Name: ______________________________________ (   )   **Class:** **Sec 4 / (   )**

南华中学

NAN HUA HIGH SCHOOL

PRELIMINARY EXAMINATION 2024

Subject	**:**	**Physics**
Paper	**:**	**6091/02**
Level	**:**	**Secondary Four**
Date	**:**	**26 August 2024**
Duration	**:**	**1 hour 45 minutes**

READ THESE INSTRUCTIONS FIRST

Write your name, class and register number in the spaces at the top of this page.

Write in dark blue or black pen.

You may use HB pencil for any diagrams or graphs.

Do not use staples, paper clips, highlighters, glue or correction fluid.

Section A
Answer **all** questions.
Write your answers in the spaces provided.

Section B
Answer **one** question.
Write your answers in the spaces provided.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
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.

For Examiners' Use	
Section A	
Section B	
Total	

Section A

Answer **all** the questions.

1 **(a)** **(i)** Circle **all** of the quantities in the list below that are scalars.

power **acceleration** **displacement** **energy** **weight** **current** [1]

(ii) Rearrange the following prefixes in order from the smallest value to the largest value.

k **d** **T** **M** **m**

.... [1]

(b) Two crewmen pull a boat through a lock with packages, as shown in Fig. 1.1.

One crewman pulls with a force of 130 N at an angle of 34° relative to the forward direction of the boat. The second crew man, on the opposite side of the lock, pulls at an angle of 45°.

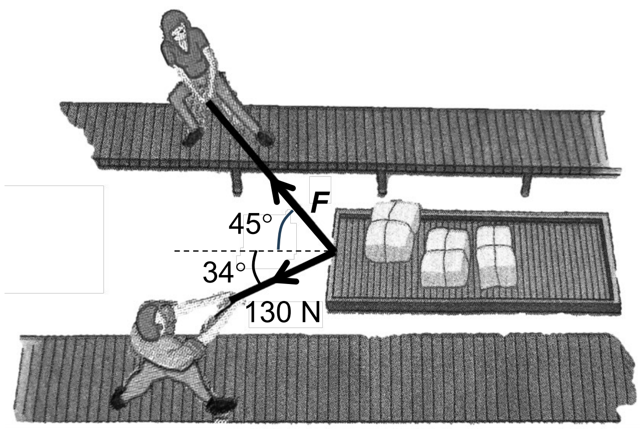


Fig. 1.1

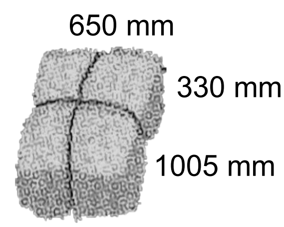


Fig. 1.2

(i) Fig. 1.2 shows the dimension of one package.

Suggest a suitable measurement tool to determine the dimension of the package.

.... [1]

(ii) If each package has a mass of 3.45 kg, determine the total mass of 75 packages in Mg.

total mass = ... [1]

(iii) By means of a scale labelled diagram, determine the size of the resultant force of the two forces.

resultant force = ...
[3]

2 A block of mass 25.5 kg hangs from a string labelled *A*, attached to a ceiling, as shown in Fig. 2.1. An identical string labelled *B*, hangs down from the bottom of the block.

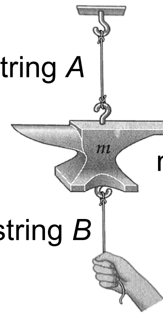


Fig. 2.1

(a) The mass is placed on Mars which has a gravitational field strength of 3.7 N kg^{-1}.

(i) Explain what is meant by Mars has a gravitational field strength of 3.7 N kg^{-1}.

....

.... [1]

(ii) Determine the weight of the mass on Mars.

weight = ... [1]

(b) **(i)** State and explain which string will break if string *B* is pulled down slowly.

....

....

.... [2]

(ii) State and explain which string will break if string *B* is pulled down with a quick jerk.

....

....

.... [2]

3 Fig. 3.1 shows a 0.80 kg ball rolling down a track from position A which is 7.5 m above the ground.

There is frictional force along the track and this produces 10.7 J of heat energy. The ball leaves the incline at position B traveling straight upward and reaches a height of 13.0 m above the floor before falling back down.

Ignore any effect due to air resistance.

