

1

Which of the following statements about Newton's law of gravitation is correct?

Newton's gravitational law explains

A the origin of gravitational forces.

☐

B why a falling satellite burns up when it enters the Earth's atmosphere.

☐

C why projectiles maintain a uniform horizontal speed.

☐

D how various factors affect the gravitational force between two particles.

☐

(Total 1 mark)

2

Which one of the following statements about gravitational potential is correct?

A gravitational potential can have a positive value

B the gravitational potential at the surface of the Earth is zero

C the gravitational potential gradient at a point has the same numerical value as the gravitational field strength at that point

D the unit of gravitational potential is N kg^{-1}

(Total 1 mark)

3

In the equation $X = \frac{ab}{r^n}$, X represents a physical variable in an electric or a gravitational field, a is a constant, b is either mass or charge and n is a number.

Which line, **A** to **D**, in the table provides a consistent representation of X , a and b according to the value of n ?

The symbols E , g , V and r have their usual meanings.

	n	X	a	b
A	1	E	$\frac{1}{4\pi\epsilon_0}$	charge
B	1	V	$\frac{1}{4\pi\epsilon_0}$	mass
C	2	g	G	mass
D	2	V	G	charge

(Total 1 mark)

4

A satellite orbiting the Earth moves to an orbit which is closer to the Earth.

Which line, **A** to **D**, in the table shows correctly what happens to the speed of the satellite and to the time it takes for one orbit of the Earth?

	Speed of satellite	Time For One Orbit Of Earth
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

(Total 1 mark)

5

Mars has a diameter approximately 0.5 that of the Earth, and a mass of 0.1 that of the Earth. The gravitational potential at the Earth's surface is -63 MJ kg^{-1} .

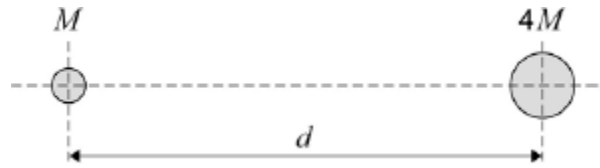
What is the approximate value of the gravitational potential at the surface of Mars?

- A -13 MJ kg^{-1}
- B -25 MJ kg^{-1}
- C -95 MJ kg^{-1}
- D -320 MJ kg^{-1}

(Total 1 mark)

6

Two stars of mass M and $4M$ are at a distance d between their centres.



The resultant gravitational field strength is zero along the line between their centres at a distance y from the centre of the star of mass M .

What is the value of the ratio $\frac{y}{d}$?

- A $\frac{1}{2}$
- B $\frac{1}{3}$
- C $\frac{2}{3}$
- D $\frac{3}{4}$

(Total 1 mark)

7

A satellite of mass m is in a circular orbit at height R above the surface of a uniform spherical planet of radius R and density ρ .

What is the force of gravitational attraction between the satellite and the planet?

A $\frac{\pi\rho GmR}{3}$

B $\frac{2\pi\rho GmR}{3}$

C $\frac{\pi\rho GmR^2}{3}$

D $\frac{2\pi\rho GmR^2}{3}$

(Total 1 mark)

8

The following data refers to two planets, P and Q.

	Radius / km	Density / kg m ⁻³
planet P	8000	6000
planet Q	16 000	3000

The gravitational field strength at the surface of P is 13.4 N kg⁻¹.
What is the gravitational field strength at the surface of Q?

A 3.4 N kg⁻¹

B 13.4 N kg⁻¹

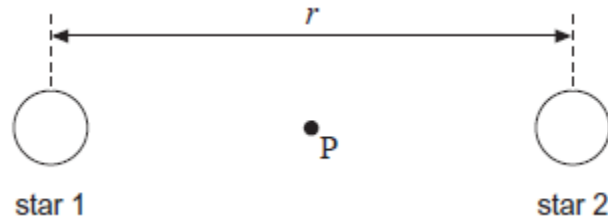
C 53.6 N kg⁻¹

D 80.4 N kg⁻¹

(Total 1 mark)

9

The diagram shows an isolated binary star system. The two stars have equal masses, M , and the distance between their centres is r .



The point P is half-way between the two stars.
What is the gravitational field strength at P?

