EXP

PUNGGOL SECONDARY SCHOOL
SECONDARY 4
EXPRESS
2024 PRELIMINARY EXAMINATION

QUESTION BOOKLET

NAME			
CLASS		INDEX NUMBER	

Physics **6091/01**

Paper 1 **27 August 2024**

1 hour

READ THESE INSTRUCTIONS FIRST

Write your class, register number and name on the Answer Sheet in the space provided.
Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.

There are **forty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.
Any rough working should be done in this booklet.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's use	
Paper 1	/40

Parent's Signature

This paper consists of **16** printed pages and **0** blank page.

1 Which quantity is a base quantity?

A speed

B density

C potential difference

D current

2 Which of the following takes the longest time to occur?

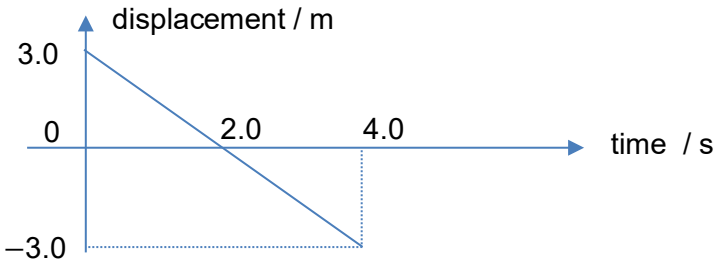
A time taken for earth to complete one revolution around the sun

B time taken for 22 mA of current to deliver 4.5 MC of charge

C time taken for 62 GJ of energy to be transferred by a 39 nW device

D time taken for an object to accelerate uniformly from rest to 4.0 km / s at a rate of 4.0 μm / s^2

3 The displacement-time graph shows how the displacement of a particle from a reference point varies with time.



Which of the following gives the total distance travelled by the particle?

A (3.0 + 3.0) m

B [3.0 + (–3.0)] m

C $[(\frac{1}{2} \times 2.0 \times 3.0) + (\frac{1}{2} \times 2.0 \times 3.0)]$ m

D $\{(\frac{1}{2} \times 2.0 \times 3.0) + [\frac{1}{2} \times 2.0 \times (-3.0)]\}$ m

4 Two objects, **X** and **Y,** have the same size and shape but **X** has a larger mass than **Y**. They are each dropped from a large altitude from rest in vacuum. The experiment is then repeated in air.

Which of the following is true?

	in vacuum	in air
A	X lands first	X lands first
B	X lands first	X and Y land together
C	X and Y land together	X lands first
D	X and Y land together	X and Y land together

5 A spacecraft was sent to the surface of the Moon. The gravitational field strength on the surface of the Moon is one-sixth that on the surface of the Earth.

How does the mass and weight of the spacecraft on the Moon compare with the mass and weight on Earth?

	mass on moon	weight on moon
A	same as on Earth	same as on Earth
B	same as on Earth	less than on Earth
C	less than on Earth	same as on Earth
D	less than on Earth	less than on Earth

6 A man pushes a heavy box with a weight of 50 N along a rough ground with a force of 30 N. The box moves at constant speed.

What is the resultant force acting on the box?

A 0 N **B** 30 N **C** 50 N **D** 80 N

7 In a game of softball, a player strikes a ball using a bat, exerting a force F on the ball.

Which of the following, with F, forms an action-reaction pair?

A the force of the ball on air

B the force of the ball on the bat

C the force of the air on the ball

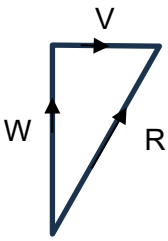
D the force of the Earth on the ball

8 A drone moves eastwards and arrives at a point due east of its starting point.

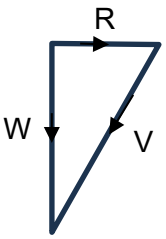
The drone has a speed of V in still air. A wind is blowing from north to south causing the drone to move with a speed of W in the same direction.

Which diagram correctly represents the resultant velocity, R, of the drone?

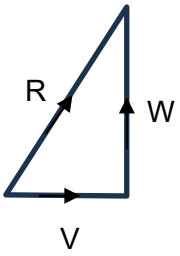
A



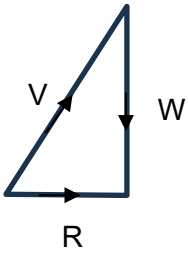
B



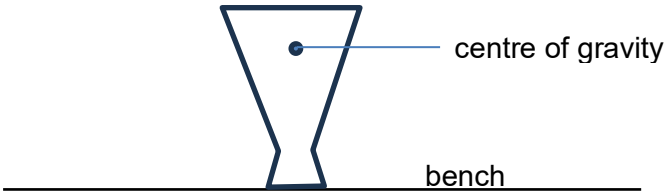
C



D



9 The diagram shows the shape of a solid object with its centre of gravity marked.



Which of the following makes the object more stable?

A Turn the object upside down.

B Make the object using a material of lower density.

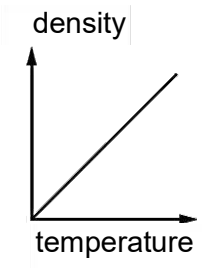
C Make the object using a material of higher density.

D Move the object to a region with a lower gravitational field strength.

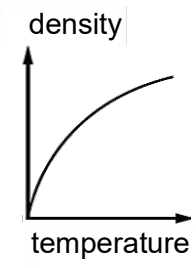
10 A piece of metal is heated, and its mass and volume are measured to determine how its density changes with temperature.

Which of the following graph shows the relationship between the density of the substance and temperature?

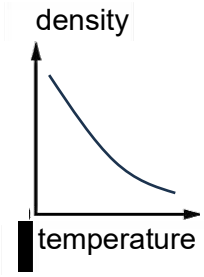
A



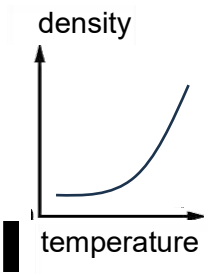
B



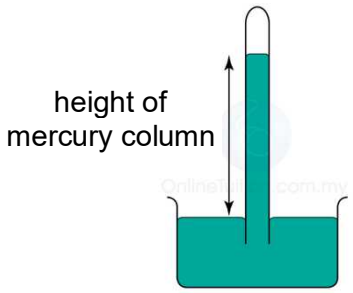
C



D



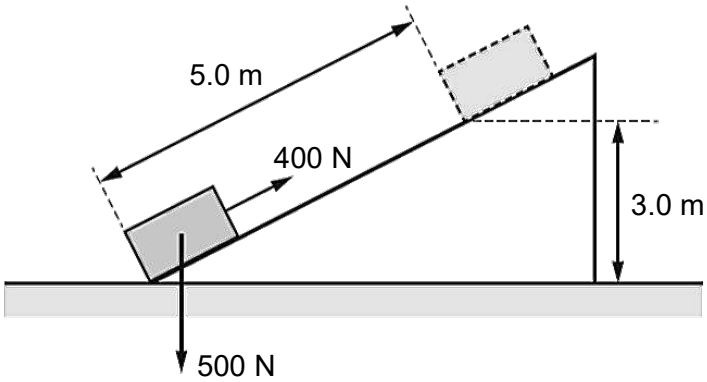
11 The diagram shows a mercury barometer used to measure atmospheric pressure.



How does the atmospheric pressure and the height of the column of mercury in the barometer change when the barometer is brought from ground level to the top of a mountain?

	atmospheric pressure	height of mercury
A	increases	increases
B	increases	remains the same
C	decreases	decreases
D	decreases	remains the same

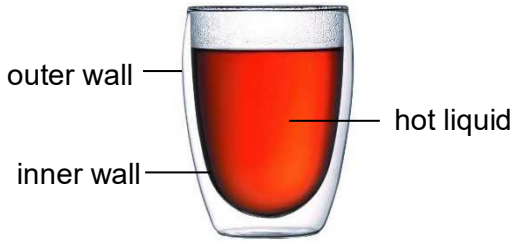
12 A force of 400 N is applied on a crate of weight 500 N along a ramp as shown in the diagram. The crate moves a distance of 5.0 m at constant speed.



Which of the following correctly shows the amount of work done by the force, and amount of energy transferred to the various stores?

	work done by force / J	amount of energy transferred to kinetic store / J	amount of energy transferred to internal store of surroundings / J
A	1500	1500	0
B	1500	0	1500
C	2000	1500	500
D	2000	0	500

13 The diagram below shows a double-walled glass.



Which of the following best explains why this design allows a user to hold the cup more safely?

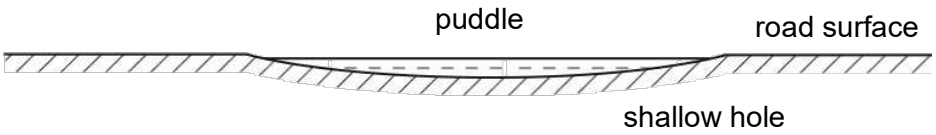
A The transparent glass increases the rate of heat loss by convection.

