QUESTION – PHYSICS

FORM – 4

THIN LENSES

1. In a short-sighted eye, rays from distant objects are not focused on the retina.
Where are these rays focused and what type of lens is needed to correct the problem?

	where focused	lens needed
A	behind the retina	converging lens
B	behind the retina	diverging lens
C	in front of the retina	converging lens
D	in front of the retina	diverging lens

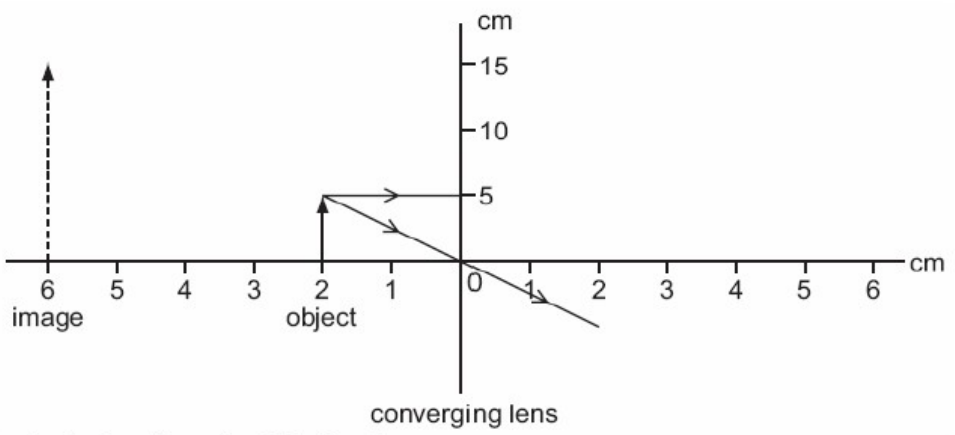
2. When an object is placed at the focus of a concave mirror, the image will be formed at _____.

A. infinity
B. focus
C. centre of curvature
D. pole

3. An object of size 2.0 cm is placed perpendicular to the principal axis of a concave mirror. The distance of the object from the mirror equals to the radius of curvature. The size of the image will be _____.

A. 0.5 cm
B. 1.5 cm
C. 1.0 cm
D. 2.0 cm

4. An object 5.0 cm high is placed 2.0 cm from a converging (convex) lens which is being used as a magnifying glass.
The image produced is 6.0 cm from the lens and is 15 cm high.

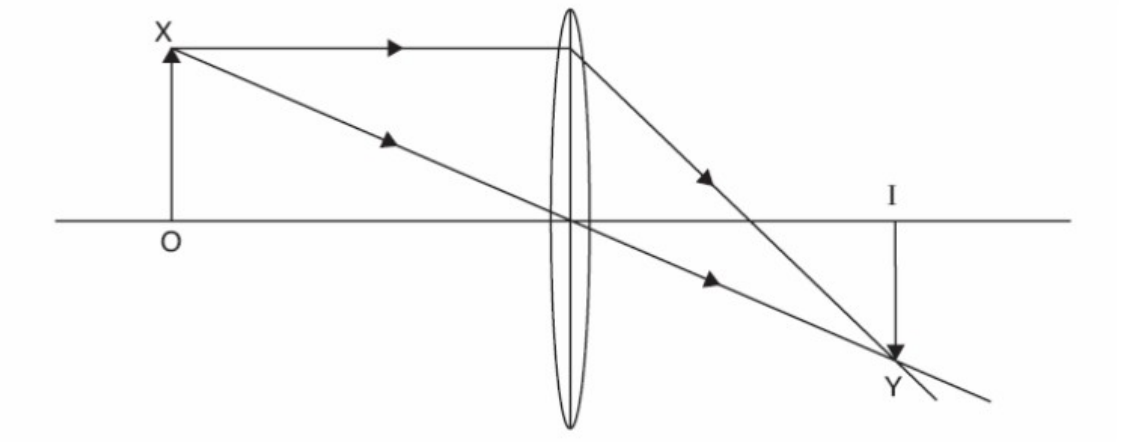


What is the focal length of the lens?
A 2.0 cm
B 3.0 cm
C 4.0 cm
D 6.0 cm

5. A real object is placed before a convex lens. The image formed by it is virtual, erect and magnified. The object is placed between

(A) 2f and infinity
(B) 2f and 3f
(C) f and 2f
(D) lens' optical centre and f

6. An object OX is placed in front of a converging lens. The lens forms an image IY.
The figure below shows two rays from the object to the image.



(a) On the figure above ,
(i) Clearly mark and label the principal focus and the focal length of the lens, [3]
(ii) Draw a third ray from X to Y. [1]

(b) The following list contains descriptions that can be applied to images.
Tick any which apply to the image shown in Figure.

real	☐
virtual	☐
enlarged	☐
diminished	☐
inverted	☐
upright	☐
image distance less than object distance	☐
image distance more than object distance	☐

[4]

(c) State two things that happen to the image in Fig. 8.1 when the object is moved further away from the lens.

1.
.....

.....

2.

.....

.....[2]

[Total: 10]

7. Fig. 5.2 shows a normal eye viewing an object close to it. Fig. 5.3 is a long-sighted eye viewing an object at the same distance.

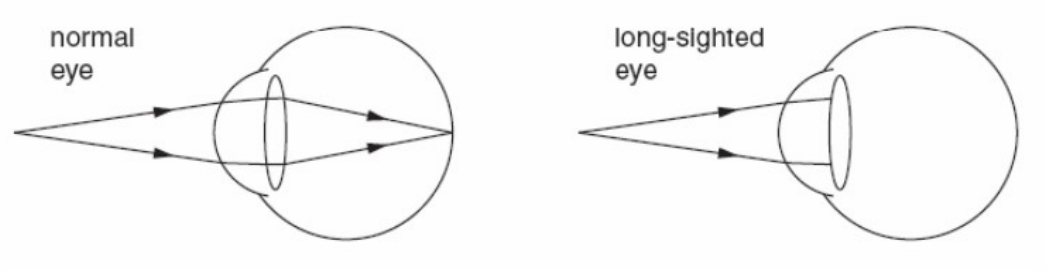


Fig 5.2

Fig 5.3

Complete Fig. 5.3 to show the rays travelling through the eye. [1]

8. Fig. 2.1 shows the lens of a simple camera being used to photograph an object.

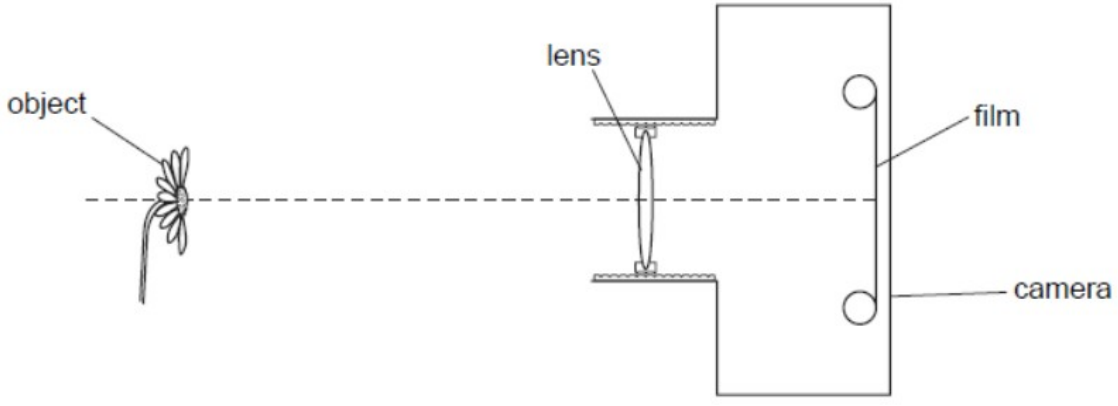


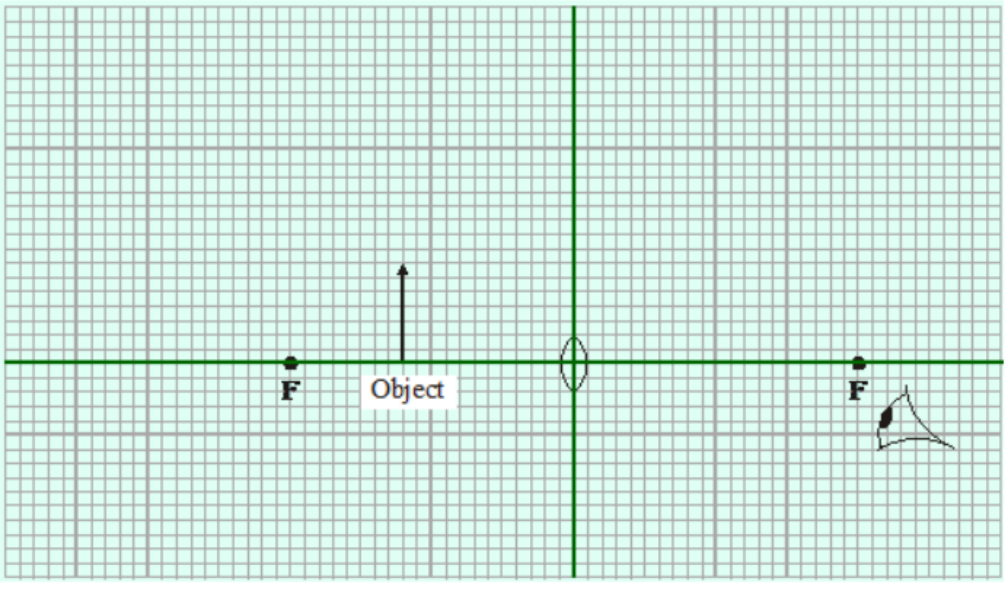
Fig. 2.1

The lens forms a focused image of the object on the film.
(a) Draw two rays from the top of the object to show how the lens forms the image. [2]
(b) The object moves closer to the camera. State how the lens is adjusted to keep the image in focus.

[1]

[Total 3m]

9. The diagram shows a converging lens of focal length 4 cm being used as a magnifying glass. An object 1.6 cm tall is placed 2.4 cm from the lens.



(a) On the diagram, use a ruler to construct accurately the position and size of the image. You should show how you construct your ray diagram and how light appears to come from the image to the eye.

(4 marks)

(b) The image is virtual. What is a virtual image?

(1 mark)

(c) Calculate the magnification produced by the lens. Show clearly how you work out your answer.

(2 marks)

(Total 7 marks)

CIRCULAR MOTION

1. A stone on a string is whirled in a vertical circle of radius 80 cm at a constant angular speed of 16 radians per second.

   Calculate the speed of the stone along its circular path.

.....

.....

Speed = ...

(2)

Calculate its centripetal acceleration when the string is horizontal.

.....

.....

.....

Acceleration = ...

(2)

Calculate the resultant acceleration of the stone at the same point.

.....

.....

.....

Resultant acceleration = ...

(3)

Explain why the string is most likely to break when the stone is nearest the ground.

.....

(2)
(Total 9 marks)

2. State the period of the Earth about the Sun.

.....

.....

.....

Use this value to calculate the angular speed of the earth about the Sun in rad s^{-1}.

.....

.....

.....

Angular speed = ...

(2)

The mass of the Earth is 5.98×10^{24} kg and its average distance from the Sun is 1.50×10^{11} m. Calculate the centripetal force acting on the Earth.

.....

.....

.....

(2)

What provides this centripetal force?

