[C272/SQP362]

Physics
Higher
Specimen Question Paper
for use in and after 2012

Time: 2 hours 30 minutes

NATIONAL QUALIFICATIONS

Read Carefully

1 All questions should be attempted.

Section A (questions 1 to 20)

2 Check that the answer sheet is for Physics Higher (Section A).
3 Answer the questions numbered 1 to 20 on the answer sheet provided.
4 Fill in the details required on the answer sheet.
5 Rough working, if required, should be done only on this question paper, or on the first two pages of the answer book provided—**not** on the answer sheet.
6 For each of the questions 1 to 20 there is only **one** correct answer and each is worth 1 mark.
7 Instructions as to how to record your answers to questions 1–20 are given on page three.

Section B (questions 21 to 32)

8 Answer the questions numbered 21 to 32 in the answer book provided.
9 Fill in the details on the front of the answer book.
10 Enter the question number clearly in the margin of the answer book beside each of your answers to questions 21 to 32.
11 Care should be taken to give an appropriate number of significant figures in the final answers to calculations.

DATA SHEET

COMMON PHYSICAL QUANTITIES

Quantity	*Symbol*	*Value*	*Quantity*	*Symbol*	*Value*
Speed of light in vacuum	c	$3{\cdot}00 \times 10^{8}\ \mathrm{m\,s^{-1}}$	Planck's constant	h	$6{\cdot}63 \times 10^{-34}\ \mathrm{J\,s}$
Magnitude of the charge on an electron	e	$1{\cdot}60 \times 10^{-19}\ \mathrm{C}$	Mass of electron	m_e	$9{\cdot}11 \times 10^{-31}\ \mathrm{kg}$
Universal Constant of Gravitation	G	$6{\cdot}67 \times 10^{-11}\ \mathrm{m^3\,kg^{-1}\,s^{-2}}$	Mass of neutron	m_n	$1{\cdot}675 \times 10^{-27}\ \mathrm{kg}$
Gravitational acceleration on Earth	g	$9{\cdot}8\ \mathrm{m\,s^{-2}}$	Mass of proton	m_p	$1{\cdot}673 \times 10^{-27}\ \mathrm{kg}$
Hubble's constant	H_o	$2{\cdot}3 \times 10^{-18}\ \mathrm{s^{-1}}$			

REFRACTIVE INDICES

The refractive indices refer to sodium light of wavelength 589 nm and to substances at a temperature of 273K.

Substance	*Refractive index*	*Substance*	*Refractive index*
Diamond	2·42	Water	1·33
Crown glass	1·50	Air	1·00

SPECTRAL LINES

Element	*Wavelength*/nm	*Colour*
Hydrogen	656	Red
	486	Blue-green
	434	Blue-violet
	410	Violet
	397	Ultraviolet
	389	Ultraviolet
Sodium	589	Yellow

Element	*Wavelength*/nm	*Colour*
Cadmium	644	Red
	509	Green
	480	Blue

Lasers

Element	*Wavelength*/nm	*Colour*
Carbon dioxide	9550, 10590	Infrared
Helium-neon	633	Red

PROPERTIES OF SELECTED MATERIALS

Substance	*Density*/kg m^{-3}	*Melting Point*/K	*Boiling Point*/K
Aluminium	$2{\cdot}70 \times 10^{3}$	933	2623
Copper	$8{\cdot}96 \times 10^{3}$	1357	2853
Ice	$9{\cdot}20 \times 10^{2}$	273	. . . .
Sea Water	$1{\cdot}02 \times 10^{3}$	264	377
Water	$1{\cdot}00 \times 10^{3}$	273	373
Air	1·29	. . . .	. . . .
Hydrogen	$9{\cdot}0 \times 10^{-2}$	14	20

The gas densities refer to a temperature of 273 K and a pressure of $1{\cdot}01 \times 10^{5}$ Pa.

SECTION A

For questions 1 to 20 in this section of the paper the answer to each question is either A, B, C, D or E. Decide what your answer is, then, using your pencil, put a horizontal line in the space provided—see the example below.

EXAMPLE

The energy unit measured by the electricity meter in your home is the

A kilowatt-hour

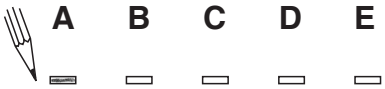
B ampere

C watt

D coulomb

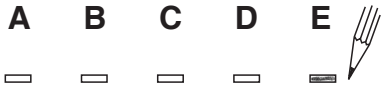
E volt.

The correct answer is **A**—kilowatt-hour. The answer **A** has been clearly marked in **pencil** with a horizontal line (see below).



Changing an answer

If you decide to change your answer, carefully erase your first answer and, using your pencil, fill in the answer you want. The answer below has been changed to **E**.



SECTION A

Answer questions 1–20 on the answer sheet.

1. A spacecraft is travelling in a straight line with a speed of $1{\cdot}4 \times 10^3\,\mathrm{m\,s^{-1}}$. Booster rockets are fired for 50 s and the speed increases to $1{\cdot}5 \times 10^3\,\mathrm{m\,s^{-1}}$.

What is the average acceleration of the spacecraft?