B The glass is a good conductor of heat and increases the rate of heat loss by conduction.

C The hot liquid is not in contact with any surface so the rate of heat loss via conduction is reduced.

D The space between the inner wall and outer wall traps air, which reduces the rate of heat transfer from the liquid to the outer wall.

14 The diagram shows the cross-sectional area of a shallow puddle of water on a road after rain.

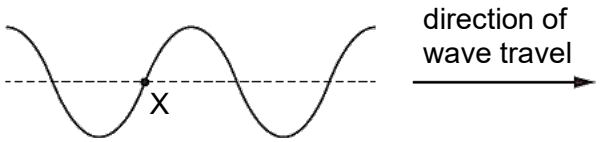


The surrounding temperature and the wind speed remain constant.

Which of the following best explains how the rate of evaporation of the water from the puddle changes?

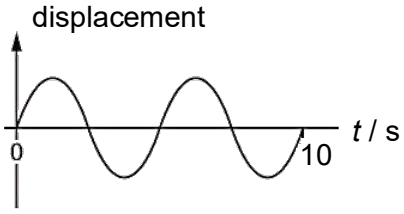
	rate of evaporation	explanation
A	decreases	depth of puddle decreases
B	decreases	surface area decreases
C	increases	volume of water decreases
D	remains constant	temperature and wind speed does not change

15 The diagram shows a transverse wave travelling along a rope at the time t = 0 s. A point on the rope is labelled X. The period of the wave is 5.0 s.

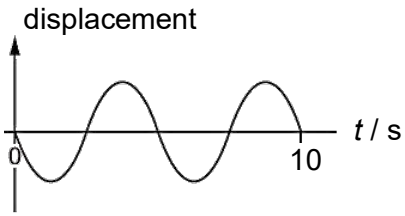


Taking upwards as positive, which graph shows the variation with time of the displacement of particle X between t = 0 s and t = 10.0 s?

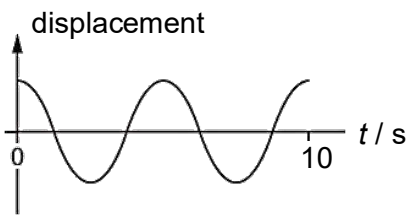
A



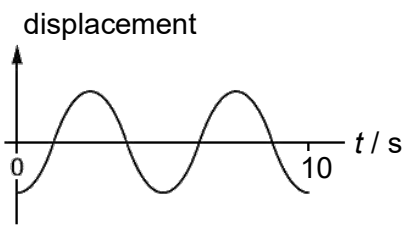
B



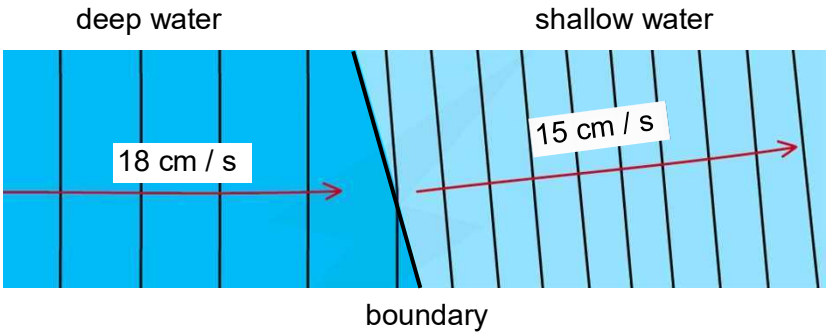
C



D



16 A water wave travels from deep water to shallow water in a ripple tank as shown in the diagram.

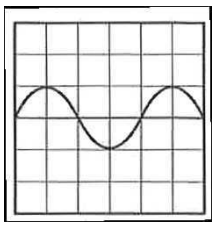


Waves in the deep water have a wavelength of 3.6 cm and a speed of 18 cm / s. The speed of the waves in shallow water is 15 cm / s.

What is the wavelength of the waves in the shallow water?

A 3.0 cm **B** 3.6 cm **C** 4.3 cm **D** 5.0 cm

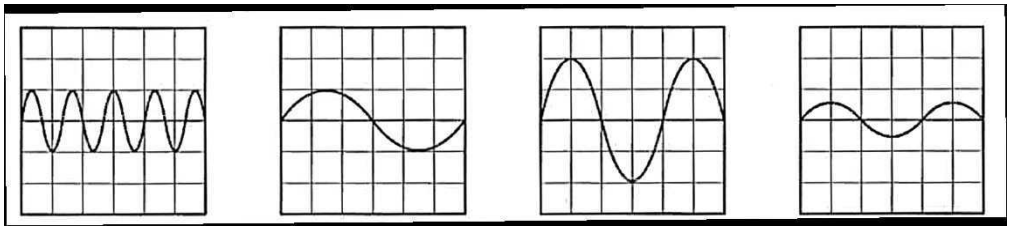
17 The diagram shows the waveform obtained when a sound was played.



The sound was changed so that it is equally loud and of a lower pitch.

Which diagram represents the waveform of the new sound?

A **B** **C** **D**



18 A pulse of sound is transmitted vertically downward from the bottom of a stationery ship, and the time taken for its echo to be detected back at the ship is recorded.

The ship repeats this process at another location. The new time recorded is 1.5 times as long as the time taken at the first location.

Which of the following is correct?

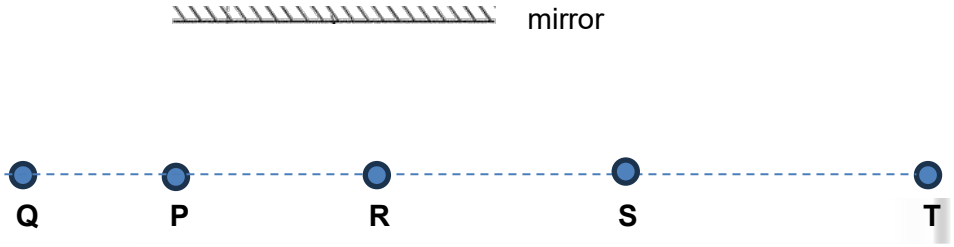
A The speed of sound at the original location is 0.75 times as fast as at the new location.

B The speed of sound at the original location is 1.5 times as fast as at the new location.

C The depth at the new location is 0.75 times as deep as the original location.

D The depth at the new location is 1.5 times as deep as the original location.

19 The diagram shows an observer **P** looking at the mirror images of students **Q**, **R**, **S** and **T**. All of them are standing equally far from the mirror.



Which student(s) can observer **P** see as a mirror image?

A **R** only

B **R** and **S** only

C **Q**, **R** and **S** only

D **Q**, **R**, **S** and **T**

20 Light in a vacuum strikes a glass surface at an angle of incidence of 42 °. In the glass, the angle of refraction is 29 °.

What is the speed of light in glass?

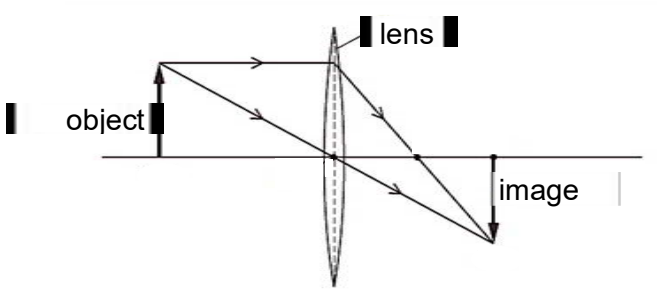
A 2.1×10^8 m / s

B 3.0×10^8 m / s

C 2.2×10^8 m / s

D 4.1×10^8 m / s

21 The diagram shows a thin converging lens forming a real image of an object.



What happens as the object is moved further away from the lens?

	how image moves	how size of image changes
A	further away from lens	increases in size
B	further away from lens	decreases in size
C	towards the lens	increases in size
D	towards the lens	decreases in size

22 A thin converging lens has a focal length of 5.0 cm. An object is placed on the principal axis, 2.0 cm away from the lens.

What type of image is formed by the lens?

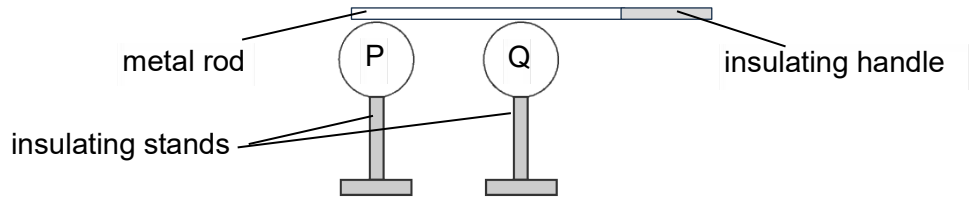
A real and inverted

B real and upright

C virtual and inverted

D virtual and upright

23 Two metal spheres are mounted on insulating stands. Sphere P is initially positively charged, and sphere Q is initially uncharged. A neutral metal rod held by an insulating handle is then placed in contact with P and Q as shown in the diagram.



