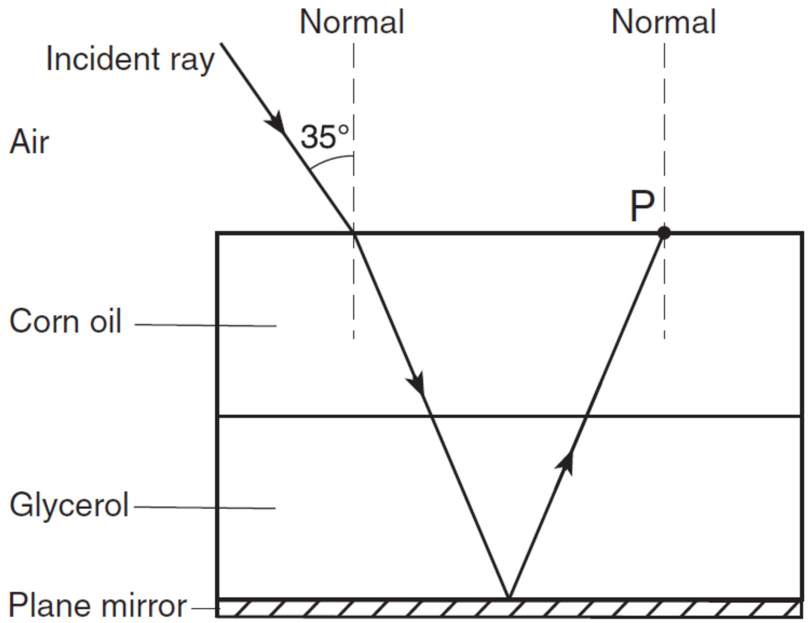


Fig. 5.1

(a) Calculate the angle of refraction of the light ray as it enters the corn oil from air.

angle = ... ° [2]

(b) The ray does not bend at the corn oil and glycerol interface. Explain why.

....

....

.... [2]

(c) Complete the ray diagram in Fig. 5.1 to show how the refracted ray leaves point P. [1]

(d) Will the reflected ray from the mirror ever go through total internal reflection at point P if we vary the angle of the incident ray in air? Explain your answer.

....

....

....

.... [3]

6 Fig. 6.1 shows a negatively charged rod lowered into an uncharged metal can standing on an insulating slab.

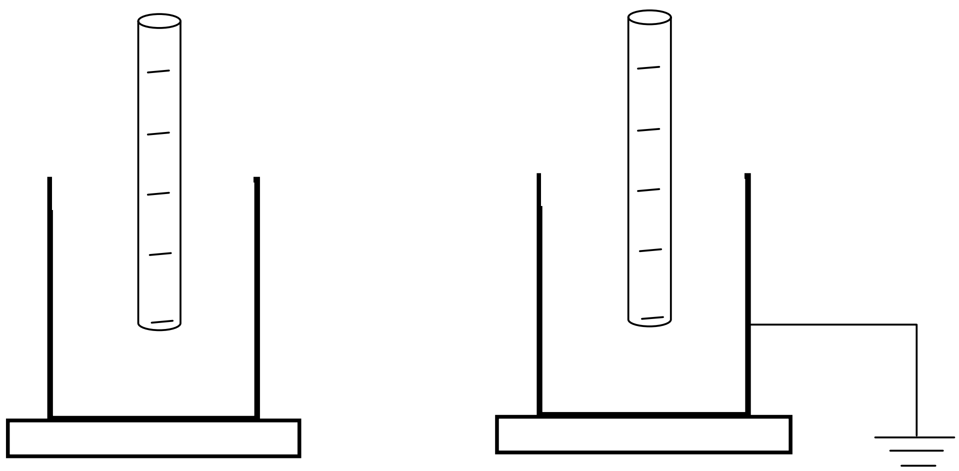


Fig. 6.1 **Fig. 6.2**

(a) Indicate on Fig. 6.1, the distribution of charges produced on the can. [1]

(b) The outside of the can is then touched with a wire connected to earth in Fig. 6.2.

Explain the effect this will produce on the charges on the can?

....

.... [2]

(c) Can the same effect in part **(a)** be produced if the insulated charged rod is replaced with a metal rod held in the hand of a student?
Explain your answer.

