ne	Register Number	Class	Calculator Model

智行萬願

MANJUSRI SECONDARY SCHOOL
文 殊 中 學

PRELIMINARY EXAMINATION 2016

Subject:	Physics (SPA)
Paper:	5059/01
Level:	Secondary 4 Express
Date:	19 Aug 2016
Duration:	1 hour
Setter:	Ms Ada Chen

Additional Materials: Optical Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your Name, Register Number and Class in the spaces at the top of this page.

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 Optical 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 on this paper.
The use of an approved scientific calculator is expected, where appropriate.

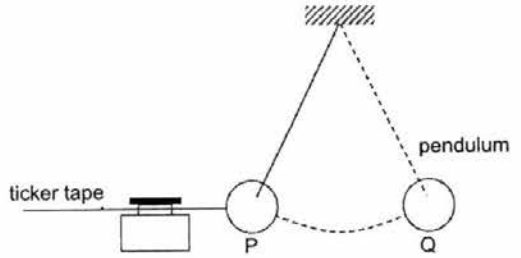
For Examiner's Use
40

This document consists of **16** printed pages, including the cover page.

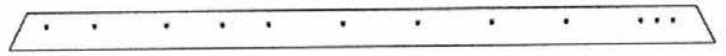
1 Which of the following pairs of physical quantities do not have the same unit?

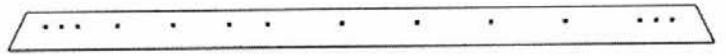
A friction and electrostatic force
B heat capacity and latent heat
C latent heat and kinetic energy
D rate of energy conversion and power

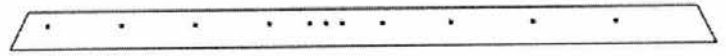
2 A ticker tape timer attached to a heavy pendulum is shown below. The timer is switched on when the pendulum bob starts to move.

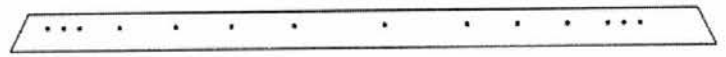


Which tape is most likely to be obtained in the first swing from P to Q?

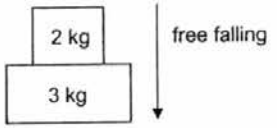
A 

B 

C 

D 

3 Two metal blocks are stacked one on top of the other as shown in the diagram below. They are dropped together in the arrangement shown below in vacuum, under earth's gravitational field. The acceleration due to free fall on Earth is 10 m/s^2.

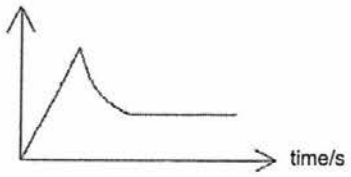


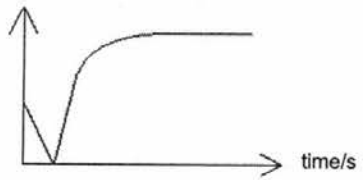
What is the net force acting on the 3 kg metal block during the fall?

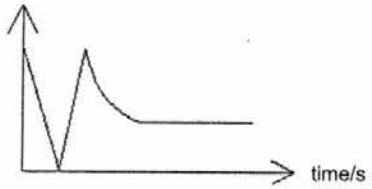
A 10 N B 20 N C 30 N D 40 N

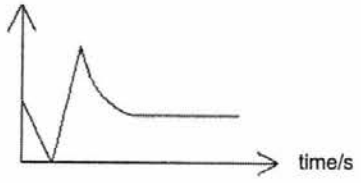
4 A diver lifts off from the diving board with an initial speed and decelerates uniformly to a momentary stop before falling with constant acceleration. Upon entering the water, he experiences decreasing deceleration and reaches constant speed after a while.

Which of the following graphs describes the motion of the diver as he leaves the diving board and dives into the pool of water?

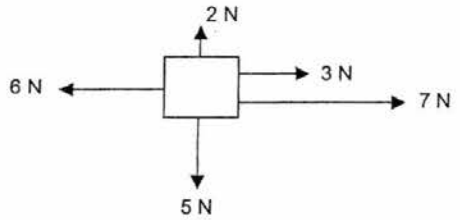
A


B


C


D


5 The diagram below shows 5 forces acting on a block.



What is the magnitude of the resultant force acting on the block?

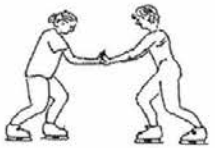
A 1.0 N B 5.0 N C 6.0 N D 23 N

6 A liquid of density ρ is thoroughly mixed with an equal mass of another liquid of density 2ρ.

Assuming that there is no chemical reaction between the two liquids, what is the density of the liquid mixture?

A $\frac{4}{3}\rho$ B $\frac{3}{2}\rho$ C $\frac{5}{3}\rho$ D 3ρ

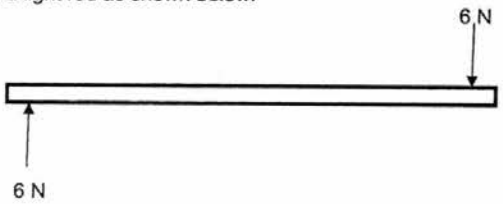
7 A girl and a boy at an ice skating ring push each other as shown below. The girl exerts a force of 20 N on the boy while the boy exerts a force of 25 N on the girl.



What is the net horizontal force experienced by the girl?

A 5 N B 20 N C 25 N D 45 N

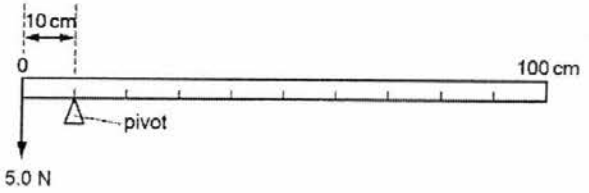
8 Two forces act on a light rod as shown below.



Which effect will be produced by the two forces?

A rotation only
B movement in a straight line only
C no effect since the forces are balanced
D both rotation and movement in a straight line

9 A uniform metre rule is pivoted at the 10 cm mark and balanced by a 5.0 N weight as shown below.



What is the weight of the metre rule?

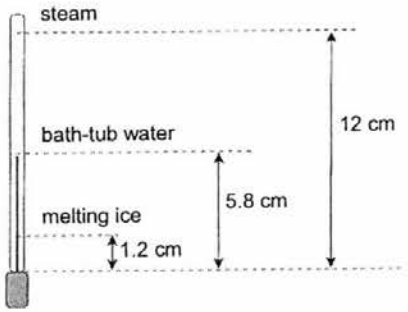
A 0.50 N B 0.56 N C 1.3 N D 20 N

Student A lifts a box weighing 50 N from the floor to a height of 0.40 m in 2.0 s. Student B lifts another box weighing 40 N from the floor to a height of 0.50 m in 1.0 s.

Compared to student A, student B does

A the same work but exerts more power.
B the same work but exerts less power.
C more work but exerts less power.
D less work but exerts more power.

11 Mary wants to know the temperature of bath-tub water. However, the markings on her thermometer are worn out and invisible. She puts the thermometer into melting ice, then into steam over boiling water and finally into bath-tub water. Each time she waits until the liquid level in the thermometer becomes steady and then marks the level on it as shown in the diagram below.



What is the possible temperature of the bath-tub water?

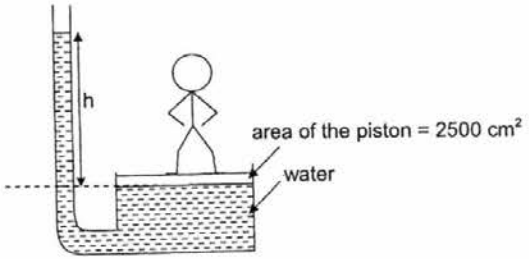
A 38 °C B 43 °C C 48 °C D 54 °C

12 Stews and soups can be kept warm in clay pots for a long period of time. Which of the following is/are the reason(s)?

I Clay is a poor conductor of heat.
II The food contains a lot of water, which has a large specific heat capacity.
III Clay does not emit infrared radiation.

A I only
B I and II
C I and III
D II and III

13 The diagram below shows a person of mass 50 kg standing on a piston of surface area 2500 cm^2. The density of water is 1000 kg/m^3 and the gravitational field strength is 10 N/kg.



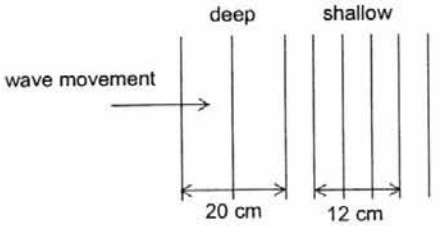
What is height h?

A 0.2 m B 2.5 m C 5.0 m D 10 m

14 A fur jacket keeps a person warm by reducing the heat loss by _____.

A conduction only
B convection only
C conduction and convection
D conduction and radiation

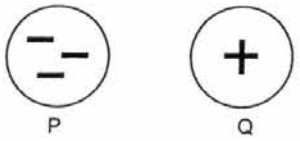
15 The diagram below shows plane waves moving from a deeper region of water to a shallower region. The speed of the wave at the deeper region is 5 m/s.



Which of the following about the frequency and speed of the waves at the shallower region is correct?

	frequency / Hz	speed / (m/s)
A	25	1
B	25	3
C	50	2
D	50	6

16 The diagram below shows two similar isolated metallic spheres P and Q. Sphere P carries three negative charges, while sphere Q carries one positive charge.

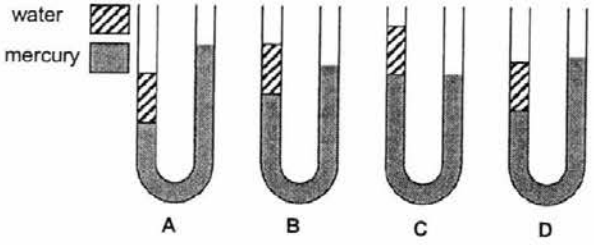


When sphere P touches sphere Q, which of the following correctly describes the movement of the charge(s)?

A The positive charge moves from Q to P.
B Two negative charges move from P to Q.
C All the negative charges move from P to Q.
D Only one negative charge moves from P to Q.

17 Water and mercury are placed in a manometer. The density of water is 1000 kg/m^3 and the density of mercury is 13 600 kg/cm^3.

Which diagram correctly shows the positions of the liquids?