What are the charges on P and Q after the rod is placed in contact with them?

	charge on P	charge on Q
A	positive	positive
B	positive	uncharged
C	uncharged	positive
D	uncharged	uncharged

24 Which of the following best describes the conventional current and its unit?

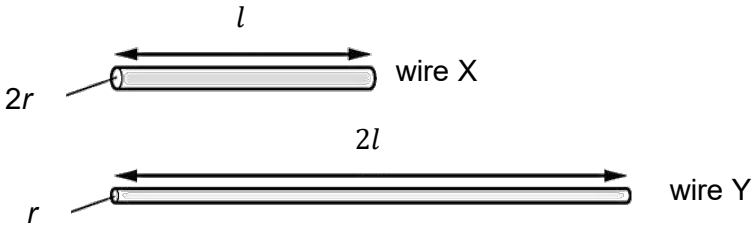
A It is the rate of flow of negative charges and its unit is the ampere.

B It is the rate of flow of negative charges and its unit is the coulomb.

C It is the rate of flow of positive charges and its unit is the ampere.

D It is the rate of flow of positive charges and its unit is the coulomb.

25 The diagram shows two wires, X and Y, made of the same material.

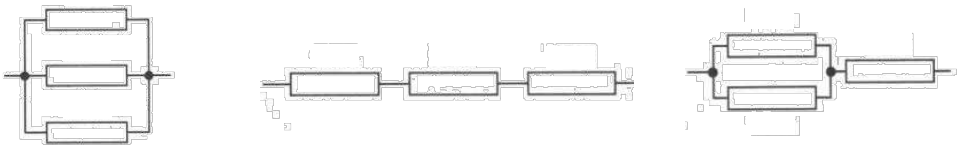


Wire X has resistance *R* and length l. Wire Y is twice as long as wire X, and its radius, *r*, is half of that of wire X.

What is the resistance of wire Y?

A *R*/2 **B** 2*R* **C** 4*R* **D** 8*R*

26 3 identical resistors are connected differently to form three different networks.



network L network M network N

Which of the following lists the networks in increasing order of effective resistance?

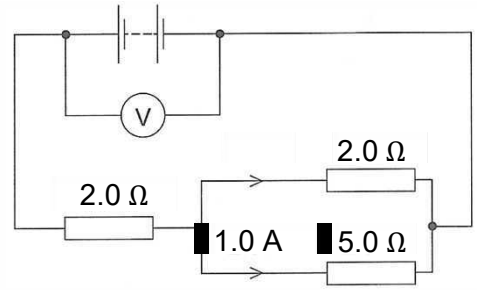
A L → M → N

B L → N → M

C M → L → N

D N → M → N

27 The circuit diagram shows a 2.0 Ω resistor connected in series with a parallel arrangement of a 2.0 Ω resistor and a 5.0 Ω resistor.

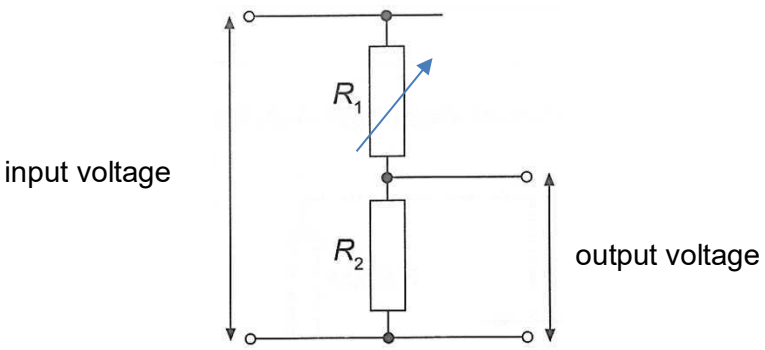


The current flowing through the 5.0 Ω resistor is 1.0 A.

What is the reading on the voltmeter?

A 7.0 V **B** 10 V **C** 12 V **D** 17 V

28 The diagram shows a variable resistor R_1 and a fixed resistor R_2 used in a potential divider.



The input voltage is kept at a constant value.

Which of the following best describes how and why the output voltage varies as R_1 increases?

	how output voltage varies	reason
A	increases	current through fixed resistor decreases
B	increases	current through fixed resistor increases
C	decreases	current through fixed resistor decreases
D	decreases	current through fixed resistor increases

29 A current of 4.5 A flows through the electrical components of a refrigerator when connected to a source of 240 V.

It costs \$0.35 for 1 kW h of electrical energy.

How much will it cost to keep the refrigerator running for 1 week?

A \$0.05 **B** \$2.25 **C** \$63.50 **D** \$378

30 Which of the following shows the outcome of installing the fuse in the neutral wire?

A The filament in the fuse will melt when excessive current flows, and the device will be disconnected from high electric potential.

B The filament in the fuse will melt when excessive current flows, and the device will still be connected to high electric potential.

C The filament in the fuse will not melt when excessive current flows, and the device will be disconnected from high electric potential.

D The filament in the fuse will not melt when excessive current flows, and the device will still be connected to high electric potential.

31 What is the function of the earth wire?

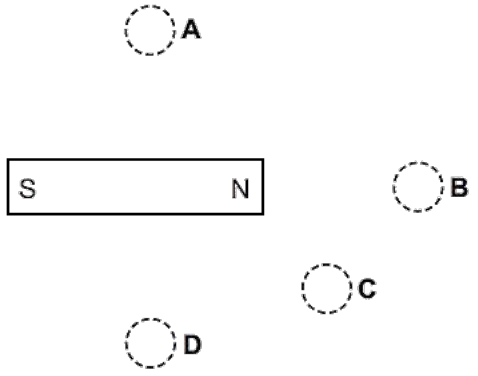
A It closes the circuit so current may flow to operate a device.

B It is a high resistance wire to reduce the amount of current to a safe level.

C It provides an alternative path for current to flow if a wiring fault occurs.

D It allows excessive charges to be stored to conserve energy.

32 A plotting compass is used to trace the magnetic field lines around a bar magnet.

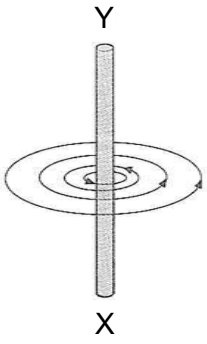


Which is a possible position where the plotting compass shows  ?

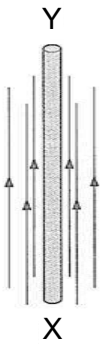
33 A magnetic field is produced when a current flows through a straight wire XY.

Which of the following correctly shows the magnetic field pattern produced by wire XY?

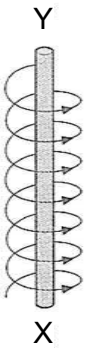
A



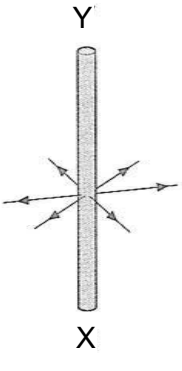
B



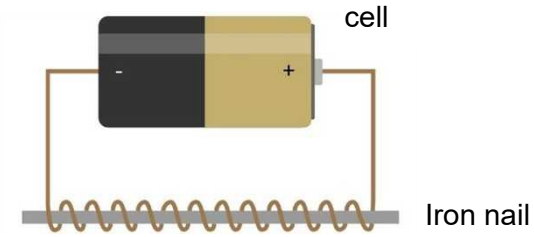
C



D



34 A simple electromagnet can be made by winding a wire round an iron nail and supplying a current through a cell as shown in the diagram below.



A student suggested the following modifications to the set up.

I increasing the number of cells

II increasing the thickness of the wires used

III winding more rounds around the nail

IV using a nail made of steel

Which of the above modifications can produce a stronger electromagnet?

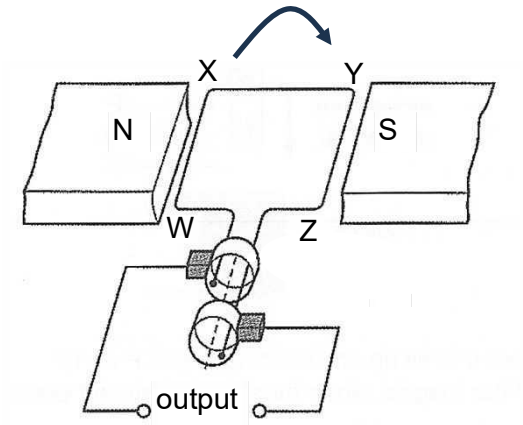
A **I** only

B **II** and **III** only

C **I, II** and **III** only

D **I, II, III** and **IV**

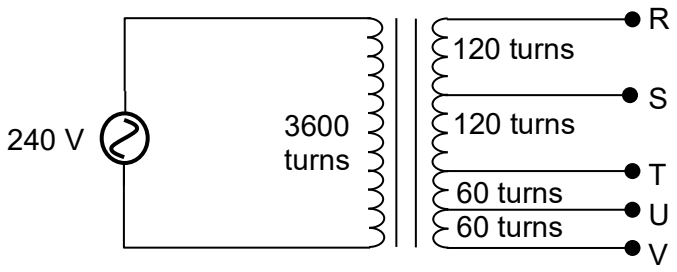
35 The diagram shows a simple A.C generator, consisting of a coil of wire WXYZ placed in between two magnets.