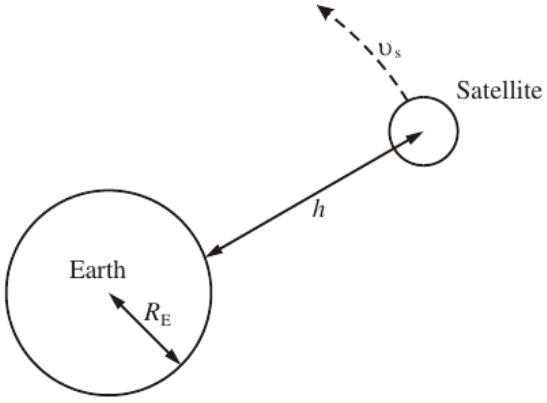
.....

.....

.....

(1)
(Total 5 marks)

3. The diagram (not to scale) shows a satellite of mass m_s in circular orbit at speed v_s around the Earth, mass M_E. The satellite is at a height h above the Earth's surface and the radius of the Earth is R_E.



Using the symbols above write down an expression for the centripetal force needed to maintain the satellite in this orbit.

.....

.....

.....

(2)

Write down an expression for the gravitational field strength in the region of the satellite.

.....

.....

.....

State an appropriate unit for this quantity.

.....

(3)

Use your two expressions to show that the greater the height of the satellite above the Earth, the smaller will be its orbital speed.

.....

.....

Explain why, if a satellite slows down in its orbit, it nevertheless gradually spirals in towards the Earth's surface.

.....

.....

.....

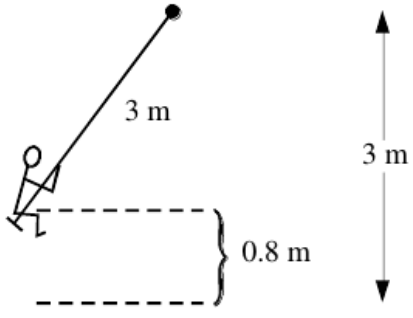
.....

.....

.....

(Total 10 mar

4. A child of mass 21 kg sits on a swing of length 3.0 m and swings through a vertical height of 0.80 m.



Calculate the speed of the child at a moment when the child is moving through the lowest position.

.....

(2)

Calculate the force exerted on the child by the seat of the swing at a moment when the child is moving through the lowest position.

.....

.....

.....

Force = ...

(3)

Explain why, as the amplitude of the motion increases, children may lose touch with the seat of the swing.

.....

.....

.....

(2)
(Total 7 marks)

5. A satellite S orbits the Earth once every 87 minutes.

Show that its angular speed is approximately 1×10^{-3} radians per second.

.....

.....

.....

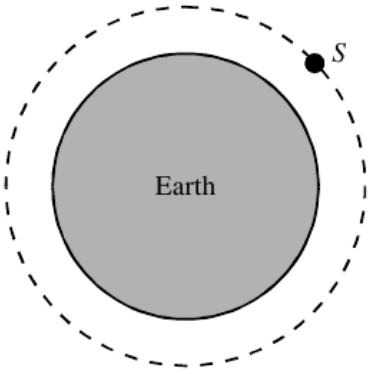
.....

.....

.....

(2)

In the space on the right draw a free-body force diagram for the satellite in the position shown.



(1)

With reference to your free-body force diagram, explain why the satellite is accelerating.

.....

.....

.....

(1)

The radius of the satellite's orbit is 6500 km. Calculate the magnitude of its acceleration.

.....

.....

.....

.....

.....

.....

Acceleration = ...

(2)
(Total 6 marks)

FLOATING AND SINKING

1. If an object floats, the volume of water is displaces is equal to or greater than the volume of.....

A the entire object.
B. the portion of the object that is above water.
C the portion of the object that is submerged.
D exactly half of the object.

2. Which of the following is true of the buoyant force?

A In order for an object to float, buoyant must be smaller than gravitational force.
B. In order for an object to float, buoyant force must be larger than gravitational force.
C In order for an object to sink, the buoyant force must be greater than gravitational force.
D a&b

3. What scientific rule states that the buoyant force on an object is equal to the weight of the fluid displaced by the object?

A Archimedes' principle
B. Pascal's principle
C Bernoulli's principle
D Newton's third law of motion

4. A ship stays afloat as long as the buoyant force is.....

A less than the ship's weight.
B. equal to the ship's weight.
C less than the ship's speed.
D greater than the ship's speed.

5. A log that is just below the surface of the water (not sinking or floating) has .....

A upward buoyancy
B. neutral buoyancy
C downward buoyancy
D no buoyancy

6. A 100-cm^3 lead block is carefully submerged in a container of mercury. One cm^3 of mercury weighs 0.13 N.

a. What volume of mercury is displaced? 1m

b. How much does that volume of mercury weigh? 2m

c. What is the buoyant force on the lead? 1m

d. Will the lead block sink or float in the mercury? 1m

[Total 5m]

7. A body weighs 600 g in air and 400 g in water. Calculate

(i) Upthrust on the body

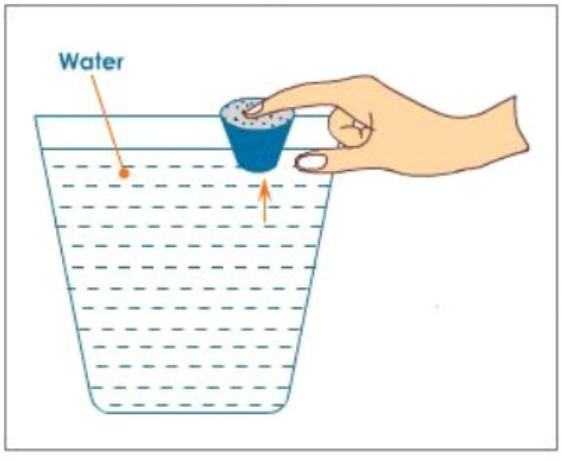
[2m]

(ii) Volume of the body

[2m]

(iii) Relative density of the body.

8. When a cork is pushed in water as shown below, we find that as soon as it is released, the cork rises on its own and comes to the surface.



(i) Explain why this happens.

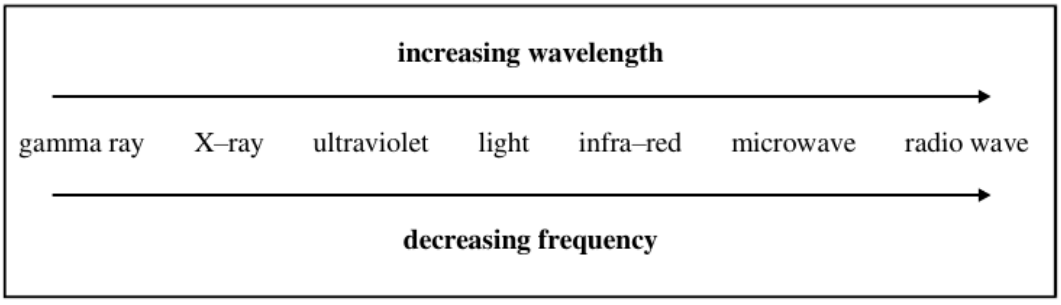
[1m]

(ii) State three factors that affect the force shown by the arrow

[3m]

ELECTROMAGNETIC WAVES

1. The diagram shows the waves that make up the electromagnetic spectrum.



(a) In going from light to radio waves, describe how:

(i) the wavelength changes;.....

.....

(ii) the frequency changes. .....

(b) Which TWO waves in the spectrum are most harmful to humans?

1.....

2.....

(2)

(c) Choose ONE of the waves shown in the diagram.
Name ONE use for the wave that you choose and describe how it is used.

Wave.....

Use.....

Description of use.....

.....

.....

(3)
(Total 7 marks)

2. The diagram shows the electromagnetic spectrum.

gamma rays	X-rays	ultra-violet	visible		micro-waves	radio waves

(a) Write the name of the missing radiation on the diagram.

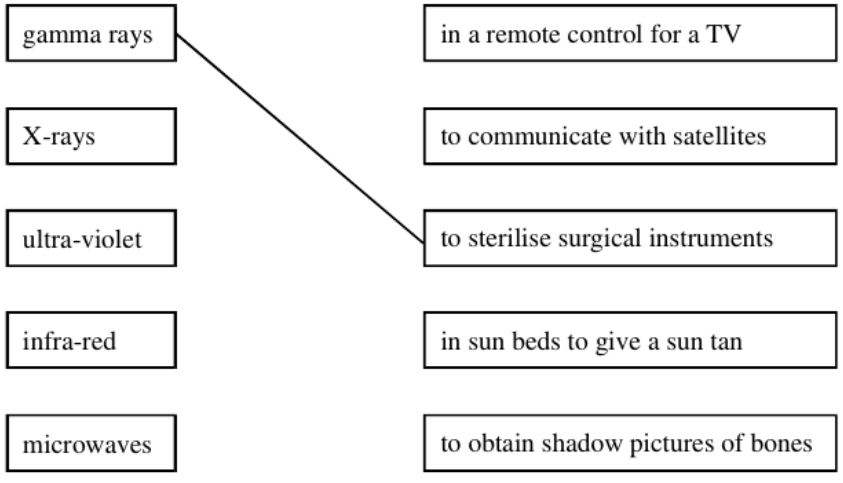
(b) Name **one** use for this radiation.

.....

(1)
(Total 2 marks)

3. The boxes on the left show types of electromagnetic radiation.
The boxes on the right show some uses of electromagnetic radiation.

Draw **one** line from each type of radiation to its use.
The first has been done for you.



(3)
(Total 3 marks)

4. The table shows some information about the electromagnetic spectrum

Low frequency ... High frequency

radio waves	micro-waves	infra-red	light **A** **B**	ultraviolet	X-rays	gamma rays

(a) State **two** characteristics of all electromagnetic waves.

1 .....

2 .....

(2)

(b) (i) What is the colour of the light at **A**?

.....

(1)

(ii) What is the colour of the light at **B**?

(1)

(c) (i) State **one** use of ultraviolet radiation.

.....

(1)

(ii) State **one** use of gamma radiation.

.....

(1)

(d) Ultraviolet radiation and gamma radiation can damage the human body.

State **one** damaging effect for each.

ultraviolet .....

gamma .....

(2)

(Total 8 marks)

5. (a) The table shows some information about the electromagnetic spectrum.

low frequency → high frequency

radio waves	**A**	infra-red	visible light	**B**	X-rays	gamma rays

(i) Name the radiation at **A**.

.....

(1)

(ii) Name the radiation at **B**.

.....

(1)

(iii) State **one** use of X-rays.

.....

(1)

(iv) State **one** harmful effect of X-rays.

.....

(1)

(v) State **two** properties that all electromagnetic waves have in common.

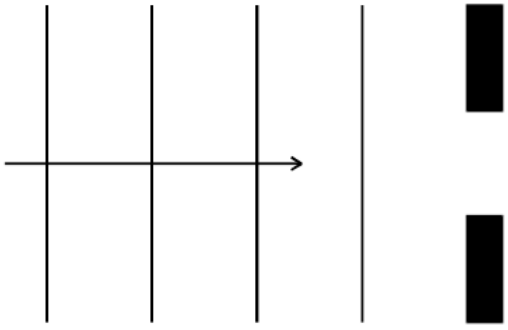
1 .....

2 .....

(2)

(b) The diagram shows water waves approaching a gap.

The wavelength of the waves is 1.5 cm. The gap is also 1.5 cm wide.



Complete the diagram to show the diffracted waves produced by the gap.