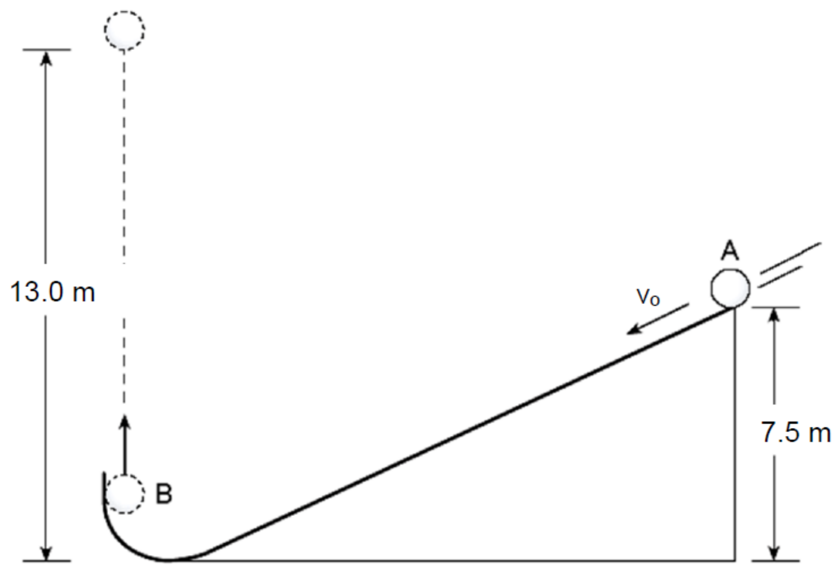


Fig. 3.1

(a) Describe the change in energy as the ball moves from A to the highest point.

-- [2]

(b) Calculate the energy in the gravitational potential store of the ball at the highest position.

energy = ______________________ [2]

(c) Determine the energy in the kinetic store of the ball at position **A**.

energy = ________________________ [2]

4 Fig. 4.1 shows an equipment being used to measure the pressure of the gas in a flask.

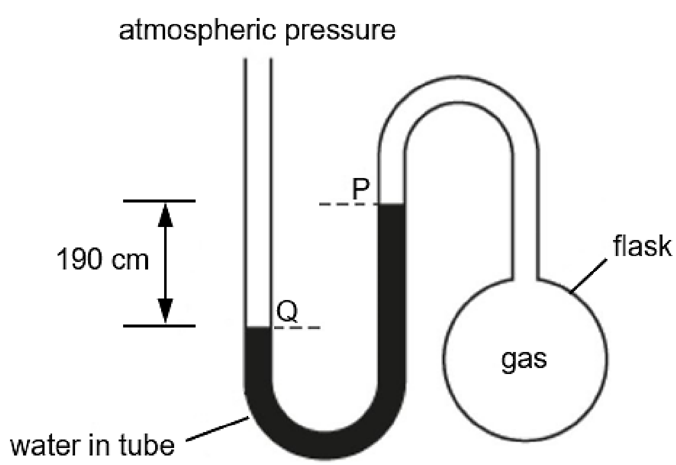


Fig. 4.1

(a) State the name of the equipment shown in Fig. 4.1 that is used to measure the pressure of the gas in the flask.

.... [1]

(b) **(i)** The atmospheric pressure is 1.0×10^5 Pa and the density of the water is 1000 kg/m^3. The distance between the water levels at P and Q is 190 cm.

Determine the pressure of the gas inside the flask.

pressure = ... [2]

(ii) The water in the equipment is fully replaced with mercury and connects to the flask with the same gas pressure.

The density of mercury is 13 600 kg/m^3.

Determine the distance between the mercury levels at P and Q.

distance = ... [2]

5 Fig. 5.1 shows a wave pool used for windsurfing training.

Plane waves are generated with a wave generator placed at the end of the pool. These waves will travel the whole length of the pool to the opposite end.

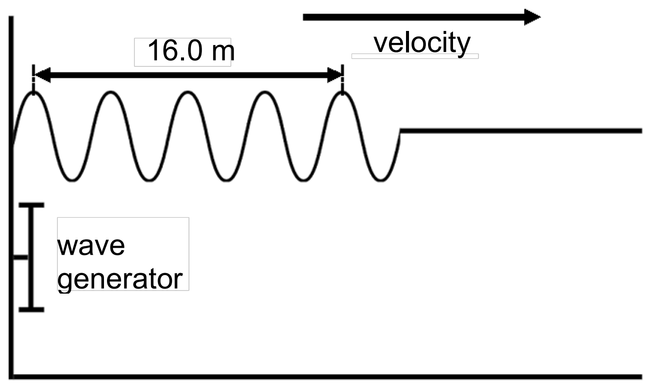


Fig. 5.1

(a) The wave generator created 50 waves in a minute as shown in Fig. 5.1.