The coil is rotated in the direction as shown in the diagram. Which of the following correctly describes the direction of the current flowing in the coil and the rule used to predict its direction?

	direction of current in the coil	rule used
A	X to W	Fleming's Left-Hand Rule
B	W to X	Fleming's Left-Hand Rule
C	Y to Z	Fleming's Right-Hand Rule
D	Z to Y	Fleming's Right-Hand Rule

36 A transformer consists of a primary coil of 3600 turns and a secondary coil with a total of 360 turns which can be tapped at various places.



A 12 V, 24 W lamp is connected to two terminals of the secondary coil, and the lamp lights at normal brightness.

Between which terminals is the lamp connected?

A R and S **B** R and T **C** S and U **D** S and V

37 Electricity is transmitted over large distances through high-voltage power cables running alternating current.

What are the advantages of using high-voltage cables and alternating current?

	advantage of using high voltage cables	advantage of using alternating current
A	lower heat loss in cables	voltage can be stepped up or down
B	lower heat loss in cables	lower average current
C	higher current in cable	voltage can be stepped up or down
D	higher current in cable	lower average current

38 Smoke detectors may make use of radioactive emissions to function.

Which of the following best explains why alpha-particles are used in smoke detectors?

	ionising ability	penetrating power
A	high, allow a current to flow	high, so alpha particles can penetrate through the smoke
B	high, allow a current to flow	low, so alpha particles cannot penetrate through the smoke
C	low, to keep the device safe for use	high, so alpha particles can penetrate through the smoke
D	low, to keep the device safe for use	low, so alpha particles cannot penetrate through the smoke

39 In a nuclear power station, energy released from nuclear reactions are harnessed to produce electricity.

Which statement about the reactors in a nuclear power plant is correct?

A The reactions are easily controlled and no harmful substances are produced in a nuclear reaction.

B Nuclear reactors make use of reactions where heavy nuclei decay into smaller nuclei.

C A nuclear reaction may be initiated when a proton bombards a heavy nucleus, causing more protons to be released in a chain reaction.

D Large amount of radioactive substances are required to produce a small amount of electricity.

40 Which of the following best explains why nuclear fission does not take place easily?

A Energy is required to overcome the repulsion between electrons of the atoms involved in nuclear fission.

B Energy is required to overcome the repulsion between the neutrons of the atoms involved in nuclear fission.

C Energy is required to overcome the repulsion between the protons of the atoms involved in nuclear fission.

D Energy is required to overcome the repulsion between the neutrons and the protons of the atoms involved in nuclear fission.

Solutions for P1

1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
D	C	A	C	B	A	B	D	A	C
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
C	D	D	B	B	A	B	D	B	C
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	D	A	C	D	B	C	C	C	B
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
C	C	A	C	C	C	A	B	B	C

EXP

PUNGGOL SECONDARY SCHOOL
SECONDARY 4
EXPRESS
2024 PRELIMINARY EXAMINATION

QUESTION BOOKLET

NAME

CLASS

INDEX NUMBER

Physics **6091/02**

Paper 2 **22 August 2024**

1 hour 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your class, register number and name on all the work you hand in.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Write in dark blue or black pen.
Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.
You may lose marks if you do not show your working or if you do not use appropriate units.

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

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

The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's use	
Section A	/70
Section B	/10
Total	/80

Parent's Signature

This paper consists of **22** printed pages and **0** blank page.

Section A

Answer **all** the questions in the spaces provided.

1 Fig. 2.1 shows how the velocity of a vehicle changes with time.

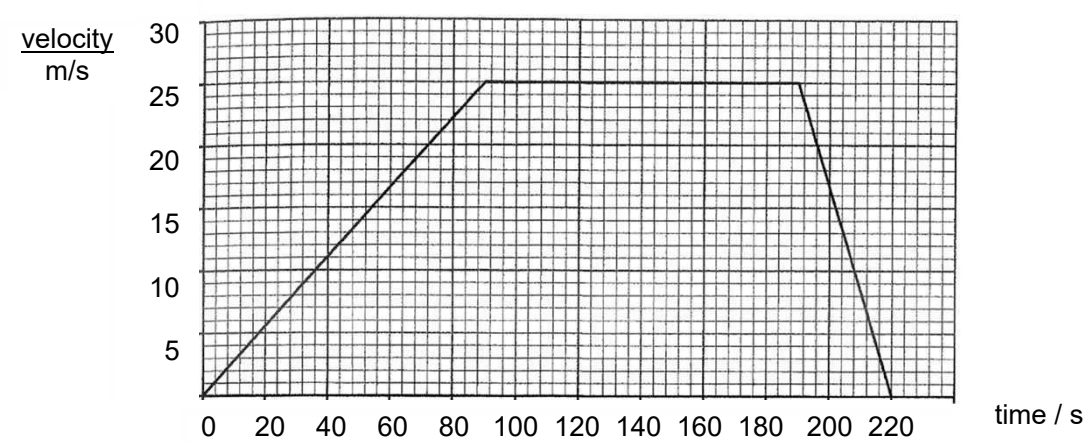


Fig. 1.1

(a) Describe how the displacement of the vehicle changes from t = 0 s to t = 80 s.

……...……...

……...……...

……...……...

…… [2]

(b) Calculate the average velocity for the whole journey.

average velocity = …… [3]

(c) Calculate the deceleration of the vehicle at t = 204 s.

deceleration = …… [2]

[total: 7]

2 Fig. 2.1 shows an aircraft dropping a crate of supplies to a region that is difficult to reach by land vehicles.

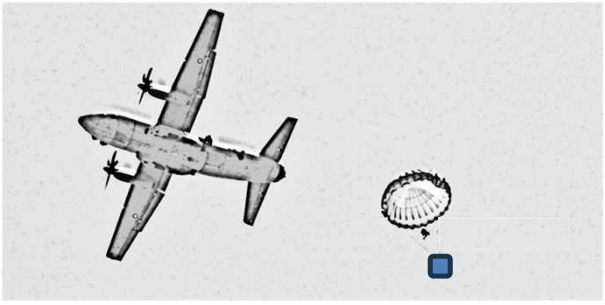


Fig. 2.1

At a certain instant in the crate's descent, it experiences a total resistive force of 1200 N. The total weight of the crate and its contents, including the parachute, is 2500 N.

(a) Draw and label the forces acting on the crate shown in Fig. 2.1 at this instant. [1]

(b) Calculate the total mass of the crate and its contents.

The gravitational field strength is 10 N / kg.

mass = …….. [1]

(c) Calculate the acceleration of the crate at the instant shown in Fig. 2.1.

acceleration = …… [3]

(d) Suggest one factor that could affect the air resistance acting on the crate.

……... [1]

(e) As the crate continues descending, it eventually attains terminal velocity.

Explain why the crate attains terminal velocity in terms of forces.

……...

……...

……...

……...

……

……... [2]

[total: 8]

3 A heater is placed at the bottom of a liquid. The liquid is heated until it becomes a gas. Fig. 3.1 shows the variation with time of the temperature of the substance.

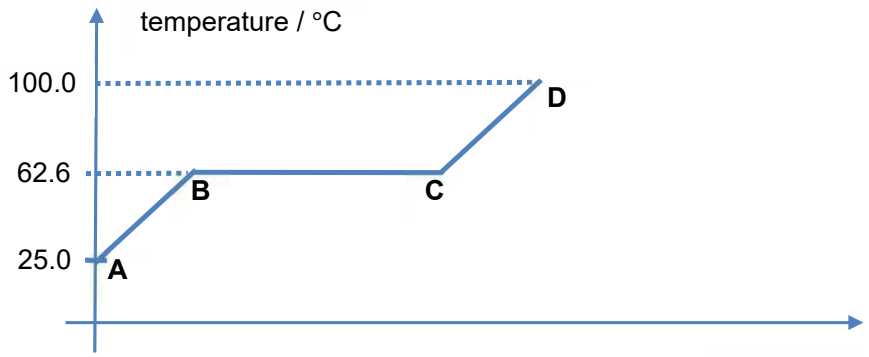


Fig. 3.1

The heater used to heat up the substance transfers energy to the substance at a steady rate.

(a) Describe how the heat is transferred efficiently throughout the liquid.

