Cambridge O Level

Cambridge Assessment International Education
Cambridge Ordinary Level

CANDIDATE NAME

CENTRE NUMBER | CANDIDATE NUMBER

0895750181

PHYSICS **5054/22**

Paper 2 Theory Practice **1 hour 45 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use an HB pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

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

Section B
Answer any **two** questions.
Write your answers in the spaces provided on the Question Paper.

Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.

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

Section A

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

1 Fig. 1.1 shows a satellite travelling at a constant speed in a circular orbit around the Earth.

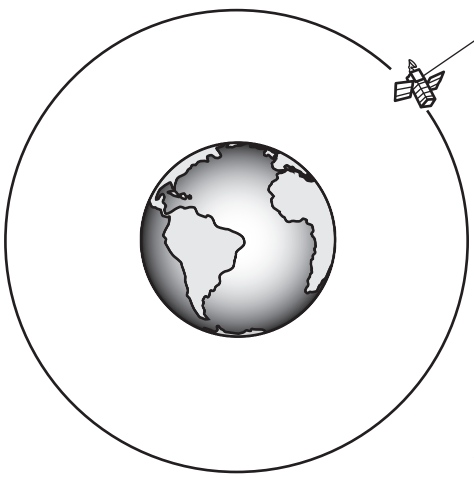

Fig. 1.1 (not to scale)

(a) State how *speed* differs from *velocity*.

....

.... [1]

(b) As it orbits the Earth, the satellite is experiencing an acceleration.

(i) Explain, in terms of its velocity, why the satellite is accelerating.

....

....

.... [2]

(ii) On Fig. 1.1, draw an arrow, starting on the satellite, to show the direction of the satellite's acceleration. [1]

(c) As the satellite orbits the Earth, it experiences a force due to gravitational attraction.

State and explain whether this force does work on the satellite and state whether the energy of the satellite is affected.

....

....

....

.... [2]

Total [6]

2 Fig. 2.1 shows a weight of 4.0 N attached to a spring.

Fig. 2.1

The unstretched length of the spring is 8.0 cm. With the 4.0 N weight attached to the spring, the length is 14.0 cm. The spring is within its limit of proportionality.

(a) State what is meant by the *limit of proportionality* of a spring.

....

....

.... [1]

(b) The 4.0 N weight is replaced with a 2.0 N weight. Calculate the new length of the spring.

new length = ... [2]

(c) Describe how the apparatus in Fig. 2.1 is used to obtain readings to plot an extension-load graph.

....

....

....

.... [2]

Total [5]

3 Fig. 3.1 shows a metal coffee cup on a metal warming plate.

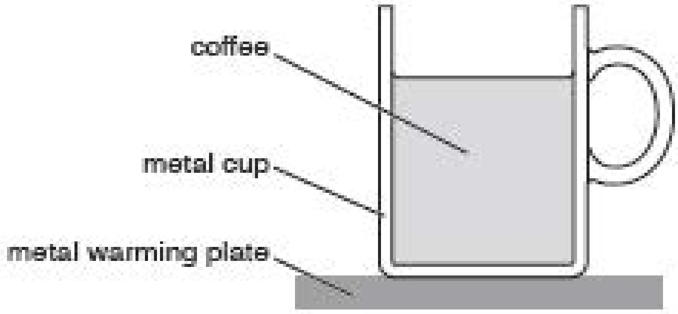

Fig. 3.1

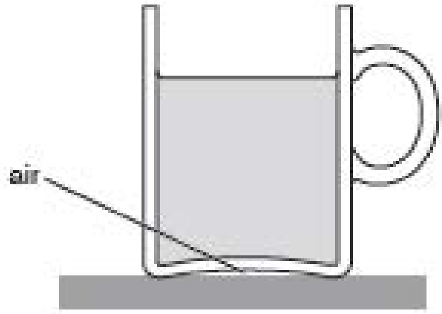

Fig. 3.2

There is a small electrical heater inside the warming plate that keeps the plate hotter than the coffee.