....

....

.... [2]

7 Fig. 7.1 shows an electrical circuit containing four resistors R_1, R_2, R_3 and R_4 connected to a 12 V battery of negligible internal resistance.

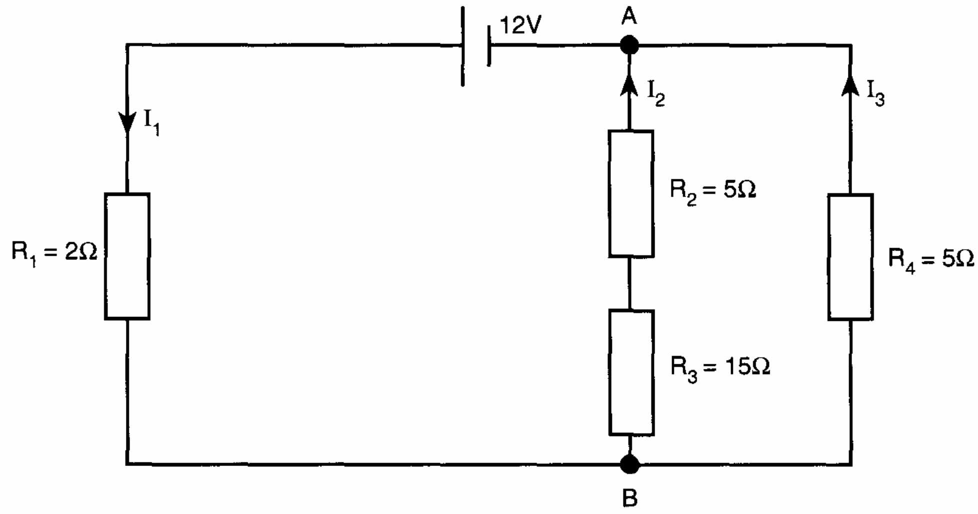


Fig. 7.1

(a) Calculate the effective resistance of the circuit.

effective resistance = ... Ω [2]

(b) Determine the value of I_1, I_2 and I_3.

I_1 = ... A

I_2 = ... A

I_3 = ... A [3]

8 Fig. 8.1 shows two identical wires, W_1 and W_2, positioned 5 cm from one another. They carry identical currents in the direction indicated.

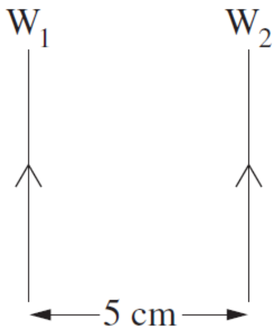


Fig. 8.1

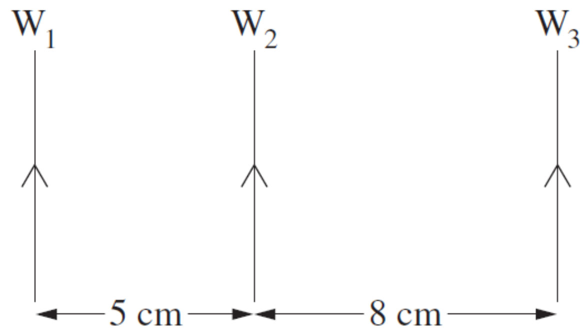


Fig. 8.2

(a) From Fig. 8.1, identify the direction of the force which W_2 experiences as a result of the current in W_1.

.... [1]

(b) Fig. 8.2 shows a third wire, W_3, carrying a smaller current, being placed 8 cm from W_2.

Explain qualitatively the forces on W_2 as a result of the currents in W_1 and W_3. (You may make reference to Fig. 8.1)

....

....

....

....