……...

……...

……...

……...

…….. [2]

(b) Explain, in terms of energy stores, why the temperature of the substance rises from **A** to **B** while the temperature remains constant from **B** to **C,** when the heater is operating normally.

……...

……...

……...

……...

…….. [2]

(c) The experiment is repeated using twice the volume of the liquid while keeping all other variables constant.

Sketch on Fig. 3.1 to show the new variation of temperature with time.

[1]

(d) Describe the changes to the arrangement of the particles from **B** to **C** using the kinetic particle model of matter.

……...

……...

…….. [1]

[total: 6]

4 Smoke particles are observed under a microscope. The particles are observed to move about randomly.

(a) Explain why the smoke particles appear to move about randomly.

……...

……...

……...

…….. [2]

(b) The lamp of the microscope heats up the sample of smoke particles being observed.

(i) Predict how the motion of the smoke particles would be different.

…….

…… [1]

(ii) Explain your answer to **(b)(i)**.

…….

…… [1]

[total: 4]

5 Fig. 5.1 shows a manometer used to measure the pressure of a gas in a syringe that is connected to one end of the manometer. The manometer is filled with mercury which has a density of 13 600 kg / m^3.

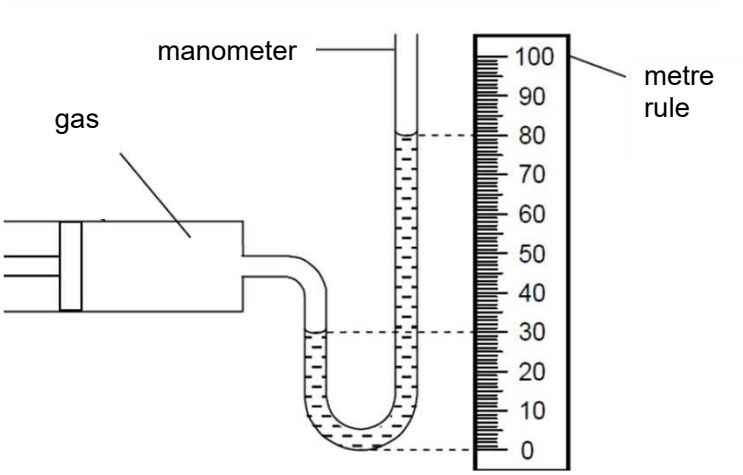


Fig. 5.1

(a) Explain how the gas particles in the syringe are able to exert such a high pressure to lift the column of mercury in the manometer on the right arm.

……...

……...

……...

……...

…….. [2]

(b) The atmospheric pressure is 760 mm Hg.

Calculate the gas pressure. Leave your answer in mm Hg.

gas pressure = ……mm Hg [1]

(c) Fig. 5.2 shows the piston pushed further to the right by a force F and the mercury level on the right arm of the manometer is observed to rise.

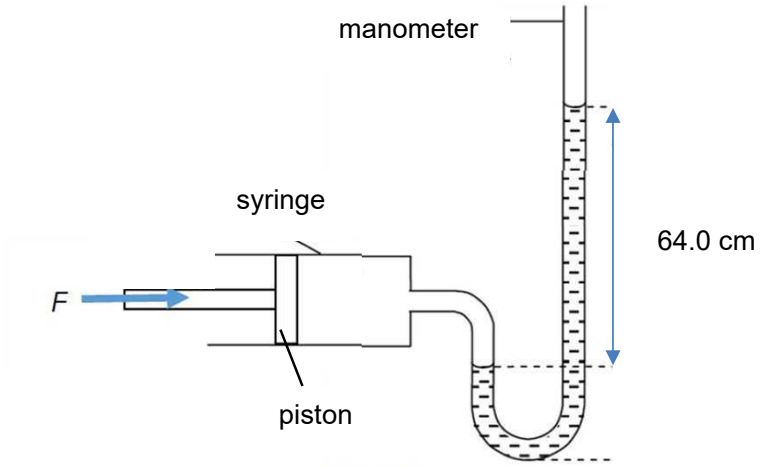


Fig. 5.2

(i) Explain why the mercury level on the right arm rises when the piston is pushed to the right using the ideas of particles.

……

……

…… [1]

(ii) Calculate the increase in gas pressure with reference to Fig. 5.1 and Fig 5.2. Leave your answer in Pa.

The gravitational field strength is 10 N / kg.

gas pressure = …… Pa [2]

(iii) The cross-sectional area of the piston is 12 cm^2. Calculate the magnitude of the force F, assuming that no energy was transferred out of the system.

force = …… [2]

[total: 8]

6 Visible light is a component of the electromagnetic (EM) spectrum, which consists of waves of different wavelengths. All EM waves can undergo reflection and refraction.

(a) State one other property that is common for all components of the electromagnetic spectrum.

……...

…….. [1]

(b) Fig. 6.1 shows a ray of blue light entering a glass block from air. The refractive index of the glass block is 1.52. The ray bends to hit surface **PQ**.

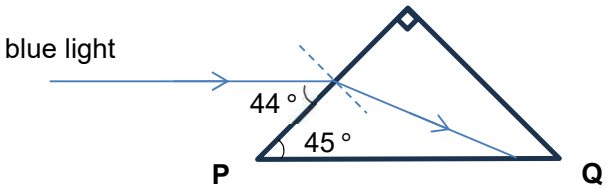


Fig. 6.1

(i) Calculate the angle of refraction for this ray.

angle of refraction = ……. ° [2]

(ii) Calculate the critical angle for the glass block.

critical angle = ……. ° [1]

(iii) Calculate the angle of incidence at the surface **PQ**.

angle of incidence = ……. ° [1]

(iv) Hence, draw a ray in Fig. 6.1 to show the path of the light ray after it is incident on the surface **PQ**. [1]

[total: 6]

7 Fig. 7.1 shows a simplified model of an electrostatic precipitator.

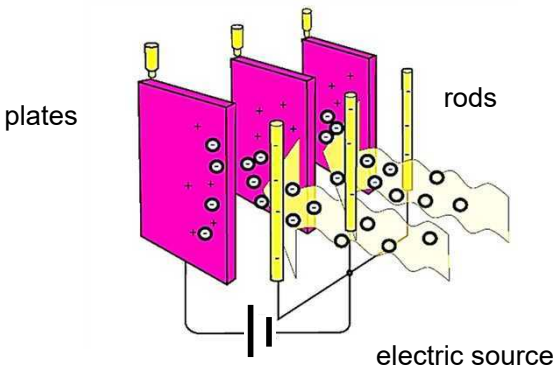


Fig. 7.1

Exhaust fumes containing dust particles are passed through metallic rods and plates that are connected to an electric source.

Dust particles passing through the rod acquire negative charges.

(a) Fig. 7.2 shows an isolated negative charge.

Fig. 7.2

(i) Draw the electric field pattern due to the charge on Fig. 7.2. [1]

(ii) State what is shown by the direction of the electric field.

……

…… [1]

(b) Explain how the electrostatic precipitator helps to produce cleaner air.

……...

……...

……...

……...

……...

…….. [2]

[total: 4]

8 A student sets up a circuit as shown in Fig. 8.1 to investigate the brightness of a lamp of resistance 5.0 Ω. A heater is placed very near a thermistor so that the temperature of the thermistor varies.

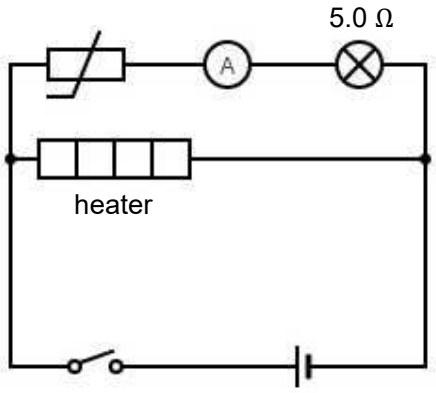


Fig. 8.1

(a) On Fig. 8.1, draw a suitable instrument to show how the potential difference across the thermistor can be measured. [1]

(b) When the switch is first closed, the lamp fails to light up.

(i) Suggest why the lamp fails to light up at first.

……

…… [1]

(ii) Explain why the lamp lights up after some time.

……

…… [1]

(c) The current and potential difference across the thermistor obtained from the experiment is shown in Fig. 8.2.