18 A sealed metal container which contains gas is heated.

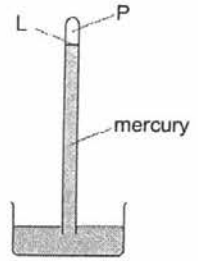
Which of the following is correct?

A The gas molecules gain kinetic energy but not the molecules of the metal container.
B The gas molecules gain potential energy but not the molecules of the metal container.
C Both the gas molecules and the molecules of the metal container gain kinetic energy.
D Both the gas molecules and the molecules of the metal container gain potential energy.

19 Both transverse and longitudinal waves can be demonstrated using a/an _____.

A rope
B slinky coil
C sound wave
D electromagnetic wave

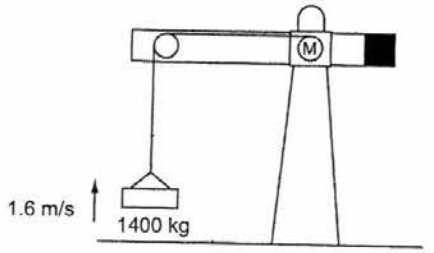
20 The diagram shows a working mercury barometer used to measure atmospheric pressure.



What happens to the mercury column and the pressure at P when atmospheric pressure increases?

	mercury column	pressure at P
A	falls	increases
B	falls	stays the same
C	rises	increases
D	rises	stays the same

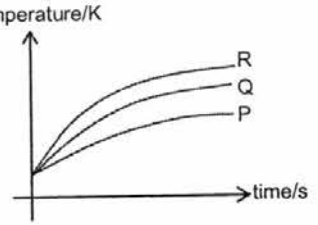
21 Motor M in a crane is used to lift a total mass of 1400 kg through a height of 16 m at a constant speed of 1.6 m/s. The motor is 20 % efficient.



What is the minimum input power to motor M?

A 14 000 W
B 22 400 W
C 24 640 W
D 112 000 W

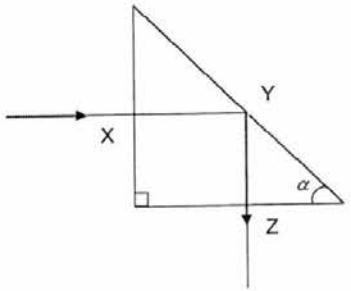
Heat energy is supplied at the same rate to 100 g of lead, 100 g of copper and 100 g of aluminum. The specific heat capacities of lead, copper and aluminum are 130 J/(kg K), 400 J/(kg K) and 900 J/(kg K) respectively. The graph below illustrates how the temperatures of the materials change with time.



Which of the following correctly shows P, Q and R and their corresponding materials?

	P	Q	R
A	aluminium	copper	lead
B	lead	copper	aluminium
C	aluminium	lead	copper
D	copper	aluminium	lead

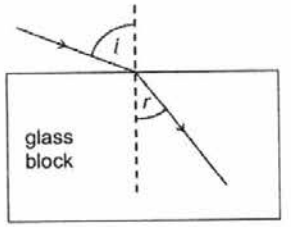
23 A ray of light enters a right-angled glass block normally at X, undergoes total internal reflection at Y and exits at Z.



If the glass block has a refractive index of 1.5, what is the maximum value of α such that light can exit at Y instead?

A 41° **B** 42° **C** 49° **D** 50°

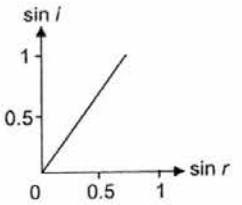
24 A ray of light enters a glass block at an angle of incidence i producing an angle of refraction r in the glass block as shown in the diagram below.



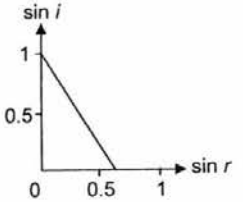
Several different values of i and r are measured, and a graph of sin i against sin r is drawn.

Which graph is correct?

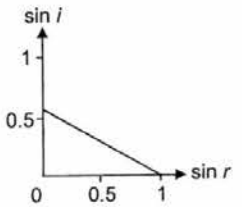
A



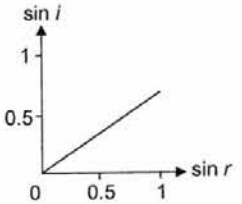
B



C



D

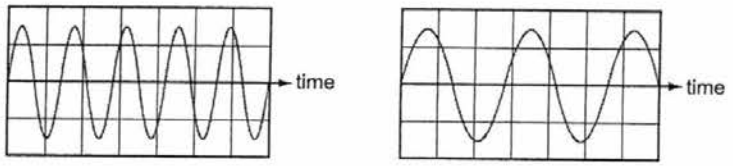


25 Four different notes, produced by a sound machine, are each associated with a different time taken for one oscillation.

Which of the following is the lowest note that is audible to a normal person?

note	A	B	C	D
time taken for one complete oscillation/s	6.7×10^{-2}	5.0×10^{-4}	5.6×10^{-5}	4.0×10^{-5}

26 The diagrams show the waveforms of two different sounds. The scales are the same in each diagram.



sound 1 sound 2

How does sound 2 compare with sound 1, in terms of loudness and pitch?

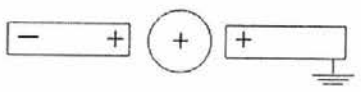
	loudness	pitch
A	equal	equal
B	equal	lower
C	equal	higher
D	lower	higher

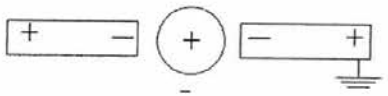
27 Which of the following statements is false?

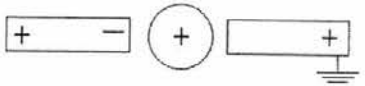
A Gamma rays are used to kill cancer cells.
B X-rays are used to detect bone fractures in patients.
C Infrared radiation is used to sterilize medical equipment.
D Microwaves are used to transmit pay-on-demand television signals.

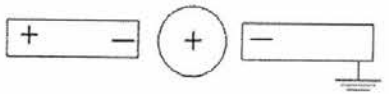
28 A positively charged metal sphere is placed halfway between previously uncharged metal rods, one of which is connected to earth.

Which diagram correctly shows how the charges are arranged in the rods?

A


B


C


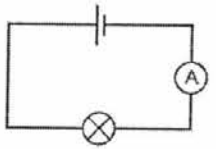
D


29 A 1 m long wire has a cross sectional radius of 1 mm and a resistance of 16 Ω.

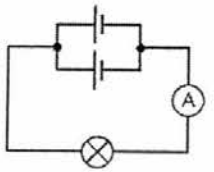
What is the resistance of another wire of the same material which is 4 m long and has a cross sectional radius of 2 mm?

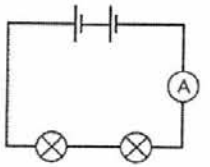
A 4 Ω B 8 Ω C 16 Ω D 32 Ω

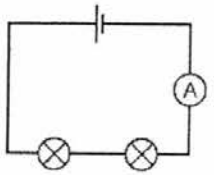
30 A dry cell is connected in series with an ammeter and a lamp. The current flowing in the circuit is 1 A.

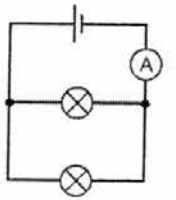


In which circuit is the current reading 2 A, assuming identical dry cells, lamps and ammeters are used?

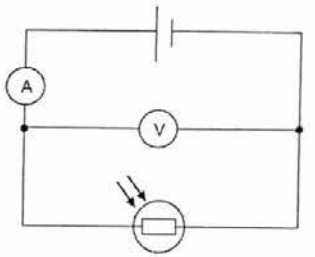
A


B


C


D


31 The diagram below shows a light dependent resistor (LDR) connected in series to an ammeter and a 3.0 V cell. A voltmeter is connected in parallel to the LDR.



Which of the following statements is incorrect?

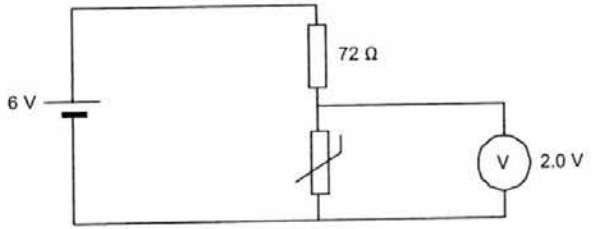
A The electrons in the wire flow in a clockwise direction in the circuit.
B As the light intensity on the LDR increases, the ammeter reading increases.
C Every one coulomb of charge supplied by the cell has 3.0 J of electrical energy.
D As the light intensity on the LDR increases, the voltmeter reading decreases.

Three compasses are placed between two permanent magnets XY and PQ as shown in the diagram below.

Which statement is true?

A PQ is a stronger magnet than XY; Y and P are both N-poles.
B PQ is a stronger magnet than XY; Y and Q are both N-poles.
C XY is a stronger magnet than PQ; Y and P are both N-poles.
D XY is a stronger magnet than PQ; Y and Q are both N-poles.

33 The diagram below shows a thermistor connected in series with a 72 Ω resistor across a 6 V power supply. When the temperature of the thermistor is 20°C, the potential difference across it is 2.0 V.



What is the resistance of the thermistor when the temperature is 20°C?

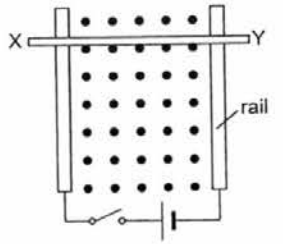
A 36 Ω **B** 48 Ω **C** 108 Ω **D** 144 Ω

34 X and Y are wires carrying electric current at right angles to the page. P, Q and R are plotting compasses. Any effect of the Earth's magnetic field has been ignored.

Which of the following is true about the direction and size of the current of wire X and wire Y?

	direction of current	size of current
A	same	larger in X than in Y
B	same	smaller in X than in Y
C	different	larger in X than in Y
D	different	smaller in X than in Y

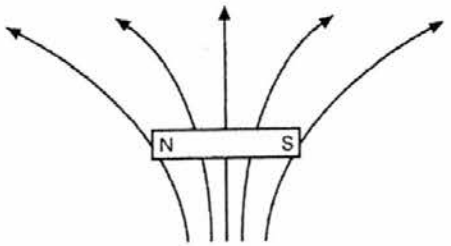
35 A metal rod XY is placed on two smooth horizontal metal rails connected to a direct current supply and a switch. The dots represent a magnetic field pointing out of the paper.



What will happen to the rod XY when the switch is closed?

A It will remain stationary.
B It will move up the paper.
C It will move down the paper.
D It will move down, and then move up the paper.