(3)

(c) In the 17th and !8th centuries, scientists debated whether light behaved as waves or particles.

Diffraction is a wave property.

When light is shone onto a 1.5 cm gap, no diffraction is observed.

Suggest **two** conclusions that could be drawn from this observation.

.....

.....

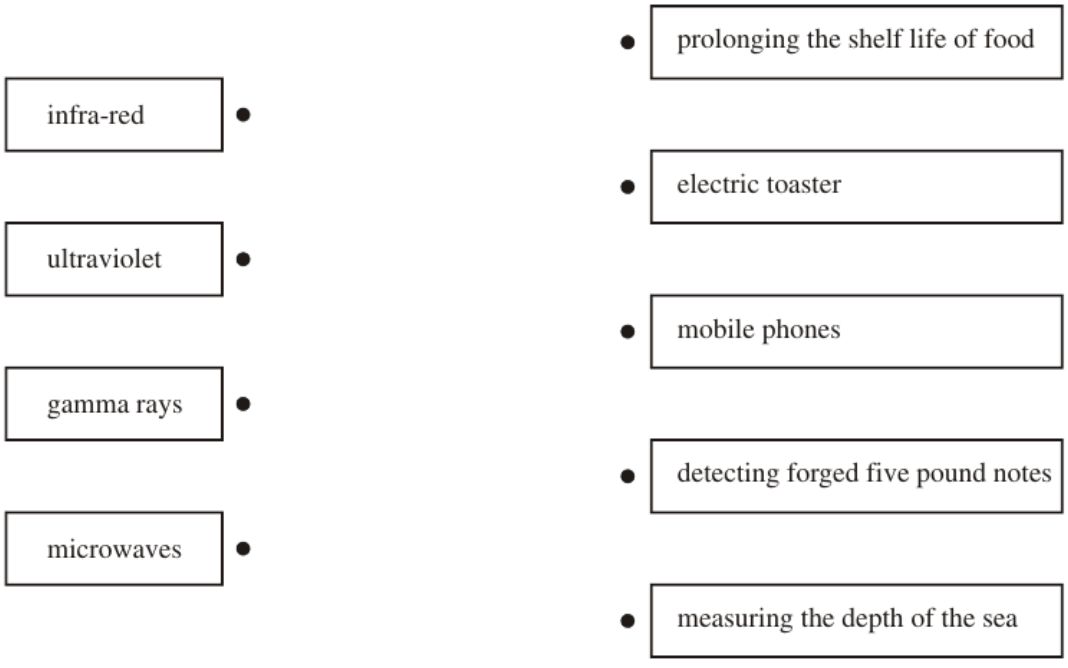
.....

.....

(3)
(Total 12 marks)

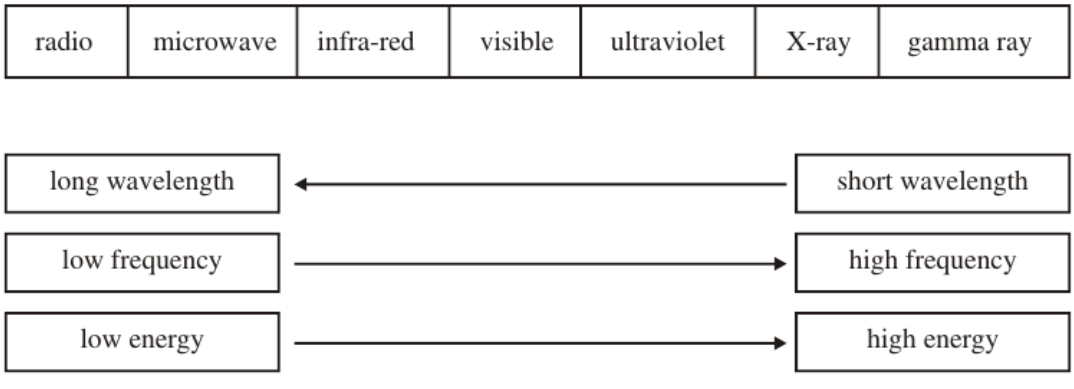
6. The boxes show the names of some of the waves in the electromagnetic spectrum and their uses.

Draw **one** straight line from each electromagnetic wave to its use.



(Total 4 marks)

7. (a) The diagram shows the various parts of the electromagnetic spectrum.



(i) Describe the relationship shown between the energy carried by an electromagnetic wave and its frequency.

.....

.....

(1)

(ii) Explain why waves with high energy are more dangerous to humans than those with low energy.

.....

.....

.....

(2)

(iii) Describe the relationship shown between the wavelength and frequency of the waves.

.....

.....

(1)

(b) Ultrasounds are also waves.

State **two** differences between ultrasound waves and radio waves.

1 .....

.....

2 .....

.....

(2)
(Total 6 marks)

8. Part of the electromagnetic spectrum is shown below.

gamma rays	**X-rays**	**A**	**visible light**	**infra-red waves**	**micro-waves**	**radio waves**

(a) Name part **A** of the electromagnetic spectrum.

.....

(1)

(b) Which part of the electromagnetic spectrum has the shortest wavelength?

.....

(1)

(c) All electromagnetic waves travel at the same speed in a vacuum.
If the frequency decreases, what happens to the wavelength?

.....

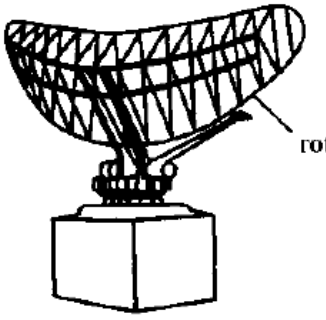
(1)

(d) Microwaves can be used to cook food.
Which other part of the electromagnetic spectrum can be used to cook food?

.....

(1)

(e) Radar uses pulses of microwaves to detect aeroplanes.



Explain how microwaves can be used to find the position of an aeroplane in the sky.

.....

.....

.....

.....

.....

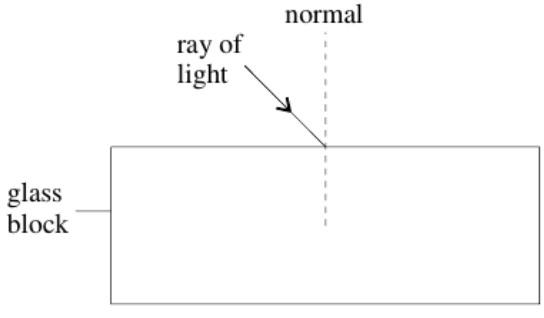
.....

.....

.....

(3)
(Total 7 marks)

9. (a) A light ray travels through air and strikes a glass block.



Use a ruler to draw the paths of the refracted ray as it passes through and out of the block.

(2)

(b) This is part of a newspaper article

> **Ditch those glasses - in 15 minutes**
>
> Using computer technology and a thin invisible beam of ultraviolet radiation, microscopic amounts of eye tissue can be removed to correct visual impairment.

(i) Suggest another use for ultraviolet radiation.

.....

.....

(1)

(ii) Visible light and ultraviolet light are parts of the electromagnetic spectrum.
Two features of an electromagnetic wave are its wavelength and frequency.
Use these features to compare ultraviolet radiation and visible radiation.

.....

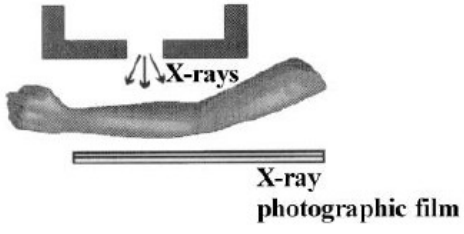
.....

.....

.....

(2)

(c) Nicola has a suspected broken arm.
She is taken to hospital for an arm X-ray.



(i) Explain how the properties of X-rays make them suitable for making an X-ray photograph of the suspected broken arm.

.....

.....

.....

(3)

(ii) Why can exposure to X-rays be harmful to the body?

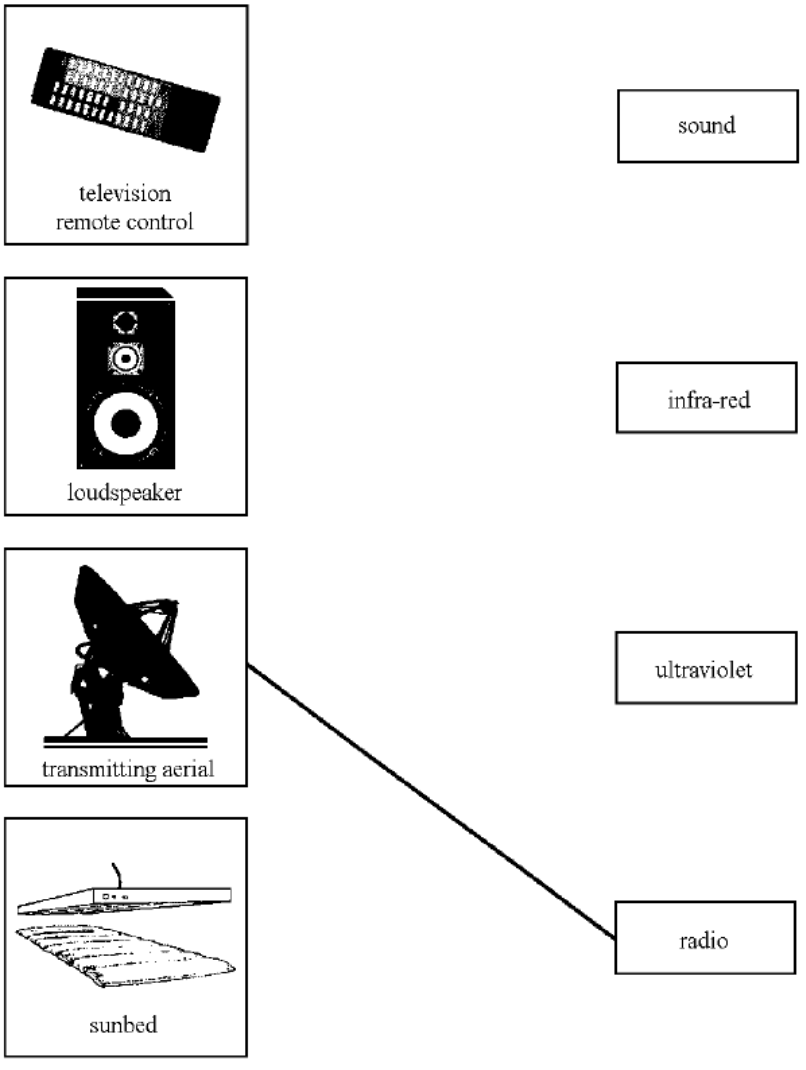
.....

.....

(1)
(Total 9 marks)

10. The diagrams show some everyday objects that produce waves.

(a) Draw a line from each diagram to the type of wave that the object produces.



(b) Which **one** of the waves is **not** in the electromagnetic spectrum?

.....

(1)

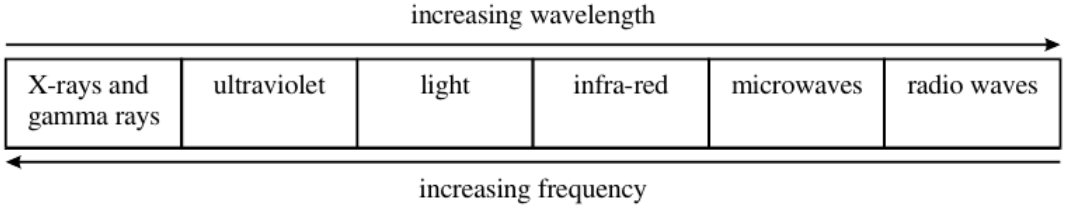
(c) Which **one** of the waves has a wavelength shorter than light?