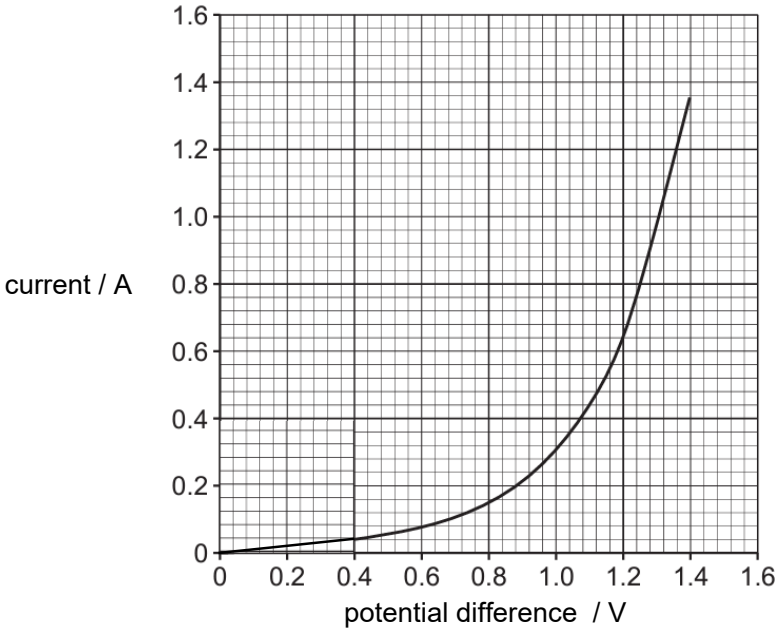


Fig. 8.2

(i) The current through the lamp is 0.48 A at one point in the experiment.

Find the e.m.f of the cell.

e.m.f = ……

[3]

(ii) The student discusses the graph in Fig. 8.2 with another student, and they conclude that the thermistor exhibits ohmic properties under certain conditions.

Suggest why they came to this conclusion.

……

……

…… [1]

[total: 7]

9 Fig. 9.1 shows an instrument that can be used to detect earthquakes. A bar magnet is suspended from a spring hanging from a metal rod. The metal rod is firmly attached to the base of the instrument and transmits vibrations on the ground to the magnet, causing it to oscillate. The coil is connected to a monitor which measures and displays the induced e.m.f in the coil.

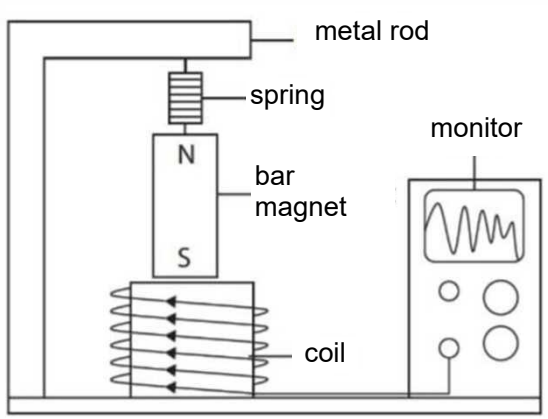


Fig. 9.1

(a) In a test, a student lowers the bar magnet into the coil and then withdraws the bar magnet. The monitor registers a reading momentarily, indicating that an e.m.f is induced.

(i) Explain why an e.m.f is induced in the circuit.

……

…… [1]

(ii) The direction of the current induced at one moment in this test is shown in Fig. 9.1.

Deduce whether the bar magnet was moving in or out of the coil at the moment shown in Fig. 9.1

…… [1]

(iii) Explain your answer to **(a)(ii)**.

……

……

……

……

…… [2]

(b) During an earthquake, the monitor registers 50 vibrations in a second and a maximum e.m.f of 500 mV.

On Fig. 9.2, sketch the voltage-time graph showing the induced e.m.f registered by the monitor.

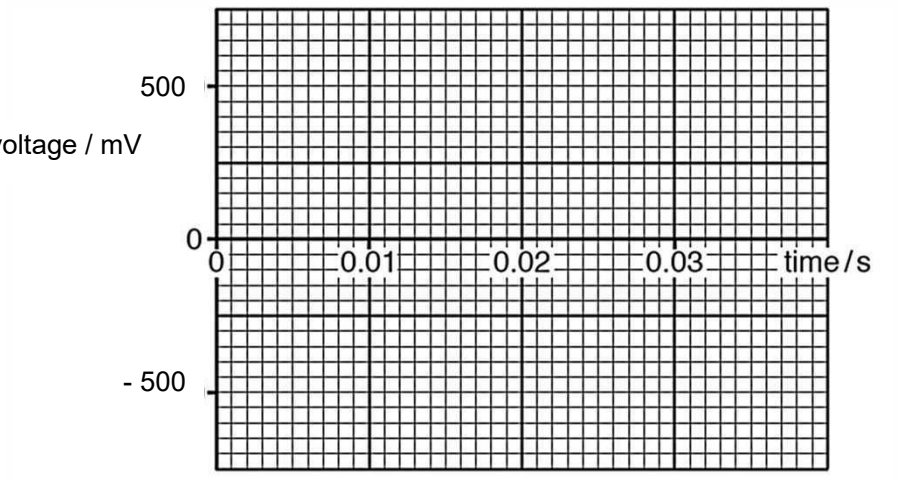


Fig. 9.2

[2]

(c) Describe two differences in your sketch in Fig. 9.2 if an earthquake that creates 25 vibrations in one second is registered by the instrument shown in Fig. 9.1.

……...

…….. [1]

(d) In another test, it was found that the monitor registered no reading when the tremors are small. Suggest how the instrument could be modified so that the induced e.m.f is larger.

……...

……...

…….. [1]

(e) The coil is removed from the set up in Fig. 9.1, and connected to a battery, as shown in Fig. 9.3. An iron core is inserted into the coil, and an iron pendulum bob is suspended near the coil.

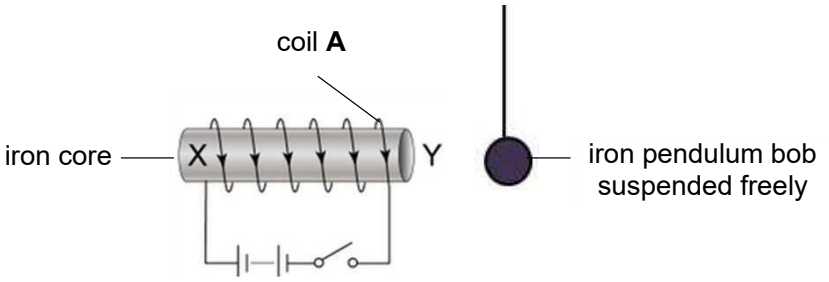


Fig. 9.3

The switch is closed and the iron pendulum bob is observed to swing towards **Y**, one end of the iron core.

Explain why the pendulum bob swings towards Y when the switch is closed.

……...

……...

……...

……...

…….. [3]

[total: 11]

10 Bubble tea is a popular beverage made by mixing flavoured syrup to tea. Chewy starch balls, called “pearls”, are often added to the beverage.

Fig. 10.1 shows a typical drink where fixed volumes of syrup, tea, ice, and pearls are mixed together.

Fig. 10.1

Table 10.2 shows the amount of each ingredient used for drinks of different sizes, the values of their specific heat capacities and specific latent heat of fusion, and the temperature of each ingredient before they are first mixed.

Table 10.2

	tea		syrup		pearls		ice	
size	small	large	small	large	small	large	small	large
mass added / g	300	450	35	50	120	150	300	450
specific heat capacity J / (g K)	4.5		3.1		3.5		2.1	
specific latent heat of fusion J / g	340		390		-		330	
temperature before they are first mixed °C	65		26		36		0	

(a) Explain what is meant by a *specific heat capacity of 4.5 J / (g K)*.

……..

……..

…… [1]

(b) A drink is usually served at 4 °C

(i) Suggest why more ice is added when a large drink is prepared.

……

…… [1]

(ii) Using information from Table 10.2, calculate the amount of energy transferred out of the internal store of the syrup for its temperature to decrease to 4 °C for a small-sized beverage.

amount of energy = ... [2]

(iii) Using information from Table 10.2, calculate the total amount of energy transferred out of the internal stores of the ingredients for a small-sized beverage to be 4 °C.

total amount of energy = ... [1]

(iv) State the amount of energy transferred to the internal store of the ice when it attains thermal equilibrium with the beverage at 4 °C.

amount of energy = ... [1]

(v) Hence, calculate the minimum mass of ice required to obtain a small beverage at 4 °C using information from Table 10.2.

The specific heat capacity of water is 4.2 J / (g K).

minimum mass = ... [3]

[total: 9]

Section B

Answer **one** question from this section.

11 Isotopes of some elements may be unstable and undergo nuclear decay, releasing radiation. One example is the isotope radium-226, which decays into radon-222 with the emission of an alpha particle.

(a) In nuclide notation, radium-226 is written as $^{226}_{88}\mathrm{Ra}$. Write the equation to represent the alpha decay of radium-226 to radon-222. The chemical symbol for radon is Rn.

[2]

(b) Radioactive substances are used in some medical procedures, and they should be handled with care as they can be dangerous to living organisms.

(i) Explain why exposure to alpha particles could be more harmful than exposure to gamma radiation.

……

……

…….. [1]

(ii) Suggest how medical professionals who handle the radioactive isotope radium-226 frequently may protect themselves from the harmful effects of radioactivity.