A $2{\cdot}0 \times 10^{-3}\,\mathrm{m\,s^{-2}}$

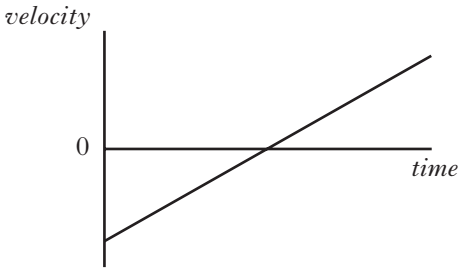
B $0{\cdot}20\,\mathrm{m\,s^{-2}}$

C $2{\cdot}0\,\mathrm{m\,s^{-2}}$

D $5{\cdot}0\,\mathrm{m\,s^{-2}}$

E $500\,\mathrm{m\,s^{-2}}$

2. Which of the following velocity-time graphs shows the motion of an object which changes direction?

A


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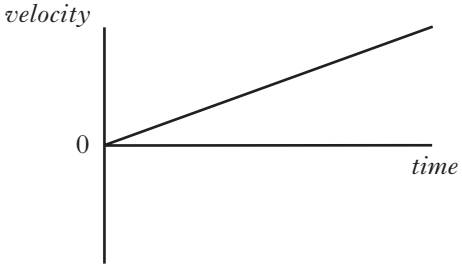
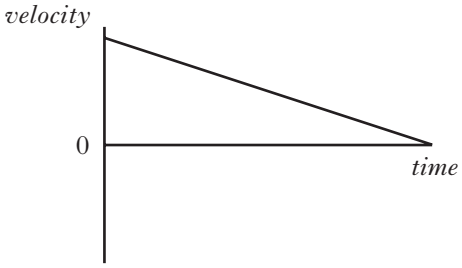
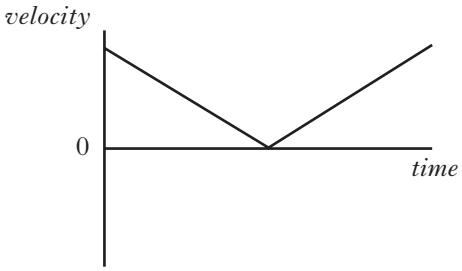
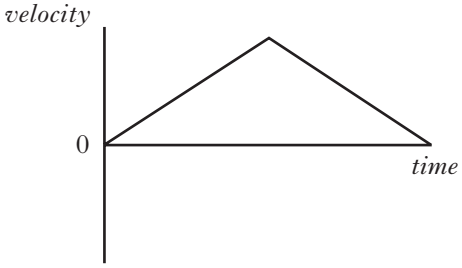


C


D


E


3. A vehicle of mass 800 kg is travelling at $20\,m\,s^{-1}$ on a straight level road. The brakes are applied to bring the vehicle to rest. The change in kinetic energy of the vehicle is

A 8·0 kJ

B 16 kJ

C 160 kJ

D 320 kJ

E 640 kJ.

4. In an experiment to determine the average speed of a toy car, the following measurements and uncertainties are recorded.

distance travelled = 0·50 ± 0·01 m

time taken = 1·20 ± 0·06 s

A student makes the following statements about the percentage uncertainties.

I The percentage uncertainty in the distance measurement is ±2 %.

II The percentage uncertainty in time measurement is ±5 %.

III The percentage uncertainty in the calculated value of the average speed is ±7 %.

Which of these statements is/are correct?

A I only

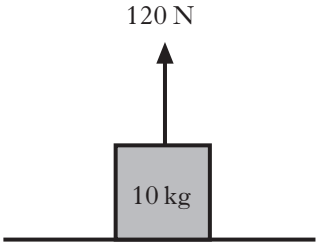
B II only

C III only

D I and II only

E I, II and III

5. A box of mass 10·0 kg is at rest on the ground. A constant vertical force of 120 N is applied to the box to lift it from the ground.



The acceleration of the box is

A $0{\cdot}80\,m\,s^{-2}$

B $2{\cdot}2\,m\,s^{-2}$

C $8{\cdot}2\,m\,s^{-2}$

D $12\,m\,s^{-2}$

E $22\,m\,s^{-2}$.

6. A football of mass 0·75 kg is initially at rest. A girl kicks the football and it moves off with an initial speed of $12\,m\,s^{-1}$. The time of contact between the girl's foot and the football is 0·15 s.

The average force applied to the football as it is kicked is

A 1·4 N

B 1·8 N

C 2·4 N

D 60 N

E 80 N.

7. A skydiver jumps out of a plane. The table shows the vertical speed of the skydiver at regular time intervals after leaving the plane.

Time/s	*Speed*/m s^{-1}
0	0·0
3	25
6	45
9	50
12	53
15	55
18	55
21	55

A student makes the following conclusions based on the information in the table.

I The acceleration due to gravity is 9·8 m s^{-2}.

II Between 15 s and 21 s the forces acting on the skydiver are balanced.

III Between 0 s and 9 s the acceleration of the skydiver is increasing.

Based on the information in the table, which of these conclusions is/are correct?

A I only

B II only

C III only

D I and II only

E II and III only

8. A spaceship on a launch pad is measured to have a length L. This spaceship has a speed of $2{\cdot}5 \times 10^8$ m s^{-1} as it passes a planet.