.....

(1)

(Total 5 marks)

11. The diagram shows the different waves in the electromagnetic spectrum.



(a) Complete the sentence.

As the wavelength of the waves increases, their frequency .....

(1)

(b) Give one use of:

(i) microwaves

.....

(1)

(ii) ultraviolet waves

.....

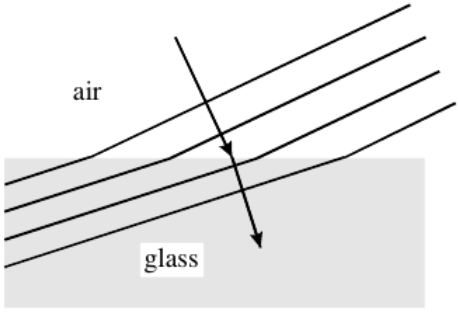
(1)

(iii) gamma rays

.....

(1)

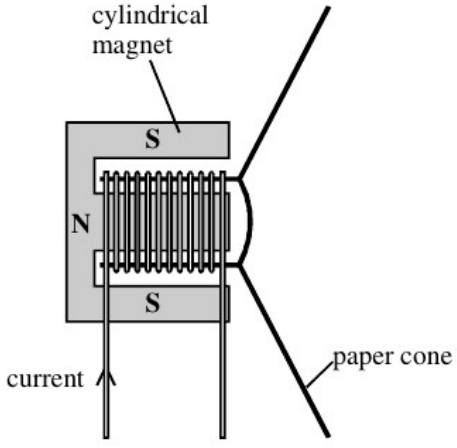
(c) The diagram shows light waves passing from air into glass.



Describe two changes that take place to the waves as they pass into the glass.

ELECTROMAGNETIC INDUCTION

1. The diagram shows a moving coil loudspeaker.



(a) (i) When the current is in the direction shown in the diagram, the paper cone moves to the right.

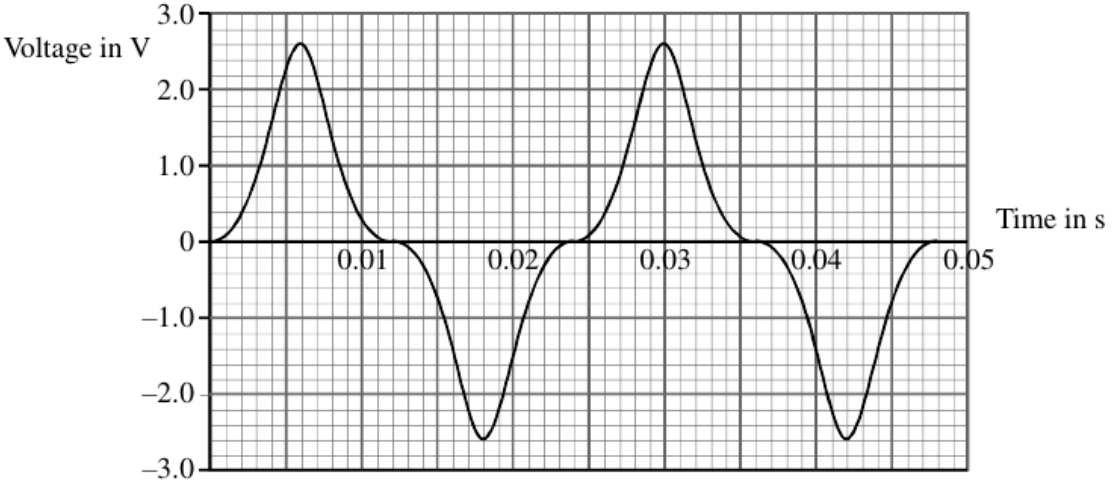
Describe the movement of the paper cone when the direction of the current is reversed.

(ii) Explain why the paper cone moves when a current passes in the coil.

(b) An alternating current passes in the coil.
Describe the movement of the paper cone.

(c)The loudspeaker is used to produce a sound that has a frequency of 800 Hz.
The wavelength of the sound as it leaves the loudspeaker is 0.40 m.
Calculate the speed of the sound in air.

2. (a) The graph shows how the output voltage of a bicycle dynamo changes with time.



(i) How can you tell that the dynamo produces an alternating voltage?

.....

(1)

(ii) Use the graph to write down the values of

the amplitude of the voltage.....

the period of the voltage.....

(2)

(iii) Calculate the frequency of the alternating voltage.

.....

.....

(2)

(b) A dynamo consists of a magnet that rotates inside a coil of wire.

(i) Explain why a voltage is generated in the coil when the magnet rotates.

.....

.....

(2)

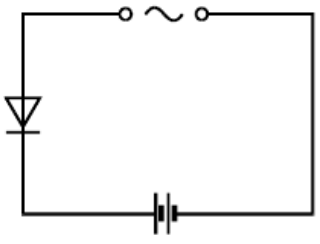
(ii) A dynamo is used as the energy source for the lights on a bicycle.
The bicycle speeds up.
State and explain the effect this has on the brightness of the lights.

.....

.....

(2)

(c) The dynamo can also be used to recharge a battery. The diagram shows the circuit that is used.



Suggest why the diode is included in the circuit.

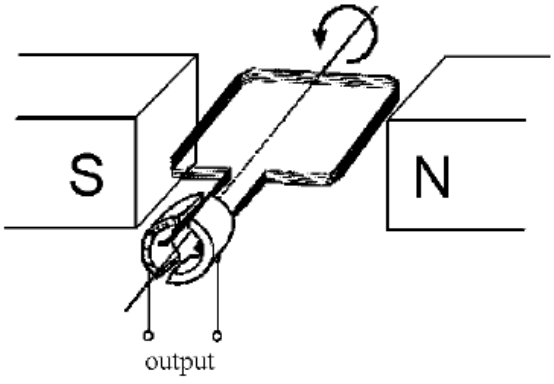
.....

.....

(2)

(Total 11 marks)

3. (a) The diagram shows the construction of a simple electrical generator. When the coil is rotated, an alternating voltage is produced at the output.



(i) Explain what is meant by an alternating voltage.

.....

.....

(1)

(ii) State **two** ways in which the voltage output could be increased.

1 .....

2 .....

(2)

(b) The generators at a power plant produce a voltage of 25 000 V. For long distance transmission, on overhead power lines, this is stepped up to 400 000 V. It is later stepped down to 240 V for domestic use.

(i) Explain why the voltage is stepped up to 400 000 V.

.....

.....

.....

.....

(2)

(ii) A transformer is used to step up the voltage. Calculate the ratio of primary turns to secondary turns needed for this transformer.

.....

.....

.....

(3)

(c) Give **one** advantage and **one** disadvantage of increasing the thickness of overhead power lines.

Advantage .....

.....

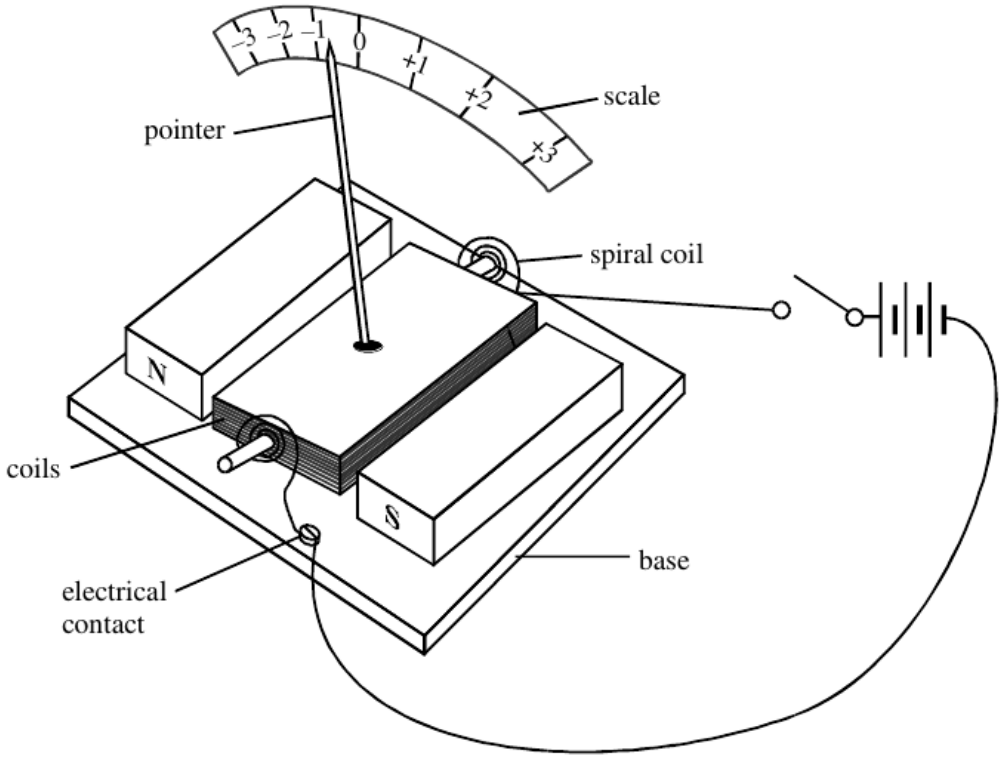
Disadvantage .....

.....

(2)

(Total 10 marks)

4. (a) The diagram shows a model ammeter built by a pupil.



When the switch is closed, the needle moves to the point +3 on the scale.

(i) Why does the needle move when the switch is closed?

.....

.....

(2)

(ii) What will happen to the movement of the needle if the battery is reversed?

.....

(1)

(iii) What change would make the needle move further?

.....

(1)

(b) State why you think the wire is formed into spirals at each end.

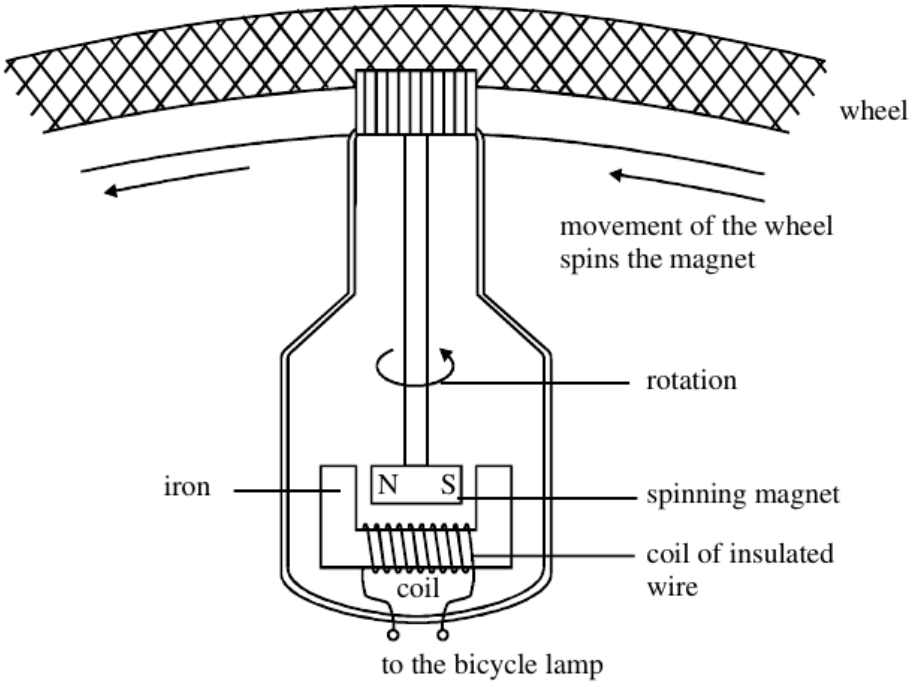
.....