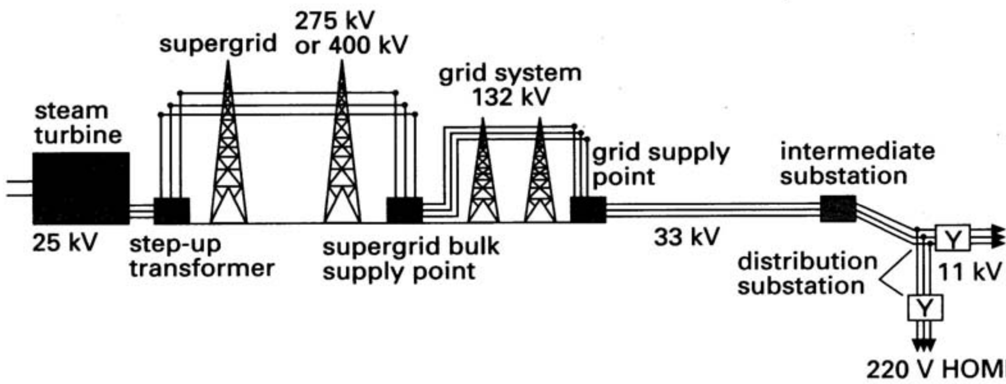
.... [4]

Section B

Answer **all** the questions from this section. Question 11 has a choice of parts to answer.

9 Read the article below and answer the following questions.

The diagram below shows how electricity is transmitted through a national grid system to our home using high alternating voltages.



The reason to have a national grid system is to have only a few large power stations generating the electricity for all consumers nationwide.

Electrical energy is generated by power plants and is then sold to end consumers by retailers. The electricity distribution networks allow the delivery of the generated electricity to consumers. The rapid industrialization in the 20th century made electrical transmission lines and grids a critical part of the economic infrastructure in most industrialized nations.

The transmission grid allows large generation facilities such as hydroelectric dams, fossil fuel plants, nuclear power plants, etc. run by large public and private utility organizations to produce large quantities of energy and then deliver it to distribution networks for delivery to retail customers for consumption.

Electricity is usually sent over long distance through a combination of overhead power transmission lines and buried cables.

A transmission grid is made up of power stations, transmission circuits, and substations. Energy is usually transmitted on the grid with 3-phase alternating current (AC). The voltage level on the bulk power transmission system is typically between 115000 V and 765000 V. Energy may also be transmitted using high voltage direct current.

At the generating plants the energy is produced at a relatively low voltage of up to 25 kV, then stepped up by the power station transformer to a higher voltage for transmission over long distances to grid exit points (substations).

It is necessary to transmit the electricity at high voltage to reduce the percentage of energy lost. For a given amount of power transmitted, a higher voltage reduces the current and resistance losses in the conductor. Long distance transmission is typically at voltages of 100 kV and higher. Transmission voltages up to 765 kV AC and up to +/-533 kV DC are currently used in long-distance overhead transmission lines.

Source: http://en.allexperts.com/q/Physics-1358/electricity-voltage.htm

(a) Give two reasons why electricity is transmitted at high alternating voltages.

....

....

....

.... [2]

(b) Name the object **Y** in the system.

.... [1]

(c) It is given that the step-up transformer in the system increases the a.c. voltage of 25 kV to 275 kV.

(i) What is its turns ratio?

turns ratio = ... [1]

(ii) Calculate the current in the secondary coil if the power input to the primary coil is 400 W.
What assumption have you made in this calculation?

Assumption: .... [2]

(d) Suggest one reason why, in a real transformer, the power drawn from the supply exceeds the power dissipated in the secondary circuit.

....

.... [1]

(e) A town is 5.0 km from the nearest electricity substations. Two conductors are used to connect the town to the substation. Each metre length of each conductor has a resistance of 1.2 mΩ.

Calculate the power loss in the conductors when the current through them is 40.0 A.

power loss = ... W [3]

10 Fig. 10.1 shows a coil being rotated in a magnetic field between two magnets.
Fig. 10.2 shows how the voltage between terminal T1 and T2 varies when the coil is rotated at a constant speed.