A zero

B $-\frac{GM}{r^2}$

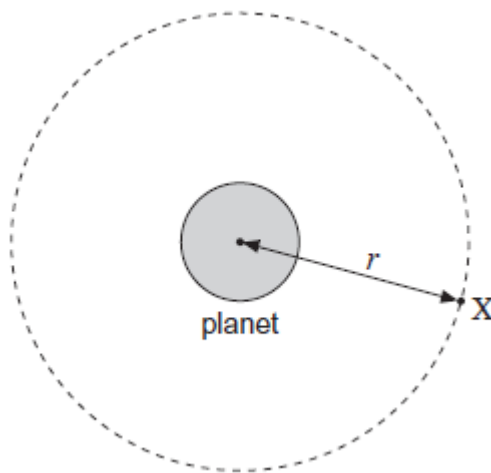
C $-\frac{2GM}{r^2}$

D $-\frac{4GM}{r^2}$

(Total 1 mark)

10

A satellite X is in a circular orbit of radius r about the centre of a spherical planet of mass M .



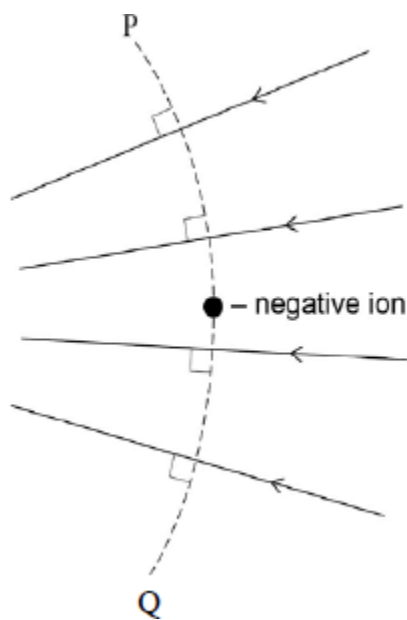
Which line, **A** to **D**, in the table gives correct expressions for the centripetal acceleration a and the speed v of the satellite?

	Centripetal acceleration a	Speed v
A	$\frac{GM}{2r}$	$\sqrt{\frac{GM}{2r}}$
B	$\frac{GM}{2r}$	$\sqrt{\frac{GM}{r}}$
C	$\frac{GM}{r^2}$	$\sqrt{\frac{GM}{2r}}$
D	$\frac{GM}{r^2}$	$\sqrt{\frac{GM}{r}}$

(Total 1 mark)

11

The diagram shows a small negative charge at a point in an electric field, which is represented by the arrowed field lines.



Which of the following statements, about what happens when the charge is displaced, is correct?

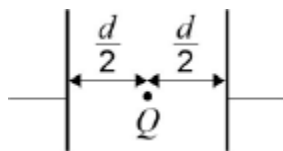
When the negative charge is displaced

- | | | |
|----------|---|--------------------------|
| A | to the left the magnitude of the electric force on it decreases. | ☐ |
| B | to the right its potential energy increases. | ☐ |
| C | along the line PQ towards Q its potential energy decreases. | ☐ |
| D | along the line PQ towards P the magnitude of the electric force on it is unchanged. | ☐ |

(Total 1 mark)

12

Two parallel metal plates are separated by a distance d and have a potential difference V across them. Which expression gives the magnitude of the electrostatic force acting on a charge Q placed midway between the plates?



A $\frac{2VQ}{d}$ ☐

B $\frac{VQ}{d}$ ☐

C $\frac{VQ}{2d}$ ☐

D $\frac{Qd}{v}$ ☐

(Total 1 mark)

13

The electric potential at a distance r from a positive point charge is 45 V. The potential increases to 50 V when the distance from the point charge decreases by 1.5 m. What is the value of r ?

A 1.3m ☐

B 1.5m ☐

C 7.9m ☐

D 15m ☐

(Total 1 mark)

14

Which one of the following statements is correct?

The force between two charged particles

A is always attractive

B can be measured in $C^2 F^{-1} m^{-1}$

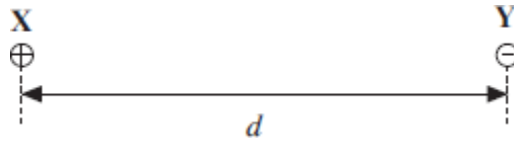
C is directly proportional to the distance between them

D is independent of the magnitude of the charges

(Total 1 mark)

15

Two point charges, **X** and **Y**, exert a force F on each other when they are at a distance d apart.