(i) Determine the wavelength of the waves.

wavelength = ... [1]

(ii) Hence, calculate the speed of the wave.

speed = ________________ [2]

(b) Fig. 5.2 shows the top view of the wavefronts for the whole pool. The arrows show the direction of the wave motion when the depth of the pool changes.

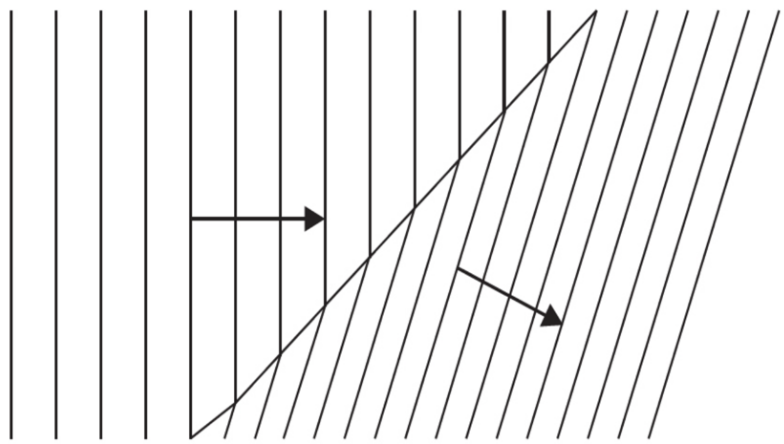


Fig. 5.2

(i) State what is meant by wavefront.

....

.... [1]

(ii) Describe the change in depth of the pool as the waves travels towards the end of the pool.

.... [1]

(iii) Explain why this change in direction of the wave motion takes place when the depth of the pool changes.

....

.... [1]

(c) Fig. 5.3 shows components of the electromagnetic spectrum in increasing frequency order.

increasing frequency →

radio waves			visible light			gamma ray

Fig. 5.3

Four components are missing from Fig. 5.3.

Complete Fig. 5.3 by adding the names of the missing components. [2]

6 **(a)** Fig. 6.1 shows a **scaled drawing** of an object PQ and its image P'Q' after passing through a thin converging lens.

By locating the position of the converging lens and drawing light rays on Fig. 6.1, determine the focal length of the converging lens.

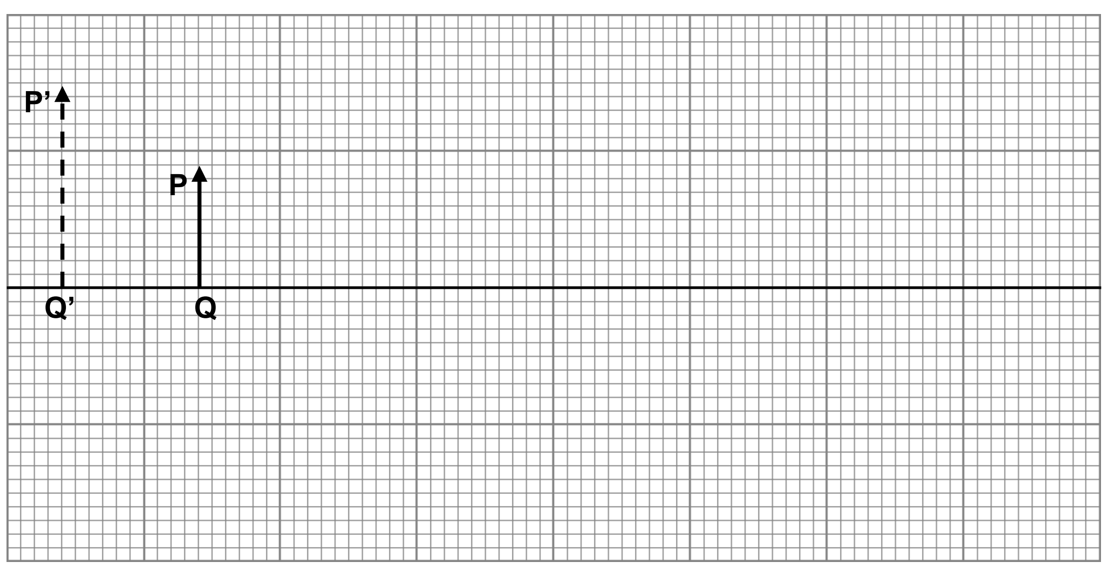


Fig. 6.1 (to scale)

focal length = ... [3]

(b) Suggest what would happen to the image P'Q' if

(i) the converging lens is replaced by a thicker lens,

....

