ELECTRICITY

Practice Exam Questions
Physics
Section 1—Questions

Speed of light in materials

| Material | Speed in $\mathrm{m} \mathrm{s}^{-1}$ |
| :--- | :--- |
| Air | $3.0 \times 10^{8}$ |
| Carbon dioxide | $3.0 \times 10^{8}$ |
| Diamond | $1.2 \times 10^{8}$ |
| Glass | $2.0 \times 10^{8}$ |
| Glycerol | $2.1 \times 10^{8}$ |
| Water | $2.3 \times 10^{8}$ |

Gravitational field strengths

|  | Gravitational field strength <br> on the surface in $\mathrm{Ngg}^{-1}$ |
| :--- | :---: |
| Earth | 9.8 |
| Jupiter | 23 |
| Mars | 3.7 |
| Mercury | 3.7 |
| Moon | 1.6 |
| Neptune | 11 |
| Saturn | 9.0 |
| Sun | 270 |
| Uranus | 8.7 |
| Venus | 8.9 |

Specific latent heat of fusion of materials

| Material | Specific latent heat <br> of fusion in $\mathrm{Jkg}^{-1}$ |
| :--- | :---: |
| Alcohol | $0.99 \times 10^{5}$ |
| Aluminium | $3.95 \times 10^{5}$ |
| Carbon Dioxide | $1.80 \times 10^{5}$ |
| Copper | $2.05 \times 10^{5}$ |
| Iron | $2.67 \times 10^{5}$ |
| Lead | $0.25 \times 10^{5}$ |
| Water | $3.34 \times 10^{5}$ |

Specific latent heat of vaporisation of materials

| Material | Specific latent heat of <br> vaporisation in $\mathrm{Jkg}^{-1}$ |
| :--- | :---: |
| Alcohol | $11.2 \times 10^{5}$ |
| Carbon Dioxide | $3.77 \times 10^{5}$ |
| Glycerol | $8.30 \times 10^{5}$ |
| Turpentine | $2.90 \times 10^{5}$ |
| Water | $22.6 \times 10^{5}$ |

Speed of sound in materials

| Material | Speed in $\mathrm{m} \mathrm{s}^{-1}$ |
| :--- | :---: |
| Aluminium | 5200 |
| Air | 340 |
| Bone | 4100 |
| Carbon dioxide | 270 |
| Glycerol | 1900 |
| Muscle | 1600 |
| Steel | 5200 |
| Tissue | 1500 |
| Water | 1500 |

Specific heat capacity of materials

| Material | Specific heat capacity <br> in $\mathrm{Jgg}^{-1} \mathrm{C}^{-1}$ |
| :--- | :---: |
| Alcohol | 2350 |
| Aluminium | 902 |
| Copper | 386 |
| Glass | 500 |
| Ice | 2100 |
| Iron | 480 |
| Lead | 128 |
| Oil | 2130 |
| Water | 4180 |

Melting and boiling points of materials

| Material | Melting point <br> in ${ }^{\circ} \mathrm{C}$ | Boiling point <br> in ${ }^{\circ} \mathrm{C}$ |
| :--- | :---: | :---: |
| Alcohol | -98 | 65 |
| Aluminium | 660 | 2470 |
| Copper | 1077 | 2567 |
| Glycerol | 18 | 290 |
| Lead | 328 | 1737 |
| Iron | 1537 | 2737 |

Radiation weighting factors

| Type of radiation | Radiation <br> weighting factor |
| :--- | :---: |
| alpha | 20 |
| beta | 1 |
| fast neutrons | 10 |
| gamma | 1 |
| slow neutrons | 3 |
| X-rays | 1 |

1. The voltage of an electrical supply is a measure of the

A resistance of the circuit
B speed of the charges in the circuit
C power developed in the circuit
D energy given to the charges in the circuit
E current in the circuit.
2. Four circuit symbols, $\mathrm{W}, \mathrm{X}, \mathrm{Y}$ and Z , are shown.


W




Which row identifies the components represented by these symbols?

|  | $W$ | $X$ | $Y$ | $Z$ |
| :--- | :---: | :---: | :---: | :---: |
| A | battery | ammeter | resistor | variable resistor |
| B | battery | ammeter | fuse | resistor |
| C | lamp | ammeter | variable resistor | resistor |
| D | lamp | voltmeter | resistor | fuse |
| E | lamp | voltmeter | variable resistor | fuse |

3. A student suspects that ammeter $A_{1}$ may be inaccurate. Ammeter $A_{2}$ is known to be accurate.
Which of the following circuits should be used to compare the reading on $A_{1}$ with $A_{2}$ ?

A


B


C


D


E


1. Two circuits are set up as shown.


Both circuits are used to determine the resistance of resistor R .
Which row in the table identifies meter X , meter Y and meter Z ?

|  | meter $X$ | meter $Y$ | meter $Z$ |
| :---: | :---: | :---: | :---: |
| A | ohmmeter | voltmeter | ammeter |
| B | ohmmeter | ammeter | voltmeter |
| C | voltmeter | ammeter | ohmmeter |
| D | ammeter | voltmeter | ohmmeter |
| E | voltmeter | ohmmeter | ammeter |

2. Which of the following statements is/are correct?

I The voltage of a battery is the number of joules of energy it gives to each coulomb of charge.
II A battery only has a voltage when it is connected in a complete circuit.
III Electrons are free to move within an insulator.
A I only
B II only
C III only
D II and III only
E I, II and III
3. A circuit is set up as shown.