When the distance between them is 20 mm, the force they exert on each other is $0.5 F$.

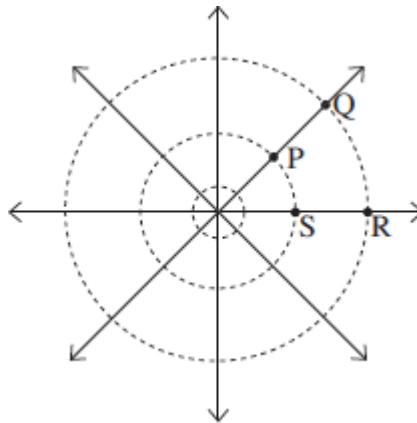
What is the distance d ?

- A 7 mm
- B 14 mm
- C 15 mm
- D 28 mm

(Total 1 mark)

16

The diagram below shows the field lines and equipotential lines around an isolated positive point charge.



Which one of the following statements concerning the work done when a small charge is moved in the field is **incorrect**?

- A when it is moved from either P to Q or S to R, the work done is the same in each case
- B when it is moved from Q to R no work is done
- C when it is moved around the path PQRS, the overall work done is zero
- D when it is moved around the path PQRS, the overall work done is equal to twice the work done in moving from P to Q

(Total 1 mark)

17

Two horizontal parallel plate conductors are separated by a distance of 5.0 mm in air. The lower plate is earthed and the potential of the upper plate is +50 V.

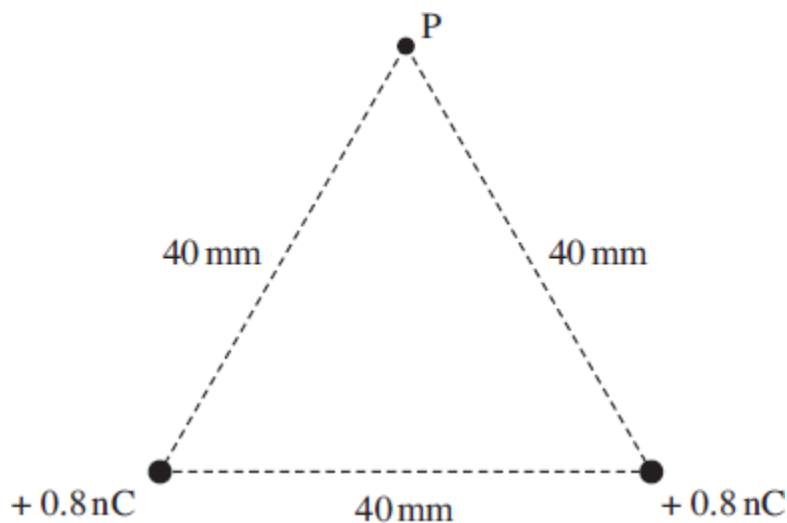
Which line, **A** to **D**, in the table gives correctly the electric field strength, E , and the potential, V , at a point midway between the plates?

	electric field strength E / Vm^{-1}	potential V / V
A	1.0×10^4 upwards	25
B	1.0×10^4 downwards	25
C	1.0×10^4 upwards	50
D	1.0×10^4 downwards	50

(Total 1 mark)

18

Two charges, each of + 0.8 nC, are 40 mm apart. Point P is 40 mm from each of the charges.



What is the electric potential at P?

- A** zero
- B** 180 V
- C** 360 V
- D** 4500 V

(Total 1 mark)

19

A repulsive force F acts between two positive point charges separated by a distance r . What will be the force between them if each charge is doubled and the distance between them is halved?

- A F
- B $2F$
- C $4F$
- D $16F$

(Total 1 mark)

20

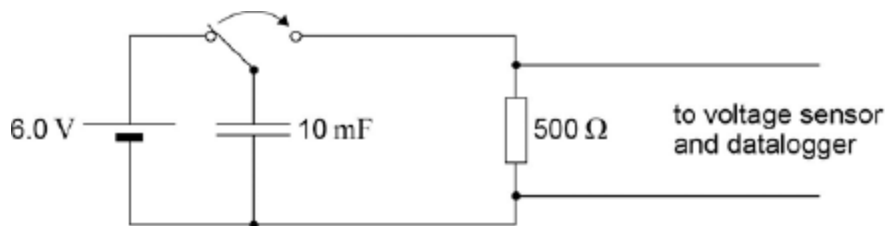
Which one of the following **cannot** be used as a unit for electric field strength?