Which row in the table describes the length of the spaceship as measured by the pilot in the spaceship and an observer on the planet?

	Length measured by pilot in the spaceship	*Length measured by observer on the planet*
A	*L*	less than *L*
B	*L*	greater than *L*
C	*L*	*L*
D	less than *L*	*L*
E	greater than *L*	*L*

9. The siren on an ambulance is emitting sound with a constant frequency of 900 Hz. The ambulance is travelling at a constant speed of 25 m s^{-1} as it approaches and passes a stationary observer. The speed of sound in air is 340 m s^{-1}.

Which row in the table shows the frequency of the sound heard by the observer as the ambulance approaches and as it moves away from the observer?

	Frequency as ambulance approaches/Hz	*Frequency as ambulance moves away*/Hz
A	900	900
B	971	838
C	838	900
D	971	900
E	838	971

10. Light from an element in a distant star is observed by an astronomer. Analysis of the line spectrum of this light shows it to be redshifted compared to the line spectrum of the same element on Earth.

Compared to the spectrum observed from this element on Earth

A the frequency of each line in the spectrum from the star is greater

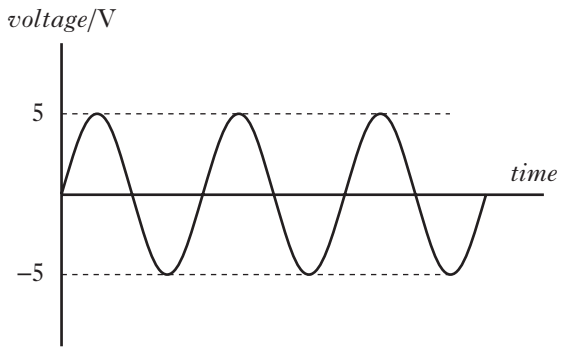
B the wavelength of each line in the spectrum from the star is less

C the frequency of each line in the spectrum from the star is less

D the wavelength of each line in the spectrum from the star is the same

E the frequency of each line in the spectrum from the star is the same.

11. The graph represents an alternating voltage.



The r.m.s. (root mean square) voltage is

A $\frac{5}{\sqrt{2}}$ V

B $10\sqrt{2}$ V

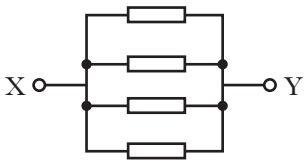
C 5 V

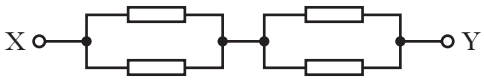
D $5\sqrt{2}$ V

E $\frac{10}{\sqrt{2}}$ V.

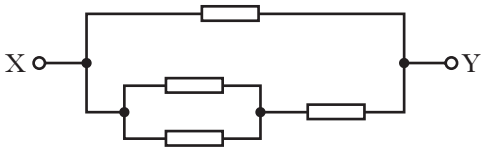
12. In the diagrams below, each resistor has the same resistance.

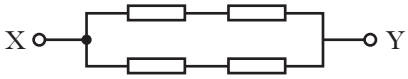
Which combination has the **least** value of the effective resistance between the terminals X and Y?

A 

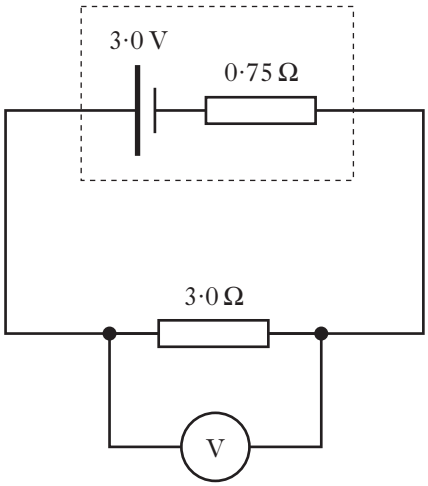
B 

C 

D 

E 

13. A cell has an e.m.f. of 3·0 V and internal resistance 0·75 Ω. The cell is connected to a 3·0 Ω resistor.



The reading on the voltmeter is

A 0·60 V

B 2·4 V

C 3·0 V

D 3·4 V

E 9·0 V.

14. In a semiconductor, the energy gap between the valence band and the conduction band is

A small, allowing some conduction to take place at room temperature

B large, allowing some conduction to take place at room temperature

C zero, allowing electrons to move freely

D large, meaning that no conduction can take place at room temperature

E small, meaning that no conduction can take place at room temperature.

15. The letters **X**, **Y** and **Z** represent the missing words from the following passage.

There are four fundamental forces.

*Gravity and the electromagnetic force act over a …***X***… range.*

*The strong and weak force act over a …***Y***…* range.

*The …***Z***… force is responsible for beta decay.*

Which row in the table identifies the missing words represented by the letters **X**, **Y** and **Z**?

	X	**Y**	**Z**
A	short	long	strong
B	long	short	strong
C	long	short	weak
D	long	long	electromagnetic
E	short	long	weak

16. Which row in the table shows an example of a hadron, lepton and boson?

	Hadron	*Lepton*	*Boson*
A	neutron	photon	electron
B	electron	neutron	photon
C	photon	electron	neutron
D	neutron	electron	photon
E	electron	photon	neutron

17. Which of the following is true concerning the photoelectric effect?

A The photoelectric effect is evidence for the wave nature of light.