.... [1]

(ii) the upper half of the converging lens is covered.

-- [1]

7 A negatively charged polythene rod is held just above a small and light piece of aluminium foil as shown in Fig. 7.1.

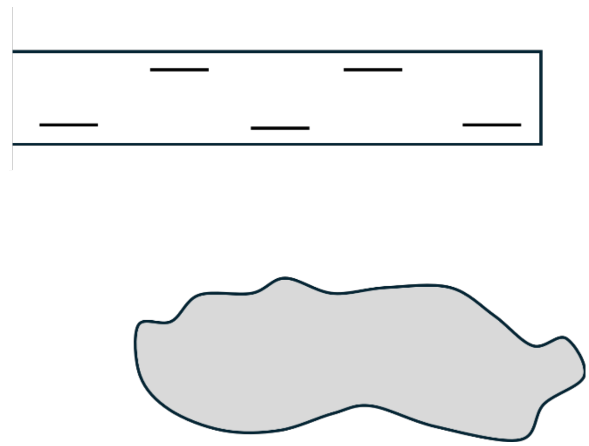


Fig. 7.1

(a) Draw on the foil in Fig. 7.1 the distribution of charges. [1]

(b) Explain your answer given in (a).

-- [2]

(c) State and explain the initial motion of the foil.

-- [3]

8 Fig. 8.1 shows the structure of a simple a.c. generator model. The coil ABCD is manually rotated between the poles of a magnet.

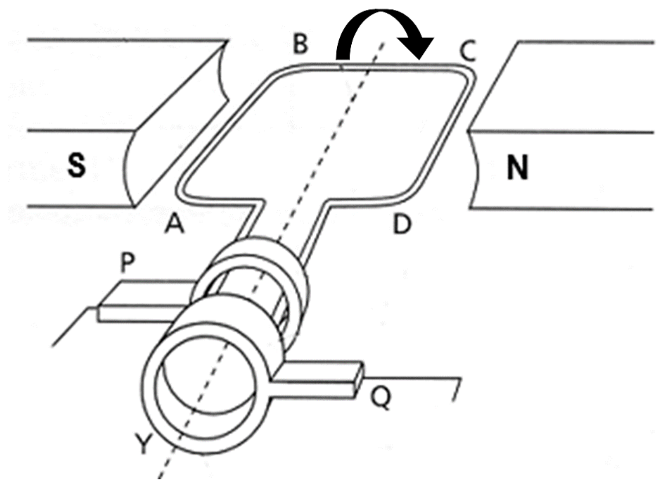


Fig. 8.1

(a) When the coil is rotated at the position shown in Fig. 8.1, a maximum induced e.m.f. of E_0 is induced in the coil.

Explain why the value of induced e.m.f. E_0, is a maximum at this position.

....

....

.... [2]

(b) **(i)** The a.c. generator is connected to an external circuit and an induced current flows through the a.c. generator.

On Fig. 8.1, draw the direction of the induced current flowing in the coil. [1]

(ii) State the purpose of the component labelled as Y

....

....

.... [1]

(c) Explain why in real power stations, a.c. is produced rather than d.c

....

....

.... [1]

(d) Fig. 8.2, shows a graph of the induced e.m.f. across PQ, against time as the coil rotates for one complete rotation from the initial position shown in Fig. 8.1.

Assume that the magnetic field within which the loop rotates in is uniform and the time taken for one complete rotation is *T*.