- A $\text{J m}^{-1} \text{C}^{-1}$
- B $\text{J A}^{-1} \text{s}^{-1} \text{m}^{-1}$
- C $\text{N A}^{-1} \text{s}^{-1}$
- D J C m^{-1}

(Total 1 mark)

21

A voltage sensor and a datalogger are used to record the discharge of a 10 mF capacitor in series with a 500 Ω resistor from an initial pd of 6.0 V. The datalogger is capable of recording 1000 readings in 10 s.



After a time equal to the time constant of the discharge circuit, which one of the rows gives the pd and the number of readings made?

	Potential difference / V	Number of readings	
A	2.2	50	☐
B	3.8	50	☐
C	3.8	500	☐
D	2.2	500	☐

(Total 1 mark)

22

An uncharged 4.7 nF capacitor is connected to a 1.5 V supply and becomes fully charged.

How many electrons are transferred to the negative plate of the capacitor during this charging process?

- A** 2.2×10^{10}
- B** 3.3×10^{10}
- C** 4.4×10^{10}
- D** 8.8×10^{10}

(Total 1 mark)

23

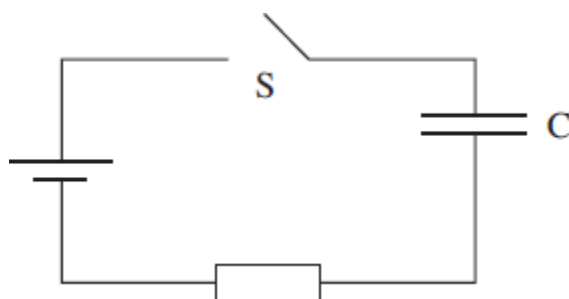
A nuclear fusion device is required to deliver at least 1 MJ of energy using capacitors. If the largest workable potential difference is 10 kV, what is the minimum capacitance of the capacitors that should be used?

- A** 0.01 F
- B** 0.02 F
- C** 2 F
- D** 100 F

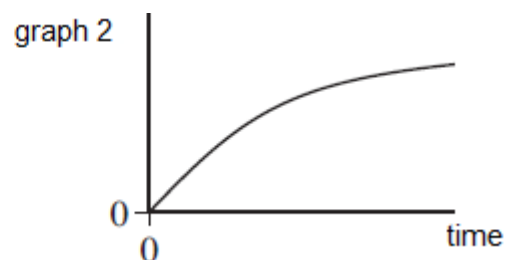
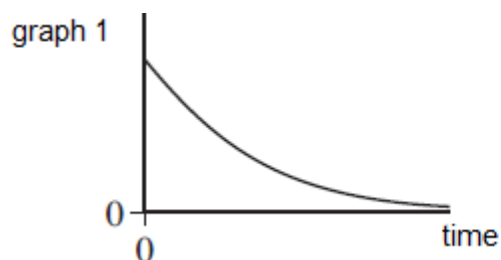
(Total 1 mark)

24

In the circuit shown the capacitor C charges when switch S is closed.



Which line, **A** to **D**, in the table gives a correct pair of graphs showing how the charge on the capacitor and the current in the circuit change with time after S is closed?



	charge	current
A	graph 1	graph 1
B	graph 1	graph 2
C	graph 2	graph 2
D	graph 2	graph 1

(Total 1 mark)

25

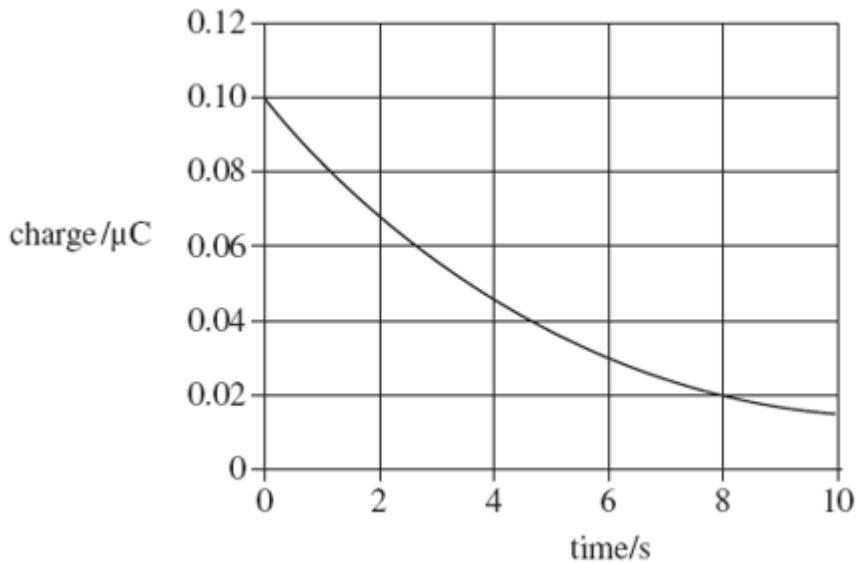
The voltage across a capacitor falls from 10 V to 5 V in 48 ms as it discharges through a resistor. What is the time constant of the circuit?