(a) Describe how heat is transferred through the metal and then to all of the liquid in the cup.

....

....

....

....

....

....

....[3]

(b) A cup of a different shape is placed on the same heater, as shown in Fig. 3.2. The two cups are made of the same metal and contain the same amount of coffee.

Explain why the coffee in the cup in Fig. 3.2 is not kept as warm as the coffee in the cup in Fig. 3.1.

....

....[1]

(c) The outside surface of the cup can be either black or white and can be either dull or shiny.

(i) Underline which colour and which type of surface is best to keep the coffee warm.

black white dull shiny [1]

(ii) Explain your answer to (c)(i).

....

....

[1]

Total [6]

4 Fig. 4.1 shows a screwdriver of mass 64 g resting in equilibrium on a pivot.

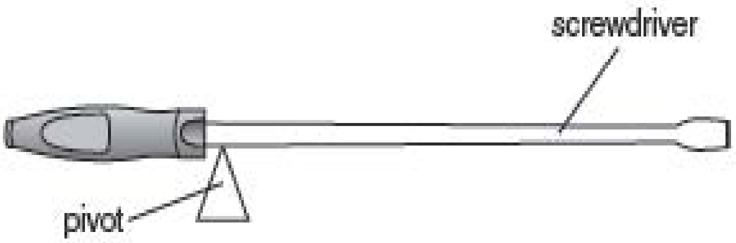

Fig. 4.1

(a) On Fig. 4.1, mark and label with a C, the centre of mass of the screwdriver. [1]

(b) The gravitational field strength is 10 N/kg.

(i) Calculate the weight of the screwdriver.

weight = ... [1]

(ii) On Fig. 4.1, draw an arrow labelled *W* to represent the weight of the screwdriver. [1]

(c) State two conditions that apply when an object is in equilibrium.

1. ....

....

....

2. ....

....

....
[2]

Total [5]

5 Optical fibres are used to transmit telephone signals. Fig. 5.1 shows a ray of light that strikes the inside surface of an optical fibre at P.

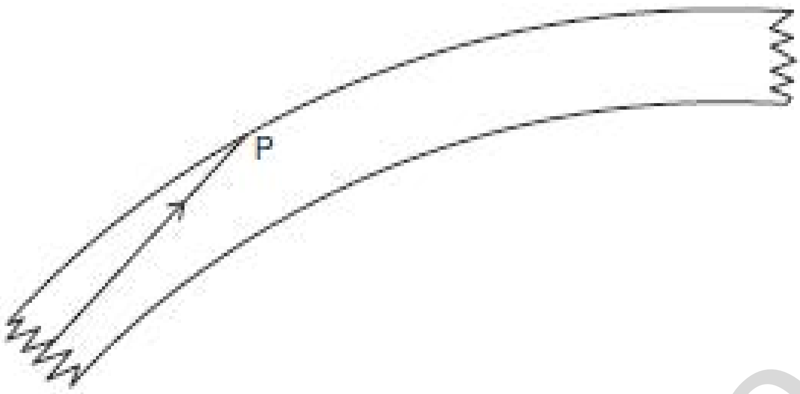

Fig. 5.1

(a) State one advantage of using optical fibres to transmit telephone signals.

....

....[1]

(b) **(i)** On Fig. 5.1, draw a normal at P and mark the angle of incidence with the letter *i*. [1]

(ii) State and explain what happens to the ray at P. Use the term *critical angle* in your answer.

....

....

....[2]

(c) The optical fibre is made of glass of refractive index 1.5.
At the start of the optical fibre, the ray enters the glass from air.
The angle of incidence in the air is 60°.