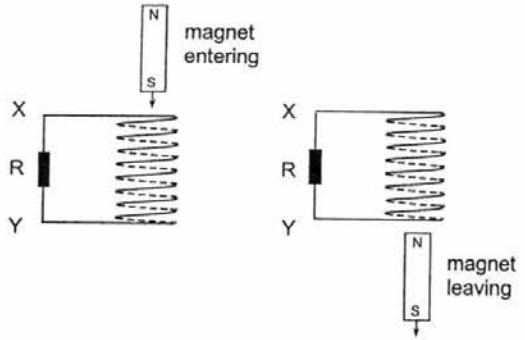
36 The diagram below shows the top view of a magnet suspended in an external magnetic field.



The magnet will

A rotate clockwise.
B rotate anticlockwise.
C move to the left.
D move to the right.

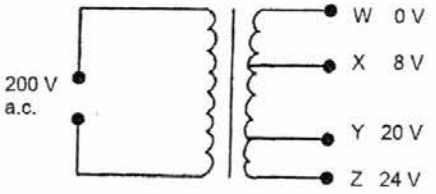
37 The diagrams below show the set-up for which a short bar magnet is dropped through a coil of wire.



Which of the following correctly indicates the direction of the induced current in the load, R?

	magnet entering the coil	magnet leaving the coil
A	X to Y	X to Y
B	X to Y	Y to X
C	Y to X	X to Y
D	Y to X	Y to X

38 A step down transformer below can convert different voltages.

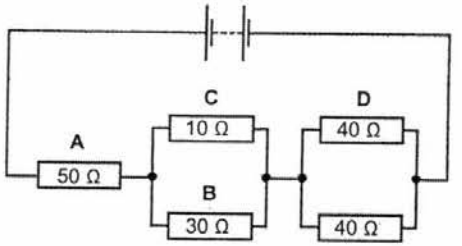


Given that the primary coil of the transformer has 5000 turns, what is the number of turns in the secondary coil between X and Y?

A 200 B 300 C 400 D 500

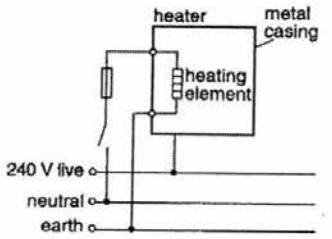
39 The diagram shows a circuit containing five resistors connected to a battery.

In which resistor is the current the smallest?

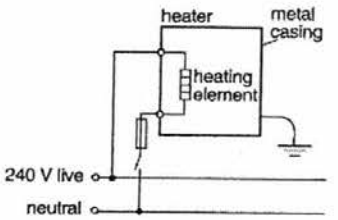


40 Which of the following correctly shows how a water heater should be connected to the mains?

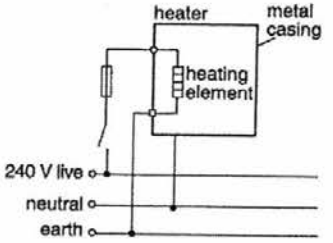
A



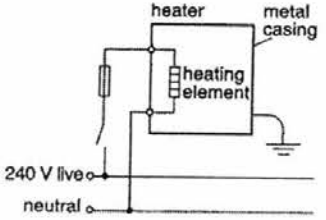
B



C



D



END OF PAPER 1

e	Register Number	Class	Calculator Model

智行菘願

MANJUSRI SECONDARY SCHOOL
文 殊 中 學

PRELIMINARY EXAMINATION 2016

Subject:	Physics (SPA)
Paper:	5059/02
Level:	Secondary 4 Express
Date:	19 Aug 2016
Duration:	1 hour 45 minutes
Setter:	Ms Ada Chen

Additional Materials: Nil

READ THESE INSTRUCTIONS FIRST

Write your Name, Index Number and Class in the space provided at the top of this page.
Write in dark blue or black ink.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, and glue or correction fluid.

Section A

Answer **all** questions.

Section B

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

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.

At the end of examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question of part question.
The total number of marks for this paper is **80**.

For Examiner's Use	
Section A	/50
Section B	/11
	/9
	/1
Total	/8

Section A

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

For Examiner's Use

An acrobat walked on the tight rope from tower A to the other tower B. During the process, she stood stationary for a moment before she continued to move to tower B. The tensions T_1 and T_2 in the rope made 30° and 16° with the horizontal respectively when the acorbat was stationary, as shown in Fig. 1.1. The diagram is not drawn to scale.

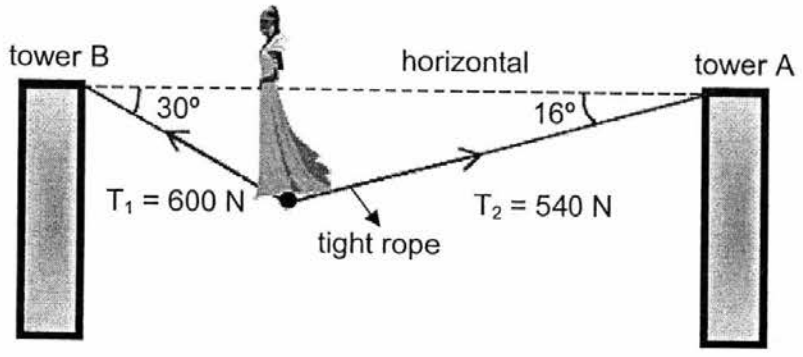


Fig. 1.1

Using a scaled diagram, determine the weight of the acrobat.

weight = ... N [4]

For Examiner's Use

Fig. 2.1 shows a non-uniform bridge of length 42 m and mass 1.6×10^5 kg resting horizontally on two supports P and Q.

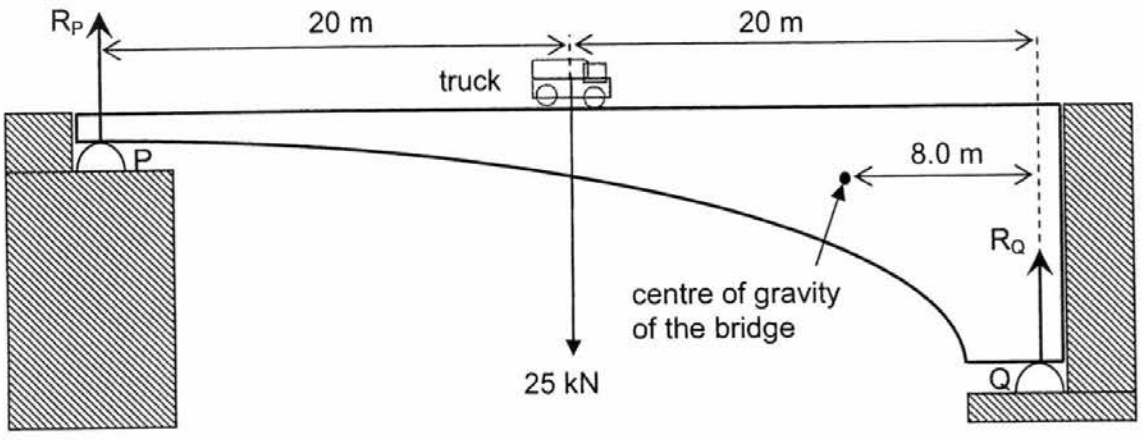


Fig. 2.1

(a) A truck of weight 25 kN stops in the middle of the bridge.

Calculate the reaction force R_p.

R_p = ...N [3]

(b) Hence, calculate reaction force R_Q.

R_Q = ...N [2]

For Examiner's Use

On a hot day, a mirage can be seen on the hot surface of a straight highway. A mirage appears as a shiny surface that looks like water on the road. Fig. 3.1 shows how a mirage is seen on the road surface by an observer.

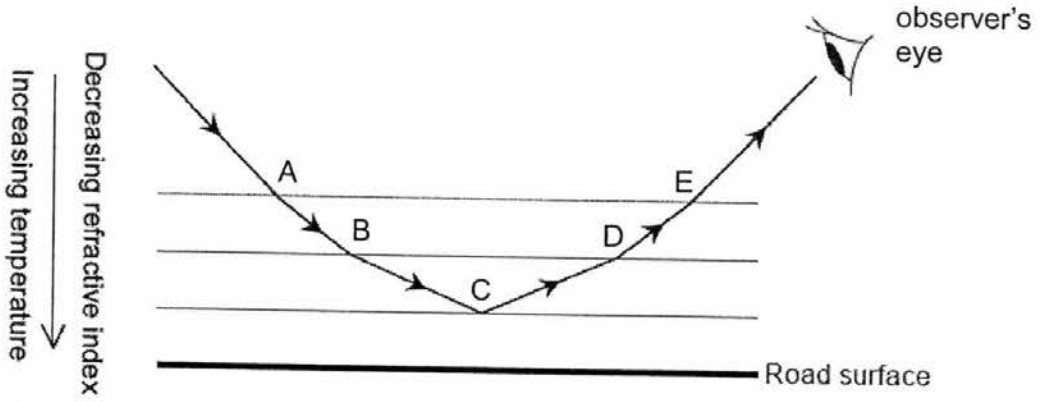


Fig. 3.1

(a) Explain why bending of light occurs at A.

.....

.....

.....

.....[2]

(b) State what happens at C. Explain your answer.

.....

.....

.....

.....

.....[3]

(c) When light from E enters the observer's eye, the observer sees a mirage as a 'puddle of water' on the road surface.

Complete the ray diagram on Fig. 3.1 to show how the observer sees the 'puddle of water'. Mark the position of the 'puddle of water' as I. [1]

For Examiner's Use

A car travels at 15 m/s on a straight road for 8 s. It slows down constantly to 10 m/s in 7 s when it passes a hump. The car then accelerates to 20 m/s in 10 s and continues travelling at this speed for 10 s.