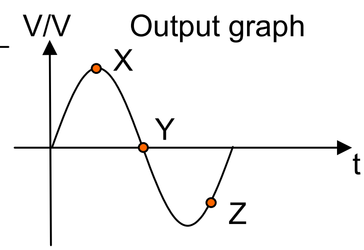


Fig. 10.2

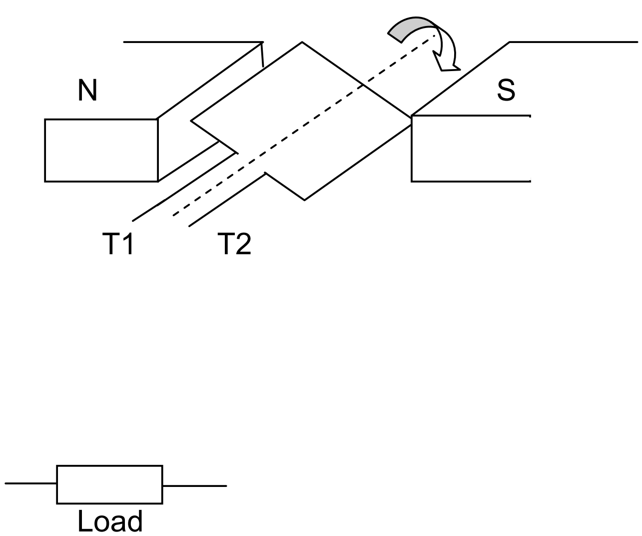


Fig. 10.1

(a) Complete Fig. 10.1 by showing the necessary connections to the load and indicate the direction of the current.
Label your drawings. [3]

(b) Which points X, Y or Z on the output graph in Fig. 10.2 could represent the voltage when coil is at the position as shown in Fig.10.1?
Explain your answer clearly.

....

....

....

....

....

.... [3]

(c) Explain briefly why the output graph in Fig. 10.2 has such a shape.

....

....

.... [2]

(d) Draw on the same axes in Fig. 10.3 a new output graph when the speed of rotation of the coil is halved. [2]

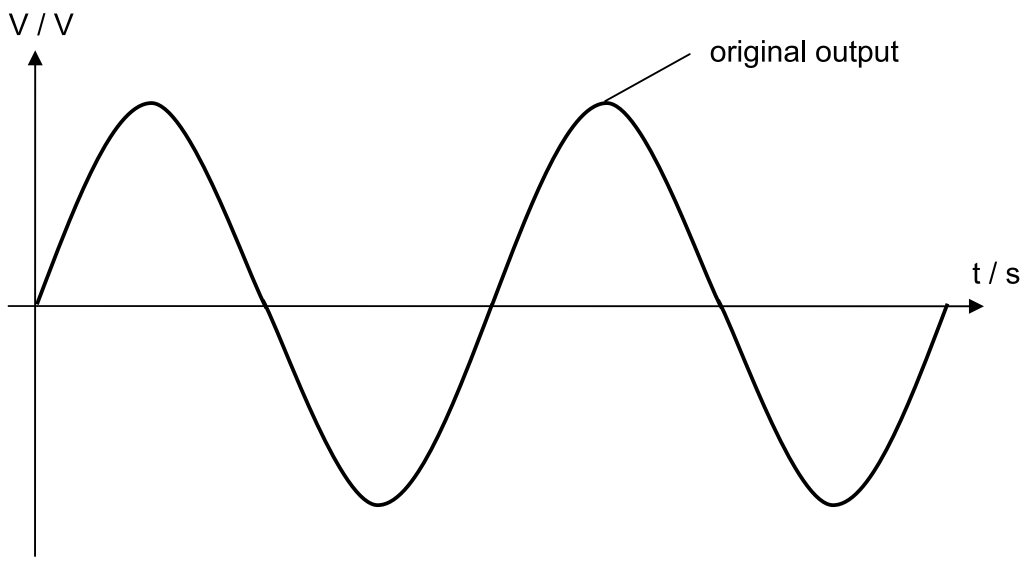


Fig. 10.3

11 Answer on the lined pages at the end of the booklet

EITHER

Fig. 11.1 shows a skateboarder of mass 54 kg about to descend a curved ramp in a skate park.