Calculate the angle of refraction in the glass.

angle = ...[2]

Total [6]

6 Fig. 6.1 is a graph of current against potential difference (p.d.) for a length of metal wire.

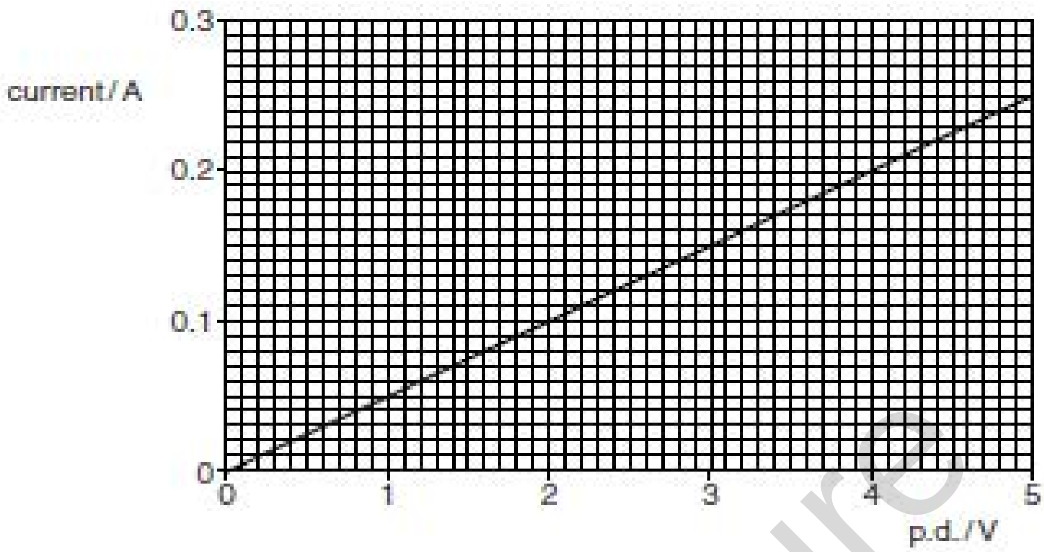

Fig. 6.1

(a) The metal wire obeys Ohm's law. State Ohm's law in words.

....

....

.... [2]

(b) Calculate the resistance of the metal wire.

resistance = ... [2]

(c) A new wire is made from the same metal as the original wire. The two wires have the same length. The cross-sectional area of the new wire is half that of the original wire.

(i) Calculate the resistance of the new wire.

resistance = ... [1]

(ii) On Fig. 6.1, draw a line to show how current varies with p.d. for the new wire. [2]

Total [7]

7 Fig. 7.1 shows a compass needle near a bar magnet. Magnetic poles are shown on the compass needle and on the magnet.

A finger stops the compass needle from turning.

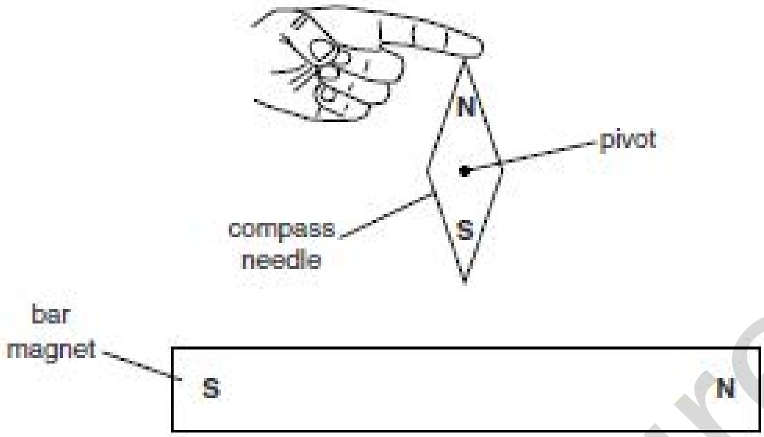

Fig. 7.1 (not to scale)

(a) **(i)** The magnet causes a force on the S-pole of the compass needle.

On Fig. 7.1, draw an arrow from the S-pole of the compass needle to show the direction of this force. [1]

(ii) Explain why the compass needle turns when the finger is removed.

....

.... [1]

(b) A small compass is used to plot the magnetic field lines of the magnet.