(a) On Fig. 4.1, plot the speed-time graph of the car using the information provided above. [2]

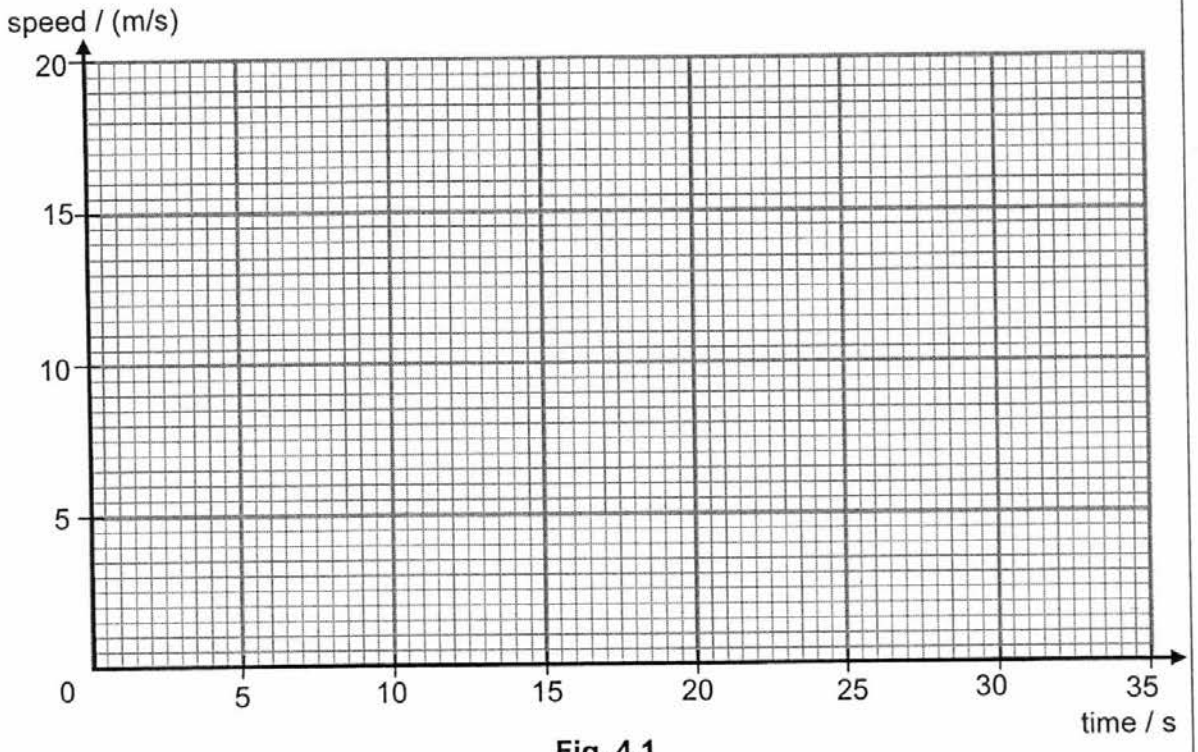


Fig. 4.1

(b) Calculate the deceleration of the car.

deceleration = ... [2]

(c) Calculate the distance travelled by the car when it is accelerating.

distance = ...m [1]

For Examiner's Use

Fig. 5.1 shows a long vertical glass tube with one end immersed in mercury and the other end connected to a vacuum pump at A. The tube fits tightly into a bell jar.

With an opening at B and all air pumped out via A, the mercury rises to a maximum height of 760 mm above the dish.

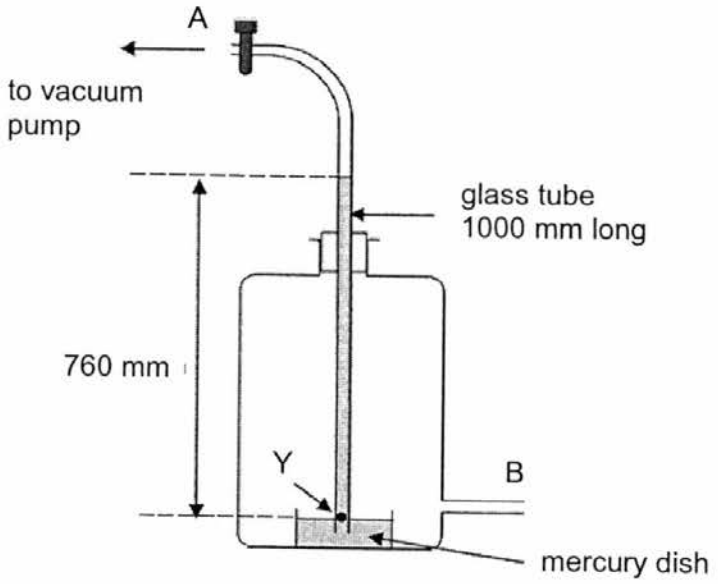


Fig. 5.1

(a) Explain why the mercury can only rise to a maximum height of 760 mm.

.....

.....

.....[1]

(b) The density of mercury is 13600 kg/m^3.

Calculate the pressure at Y in Pa.

pressure = ... Pa [2]

For Examiner's Use

(c) A container of air initially at atmospheric pressure is connected to B and subsequently heated over a flame as shown in Fig. 5.2.

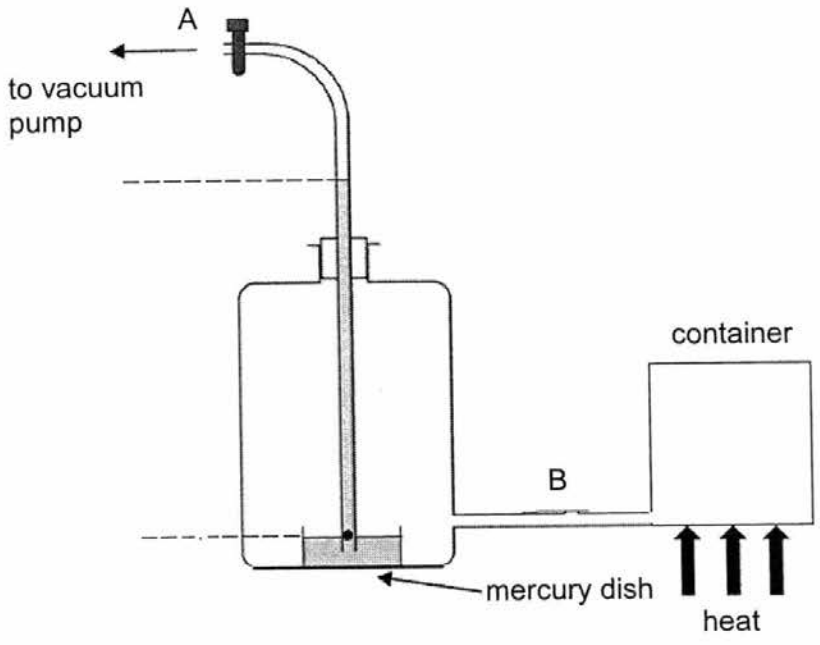


Fig. 5.2

(i) With the opening at A sealed, will the height of mercury column rise, fall or remain the same?

.....[1]

(ii) Explain your answer in **(c)(i)** using concepts on kinetic theory of matter.

.....

.....

.....

.....

.....[3]

In Fig. 6.1, the battery has an electromotive force (e.m.f.) of 24 V.

For Examiner's Use

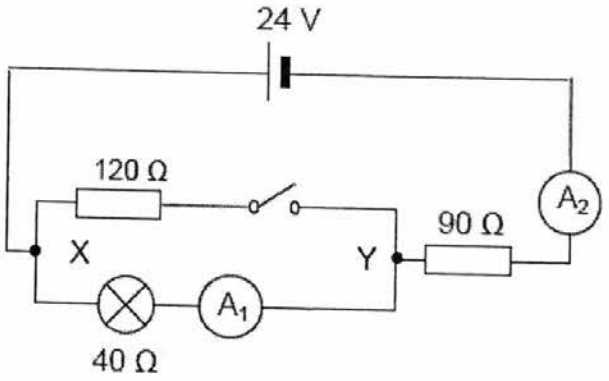


Fig. 6.1

(a) Explain each of the following observations:

(i) when the switch is closed, the current through ammeter A_2 increases.

.....

.....

.....[1]

(ii) when the 120 Ω resistor is replaced with a copper wire, ammeter A_1 reads zero.

.....

.....

.....

.....[2]

(b) Calculate the current readings through A_1 and A_2 when the switch is closed.

current through A_1 = ...A

current through A_2 = ...A [3]

For Examiner's Use

(a) Fig. 7.1 shows a mercury-in-glass thermometer.

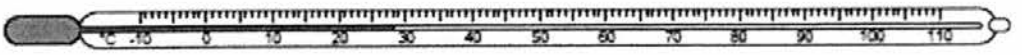


Fig. 7.1

(i) Describe briefly how to calibrate a thermometer.

.....

.....

.....

.....

.....[3]

(ii) Explain what is meant by a 'thermometric property' and hence state the thermometric property used in this thermometer.

.....

.....

.....

.....[2]

(b) Fig. 7.2 shows a copper block of mass 1.8 kg with two holes at the top. A 80 W heater is placed in one hole and a mercury-in-glass thermometer in the other.

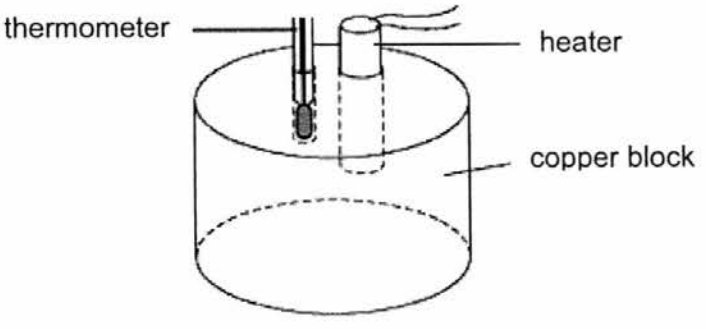


Fig. 7.2

The heater is switched on for 5.0 minutes. Assume that no energy is lost from the block.

(b) (i) Calculate the energy supplied to the block.

For Examiner's Use

energy supplied = ...[2]

(ii) The specific heat capacity of copper is 390 J/(kg °C).

Calculate the rise in temperature of the block.

rise in temperature = ...[2]

For Examiner's Use

Fig 8.1 shows a gymnast, of mass 48 kg, jumping on a trampoline.

Fig. 8.1

The speed-time graph of the gymnast is shown in Fig 8.2. The gymnast started his motion at the maximum height.