B The photoelectric effect can be observed using a diffraction grating.

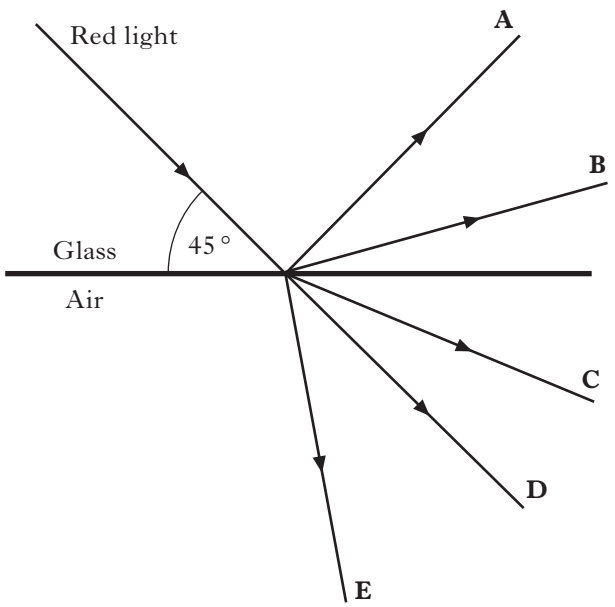
C The photoelectric effect can only be observed with ultra-violet light.

D The photoelectric effect can only be observed with infra-red light.

E The photoelectric effect is evidence for the particulate nature of light.

18. The diagram below shows a ray of red light meeting a boundary between glass and air.

The refractive index of the glass for this light is 1·48.



Which of the lines labelled **A**, **B**, **C**, **D** and **E** shows the direction of the ray after meeting the boundary?

19. Light from a point source is incident on a screen. The screen is 3·0 m from the source.

The irradiance at the screen is 8·0 W m^{-2}.

The light source is now moved until it is 12 m from the screen.

The irradiance at the screen is now

A 0·50 W m^{-2}

B 1·0 W m^{-2}

C 2·0 W m^{-2}

D 4·0 W m^{-2}

E 8·0 W m^{-2}.

20. The spectral type of stars is a classification which depends on the wavelength of the brightest emitted light.

Spectral type	*Wavelength of brightest light*
O	<97 nm
B	97–290 nm
A	290–390 nm
F	390–480 nm
G	480–580 nm
K	580–830 nm
M	>830 nm

The spectrum of the star Polaris is found to emit very strong violet and ultraviolet light corresponding to lines in the spectrum of hydrogen.

The spectral type of Polaris is

A Spectral type O

B Spectral type B

C Spectral type F

D Spectral type K

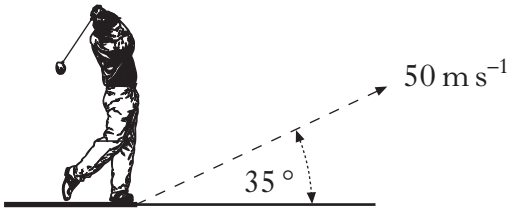
E Spectral type M.

SECTION B

Marks

Write your answers to questions 21 to 32 in the answer book.

21. A golf ball is hit with a velocity of $50\,\mathrm{m\,s^{-1}}$ at an angle of 35 ° to the horizontal as shown.

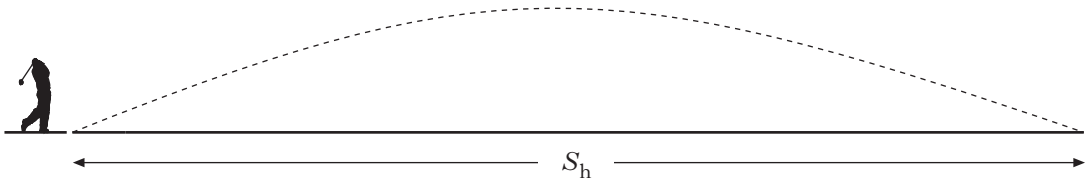


(*a*) (i) Calculate the initial horizontal component of the velocity of the ball. **1**

(ii) Calculate the initial vertical component of the velocity of the ball. **1**

(*b*) Assuming air resistance is negligible, calculate the maximum height reached by the ball. **2**

(*c*) The diagram below shows the trajectory of the ball when air resistance is negligible.



(i) Show that the horizontal distance, S_h, travelled by the ball is 240 m. **3**

(ii) Copy this diagram and, on it, draw the trajectory taken by the ball if air resistance is **not** negligible. Numerical values are not required but your answer should illustrate how the original path will change. **2**

(9)

Marks

22. In the paragraph below, an author describes the pursuit of a Roman soldier by an archer.

He sensed as much as saw the solid black line of an arrow as it shot past him, accelerating into the night. A second later, he heard the wisp of an arrow's passing. He wondered if it was another unseen arrow or the sound of the first.

Using physics principles comment on the paragraph. **(3)**

23. By observing the spectrum of light received from galaxy M101, astronomers have determined that the galaxy is moving away from us with a velocity of $5{\cdot}5 \times 10^5\ \mathrm{m\,s^{-1}}$.