Describe how the compass is used to plot magnetic field lines on a piece of paper.

....

....

....

....

.... [3]

Total [5]

8 The nuclide notation for the radioactive isotope boron-12 is ${}^{12}_{5}B$.

(a) In the space below, draw a labelled diagram to illustrate the structure of a neutral atom of this isotope. Show all the particles in the atom.

[4]

(b) As boron-12 decays, it emits a beta-particle. A new atom is produced.

Determine

(i) the proton number (atomic number) of the new atom,

proton number = ...[1]

(ii) the nucleon number (mass number) of the new atom.

nucleon number = ...[1]

Total [6]

Total [46]

Answer two questions from this section. Answer in the spaces provided.

9 Different energy sources are used to generate electricity.

(a) Energy sources are renewable or non-renewable.

(i) Nuclear energy is described as a non-renewable source.

Explain what is meant by a *non-renewable* energy source.

....

....[1]

(ii) Four of the energy sources used are:

hydroelectric   oil   geothermal   wind

Write the name of these energy sources in the correct column of the table below.

non-renewable	renewable and caused by energy from the Sun	renewable and not caused by energy from the Sun

[3]

(iii) State one way in which using nuclear energy is better for the environment than using oil.

....

....[1]

(iv) State one way in which using nuclear energy is worse for the environment than using oil.

....

....[1]

(b) Fig. 9.1 is a block diagram of a power station that produces electrical energy from oil.

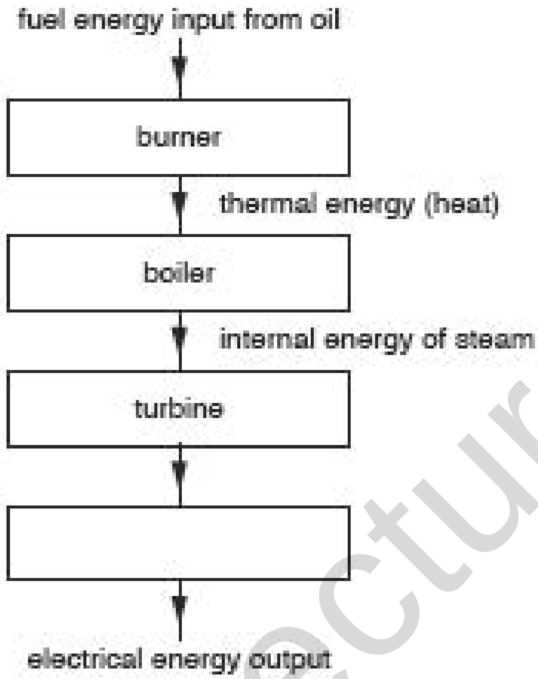

Fig. 9.1

(i) Write the name of the missing part of the power station in the empty box on Fig. 9.1. [1]

(ii) State the form of energy that the turbine possesses.

....[1]

(iii) A small boiler in the power station contains 24 m^3 of water at 30 °C. High pressure in the boiler increases the boiling point of water to 120 °C.

Thermal energy supplied to the boiler is used to heat the water from 30 °C to 120 °C and then to turn it all to steam at 120 °C.

The density of water is 1000 kg / m^3.
The specific heat capacity of water is 4200 J / (kg °C).
The specific latent heat of vaporisation of water is 2.3×10^6 J / kg.

1. Calculate the mass of water in the boiler.

mass = ...[1]

2. Calculate the total thermal energy (heat) supplied to the boiler.

thermal energy = ...[4]

(iv) The electrical energy output from the power station is transmitted over long distances at a high voltage.

Explain why electricity is transmitted at a high voltage.

....

....

....

....[2]

Total [15]

10 **(a)** Fig. 10.1 shows the path of a ray of blue light as it passes through a glass prism.