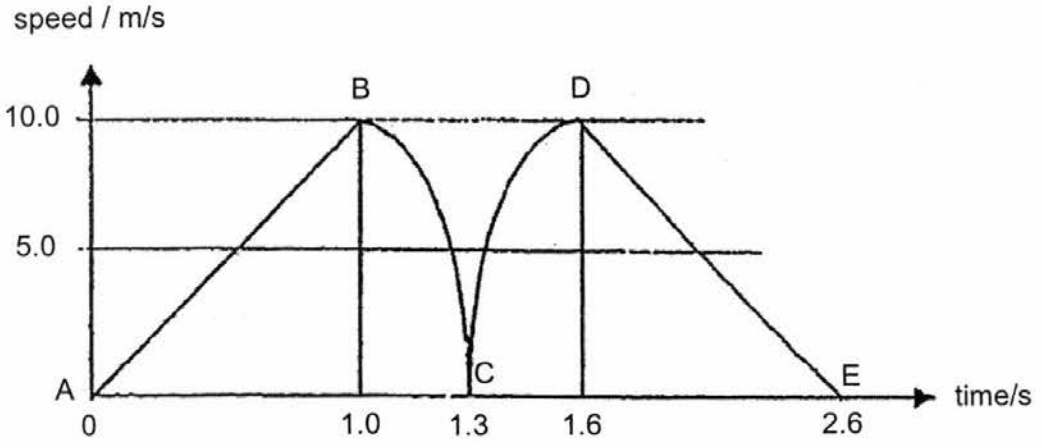


Fig. 8.2

(a) Describe the motion of the gymnast in the first 1.3 s.

.....

.....

.....

.....[2]

(b) Identify a point at which the gymnast possessed maximum gravitational potential energy.

.....[1]

For Examiner's Use

(c) Calculate

(i) the loss in kinetic energy when the gymnast reaches the maximum height,

loss in K.E. = ... [2]

(ii) the maximum height reached by the gymnast.

maximum height = ...m [2]

(d) In reality, the gymnast was only able to reach a maximum height of 4.50 m.

Using the principle of conservation of energy, explain why the maximum height reached by the gymnast is less than the value calculated in **(c)(ii)**.

.....

.....

.....[1]

END OF SECTION A

Section B

Answer **all** the questions in this section.
Answer only one of the two alternative questions in **Question 11**.

For Examiner's Use

The issue of haze generated from forest fire has become a yearly problem for many countries. This is not only an expensive problem but has become a critical health hazard for many who are exposed to its effect. Moreover the generation of greenhouse gases from these fires has caused alarm as it will most likely further contribute to changes in the world's climate and weather pattern. One way in which the regional government has sought to combat this problem of forest fire is through the use of infra-red thermal imaging. Satellites equipped with infra-red sensors are used to detect problem spots. With this information, the local authorities are then mobilised to put out the fire before it spreads and worsens.

Visible light is unable to pass through clouds and haze, but infra-red radiation can. The infra-red (IR) sensors mounted on satellites detect the relative thermal energies emitted by objects like burning trees, fields and streams. With the aid of a signal processor, this information is converted into a coloured coded visual presentation showing regions with varying range of temperature. The IR band is often subdivided into smaller sections, coded as shown in Table 9.1 below.

Section Code	**NIR**	**SWIR**	**MWIR**	**LWIR**	**FIR**
Wavelength/μm	0.75 – 1.4	1.3 – 3	3 – 8	8 – 15	15 – 1000

Table. 9.1

IR radiations that fall into individual sections are assigned colour codes by the signal processor. Forest fires which are normally detected in the range of 3 to 4.5 μm. They fall under the **MWIR** section and may be assigned the colour red. Bodies of water which are cooler, like rivers and waterfall in the range of 10+ μm, fall under the **LWIR** section and may be assigned the colour blue.

As a result, a coloured image of red for hot and blue for cold objects can be constructed and used to detect hot spots.

(a) State the IR section code that has the lowest energy level.

.....[1]

(b) Calculate the range of the IR frequencies for the MWIR section code.

range of the IR frequencies = ...[4]

For Examiner's Use

(c) State the IR section code that is nearest to the electromagnetic spectrum of visible light.

.....[1]

(d) Deduce from the information above, if the method of IR imaging is more useful in detecting exact spots of forest fire compared to a normal coloured photograph taken from a satellite. Explain your answer.

.....

.....

.....

.....[2]

(e) Besides the application above, state one other application of infra-red radiation.

.....[1]

(f) To reduce pollution to the environment, some factories install the setup shown in Fig. 9.2 in their factory chimney. As the gases pass upwards through the wire mesh out of the chimney, the dust particles in the gas acquire a negative charge.

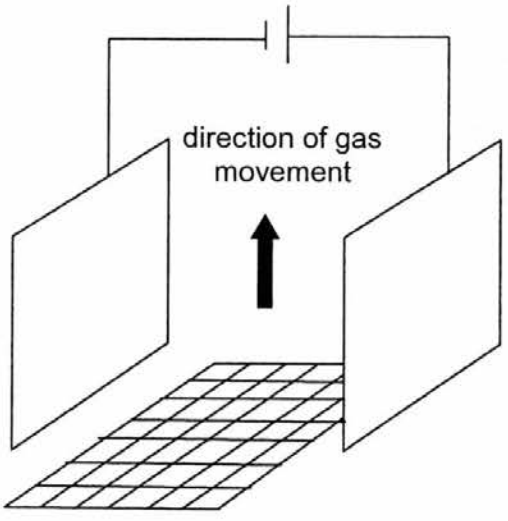


Fig. 9.2

Explain how the setup removes dust particles from the gases.

.....

.....

.....

.....[2]

For Examiner's Use

Ultrasonic waves are emitted by a transmitter to measure the depth of the sea. A receiver is used to detect the reflected waves and the signals are shown on a cathode-ray oscilloscope screen in Fig. 10.1.

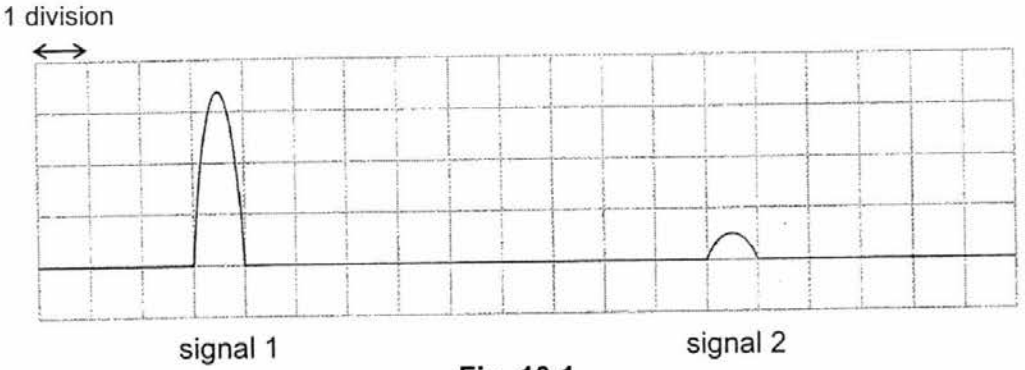


Fig. 10.1

(a) What do the two signals shown on the cathode-ray oscilloscope screen represent?

.....

.....

.....

.....[2]

(b) Explain why signal 2 is much lower than signal 1.

.....

.....

.....

.....[2]

(c) If the speed of ultrasonic waves in seawater is 1400 m/s and the time base of the cathode-ray oscilloscope is set to 0.2 second per division, calculate the depth of the sea.

depth = ...m [2]

For Examiner's Use

(d) Other than measuring depth, suggest one other application of ultrasonic waves.

.....

.....[1]

(e) There is no air on the Moon.

Is it possible to use the same method to determine the depth of a pool of liquid on the Moon? Explain your answer.

.....

.....

.....

.....[2]

For Examiner's Use

EITHER

(a) Fig. 11.1 shows a simplified diagram of a "wind-up" torch that operates without having batteries. The torch uses the energy stored in a wound-up spring to generate the electrical energy that is needed to power the torch bulb.

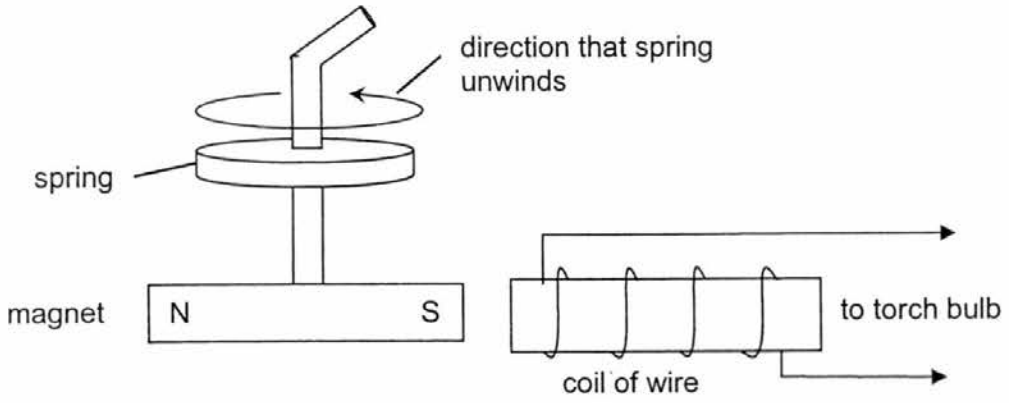


Fig. 11.1

(i) Explain why an electromotive force (e.m.f.) is induced in the coil of wire when the spring unwinds.

.....

.....

.....

.....[2]

(ii) As the spring unwinds, the energy in the spring decreases.

Explain how this affects the brightness of the torch bulb.

.....

.....

.....

.....[2]

For Examiner's Use

(b) Fig. 11.2 shows a transformer X stepping up an alternating current supply. The electrical energy is transmitted through two transmissions wires AC and BD, each having a resistance of 2.0 Ω. The voltage is then stepped down to the normal operating voltage of a 24 W, 12 V lamp by transformer Y which has a turn ratio of 1:10.

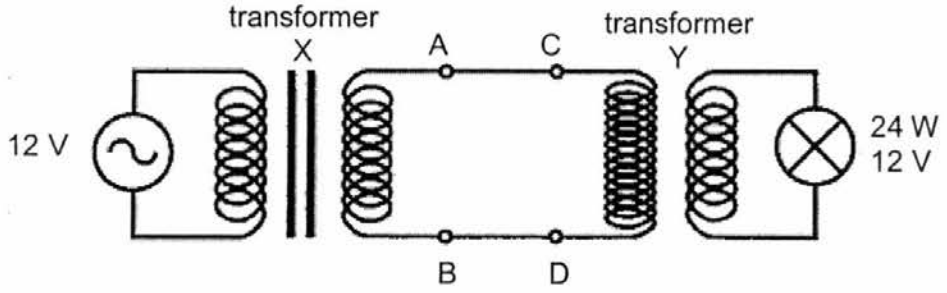


Fig. 11.2

The transformers are 100 % efficient.