- A** 24 ms
- B** 33 ms
- C** 69 ms
- D** 96 ms

(Total 1 mark)

26

The graph shows how the charge on a capacitor varies with time as it is discharged through a resistor.



What is the time constant for the circuit?

- A 3.0 s
- B 4.0 s
- C 5.0 s
- D 8.0 s

(Total 1 mark)

27

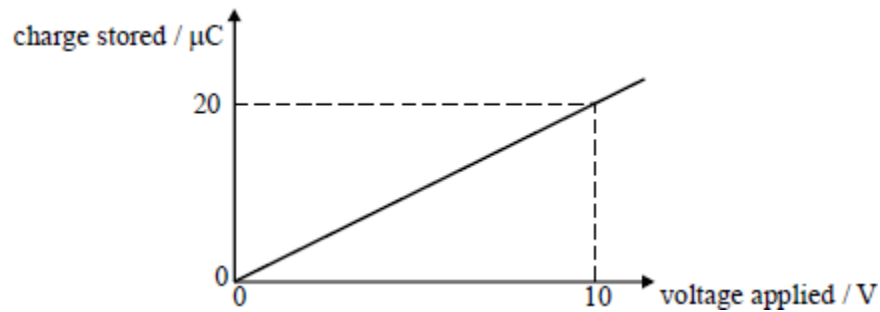
A 2.0 mF capacitor, used as the backup for a memory unit, has a potential difference of 5.0 V across it when fully charged. The capacitor is required to supply a constant current of 1.0 μA and can be used until the potential difference across it falls by 10%. How long can the capacitor be used for before it must be recharged?

- A 10 s
- B 100 s
- C 200 s
- D 1000 s

(Total 1 mark)

28

The graph shows the charge stored in a capacitor as the voltage across it is varied.



The energy stored, in μJ , when the potential difference across the capacitor is 5 V, is

- A 25
- B 50
- C 100
- D 200

(Total 1 mark)

29

Which one of the following statements is correct?

An electron follows a circular path when it is moving at right angles to

- A a uniform magnetic field.
- B a uniform electric field.
- C uniform electric and magnetic fields which are perpendicular.
- D uniform electric and magnetic fields which are in opposite directions.

(Total 1 mark)

30

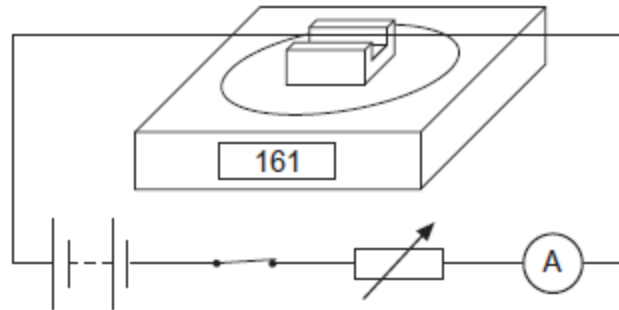
A lamp rated at 12 V 60 W is connected to the secondary coil of a step-down transformer and is at full brightness. The primary coil is connected to a supply of 230 V. The transformer is 75% efficient.

What is the current in the primary coil?

- A 0.25 A
- B 0.35 A
- C 3.75 A
- D 5.0 A

31

The diagram shows a rigidly-clamped straight horizontal current-carrying wire held mid-way between the poles of a magnet on a top-pan balance. The wire is perpendicular to the magnetic field direction.