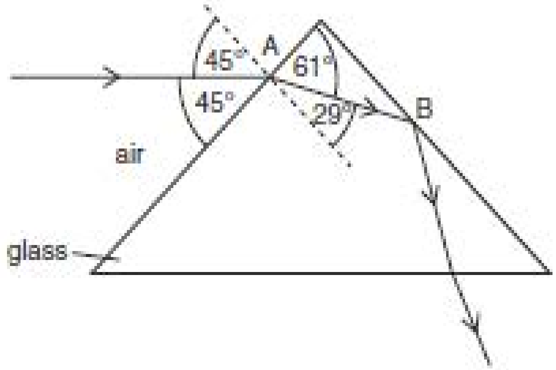

Fig. 10.1

(i) State the wave term used to describe what happens to the ray of light at A.

....[1]

(ii) Using angles from Fig. 10.1, calculate the refractive index of the glass.

refractive index = ...[3]

(iii) Explain why the ray does not emerge from the prism at B.

....

....[2]

(iv) Fig. 10.2 shows a second, horizontal, ray of blue light striking the prism at point C.

On Fig. 10.2, continue the path of the second ray through and out of the glass prism. [2]

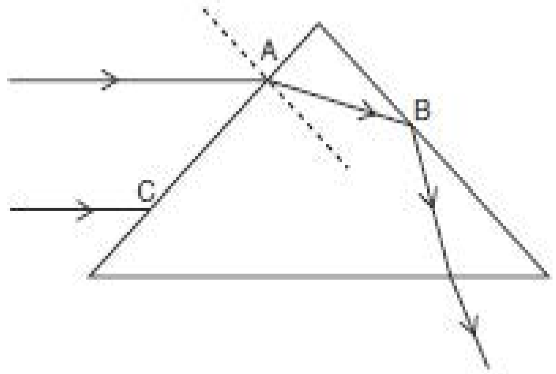

Fig. 10.2

(b) The camera lens shown in Fig. 10.3 is used to photograph the object O.

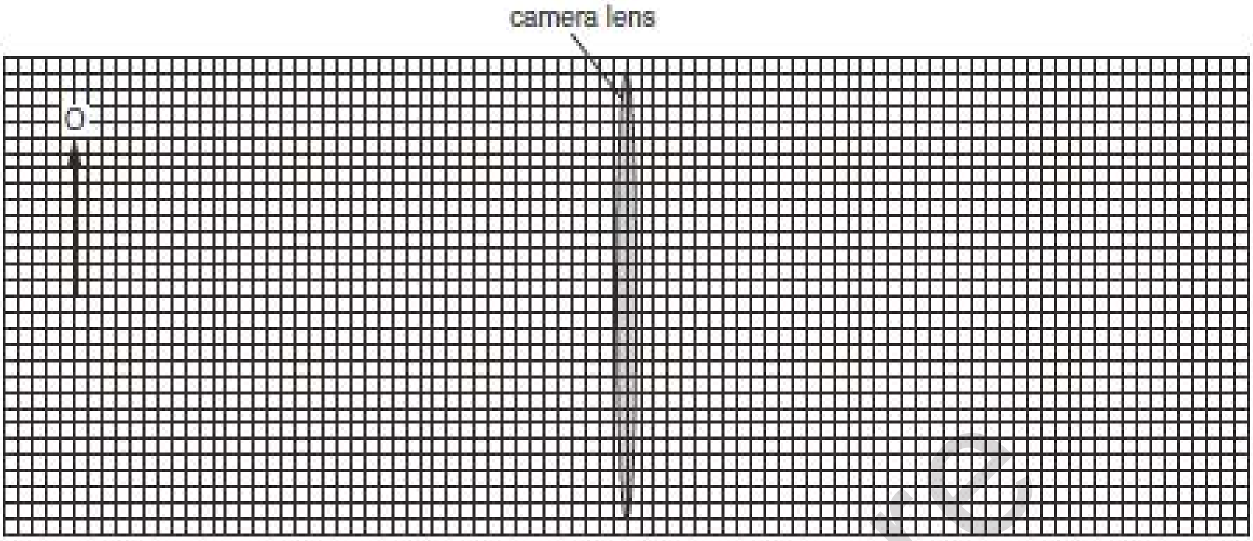

Fig. 10.3 (full scale)

The object O is 2.0 cm high and is placed 8.0 cm from the centre of the lens. The lens has a focal length of 3.0 cm.