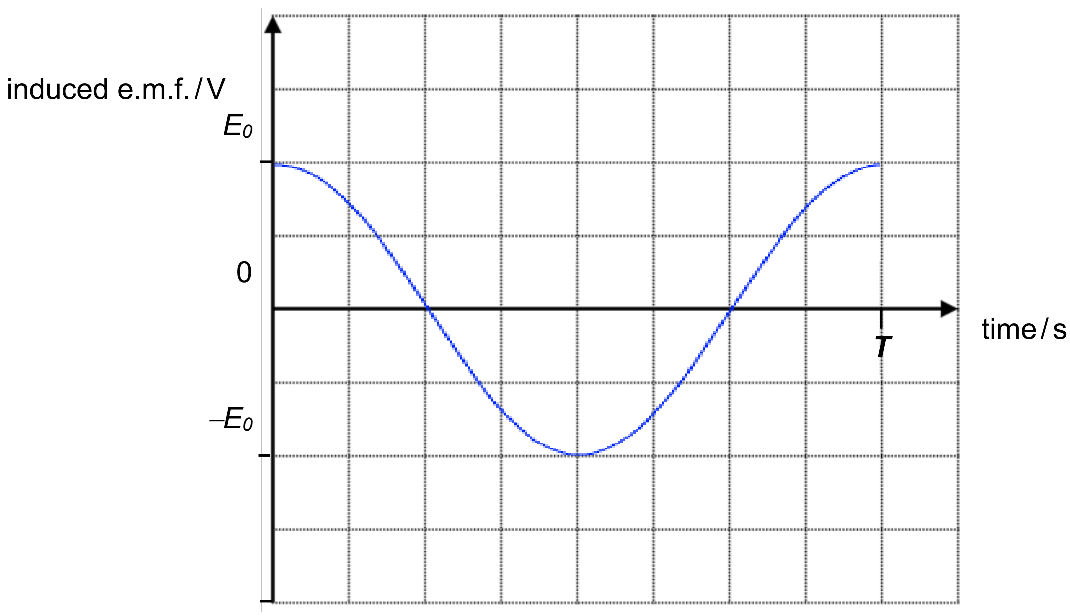


Fig. 8.2

In Fig. 8.2 above, sketch a new graph in dotted lines to show the change when the coil is rotated in the **opposite** direction and at two times the speed within *T* . [2]

9 **(a)** Fig. 9.1 shows a set-up used to study the radiation released by a source.

A GM tube is placed at position P which is 30 cm from the source.

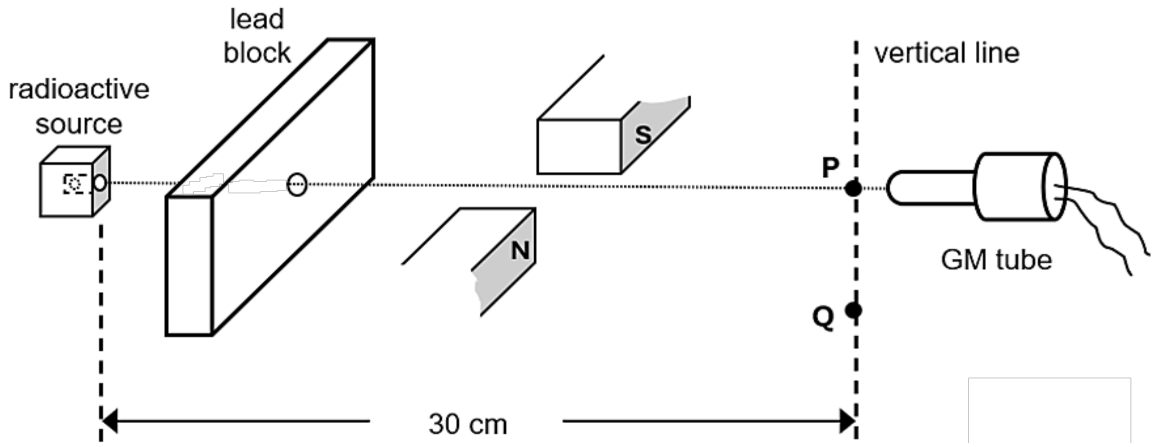
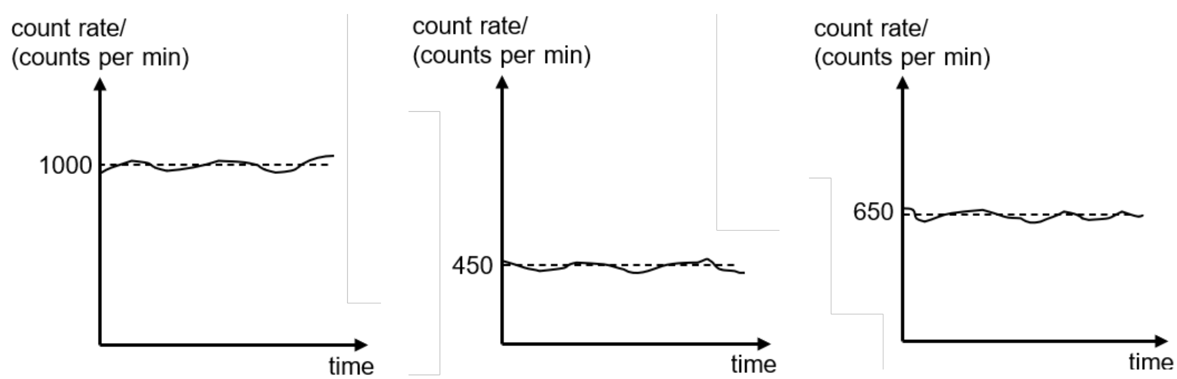


Fig. 9.1

Without any radioactive source, an average count rate of 100 counts per minute is recorded by the GM tube.