(*a*) Calculate the distance of the galaxy from us. **3**

(*b*) The observation that galaxies are moving away from us is evidence for the expanding universe. As the universe expands it cools down.

What property of the Cosmic Microwave Background has been measured by astronomers to determine the present temperature of the universe? **1**

(4)

24. According to Newton's Universal Law of Gravitation, the force exerted by the Earth on an object is proportional to the mass of the object. A student suggests that this means that a heavy object will fall with a greater acceleration than a light object.

Use your knowledge of physics to explain why this is not true. **(2)**

Marks

25. (*a*) The average density, ρ, of an object of mass, m, and volume, V, can be found using the relationship $\rho = m/V$.

A spacecraft orbits a planet which can be assumed to be spherical. The planet has a radius of $6{\cdot}05 \times 10^6$ m and a mean density of $5{\cdot}24 \times 10^3$ kg m^{-3}.

Table A gives values of the masses of three different planets.

Planet	*Mass of planet*/kg
Mercury	$3{\cdot}30 \times 10^{23}$
Venus	$4{\cdot}86 \times 10^{24}$
Earth	$5{\cdot}97 \times 10^{24}$

Table A

Show by calculation which planet the spacecraft is orbiting. **3**

(*b*) The spacecraft can orbit the planet at various distances, R, from its centre. The period of the spacecraft's orbit, T, is related to the distance from the centre of the planet.

Table B gives data on the period of orbit and the distance from the centre of the planet.

Period of orbit $T/10^3$ s	*Distance from centre* $R/10^6$ m
2·20	8·00
4·04	12·0
6·22	16·0

Table B

Using all the data given in Table B, show which **one** of the following relationships is true.

(i) $T \propto R$

(ii) $T^2 \propto R^2$

(iii) $T^2 \propto R^3$ **3**

(6)

Marks

26. (*a*) A conversation is overheard between two young pupils who are discussing their science lessons.

Pupil A *"We learned in science today that the nucleus of an atom is made of protons which are positively charged and neutrons which have no charge."*

Pupil B *"That's interesting because we learned in science that like charges repel. How come the protons in the nucleus don't fly apart?"*

Pupil A *"I don't know."*

Write a paragraph that would explain to the pupils why the protons in a nucleus do not fly apart. **3**

(*b*) Protons and neutrons each contain two different types of quark: the up quark which has an electric charge of $+\frac{2}{3}$ and the down quark which has an electric charge of $-\frac{1}{3}$.

Use this information to show:

(i) the overall charge on the proton is +1;

(ii) the overall charge on the neutron is zero. **2**

(*c*) The Large Hadron Collider (LHC) accelerates beams of protons in opposite directions. The protons are allowed to collide within a very small space, releasing a substantial amount of energy.

By referring to the equation $E = mc^2$, explain how this produces a shower of particles. **1**

(6)

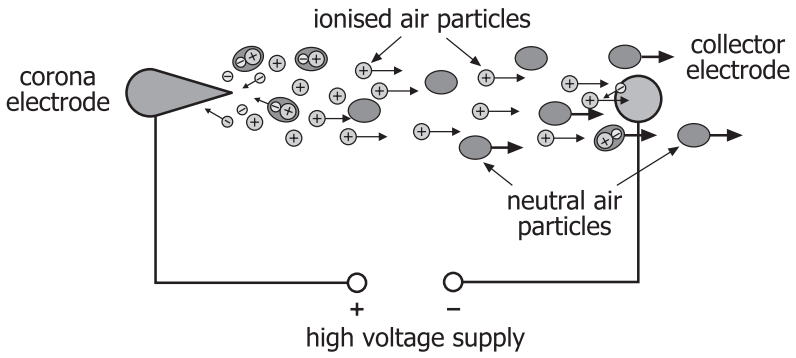
Marks

27. The following article features in a "How Things Work" website.

HOW THINGS WORK

HOW THINGS WORK

Scientists have created several working prototypes of a corona discharge cooler, which can silently but effectively cool the microprocessor of a computer.



The corona discharge cooler works in the following manner.

A strong electric field is created at the tip of the corona electrode, which is placed on one side of the microprocessor. This causes the oxygen and nitrogen molecules in the air to become ionised (positively charged) and create a cloud (corona) of charged particles.

Placing a negative electrode at the opposite end of the microprocessor causes the charged ions to accelerate towards this electrode, colliding with neutral air molecules on the way. During these collisions, momentum is transferred from the ionised gas to the neutral air molecules, resulting in movement of gas towards the collector electrode.

The advantages of the corona-based cooler are: it has no moving parts, it operates with a near-zero noise level and it has a very low power consumption of 0·1 W.