……

……

…….. [1]

(c) The isotope radon-222 is also unstable and continues to decay into smaller nuclides. The half-life of radon-222 is 8.3 days.

The initial mass of a sample of radon-222 before decay is observed to be 100 g. Calculate the number of days it will take for 12.5 g of radon-222 to be left in the sample.

number of days = …….. [2]

(d) A student measures the count rate of a sample of radon-222 to determine its half-life.

Describe how he could determine an accurate count rate for the sample of radon-222 using a named apparatus.

……..

……..

……..

…… [2]

(e) A beam of the alpha particles is directed into a uniform magnetic field as shown in Fig. 11.1.

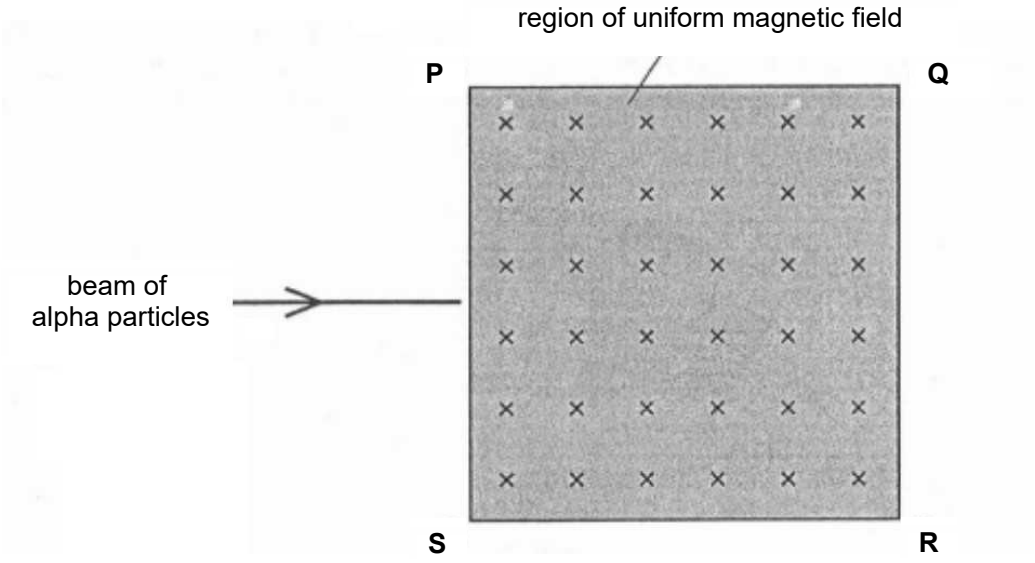


Fig. 11.1

(i) Draw the subsequent path of the alpha particles as they pass into the magnetic field in Fig. 11.1. [1]

(ii) The beam of alpha particles is replaced with a beam of gamma radiation.

Explain how your answer to **(e)(i)** will be different.

……

……

…… [1]

[total: 10]

12 A crane uses a motor to lift a concrete slab of weight 2400 N as shown in Fig. 12.1.

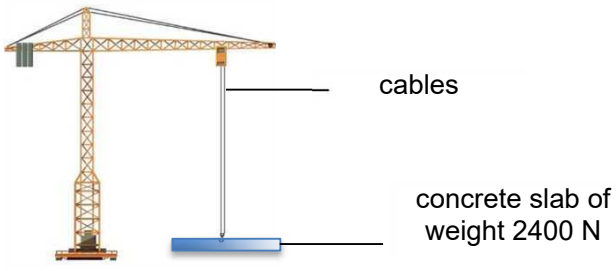


Fig. 12.1

(a) State the *principle of conservation of energy*.

……...

……...

…….. [2]

(b) The concrete slab was lifted from the ground to a height of 25 m in 1.2 minutes at constant speed.

(i) Calculate the useful power output of the motor.

useful power output = …… [2]

(ii) The efficiency of the motor is 65%. Calculate the minimum power input required by the motor.

minimum power input = …… [1]

(iii) In a safety simulation, engineers conducted an experiment to find out the damage that faulty cables could cause to the construction site, in the event that the cables snap and the concrete slab falls.

The concrete slab is released 25 m above the ground. Calculate the maximum speed of the slab just before reaching the ground.

speed = ... [2]

(c) Fig. 12.2 shows a counterweight of 12 000 N used to balance the crane, which is pivoted at **X**. The weight of the frame of this crane is 150 000 N, and its centre of gravity is at the point **G**, 0.20 m away **X**.

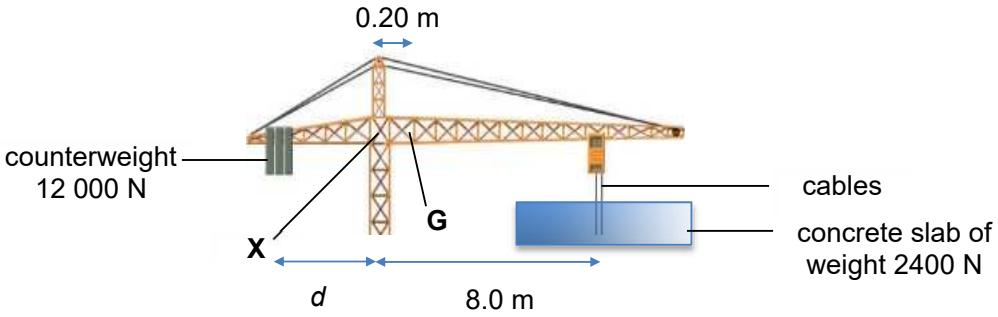


Fig. 12.2

Given that the crane is in equilibrium when the concrete slab is 8.0 m away from the pivot **X**, calculate *d*, the distance the counterweight is from **X**.

d = ... [3]

[total: 10]

– End of paper –

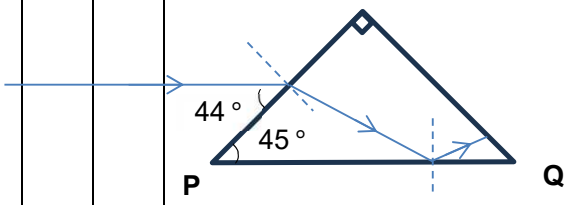
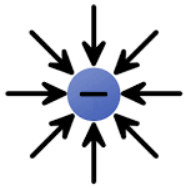
Suggested Marking Scheme for PSS 6091 Prelim 2024

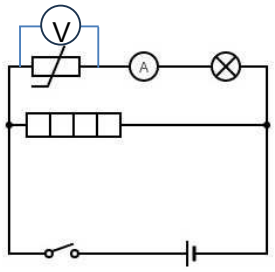
- Correct units are expected for all questions, unless otherwise stated. Penalise units up to once in section A, and up to once in section B.
- Expect lowest sf after multiplication and division, condone 1 more sf than expected. Penalise dp/sf once for the entire paper.

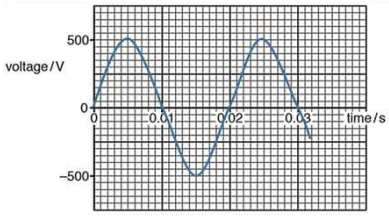
Question			Marking point	Mark	Markers comments
1	a		The velocity is increasing from t = 0 s to t = 80 s Since velocity is the rate of change of displacement, the displacement is increasing at an increasing rate.	B1 B1	
	b		displacement = area under graph $= \frac{1}{2}[(190-90)+220)\times 25.0$ = 4000 m average velocity = $\frac{4000}{220}$ = 18.2 = 18 m / s (2sf)	M1 M1 A1	
	c		$a = \frac{v-u}{t}$ $= \frac{0-25}{30}$ (or $\frac{0-13}{16}$ or $\frac{13-25}{14}$) =−0.83 m/s^2 (or -0.81 or -0.86) d=0.83 m/s^2 penalize for units once with 2c	M1 A1	
					[total: 7]
2	a		 resistive forces = 1200 N W = 2500 N	B1 for both forces	
	b		W=mg 2500 = m × 10 m=250 kg	B1	
	c		F_R=2500 – 1200 = 1300 N $F_R = ma$ 1300 = 250 a $a = \frac{1300}{250}$ = 5.2 m/s^2 penalise for unit once with 1c	M1 M1 A1 / ECF1	

Question			Marking point	Mark	Markers comments
	d		• The surface area of the crate. • The surface area of the parachute. • Presence of wind.	B1 for any	
	e		• As speed increases, air resistance increases • until it is equal in magnitude to weight. • so resultant force is 0.	B1 for any 1 point B2 for all 3 points	
					[total: 8]
3	a		Liquid that is heated at the bottom expands, resulting in a lower density, and rises. Cooler liquid, being denser, sinks, to be heated. Process repeats to form a convection current.	B1 for any 1 point B2 for all 3 points	
	b		From **A** to **B**, energy is transferred to the internal kinetic store and so the temperature of the substance rises. From **B** to **C**, energy is transferred to the internal potential store to separate the particles and not to the internal kinetic store.	B1 B1	
	c		• less steep AB and CD • longer BC • same boiling point	B1	
	d		Particles are changing from closely and disorderly packed to far apart and randomly arranged.	B1	
					[total: 6]
4	a		air particles (molecules) are in constant random motion and collide with the smoke particles randomly, exerting a force	B1 B1	
	b	i	The smoke particles change directions more frequently. Reject “more randomly”	B1	