Calculate

(i) the voltage across CD,

voltage = ...V [2]

(ii) the current in the transmission wires,

current = ...A [2]

(iii) the power dissipated in the wires,

power = ...W [1]

(iv) the power output by the a.c. supply.

power = ...W [1]

For Examiner's Use

OR

(a) Fig. 11.1 shows a type of electric motor where coil PQRS is connected to a battery and is placed between two solenoids AB and CD which are connected to a separate d.c. power supply.

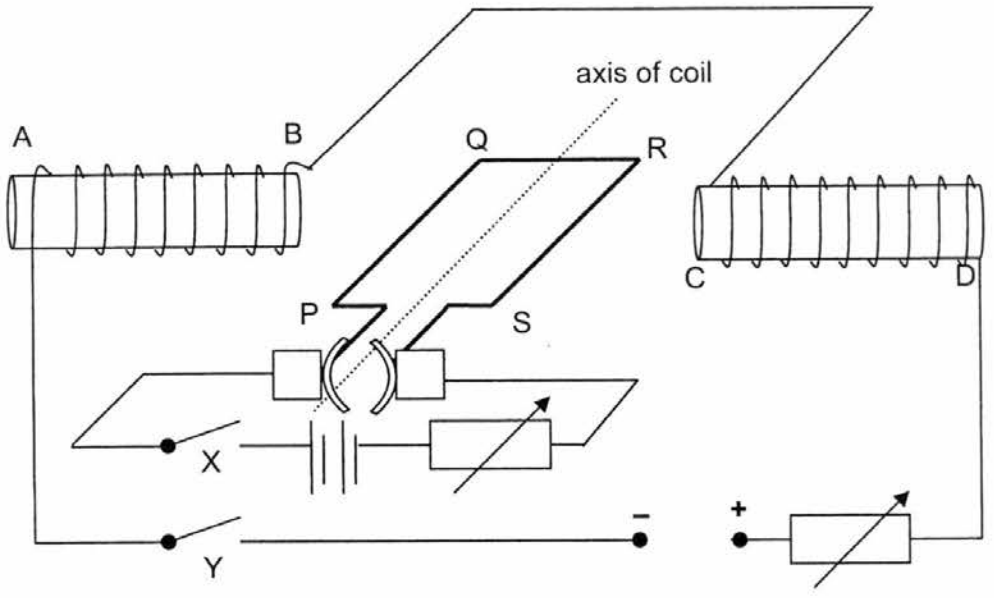


Fig. 11.1

(i) On Fig. 11.1, draw arrows to indicate the direction of force experienced by sides PQ and RS of the coil when both switches X and Y are closed. [2]

(ii) State the direction of rotation of coil PQRS and explain how the forces that you have shown in **(a)(i)** result in the rotation of coil PQRS.

.....

.....

.....

.....

.....[2]

(iii) Explain briefly the effect on the movement of coil PQRS when the d.c. power supply connected to solenoids AB and CD is replaced by an a.c. power supply.

.....

.....

.....[1]

For Examiner's Use

(b) Fig. 11.2 shows a cathode-ray oscilloscope (c.r.o.) being used to measure the frequency and peak voltage of an a.c. supply.

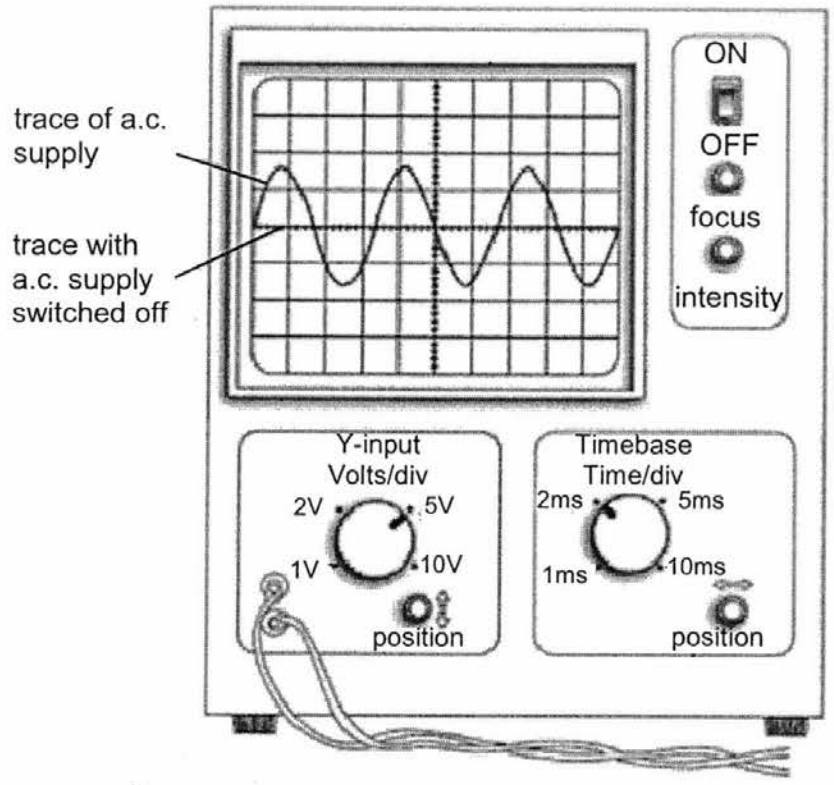


Fig. 11.2

(i) By noting the Y-input and timebase settings in Fig. 11.2,

estimate the peak voltage of the a.c. supply, V_p = ...V [1]

calculate the period of the a.c. supply. T = ...ms [1]

(ii) Calculate the frequency of the a.c. supply.

frequency = ...[1]

(iii) Explain why it would not be possible to measure the frequency of an a.c. supply of frequency 15 Hz using the c.r.o. on the settings shown in Fig 11.2.

.....[1]

(iv) Suggest a setting for the time-base (1 ms, 2 ms, 5 ms or 10 ms) of the c.r.o. which could be used when measuring the frequency of a 15 Hz a.c. supply.

.....[1]

END OF PAPER

orrect scale 1 cm : 50 N [1]
ect orientation of vectors [1] with labelling [1]
ght = 430 to 470 N [1]

2.

3a $W = mg = = 1.6 \times 10^5 \times 10 = 1.6 \times 10^6$ N A1

3b Taking moments about Q,

$25\,000 \times 20 + 1\,600\,000 \times 8.0 = R_P \times 40$ C1

R_P = 332 500 N ($\approx$333 kN or 330 kN) A1

3c Total upward force = total downward force

$R_P + R_Q$ = 25 000 + 1 600 000 C1

R_Q = 1 292 500 N ($\approx 1.29 \times 10^6$ N or 1.3×10^6 N) A1

Or Taking moments about P,

$25\,000 \times 20 + 1\,600\,000 \times 32 = R_Q \times 40$

R_Q = 1 292 500 N ($\approx 1.29 \times 10^6$ N or 1.3×10^6 N)

3. 4 (a) As light travels from an optically denser to an optically less dense medium, speed of light increases and bends away from the normal.

[B1]

[B1]

(b) At C, total internal reflection occurs.

Light is travelling from an optically denser to an optically less dense medium and its angle of incidence is greater than its critical angle.

[B1]

[B1]

[B1]

(c) Extend in a straight line from E. Line must be drawn in dotted line.

Position of the image marked as I. (image is virtual)

[B1]

4. (a)As the distance to the hinge is longer,

less force would be needed to apply the same turning effect.

(b)(i) Taking moments about the hinge H

Clockwise moments = Anticlockwise moments

$F \times 0.03 = 4.0\ (0.14)$

$F = 18.6667$ N = 18.7 N

(b)(ii) The ratio of force applied to force on nut is

tio of the respective distances from the pivot. (dapplied / dnut)-1 = 0.214.

) The force on the left handle serves to keep the nutcracker stationary as the force

the right handle pushes against the nut.

5. 4) a) The air in the jar exerts atmospheric pressure on the mercury and is only able to support the weight of 76 cm of mercury in the column.

b) P = hpg = (0.76)(136000(10) = 103360 Pa ≈1.03 x 105 Pa

c) (i)The mercury column will rise to more than 76 cm.

(ii)When gas is heated, air molecules gain kinetic energy and move around faster. Air molecules collide into the surface of mercury pool more frequently and with a larger force. The force per unit area on the pool increases and hence pressure increases.

6.

6ai	Total resistance in the circuit decreased, causing total current flowing to increase	B1
	→ A_2 has a higher reading	B1
	PD across 40Ω resistor decreased, by Ohm's Law, current decreases as well → A_1 has a lower reading	
6aii	Copper wire forms a short circuit, as the copper wire provides a path of low resistance for the current to flow.	B1
	No current flows through the 40Ω resistor	B1
6b	Total Resistance = $(1/120 + 1/40)^{-1} + 90$	M1
	= 120 Ω	A1
	V = IR	
	$24 = I_2(120)$	
	I2 = 0.20 A	
	I1 = 120/160 x 0.2	
	= 0.15 A	

7.

(i) Describe briefly how to calibrate a thermometer.

Insert the thermometer into pure melting ice, and in steam above pure boiling water separately (at standard P_{atm}). ***[1]***

Make markings on the thermometer to mark the lower and upper fixed points (or ice and steam points respectively). ***[1]***

Divide the length between the two points into 100 equal parts (to correspond to 1 °C per division). ***[1]***

(ii) State how you know that the scale of the thermometer in Fig. 10.1 is linear.

The distance between each division is equal.

OR: Each equal division is 1 °C. [1]

(iii) Explain what is meant by a 'thermometric property' and hence state the thermometric property used in this thermometer.

A 'thermometric property' is the physical property of a

substance that changes continuously with temperature. ***[1]***

The thermometric property used is the volume of a fixed mass of liquid (mercury). ***[1]***

[2]

(i) Calculate the energy supplied to the block.

$P = \frac{Q}{t}$

$Q = Pt$ ***[1]***

$= (80)(5 \times 60)$

$= 24\,000$

$= \underline{2.4 \times 10^4\ J}$ *(2 s.f.)* ***[1]***

energy supplied = _____ [2]

(ii) The specific heat capacity of copper is 390 J/(kg °C). Calculate the rise in temperature of the block.

$Q = mc\Delta\theta$

$24\,000 = (1.8)(390)\Delta\theta$ ***[1]***

$\Delta\theta = 34.2$

$= \underline{34\ ℃}$ *(2 s.f.)* ***[1]***

8. 2a Energy cannot be created nor destroyed but it can be converted from one form to another.
1
2b Point E 1
2c $E_k = ½\ m\ v_2 = ½ \times 48 \times 10_2$ 1
= 2400 J 1
2d $E_k = E_p$
2400 = 48 x 10 x h 1
H = 5.00 m 1
(alt) can also find area of triangle from D to E.
2e Work is done against air resistance. 1
If we find the sum of potential energy, kinetic energy and work done against air resistance, total energy is conserved.
1
3ai

9.