.....

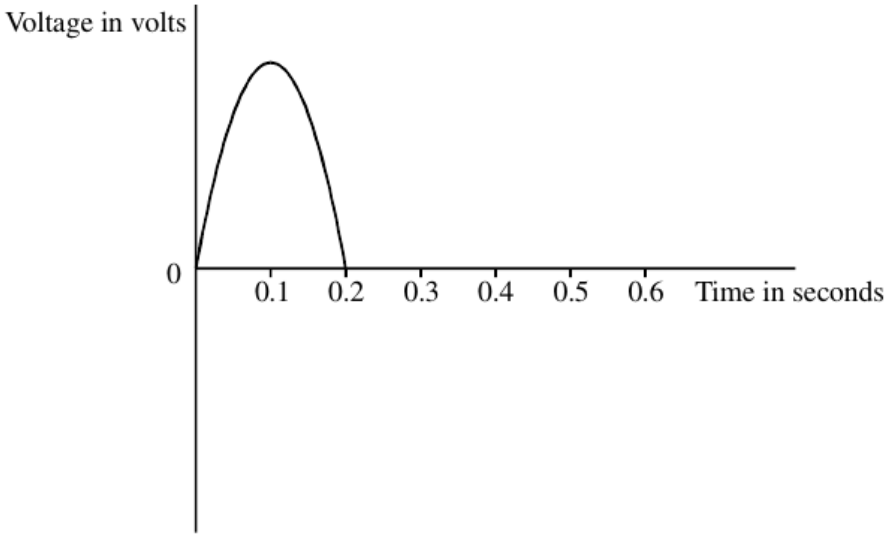
(2)

(Total 6 marks)

5. (a) The diagram shows a bicycle dynamo used to power the bicycle lamps.



An alternating voltage is induced in the coil when the magnet rotates. The graph shows how the induced voltage changes with time for half a revolution of the magnet.



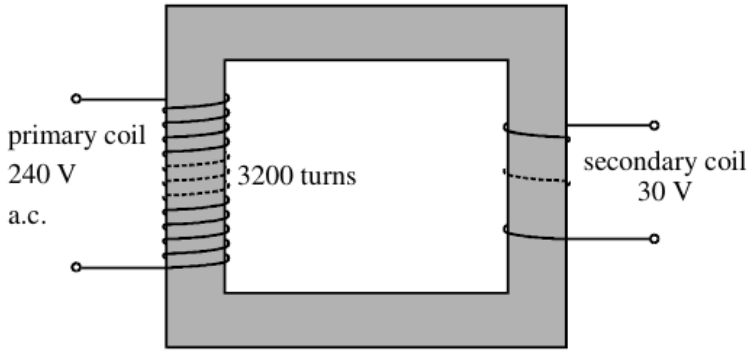
(i) Continue the graph to show the voltage as the magnet turns through a further half revolution.

(3)

(ii) On the same grid, sketch the voltage graph produced when the bicycle wheel is turning more slowly.

(2)

(b) A computer printer operates at 30 V. The diagram shows the transformer used to step down the mains voltage from 240 V to the 30 V needed by the printer.
There are 3200 turns on the primary coil.



(i) Calculate the number of turns on the secondary coil.

.....

.....

.....

.....

(3)

(ii) The current in the printer is 0.4 A.
Calculate the energy supplied to the printer in one second.

.....

.....

.....

(2)

(iii) The energy supplied to the transformer by the mains in one second is 15 J.
Calculate the efficiency of the transformer.

.....

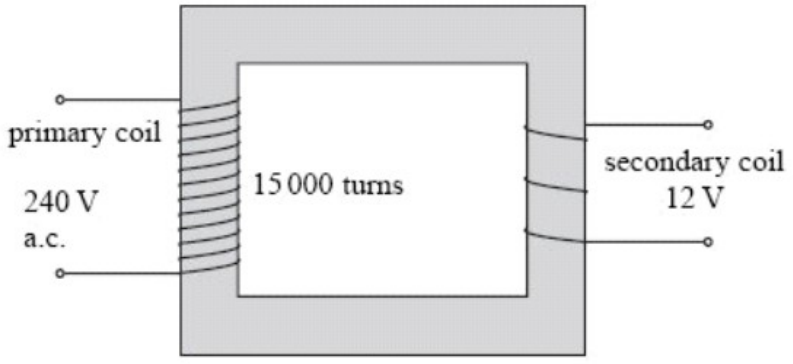
.....

.....

(3)

(Total 13 marks)

6. The diagram shows a transformer which is used to step down the 240 V mains voltage to light a 12 V lamp. The number of turns in the primary coil is 15 000.



(a) (i) Write down an equation which could be used to calculate the number of turns in the secondary coil.

.....

.....

(1)

(ii) Calculate the number of turns in the secondary coil.

.....

.....

.....

.....

.....

(2)

(b) 250 J of electrical energy is supplied to the primary coil in 10 s.

Calculate the current in the primary coil.

.....

.....

.....

.....

(3)

(c) (i) The energy output from the secondary coil is 225 J in 10 s.

Calculate the efficiency of the transformer.

.....

.....

.....

.....

(2)

(ii) Explain why the efficiency is less than 100%.

.....

.....

.....

.....

(2)

(Total 10 marks)

MAINS ELECTRICITY

1. The metal case of an electric heater is earthed. The plug to the heater contains a 5 A fuse. There is a current of 4 A when the heater works normally. The cable to the heater becomes so worn that the live wire makes electrical contact with the case.

What happens? Give a reason for your answer

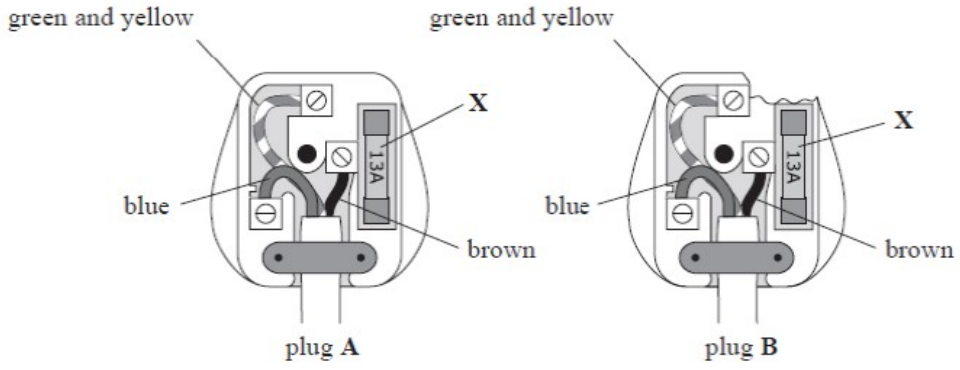
[2m]

2. A lamp with a resistance of 576Ω is connected to a 120-V source.

a. What is the current through the lamp?

b. What is the power rating of the lamp?

3. (a) The covers are removed from two plugs, **A** and **B**. The diagram shows the inside of the plugs.



(i) Identify a problem with plug **B**.

.....

.....

(1)

(ii) Suggest why this makes plug **B** unsafe.

.....

.....

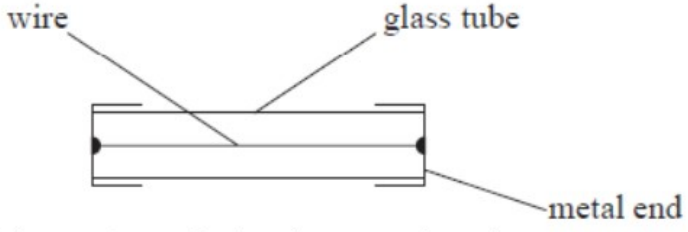
(1)

(iii) Name part **X**.

.....

(1)

(iv) The diagram below shows the structure of part **X**.



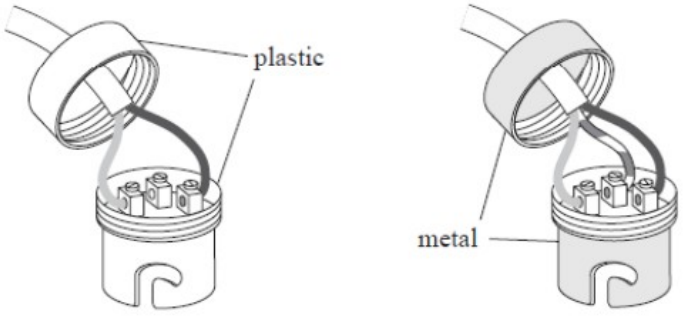
State **one** change which occurs in part **X** when the current is too large.

.....

.....

(1)

(b) The diagram shows two light fittings, **Y** and **Z**.



Y **Z**

When the tops are screwed on, each fitting is safe to use.
(i) State why light fitting **Y** is safe to use.

.....

.....

(1)

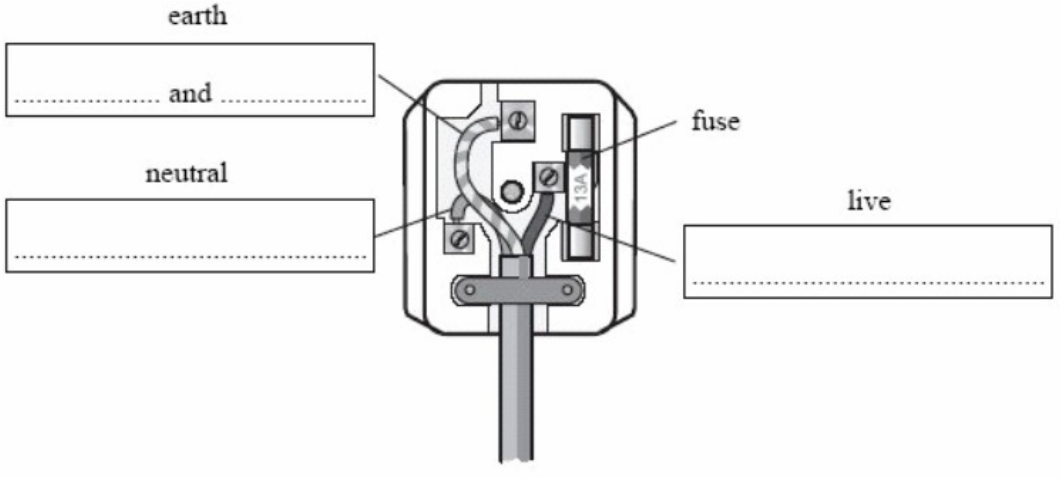
(ii) Why is light fitting **Z** safe to use?

.....

.....
(1)

4. (a) The diagram shows a correctly wired 3-pin plug.

Label the wires with the correct colours.



(3)

(b) The table shows information about some household electrical appliances.

appliance	power	current
table lamp	100 W	0.40 A
clothes iron	2.2 kW	8.8 A
television set	80 W	0.32 A

(i) The mains cable for the iron is thicker than the mains cables for the other two appliances.

Suggest **two** reasons for this.

1 .....

.....

2 .....

.....

(2)

(ii) The three appliances are switched on for 30 minutes.

Which costs the least to run?

Explain your answer.

.....

.....

.....