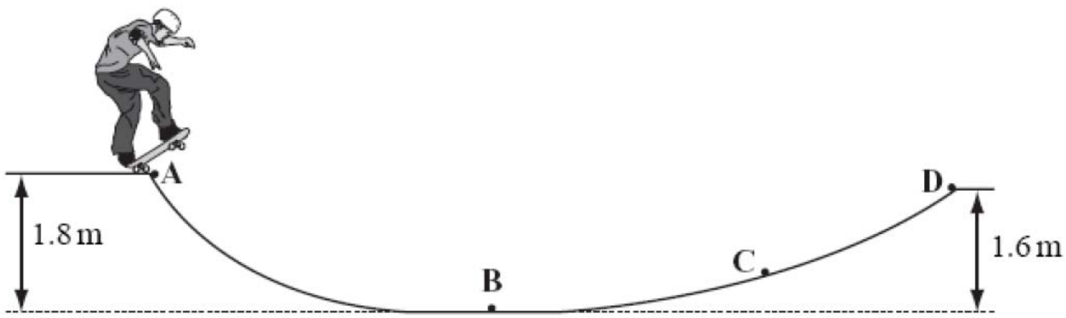


Fig. 11.1

The skateboarder can be assumed to be a rigid body during the motion.

(a) At which of the points **A**, **B**, **C** or **D** is the acceleration greatest along the track? Explain your choice. [2]

(b) The skateboarder is initially at rest. Neglecting the frictional force acting on the ramp, calculate the speed of the skateboarder at **B**, [2]

(c) The skateboarder has just enough energy to reach **D** because of friction. The total length of the track between **A** and **D** is 8.0 m.

(i) Determine the frictional force along the ramp, assuming it to be constant. [3]

(ii) If the skateboarder wants to go back to point **A**, with what minimum speed should he leave point **D.** [3]

OR

Fig. 11.2 illustrates an experiment in which the electrical energy used to produce a measured rise in temperature of a liquid can be determined.

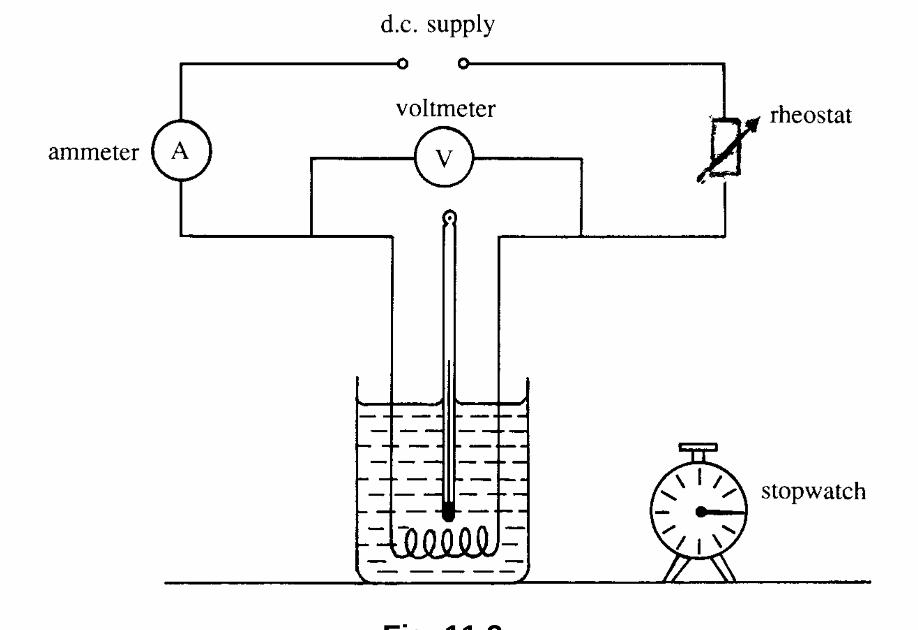


Fig. 11.2

(a) Define the specific heat capacity of a substance. [1]

(b) Explain why the heater is usually placed at the bottom of the container. [2]

(c) Explain why the temperature of the liquid will eventually stop increasing even though the current is still passing through the heating coil. [2]

(d) Explain why the specific heat capacity of the liquid calculated will be more accurate if the liquid is first cooled to about 5 °C below room temperature and the current passed until the temperature is about 5 °C above room temperature. [1]

(e) The power rating obtained from the readings of the ammeter and voltmeter is 240 W. After 16 min, the rise in temperature for 6 kg of liquid is 10 °C. Calculate the specific heat capacity of the liquid. [2]

(f) The specific latent heat of vaporisation of the substance is 2.26×10^6 J/kg and its specific latent heat of fusion is 3.36×10^5 J/kg.
Why is the specific latent heat of vaporisation so much higher? [2]