(*a*) Describe how the gas molecules "become ionised". **1**

(*b*) Explain why the charged ions accelerate towards the collector electrode. **1**

(*c*) The p.d. between the electrodes is 1·0 kV. Assuming that the field between the electrodes is uniform and the charge on each ion is $1{\cdot}6 \times 10^{-19}$ C:

(i) calculate the work done in moving one ion between the electrodes; **2**

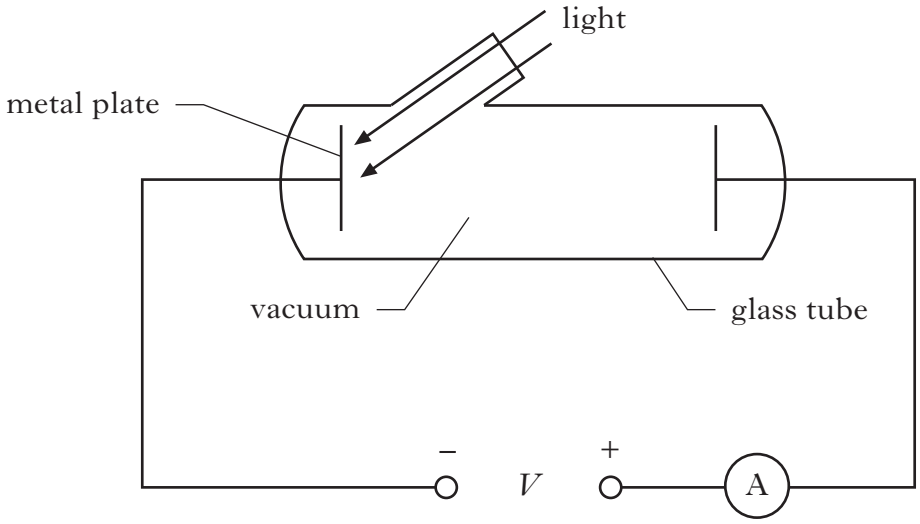
(ii) calculate how many ions are created each second. **2**

(*d*) Explain how this device cools the microprocessor. **2**

(8)

Marks

28. (*a*) The diagram shows equipment used to investigate the photoelectric effect.



When blue light is shone on the metal plate there is a current in the circuit.

When blue light is replaced by red light there is no current.

Explain why this happens. **2**

(*b*) The blue light has a frequency of $7{\cdot}0 \times 10^{14}$ Hz.

The work function for the metal plate is $2{\cdot}0 \times 10^{-19}$ J

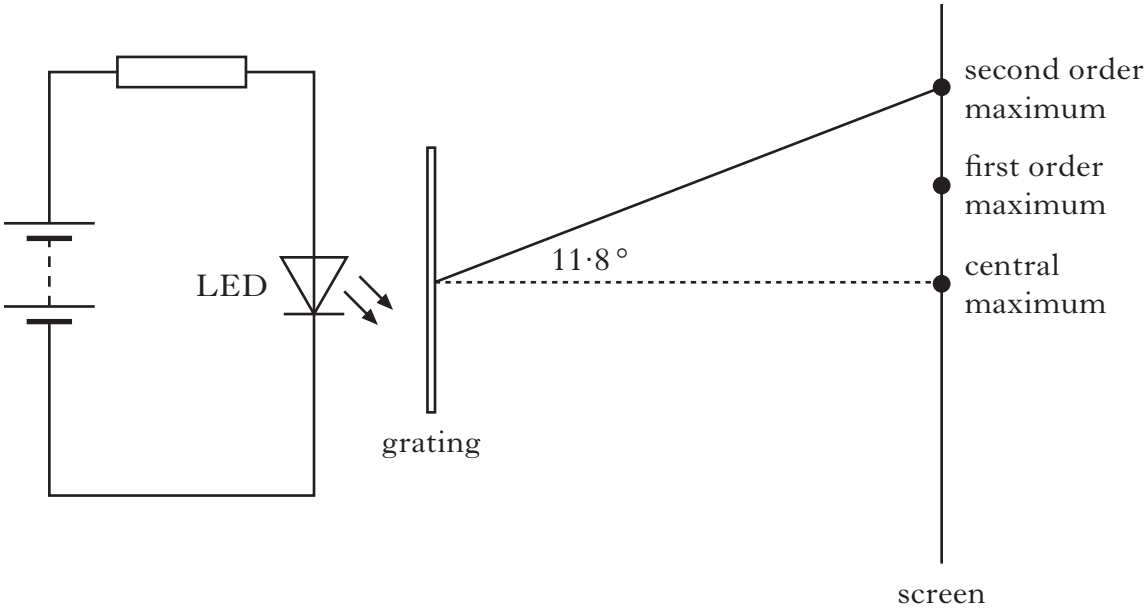
Calculate the maximum kinetic energy of the electrons emitted from the plate by this light. **3**

(5)

Marks

29. (*a*) Monochromatic light from a light emitting diode (LED) is incident on a grating as shown.

The grating has 200 lines per mm.



(i) Calculate the wavelength of the light emitted by the LED. **3**

(ii) State the colour of the LED. **1**

(*b*) The grating is now changed for one which has more lines per mm.

State the effect this has on the pattern observed on the screen. Justify your answer. **2**

(*c*) The grating is now used to view the spectrum produced by sunlight. A number of dark lines are observed on the spectrum.