(2)

(iii) The iron is switched on for 30 minutes.

Calculate the electrical energy used in kW h.

.....

.....

.....

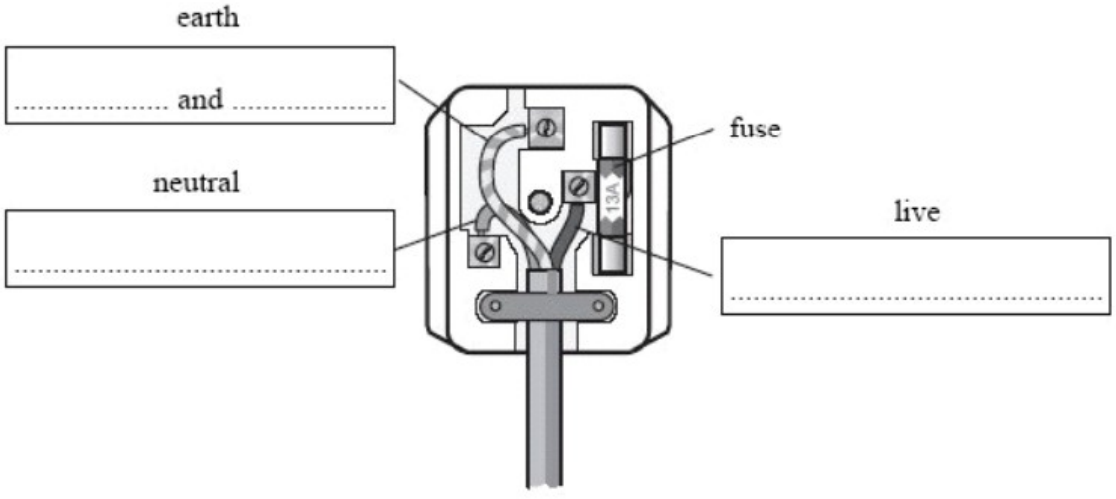
.....kW h

(3)

(Total 10 marks)

5. The diagram shows a correctly wired 3-pin plug.

Label the wires with the correct colours.



(3)

6. The table lamp shown in Fig. 10.2 is made from plastic. It has only two wires in the cable to connect it to the plug.

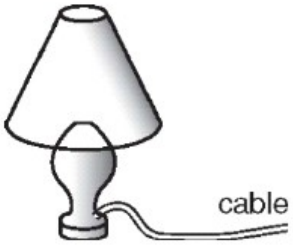


Fig. 10.2

The lamp has a power rating of 100 W and is used with a 230 V supply.

(i) Which wire, earth, live or neutral, is **not** needed in the cable for the lamp?

.....

[1]

(ii) Explain why the lamp is safe to use even though it has only two wires in the cable.

.....

.....

[2]

(iii) Explain what is meant by a *power rating of 100 W*.

.....

.....

[2]

(iv). Calculate the value of the fuse that should be used in the plug for this lamp.

(v) Calculate the electrical energy supplied to the lamp in 30 minutes.

CATHODE RAYS

1. State one way of producing a beam of electrons and define the phenomenon.

[2m]

2. (ii) What are Cathode rays?

[1m]

(ii) Give three properties of these rays.

(a)
.....

(b)
.....

(c)
.....[3m]
[Total 4m]

3. A thin metal filament J and a metal plate K are sealed inside an evacuated

glass vessel. The electrical connections pass through the glass to external components as shown in Fig. 11.1.

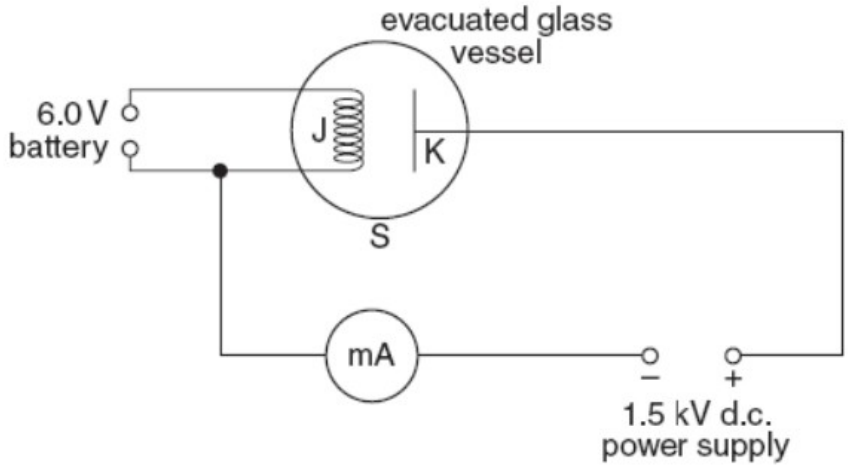


Fig. 11.1

(a) A 6.0 V battery is connected to J and the filament becomes white hot. The current from the battery is 1.6 A. Calculate the power supplied by the battery.

[2]

(b) A milliammeter and a 1.5 kV d.c. power supply are connected in series between K and J. The positive terminal of the power supply is connected to K.
(i) The milliammeter registers a small current. Explain the presence of a current in this circuit despite the gap between J and K.

[3]

(ii) State why the glass vessel must be evacuated.

[1]

(iii) One pole of a bar magnet is brought close to the side S of the glass vessel and the current registered by the milliammeter decreases. Explain why this happens.

[2]

(iv) The terminals of the 1.5 kV d.c. power supply are reversed. Explain how this affects the current in the milliammeter.

[2]

(c) Fig. 11.2 shows two terminals M and N of a potential divider (potentiometer) connected to a 6.0 V battery. N is also connected to one of the two Y-input terminals of a cathode-ray oscilloscope. The other Y-input terminal is connected to the sliding contact of the potential divider (potentiometer).

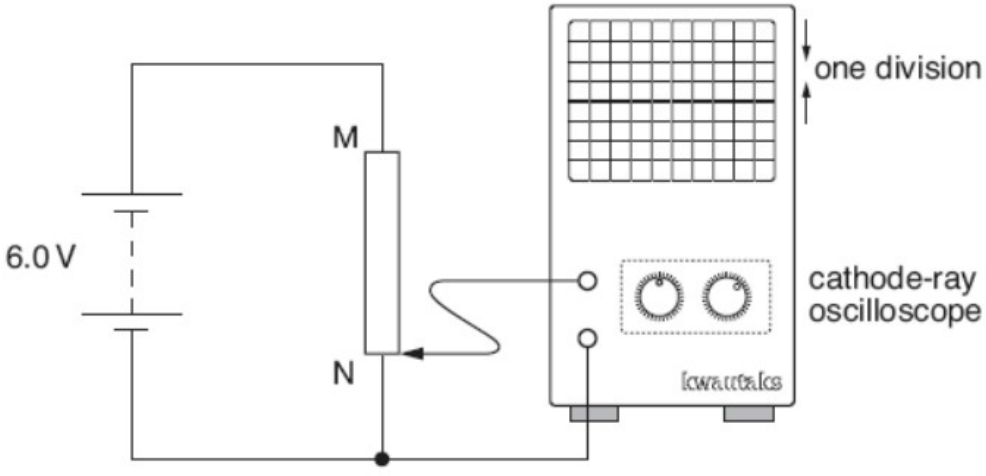


Fig. 11.2

The sliding contact is at N and the trace on the oscilloscope is a horizontal line passing through the centre of the screen.

(i) The timebase setting is 1.0 ms / div. Explain why the trace is a horizontal line.

[1]

(ii) The Y-gain setting is 2.0 V / div. The sliding contact is moved at a slow, uniform rate from N to M. Describe in detail what happens to the trace on the screen.

[3]

(iii) The Y-gain setting is now changed to 1.0 V / div and the trace disappears from the screen.
State why this happens.

[1]

4. Fig. 7.1 shows a simple version of an electron-beam tube.

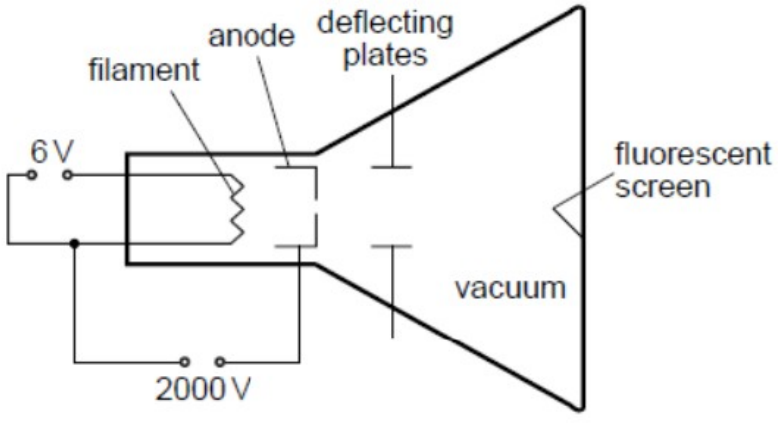


Fig. 7.1

The filament is connected to a 6 V power supply and there is a potential difference of 2000 V between the filament and the anode. As the electron beam hits the fluorescent screen, a spot of light appears on the screen.
(a) Explain why
(i) Electrons are emitted from the filament,

(ii) Electrons accelerate after they leave the filament,

(iii) A vacuum is needed in the tube.

[3]

(b) An alternating potential difference of very low frequency is applied across the deflecting plates in Fig. 7.1. The spot of light on the screen is seen to move. Describe and explain the movement of the spot.

[2]

Total [5]

X-RAYS

1. a) Explain why an x-ray tube is evacuated. (1mk)

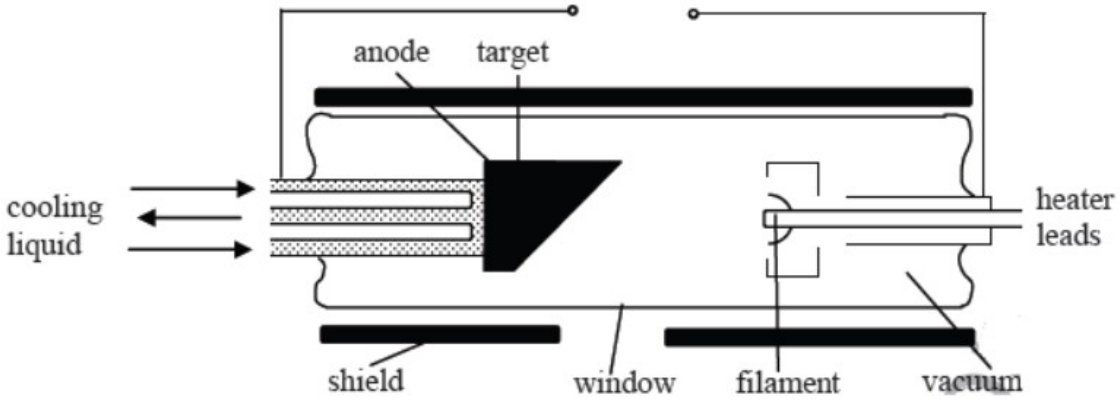
(b) Distinguish between 'hard and soft' x - rays. (3mk)

(4mk)

2. An X -ray machine is almost entirely surrounded by a metal shield. Name this metal and explain why this metal must surround it. Also, explain why the person who operates the machine must wear a similar metal shield.

[3]

3. The diagram shows a picture of a machine that produces X-rays. There is a high potential difference between the target and the filament. The target is connected to the positive side and is called the anode.