(i) Draw rays on Fig. 10.3 to find the position and height of the image formed by the lens. Label the image I. [3]

(ii) Determine the height of the image.

....[1]

(iii) The image formed by the lens is a real image.

1. Explain the difference between a real image and a virtual image.

....

....

....[1]

2. Explain how a converging lens is used to produce and view a virtual image.

....

....

....

....[2]

11 The metals in the list below have many different uses.

aluminium copper iron silver steel

(a) State which metal from the list is used for

(i) a compass needle,

....

(ii) magnetic screening,

....

(iii) the core of a transformer.

.... [2]

(b) (i) Describe one use for a transformer.

....

....

.... [2]

(ii) An a.c. generator supplies an input voltage of 220 V to a transformer.

1. In the space below, sketch a graph of the output voltage against time for the a.c. generator. [2]

2. The transformer has 1700 turns on the primary coil and 85 turns on the secondary coil.

Calculate the output voltage of the transformer.

output voltage = ... [2]

(c) Fig. 11.1 shows a magnet next to one end of a solenoid.

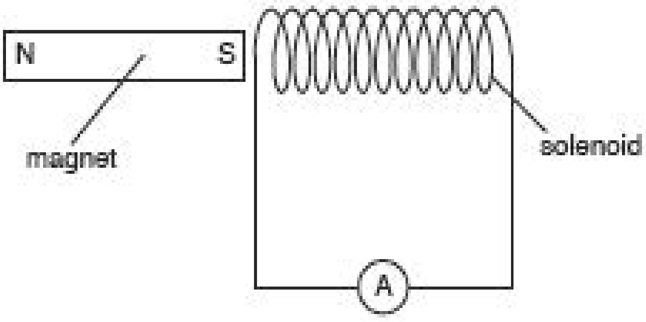

Fig. 11.1

The terminals of the solenoid are connected to a very sensitive ammeter.

(i) The magnet is moved to the right at a constant speed and a reading is observed on the ammeter.

1. Explain why there is a current in the ammeter.

....

....

....

....

....[3]

2. Explain how the current in the ammeter opposes the change producing it.

....

....

....

....[2]

(ii) The magnet stops when the S-pole reaches the middle of the solenoid.

The reading on the ammeter is observed when the magnet is moved to the left at a constant speed that is less than its speed in (c)(i).

State two ways in which the reading on the ammeter differs from the reading observed in (c)(i) as the magnet moves to the left.

1. ....

2. ....
[2]

2 (a) where extension/stretching stops being proportional to force/load/weight/mass
or extension/load = constant
or point where length or extension against load graph curves C1 [1]
(b) 4 = k 6 or 4/6 or 6/4 or 6 × 2/4 or 3 (cm) seen C1
11 cm A1 [2]
(c) different weights/masses/load and measure new length B1
how extension is found e.g. reading on scale for loaded spring subtracted from
reading with no load/mass/original B1 [2]

4 (a) (point) C immediately above tip of pivot (and in middle(vertically) of screwdriver
(±1 mm)) B1
(b) (i) 0.64 N B1
(ii) arrow W vertically downwards through candidate's C or pivot B1
(c) no resultant force or upward force = downward force or force left = force right B1
no resultant moment (of force) or clockwise moment = anticlockwise moment B1 [5]
5 (a) more telephone signals (at one time)
OR great(er) bandwidth; more data (per sec); more signals
OR faster data/information transfer
OR less attenuation; less energy/power/signal loss;
OR long(er) distance (before regeneration)
OR (more) secure
OR less noise/interference OR high(er) quality/clear(er) B1
(b) (i) correct normal and angle marked B1
(ii) total internal reflection B1
angle of incidence is larger than critical angle B1
(c) (n =) sin i/sin r in any form numerical or algebraic C1
35(.2644)° unit ° needed A1 [6]