11	**(a)**	(i)	Rate of consumption = (Mass of external tank at launch - Mass of empty tank) ÷ (Time taken) $= (7.52 \times 10^5 - 2.95 \times 10^4) \div 8.5 = 85\,000$ kg/min = $\underline{8.5 \times 10^4\ \text{kg/min}}$

		(ii)	Fuel used up after 2 min = Rate of fuel consumption × Time taken $= 85\,000 \times 2 = 170\,000$ kg Mass of external tank 2 min after take-off $= 7.52 \times 10^5 - 170\,000 = 582\,000 = \underline{5.82 \times 10^5 \text{ kg}}$	1 1
		(iii)	Total mass of shuttle and external tank $= 1.05 \times 10^5 + 5.82 \times 10^5 = 6.87 \times 10^5$ kg Total weight, $W = mg = (6.87 \times 10^5)(10) = \underline{6.87 \times 10^6 \text{ N}}$	1 1
	(b)	(i)	Fuel is used during the 2 minutes to provide the thrust. So total mass, m, of the space shuttle is decreasing with time. As thrust, F provided by the main engines is constant (since F = ma), if m is decreasing, acceleration a will be increasing.	1 1
		(ii)	Total thrust = $(1.75 \times 10^5) \times 3 = \underline{5.25 \times 10^6 \text{ N}}$	1
		(iii)	Between t = 2 min & t = 3.5 min, total thrust of 5.25×10^6 N is less than the total weight of 6.87×10^6 N. Hence the resultant force acting on the space shuttle is negative and acceleration is also negative (since F = ma).	1
	(c)	From graph: Acceleration, a at 2 min after take-off = 35 m s^{-2} (whole no.) Resultant F = ma = $(6.87 \times 10^5) \times 35 = 2.40 \times 10^7 = \underline{2.4 \times 10^7 \text{ N}}$ (2 s.f.)		1 1

10.

a) The first pulse represents the signal that is sent out by the transmitter. [1]

The second pulse represents the signal after the emitted pulse is reflected off the bottom of the sea. [1]

b) Once the ultrasonic wave is emitted by the transmitter, the wave disperses from the source. Only a fraction of the emitted wave is reflected back to the receiver. [1]

Energy is lost to the surroundings when the ultrasonic wave travels through the seawater. [1]

c) Time taken for the ultrasonic wave to travel from the transmitter to the seabed
= (10 divisions x 0.2) / 2
= 1.0 s [1]

Depth = vt = 1400 x 1.0 = 1400 m [1]

d) Ultrasonic waves is also used in pre-natal scanning to check on the growth of the foetus. [1]

Ultrasound is also used in quality control during manufacturing processes to detect flaws. [1]

e) Yes, it is possible to use the same method on the Moon.

Ultrasound can travel through a liquid to determine the depth. [1]

The liquid is the only medium required. Air is not needed at all. [1]

12 **EITHER**

12ai As the spring unwinds, it causes the magnet to rotate. B1

The rotating magnet causes a change in magnetic flux linking the coil of wire which causes an induced emf to be produced. B1

12aii As the force in the spring decreases, the magnet will rotate slower. B½

Since the magnetic flux linking the coil is changing more slowly, B½

the induced emf will be smaller and the torch would be less bright. B1

12bi $\frac{V_p}{V_s} = \frac{N_p}{N_s}$

$\frac{V_p}{12} = \frac{10}{1}$ M1

$V_p = 120$ V A1

12bii $V_p I_p = V_s I_s$

$120 I_p = 24$ M1

$I_p = 24/120 = 0.20$ A A1

12biii $P = I^2R = 0.2^2 \times 4 = 0.16$ W A1

12biv 24 W + 0.16 W = 24.2 W (3 sf) A1

OR

ai Downward force on PQ and upward force on RS. A2

Both forces must be drawn perpendicular to PQ and RS respectively.

12aii The downward force on PQ and the upward force on RS produce anti-clockwise moments about the axis of the coil, B1

causing the coil PQRS to rotate in an anti-clockwise direction. B1

12aiii PQRS will only rotate anticlockwise for a while when current in circuit is as shown above.

When direction of current in AB and CD is reversed, PQRS would rotate back to its original position. B1

12bi **1.** $5 \times 1.6 = 8$ V A1

Accept answers in the range of 7.5 to 8.5 V

2. 1.5 cycles take 5 x 2 = 10 ms

1 cycle takes 10 ÷ 1.5 = 6.67 ms A1

12bii $f = 1/T$

$= 1/0.00667 = 150$ Hz A1

12biii A 15 Hz wave has a much longer period for one wave and the screen could not display one complete wave. B1

12biv 10 ms/div A1

The Senoko power station in Singapore contains a Combined Cycle Plant to generate electricity. Natural gas is burnt in a combustion chamber and the hot gases produced are used to drive four gas turbines connected to electrical generators. The exhaust gases from the four gas turbines are passed through a Heat Recovery Steam Generator, where thermal energy is used to produce steam at high pressure. Each second, 70 kg of steam is output from the Heat Recovery Steam Generator.

This steam is passed into two steam turbines which are also connected to electrical generators.

This multi-stage process ensures that 42% of the total energy in the natural gas is converted into electrical energy. When the Heat Recovery Steam Generator and steam turbines are used, the total electrical power output of the plant increases without burning more natural gas.

Details of the gas and steam turbines are given and a simplified diagram of the Heat Recovery Steam Generator is shown in Fig. 9.1.

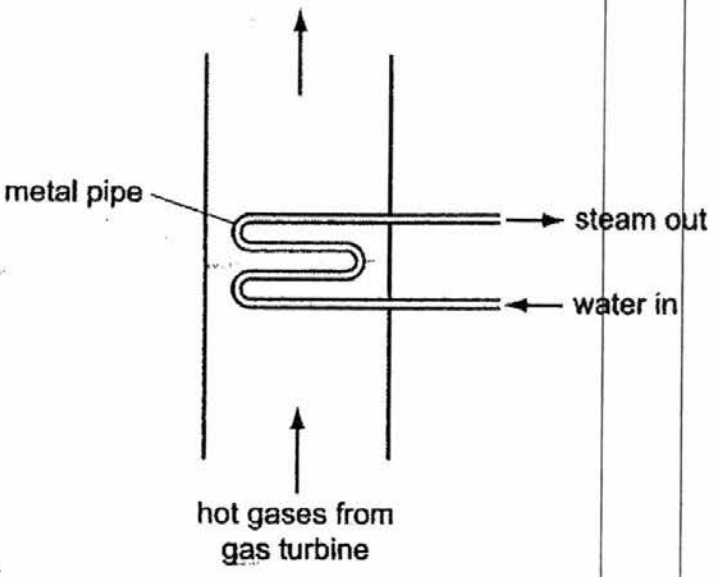


Fig. 9.1

Gas turbines
gas input temperature is 1050°C
gas output temperature is 550°C
electrical output from the generator connected to each turbine is 130 MW

Steam turbines
electrical output from the generator connected to each turbine is 160 MW

(a) Explain why the addition of the Heat Recovery Steam Generator and the steam turbines allows more electrical power to be generated without burning more natural gas.

This is because less thermal energy is wasted/ thermal energy recycled/reused. [1]
The hot exhaust gases coming out from the gas turbines contain thermal energy which is used to produce steam at high pressure. [1]

(b) Describe how energy is transferred from the hot gases to the water in the Heat Recovery Steam Generator.

The thermal energy is transferred from the hot gases to the water in the Heat Recovery Steam Generator by conduction because the metal pipe is a good thermal conductor. [1]

The particles in contact with the hot exhaust gases gain energy and vibrate faster and collide with their less energetic neighbours. In this way the thermal energy is transferred from the hot exhaust gases to the pipe and then to the water in the pipe. [1] [2]

(c) Explain, in terms of molecular behaviour,

(i) how the internal energy of the gas decreases as it passes through the gas turbine,

The molecules move slower / decrease in the KE of molecules. [1] [1]

(ii) why energy is needed to produce steam in the Heat Recovery Steam Generator.

Energy is needed to increase the speed or kinetic energy of the water molecules. [1]
Energy is needed to break the intermolecular bonds in the liquid state. [1] [2]

(d) The specific latent heat of vaporisation of water is 2.3×10^6 J/kg.
Calculate

(i) the thermal energy required to produce the mass of steam output each second from the Heat Recovery Steam Generator,

$Q = ml = 70 \times 2.3 \times 10^6 = 1.61 \times 10^8$ J [1]

energy per second = ... [1]

(ii) the total electrical power output from the Combined Cycle Plant comprising four gas turbines and two steam turbines,

Power = $(130 \times 4) + (160 \times 2) = 520 + 320 = 840$ MW [1]

power output = ... [1]

(iii) the total power input of natural gas into the plant.

$42\ \% \times P_{in} = 840\ MW$

$P_{in} = (100 / 42) \times 8.40 \times 10^{8}$

$= 2.0 \times 10^{9}\ W$ [1]

power input = ... [1]

ıe	Register Number	Class	Calculator Model
Marking Scheme			

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MANJUSRI SECONDARY SCHOOL
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PRELIMINARY EXAMINATION 2016

Subject:	Physics (SPA)
Paper:	5059/01
Level:	Secondary 4 Express
Date:	19 Aug 2016
Duration:	1 hour
Setter:	Ms Ada Chen

Additional Materials: Optical Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your Name, Register Number and Class in the spaces at the top of this page.
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.

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 Optical 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 on this paper.
The use of an approved scientific calculator is expected, where appropriate.

For Examiner's Use
4(

16 MJR Prelim
59 Physics (SPA)
per 1

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

ıme	Register Number	Class	Calculator Model
Marking Scheme			

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MANJUSRI SECONDARY SCHOOL
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PRELIMINARY EXAMINATION 2016

Subject:	Physics (SPA)
Paper:	5059/02
Level:	Secondary 4 Express
Date:	19 Aug 2016
Duration:	1 hour 45 minutes
Setter:	Ms Ada Chen

Additional Materials: Nil

READ THESE INSTRUCTIONS FIRST
Write in dark blue or black pen on both sides of the paper.
The use of a scientific calculator is expected, where appropriate.
You may use a soft pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, and glue or correction fluid.