(a) On the diagram draw three straight lines (representing X-rays) to show the direction of travel of the X-rays. [2]

(b) State the name given to the filament when it is connected to the negative side of the potential difference.

[1]

(c) State an approximate value for the potential difference across the X-ray tube.

[1]

(d)Describe what happens when the filament is heated in the X-ray tube.

[2]

(e) Explain why a cooling system is needed near the anode.

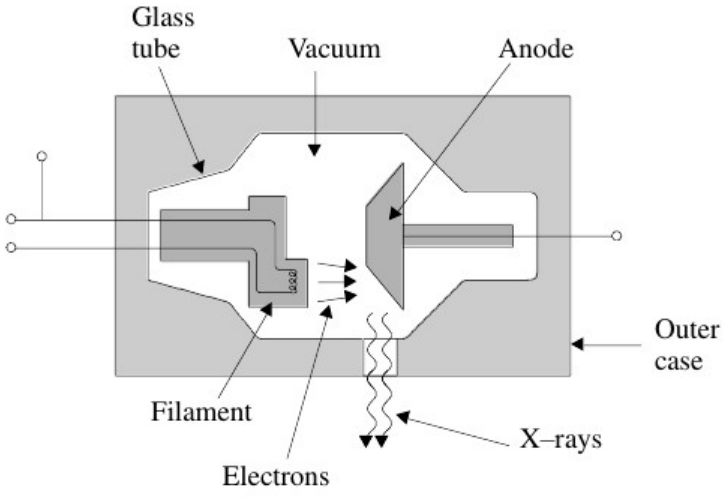
[2]

(f) Explain what would happen if there was a gas inside the tube instead of a vacuum.

[2]

(g) The machine is almost entirely surrounded by a metal shield. Name this metal and explain why this metal must surround it. Also, explain why the person who operates the machine must wear a similar metal shield.

4. The diagram shows part of a diagnostic X-ray tube.



Suggest an appropriate operating voltage for this tube.

.....

(1)

Why is the anode rotated?

.....

(1)

Why is the X-ray tube evacuated?

.....

(1)

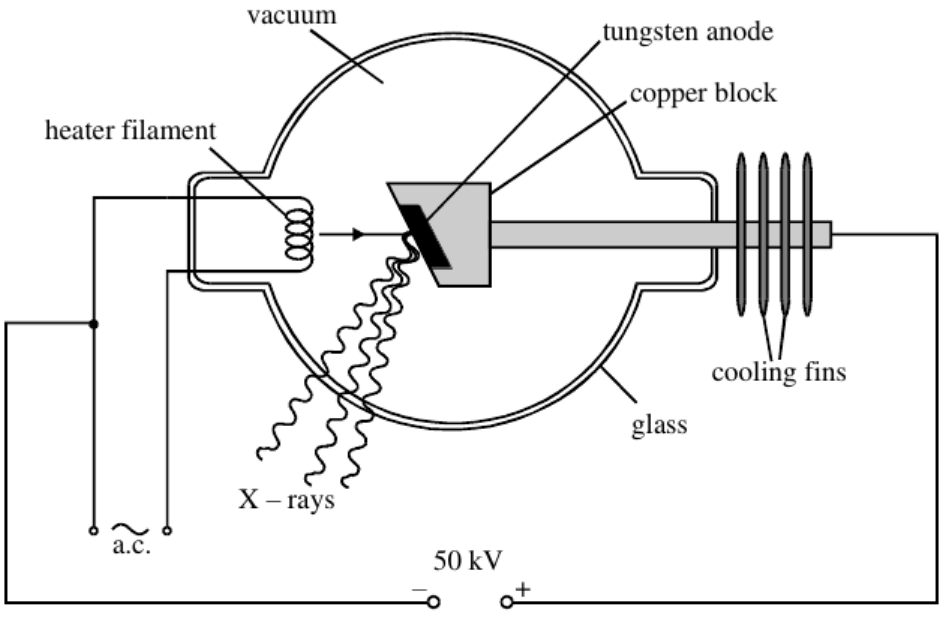
Suggest an appropriate material for the outer case.

.....

(1)

(Total 4 marks)

5. The diagram shows the construction of an X-ray tube. Electrons are emitted by the hot filament and fired at the tungsten anode where they are rapidly slowed down and produce X-rays.



(a) (i) Name the process in which electrons are emitted by a hot filament.

.....

(1)

(ii) Describe the energy transfers as the electrons move from the filament to the tungsten anode to produce X-rays.

.....

.....

.....

(iii) What is the source of energy for the electrons?

.....

PHOTOELECTRIC EFFECT

1. (a) The following equation describes the release of electrons from a metal surface illuminated by electromagnetic radiation.

$$hf = k.e._{max} + \phi$$

Explain briefly what you understand by each of the terms in the equation.

hf .....

.....

$k.e._{max}$ .....

.....

ϕ .....

.....

(3)
(Total 3 marks)

2. A 60 W light bulb converts electrical energy to visible light with an efficiency of 8%. Calculate the visible light intensity 2 m away from the light bulb.

.....

.....

.....

Intensity = ...

(3)

The average energy of the photons emitted by the light bulb in the visible region is 2 eV. Calculate the number of these photons received per square metre per second at this distance from the light bulb.

.....

.....

.....

Number of photons = ...m^{-2} s^{-1}

(2)
(Total 5 marks)

3. (a) Describe briefly how you would demonstrate in a school laboratory that different elements can be identified by means of their optical spectra

.....

.....

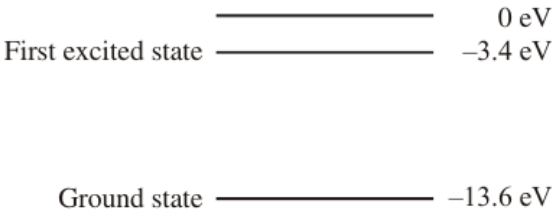
.....

.....

.....

(3)

(b) The diagram below is a simplified energy level diagram for atomic hydrogen.



A free electron with kinetic energy 12 eV collides with an atom of hydrogen and causes is to be raised to its first excited state.

Calculate the kinetic energy of the free electron (in eV) after the collision.

.....

.....

Kinetic energy = ...

Calculate the wavelength of the photon emitted when the atom returns to its ground state.

.....

.....

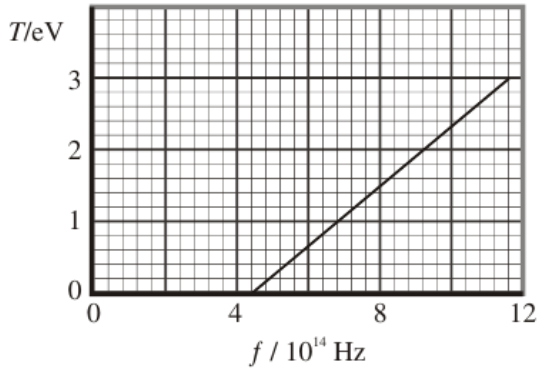
.....

Wavelength = ...

(4)

(Total 7 marks)

4. The graph shows how the maximum kinetic energy T of photoelectrons emitted from the surface of sodium metal varies with the frequency f of the incident radiation.



Why are no photoelectrons emitted at frequencies below 4.4×10^{14} Hz?

.....

.....

(1)

Calculate the work function Ø of sodium in eV.

.....

.....

.....

Work function = ...

(3)

Explain how the graph supports the photoelectric equation $hf = T + Ø$

.....

.....

.....

(2)

How could the graph be used to find a value for the Planck constant?

.....

.....

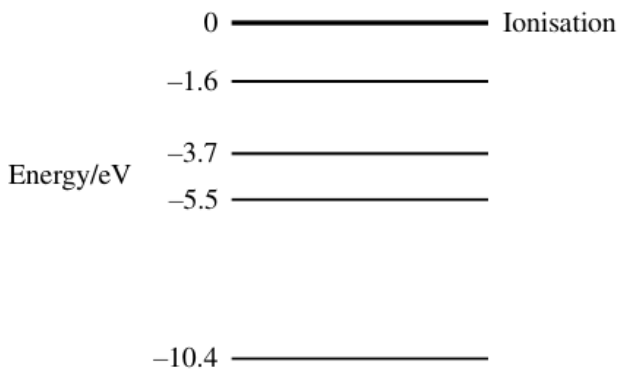
(1)

Add a line to the graph to show the maximum kinetic energy of the photoelectrons emitted from a metal which has a greater work function than sodium.

(2)

(Total 9 marks)

5. The diagram shows some of the outer energy levels of the mercury atom.



Calculate the ionisation energy in joules for an electron in the -10.4 eV level.

.....

.....

Ionisation energy = ...

(2)

An electron has been excited to the -1.6 eV energy level. Show on the diagram all the possible ways it can return to the -10.4 eV level.

(3)

Which change in energy levels will give rise to a yellowish line (λ = 600 nm) in the mercury spectrum?

.....

.....

.....

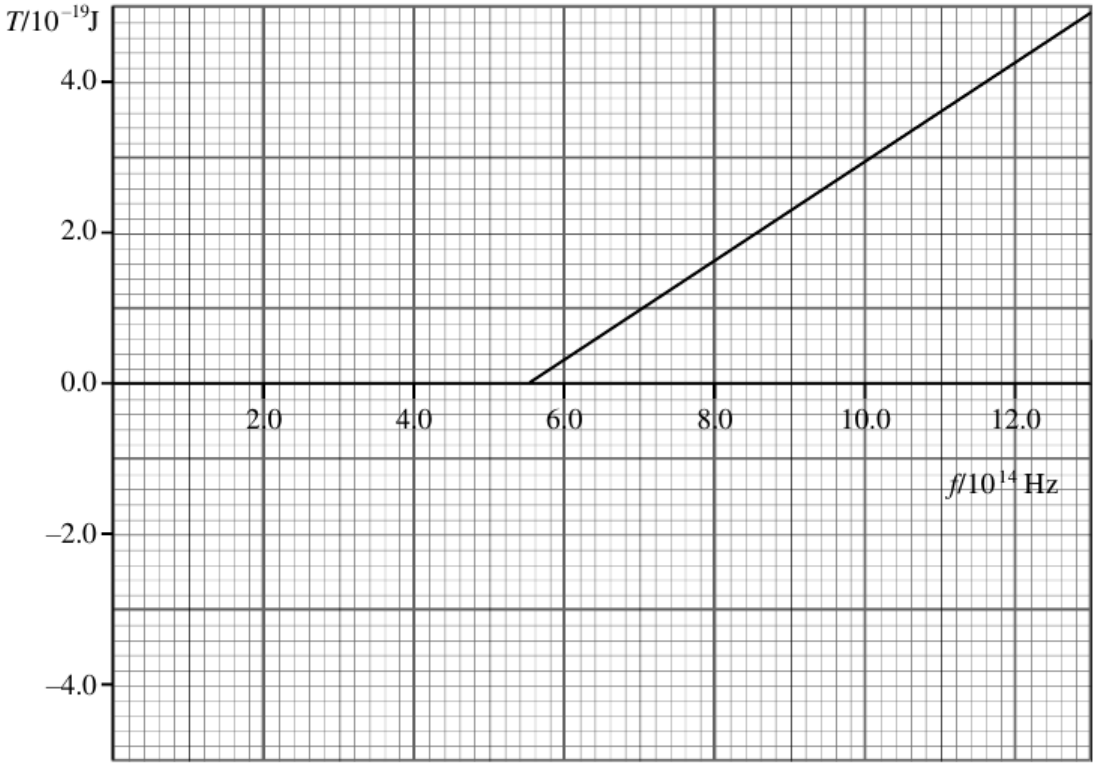
.....