6 (a) current is directly proportional to voltage (accept voltage/current = constant, but
not just = R) B1
if temperature/physical conditions constant B1
(b) (R=) V/I in any form algebraic or using any value of V and I from graph C1
20 Ω A1
(c) (i) 40 Ω or 2 × (b) B1
(ii) straight line graph through origin below given line ecf (b) (e.g. accept above
line if R < 20) M1
goes through 0.1 A at 4 V ecf (b) (e.g. allow through 0.2 A at 2 V if R = 10 Ω) A1 [7]
7 (a) (i) horizontal arrow to right (by eye) [B1]
(ii) forces / resultant causes moment or (turns because) force is not at pivot [B1]
(b) mark made at one end/pole/direction of compass (on paper) [B1]
move compass so that other end of compass is on mark and remark [B1]
join marks made as compass moved on in some way (to draw line) [B1]
[5]
8 (a) neutrons and protons together and alone in the middle B1
5 protons B1
7 neutrons (if protons and neutrons unlabelled 1/2) B1
5 electrons and electrons surrounding nucleus B1
(b) (i) 6 B1
(ii) 12 B1 [6]

10 (a) (i) refraction B1
(ii) (n =) sin i/sin r C1
sin 45°/sin 29° C1

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Question	Answer	Marks
1(a)	it / speed does **not** have a direction / is a scalar quantity	B1
1(b)(i)	direction (of velocity) changes (as it moves around the Earth)	B1
	its velocity changes with time (this is an acceleration)	B1
1(b)(ii)	arrow from satellite towards (centre of) Earth	B1
1(c)	**no** work done **and** force perpendicular to motion / no movement in direction of force	B1
	(kinetic and gravitational potential) energy remains constant / no effect	B1

2 (a) where extension/stretching stops being proportional to force/load/weight/mass
or extension/load = constant
or point where length or extension against load graph curves C1 [1]
(b) 4 = k 6 or 4/6 or 6/4 or 6 × 2/4 or 3 (cm) seen C1
11 cm A1 [2]
(c) different weights/masses/load and measure new length B1
how extension is found e.g. reading on scale for loaded spring subtracted from
reading with no load/mass/original B1 [2]

Question	Answer	Marks
3(a)	conduction in metal **or** convection (in liquid) mentioned by name	B1
	conduction explained as heat / energy passing from molecule to molecule **or** movement / diffusion / collision of (free) electrons	B1
	convection explained by rising of hot liquid **or** correct density changes	B1
3(b)	air is a bad conductor **or** less area in contact / all of cup does not touch plate	B1
3(c)	white **and** shiny	B1
	less radiation emitted / less emission	B1

4 (a) (point) C immediately above tip of pivot (and in middle(vertically) of screwdriver
(±1 mm)) B1
(b) (i) 0.64 N B1
(ii) arrow W vertically downwards through candidate's C or pivot B1
(c) no resultant force or upward force = downward force or force left = force right B1
no resultant moment (of force) or clockwise moment = anticlockwise moment B1 [5]

5 (a) more telephone signals (at one time)
OR great(er) bandwidth; more data (per sec); more signals
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OR less attenuation; less energy/power/signal loss;
OR long(er) distance (before regeneration)
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(b) (i) correct normal and angle marked B1
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angle of incidence is larger than critical angle B1
(c) (n =) sin i/sin r in any form numerical or algebraic C1
35(.2644)° unit ° needed A1 [6]

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if temperature/physical conditions constant B1
(b) (R=) V/I in any form algebraic or using any value of V and I from graph C1
20 Ω A1
(c) (i) 40 Ω or 2 × (b) B1
(ii) straight line graph through origin below given line ecf (b) (e.g. accept above line if R < 20) M1
goes through 0.1 A at 4 V ecf (b) (e.g. allow through 0.2 A at 2 V if R = 10 Ω) A1 [7]