The graphs below show the count rate obtained by the GM tube under different circumstances at different positions.



graph A **graph B** **graph C**

graph A : Count rate obtained at position P initially <u>without</u> the presence of the magnets.

graph B : Count rate obtained at position P with the magnets in place.

graph C : Count rate obtained at position Q with the magnets in place.

(i) Explain why the count rate shown at graph A is **not** due to alpha particles, no matter what kinds of radiation are emitted by the source.

-- [1]

(ii) State and explain what type of radiation(s) is/are emitted by the source based on graph B and graph C.

-- [3]

(iii) Explain why the sum of the average count rate obtained at graph B and graph C is greater than that recorded at graph A.

-- [1]

(b) Wood contains carbon, most of which is the isotope Carbon-12. There is also a small fraction of the radioactive isotope Carbon-14 (half-life = 5700 years).

While a tree is alive it contains a constant fraction of Carbon-14, but after the tree dies, this fraction decays because of radioactive decay. Measurement of this amount of this fraction allows us to work out the age of the prehistoric wood.

In such an experiment, measurements were taken from 3 situations and the following count rates were obtained.

specimen	count rate / (counts per min)
1 g sample of living wood	80
1 g sample of archaeological specimen	35
no sample	20

(i) Explain what you understand by the term *half-life* of a radioactive substance.

-- [1]

(ii) Calculate an approximate age of the archaeological specimen.

approximate age = ... [2]

(c) There are many medical uses for *radio-isotopes*. The table below shows information of some isotopes.

isotope	solid, liquid or gas at 20 °C	type of radiation	half-life
Strontium-90	solid	beta	28 years
Cobalt-60	solid	gamma	5 years
Xenon-133	gas	gamma	5 days
Actinium-227	solid	alpha	22 years
Terbium-160	solid	beta	72 days
Hydrogen-3	gas	beta	12 years

A doctor suspects that some air passages are blocked in a patient's lungs.

Suggest which isotope would be suitable for identifying which air passages are blocked. and explain your answer.

....

....

....

.... [2]

10 Usain Bolt of Jamaica is currently regarded as the '*fastest man'* who has ever lived.

He holds the current world record for the 100 m race (9.58 s). In the 2008 Olympics, held at Beijing, he broke the 100 m world record back then and ran the race in 9.69 s.

Table 10.1 shows the distance-time data for Bolt's race in 2008.

Table 10.1

distance / m	0	10	20	30	40	50	60	70	80	90	100
time / s	0	1.85	2.87	3.78	4.65	5.50	6.32	7.14	7.96	8.79	9.69

"Split" is a running and racing term that refers to the time that it takes to complete a specific distance.

Table 10.2 which is incomplete, attempts to capture the split timings for the above race for every 10 m interval.

Table 10.2

sections (in m)	0 - 10	10 - 20	20 - 30	30 - 40	40 - 50	50 - 60	60 - 70	70 - 80	80 - 90	90 - 100
time for sections /s	1.85	1.02								

(a) **(i)** Calculate the average speed of Bolt at the Beijing Olympics in km/h.

average speed = ... [2]

(ii) Complete Table 10.2. [1]

(iii) Suggest a reason why Bolt's time in Table 10.2 for the first 10 m is very much higher than the next 10 m.

....

.... [1]

(iv) Suggest during which part of the race, Bolt was probably running at constant speed. Explain your answer.

-- [2]

(b) Fig. 10.3 shows the posture normally athletes adopt in a typical 100 m race.

The force applied by the muscles for a forward motion is known as the propulsion force, *P*.