.....

(4)

(Total 9 marks)

6. The graph shows how the maximum kinetic energy T of photoelectrons emitted from the surface of sodium metal varies with the frequency f of the incident electromagnetic radiation.



Use the graph to find a value for the Planck constant.

.....

.....

.....

.....

Planck constant = ...

Use the graph to find the work function ϕ of sodium metal.

Work function = ...

(2)

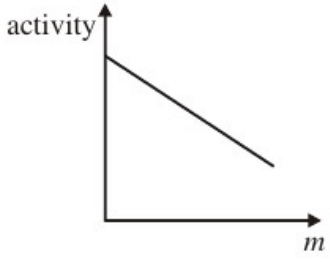
Calculate the stopping potential when the frequency of the incident radiation is 9.0×10^{14} Hz.

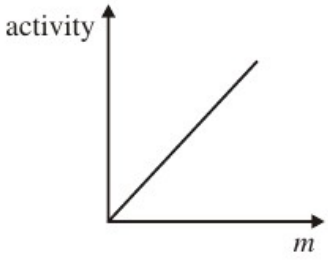
.....

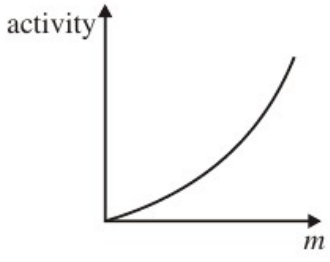
Stopping potential = ...

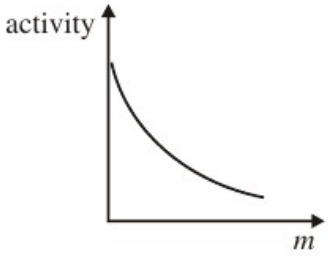
RADIOACTIVITY

1. Which of the following graphs shows the variation with mass *m* of the activity of a sample of a radioactive material?

A. 

B. 

C. 

D. 

(1)

2. When the isotope aluminium-27 is bombarded with alpha particles, the following nuclear reaction can take place

$$^{4}_{2}\mathrm{He} + {}^{27}_{13}\mathrm{Al} + \rightarrow \mathrm{X} + \mathrm{neutron}.$$

Which **one** of the following correctly gives the atomic (proton) number and mass (nucleon) number of the nucleus X?

	Proton number	Nucleon number
A.	15	30
B.	16	31
C.	30	15
D.	31	16

(1)

3. The following is a nuclear reaction equation.

$$^{1}_{1}\mathrm{H} + {}^{7}_{3}\mathrm{Li} \rightarrow 2\mathrm{X}.$$

X is

A. an alpha particle.

B. a neutron.

C. a proton.

D. an electron.

(1)

4. A sample of a radioactive isotope of half-life $T_{1/2}$ initially contains N atoms. Which **one** of the following gives the number of atoms of this isotope that have **decayed** after a time 3 $T_{1/2}$?

A. $\frac{1}{8}N$

B. $\frac{1}{3}N$

C. $\frac{2}{3}N$

D. $\frac{7}{8}N$

(1)

5. Thorium-234 is a radioactive substance. It decays into protactinium by emitting beta particles (â) and gamma rays (g).

(a) Complete the equation for this decay.

$$^{234}_{90}\mathrm{Th} \longrightarrow {}^{\ldots\ldots}_{\ldots\ldots}\beta + {}^{\ldots\ldots}_{\ldots\ldots}\mathrm{Pa}$$

(2)

(b) When a gamma ray (g) is emitted from a nucleus, the mass number and atomic number do not change.
Explain why.

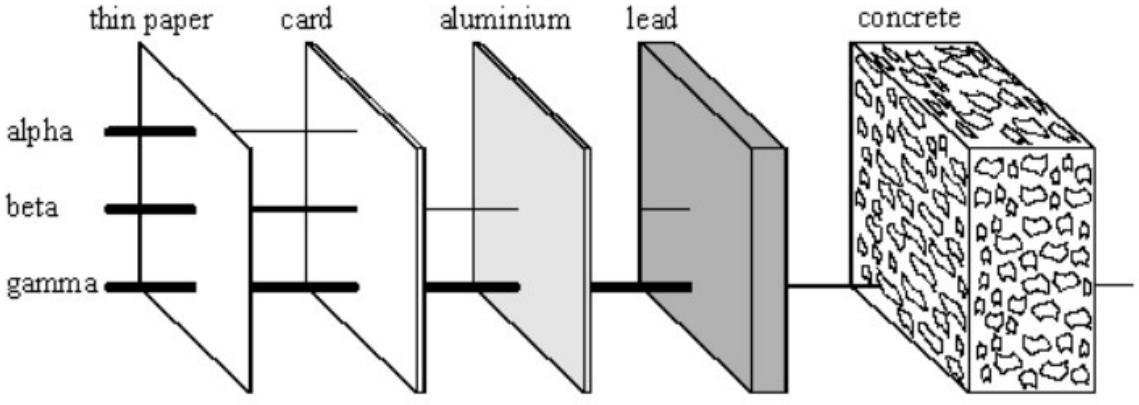
.....

.....

.....

(2)
(Total 4 marks)

6. The three main types of radioactive emission are called alpha, beta and gamma. The diagram shows the penetrations of alpha, beta and gamma radiation.

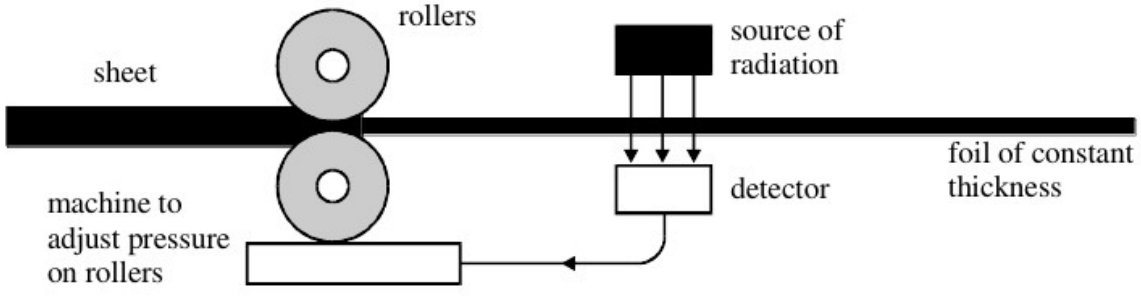


(a) Which type of radiation has the greatest penetration?

.....

(1)

(b) The diagram shows how aluminium sheet is rolled to form foil of constant thickness.



(i) Which type of radiation should be used to check the thickness of the foil?

.....

(1)

(ii) Explain why the other TWO types of radiation are **not** suitable.

.....

.....

.....

.....

(2)

(Total 4 marks)

7. The apparatus for investigating the absorption of the emissions from a radioactive source is shown in Fig. 11.1.

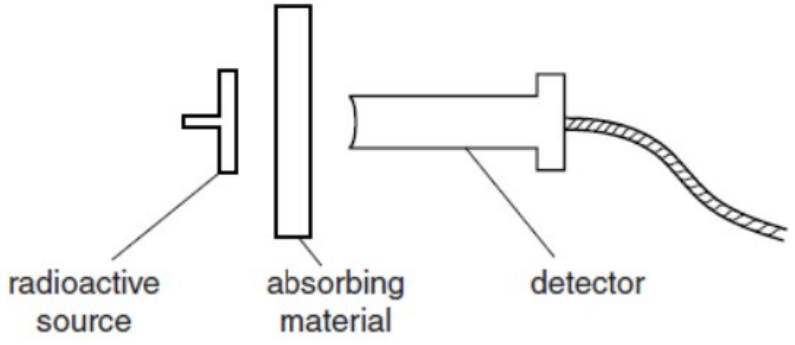


Fig. 11.1

The source and detector are about 2 cm apart. The detector is connected to a scaler, which measures the count rate.
Different absorbing materials are placed between the source and the detector.
The table below shows the count rate obtained with each of five absorbers.

absorbing material	count rate / counts/s
air	523
sheet of paper	523
0.5 mm of aluminium	391
10 mm of aluminium	214
10 mm of lead	122

ELECTRONIC

1. In n type semi conductor, added impurity is .....

(A) pentavalent.

(B) divalent.

(C) tetravalent.

(D) trivalent.

2. n-type semiconductor is an example of .....

(A) extrinsic semiconductor.

(B) intrinsic semiconductor.

(C) super conductor.

(D) insulators.

3. All semiconductors in their last orbit have .....

(A) 8 electrons.

(B) 2 electrons.

(C) 4 electrons.

(D) 6 electrons.

4. Holes are majority carriers in .....

(A) P-type semiconductors.

(B) N-type semiconductors.

(C) Insulators.

(D) Superconductors.

5. In order to obtain p-type germanium it should be doped with a.....

(A) Trivalent impurity.

(B) Tetravalent impurity.

(C) Pentavalent impurity.

(D) Any of the above will do.

6. Briefly explain how a p-type semiconductor is formed

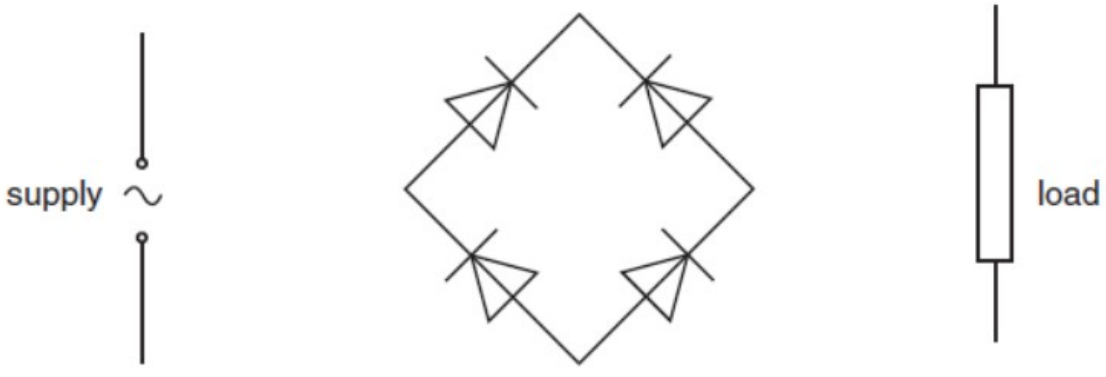
.....

.....

.....

(2mks)

7. The components for a bridge rectifier are shown in Figure.



(a) Complete the circuit of Figure by showing the connections of the supply and of the load to the diodes. [2]

(b) Suggest one advantage of the use of a bridge rectifier, rather than a single diode, for the rectification of alternating current.

.....

.....

.....

[1]

(c) State
(i) What is meant by *smoothing*,

.....

.....

.....

[1]

(ii) The effect of the value of the capacitance of the smoothing capacitor in relation to smoothing.

.....

.....

.....

[2]

8. (a) Draw a well labeled diagram of a P-N junction in forward bias mode.

[2m]

(b) Sketch a V-I graph for a diode and clearly show the forward and reverse bias characteristics.

[3m]
[Total 5m]

9. (a) What is the difference between intrinsic and extrinsic semi-conductors?

.....

.....

[2m]

(b) What do you understand by the term doping?

.....

.....

[1m]

(c) Suggest a suitable doping material for n-type semi-conductor.

.....

[1m]

[Total 3m]