Question			Marking point	Mark	Markers comments
		ii	Air particles move <u>more quickly</u> and <u>collide with the smoke particles more frequently</u>.	B1	
					[total: 4]
5	a		• <u>The gas particles travel at high speeds</u> and • <u>collide frequently with the mercury</u> and • <u>exerting a force</u> • Since <u>pressure is force per unit area</u>, a pressure is exerted (which pushes the column of mercury)	B1 for any 2 B2 for all 4	
	b		$P_{gas} = P_{atm} + P_{mercury}$ $= 760 + 500$ $= 1260$ mm Hg	B1	
	c	i	• Less space for gas or shorter distance to travel (or more particles per unit volume) • Increased frequency of collision with walls of manometer • Increase in gas pressure	B1 for all 3	
		ii	$P_{new} - P_{old}$ $= (P_{atm} + P_{new\ Hg}) - (P_{atm} + P_{old\ Hg})$ $= P_{new\ Hg} - P_{old\ Hg}$ = 640 mm Hg – 500 mm Hg = 140 mm Hg $= 13\,600 \times 10 \times (140 \times 10^{-3})$ = 19 040 = 19 000 Pa (3sf)	M1 A1	
		iii	F=PA $= 19\,040 \times \frac{12}{100^2}$ = 22.8 = 23 N (2sf)	M1 A1 / ECF1	
					[total: 8]

Question			Marking point	Mark	Markers comments
6	a		Accept any correct answer. • Travel at 3.0 x 10^8 m / s in vacuum (insist on 3.0 or 3.00) • They are all transverse waves. • They transfer energy without transferring mass. • They can travel through vacuum.	B1 for any 1 point	
	b	i	$\frac{\sin i}{\sin r} = 1.52$ $\frac{\sin 46°}{\sin r} = 1.52$ $\sin r = \frac{\sin 46°}{1.52}$ $r = \sin^{-1}\left(\frac{\sin 46°}{1.52}\right)$ $= 28.2°$	M1 A1	
		ii	c = $\sin^{-1}\left(\frac{1}{n}\right)$ = $\sin^{-1}\left(\frac{1}{1.52}\right)$ =41.1°	B1	
		iii	 Angle of incidence = 90 – (180 – 45 – 90 – 28.2) = 73.8 °	B1 / ECF1	
		iv	• Total internal reflection occurs at PQ, expect $i \approx r$. • Arrows on rays	B1	
					[total:6]
7	a	i	 • Arrows pointing in • Symmetric	B1	

Question			Marking point	Mark	Markers comments
		ii	It shows the direction of a force that a positive test charge would experience if placed at that point.	B1	
	b		• The metal plates are positively charged • The dust particle are negatively charged. • Opposite charges attract • The dust particles are attracted to the metal plates and stay there.	B1 for any 2 points B2 for all 4	
					[total: 4]
8	a			B1	
	b	i	Resistance of thermistor is very high at first so current in that branch is too low to light the lamp. Reject short circuit.	B1	
		ii	the resistance of the thermistor decreased with increasing temperature as it is heated up by the heater so current in that branch increased.	B1	
	c	i	from graph, when I = 0.48 A, V=1.12 V pd across 5.0 Ω bulb, V = IR =0.48 x 5.0 =2.4 V E.M.F = 1.12 + 2.4 = 3.5 V (accept 3.52 V)	M1 M1 A1	
		ii	The graph • Passed through the origin • and is straight when V was between 0 V to 0.40 V. (or I is directly proportional to V between 0 V to 0.40 V)	B1 for both points	
					[total: 7]

Question			Marking point	Mark	Markers comments
9	a	i	There is a change in magnetic flux as the magnet was moving into and out of the coil. (By Faraday's Law, and e.m.f is induced.)	B1	
		ii	It was moving into the coil	B1	
		iii	As a south pole is induced at the end near the bar magnet (using RHGR), the coil was repelling the magnet to oppose the change, and thus by Lenz's Law, the magnet bar was moving into the coil	B1 B1	
	b		 Shape (sine on the t-axis) amplitude at 500 mV	B1 B1	
	c		smaller amplitude and larger period	B1	
	d		Increase the number of coils in the solenoid Use a stronger magnet	B1 for any	
	e		When switch is closed, a N pole is produced at Y using the right-hand grip rule. As iron is a magnetic material, a S pole is induced on the end of the pendulum bob nearer Y. Since unlike poles attract, the bob swings towards the solenoid.	B1 B1 B1	
					[total: 11]
10	a		4.5 J of energy is required to raise 1 g of the substance (or tea) by 1 K (or 1 °C)	B1	
	b	i	more energy needs to be absorbed (or transferred out of the internal store of the ingredients) to reduce the temperature of the drink when the mass of tea is larger.	B1	

Question			Marking point	Mark	Markers comments
	b	ii	$Q_{syrup} = m_{syrup}c_{syrup}\Delta\theta_{syrup}$ $= 35 \times 3.1 \times (26 - 4)$ $= 2387$ $= 2400$ J (2sf)	M1 A1	
		iii	$Q_{tea} = m_{tea}c_{tea}\Delta\theta_{tea}$ $= 300 \times 4.5 \times (65 - 4)$ $= 82\ 350$ J $Q_{pearls} = m_{pearl}c_{pearl}\Delta\theta_{pearl}$ $= 120 \times 3.5 \times (36 - 4)$ $= 13440$ J total energy = 2387 + 82 350 + 13 440 = 98 177 = 98 000 J (2sf)	 B1	
		iv	98 000 J	B1/ ECF1	
		v	energy transferred out from ingredients = energy transferred into internal store of ice = energy required to melt the ice + energy required to raise to $4°C$ $= m_{ice}l_{fice} + m_{ice}c_{water}\Delta\theta_{water}$ $m_{ice}l_{fice} = m_{ice}\ 330$ $= 330\ m_{ice}$ $m_{ice}c_{water}\Delta\theta_{water} = m_{ice} \times 4.2 \times 4$ $= 16.8\ m_{ice}$ $98\ 177 = 330\ m_{ice} + 16.8\ m_{ice}$ $98\ 177 = 346.8\ m_{ice}$ $m_{ice} = 283.1$ $= 280$ g (2sf)	 M1 M1 A1 / ECF1	
					[total: 9]

Question			Marking point	Mark	Markers comments
11	a		$^{226}_{88}Ra \rightarrow {}^{222}_{86}Rn + {}^{4}_{2}He\ (or\ {}^{4}_{2}\alpha)$ correct reactants and products correct number of nucleons and protons	 B1 B1	
	b	i	Alpha particles are more ionizing than gamma radiation	B1	
		ii	• Use thongs to handle the radioactive substances • Wear protective gears when handling the substances • Minimize contact with the substances whenever possible • Reduce exposing the substance to colleagues accept reasonable answers.	B1	
	c		100 → 50 → 25 → 12.5 3 half-lives 3 x 8.3 = 25 days (2 sf)	 M1 A1	
	d		take the background count using a GM-counter (or Geiger-Muller tube). subtract the background count from the measured count to get the corrected count rate. accept description of measurement taken without the source then with the source.	B1 B1	
	e	i	curve upwards towards PQ (circular)	B1	
		i	no deviation as the gamma radiation has no electric charge, so no magnetic force is produced.	B1	

Question			Marking point	Mark	Markers comments
12	a		• Energy cannot be created or destroyed. • It can be transferred from one store to another store. • Total energy in the (closed) system remains constant.	B1 for any 1 point B2 for all 3 points	
	b	i	$E_p = mgh$ $= 2400 \times 25$ $= 60\,000$ J P = $\frac{W}{t}$ $= \frac{60\,000}{60 \times 1.2}$ = 833.3 = 830 W (2 s.f)	M1 A1	
		ii	$\frac{useful\ power\ output}{total\ input\ power} \times 100 = 65$ $\frac{833.3}{input\ power} \times 100 = 65$ input power = 1282 W = 1300 W (2sf)	B1	
		iii	All the E_p is transferred to the kinetic store. $E_k = E_p$ $\frac{1}{2}mv^2 = 60\,000$ $\frac{1}{2} \times 240 \times v^2 = 60000$ $v^2 = 500$ $v = 22.4$ = 22 m / s (2sf)	M1 A1	
	c	i	total cw momemts = 2400 × 8.0 + 150 000 × 0.20 = 49 200 Nm 12 000 d = 49200 d = 4.1 m	M1 M1 A1	
					[total:10]