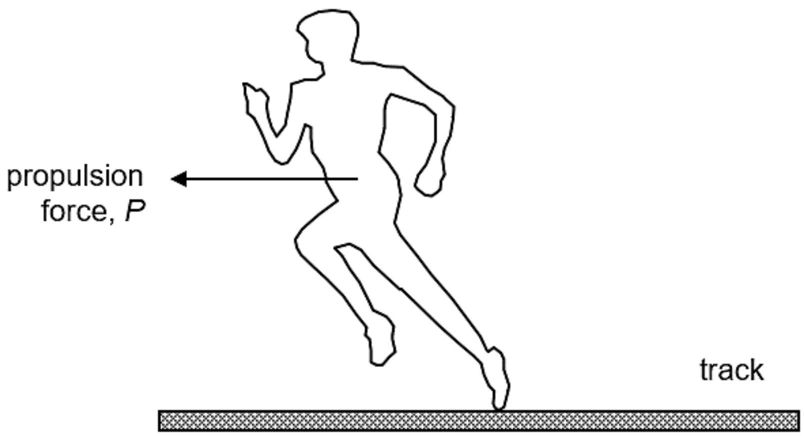


Fig. 10.3

(i) Mark and label two vertical forces acting on the athlete in Fig. 10.3. [1]

(ii) Describe a Newton's Third Law action-reaction pair of forces acting in the horizontal direction in Fig. 10.3.

-- [2]

(iii) Experts have calculated that Bolt accelerated from rest and achieved a speed of 8.4 m/s in the first 0.89 s, by exerting an average horizontal force of 890 N against the ground.

Determine the mass of Bolt.

mass = ... [1]

Section B

Answer **one** question from this section.

11 A student poured 250 g of hot tea into a container. He placed a thermometer into the tea and started measuring the temperature with respect to time. After a while, he added *m* kg of ice cubes into the tea.

Fig. 11.1 shows the temperature–time graph obtained.

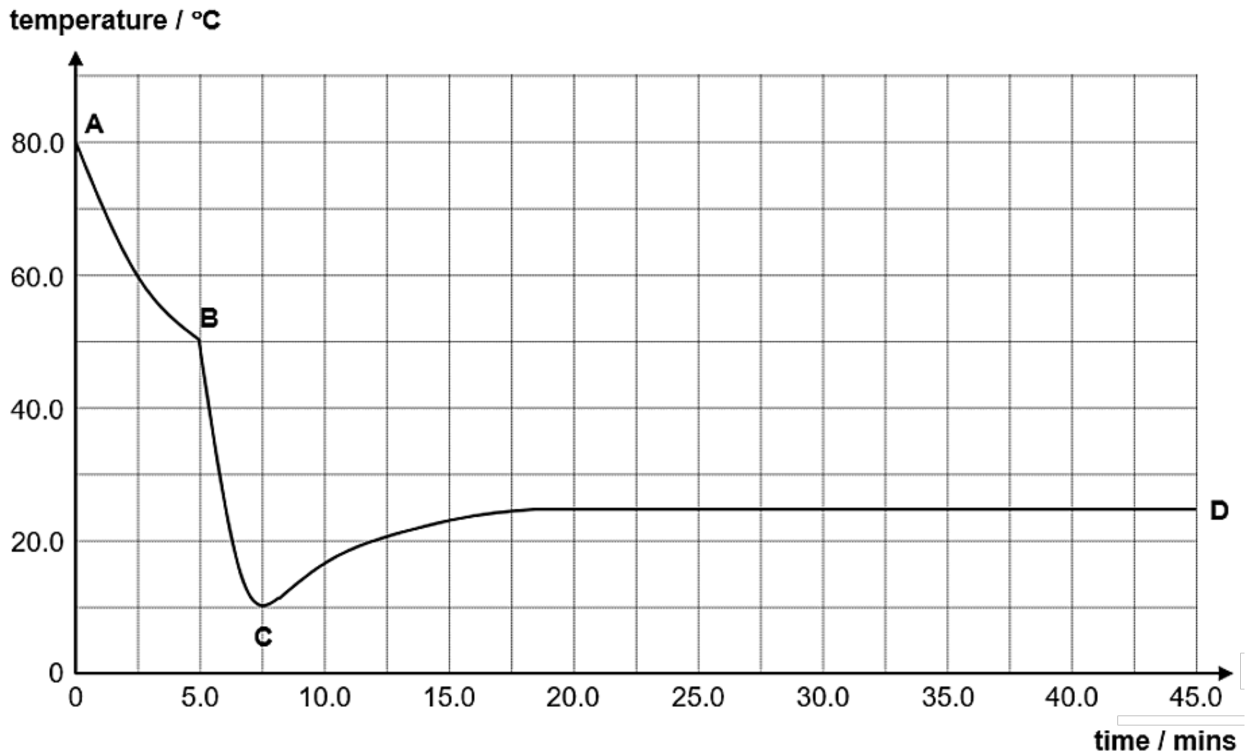


Fig. 11.1

The following information is provided:

specific heat capacity of ice = 2.1×10^3 J/(kg °C)
specific latent heat of fusion of ice = 3.36×10^5 J/kg
specific heat capacity of water or tea = 4.2×10^3 = J/(kg °C)
specific latent heat of vapourisation of water or tea = 2.26×10^6 J/kg

The temperature of the ice cubes before being added into the hot tea is 0 °C.