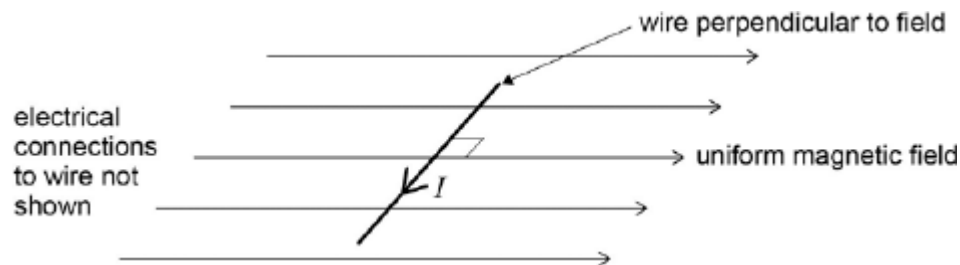
The balance, which was zeroed before the switch was closed, read 161 g after the switch was closed. When the current is reversed and doubled, what would be the new reading on the balance?

- A -322 g
- B -161 g
- C zero
- D 322 g

(Total 1 mark)

32

A horizontal straight wire of length 0.30 m carries a current of 2.0 A perpendicular to a horizontal uniform magnetic field of flux density 5.0×10^{-2} T. The wire 'floats' in equilibrium in the field.



What is the mass of the wire?

- A 8.0×10^{-4} kg ☐
- B 3.1×10^{-3} kg ☐
- C 3.0×10^{-2} kg ☐
- D 8.2×10^{-1} kg ☐

(Total 1 mark)

33

Charged particles, each of mass m and charge Q , travel at a constant speed in a circle of radius r in a uniform magnetic field of flux density B .

Which expression gives the frequency of rotation of a particle in the beam?

A $\frac{BQ}{2\pi m}$ ☐

B $\frac{BQ}{m}$ ☐

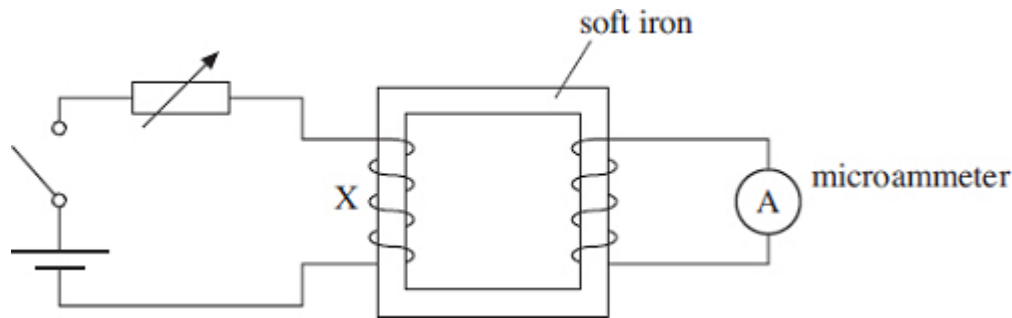
C $\frac{BQ}{\pi m}$ ☐

D $\frac{2\pi BQ}{m}$ ☐

(Total 1 mark)

34

Using the circuit shown, and with the switch closed, a small current was passed through the coil X. The current was slowly increased using the variable resistor. The current reached a maximum value and was then switched off.



The maximum reading on the microammeter occurred when

- A the small current flowed at the start.
- B the current was being increased.
- C the current was being switched off.
- D the current in X was zero.

(Total 1 mark)

35

A coil rotating in a magnetic field produces the following voltage waveform when connected to an oscilloscope.



With the same oscilloscope settings, which one of the following voltage waveforms would be produced if the coil were rotated at twice the original speed?



(Total 1 mark)

Mark schemes

1	D	[1]
2	C	[1]
3	C	[1]
4	C	[1]
5	A	[1]
6	B	[1]
7	A	[1]
8	B	[1]
9	A	[1]
10	D	[1]
11	D	[1]
12	B	[1]
13	D	[1]
14	B	[1]
15	B	[1]
16	D	[1]
17	B	[1]
18	C	[1]

19	D	[1]
20	D	[1]
21	D	[1]
22	C	[1]
23	B	[1]
24	D	[1]
25	C	[1]
26	C	[1]
27	D	[1]
28	A	[1]
29	A	[1]
30	B	[1]
31	A	[1]
32	B	[1]

33

A

[1]

34

C

[1]

35

C

[1]