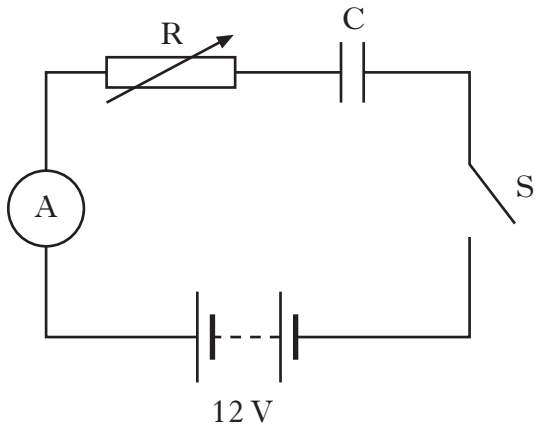
Why does the spectrum of sunlight include these dark lines? **2**

(8)

Marks

30. A 200 μF capacitor is charged using the circuit shown.

The 12 V battery has negligible internal resistance.



The capacitor is initially uncharged.

The switch S is closed. The charging current is kept constant at 30 μA by adjusting the resistance of the variable resistor, R.

(*a*) Calculate the resistance of the variable resistor R just after the switch is closed. **2**

(*b*) Should the resistance of R be increased or decreased to keep the current constant as the capacitor is charging?

You must justify your answer. **2**

(*c*) Calculate:

(i) the charge on the capacitor 30 s after the switch S is closed; **2**

(ii) the potential difference across R at this time. **3**

(9)

31. The Sun is constantly ejecting positive and negative charged particles at very high speed. This flow of charged particles is called the solar wind. The charged particles can cause significant damage to life and also to electrical equipment if they reach the surface of the Earth. We are protected from the charged particles by a field. This field, produced by the Earth, deflects the solar wind.

Using your knowledge of physics, explain whether the protecting field is electric, magnetic or gravitational. **(3)**

Marks

32. An extract from a student's investigation diary is shown.

9th November

Investigation – Preventing damage from earthquakes

Today we carried out an experiment to find out how the amplitude of vibration of the top of a tall building depended on the frequency of vibration of the ground.

We used a flexible model of a building which was stuck to a horizontal plate that we vibrated at different frequencies.

Here are the results.

Vibration Frequency (Hz)	Amplitude of Vibration (cm)
0·5	1·8
1·0	3·2
1·5	4·8
2·0	4·9
2·5	3·4
3·0	1·0

The student has taken six sets of readings.

(*a*) Sketch a graph of the results. **2**

(*b*) Suggest a possible conclusion based on the results and your sketch graph. **1**

(*c*) Suggest **two** improvements that the student could have made to the collection of data for this experiment. **2**

(*d*) Describe further experimental work that would produce data that could inform engineers in the design of buildings in earthquake zones. **2**

(7)

[*END OF SPECIMEN QUESTION PAPER*]

[C272/SQP362]

Physics
Higher
Specimen Marking Instructions
for use in and after 2012

NATIONAL
QUALIFICATIONS

Physics Higher

Specimen Question Paper

Marking scheme

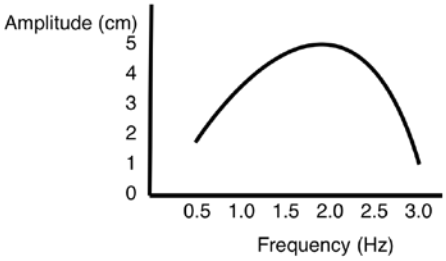
Section A

1.	B	11.	A
2.	A	12.	A
3.	C	13.	B
4.	D	14.	A
5.	B	15.	C
6.	D	16.	D
7.	B	17.	E
8.	A	18.	A
9.	B	19.	A
10.	C	20.	C

Physics − Higher Specimen Question Paper						
Sample Answer and Mark Allocation					**Notes**	Inner Margin	Outer Margin
21	(*a*)	(i)	Initial horizontal component = $v\cos\theta$ = 50 × cos 35 = 41 m s^{-1}	1	no formula half	1	9
		(ii)	Initial vertical component = $v\sin\theta$ = 50 × sin 35 = 29 m s^{-1}	1	no formula half	1	
	(*b*)		$v^2 = u^2 + 2as$ $0 = 29^2 + 2 \times (-9{\cdot}8) \times s$ $s = 29^2/19{\cdot}6$ = 43 m	½ ½ 1		2	
	(*c*)	(i)	$v = u + at$ $v = 29 - 9{\cdot}8\,t$ $t = 0 - 29/-9{\cdot}8$ = 2·96 (s) Total time (up and down) = 2·96 × 2 = 5·92 (s) $s_h = v_h \times t$ = 41 × 5·92 (= 240 m)	½ ½ ½ ½ ½ ½		3	
		(ii)	Reduced maximum height Smaller horizontal distance travelled	1 1	No requirement to show position of max height, nor unsymmetrical trajectory	2	
22			Demonstrates no understanding Limited understanding Reasonable understanding Good understanding	0 1 2 3	Open ended question	3	3
23	(*a*)		$v = H_0\,d$ $H_0 = 2{\cdot}3 \times 10^{-18}$ (s^{-1}) $5{\cdot}5 \times 10^5 = 2{\cdot}3 \times 10^{-18} \times d$ d = $2{\cdot}4 \times 10^{23}$ m	½ 1 ½ 1	Look up Hubble's constant	3	4
23	(*b*)		Wavelength (or frequency)	1	Single word answer is acceptable	1	
24			Reference to $F = ma$ (or equivalent) F and m increase by same amount hence a is constant	1 1		2	2