(a) Explain why the specific latent heat of vapourisation of water is much higher than the specific heat capacity of water.

....

....

....

.... [2]

(b) Calculate the loss in thermal energy in the hot tea from B to C.

loss in thermal energy = ... [2]

(c) The ice cubes are added into the hot tea at point B and completely melts and reaches the same temperature as the tea at point C.
Assume that there is no loss of thermal energy to the surroundings.

Calculate the value of *m*.

m = ... [2]

(d) In another experiment, the student placed 250 g of hot tea in the same empty container.

When the temperature of the hot tea was 80 °C, he started the stopwatch. He continued to measure the temperature of the tea **without** adding any ice cubes.

On Fig. 11.1, draw the temperature–time graph for the second experiment. [2]

(e) The electric kettle that was used to heat up the water for the tea initially was rated at '120 V, 500 W'. The appliance was used for 10 minutes each day in a 30-day period.

Calculate the cost of electricity for this usage if one kWh costs 30 cents.

cost of electricity = ______________________ [2]

12 A potential divider is connected across a 6.0 V d.c. power supply as shown in Fig. 12.1.

V_{out} is used to drive the heating element of a greenhouse for the regulation of room temperature.

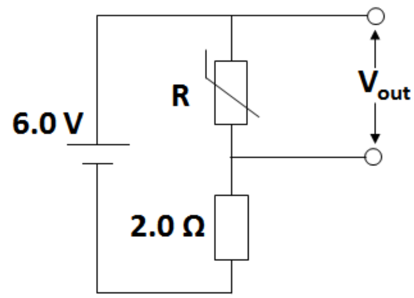


Fig. 12.1

Fig. 12.2 shows how the resistance of the thermistor changes with temperature.

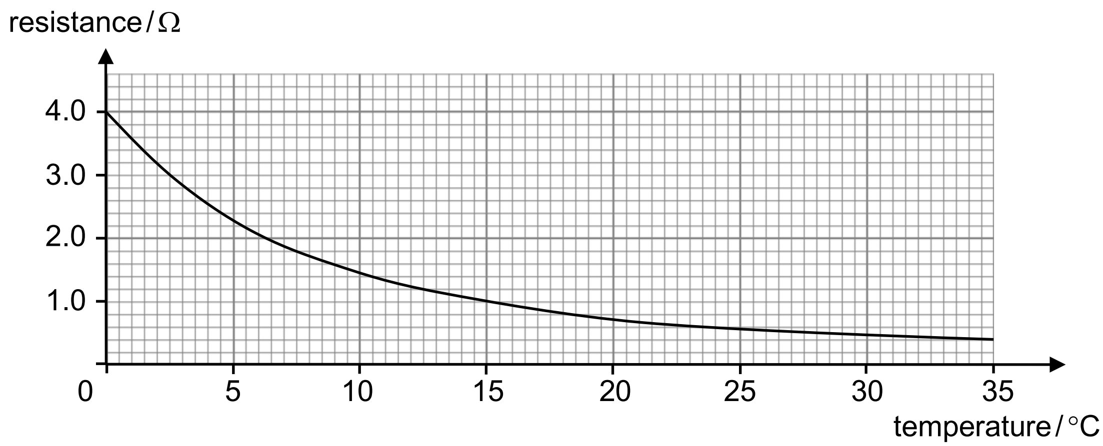


Fig. 12.2

(a) Explain how the use of a thermistor in the potential divider helps to regulate the temperature in a greenhouse.

....

....

....

.... [2]

(b) In the present environmental setting, it was measured that in one minute, 720 J of energy in the electrical store was converted from energy in the chemical potential store in the power supply.

Calculate

(i) the amount of charge passing through the power supply in one minute,

charge = ... [2]

(ii) the potential difference across the 2.0 Ω resistor,

potential difference = ... [2]

(iii) the temperature of the environment.

temperature = ... [2]

(c) The 2.0 Ω fixed resistor in Fig. 12.1 is replaced with a 4.0 Ω fixed resistor.

Describe and explain how this change affects the amount of heat supplied by the heating element for the same environmental temperature.

....

....

....

.... [2]