7 (a) (i) horizontal arrow to right (by eye) [B1]
(ii) forces / resultant causes moment or (turns because) force is not at pivot [B1]
(b) mark made at one end/pole/direction of compass (on paper) [B1]
move compass so that other end of compass is on mark and remark [B1]
join marks made as compass moved on in some way (to draw line) [B1]
[5]

8 (a) neutrons and protons together and alone in the middle B1
5 protons B1
7 neutrons (if protons and neutrons unlabelled 1/2) B1
5 electrons and electrons surrounding nucleus B1
(b) (i) 6 B1
(ii) 12 B1 [6]

Question	Answer	Marks
9(a)(i)	not being replaced or will run out	B1
9(a)(ii)	only oil in 1st column	B1
	only wind and hydroelectric in 2nd column	B1
	geothermal in 3rd column	B1
9(a)(iii)	less greenhouse gases / global warming / acid rain / or toxic gases / oil spills and how they affect a named organism / ecosystem	B1
9(a)(iv)	nuclear waste / radioactive waste causes (storage) problems or explosion / melt down / leak emits radioactivity	B1
9(b)(i)	generator (and transformer)	B1
9(b)(ii)	kinetic (energy)	B1
9(b)(iii)	1 24 000 kg	B1
	2 formula (E) = mL or (E =) mcT seen	C1
	$24\,000 \times 2.3 \times 10^{6}$ or $5.5(2) \times 10^{10}$ (J)	C1
	$24\,000 \times 4200 \times 90$ or $9.0(72) \times 10^{9}$ (J)	C1
	6.4×10^{10} J	A1
9(b)(iv)	low current	B1
	less energy / heat loss (in resistance or cables) or thinner wires can be used	B1

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10 (a) (i) refraction B1
(ii) (n =) sin i/sin r C1
sin 45°/sin 29° C1
1.4585 to more than 1 sig. fig. A1
(iii) the angle of incidence/incident angle is greater than the critical angle B1
total internal reflection occurs B1
(iv) correct refraction at C with ray parallel to AB B1
correct reflection (and correct refraction on other face i.e. downwards) B1
(b) (i) Any TWO of:
undeviated ray through centre of lens
ray parallel to axis through point 3 cm from lens on right after lens
ray through point 3 cm to left of lens parallel to axis after lens M2
rays converge and vertical image drawn and labelled / A1
(ii) 1.2 ± 0.2 cm B1
(iii) 1. real image (can be) formed on screen; virtual image not found on screen;
rays converge on real image; rays do not converge on virtual image;
rays only appear/seem to come from a point on virtual image B1
2. place object within focal length; between lens and focal point/principal
focus B1
view from other side of lens; look through lens; image same side as/behind
object B1 [15]

Question	Answer	Marks
11(a)(i)	steel	B1
11(a)(ii)	iron	B1
11(a)(iii)	iron B1 (i) and (iii) both correct B1 (ii) correct	
11(b)(i)	clear use (e.g. change voltage / current)	M1
	detail of operation (to transmit electricity or in a charger etc.)	A1
11(b)(ii)	1 voltage on vertical axis and time on horizontal axis	B1
	clear attempt at sinusoidal curve for at least one cycle	B1
	2 (V_S =) $V_P N_S / N_P$ or 220 × 85 / 1700	C1
	11 V	A1
11(c)(i)	1 magnetic field / flux / flux linkage mentioned	B1
	magnetic field (lines) cut solenoid or v.v. or changing (magnetic) field / flux / flux linkage (in solenoid)	B1
	induced e.m.f. / voltage	B1
	2 it / current magnetises solenoid / produces magnetic field / flux(linkage) in solenoid / produces a S-pole (in solenoid)	B1
	magnet repelled or experiences a force to the left	B1
11(c)(ii)	smaller reading / deflection	B1
	reading in opposite direction	B1