25	(*a*)		Volume = $4/3\ \pi\ r^3$ $= 4/3\ \pi\ (6{\cdot}05 \times 10^6)^3$ $= 9{\cdot}27 \times 10^{20}\ m^3$ $\rho = m/V$ $5{\cdot}24 \times 10^3 = m\ /\ 9{\cdot}27 \times 10^{20}$ $m = 4{\cdot}86 \times 10^{24}$ (kg) Spacecraft orbits Venus	½ ½ ½ ½ ½ ½	Selected from data booklet No formula half	3	6
	(*b*)		Period^2 Radius^3 Period^2/Radius^3 4·84 512 9·45 16·3 1728 9·43 38·7 4096 9·45 Calculation of T^2 and R^3 Calculation of T^2 / R^3 Concluding T^2 / R^3 is constant	 1 1 1	 No requirement to show powers of 10	3	
26	(*a*)		Reference to nuclear force Statement that nuclear force acts to oppose electric force Statement that nuclear force and electric force are balanced	1 1 1	No requirement to state range of nuclear force	3	6
	(*b*)		Proton consists of 2 up quarks and 1 down Proton charge = 2 × (2/3) + 1 × (–1/3) = +1 Neutron consists of 1 up quarks and 2 down Neutron charge = 1 × (2/3) + 2 × (–1/3) = zero	 1 1	 One mark or zero. Arithmetical statement required. One mark or zero. Arithmetical statement required.	2	
	(*c*)		$E = mc^2$ shows that mass and energy are equivalent	1	or similar statement	1	
27	(*a*)		An electron is removed by the + electrode	1		1	8
	(*b*)		The ions experience a force due to electric field	1	Or similar explanation	1	
	(*c*)	(i)	$W=QV$ $= 1{\cdot}6 \times 10^{-19} \times 1000$ $= 1{\cdot}6 \times 10^{-16}$ J	½ ½ 1		2	
		(ii)	$P = E/t$ $0{\cdot}1 = E\ /\ 1$ $E = 0{\cdot}1$ (J) No of ions = $0{\cdot}1/1{\cdot}6 \times 10^{-16}$ $= 6{\cdot}25 \times 10^{14}$	½ ½ 1		2	

	(*d*)		Flow of molecules/air current Energy/heat removed from chip	1 1	or similar statement, indicating bulk movement	2	
28	(*a*)		Blue light has higher frequency/energy per photon than red light. Photons of red light do not have enough energy to eject electrons	1 1	Or similar statement comparing blue and red light Or similar statement in terms of threshold frequency or work function	2	5
	(*b*)		$E_k = hf - hf_0$ $= 6{\cdot}63 \times 10^{-34} \times 7{\cdot}0 \times 10^{14} - 2{\cdot}0 \times 10^{-19}$ $= 2{\cdot}461 \times 10^{-19}$ J	½ ½ ½ ½ 1	Half mark for look up of h Half mark for calculation of h*f* Half mark for subtraction of work function	3	
29	(*a*)	(i)	d = 1/200 × 1000 = 5×10^{-6} (m) n $\lambda = d \sin \theta$ $2 \times \lambda = 5 \times 10^{-6} \times \sin 11{\cdot}8$ $\lambda = 5{\cdot}11 \times 10^{-7}$ m	1 ½ ½ 1		3	8
		(ii)	Colour is green	1	Look up spectral line in data sheet	1	
	(*b*)		Maxima are spaced further apart d and sinθ are inversely proportional	1 1		2	
	(*c*)		Dark lines are absorption lines caused by certain elements in sun absorbing particular frequencies	1 1		2	
30	(*a*)		$R = V/I$ $= 12/30 \times 10^{-6}$ = 400 000 Ω	½ ½ 1	 Or equivalent in kΩ, MΩ	2	9
	(*b*)		As voltage across the capacitor increases, voltage across the resistor increases. To maintain the same current through the resistor, the resistance must be decreased.	1 1	 No marks for a statement with no justification. No marks for correctly stating resistance decrease, with an incorrect justification.	2	

	(*c*)	(i)	$Q = It$ $= 30 \times 10^{-6} \times 30$ $= 900 \times 10^{-6}$ C	½ ½ 1	Or equivalent milli/micro	2	
		(ii)	$C = Q/V$ $200 \times 10^{-6} = 900 \times 10^{-6} / V$ $V = 4{\cdot}5$ V Therefore voltage across resistor is $12 - 4{\cdot}5 = 7{\cdot}5$ V	½ ½ 1 1		3	
31			Demonstrates no understanding Limited understanding Reasonable understanding Good understanding	0 1 2 3	Open ended question	3	3
32	(*a*)		 Peak in approx correct position Ends of graph in approx correct position	 1 1	 Indication of axes scales required	2	7
	(*b*)		Amplitude of peak has a peak frequency at or about 2 Hz	1		1	
	(*c*)		Repeat measurements More measurements, especially close to and on either side of the peak	1 1	Or any other valid improvement	2	
	(*d*)		Any valid investigation Examples include: Finding the relationship between the frequency that results in the peak amplitude and height of a building (i.e. resonant frequency vs height) Investigating how to reduce the amplitude of vibration (i.e structural improvements) Brief plan of how investigation would be undertaken	 1 1		2	

[*END OF SPECIMEN MARKING INSTRUCTIONS*]