The resistance between X and Y is
A $1.3 \Omega$
B $4.5 \Omega$
C $6.0 \Omega$
D $8.0 \Omega$
E $\quad 12 \Omega$.
4. The rating plate on an electrical appliance is shown.


The resistance of this appliance is
A $0.017 \Omega$
B $0.25 \Omega$
C $4.0 \Omega$
D $18.4 \Omega$
E $\quad 57 \cdot 5 \Omega$.

1. The symbol for an electronic component is shown.


This is the symbol for
A an LDR
B a transistor
C an LED
D a photovoltaic cell
E a thermistor.
2. A uniform electric field exists between plates $Q$ and $R$.

The diagram shows the path taken by a particle as it passes through the field.


Which row in the table identifies the charge on the particle, the charge on plate Q and the charge on plate R ?

|  | Charge on particle | Charge on plate $Q$ | Charge on plate $R$ |
| :---: | :---: | :---: | :---: |
| A | negative | positive | negative |
| B | negative | negative | positive |
| C | no charge | negative | positive |
| D | no charge | positive | negative |
| E | positive | positive | negative |

3. A circuit is set up as shown.


The reading on ammeter $A_{1}$ is 5.0 A .
The reading on ammeter $A_{2}$ is 2.0 A .
The reading on ammeter $A_{4}$ is 1.0 A .
Which row in the table shows the reading on ammeters $A_{3}$ and $A_{5}$ ?

|  | Reading on ammeter $A_{3}$ <br> (A) | Reading on ammeter $A_{5}$ <br> (A) |
| :---: | :---: | :---: |
| A | 2.0 | 1.0 |
| B | 3.0 | 1.0 |
| C | 2.0 | 4.0 |
| D | 3.0 | 4.0 |
| E | 5.0 | 5.0 |

4. Two resistors are connected as shown.


The total resistance between P and Q is
A $0.17 \Omega$
B $3.0 \Omega$
C $6.0 \Omega$
D $16 \Omega$
E $\quad 32 \Omega$.
2. A circuit is set up as shown.


The reading on ammeter $A_{1}$ is 5.0 A . The reading on ammeter $\mathrm{A}_{2}$ is 2.0 A . The charge passing through the lamp in 30 seconds is

A 0.1 C
B 10 C
C $\quad 60 \mathrm{C}$
D $\quad 90 \mathrm{C}$
E 150 C .
3. A lamp is connected to a constant voltage power supply. The power supply is switched on. The graph shows how the current in the lamp varies with time.
current (A)


Which row in the table shows what happens to the current and resistance of the lamp between 0.05 s and 0.45 s ?

|  | Current | Resistance |
| :---: | :---: | :---: |
| A | decreases | increases |
| B | decreases | stays the same |
| C | stays the same | decreases |
| D | increases | decreases |
| E | increases | increases |

4. A circuit is set up as shown.


The purpose of the transistor is to
A supply energy to the circuit
B decrease the voltage across $\mathrm{R}_{1}$
C change electrical energy to kinetic energy
D supply energy to the motor
E switch on the motor.


1. A toy car contains an electric circuit which consists of a 12.0 V battery, an electric motor and two lamps.


The circuit diagram is shown.

(a) Switch 1 is now closed.

Calculate the power dissipated in the motor when operating.
Space for working and answer

1. (continued)
(b) Switch 2 is now also closed.
(i) Calculate the total resistance of the motor and the two lamps.
Space for working and answer
(ii) One of the lamps now develops a fault and stops working.

State the effect this has on the other lamp.
You must justify your answer.
2. A thermistor is used as a temperature sensor in a circuit to monitor and control the temperature of water in a tank. Part of the circuit is shown.

(a) (i) The variable resistor R is set at a resistance of $1050 \Omega$.

Calculate the resistance of the thermistor when the voltage across the thermistor is 2.0 V .
Space for working and answer
2. (a) (continued)
(ii) The graph shows how the resistance of the thermistor varies with temperature.
resistance
$(\Omega)$


Use the graph to determine the temperature of the water when the voltage across the thermistor is 2.0 V .
2. (continued)
(b) The circuit is now connected to a switching circuit to operate a heater.

(i) Explain how the circuit operates to switch on the heater when the temperature falls below a certain value.
(ii) The resistance of the variable resistor R is now increased.

What effect does this have on the temperature at which the heater is switched on?

You must justify your answer.

1. A student sets up the following circuit using a battery, two lamps, a switch and a resistor.

(a) Draw a circuit diagram for this circuit using the correct symbols for the components.
(b) Each lamp is rated $2.5 \mathrm{~V}, 0.50 \mathrm{~A}$.