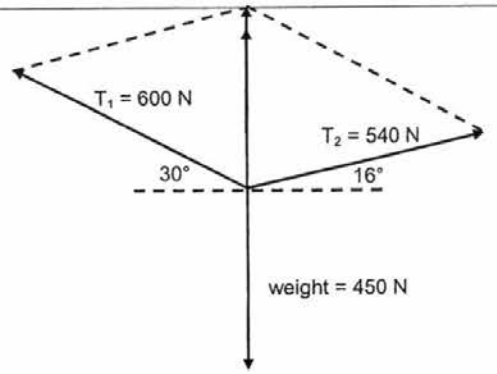
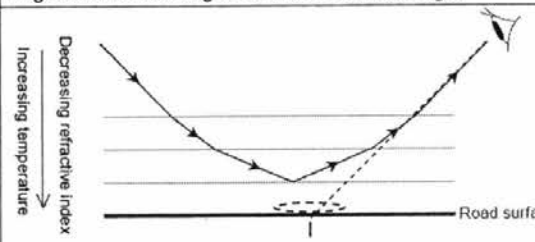
Section A
Answer **all** questions.

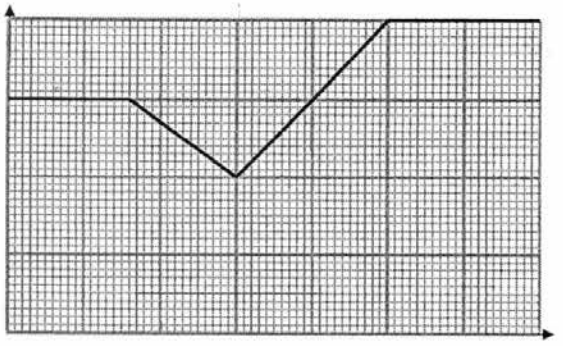
Section B
Answer **all** questions. Question **11** has a choice of parts to answer.

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.
At the end of examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question of part question.
The total number of marks for this paper is **80**.

For Examiner's Use	
Section A	50
Section B	11
	9
	10
Total	80

Section A

1		
	correct scale 1 cm : 60 N	1
	correct orientation of vectors	1
	with labelling	1
	weight = 430 to 470 N (weight = 449 N using sine rule)	1
2a	$W = mg = 1.6 \times 10^5 \times 10 = 1.6 \times 10^6$ N	1
	Taking moments about Q,	
	$25\,000 \times 20 + 1\,600\,000 \times 8.0 = R_p \times 40$	1
	$R_p = 332\,500$ N	1
2b	Total upward force = total downward force	
	$R_p + R_Q = 25\,000 + 1\,600\,000$	1
	speed / (m/s) $R_Q = 1\,292\,500$ N	
	$R_Q = 1.29 \times 10^6$ N	1
	OR	
	taking moments about P,	
	$25\,000 \times 20 + 1.6 \times 10^5 \times 10 \times 32 = R_Q \times 40$	
	$R_Q = 1\,292\,500$ N	
	$R_Q = 1.29 \times 10^6$ N	
3a	As light travels from an optically denser to an optically less dense medium,	1
	the speed of light increases and bends away from the normal.	1
3b	At C, total internal reflection occurs.	1
	Light is travelling from an optically denser to an optically less dense medium and its	1
	angle of incidence is greater than its critical angle.	1
3c		
	Extend in a straight dotted line from E.	
	Position of the image marked as I. The image is virtual and drawn in dotted lines.	1

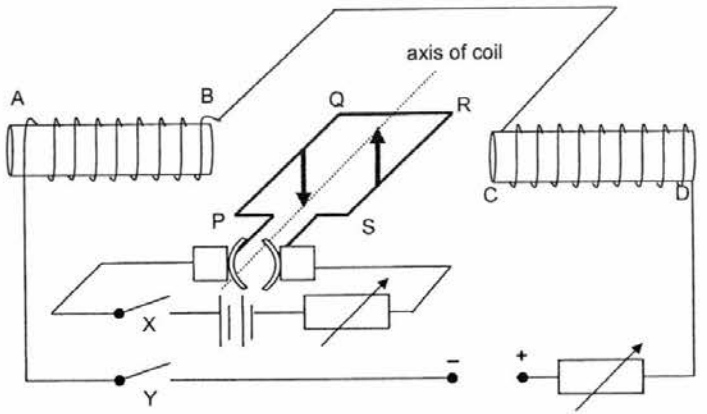
4a		
	Points plotted correctly. Correct line and slope of graph.	1 1
4b	Deceleration = (15 – 10) / 7 = 0.714 m/s^2	1 1
4c	Distance travelled = ½ (10 + 20) (10) = 150 m	1
5a	The air in the jar exerts atmospheric pressure on the mercury and is only able to support the weight of 760 mm of mercury in the column.	1
5b	pressure = pgh = (13600)(10)(0.76) = 103360 Pa = 1.03 x 10^5 Pa	1 1
5c	(i) The mercury column will rise to more than 760 mm.	1
	(ii) When gas is heated, air molecules gain kinetic energy and move around faster. Air molecules collide into the surface of mercury pool more frequently and with a larger force. The force per unit area on the pool increases and hence pressure increases.	1 1 1
6a	(i) Total resistance in the circuit decreased, causing total current flowing to increase, thus ammeter A2 has a higher reading.	1
	(ii) Copper wire forms a short circuit, as the copper wire provides a path of low resistance for the current to flow. No current flows through the 40Ω resistor	1 1
6b	Total Resistance = $(1/120 + 1/40)^{-1}$ + 90 = 120 Ω V = IR 24 = I2(120) I_2 = 0.20 A I_1 = 120/160 x 0.2 = 0.15 A	1 1 1
7a	(i) Insert the thermometer into pure melting ice to mark the lower fixed point (or ice point) and in steam above pure boiling water (at standard pressure) to mark the upper fixed points (or steam points). Divide the length between the two points into 100 equal parts to correspond to 1 °C per division.	1 1 1
	(ii) A 'thermometric property' is the physical property of a substance that changes	

	continuously with temperature. The thermometric property used is the volume of a fixed mass of liquid (mercury).	1 1
7b	(i) Q = Pt = (80)(5 × 60) = 24 000 = 2.4 × 10^4 J	 1 1
	(ii) Q = mcΔθ 24 000 = (1.8)(390)Δθ Δθ = 34.2 °C	 1 1
8a	At the maximum height, the gymnast accelerates constantly at 10m/s^2 from t=0s to t=1.0s. From t=1.0s to t=1.3s, the gymnast decelerates at an increasing rate.	 1 1
8b	A or E.	1
8c	(i) Loss in K.E. = ½ m v^2 = ½ x 48 x 10^2 = 2400 J	 1 1
	(ii) Loss in K.E. = gain in GPE 2400 = 48 x 10 x h h = 5.00 m	 1 1
8d	Work is done against air resistance.If we find the sum of potential energy, kinetic energy and work done against air resistance, total energy is conserved.	1

Section B

9a	FIR (since longest wavelength = lower frequency = less energy)	1
9b	For 3 μm, f = 3.0 x 108 / 3.0 x 10-6 = 1.0 x 1014 Hz For 8 μm, f = 3.0 x 108 / 8.0 x 10-6 = 3.75 x 1013 Hz Range: 3.75 x 1013 Hz to 1.0 x 1014 Hz	1 1 1
9c	NIR	1
9d	An IR image is more useful than a photograph. If clouds or haze is present, they will block out the spots which are on fire, rendering a photograph useless.	1 1
9e	Heat treatment for illnesses or check for diseased crops or intruder alarm or remote control or thermograph	1
9f	As the negatively charged dust particles pass through the two plates, they will be attracted to the positively charged plate and repelled by the negatively charged plate, since unlike charges attract and like charges repel. Note: answer is still acceptable if only "unlike charges attract" or "like charges repel" is	

	provided (1m is awarded only)	
a	The first pulse represents the signal that is sent out by the transmitter. The second pulse represents the signal after the emitted pulse is reflected off the bottom of the sea.	1 1
10b	Once the ultrasonic wave is emitted by the transmitter, the wave disperses from the source. Only a fraction of the emitted wave is reflected back to the receiver. Energy is lost to the surroundings when the ultrasonic wave travels through the seawater.	1 1
10c	Time taken for the ultrasonic wave to travel from the transmitter to the seabed = (10 divisions x 0.2) / 2 = 1.0 s Depth = vt = 1400 x 1.0 = 1400 m	1 1
10d	Ultrasonic wave is also used in pre-natal scanning to check on the growth of the foetus. OR Ultrasound wave is also used in quality control during manufacturing processes to detect flaws.	1
10e	Yes, it is possible to use the same method on the Moon. Ultrasound can travel through a liquid to determine the depth. (The liquid is the only medium required. Air is not needed at all.)	1 1
	EITHER	
11a	(i) As the spring unwinds, it causes the magnet to rotate. The rotating magnet causes a change in magnetic flux linking the coil of wire which causes an induced emf to be produced.	1 1
	(ii) As the force in the spring decreases, the magnet will rotate slower. Since the magnetic flux linking the coil is changing more slowly, the induced emf will be smaller and the torch would be less bright.	1 1
11b	(i) $\frac{V_p}{V_s} = \frac{N_p}{N_s}$ $\frac{V_p}{12} = \frac{10}{1}$ Vp =120 V	1 1
	(ii) $V_pI_p = V_sI_s$ $120I_p = 24$ $I_p = 24/120$ = 0.20 A	1 1
	(iii) $P = I^2R$ $= 0.2^2 \times 4$ = 0.16 W	1
	(iv) 24 W + 0.16 W = 24.2 W	1

	OR	
11a	 (i) Downward force on PQ and upward force on RS. Both forces must be drawn perpendicular to PQ and RS respectively.	1 1
	(ii) The coil PQRS to rotate in an anti-clockwise direction. The downward force on PQ and the upward force on RS produce anti-clockwise moments about the axis of the coil.	1 1
	(iii) PQRS will only rotate anticlockwise first, when direction of current in AB and CD is reversed, PQRS would rotate back to its original position.	1
11b	(i) $V_p = 5 \times 1.6 = 8$ V Accept answers in the range of 7.5 to 8.5 V. 1.5 cycles take 5 x 2 = 10 ms T= 10 ÷ 1.5 = 6.67 ms	1 1
	(ii) f = 1/T = 1/0.00667 = 150 Hz	1
	(iii) A 15 Hz wave has a much longer period for one wave and the screen could not display one complete wave.	1
	(iv) 10 ms/div	1