Calculate the resistance of one of the lamps when it is operating at the correct voltage.

Space for working and answer

1. (continued)
(c) When the switch is closed, will lamp L be brighter, dimmer or the same brightness as lamp M?
You must justify your answer.
2. (a) A student investigates the electrical properties of three different components; a lamp, an LED and a fixed resistor.
Current-voltage graphs produced from the student's results are shown.


Graph X


Graph Y


Graph Z

Explain which graph $\mathrm{X}, \mathrm{Y}$ or Z is obtained from the student's results for the LED.
(b) One of the components is operated at 4.0 V with a current of 0.50 A for 60 seconds.
(i) Calculate the energy transferred to the component during this time.
Space for working and answer
2. (b) (continued)
(ii) Calculate the charge which passes through this component during this time.
Space for working and answer

1. Electrical storms occur throughout the world.


During one lightning strike 24 C of charge is transferred to the ground in 0.0012 s .
(a) Calculate the average current during the lightning strike.

Space for working and answer
(b) The charge on an electron is $-1.6 \times 10^{-19} \mathrm{C}$.

Determine the number of electrons transferred during the lightning strike.
Space for working and answer

1. (continued)
(c) Many tall buildings have a thick strip of metal attached to the side of the building.


This strip is used to protect the building from damage during electrical storms.

Explain how this strip protects the building from damage.
2. A student investigates the resistance of a resistor using the circuit shown.

(a) Complete the circuit diagram to show where a voltmeter must be connected to measure the voltage across resistor R .
(An additional diagram, if required, can be found on Page 33.)
(b) Describe how the student obtains a range of values of voltage and current.
2. (continued)
(c) The results of the student's investigation are shown.

| Voltage across resistor $R(\mathrm{~V})$ | Current in resistor $R(\mathrm{~A})$ |
| :---: | :---: |
| 1.0 | 0.20 |
| 2.5 | 0.50 |
| 3.2 | 0.64 |
| 6.2 | 1.24 |

Use all these results to determine the resistance of resistor R.
Space for working and answer
(d) The student now replaces resistor R with a filament lamp and repeats the investigation. A sketch graph of the student's results is shown.


State a conclusion that can be made about the resistance of the filament lamp.

1. The rating plate on a food blender is shown.

(a) The plugs on all modern electrical appliances in the UK are fitted with fuses rated at either 3 A or 13 A .
(i) Draw the circuit symbol for a fuse.
(ii) State the purpose of the fuse fitted in the plug of an appliance.
(iii) Determine the rating of the fuse fitted in the plug of the blender. Justify your answer by calculation.
Space for working and answer
2. (continued)
(b) The blender is connected to an alternating current (a.c.) supply. Explain in terms of electron flow what is meant by alternating current.
3. A student sets up the following circuit.

(a) The student closes switch S1.
(i) Calculate the voltage across the motor.
Space for working and answer
(ii) Calculate the power dissipated in the motor.

Space for working and answer
2. (continued)
(b) The student now also closes switch S2.
(i) Calculate the combined resistance of the two resistors.
Space for working and answer
(ii) State the effect that closing switch S 2 has on the power dissipated in the motor.

Justify your answer.


Physics
Relationships Sheet

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\begin{array}{ll}
E_{p}=m g h & d=v t \\
E_{k}=\frac{1}{2} m v^{2} & v=f \lambda \\
Q=I t & T=\frac{1}{f} \\
V=I R & A=\frac{N}{t} \\
R_{T}=R_{1}+R_{2}+\ldots & D=\frac{E}{m} \\
\frac{1}{R_{T}}=\frac{1}{R_{1}}+\frac{1}{R_{2}}+\ldots & H=D w_{R} \\
V_{2}=\left(\frac{R_{2}}{R_{1}+R_{2}}\right) V_{s} & \dot{H}=\frac{H}{t} \\
\frac{V_{1}}{V_{2}}=\frac{R_{1}}{R_{2}} & s=v t \\
P=\frac{E}{t} & d=\bar{v} t \\
P=I V & s=\bar{v} t \\
P=I^{2} R & a=\frac{v-u}{t} \\
\frac{V_{1}}{T_{1}}=\frac{V_{2}}{T_{2}} & W=m g \\
P=\frac{V^{2}}{R} & E=\frac{p_{1}}{T_{1}}=\frac{p_{2}}{T_{2}} \\
E_{h}=c m \Delta T & E=m a \\
p=\frac{F}{A} & \\
p_{1} V_{1}=p_{2} V_{2} & \\
\hline
\end{array}
$$

## Additional Relationships

## Circle

circumference $=2 \pi r$
area $=\pi r^{2}$

## Sphere

area $=4 \pi r^{2}$
volume $=\frac{4}{3} \pi r^{3}$

## Trigonometry

$\sin \theta=\frac{\text { opposite }}{\text { hypotenuse }}$
$\cos \theta=\frac{\text { adjacent }}{\text { hypotenuse }}$
$\tan \theta=\frac{\text { opposite }}{\text { adjacent }}$
$\sin ^{2} \theta+\cos ^{2} \theta=1$

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